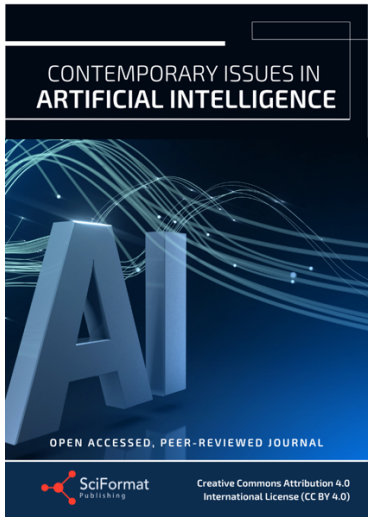

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DECARBONIZATION WITH THE HELP OF ARTIFICIAL INTELLIGENCE - ONE OF THE PRIORITIES OF INTERNATIONAL CIVIL AVIATION

Chulinda Lyudmila *(Correspinding Author)*
Ph.D. in Law, Associate Professor, Associate Professor of the Department of Constitutional and Administrative Law, Faculty of Law, Kyiv Aviation Institute
ORCID ID: 0000-0002-3771-4854

ABSTRACT

The article is devoted to the analysis of the role of the International Civil Aviation Organization in solving the problem of global warming, one of the main causes of which is considered to be the increase in greenhouse gas emissions into the atmosphere, highlights directions for achieving the goal of decarbonization of civil aviation by 2050. An analysis of aviation experts' proposals for reducing CO_2 emissions through AI was conducted, which can help reduce the environmental impact of aviation, improve aircraft and engine technologies, use sustainable aviation fuel (SAF), implement economic measures, and improve air traffic management and aircraft operations. Harnessing the power of AI to develop more efficient aircraft and engines will help bring zero-emission aircraft to market by 2035. An important area of carbon reduction is the ability of airports to provide clean airspace. Airports Council International has set high standards for reducing absolute carbon emissions. ACI and its member airports have already committed globally to achieving net zero carbon emissions by 2050, with the support of governments. Ukraine has undertaken international legal obligations to implement a program to reduce greenhouse gas emissions into the atmosphere, which are mandatory for implementation after the restoration of airport infrastructure destroyed as a result of the Russian invasion, in particular, obtaining Airport Carbon Accreditation. It is argued that research into AI capabilities, technological advancements, infrastructure development and operational improvements, and collaboration between governments and industry stakeholders are crucial to creating the necessary foundation to achieve decarbonization goals.

KEYWORDS

Reducing CO_2 Emissions, Decarbonization, Artificial Intelligence, Ecological Aviation Fuel, Aviation Technologies

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Introduction.

The aviation sector is under intense scrutiny due to its significant environmental impact. Aviation accounts for approximately 2% of global energy-related carbon dioxide (CO2) emissions, but international civil aviation organizations (ICAO, Eurocontrol, and others) have set ambitious targets for net zero emissions by 2050.

AI has a unique opportunity to accelerate the search for optimal directions for sustainable development of civil aviation, as it has the ability to help solve complex problems unique to the aviation industry.

Artificial intelligence innovations have the impact of increasing fuel efficiency and reducing the environmental footprint of the aviation industry, contributing to a greener and more sustainable future of air transport.

The efforts of international and European organizations are an example of the international desire to work together to develop further AI innovations.

The increase in the volume of air transportation in the world is accompanied by an increase in indicators of the negative effects of the activities of aviation enterprises and airports on the environment. Responding to the climate emergency will require an unprecedented level of global cooperation and commitment. The Paris climate agreement, adopted at the climate conference in Paris (2015), is an international initiative to combat

global warming, one of the main causes of which is considered to be the increase in greenhouse gas emissions into the atmosphere. The Paris Agreement sets the goal of keeping the global temperature on Earth within 2°C by 2100 [1]. 196 countries, including Ukraine, joined this agreement. The Paris Agreement requires each country to submit an updated national climate change action plan, known as a Nationally Determined Contribution (NDC), every five years. In their national reports, countries report on the actions they are taking to reduce greenhouse gas emissions. Countries also report on the actions they plan to take in the future to increase resilience to the effects of rising temperatures.

The aviation industry plays an important role in the global development of social relations through advances in technology and infrastructure development. For the purpose of creating a better aviation space for future generations, reducing the global impact on the climate, the International Civil Aviation Organization (ICAO) is actively involved in the implementation of the provisions of the Paris Climate Agreement, as well as the document United Nations «Sustainable development goals for the period up to 2030» [2], developing standards and recommendations. Among the 17 Sustainable Development Goals, ICAO pays special attention to such civil aviation priorities as safety, air navigation capacity and efficiency, security and simplification, economic development of air transport and environmental protection [3]. Through the development of international standards and recommended practices, ICAO contributes to the safe and orderly development of international civil aviation throughout the world. The 1944 Convention on International Civil Aviation declares that the efforts of ICAO are aimed at ensuring that civil aviation can develop in a safe and orderly manner, so that international air services can be established on a basis of equality by air and be carried out rationally and economically [4].

