नागर विमानन महानिदेशालय
DIRECTORATE GENERAL OF CIVIL AVIATION

India's Civil Action Plan
Directorate General of Civil Aviation

Managing the Carbon Footprint of India's Civil Aviation

India's Action Plan developed in response to the International Civil Aviation Organization (ICAO) 2010 Assembly Resolution A37-19

June 2021

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1. BACKGROUND

Climate Change is increasingly impacting people and businesses all over the world and is seen as the biggest threat to humanity. Human activities from different sectors all over the world is contributing towards anthropogenic emission of GHGs, which is the biggest cause of climate change. Emission from aviation activities also contributes towards climate change, however, the contribution of aviation sector towards GHG emission is only 2% (IPCC), which is still significantly low.

To address the contribution of aviation sector towards GHG emission and climate change, ICAO has been taking pro-active measures over the years. In the past, ICAO Member States have demonstrated that they are interested in taking action and advancing initiatives on environmental protection. The prime challenge faced by many ICAO member states were to arrange and align human, technical and financial resources to do so. To address this challenge, ICAO launched the State Action Plan initiative in 2010 as a means to provide States with the capacity and tools to take action.

India has been at the forefront of addressing climate change concerns at the national level and have demonstrated a leadership position globally. In response to ICAO's call to submit State Action Plan by all the States, DGCA, India had submitted the initial State Action Plan in 2015. This State Action Plan is an update of the earlier submission to ICAO. Directorate General Civil Aviation (DGCA), India has prepared and updated the State Action Plan on Reducing Carbon Emissions from Civil Aviation as per the guidelines given in ICAO Doc 9888.

2. INTRODUCTION

India is the seventh largest country by area and the second most populous country with over 1.3 billion people in the world. India is the largest democracy in the world and one of the countries with most ancient civilizations. Home to the ancient Indus Valley Civilization and a region of historic trade routes and vast empires, the Indian subcontinent was identified with its commercial and cultural wealth for much of its long history.

India signed the UNFCCC on 10th June, 1992 and ratified it on 1st November, 1993. The Kyoto Protocol to the UNFCCC was adopted in 1997, which requires developed countries and economies in transition to reduce their Greenhouse Gas (GHG) emissions below 1990 levels. India acceded to the Kyoto Protocol on 26th August, 2002. As per the UNFCCC and its protocol, developing countries such as India, do not have binding on GHG mitigation commitments in recognition of their small contribution as well as low financial and technical capacities.

India continues to face the challenges of sustaining its rapid economic growth while dealing with the global threat of climate change. This threat emanates from accumulated GHG emissions in the atmosphere, anthropogenically generated through long-term and intensive industrial growth. Climate change may alter the distribution and quality of India's natural resources and adversely affect the livelihood of its people. With an economic closely coupled with its natural resources and climate sensitive sectors such as agriculture, water and forestry, India may face a major threat because of the projected changes in climate in the years to come.

International Civil Aviation Organization (ICAO), which serve as the global forum of States for International civil aviation, shall also respect and consider the principles and provisions made in UNFCCC. ICAO shall keep in mind the differentiated responsibilities based on historic emissions and shall classify the actions between developed and developing countries while finalizing goals, various measures including market-based measures, monitoring, reporting and verifying (MRV) instead of implementing equal standards and requirements for all its Member States.

Being a signatory to UNFCCC, India strongly believes that principles of **Common but Differentiated Responsibilities (CBDR)** and respective capabilities enshrined in the UNFCCC should be respected and acknowledged while addressing the climate change related issues in international aviation sector. The principle of CBDR shall be adopted in totality which lays down the foundation for further actions to curb emissions from international aviation.

The State Action Plan must be considered in the context of national and regional circumstances of India and therefore these plans must be understood as purely voluntary actions that take into account the specific national context and not as part of a global goal in the international aviation transport. In this context, there is a need to ensure the transfer of financial resources, technology transfer and deployment and capacity building support to developing countries for enabling them to voluntarily undertake action plans.

3. GROWTH IN INDIAN AVIATION

The civil aviation industry in India has emerged as one of the fastest growing industries in the country in last few years. India has become the third largest domestic aviation market in the world and is expected to overtake UK to become the third largest air passenger market by 2024. The fundamental drivers of air passenger demand – including population and demographics and increasing incomes – are favourable and supportive of ongoing growth over the longer-term. Over the next 20 years IATA has predicted a growth of 6.1% per year on average. The number of annual air passenger journeys is estimated to increase by more than 350 million over this period, reaching almost 520 million journeys in 2037. In the year 2018, Revenue Passenger Kilometre (RPK) in domestic airline demand growth of 18.6% was three times the global RPK growth of 6.5% as compared to previous year data.

Total passenger in the year 2008-09 was 68.4 million and it has increased more than 3 times by the year 2018-19 to reach 204.21 million as shown in Figure 1. The domestic passenger traffic registered a compound annual growth rate (CAGR) of 13.53% during the period 2008-09 to 2018-19 while the international passenger traffic grew at 8.24% (CAGR) during the same period.

Figure 1. Passengers Carried by all Scheduled Indian Airlines (Source: DGCA)

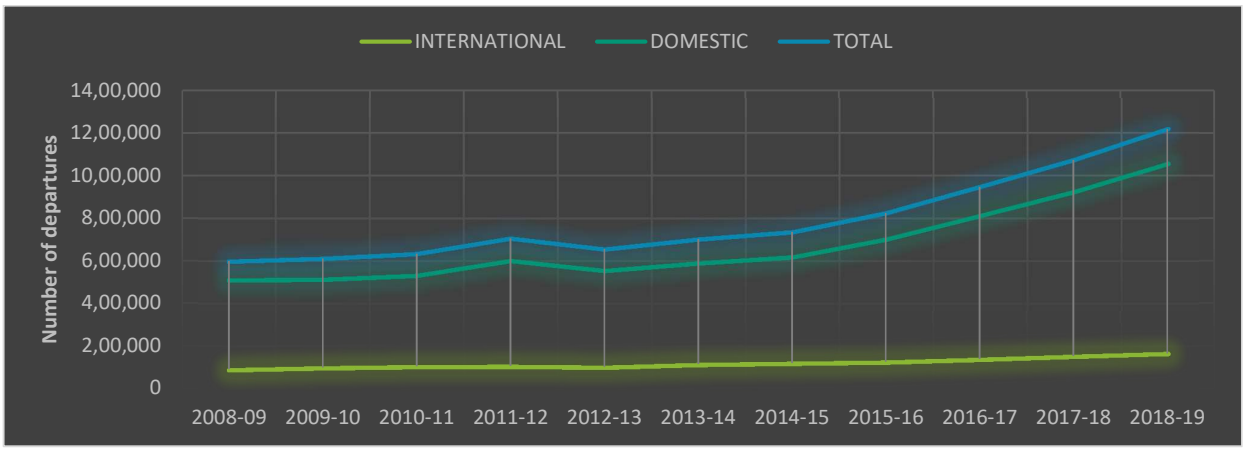


Figure 2. Number of Departures by all Scheduled Indian Airlines (Source: DGCA)

The total departures of all scheduled Indian airlines registered a compound annual growth rate (CAGR) of 7.4% during the period 2008-09 to 2018-19 as depicted in Figure 2. During the year from 2008-09 to 2018-19, the capacity (ASK) in the domestic market grew at a rate of 10.24% (CAGR) while the demand (RPK) grew at 13.59% (CAGR) during the same period (refer to Figure 3).

