Exploring the Different Approaches Made for Achieving the Zero Flight Emissions and their Benefit to the Environment

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Abstract

Pollution is the main global issue faced by the entire world and air pollution is one of the severe types of pollution which affects the temperature changes on the earth's surface. The rise in global warming is one of the effects of the rise in air pollution. Aviation required a large amount of fuel for transportation from one location to another location which creates more pollution due to the exhaustion of harmful gases. Thus, the focus of the study is to know the different approaches made by different organizations in the world to achieve zero emissions among flights to reduce pollution. There are different studies made by different organizations in the world on the impact of air pollution due to flights and preventive measures to control pollution to reduce global warming. Biofuels and air purifiers with carbon dispensers are the new approaches made to control the harmful greenhouse gas emissions of flights. The study will further help in developing the flight system to control the air pollution of flights at a low cost and in an eco-friendly manner

Keywords: Carbon, Environment, Flight, Greenhouse Gas, Pollution,

1. Introduction

Aircraft emissions dramatically exacerbate climate change. When airplanes use fossil fuels, non-CO_2 warming impacts such as nitrogen oxides (NO_2), vapor trails, and cloud formation caused by the altitude at which they fly are also created. In 2018, two-thirds of aviation's influence on climate change was attributable to non-CO_2 causes, which doubled the contribution of aircraft CO_2 to global warming. More than any other mode of transportation, aviation emissions are expanding the quickest. Since 2013, airplane emissions in Europe have increased by 28%, whilst emissions from other industries have declined. All planes departing from EU airports have increased their emissions, which have climbed from 1.4% of the overall output in 1990 to 3.7% now. Under a 1.5-degree scenario, aviation emissions are projected to treble or triple by 2050, consuming as much as a quarter of the carbon pollution budget [1]–[3].

The Paris Agreement requires all states to establish "economy-wide" carbon reduction objectives, in contrast to the Climate Agreement, which set particular emission limits primarily for wealthy nations. Due to the "economy-wide" requirement, even though the aviation industry is not specifically mentioned in the agreement nor are any other particular industrial sectors it is nonetheless covered by it, as are all other fields. T&E is urging nations to include aviation emissions in their nationally determined contributions, or NDCs, to the Paris Agreement to assure compliance (NDCs). By including it, nations would be encouraged to address the climate effect of aviation through appropriate national and international action. The shipping industry can make the same case. On the heels of the UK's decision in 2021 to become the first large economy to contribute to its aviation and shipments emission levels underneath its carbon budget, other authorities should follow suit. The EU's 2030 goal already would include outbound aviation emissions, even though these are in reality not covered by any legislation [4]–[6].

Despite such a profound effect, there are no policies in place at the regional or international levels to address the non-CO_2 climate consequences of aviation. The most recent findings on aviation's non-CO_2 climate consequences are examined in this study, along with solutions. The main effects are caused by contrails, which are the long white streaks that jets leave behind, and the cirrus clouds that are created as a result of moisture and soot particles released by flight crews. To reduce their non-CO_2 impacts, planes can switch to cleaner fuels and fly at lower altitudes, where contrail formation is impossible. Reconfiguring less than 2% of Japan's aircraft fleet reduced the warming effect of contrails by around 60% [7]–[9].

E-fuels [24], [34]-[35], like power-to-liquid, have the potential to be a source of alternative fuels with zero or minimal carbon emissions. The only fuel that can be scaled up sustainably to lessen aviation's impact on the environment is e-kerosene. However, they consume a significant quantity of renewable energy, and the origin of the CO_2 needed to manufacture the fuels affects how environmentally friendly they are. They do have the potential to drastically cut the sector's emissions, though. Find out more about sustainable advanced aviation fuels here [10].

[16] Concerns regarding the impact of aircraft engines on local and global air quality are warranted because they emit gases, noise, and particles similar to those produced by the combustion of fossil fuels. While carbon dioxide (CO_2) is the best-studied greenhouse gas, jet aircraft also release nitrogen oxides (NO_2), contrails, and particulates. These clouds are thought to be a source of radiation, except induced cirrus clouds, whose radioactive forcing is expected to be 1.3-1.4 times that of CO_2 alone. In 2018, international commercial operations were responsible for 2.4% of the world's total carbon dioxide emissions. [17]–[18].