At the 41st ICAO Assembly (2022), States emphasized the importance of effective financing and investment support to achieve the CO_2 reduction target and fully supported the ICAO Aviation Fuels Assistance, Capacity Building and Training (ACT-SAF) program aimed at disseminating and the use of SAF, offering to continue discussions on alternative fuels as well [5]. A key element is the goal of reducing CO_2 emissions from international aviation by 5 percent by 2030 through the use of SAF and low-carbon aviation fuel (LCAF). Participating states support the safety of air transport, including a key global agreement to achieve its full decarbonization by 2050, promote cooperation between states by providing recommendations on economic policy, implementing relevant measures, creating the necessary regulatory and legal acts [6].

The use of sustainable aviation fuel (SAF) is critical for airlines. A flight that consists of 100 percent SAF can effectively use the full emission reduction potential of this environmentally friendly fuel, reaching up to 80 percent compared to traditional jet fuel over the entire life cycle. As the expected increase in supply will reduce the cost of purchasing SAF in the coming years, this decision becomes economically feasible, allowing for significant emission reductions for the business aviation sector [7].

The international community has the opportunity to communicate not only with airports, airlines, aircraft designers, but also with fuel producers, investors, banks, associations, international organizations and other interested parties. In the future, AI can help in the development and implementation of environmentally friendly aviation fuels by analyzing data on biofuel production, performance and environmental impact, accelerating the transition to cleaner fuels.

Developed countries should be involved in providing financial assistance to countries that are less well-off and more vulnerable, encouraging voluntary contributions from other parties. Climate finance is needed for mitigation because significant emissions reductions require large investments.

Research Methodology.

The methodological basis of the study is a system of general and special means of scientific knowledge of the features of such an important issue of international civil aviation as reducing carbon emissions, which is of practical importance for ICAO member states, including Ukraine. The substantiation of the priority areas of decarbonization research for the period up to 2050 is being carried out. The study uses a global reporting format analysis method to investigate ICAO's recommendations for the use of aviation fuel (SAF), low-carbon aviation fuel (LCAF) and other clean energy sources, which would provide more than half of the required emission reductions. Document analysis was used to collect data. Relevant information was obtained from trainings, webinars and documents on the ICAO website, which are constantly updated by international aviation organizations. This allows us to analyze the current state of legal regulation of the implementation of the relevant regulatory framework, the potential evolution of the strategies of international and European civil aviation organizations in the coming decades, and its impact on the environment.

Addressing the challenge of decarbonization requires creating a universal system to orchestrate a safe future for international flights, implementing innovation and expanding partnerships between the UN and stakeholders, leveraging advances in artificial intelligence to deliver a strategic global vision and effective, sustainable solutions.The CORSIA Agreement (Carbon Offsetting and Reduction Scheme for International Aviation) provides guidance for ICAO and its member states to cooperate with the aviation industry. A number of states require targeted assistance to prepare for the implementation of the CORSIA monitoring, reporting and verification (MRV) system Technical experts work together with States' CORSIA Focal Points to provide on-the-ground training and closely monitor the preparation and implementation of Member States' CORSIA framework [8]. The systematic method of research allows to justify several directions for achieving the goal of decarbonization of civil aviation by 2050, for example, improvement of aviation technologies; modernization of energy infrastructure; improvement (discovery of new) methods of operation of existing aircraft. The prognostic method makes it possible to determine ways of improving air transport to zero net international aviation, which requires the financial support of state policy. Compliance with the requirements of standards and recommended practices regarding the decarbonization of international civil aviation, clarification of the requirements of acts of international and European civil aviation organizations requires attention, which determines the relevance of the chosen topic.

Research Results.

Aviation professionals are constantly searching for innovative solutions to improve efficiency, safety and passenger service. Artificial intelligence has the ability to process huge amounts of data and identify complex situations. AI applications are revolutionizing various aspects of aviation, including flight optimization and predictive maintenance, and improving air traffic management.

Environmental protection is a priority task for international and European civil aviation organizations. With the growth of air traffic, airports must provide environmentally clean airspace. Scientists draw attention to the fact that modern airports have a rapidly developing infrastructure. As a result, objects of non-aviation activity are appearing, the number of which is increasing. All this leads to an increase in the demand for electrical and thermal energy [9].