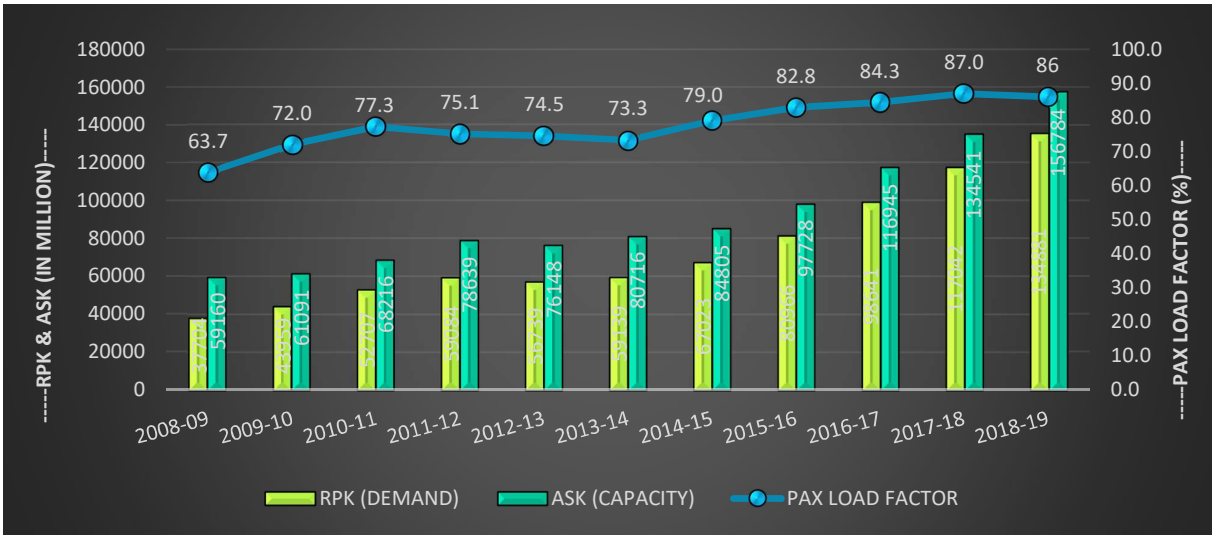


Figure 3: Capacity and Demand in Indian Domestic Sector

In the year 2018-19, both ASK and RPK in the domestic market registered a positive growth compared to the previous year. However, the Passenger Load Factor in the domestic market, fell to 86.0 %.

The aviation industry in India continues to work constructively with all the key stakeholders – including the government, policy-makers and regulators – to ensure that the increase in demand can be met adequately and the full benefits of aviation industry can be realised. To meet this growing demand, Indian carriers are projected to increase their fleet size to 1,200 aircraft by 2024 and demand for aircraft in India is expected to be 1,750 by 2037. The current fleet mix[1] of Indian carriers are presented in Figure 4.

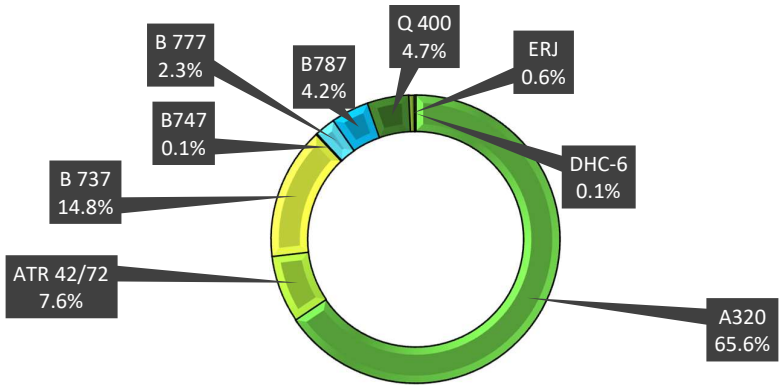


Figure 4: Fleet Mix of Indian Carriers

[1] http://www.knowindia.net/aviation7.html

As shown in **Figure 4,** A320 is the predominant type of aircrafts used by Indian carriers, followed by B737 and Bombardier Q400. The county's civil aircraft fleet is amongst the youngest in the world as most of the Indian carriers are having young, modern and efficient fleets. The average age of airplanes in India is 6.5 years[2] in 2020. The CAGR of the airplane fleet in India was projected to be over 12 percent for the ten-year period from 2020 to 2030. Thus even though the overall aviation activity and fleet numbers are going to increase, India is working towards fulfilling the ICAO's aspirational goals using a basket of measures such as – technology, operational improvement and sustainable aviation fuel etc. The details of these measures have been mentioned in Chapter 4 and Chapter 5 of this State Action Plan.

The COVID 19 Impact

The impact of the Covid-19 crisis on all aspects of the economy and society is well known and Aviation has been particularly acutely impacted. This has had a devastating impact on travel and tourism and on the frontline companies operating the aviation system and the rest of the supply chain. However, shocks to air traffic growth in the past have always been followed by a rebound in traffic and, while this may take longer than in previous crises, traffic will come back. According to IATA, Global passenger traffic (revenue passenger kilometres or RPKs) will not return to pre-COVID-19 levels until 2024. The recovery in short haul travel is still expected to happen faster than for long haul travel. As a result, passenger numbers will recover faster than traffic measured in RPKs. This impact will also be applicable to Indian context and the passenger load will be lower than the initially projected values till 2023-24.

[2] https://www.statista.com/statistics/1189832/india-average-airplane-fleet-age/

4. INDIA'S APPROACH TOWARDS CLIMATE CHANGE

Climate Change is a global phenomenon but with local consequences. India faces a bigger challenge in coping with the consequences of Climate Change than most other countries. India's Climate Change policy revolves around two key documents published by Government of India. One is the National Action Plan on Climate Change (NAPCC) adopted in 2008. The other is India's Nationally Determined Commitments (NDC) submitted to the UN Framework Convention on Climate Change (UNFCCC) in 2015. The NAPCC includes India's vision of ecologically sustainable development and various implementation steps. It is based on the understanding that Climate Change action must proceed simultaneously on several intimately inter-related environment and social sustainability domains. This need for inter-related policy and coordinated action was recognised several years later the UN while developing the 17 Sustainable Development Goal (SDG).

India is actively engaging in multilateral climate change relate negotiations & discussions with an objective to create an effective, cooperative and equitable global approach, that is based on the principle of Common but Differentiated Responsibilities (CBDR) and respective capabilities of each individual state. India has adopted a pro-active, ambitious and forward looking approach towards climate change through global negotiations. This is also well reflected in the country's NDC document that links India's commitment to ecologically sustainable development with its age old civilizational values of respecting Nature, incorporating a sense of inter-generational equity and common humanity.

