

The Impact of Aviation Business on Global Climate Change

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Abstract: In twenty first centuries, climate crisis is one of the crucial problems which occurs globally. Climate change is mainly derived by man-made and/or human activities from various sectors such as industry, energy, agriculture and aviation business. Air pollution and climate change caused by aircraft engine are the significant issues which should be urgently solved. CO₂ emission reduction schemes are significant keys to control the concentration of atmospheric carbon dioxide. This article will identify the causes and the impact of aviation business on climate change. And how to mitigate carbon emission, carbon offset program including how to calculate the amount of carbon emissions for the airline. So, International Air Transport Association (IATA) and International Civil Aviation Organization (ICAO) has set the target and how to reduce CO₂ in order to afford the airlines to join the carbon offset activities for protecting the world atmosphere.

Key words: climate change, aviation business, carbon emission, mitigation, carbon offset and program

1. Introduction

This article aims to present the impact of climate change on aviation business and how airlines respond to climate change in terms of adaptation and mitigation or reducing the impact. The aviation business is related climate change and must be understood, raise awareness and responsible for reducing carbon emissions into the environment.

Aviation business is one that effects significantly of the greenhouse gases. Due to the launch of new airline and many of low-cost airlines. So, International Air Transport Association predicts that by the year 2036, passengers on airlines around the world will increase twice or approximately 7,800 million years [1].

The aviation industry is likely to grow by 300-700% [1] over the years 2005 and 2050 if there are no effective measures to reduce greenhouse gases. The proportion of greenhouse gas emissions in the aviation industry may increase to 15% of all greenhouse gas sources.

In October 2016 the International Civil Aviation Organization (ICAO) [1], a specialized agency of the United Nations was put regulations and activities for international aviation. They resolved to prepare guidelines and measures to control greenhouse gas emissions in the aviation industry. The plan is a framework and measures that are clearly within the next 4 years. Airlines around the world must have measures to monitor and control the emissions that performing airline by the year 2020 onwards. The measures might start with a voluntary airline and may not use these measures with the airlines that have few flights.

2. Material and Methods

Air freight or air transport services is important for the transportation, especially in economy. Aviation business is the first element of the aviation industry and conducted by any person or entity engaged in the business of air transport passenger and cargo service.

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Due to the high speed of air transport, you can travel to destinations both short and long distance in a short time. The frequency of flights and the fuel that were burned from the aircraft. It produced greenhouse gas such as carbon dioxide (CO_2) etc. That will impact on global climate.

The impacts of aviation business and mitigation are as follows:

Global warming [2] is a phenomenon of climate change characterized by a general increase in average temperatures of the Earth, which modifies the weather balances and ecosystems for a long time. It is directly linked to the increase of greenhouse gases in our atmosphere, worsening the greenhouse effect.

And, it is the long-term heating of Earth's climate system observed since the pre-industrial period (between 1850 and 1900) due to human activities, primarily fossil fuel burning, which increases heat-trapping greenhouse gas levels in Earth's atmosphere. The term is frequently used interchangeably with the term climate change, though the latter refers to both human- and naturally produced warming and the effects it has on our planet [3].



Fig. 1 Global Temperature (2019) [3].

Greenhouse Gas (GHG) [2] is a gas that could absorb infrared waves or IR radiation very good. These gases are needed to keep the temperature constant in Earth's atmosphere. If there is no atmosphere of greenhouse gases in the atmosphere. The temperature will be hot in the daytime and very cold at night. Because these gases absorb radiant heat wave in the daytime. Then gradually heat is radiated out at night. The temperature

in the atmosphere does not change abruptly with a lot of gas that could absorb infrared waves and its classified as a greenhouse gas. This is the gas that occurs naturally and is caused by human activity. The main greenhouse gas is water vapor, carbon dioxide, ozone, methane and nitrous oxide and chlorofluorocarbons (CFCs), etc. Carbon dioxide [4] is a colorless, odorless gas found in our atmosphere. Its chemical formula is CO₂, which means it is one carbon atom bonded to two oxygen atoms. It is a waste product in our bodies and is also produced by burning fossil fuels that affect the global warming.

Climate change [5] is one of the biggest threats we face. Everyday actions like using electrical equipment, heating your home, driving a car and flying consume energy and produce greenhouse gases emissions, particularly carbon dioxide (CO₂) which contributes to climate change. The International Civil Aviation Organization (ICAO) has warned that the aviation industry needs to prepare for severe disruptions as a result of climate change and that it needs to make full use of clean technology and policy tools in order to reduce its carbon emissions.