The program of voluntary accreditation of European airports regarding the implementation of limiting the impact of aviation on the environment began to operate in June 2009. ICAO provides States with practical information on airport planning and design and presents specific options that they can use. For example, the goal of the Eco-Airport Toolkit electronic collection is to provide practical and ready-to-use information to support the development of airport infrastructure projects. The recommendations take into account the urgent operational needs of the states. Each recommendation addresses a specific aspect of environmental planning at airports. "Eco-Airport Toolkit" is a new document for states to make informed decisions when financing a new airport infrastructure project or environmental management improvement programs [10], for example, sustainable Considerations for Airport Surface Access; Air Quality Management at Airports; GHG Management and Mitigation at Airports; The Eco Design of Airport Buildings; A Focus on the production of renewable energy at the Airport site; Waste Management at Airports.

Global greenhouse gas emissions have increased significantly over the last century, mainly due to industrial activities, the burning of fossil fuels and deforestation. This rise in CO_2 levels is a major driver of climate change, leading to a warming atmosphere, rising sea levels and more frequent extreme weather events. Efforts to mitigate these emissions are critical to slowing the rate of global warming and reducing its impact on ecosystems and human societies.

The European Union will win a decisive role in achieving global net zero carbon goals adopted by ICAO. The European Commission funded seven SAF feasibility studies in Africa and the Caribbean proposed by ICAO. By 2026, more than 20 such SAF studies are planned, of which 10 will be conducted in Africa and India, funded by the European Commission [11]. The European aviation sector has unveiled its flagship sustainability initiative, Destination 2050 – the path to net-zero European aviation [12]. This document envisages that by 2050 all flights within the EU will have zero CO_2 emissions. A comparative overview of aviation transition paths to zero CO_2 emissions shows that there are several paths to achieving the goal of decarbonizing aviation by 2050. The largest decarbonization in 2050 will occur through SAF. It is sustainable aviation fuel (SAF) that will contribute the largest CO_2 reduction by 2050, with the role of SAF ranging from 24% to 70%. Financial support from government policy is needed to increase SAF production. To calculate the reduction of CO_2 emissions, experts of international civil aviation organizations offer several directions**:** improvement of aviation technologies; modernization of energy infrastructure; improvement (discovery of

new) methods of operation of existing aircraft [13]. For example, improvements in aviation technology involve the development of more efficient aircraft and engines. Of particular importance are the steps required to ensure aircraft can operate 100% on SAF fuel, hydrogen or batteries. All development steps depend on investment programs. New engines, aerodynamics, aircraft designs and flight systems are also important. The IATA Net Zero Roadmaps are the first detailed assessment of the key steps needed to accelerate the transition to net zero by 2050. Road maps oriented on airlines, as well as on governments, suppliers and financiers. Collaboration between governments and industry stakeholders is critical to achieving decarbonization goals.