- National Action Plan on CO2 reduction
- Aviation Environment system efficient monitoring for international aviation
- Implementation of mitigation measures through priority areas identification, evaluation, implementation

The targets India has voluntarily committed itself to are unparalleled for a developing country. The targets are-

1. To put forward and further propagate a healthy and sustainable way of living based on traditions and values of conservation and moderation.
2. To adopt a climate friendly and a cleaner path than the one followed hitherto by others at corresponding level of economic development.
3. To reduce the emissions intensity of its GDP by 33 to 35 percent by 2030 from 2005 level.
4. To achieve about 40 percent cumulative electric power installed capacity from non-fossil fuel based energy resources by 2030 with the help of transfer of technology and low cost international finance including from Green Climate Fund (GCF).
5. To create an additional carbon sink of 2.5 to 3 billion tonnes of CO2 equivalent through additional forest and tree cover by 2030.
6. To better adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change, particularly agriculture, water resources, Himalayan region, coastal regions, health and disaster management.
7. To mobilize domestic and new & additional funds from developed countries to implement the above mitigation and adaptation actions in view of the resource required and the resource gap.
8. To build capacities, create domestic framework and international architecture for quick diffusion of cutting edge climate technology in India and for joint collaborative R&D for such future technologies

However, it is to be noted that, the NDC commitments cover domestic emission of India and the international aviation sector is not a part of these commitments. DGCA is working along with relevant stakeholders to ensure that the ICAO's aspirational goals as adopted in ICAO's 37th Assembly in October 2010, under Resolution A37-19 can be met within the time frame. DGCA is focusing on implementation of all the basket of measures as suggested by ICAO which will help in ensuring a sustainable growth of Indian aviation. These measures are taken and implemented without compromising on safety and security of passengers. Aviation stakeholders also consider technical feasibility, operational requirements and economic viability while adopting new technologies. While ICAO's focus is on emissions from the international aviation sector, most of the measures to reduce aviation emissions apply to both international as well as domestic aircraft operations. The State Action Plan document has highlighted measures undertaken by airlines and airports that benefits both international and domestic aviation.

5. EMISSION SCENARIO OF INTERNATIONAL AVIATION OF INDIA

5.1. CO2 BASELINE OF INDIA CARRIERS

In order to formulate an effective framework to address the challenges of climate change, it is important to determine the sources and level of aviation's CO2 emissions, identify trends and make predictions about future growth. For this purpose, a baseline of CO2 emission for India's international aviation has been prepared by DGCA (refer Figure 5).

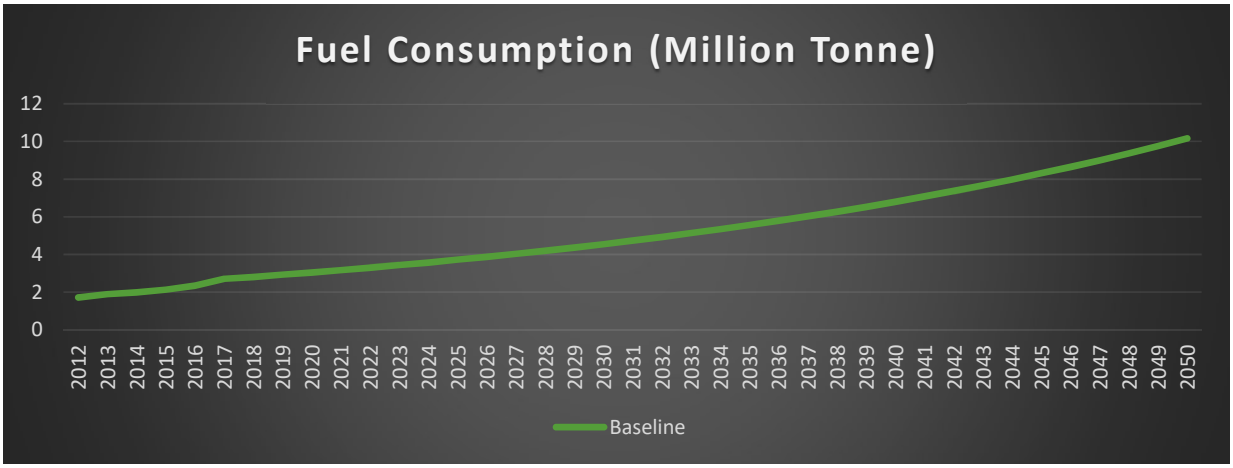


Figure 5: India's projected international aviation carbon emissions to 2050

The future growth in fuel demand in the baseline scenario (business as usual scenario) was forecasted based on the historical trend of fuel demand and future traffic growth. The consumption was calculated based on the International RTK data of ICAO for India and the fuel efficiency of international operations from India (RTK/Tonne). As per the estimations, the carbon emission will **be 9.60 Million Tonnes in 2020** and it will reach **32.07 Million Tonnes** in the year 2050, under the business as usual scenario with ongoing trend considering no fuel reduction measures are taken.

In addition to baseline scenario, few more scenarios- technology improvement, bio jet fuel and CNG 2020 has also been prepared and presented in section 3.2 of this State Action Plan.

5.2. SCENARIOS FOR INDIA'S FUTURE AVIATION CARBON FOOTPRINT

In developing the scenarios for this Action Plan, it has been important to consider progress made globally and the targets set by ICAO. As part of the three yearly review of this Action Plan, the scenarios will be reassessed and new trajectories may be included. The revision of scenarios will enable India to consider the impact of any targets agreed at future ICAO Assemblies or arising from progress of work under the United Nations Framework Convention on Climate Change (UNFCCC), as well as reflect changes to national emission reduction targets.

In the scenario preparation, Carbon Neutral Growth (CNG) scenario was assumed from 2020 in line with ICAO's CNG 2020 goal. Under the CNG 2020, which is an aspirational goals adopted by the ICAO Assembly Resolution A37-19 in 2010, ICAO states will work together to keep the global net carbon emissions from international aviation at the same level from 2020 onwards. Under this scenario, the CO2 emission from international aviation is assumed that, there will be no net increase in CO2 emission, beyond 2020, which is expected to be **9.61 Million Tonnes** for the year 2020.

Based on the data submitted by stakeholders, the fuel efficiency has increased by 1.3% per year from 2012 to 2018. This improvement in carbon emission can be related to basket of measures including technological improvements,

operational effectiveness, improving Air Navigation Services, etc. This improvement is projected to achieve a reduction of approximately **12.89 Million Tonnes** in the year 2050.

Keeping in view the various developments in the field of bio jet fuel, it is assumed that bio jet fuel will contribute 1% every year in fuel consumption. Gradual inclusion of bio jet fuel was estimated to reach up to 30% in the year 2050. This will help to achieve a total reduction of approximately **19.02 Million Tonnes** in the year 2050 together with technological improvements.