Table 1 Aviation emission

Emission	Description	Emission Sources	Impact
CO ₂	Carbon dioxide is the product of complete combustion of hydrocarbon fuels like gasoline, jet fuel and diesel. Carbon in fuel combines with oxygen in the air to produce CO ₂	 Aircraft APU GSE Vehicles Stationary power plants Construction equipment 	Climate change

One of the most serious impacts of climate change [6] is how it will affect water resources around the world. Water is intimately tied to other resources and social issues such as food supply, health, industry, transportation and ecosystem integrity. Climate change also threatens the health of our children and grandchildren through increased disease, freshwater shortages, worsened smog and more. These impacts also pose incalculable economic risks that far outweigh the economic risks today. The world's leading scientists report that to prevent dangerous levels of global warming, governments should act to limit global warming to less than 2°C by taking concerted action to reduce greenhouse gas emissions.

The impacts of climate change not only impact carbon emissions but also impact in aviation too. Climate change impacts on aviation [7] impact by 1) changes in weather behavior observed 2) including increased frequency and intensity of weather events with adverse effect on aviation 3) strong regional differences. Moreover, it is impacts 4) operational such as route changes and flight times 5) disruptions such as thunderstorms and heavy snowfall 6) disasters, e.g., hurricanes and 7) route network change in the longer term.

A carbon offset [9] is a means of reducing emissions to zero by saving enough carbon to balance the carbon emitted by a particular action. Several airlines have begun offering carbon offsets to passengers to offset the emissions created by their proportion of the flight. Money generated is put to projects around the world to invest in green technology such as renewable energy and research into future technology.

In the context of addressing climate change concerns, offsetting is an action by companies or individuals to compensate for greenhouse gas emissions, in this case arising from their use of commercial aviation. Carbon offsets or an equivalent offset by another greenhouse gas, can be purchased by countries, companies or individuals to reduce their net carbon emissions.



Fig. 2 Impacts of climate change on aviation [8].

Offsets can either be bought from within the international compliance system under the Kyoto Protocol [10], or in the voluntary market. Each passenger can therefore pay to offset the emissions caused by their share of the flight's emissions. The principle is that emissions for each flight are divided amongst the passengers. They can therefore pay to offset the emissions caused by their share of the flight's emissions by investing in carbon reduction projects that generate carbon credits.

There are two principal types of carbon credits:

- certified emission reductions, which are backed by the UN, and
- voluntary emission reductions.

Each passenger can purchase carbon credits generated by certified renewable energy and energy efficiency projects in developing countries that are verified to reduce greenhouse gas emissions. A carbon credit is a permit that represents one ton of carbon dioxide that has either been removed from the atmosphere or saved from being emitted. These carbon credits are then "cancelled" on an official register to ensure that they cannot be sold or used again [5].

International Air Transport Association (IATA) [11] has carried out the way to offset carbon emissions, international accepted and reliable. They have developed a program to calculate the amount of carbon emissions by the International Civil Aviation Organization (ICAO). The system is managed in a transparent and verifiable way and certified by UKs carbon offset quality assurance scheme. The ways to offset carbon emissions are translating the distance traveled into the amount of money that passengers will voluntarily donate to the project. This project was certified by the United Nations.



Fig. 3 The process of offsetting (IATA guidelines and toolkit) [9].

How to calculate the amount of carbon emissions?

The combustion of 1 kg [7] of jet fuel in an aircraft engine produces 3.15 kg of carbon dioxide (CO_2). However, the volume released per flight is based on several factors such as aircraft efficiency and maintenance, distance travelled, the load carried (passengers and cargo) and weather conditions. Although there are several ways of calculating the carbon emissions from a flight, airlines participating in the IATA offset program using a methodology based on that developed by the UN's International Civil Aviation Organization (ICAO). The International Air Transport Association (IATA) has developed this concept further by creating a tool that allows airlines to use their own verified data on fuel burn, passenger and cargo weights, seat configurations and load factors

For passenger aircraft, fuel burn was apportioned to passenger and freight carriage using the following three equations.

Table 2Three equation [12].

Equation I Total Passenger Fuel Use $(kg) = (\underline{Total Passenger Weight (kg)})$ (Total Weight (kg)) (Total Fuel Use (kg))

Equation II

Total Passenger Weight (kg) = (Number of Aircraft Seals) (50 kgs) + (Number of Passengers) (100kgs)

Equation III

Total weight (kg) = Total Passenger weight (kg) + Total Freight Weight (kg)

Carbon emissions were estimated using the accepted constant of 3.16 tons of CO_2 emitted from the consumption of one ton of aviation fuel.