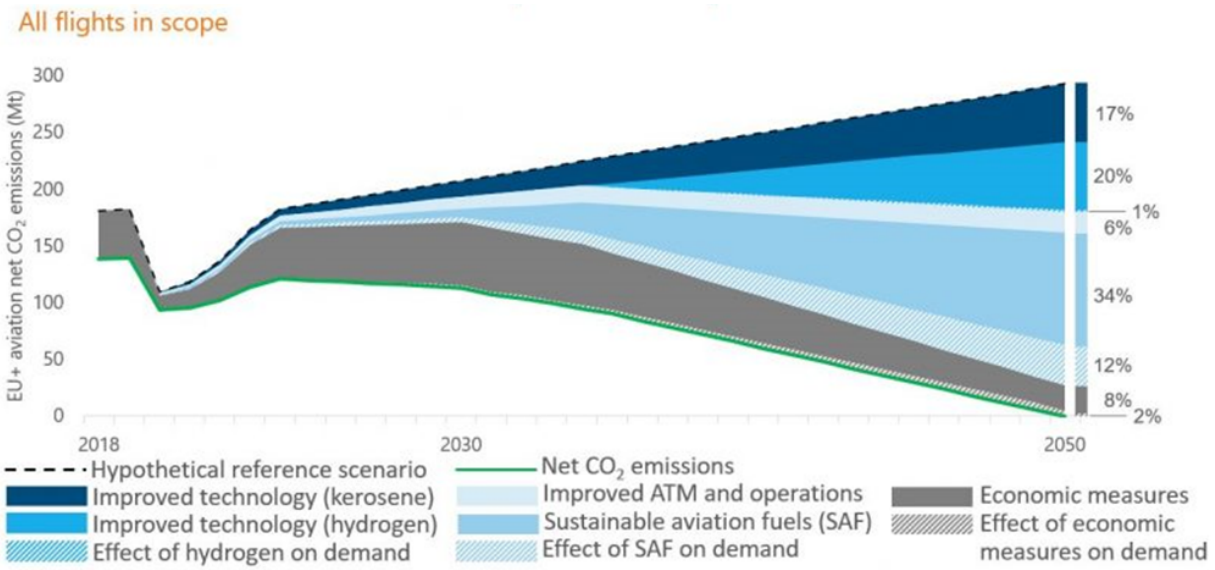

Fig. 1. *Decarbonization roadmap for European aviation. Source: [12]*

The table shows that improving aircraft and engine technology through artificial intelligence can achieve a 37% reduction in emissions; the use of sustainable aviation fuel (SAF) can achieve a 34% reduction in emissions; the implementation of economic measures can achieve an 8% reduction in emissions; and improving air traffic management (ATM) and aircraft operations can achieve a 6% reduction in emissions.

Let's analyze several examples of improvement of aviation technologies. According to Airbus, it is developing a new aircraft that will run on hydrogen stored at a temperature of -253°C, and is also developing new cryogenic hydrogen storage tanks for future liquid hydrogen aircraft, which are at the heart of the new hydrogen aircraft ZEROe. Hydrogen is key to the mission to bring zero-emission aircraft to market, but it must be stored at an extremely low temperature of -253°C. Airbus explains that there are two main technologies that allow the aircraft to fly directly on hydrogen: powering the engine that burns hydrogen through modified gas turbine engines or using hydrogen fuel cells to generate electricity. Another option is a hybrid approach that uses a combination of both technologies [14]. This project brings environmental sustainability to the forefront of the industry. The use of innovative technologies will help bring zero-emission aircraft to the market by 2035.

The European Union Aviation Safety Agency (EASA) is setting safety standards for AI in aviation. The EASA AI Roadmap outlines a strategy for integrating AI technologies while maintaining human control and accountability. EASA fosters innovation in the aviation sector, ensures the safe deployment of AI, and supports the evolution of the industry.

Company SE Aeronautics has unveiled a new giant jet concept that takes an unusual approach to all aspects of wide-body aircraft design and performance, including the rarely seen three pairs of wings, dual tail stabilizer and twin rear engines. The new prototype, named the SE200, can carry 264 passengers and consumes 70% less fuel than other aircraft of a similar size [15].

The aviation industry is exploring new approaches to bringing hybrid and electric aircraft to market, improving environmentally friendly aviation fuels and battery technologies. The Eather One aircraft will use air friction to generate energy. Eather One will generate renewable energy by harnessing the strong friction that occurs between the aircraft and the air as it flies at high speeds. As a result, the jet would not need fuel tanks or batteries, as it would generate energy from the surrounding air. This energy will be used to power the engine and electric motors, as well as to charge the batteries [16].

The new JetZero Blended Wing aircraft will significantly improve aerodynamic efficiency. JetZero has announced that its blended wing demonstrator has received FAA approval to begin test flights. A blended wing aircraft is where the fuselage and wings blend together to form a smooth shape that is a cross between a conventional airliner and a flying wing. JetZero claims its blended wing will use 50% less fuel than a standard jet [17].

Aerospace startup AMSL Aero (AMSL) has begun development of a hydrogen-electric vertical take-off and landing eVTOL aircraft that could revolutionize regional air transport. Designed as a low-noise and high-speed zero-emission eVTOL, Vertiia will be able to carry up to five passengers over a distance of 1,000 km. Such an aircraft is important for use in medical aviation, emergency services, as well as for passenger and cargo transportation. Its unique configuration offers emergency services new ways to deal with special situations, such as fighting forest fires. In addition to increasing the flight range, switching to hydrogen as a fuel will allow the Vertiia to refuel much faster, making it more practical and economical [18].

The analyzed examples illustrate the enormous potential that AI offers for reducing CO2 emissions. AI conducts computational fluid dynamics modeling, modeling airflow over aircraft surfaces, which leads to optimization of wing shapes and other important components, which reduces CO2 emissions. The future of flying is becoming safer, more efficient, and increasingly dependent on the information that AI can provide. AI is having a significant impact in predictive maintenance. By analyzing data from aircraft sensors, AI can predict potential failures before they occur. This approach helps reduce maintenance costs and increase aircraft availability. Efficiency is improved through AI algorithms that optimize fuel consumption. AI analyzes flight data to suggest optimal speeds and routes, contributing to decarbonization.