Finally, a reduction of approximately **3.44 Million Tonnes** will be required in the year 2050 to maintain the CO2 emission level at 2020 value, which will ensure India continues to meet CNG 2020 targets. This gap will be fulfilled by focusing on enhanced use of bio jet fuel and also by using offset mechanism under CORSIA. The projected emission till 2050 under baseline scenario and contribution from technological improvements, bio jet fuels vis a vis CNG 2020 is presented in Figure 6**.**

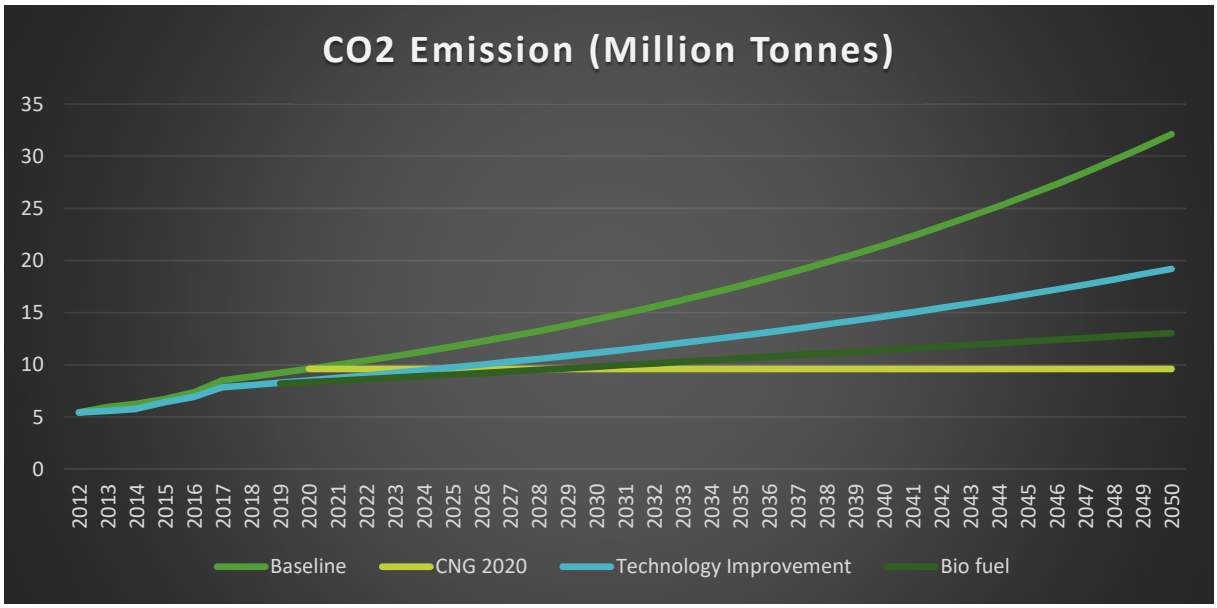


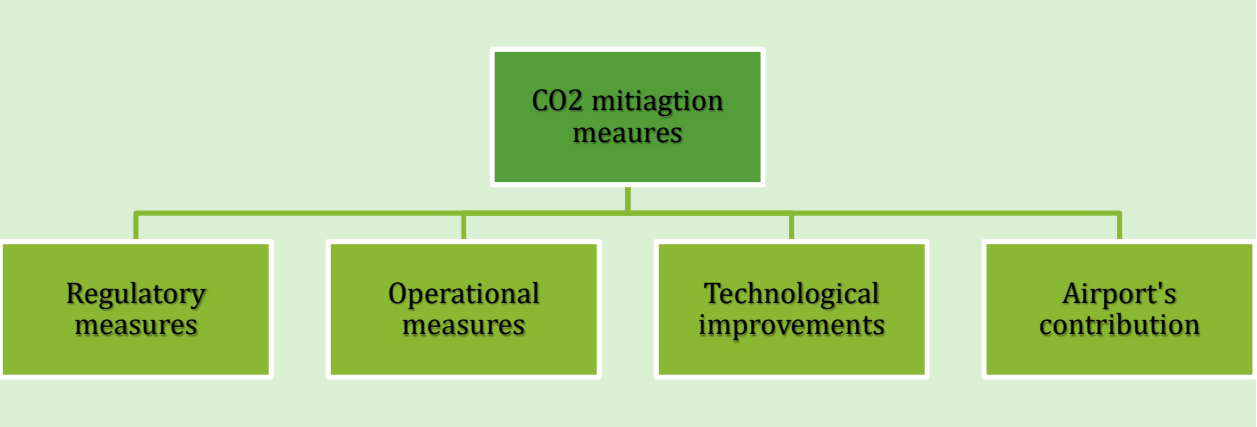
Figure 6: India's projected international aviation carbon emissions to 2050

CO_2 Emission (Mill Ton)	2018	2020	2030	2050
Baseline	8.85	9.61	14.35	32.07
CNG 2020	-	9.61	9.61	9.61
Technology Improvement	8.06	8.50	11.15	19.18
Biofuel	-	8.34	9.83	13.05

6. MITIGATION MEASURE TO REDUCE CO2 EMISSION

India's fast growing aviation industry has begun taking proactive actions to address the environmental issues. Given India's commitment to environmental improvements, the DGCA maps the CO2 emissions of Indian aviation regularly. DGCA has issued Civil Aviation Requirements (CAR), Section 10 – Aviation Environmental Protection Series 'B' Part I, Issue I, 5th August 2015 in order to address climate change, local air quality issues in Indian Aviation.

Following the direction and guidance of DGCA, various stakeholders have taken number of steps to address their contribution to climate change. With continued environmental training sessions, modern aircraft fleets, participation in Airport Carbon Accreditation program by airports, use of solar power, improved air traffic flow management, etc., the stakeholders are on the right path to reduce carbon emission from aviation. For India, the mitigation measures are categorised into four categories-



6.1. REGULATORY MEASURES

6.1.1. NATIONAL CIVIL AVIATION POLICY & WHITE PAPER ON GREEN AVIATION POLICY BY MINISTRY OF CIVIL AVIATION

Ministry of Civil Aviation, India, is responsible for formulation of national policies and programmes for the development and regulation of the Civil Aviation sector in the country. The Ministry of Civil Aviation, Government of India is committed to inclusive and sustainable growth of the civil aviation sector in the country while mitigating its negative impacts on environment at the same time. To encourage the civil aviation sector in India, the MoCA has released the National Civil Aviation Policy 2016 (NCAP) in June 2016. The major focus of this policy is to make flying affordable to the masses and to strengthen the regional air connectivity and also covers aspects related to sustainable aviation.

In addition to NCAP, Ministry of Civil Aviation has also published White Paper on National Green Aviation Policy in 2019. The White Paper sets out a strategic framework to address the major environmental challenges of the aviation industry including GHG emission. It summarises the key measures to be adopted by all aviation stakeholders. The key policy areas are-

- Environment Management System (EMS)
- Airport Master Planning
- Green Infrastructures
- Noise
- Greenhouse Gas Emissions and Climate Change

- Local Air Quality
- Energy & Resources
- Solar and other renewable energy
- Waste
- Water
- Land, soil, habitat and biodiversity
- Spills, releases and other incidents
- Competency & Skill developments
- Simplified Regulatory Regime

6.1.2. DGCA'S CIVIL AVIATION REQUIREMENTS (CAR)

Directorate General of Civil Aviation (DGCA) has issued various environmental guidelines for its stakeholders especially related to emissions from aircraft. In order to have a sustainable aviation industry, stakeholders have been advised to establish Environment Cell in their organisations and to develop their carbon footprint. Airlines have been advised to - retrofit existing aircrafts; adopt aggressive fuel efficiency method; explore possibility of using biofuels; fix winglets & riblets; minimize dead weights on board; improve load factors; adhere to maintenance schedules; select the appropriate aircraft for a particular route; improve taxing and parking procedures and others.