Children who have their sleep and learning disrupted by aviation noise can be at a higher risk of cardiovascular disease. Airports pose a threat to nearby water supplies due to the intensive usage of these facilities for the storage, transfer, and use of airplane fuel and cooling chemicals. Aviation activities contribute to harmful levels of ozone and ultrafine particles in the air. The combustion of avgas in general aviation piston engines releases toxic lead into the atmosphere. [19]–[21].

Aviation can reduce its environmental impact by enhancing fuel efficiency in aircraft or air traffic control and by optimizing flight patterns to reduce non-CO_2 influences on the climate from NO x, particulates, or contrails..The International Civil Aviation Organization (ICAO) has developed a strategy to cut down on carbon dioxide (CO_2) emissions called CORSIA, which includes the use of aviation biofuels, emissions trading, and carbon offsetting. [22]. It is possible to minimize aviation use through the elimination of short-haul flights, the expansion of train connections, the consideration of individual preferences, the imposition of taxes and the provision of subsidies on planes, and so on. Fuel-powered aircraft could be phased out in favor of hydrogen, electrical, or hybrid aircraft. [23]. Researchers working in e-Science fields such as meteorology, connectomics, sophisticated physics simulations, biology, genomics, and environmental studies meet difficulties [16]- [41].

2. Literature Review

McLaren et al. (2019) [11] evaluated that Existing and future emission reduction targets should be handled independently from negative emissions. Without distinguishing between the two, climate policy is hampered because climate models overestimate the future contribution of negative emissions and the volume and rate of investment needed to produce negative emissions are not clearly understood. It is possible that pledges and deployments of negative emissions could have unintended negative implications for emissions reduction, such as temporal trade-offs, excessive offsetting, and technological lock-in. International, national, local, organizational, and sectorial planning would all benefit from more clarity regarding the role and timing of negative emissions in conjunction with rapid emissions reduction.

Efthymiou et al. (2019) [12] discussed that Policymakers can face a significant challenge in attempting to mitigate the effects of aviation on global warming. As part of its effort to reduce emissions of greenhouse gases, the European Union has turned to the Emissions Trading Scheme (EU ETS). Policy worries about implementing the EU ETS in the aviation sector are explored in this article. A total of 31 professionals from airlines, the International Air Transport Association, air navigation service providers, civil aviation authorities, and other relevant fields participated in a two-round Delphi survey (consultants and academics). EU ETS is expected to be significantly impacted by the various allowance allocation systems, the linking of EU ETS to comparable schemes in other countries/continents, and the integration of the scheme with important environmental policies in Europe. We recommend that the processes of monitoring, reporting, and verification be streamlined; that the revenue scheme for auctions and fines be made more transparent; and that balance is reached in the allowance market.

Nisbet et al. (2020) [13] suggested that the atmospheric methane load is rapidly increasing in ways that are incompatible with the goals of the 2015 Paris Agreement of the United Nations Framework Convention on Climate Change. Methane emissions must be brought back onto a path that is more in line with the Paris goals immediately. Improvements in technology since the turn of the century have made it much simpler to pinpoint and cut emissions from "tractable" (easy to mitigate) human sources like the fossil fuel sector and garbage dumps. Less discussed, but more feasible, is the removal of elevated methane ambient air close to sources, which can be used to cut emissions from "intractable" (more difficult to regulate) human sources like agricultural and biomass burning. The larger effort to use microbiological and nutritional intervention to reduce emissions from cattle is glossed over in this largely geophysical study.