Backtracks, the thin white lines that follow airplanes, have a big impact on the climate. The clouds created by contrails are responsible for an estimated 35% of aviation's global warming impact, accounting for more than half of the global impact of jet fuel. Unlike typical greenhouse gas emissions, contrail formation depends on specific atmospheric conditions, such as humidity and temperature. Weather forecasts are designed to work at low altitudes and do not work well at flight altitudes, and humidity measurements are lacking.

It is AI that can synthesize signals from multiple data sources. By combining weather, satellite, and flight data, AI can predict when and where contrails are likely to form, which can then be used to adjust flight altitudes.

AI has a unique ability to accelerate contrail avoidance, which could reduce aviation's climate impact by 35%.

The international drive to work together to develop AI capabilities is accelerating aviation's transition to sustainability, the industry's move toward net zero.

So, the aviation industry plays an important role in the global development of social relations thanks to the progress in technology and the development of infrastructure. Improvements in aircraft and engine technology can change the situation. The activities of the aviation technological complex show that by 2035, planes with highly efficient power plants and 30% less fuel consumption may appear. The development of more fuel-efficient aircraft, engines and optimized range and capacity of hybrid-electric rotorcraft and regional aircraft will reduce CO_2 emissions per flight by 50%. Hydrogen-powered aircraft and hybrid-electric helicopters and regional aircraft require special technological readiness by 2027-2030 at both the aircraft and power plant levels [19]. Once ready, the new technologies should be rapidly incorporated into all commercial fixed-wing and rotary-wing products. This will require new and effective certification procedures for revolutionary technologies. Therefore, aircraft and engine upgrades will continue to reduce CO_2 emissions and achieve the goal of decarbonizing civil aviation.

In the future, AI has the potential to help design more fuel-efficient aircraft by analyzing massive data sets and running simulations to optimize aerodynamics, materials, and engine performance.

Discussion.

By integrating AI systems, airlines and airports can improve decision-making processes and ensure aviation safety. AI quickly analyzes huge amounts of data, helps predict and prevent potential hazards. Intelligent systems can monitor performance in real time, detect potential anomalies, and recommend corrective actions. Implementing AI not only simplifies operations, but also significantly reduces the risks associated with human error.

A growing number of ICAO member states are voluntarily participating in the International Aviation Carbon Offsetting and Reduction Program, which will help meet global fuel efficiency goals. Airlines and airports around the world recognize the importance of reducing, reusing and recycling waste. Concerned about environmental protection, ICAO develops recommendations for environmentally friendly airports, analyzes policies for recycling aircraft at the end of their service life. ICAO conducts research on the economic, environmental and social impact of civil aviation and shares experience with other international organizations.

Airport carbon accreditation enhances the ability to promote and drive the ambitions of the airport industry to achieve net zero CO_2 emissions. An important area of reducing carbon emissions is the ability of airports to provide environmentally clean airspace. The Airports Council International has developed the Level 5 Airport Carbon Accreditation Program - this is the highest level of the global standard of carbon management and reduction for airports, its implementation is another step in the management of carbon emissions in airports, the certification of airports to achieve and maintain a net zero carbon balance for emissions, which they control, and extending mapping, impact and reporting requirements to all other emissions [20]. Airports that achieve this level are fully compliant with the Paris Agreement target for emissions under their control, while advocating for the transition to zero balance among their business partners, including airlines, ground handling companies, retailers, tenants.

Among the priorities for the implementation of aerodrome certification are the aerodrome's physical environment, visual aids and other infrastructure, its operational procedures and safety management system, relevant documentation, as well as the aerodrome's compliance with regulatory requirements for issuing a certificate [21].

Level 5 is the highest level in the airport's Carbon Accreditation program, setting high standards for airports to significantly reduce absolute carbon emissions. Airports at this level must work with their entire ecosystem, including employees, suppliers, business partners, airlines and third parties operating on the airport premises, to reduce CO_2 emissions in line with the sector's wider Net Zero commitments. Regular monitoring and evaluation are essential to measure progress and ensure transparency.

The new level of accreditation demonstrates that the airport maintains a net zero carbon balance. To achieve Level 5 accreditation, an airport must develop a Carbon Management Plan (CMP) that describes the steps to achieve emission targets, encourage third parties at the airport to self-deliver CO_2 reductions through milestones in line with net zero commitments. Airports Council International's Airport Carbon Accreditation program assesses and recognizes airports' efforts to manage and reduce carbon emissions through its certification levels: «Mapping», «Reduction», «Optimisation», «Neutrality», «Transformation», «Transition» and «Level 5» [20].