DGCA has also formulated the Civil Aviation Requirements (CAR) that stipulate the general requirements, procedures and practices to be adhered to by all stakeholders/organizations that are engaged in activities that directly or indirectly impact climate change. The objective of this CAR is to manage the adverse impact of aviation activities on the atmosphere leading to sustainable growth of the industry.

- The CAR, "Climate Change Initiatives and Local Air Quality Monitoring in Civil Aviation"
- The CAR, "Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)"

6.2. TECHNOLOGICAL IMPROVEMENTS

6.2.1. FLEETS MODERNISATION & RENEWAL

Indian airlines play an important role in overall aviation emissions reductions. All the Indian carriers have a very young fleet and they operate modern, fuel efficient aircraft (e.g. Boeing 787 Dreamliner, Airbus 320/B737 NG with sharklets/winglets). According to historic trends in measurements of aircraft fuel usage per seat, modern aircraft are approximately 80% more fuel efficient than aircraft of the 1960s through a combination of increased passenger capacity and technological improvements to improve fuel usage.

Air India, which is the national carrier of India operates a significant number of Boeing 787 aircrafts. The 787 family provides airlines with unmatched fuel efficiency, resulting in exceptional environmental performance. The airplane uses 20 percent less fuel than today's similarly sized airplanes. The key to the exceptional performance of the 787 Dreamliner is its suite of new technologies and its revolutionary design. Composite materials make up 50 percent of the primary structure of the 787, including the fuselage and wing. It's wings, tail, nose and flight deck windows have all been engineered for the maximum aerodynamic efficiency, reducing fuel burn. Advances in engine technology are the biggest contributor to overall fuel efficiency improvements on the Dreamliner. The 787 features new engines from General Electric that represent nearly a two generations jump in technology. The Boeing 787 airplane is manufactured using fewer hazardous materials, consumes 20% less fuel and produces 20% fewer CO2 emissions.

As well as number of other carriers are operating A320 Neo aircraft that is powered by quiet, fuel-efficient engines. These next-generation engines have also taken another great step forward. Compared with conventional engines, they

consume approximately 15 per cent less fuel, reducing carbon dioxide emissions accordingly. Nitrogen oxide emissions are even reduced by 22 per cent thanks to a new combustion chamber, the TAPS II (twin-annular, pre-mixing swirler).

A number of Airlines are also using ATR 72-212A (600 Version) aircraft, which is a state of ART modern aircrafts. recognized as the most fuel-efficient aircraft in their category, due to high-tech engines and propeller efficiency. Compared with an equivalent jet aircraft on a 300Nm average trip, the ATR 72 provides a 35% block fuel saving per passenger. Airlines have also inducted B737 Max aircrafts to its fleet, which is 14-15% more efficient than its previous fleets.

Initiatives have also been taken towards engine modification and fleet upgradation. Airlines are replacing older engines which improves fuel efficiency by 14-16%. Airlines are also selecting engines with High by Pass Ratio which is fuel efficient and low noise emission with greater thrust.

6.2.2. ENGINE-PERFORMANCE IMPROVEMENT

Apart from inducting newer fleets, Indian airlines are continuously focusing on improving the engine performance of all existing aircrafts. Airlines have adopted engine ECO wash at regular intervals improves thrust specific fuel consumption. This is a closed-loop system that protects the environment and offers a mobile, fast, repeatable, and efficient process. Deionised, heated and atomised water is sprayed to clean the engine components without the use of any toxic chemicals or detergents. The water is collected and filtered to produce pure, deionised water for reuse. Further, airlines are ensuring Engine Gas path cleaning with a higher frequency and many airlines are exploring the use of advanced 360-degree foam wash for engine gas path. In addition, all the airlines are carrying out periodic Engine Hot section core wash to improve overall performance and ensure reduced emission from aircrafts.

Airlines are also adopting de-rated take offs and de-rated Climb schedules to ensure reduced thrust (de-rate) may be used in both take-off and climb to extend engine life and reduce maintenance cost. Along with this, airlines are also conducting engine condition monitoring on real time basis (24X7), which apart from other benefits such as risk mitigation, fact based decision making, Combustion Dynamics Monitoring also help in reducing engine emissions.

Airlines are also focussing on scheduled and predictive maintenance that leads to efficient engine function. Engine bleed leak tests are being carried out by airlines for checking the pneumatic system manifolds for any leakage and rectifying the same as necessary.

6.2.3. FUEL-EFFICIENCY IMPROVEMENT

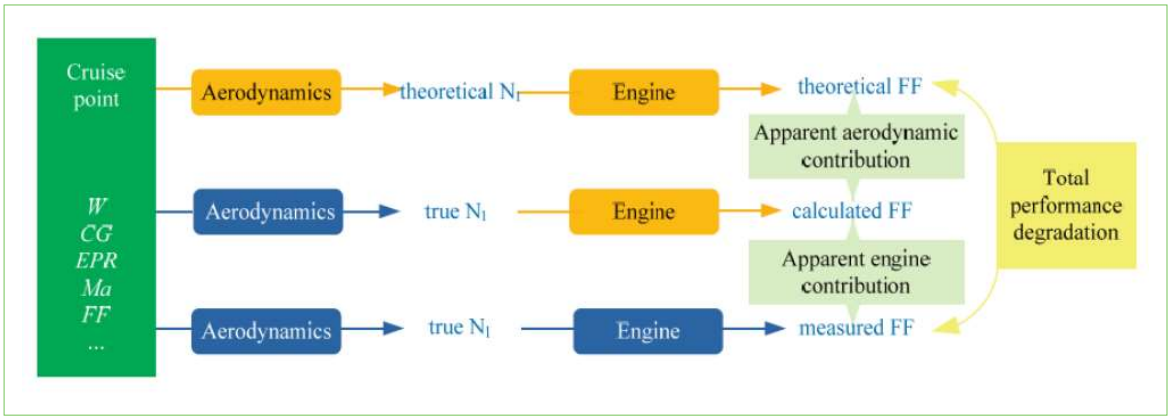
Fuel cost is a major part of overall operating expenses of airlines. Indian carriers along with OEMs are working towards fuel efficiency improvements of their fleets. Some of the key steps taken by airlines are-

