SUGAM
SUSTAINABLE GREEN AIRPORTS MISSION
of Airports Authority of India
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of Airports Authority of India

2023
MESSAGE

Civil aviation is one of the fastest-growing sectors in India. The growing prosperity and aspirations of Indians are fueling an increase in demand for air travel. India is projected to have more than 50 crore air travellers by 2030 and has the potential to grow to be the world’s leading aviation market by 2047. During the year 2022, domestic passengers witnessed a growth of almost 50% while international passenger traffic grew by over 150%. Meanwhile, the number of airports and associated facilities will go up to more than 200 in the next three to four years. The major airports are also growing, with most of them implementing expansion plans.

The Indian aviation industry is working towards being environmentally conscious and sustainable. To balance this exponential growth, the sector has committed itself to a low-carbon growth trajectory. The Airports Authority of India (AAI), India’s leading airport operator and sole air navigation service provider, is committed to conserving the environment and resources and has instituted an Environment Policy. The policy reflects AAI’s commitment to sustainable development by implementing cost-effective carbon mitigation actions to preserve the environment and thus contribute to sustainable development goals.

In line with India’s Nationally Determined Contributions (NDCs), the AAI is adopting a climate-friendly and cleaner path through several initiatives including:

- Construction of terminals as Green Buildings with GRIHA (S-star) and according to ECBC+ guidelines
- 100% use of Green Energy at all its airports by 2024 and Net Zero by 2030
- Airports Council International’s Airport Carbon Accreditation (ACI-ACA) Level 2 certification for major AAI airports
- Adoption of electric vehicles

The Ministry of Civil Aviation (MoCA) has advised all the upcoming Greenfield Airports operators to work towards achieving Carbon Neutrality & Net Zero. AAI has taken the initial step with the Leh airport which is being built as a carbon-neutral airport harnessing both geothermal and solar energy. Developing net-zero airports calls not only for the use of Green Energy but also for the inclusion of adaptive design principles, new building materials and new Building Energy Management Systems.

I am pleased to note that AAI has prepared this SUGAM booklet to record all the initiatives taken for making Indian airports among the leading airports in terms of improved energy efficiency and use of Green Energy in its airport terminals.

As air transportation transforms from a luxury to a necessity MoCA and AAI hope to enable the growing air passenger base to travel at minimal carbon footprint.

(Jyotiraditya M. Scindia)
MESSAGE

The domestic and international connectivity of India by air has increased tremendously in the past few years. More and more Indians are travelling by air within India and abroad. The Ministry of Civil Aviation’s flagship program, Regional Connectivity Scheme UDAN (Ude Desh ka Aam Nagrik), has contributed immensely to fulfilling this aspiration of common citizens.

UDAN has significantly enhanced aviation infrastructure and regional connectivity since its launch in 2016. The Government has approved the ‘Revival of unerved and underserved airports’ scheme to revive and develop 100 unerved and under-served Airports by 2024. More than seventy unerved, underserved airports, such as Ludhiana, Kadappa and Deoghar, have already been operationalized for benefit of the citizens.

As the number of airports and air passengers is growing, reducing the carbon emissions from these airports becomes important. I am extremely pleased that the Airports Authority of India (AAI) has been at the forefront of decarbonizing their airports in-line with the Nation’s commitment to a sustainable and carbon-neutral future. I give my best wishes to the vision, achievements and roadmap of AAI towards clean and efficient energy systems brought out in SUGAM.

[Gen. (Dr.) V.K. Singh (Retd.)]
MESSAGE

Aviation sector in India has rapidly grown in the past ten years and still has tremendous potential to grow further. India’s domestic and international aviation sectors are still evolving to reach out to the common citizen and make air-travel affordable for all. It gives me much delight to share that India has big plans in the near future to continue adding new airports and improve air-connectivity.