In May 2024, the Airports Council International (ACI) reported that Finnish airports had achieved a net zero CO_2 balance under their control. The four regional airports managed by Finavia - Ivalo, Kittila, Kuusamo and Rovaniemi - meet all the strict requirements of level 5 carbon airport accreditation [22].

In 2023, Finavia switched to using renewable motor fuel in heavy airport equipment, such as fire engines, at Ivalo, Kittila, Kuusamo and Rovaniemi airports. The airport operator has also switched to renewable energy sources for terminal heating, such as biofuel-based district heating. In addition, ground handling is carried out with the help of electric vehicles or only with the use of renewable energy sources. In this way, Finavia was able to minimize carbon dioxide emissions from its operations and achieve the goal of zero emissions at four airports in Northern Finland. By switching exclusively to renewable energy sources, Finnish airports have reduced their carbon emissions by 98% over the past ten years. The airport operator has also switched to renewable energy for terminal heating, such as biofuel-based district heating. In addition, ground handling is carried out with the help of electric vehicles or only with the use of renewable energy sources.

As of June 2024, 14 international airports have met the stringent Tier 5 requirements, including reducing emissions by 90% by removing the remainder from the atmosphere with new technologies and committing to be net zero in Area 3 by 2050 or earlier: Amsterdam Airport Schiphol Airport Eindhoven, Rotterdam The Hague Airport, Beja Airport, Madeira Airport, Ponta Delgada Airport, Christchurch Airport, Gothenburg Landvetter Airport, Malmö Airport, Toulon-Hyères Airport and the Lapland Airport Group: Ivalo, Kittila, Kuusamo and Rovaniemi [23].

The researchers recommend that airport operating companies take the first step by establishing local "decarbonization" councils that bring together all relevant airport-specific stakeholders. Thus, airports can take an active role in promoting sustainable development. But more importantly, the councils they bring together can coordinate comprehensive actions that really effectively reduce CO2 emissions [24].

Although airports only account for a small proportion of industrial emissions, they should prioritize decarbonisation. Airports Council International and its members are committed to implementing clean technologies, reducing carbon and greenhouse gas emissions, and exploring new market opportunities. More than 130 ACI member airports plan to reach the goal by 2030 or even earlier. Some plan to be net zero by 2040, while others will need additional support to develop and implement their decarbonisation roadmaps. ACI works with governments and other sectors to support all its members in achieving these ambitious but achievable goals [25].

With levels of certification, Airport Carbon Accreditation confirms that airports are at different stages of their journey towards integrated carbon management. It is a program for airports of all sizes, beyond hub and regional airports with regular passenger traffic, including general aviation airports and cargo airports.

The integration of artificial intelligence into aviation is driven by the need to solve existing problems, while setting ambitious goals for the future. With the help of innovative AI solutions, the aviation industry seeks to improve safety, reduce CO2 emissions, and contribute to climate improvement. AI can optimize flight routes, significantly saving fuel and reducing emissions. AI can suggest the most efficient flight routes by analyzing weather conditions and air traffic.

The application of AI in aviation allows for the optimization of flight trajectories. Using machine learning algorithms, airlines can analyze huge amounts of data related to weather conditions and air traffic. This allows them to determine the most efficient routes, reducing fuel consumption and minimizing carbon emissions.

The integration of artificial intelligence into aviation can fundamentally change the industry. The expected transformations lead to a safer, more efficient, and more environmentally sustainable aviation ecosystem.

The analyzed ways of decarbonization of the air space can ensure the achievement of a high level by 2050. However, their effective implementation requires significant funding, assistance from international civil aviation organizations, specialized software, and qualified professionals. ICAO standards and recommendations make it possible to achieve the set goal.

Ukraine has undertaken international legal obligations regarding the implementation of sustainable low-carbon development in all sectors of the economy; creation of an effective legal mechanism that would reliably guarantee the priority of environmental safety; implementation of precautionary measures for environmental protection; safe implementation of the latest technologies, etc. [26]. Global experience and the results of implementing investment projects to improve the energy efficiency of individual cities of the country (Kyiv, Dnipro, Lviv, Uzhhorod, etc.) can be used to spread the low-carbon policy at the non-aviation facilities of Ukraine's international airports [9].

In September 2022, the Parliament of Ukraine ratified the agreement on Ukraine's participation in the EU LIFE program for climate and environment [27]. By joining the LIFE program, Ukraine will be able to receive funding for recovery of its environment after the destruction caused by the Russian invasion, in particular, recovery airport infrastructure, obtaining the Airport Carbon Accreditation of the International Council of Airports.

Conclusions.