- Many airlines have adopted outstation certification of aircraft by Foreign Approved Maintenance Organisation (FAMO), this has reduced the carriage of on-board spares, thus reducing in weight and improving overall fuel efficiency. Aircrafts are also participating in pooling arrangement of spare parts at various destinations to reduce on board weights.
- Airlines are also using the of FEGP or GPU and ground air-conditioning unit available in airports, instead of APU while on ground. This has reduced aircraft fuel consumption and associated emissions.
- Airlines are also following IATA best fuel saving practices using "Skybreathe fuel efficiency software" with planned 2% of fuel saving overall. Airlines are also focussing on 2% fuel savings target using measures such as optimization of alternates, reduction in fuel carriage (Destination holding time, Taxi out, Disp. extra) etc.
- Airlines also advice their pilots to adopt One Engine Taxi Departure and Taxi Arrival. Aircrafts also uses Packs off departure to ensure engine can attain maximum thrust with minimum fuel consumption.
- Airlines are also using data driven provision for additional fuel (for destination holding to at traffic delays) through monthly reviews, which helps in better fuel planning to avoid carrying extra fuel.
- Deployment of aircraft (e.g. B747-400, B777-200 LR/300 ER & B787-8) on optimum sectors based
    a. Range, Seating Capacity, passenger load and sector length.
    b. Further on the aircraft performance factor within a fleet type.
- Airlines are adopting weight reduction through use of electronic flight bag, thereby reducing 40 kg of on-board documentation per aircraft which results in savings of approximately 1.2 kg/hr of fuel burn for each aircraft.
- Pilot performance report is being shared with the respective pilots to identify the potential fuel savings and enhance the fuel savings.
- Airlines also focuses on judicious uplift of potable water and meals etc. to reduce on board weight.
- Airlines issue guidelines to pilots to adopt single pact operations for Taxi In & taxi Out and Idle reverse landing

6.2.4. AIRFRAME PERFORMANCE IMPROVEMENT

Airframe performance plays a major role in improving overall aerodynamics of Aircrafts and overall fuel consumption of aircrafts. Some of the key measures adopted by airlines are-

- Airlines are focussing on regular repair of dents, cracks etc. in order to reduce drag at earliest possible opportunity and improve fuel efficiency.
- Airlines carry out regular aerodynamics cleanliness check for airframe drag issues:
  - ✓ Surface Irregularities/Mismatch: Cleaning the fuselage and other surfaces and removing any unevenness or dents etc. especially in the aerodynamically critical areas of the aircraft.
  - ✓ Seal Checks: checking the condition of all seals at flight controls, entry doors etc. and replacing as found necessary.
  - ✓ Flight control rigging: Checking the flight control rigging and adjusting as necessary.
  - ✓ Flight instruments: Checking the flight instruments for accuracy and calibrate as necessary.
- Aircraft performance monitoring for any deteriorations and high fuel burn are rectified via corrective maintenance such as cleaning and ensuring properly flushed surfaces.
- Some of the airlines have modified aircrafts by adding sharklets. Sharklets save around 3% fuel as compared to non-sharklets aircrafts.



AIRCRAFT PERFORMANCE MONITORING

6.3. OPERATIONAL MEASURES

Another focus area for Indian aviation sector is improving operation efficiency. Improving operational efficiency requires a collaborative approach among aviation stakeholders such as airlines, Air Navigation Service Provider, Airports, Ground handling agencies etc. All these key stakeholders are working coherently to ensure high operational efficiency in Indian aviation sector. Some of the key measures are-

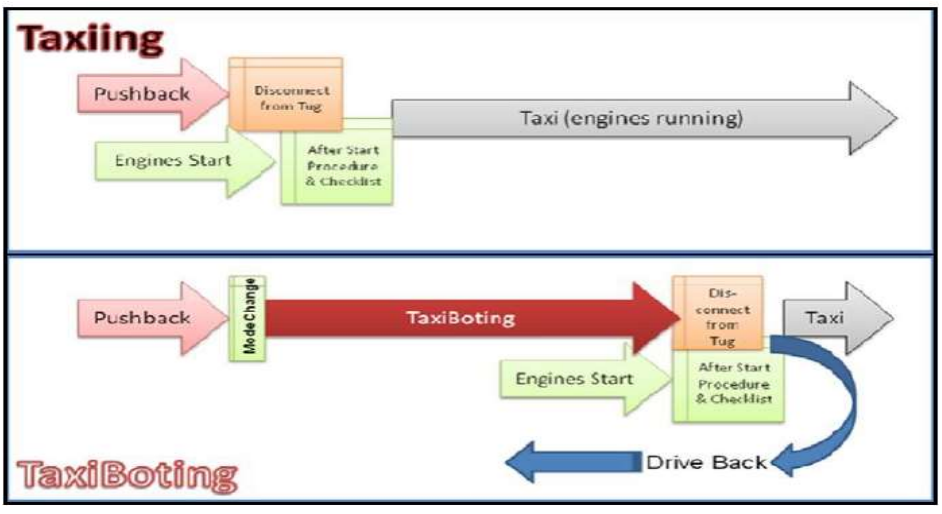
6.3.1. AIR TRAFFIC FLOW MANAGEMENTS

In order to regulate air traffic, all the aviation stakeholders have taken a number of initiatives. All the major metro airports in India has implemented A-CDM. A-CDM can reduce airport and en-route delay and optimize airport operations, by increasing an efficient turnaround pro- cess and improving flight predictability through real time data exchange for air navigation services.

Airports Authority of India (AAI) has established a Central Air Traffic Flow Management (C-ATFM) system in India. The C-ATFM system is primarily meant to address the balancing of capacity against the demand to achieve optimum utilization of the major resources viz., airport, airspace and aircraft at every Indian airport where there is a capacity constraint. The C-ATFM network consist of a Central Command Center (CCC) at Delhi supported by Flow Management Positions (FMPs) at major Area Control Centres (ACCs) and ATC towers across the country. The CCC provides ATFM service in conjunction with the FMPs. The C-ATFM system provides ATFM services covering all the four Indian FIRs including the oceanic airspace areas of Bay of Bengal, Indian Ocean and Arabian Sea, designated to India for the provision of ATS Services. This is called Indian Air Traffic Flow and Capacity Management (ATFCM) area.

Airlines are sending updated schedule on a regular basis to ATFM developed by Airport Authority of India (AAI) on which they analyse the density of flights for optimum utilization of the airspace and Aerodrome utilization. Implementation of A-CDM along with ATFM has given significant reduction in aircraft holding overhead the Airport.

Apart from this, airlines and Airports have developed and implemented additional measures to improve on-time performance and reduce ground delays. One of the highlight measure is implementation of TaxiBot in Delhi Airport. Number of Airlines have participated in the trial phase. Currently, commercial use of TaxiBot have been started at Delhi Airport. This is the first instance of commercial use of green taxing across the world.