This potential growth demands the need to manage the future huge inflow of passengers. Subsequently, the overall energy demand and resultant emissions from airport operations will also witness a rise. Energy use benchmarking at the airport terminal scan provide valuable insights into their consumption patterns, identify areas of improvement, and implement targeted strategies for energy optimization and emission reduction. This can be instrumental in the implementation of cost-effective carbon mitigation actions, contributing to AAI’s commitment to sustainable development.

I would like to commend AAI on bringing out SUGAM for showcasing the sustainable initiatives taken at its airports emphasizing on benchmarking of energy intensity, optimization of renewable energy and reduction in carbon footprint. This effort can promote transparency and knowledge sharing, encouraging other airports, in India and abroad, to learn from AAI’s experiences and contribute to the collective goal of achieving net zero emissions.

(Rajiv Bansal)

3rd June, 2024
The Airports Authority of India (AAI) was created to be the foundation of an enduring aviation network by providing high-quality, safe and customer-oriented airport and air navigation services, thereby acting as a catalyst for economic growth. AAI envisions achieving this by providing sustainable and robust airport infrastructure. Aviation is fundamental to the world economy and keeping people connected. Today more than ever, it plays a vital role in expanding horizons and broadening opportunities to work, live and learn for people worldwide. If even more people, communities and businesses are to enjoy these benefits, the aviation sector must grow responsibly and play its part in a net-zero future.

AAI manages a total of 137 airports, including 24 International airports, providing air navigation services of over 2.8 million square miles of air space. During 2021-22, AAI handled 700,000 aircraft movements comprising 78 million passengers. AAI infrastructure consumed 322 GWh of electricity during 2021-22. Of this, about 30% was from renewable energy. AAI airports have installed a total of around 40 MWp of solar power; the rest was procured through open access.

AAI’s vision is to be an environmentally conscious enterprise, continuously taking up initiatives toward sustainable development while maintaining the highest standards of excellence in providing sustainable, modern and robust airport infrastructure. Towards this objective, AAI has set a carbon-neutral target for scope 1 and scope 2 emissions of AAI airports by 2027. AAI is continuously and consistently implementing best practices in carbon management and power generation from renewable sources of energy. Efforts are also being made to make terminal buildings sustainable, considering adverse climatic conditions. AAI has been conducting periodical Energy Audits of AAI Airports, and the recommendations of energy auditors are being implemented to optimize energy consumption. ACI-ACA Level-2 accreditation certificates have already been obtained for Kolkata, Bhubaneswar and Varanasi airports, and will soon be obtained for several other AAI airports also.

AAI airports are implementing best-in-practice methods such as investments in energy efficiency technologies, power generation from renewable energy sources, and procurement of renewable energy from open markets to minimize the carbon footprint. Several AAI airports are performing well in terms of certain benchmark indicators and are at par with the best of their peers in the country. Among the leading airports on passenger traffic, Chennai, Kolkata, Goa, Pune and Varanasi are doing very well on these benchmarks.

This booklet highlights the various initiatives taken up by AAI on sustainability and becoming carbon neutral, in line with the Panchamrit goals declared by the Hon’ble Prime Minister of India at COP26. The objective of this booklet is to document and inform all stakeholders about the initiatives being taken by AAI, learn over time, track progress, and seek cooperation in enhancing actions towards efficient and sustainable airport operations and achieving the target of carbon neutrality.

Sanjeev Kumar, IAS
Chairman
The purpose of SUGAM “Sustainable Green Airports Mission” is to showcase the sustainable initiatives undertaken by Airports Authority of India at its airports. The booklet emphasizes on renewable energy and energy efficiency measures. It highlights infrastructural initiatives such as adopting green buildings, installing solar power plants, and implementing energy-efficient HVAC systems and innovative & energy efficient technologies such as geo-thermal HVAC system etc.

Furthermore, the booklet emphasizes AAI’s participation in the Airport Carbon Accreditation program initiated by the Airports Council International (ACI) to follow best practices in GHG emission reduction.