Sovacool et al. (2022) [14] discussed that direct air capture with Carbon Storage (DACCS) technologies constitute one of the most promising possible tools for combating climate change by enabling net-zero and net-negative emissions, as recommended by the Intergovernmental Panel on Climate Change and the European Green Deal. We extract ten recommendations for future DACCS policy from a novel and original dataset of expert interviews (N = 125) using a novel and original dataset of expert interviews (N = 125). After providing a literature analysis on DACCS and describing our data-gathering methods, we give the following recommendations: (a) adhere to governance principles that ensure 'negative' emissions; (b) prioritize long-term carbon storage; (c) value and incentivize scale; (d) co-develop with capture, transport, and storage; (e) phase in a carbon price; (f) coupled with renewables; (g) leverage hub deployment; (h) maintain separate targets; I embrace certification and compliance; and (j) acknowledge social acceptance. All ten ideas are significant, and they all relate to the urgency and importance of properly controlling and directing the DACCS transition, which can be imminent.

Epstein et al. (2019) [15] evaluated that Lessening the industry's carbon footprint is a major priority for the aviation industry. Aircraft with a gross takeoff weight of more than 25 tons, also known as "airliners," are responsible for 98% of aviation CO2 emissions worldwide. Propulsion systems for such planes can eat up tens of megawatts of power and hundreds of thousands of kilowatt hours of energy for each flight. To reduce CO2 emissions, this article explores the challenges of electrically powering this plane. Noise reduction and financial savings are explored as additional potential benefits. All-electric, hybrid, and turboelectric systems are all taken into account. Weighing in on technicalities like efficiency, heat rejection, and mass. The shift to electric propulsion is also examined from an economic and regulatory perspective. Using electric propulsion to considerably reduce aviation's CO2 emissions in the first half of the 21st century is, according to this analysis, not feasible. Table 1 provides a summary of the literature review:

Table 1. *summary of the literature review*

Author	Methodology	Outcomes
McLaren et al. (2019) [11]	CO_2 extractions	International, national, local, organizational, and sectorial planning would all benefit from more clarity regarding the role and timing of negative emissions in conjunction with rapid emissions reduction.
Efthymiou et al. (2019) [12]	EU ETS	Researchers suggest that the monitoring, reporting, and verification procedures be simplified, the revenue structure for auctions and fines be made clearer, and equilibrium be found in the allowance market.
Nisbet et al. (2020) [13]	Methane emissions	This mostly geophysical study glosses over the bigger endeavor to apply the microbiological and nutritional intervention to decrease emissions from cattle.
Sovacool et al. (2022) [14]	DACCS	The DACCS transition can soon occur, and all 10 of these ideas are crucial to its successful management and direction.
Epstein et al. (2019) [15]	CO_2 emissions	Aircraft with a gross takeoff weight of more than 25 tons, also known as "airliners," are responsible for 98% of aviation CO_2 emissions worldwide.

3. Results and Discussion

When released, these gasses like CO2, water vapor, NOx, or carbon monoxide and air particles like incompletely burnt hydrocarbons, sulfur oxides, and black carbon interact with one another and the surrounding environment. Jetliners contribute to global warming in four different ways when aircraft fly in the tropopause, despite CO2 being the principal greenhouse gas emitted by powered aircraft:

The most major and well-understood cause of climate change is CO2 emissions. No matter the altitude, CO2 emissions have identical consequences. The emissions from the airport building and aircraft production, as well as those produced by ground transportation to and from airports utilized by passengers and personnel, all contribute to the aviation sector's greenhouse gas emissions. Burning fuel releases water vapor, which solidifies at high elevations in chilly, humid circumstances to form visible line clouds: condensation trails (contrails). They are believed to have a small but discernible impact on global warming compared to CO2 emissions. It is unusual for lower-altitude aircraft to produce contrails.

Following the production of continuous contrails, cirrus clouds can form and can contribute to further global warming. Their impact on global warming is unknown, and cirrus cloud augmentation is sometimes left out when calculating aviation's total impact. The direct impact of sulfate and soot particles is less than that of other pollutants; sulfate particles reflect sunlight while soot particles absorb heat. Particles also affect the characteristics and production of clouds. Compared to CO2 emissions, contrails as well as cirrus clouds that form from particles could have a stronger radiative forcing impact.

Soot particles are believed to produce the greatest contrail production because they are big enough to act as condensation nuclei. Jet fuel's aromatic ingredient can be reduced to lessen soot generation. Without accounting for the possible impact of cirrus cloud augmentation, the IPCC calculated in 1999 that aviation's temperature increases in 1992 was 2.7 (2 to 4) orders of magnitude larger than that of CO2 alone. According to an update for 2000, aviation's radiative forcing was calculated to be 47.9 mW/m2, which is 1.92 times the overall effect of Carbon dioxide emission alone, which was 25.4 mW/m2.