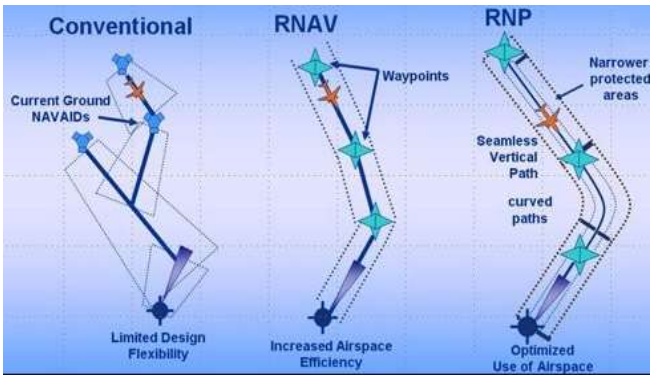


TaxiBoting Operation at Airport

6.3.2. REQUIRED NAVIGATION PERFORMANCE

Air Navigation Service Provider (ANSP) is currently focussing on RNP routes which provides optimum utilization of Airspace for fuel savings. Aircraft fleets are approved for various PBN specifications inclusive of RNP APCH. Airlines are also using UPR system enabling them to make best use of the available airspace on the operating sector is being considered under which CDR has been introduced. Filing user preferred routes in co-ordination with ATC helps airlines in saving of 1-2% fuel consumption.

CDR program has been launched jointly by Civil and Defence authorities under which AUP are issued on daily basis for civil operators to plan flights for the next day as per the available rotes and timings. Stakeholders are also working towards flexible routes development such as CDR-2, UPR, OTS etc. Direct routings are given by ATC as far as practical for departures based on the traffic scenario. Pilots are advised to request for more direct routing (subject to ATC Approval). It is estimated that 1 min of direct routing can save around 36 kgs of fuel.



INDIA TO START USING SPACE-BASED ADS-B

6.3.3. ELECTRIFICATION OF GROUND FLEET

Airports, Airlines, ground handling agencies and other aviation stakeholders are progressively shifting towards electric vehicles. In few Airports, airlines are also using battery swapping system for electrical tugs and all tarmac operations (tail to tail) are being carried out by electrical tug. Delhi Airport has also set up electric charging facilities for electric vehicles and have deployed electric buses for passenger movement in the city side within the airport. At many Airports Ground Handling Service Providers have introduced Battery Powered Electric Vehicles which has reduced emissions.

Battery operated BFL (EBFL)

6.3.4. OTHER OPERATIONAL MEASURES

Apart from the above listed measures some additional measures being adopted by Airlines and Airports are

Smart Tracking

Airlines have adopted flight tracking mechanism and well defined procedures for flight tracking have been put into place. In addition, smart tracking of old vehicles by service provider on GSE are also being used. With the tracking and monitoring, Airlines and GSEs are ensure that all performance records of GSE are checked and improvements as necessary are carried out.

Continuous climb & Descent Operation (CCO)

Airlines are focussing on Continuous climb and descent operation based on ATC advice. It is estimated that CCO can save around 270 Kgs of fuel per flight, whereas CDO can save around 200 Kgs of fuel per flight.

Improved flight plan calculation

Airlines have adopted improved flight planning system and fuel calculation methods. In this initiative, all the fixed fuel parameters are converted to system calculated values. By optimizing the flight plan calculations, approximately 400kg fuel uplift is reduced per flight, and also resulting in reduction in carbon emission.

Optimum Center of Gravity

The Center of Gravity limits are defined for each aircraft to make sure the aircraft maintains a safe flight through all phases of flight. Considering the fuel burn, a forward CG will lead to an extra fuel burn and an aft CG will lead to a lower fuel burn. Airlines have adopted a practice to place the CG aft, ensuring to stay within the safety limits. This helps in planning the CG aft, whenever operationally possible and thereby leading to lower fuel burn and CO2 reduction.

Low drag approach

Airlines have introduced low drag approach policy wherein all the landing will be done by using Flap 30 instead of Flap 40 (except performance limited airfields). This brings a fuel savings of 16kg per landing compared to flap 40 landing, which results in reduction of 50.512kg of CO2.

Idle thrust reverser

If adequate runway length is available, all the landings are preferably done with Idle thrust reverser by Airlines. This brings a fuel savings of 13.7 kg per landing, which results in reduction of 43.25 kg of CO2.

Improved method for calculating DEST hold fuel requirement

DEST Hold fuel is calculated to cover anticipated hold over destination airport due to traffic congestion and weather. Airlines have adopted improved calculation methodology for DEST Hold. This has increased pilot confidence on CFP fuel calculation and has helped to reduce the average Pilot extra fuel to below 100kg.

Cost Index

Airlines have converted from Mach flying to Dynamic Cost Index flying which results in reduction of Fuel consumption and Carbon dioxide emissions. In addition, airlines have also reduced contingency fuel from 10% to 5% based on routes and destination airport condition.

6.4. CORSIA AND EMISSION REPORTING

The Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) was adopted at the 39th session of the ICAO Assembly in 2016. The ICAO Council approved this adoption of a global market-based measure scheme to address CO2 emissions from international aviation on 27th June 2018. The aim is to address any annual increase in total CO2 emissions from international civil aviation above 2020 levels and contribute to the industry's commitment to carbon neutral growth from 2020. This market-based measure was adopted based on ICAO's aspirational goal of Carbon Neutral Growth beyond 2020 levels. CORSIA will be in effect from 2021-2035 and cover only emissions from international airline routes. On average (2021-2035), flights subject to CORSIA's offsetting requirements will account for over 600 million tons of CO2 per year. This makes CORSIA one of the largest carbon pricing instruments in the world in terms of greenhouse gas emissions coverage.

Under Monitoring, Reporting & Verification (MRV) provision of CORSIA, airlines will capture fuel consumptions from international operations and submit the carbon emissions to DGCA annually. Indian airlines started monitoring Fuel Consumption from all international Flights as per DGCA CAR on CORSIA from 1st January 2019. Airlines has set up Quality Processes for Quality Check of CORSIA data through an Internal Audit Team. The Internal Audit Team carries out Quality Checks on CORSIA data on a Quarterly basis and Internal Pre-verification of CORSIA data and Processes to comply with approved Emissions Monitoring Plan, DGCA CAR on CORSIA, ICAO's ETM-Environmental Technical Manual (Doc 9501) and Annex 16 - Environmental Protection (EP), Volume IV - CORSIA.

The CORSIA verification pertaining to international flights covering the period 1st January 2019 to 31st December 2019 was conducted in the month of February - March 2020 by DGCA accredited Verifier with oversight by DGCA and M/s NABCB.

6.5. INITIATIVES BY AIRPORTS

Airports is a focal point of aviation activities, such as flights, passenger/public access, and all support functions such as ground handling, catering, fuelling. Airports play a major role in establishing guidelines and recommendations for emission reductions. Airports can contribute and support the overall improvement in aircraft's emissions through more efficient use and planning of airport infrastructure and operations. Some of the key measures adopted by Indian Airports are highlighted below-

6.5.1. AIRPORT CARBON ACCREDITATION PROGRAM OF ACI

Airport Carbon Accreditation is the global standard for carbon management in the airport industry. It aims to encourage and enable airports and its stakeholders to implement best practices in Greenhouse Gas (GHG) management and achieve emission reductions.

The Airport Carbon Accreditation programme of ACI was launched in 2009. Initially, the Program had 4 Levels- "Level 1: Mapping", "Level 2: Reduction", "Level 3: Optimisation" and "Level 3+ Neutrality". Delhi Airport reached "Level 3+, Neutrality" in 2016, as the first Carbon Neutral Airport in Asia Pacific region. After this Hyderabad, Mumbai and Bangalore Airport also achieved Level 3+ accreditation and became carbon neutral airports.