SUGAM aims to promote transparency and knowledge sharing, encouraging other airports to learn from AAI’s experiences for achieving collective goal of net zero emissions and effectively mitigating the issues related with Climate Change.

I would like to express my gratitude and appreciation to all those who gave me their valuable support to complete SUGAM. I thank Sh. Sanjeev Kumar, IAS, Chairman-AAI for valuable inputs and suggestions to make SUGAM more informative and illustrative.

My Special thanks to Ms. Reena Rai, Executive Director (Tech), Mr. Mukesh Yadav, Jt. General Manager (Engg. Electrical), Mr. Gurpreet Singh, Assistant Manager (Engg. Electrical) and Ms. Parul Sharma, Assistant Manager (Ops) and other officers who have individually provided their valuable inputs in formulation of SUGAM.

I would also like to acknowledge the active participation and contribution of the Alliance for an Energy Efficient Economy (AEEE) in data analysis, benchmarking and developing this publication.

A. K. Pathak
Member (Planning)
AIRPORTS AUTHORITY OF INDIA

ENVIRONMENT POLICY

Airports Authority of India (AAI) being the sole Air Navigation Service (ANS) provider and operator of majority of Indian Airports is consistently and continuously honoring Corporate Social Responsibility (CSR) and is committed to Green House Gas (GHG) management and emission reduction to support India’s Nationally Determined Contributions (NDCs) for reduction of adverse impact on society, community and ecosystem. AAI is adopting "Panchamrit Mantra", declared by Hon’ble Prime Minister in Glasgow Summit COP-26 to ensure greener, cleaner and healthier environment for generations to come.

As a part of this policy, AAI is committed to reduce carbon intensity in a phased manner and achieve the goal of carbon neutrality and net-zero emissions by implementation of suitable measures including but not limited to:

- Optimizing energy consumption by enacting energy efficiency and conservation measures including maximizing the usage of affordable green and renewable energy resources.
- Reducing the fossil fuel consumption by promoting and adopting alternative greener fuels and ensuring judicious and deliberate use of natural resources.
- Integrating net-zero building design concepts and optimum usage of eco-friendly and biodegradable products without compromising structural integrity requirements and safety standards.
- Integrating sustainable transportation technologies and strategies with use of Electric and Hybrid vehicles.
- Implementing sustainable waste-management practices and appropriate disposal.
- Conserving natural resources by inculcating the culture of refuse, reduce, reuse, repurpose and recycle.
- Implementing water conservation through rain water harvesting, waste water reclamation and other emerging practices to reduce wastage.
- Documenting and quantifying GHG resources and mitigating carbon footprint by adopting best and technologically advanced procedures and implementing best industry practices in vogue.
- Monitoring air-quality and implementing best practices in vogue to improve indoor air quality at airport terminals.
- Implementing/Adopting best Air Traffic Management facilities, practices and procedures.
- Directing, educating, sensitizing, motivating and imparting training to all employees and stakeholders to enable them to understand desired behavior towards environment health.
- Fulfilling all applicable environmental compliance obligations.

AAI is dedicated for upholding this policy with responsibility and strives to periodically review the same in-line with emerging requirements and practices.