Thus, reduction of CO_2 emissions can be achieved through improvements in aircraft and engine technologies, use of sustainable aviation fuel (SAF), implementation of cost-effective measures, improvements in air traffic management (ATM) and aircraft operations. Airspace modernization or the use of more economical aircraft reduce carbon emissions, contribute to the achievement of the desired Net Zero goal of international civil aviation. Technological progress, infrastructure development and operational improvements, collaboration between governments and industry stakeholders are critical to creating the necessary framework to achieve decarbonisation goals. The adoption by the ICAO Assembly of the Long-Term Global Preferred Target (LTAG) for international aviation for net zero carbon emission by 2050, the adoption of the ICAO Global Plan for Sustainable Aviation Fuels (SAF), Low Carbon Aviation Fuel (LCAF) and other clean energy forms contributes progress in the implementation of these important issues.

Artificial intelligence plays a crucial role in improving air traffic management, increasing efficiency and safety, and enabling decision-making to address the issue of reducing CO2 emissions. The integration of AI into air traffic management has a direct impact on aviation safety.

AI has revolutionary potential in the aviation industry, offering significant safety benefits. While challenges and risks exist, the continued development and responsible implementation of AI will shape the future of air travel, creating the necessary foundation to achieve decarbonization goals.

The use of AI accelerates the development of clean aviation fuels, helps reduce the aviation industry's carbon footprint, and demonstrates that AI can revolutionize the development of sustainable aviation fuels by making SAF more accessible.

AI can optimize flight routes to reduce fuel consumption and emissions, contributing to a greener future. Harnessing AI advances will help further improve energy management practices in airports and aircraft, aligning the industry with global sustainable development goals.

By harnessing the power of artificial intelligence, the aviation industry is discovering new ways to improve efficiency, safety, and sustainability. With artificial intelligence, operational efficiency and environmental responsibility will be seamlessly integrated.

Success requires the coordinated efforts of the entire industry (airlines, airports, air navigation service providers, manufacturers) and significant government support. Member States of international and European civil aviation organizations should continue to develop national legislation to reduce CO_2 emissions in civil aviation. Airspace modernization or the use of more economical aircraft reduce carbon emissions, contribute to the achievement of the desired Net Zero goal of international civil aviation. Technological progress, infrastructure development and operational improvements, collaboration between governments and industry stakeholders are critical to creating the necessary framework to achieve decarbonisation goals. Civil aviation is one of the most important branches of the national economy, its effective functioning is a necessary condition for stabilization, development of international activity, meeting the needs of the population in air transportation, ensuring the protection of the national interests of states, in particular, Ukraine, with the aim of creating a better aviation space for future generations, reducing the global impact on the climate, as well as to achieve zero net carbon emissions by 2050.