Methods of mitigating aviation's CO₂ emissions.

Mitigation of aviation's environmental impact can be achieved through a variety of measures; the most obvious and arguably economical of which is to reduce the fuel burn of the aircraft [13].

The next generation of aircraft, including the Boeing 787 [14] Dreamliner, Airbus A350 and Bombardier C Series (airbus family design by Bombardier), are 20% more fuel efficient per passenger kilometer than current generation aircraft. This is primarily achieved through more fuel-efficient engines and lighter airframes & supporting structures made of composite materials but is also achieved through more aerodynamic shapes, winglets, a "one-piece" fuselage and more advanced computer systems for optimizing routes and loading of the aircraft.

3. Results and Discussion

The Intergovernmental Panel on Climate Change (IPCC) [15] has estimated that the aviation emissions account for 2% of all sources of greenhouse gases. It will be increasing the proportion of 5% by the year 2050 due to the rapidly growing aviation industry along with the opening of new routes and new airlines. Including when the airplane is starting the engine, its causing heat and greenhouse gas from the engine combustion. Even with the development of technology to enhance fuel efficiency, the proportion of greenhouse gas emissions in the aviation industry is still growing steadily. If there are no measures to reduce greenhouse gases. The proportion of greenhouse gas emissions in the aviation industry may increase to 15% of all greenhouse gas sources. Airline has been prepared and awareness to responsibility of reducing the impact of aviation, social and environmental seriously. The measure to reduce energy consumption, management and changing flight patterns including operations the "carbon offset activities" to make greenhouse gas emissions reduced or set zero.

Total global carbon emissions. We estimate that global aviation operations for both passenger and cargo carriage emitted 918 MMT of CO_2 in 2018, bout 2% higher than IATA's published value. This equals 2.4% of the estimated 37.9 gigatons of CO_2 emitted globally from fossil fuel use that year [16]. Using industry's values, CO_2 emissions from commercial flights have increased 32% over the past five years from the 694 MMT emitted in 2013 [17]. The implied annual compound growth rate of emissions, 5.7%, is 70% higher than those used to develop ICAO's projections

that CO_2 emissions from international aviation will triple under business as usual by 2050 [18].

As shown in Table 2, passenger transport accounted for 747 MMT, or 81%, of commercial aviation carbon emissions in 2018. Passenger movement in narrow body aircraft was linked to 43% of aviation CO₂, followed by widebody jets (33%), and regional aircraft (5%). The remaining 19% of total aviation emissions, 171 MMT, were driven by freight carriage and divided between "belly" freight carriage on passenger jets (11%) and dedicated freighter operations (8%).

Control omission from	% of total		
Carbon emission from	Passenger 0perarions	Freight Operations	
Narrow body	43		
Widebody	33		
Regional	5		
Belly Freight		11	
Dedicated Freighter		8	
Total	100		

 Table 2
 Carbon emissions in 2018 by operation and aircraft class.

There is the airline that join carbon offset program such as:

Cathay Pacific [19] Airline has prepared a project "FLY Greener" program, which was implemented in 2007 to provide passenger airline Cathay Pacific, and Cathay Dragon contribute to offset the greenhouse gas emissions from air travel by themselves. Passengers can use cash or Asia Miles to buy "carbon offset" or donate a large sum of money. The airline will buy carbon credits from projects as well as projects to reduce or prevent the emission of carbon dioxide (CO_{2}). In addition, airlines itself has offset the carbon dioxide (CO_2) emissions that arising from staff travel with Cathay Dragon and Cathay Pacific too.

Being one of Australia's largest international and domestic airlines, Qantas [20] is at the forefront in reducing their carbon emission through various programs and projects. Qantas has been certified carbon neutral under the National Carbon Offset Standard (NCOS) Carbon Neutral Program since the year 2007. Qantas has been ranked the largest carbon off setter in world with over 2.5 million tons of carbon emission.

Virgin Australia [20] seeks to minimize environmental impacts caused by their operational activities, therefore pushing them to implement initiatives that help reduce carbon emission. Virgin Australia has a fleet of young planes that are efficient on fuel; the 777 aircraft, ATR 72s, Boeing 737 and Airbus A330s. The airline has also invested in reducing the aircraft weight, supporting the growth of sustainable aviation biofuel and enhanced flight planning through their technological and operational initiatives. Virgin Australia launched its carbon offset program in 2007 being the first airline to get government certification when it came to carbon offset programs.