In 2020, ACI had revised the program's Levels and added two new levels, Level 4 (Transformation) and Level 4+ (Transition). These two Levels have been introduced to make the programme objectives in line with Paris Agreement and to limit the increase of global average temperature to 2°C above pre-industrial levels and aim to not exceed 1.5°C.

This is also in line with IPCC's recommendations & ICAO's Aviation Climate Change mitigation objectives. Level 4+ encourages airports to reduce their emissions as per the latest scientific developments and meet to stakeholder expectations. Delhi International Airport Limited has become Asia Pacific's first Level 4+ (Transition) accredited airport under ACI's Airport Carbon. As of now Delhi Airport is only the second Airport globally to have achieve Level 4+ accreditation. Delhi Airport is also working towards becoming a zero emission airport by 2030.

Some of the emission reduction measures adopted by airports in India are-

- Green infrastructures concepts
- Renewable/Green Energy Generations
- Airport Collaborative Decision Making (A-CDM)
- Energy Efficiency Measures for Terminal Buildings
- Integrated Building Management System (IBMS) for energy efficiency
- LEDs at Buildings & Airport Ground Lightings networks
- UPS system for Airport Ground Lightings networks
- Bridge Mounted Equipment's (BMEs): FEGP & PCAs Supply
- Fuel Hydrant systems
- CNG Vehicle Operation & Fuelling Station
- Electrical Tugs & Buggies
- Multimodal Connectivity (Road & Metro)
- Environment Management System (ISO 14001) & Green House Gas Reporting System (ISO 14064)
- & Energy Management System (ISO 50001)
- Landscaping & Tree Plantations

6.5.2. GREEN INFRASTRUCTURE PROGRAM

Several Indian airports have obtained Green Building certifications i.e. LEED certifications (Leadership in Energy and Environment Design) and have adopted other measures as well, such as the use energy efficient systems, operating environment friendly vehicles, etc. To comply with green building requirements, airports have adopted renewable energy development and use, energy efficient systems & equipment, water efficiency measures, water recycling and reuse, rain water harvesting, water resource mapping, waste minimisation and waste to wealth measures etc.

6.5.3. RENEWABLE ENERGY PROGRAM

Indian Airports have been taking proactive measures for setting up of renewable energy sources such as solar power systems. Onsite renewable energy reduces grid dependency, helps in land utilization, reduces airport's overall GHG emission and also reduces overall energy cost.

Many Indian airports such as Delhi International Airport Limited (DIAL), Hyderabad International Airport Limited (HIAL), Bangalore International Airport Limited (BIAL), Cochin International Airport Limited (CIAL), Mumbai International Airport Limited (MIAL) and have installed solar power at their site and some of them are also using offsite renewable energy through open access. Number of Airport Authority of India run airports have also taken a lead in powering the airports through onsite and offsite renewable energy sources.

Cochin International Airport Solar Power Project is a 40 megawatt (MW) photovoltaic power station

7. FUTURE INITIATIVES

All the stakeholders including Airlines, Airports and Air Navigation Service Providers are continuously focusing on adopting improved technological measures, operational measures, developing state of the art infrastructures to reduce the overall emission load of aviation.

More emphasis will be given on PBN and ATM related technical issues to further streamline congestions at airports and airspace, avoid delays at runways for take-off and landings, etc. Indian Space Research Organization and Airport Authority of India has developed GPS-aided geo augmented navigation (GAGAN) satellite based navigation system which was certified by the DGCA. The system provides improved efficiency, direct routes, approach with vertical guidance at runways, reduced workload of flight crew and air traffic controllers, increased fuel savings. Going forward this system is going to benefit Indian aviation towards emission reduction.

Induction of new generation fleets, fleet upgradation, engine modifications, use of alternative and sustainable aviation fuel are some of the key focus area for airlines to reduce emission. All the airports are currently focussing on developing efficient and eco-friendly infrastructures which will not only enhance environmental performance but also will ensure safety, security and better flying experiences for passengers. All the airports have adopted green building concepts to develop new infrastructure and operate existing infrastructure.

Special emphasis is being given on electrification of ground handling equipment and vehicles, better surface access to reduce congestion and support growth of airports and aviation. Airports are also enhancing their renewable energy capacities.

The key initiative which will be a focus area for India are-

- All airlines will be advised to upgrade their fleets to fuel efficient aircrafts.
- Airlines will be advised to make use to data, tool and Artificial Intelligence to make better strategic decisions regarding fuel burn patterns.
- Airports and airlines will work collaboratively with DGCA to make green taxing feasible in India, with an objective of reducing ground emissions by airlines.
- ANS/ATC will prefer Continuous Descent Operation & Continuous Climb Operation and share information related to aircraft tracking and situational awareness at airspace and ground movement with the concerned Airport for better planning and improved operational efficiency.
- DGCA will work with other government agencies including MoPNG& private agencies for ensuring availability of bio jet fuels for aircraft use which is commercially viable. All aviation stakeholders shall also explore the possibilities of use of bio-fuel and other alternate fuels with lower emissions for ground vehicle application.
- All the new green field airports will install Bridge Mounted Equipment (BME), with Fixed Electrical Ground Power Units (FEGPU) and Pre Conditioned Air (PCA) supply provisions, with appropriate cost recovery mechanism. All existing airports will explore the possibilities of installing such facilities.
- All airlines will use the BME facilities if such facilities are available in Airports as a preferred choice for meeting on gate power and conditioned air requirements.

- All the aviation stakeholders including Airlines will adopt GHG management framework for their operation. Airports, ANS, Ground Service Agencies shall adopt GHG management frameworks as per ACI's Airport Carbon Accreditation & ISO 14064 and progressively move towards achieving carbon neutral status.
- All aviation stakeholders including Airlines, Airports, Ground Support Service Agencies, Air Navigation Service Provider, etc. shall adopt best energy and fuel efficient solutions that are technically feasible, economically viable and environment friendly for reduced GHG emission and preventing climate change.
- DGCA will issues guidelines and advisories to all stakeholders to adopt measures to reduce emissions in all areas—aircraft operation, ground support, airport infrastructure etc.

8. ASSISTANCE REQUIRED

India being a developing country and one of the largest markets for civil aviation globally has a major role to play in terms of improving overall aviation sector globally. It need to have a robust and financially sound market, which in turn will complement the growth and development of other countries. In order to ensure long term sustainability of Aviation market in India, it will need access to cleaner technology for airlines as well as for deployment in Airports. Also there is a need for improved capacity building among aviation professionals in India in order to develop competency to achieve desired objectives of implemented measures.

9. CONCLUSION

In aviation, investing in new technologies is the best strategy for protecting the environment and people. DGCA is confident that with the induction of latest technology, improved operational measures, better financing mechanism, favourable regulatory regime and updated knowledge and skills of aviation professionals in coming years will take Indian aviation to higher level of glory and it will help India fulfil the CNG 2020 goal of ICAO for international aviation.

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