REFERENCES

1. The Paris Agreement. 2015. Available from: https://unfccc.int/process-and-meetings/the-paris-agreement
2. Goals to Transform Our World. 2015. Available from: https://www.un.org/sustainabledevelopment/
3. What contribution does transport make to the UN sustainable development goals? Available from: https://unitingaviation.com/news/general-interest/what-contributions-does-air-transport-make-to-the-un-sustainable-development-goals/?fbclid=IwAR0ifCL-SIJl1bOv_mLdNSTe6McNQbYXl IWL xlUFOTxN1 XipsJrH2mRfslI
4. Convention on International Civil Aviation - Doc 7300. Available from: https://www.icao.int/publications/pages/doc7300.aspx#:~:text=%E2%80%8BConvention%20on%20International%20Civil,1945%20until%204%20April%201947.
5. Assembly Report and Minutes. Available from: https://www.icao.int/Meetings/a41/Pages/assembly-report-and-minutes.aspx
6. Chulinda L.I. Vplyv rishen 41-Yi Asamblei ICAO na rozvytok tsyvilnoi aviatsii. Yurydychnyi visnyk «Povitriane i kosmichne pravo». 2023. №1. P.17-23. Available from: http://www.law.nau.edu.ua/uk/nauka/4445--1-66-2023. DOI: 10.18372/2307-9061.66.17412
7. Federico Ricci Buffetti. New ICAO's decarbonisation targets reinvigorate Business aviation own impetus to adopt SAF.2023. Available from: https://www.ebaa.org/industry-updates/new-icaos-decarbonisation-targets-reinvigorate-business-aviation-own-impetus-to-adopt-saf/
8. Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). Available from: https://www.icao.int/environmental-protection/CORSIA/Pages/default.aspx
9. Agieieva G. M. Decarbonizing the activities of airports. Available from: https://www.researchgate.net/publication/334082781_Dekarbonizacia_dialnosti_aeroportiv
10. Eco-Airport Toolkit e-collection. Available from: https://www.icao.int/environmental-protection/Pages/Ecoairports.aspx
11. Encouraging Europe's sustainable aviation leadership to support ICAO goals. Available from: https://unitingaviation.com/news/environment/encouraging-europes-sustainable-aviation-leadership-to-support-icao-goals/
12. A route to net zero European aviation. Available from: https://www.destination2050.eu
13. Net Zero Roadmaps. Available from: https://www.iata.org/en/programs/environment/ roadmaps/
14. New Airbus plane will run on hydrogen stored at -253°C. Available from: https://building-tech.org/Транспорт/noviy-samolet-airbus-budet-rabotat-na-vodorode-khranyashchemsya-pry-temperature--253°c
15. The SE200 jet, with three pairs of wings, will reduce fuel consumption by 70%. Available from: https://building-tech.org/Транспорт/reaktyvniy-samolet-se200-s-tremya-paramy-krilev-snyzyt-raskhod-toplyva-na-70pers?fbclid=IwAR3xTXaG1J7fU-9q8KM-Rw_cwlfSUAbabiulvCNUodU9vjYmEXhBGrXxDtQ
16. Eather One will use air friction to generate energy. Available from: https://building-tech.org/Транспорт/samolet-eather-one-budet-yspolzovat-vozdushnoe-trenye-dlya-virabotky-energyy?fbclid=IwAR0lWYm0r1UEFRbvhrprQKuSBfUcIhaRQ2wUDfcpwdesXvwdAZyYOkFfLQE
17. The JertZero blended wing aircraft uses 50% less fuel than a standard aircraft and will have more space for cargo and. Available from: https://building-tech.org/Транспорт/samolet-so-smeshannim-krilom-jertzero-yspolzuet-na-50pers-menshe-toplyva-chem-standartniy-samolet-v-nem-budet-bolshe-mesta-dlya-gruza-y-passazhyrov
18. AMSL Aero is developing the world's first hydrogen-powered eVTOL aircraft. Available from: https://building-tech.org/Транспорт/amsl-aero-razrabativaet-perviy-v-myre-letatelniy-apparat-evtol-na-vodorodnom-toplyve-

19. Improvements in aircraft and engine techlogies. Available from: https://www.destination2050.eu/wp-content/uploads/2021/02/D2050_Focus_Improvements_in_aircraft_and_engine_technologies.pdf
20. Accredited Airports across the world. Available from: https://www.airportcarbonaccreditation.org/accredited-airports/
21. Maksym'yuk Y.V.,Chulinda L.I., Korchova G.L., Pochka K.I. (2022) Priority directions of international airport infrastructure development. Opir materialiv i teoriia sporud: KNUBA.2022. № 109. 301-316. DOI: https://doi.org/10.32347/2410-2547.2022.109.301-316.
22. Finnish airports achieve net zero carbon balance for emissions they control. Available from: https://www.aci-europe.org/media-room/489-finnish-airports-achieve-net-zero-carbon-balance-for-emissions-they-control.html
23. Global airport carbon management programme recognised as the best sustainability initiative of the year at Association World Congress. Available from: https://www.airportcarbonaccreditation.org/global-airport-carbon-management-programme-recognised-as-the-best-sustainability-initiative-of-the-year-at-association-world-congress/?fbclid=IwZXh0bgNhZW0CMTAAAR3mO4-E39feUSNVRzd-vL-3J-WBy4PsNDc8de_4pCINBhaRsicSbrQezVE_aem_ZmFrZWR1bW15MTZieXRlcw
24. Philipp Grosche, Gabriel Schillaci and Nikhil Sachdeva. Accelerating airport decarbonization 2023. Available from: https://www.rolandberger.com/en/Insights/Publications/Accelerating-airport-decarbonization.html
25. Global goal essential for aviation to grow sustainably while continuing to deliver socio-economic benefits. Available from: https://aci.aero/2022/07/14/the-time-to-act-is-now-aci-urges-states-to-reach-agreement-on-decarbonization-goal-ahead-of-icao-meeting/
26. Pro Osnovni zasady (stratehiiu) derzhavnoi ekolohichnoi polityky Ukrainy na period do 2030 roku. Zakon Ukrainy 2697-VII 28.02.2019. Available from: https://zakon.rada.gov.ua/laws/show/2697-19#Text.
27. Pro ratyfikatsiiu Uhody mizh Ukrainoiu ta Yevropeiskym Soiuzom pro uchast Ukrainy u Prohrami YeS LIFE - Prohrami dii z dovkillia ta klimatu: Zakon Ukrainy. 2022. Available from: https://zakon.rada.gov.ua/laws/show/2590-20#Text