This weighting factor was calculated in 2012 by a Chalmers University study to be 1.3–1.4 if aviation-induced cirrus is excluded, and 1.70–1.80 if it is within a range of 1.31–2.9. There are still questions about the interactions of NOx, O3, and CH4, the generation of aviation contrails, the impact of soot particles on cirrus clouds, and the measurement of non-CO2 radiative forcing. When fuel is used in aircraft engines, carbon dioxide, water vapor, nitrous oxide, unburned hydrocarbons, and soot are released. In the lower atmosphere, nitrogen oxides from airplanes are a pollutant that contributes to global warming, while at higher altitudes, it depletes the layer of stratospheric ozone.

Given that the carbon emissions occur at a greater altitude and a quicker rate, they have a significant impact. It is controversial if the aviation sector contributes to noise. This is due to the transient nature of aviation noise. However, the noise has a significant impact on individuals who live at or near airports. These individuals have a variety of negative impacts, such as sleep problems, performance issues, communication difficulties, as well as cardiovascular and psycho-psychological issues. The airport operator is accountable for an aircraft's noise, and therefore he or she can make sure that the necessary processes are in place to establish, evaluate, and guarantee sound protection strategies.

The heat that otherwise would have been emitted from the ground is trapped by contrails, water vapor generated by aircraft that resemble condensation trails. The result is global warming. Studies show that night flights have a greater impact on global warming than day trips since contrails help reflect light throughout the day. Higher altitudes are where contrails form in the sky, and they can extend up to two kilometers from their original location. They frequently trap heat that otherwise would escape from the planet, significantly accelerating global warming.

Regulation of the sector is required to address environmental damage brought on by air travel. This same Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), which places limitations on airline carbon emissions, was suggested by the International Civil Aviation Organization (ICAO) in 2016. Airlines will purchase compensatory measures from other industries if the cap is surpassed. This, nevertheless, did not work as anticipated, demonstrating the difficulty of regulating airlines. As a result, Kyoto Protocol, whose authority is confined to domestic flights, is given responsibility for controlling the number of carbon emissions.

The aviation sector can have a lessening of its negative effects on the natural world if technological advancements are used to enhance aircraft design and systems. The world can be saved from destruction by kerosene-powered aircraft engines if a discovery in the use of a more environmentally friendly fuel is made, such as biofuels, hydrocarbons, solar cells, and batteries. The speed at which this development occurs, however, can indeed be equated to the speed at which people are purchasing tickets. Additionally, the requirement that aero planes transport their energy needs to be addressed, such engineering issues investigated, and a solution found.

Charges for the greenhouse gases that airplanes release into the atmosphere might significantly reduce pollution. Airlines should be required to pay these fees for each ton of greenhouse gas emissions. Like other transport providers, it makes airlines pay for the pollution they produce, forcing them to restrict their emissions since doing so has a cost. The government can also include environmental and social expenses in addition to emission costs. Most aircraft have accepted this and started developing initiatives to reduce their ecological footprint. There is a method that aids in calculating the carbon footprint left by a flight, and the money made from offsetting permits the aviation industry to launch environmental protection programs.

4. Conclusion

The biggest worldwide problem that everyone faces is pollution, and carbon emissions are among the most serious forms of pollution that have an impact on variations in the earth's surface temperature. One consequence of the increase in air pollution is the acceleration of global warming. Aviation uses a lot of fuel to get from one place to another, which releases toxic gases into the atmosphere and increases pollution. The study's main goal is to understand the various strategies used by various businesses throughout the globe to achieve zero emissions during takeoff and landing to minimize pollution. There are several research on the effects of air pollution from aircraft and the prevention of pollution to lessen global warming have been conducted by various organizations worldwide. The usage of biofuels as well as air purifiers containing carbon exchangers is one of the new strategies developed to reduce the damaging emissions of greenhouse gases from aircraft.

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