In 2009, Thai Airways International Company Limited [21] has taken list offset carbon emissions, together with the International Air Transport Association (IATA) to passengers who want to offset the carbon emissions from air travel by the applicant. When the passengers purchase tickets through the website. The program will show the amount of carbon emissions from passenger according to distance and the value for money. The program compensates for the carbon emissions have been audited by the Carbon Offset Approval Scheme of the United Kingdom. Carbon compensation will be taken to support renewable energy projects and certified.

Year 2009, British Airways' [22] carbon offsetting scheme involves paying a fee dependent on aircraft type, class of travel and distance flown and therefore prices vary.

In 2010, Continental Airlines' [23] carbon offsetting scheme involves paying a fixed fee of \$2 to cancel out emissions through reforestation. Passengers can also choose to pay \$50 for offsetting emissions through renewable energy projects.

Jetstar Airline [24] has provided "Fly Carbon Neutral Program" or projects from a zero carbon passenger flights with Qantas and Jet Star. This program has been accredited by the National Carbon Offset Standard of Australian Government (National Carbon Offset Standard: NCOS). In 2009, they can offset the carbon emission of more than 2 million tons.

Delta Airlines [20] has been investing in carbon offset in order to promote carbon neutrality in both domestic and international flights since 2012. Delta Airlines has invested in fuel efficiency, electric powered tugs, and the exploration of carbon markets to accomplish their goal of carbon neutrality. Further, they have ensured their carbon emissions do not reach 2012 levels. It offers customers the chance to offset the carbon emission caused by their flight through donations made to their carbon neutrality initiative and environmental projects.

4. Conclusion

Climate Change is an issue that affected by air transport more. Many airlines and several foreign governments are focus on it. There is the policy that used as the standard for new aircraft and the projects to reduce and offset the carbon emissions of the International Civil Aviation Organization (ICAO). But it has no effect on carbon emissions from aviation significantly. International Civil Aviation Organization expected carbon emissions from global aviation are increasing three-fold by 2050 [25] and if the sector can reduce carbon emissions down. Aviation sector will account for 1 in 4 of the carbon budgets. May 2018, International Air Transport Association (IATA) [26] has set 3 targets to reduce carbon emissions from aviation base by

- increase fuel using in efficiency by 1.5% per year during 2009-2020.
- 2) limiting net carbon emissions from 2020, and
- a 50% reduction in net aviation carbon emissions by 2050 relative to 2005 levels.

Thai Airways International Company Limited [27] is the first airline in the Asia-Pacific that has signed a record deal with IATA to perform offsetting carbon emissions into the environment. They need to be the green airline.

Thai Airways International is committed to take part in the global effort to minimize aviation industry's impact on the environment. THAI has opted to adopt the IATA-administered carbon offset program, as it is a readily available tool that enables airlines to offer passengers the ability to compensate for the carbon emissions from their flying.

THAI introduces the Carbon Offset Program to passengers who would like to offset the carbon dioxide (CO₂) generated from their air travel when buying the ticket via our THAI website [28]. The carbon emission is calculated based on a methodology developed by the International Air Transport Association (IATA).

Funds collected through our Voluntary Carbon Offset Program will be contributed to the following project:

The Bangkok Kamphaeng Saen East project is Thailand's first landfill gas project. It converts methane emissions from landfill waste into electricity, channeling it into the country's national grid. The methane (a potent greenhouse gas) would otherwise escape into the atmosphere, contributing to climate change. Creating renewable electricity is also helping to reduce Thailand's reliance on fossil fuel-generated electricity, and lower its carbon emissions. In its first seven years, the project saved more than 270,000 tons of CO_2 annually. And, The International Civil Aviation organization [29] will limit the net carbon emissions of international flights between participating countries for the years 2021-2035. The limit is initially set at the average of 2019-2020 levels. Provisions in the Carbon Offsetting and Reduction Scheme for International Aviation, or CORSIA, require evaluation of it every three years in view of the goals of the Paris climate agreement, offering the possibility of tightening the limit in the future. If it fully implemented, CORSIA could be a significant step forward for global climate action. It could prevent nearly 2.5 billion tons of CO₂ emissions into the atmosphere over the first 15 years of the program — more if the ambition is increased by tightening the limit.

CORSIA [29] affords airlines flexibility to choose how to cut CO₂. They can:

- 1) Fly with more efficient aircraft.
- Use new technologies to set more efficient flightpaths and reduce delays.
- 3) Use sustainable lower-carbon alternative fuels.
- Invest in emissions offsets within or outside of the aviation sector.

Aviation industry is also a significant source of carbon dioxide emissions and presents a major threat to aviation business in terms of carbon emissions growth.

But on March 6, 2020 [30] last news from New York Times reported that this program/project will be slowdown due to coronavirus 19 crisis.

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