Sd/-
(Sanjeev Kumar)
Chairman, AAI
Dated: 16/08/2022
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<tr>
<td>AAI</td>
<td>Airports Authority of India</td>
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<td>ACA</td>
<td>Airport Carbon Accreditation</td>
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<td>A-CDM</td>
<td>Airport Collaborative Decision Making</td>
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<td>ACI</td>
<td>Airports Council International</td>
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<td>APU</td>
<td>Auxiliary Power Unit</td>
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<td>ATF</td>
<td>Airport Turbine Fuel</td>
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<td>ATM</td>
<td>Air Traffic Management</td>
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<td>AVR</td>
<td>Automatic Voltage Regulator</td>
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<td>BEE</td>
<td>Bureau of Energy Efficiency</td>
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<td>BEMS</td>
<td>Building Energy Management System</td>
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<td>BEV</td>
<td>Battery Electric Vehicle</td>
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<td>BMS</td>
<td>Building Management System</td>
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<td>CAPEX</td>
<td>Capital Expenditure</td>
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<td>CATFM</td>
<td>Central Air Traffic Flow Management</td>
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<td>CDOs</td>
<td>Continuous Descent Operations</td>
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<td>CIAL</td>
<td>Cochin International Airport Limited</td>
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<tr>
<td>CO₂</td>
<td>Carbon Dioxide</td>
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<tr>
<td>COP26</td>
<td>26th United Nations Climate Change Conference of the Parties</td>
</tr>
<tr>
<td>CSMIA</td>
<td>Chhatrapati Shivaji Maharaj International Airport</td>
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<tr>
<td>CY</td>
<td>Calendar Year</td>
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<tr>
<td>DGCA</td>
<td>Directorate General of Civil Aviation</td>
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<tr>
<td>DSM</td>
<td>Demand-side Management</td>
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<tr>
<td>FEGP</td>
<td>Fixed Electrical Ground Power</td>
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<tr>
<td>FY</td>
<td>Financial Year</td>
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<tr>
<td>GHG</td>
<td>Greenhouse Gas</td>
</tr>
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<td>GoI</td>
<td>Government of India</td>
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<tr>
<td>GPU</td>
<td>Ground Power Unit</td>
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<td>GROW</td>
<td>Government Recycled Office Waste</td>
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<td>GRIHA</td>
<td>Green Rating for Integrated Habitat Assessment</td>
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<tr>
<td>GW</td>
<td>Gigawatt</td>
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<tr>
<td>GWh</td>
<td>Gigawatt-hour</td>
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<tr>
<td>Abbreviation</td>
<td>Description</td>
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<td>--------------</td>
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<tr>
<td>HVAC</td>
<td>Heating, Ventilation and Air Conditioning</td>
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<td>IATA</td>
<td>International Air Transport Association</td>
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<td>ICAO</td>
<td>International Civil Aviation Organisation</td>
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<td>IEA</td>
<td>International Energy Agency</td>
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<tr>
<td>IGI Airport</td>
<td>Indira Gandhi International Airport</td>
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<tr>
<td>IPCC</td>
<td>Intergovernmental Panel on Climate Change</td>
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<tr>
<td>ISEER</td>
<td>Indian Seasonal Energy Efficiency Ratio</td>
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<td>ISO</td>
<td>International Organisation for Standardization</td>
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<tr>
<td>kWh</td>
<td>kilowatt-hour</td>
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<tr>
<td>kWp</td>
<td>kilowatt peak</td>
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<tr>
<td>LED</td>
<td>Light Emitting Diode</td>
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<td>LEED</td>
<td>Leadership in Energy and Environmental Design</td>
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<td>LTAG</td>
<td>Long-term Aspirational Goal</td>
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<tr>
<td>M&amp;V</td>
<td>Measurement and Verification</td>
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<tr>
<td>m²</td>
<td>Square meter</td>
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<tr>
<td>MU</td>
<td>Million Units</td>
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<tr>
<td>MW</td>
<td>Megawatt</td>
</tr>
<tr>
<td>MWp</td>
<td>Megawatt peak</td>
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<tr>
<td>NDC</td>
<td>Nationally Determined Contribution</td>
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<td>PAX</td>
<td>Passengers</td>
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<td>PBN</td>
<td>Performance Based Navigation</td>
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<tr>
<td>PCA</td>
<td>Pre-conditioned Air</td>
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<tr>
<td>PPP</td>
<td>Public-Private Partnership</td>
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<td>PSU</td>
<td>Public Sector Undertakings</td>
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<tr>
<td>PV</td>
<td>Photovoltaic</td>
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<tr>
<td>RE</td>
<td>Renewable Energy</td>
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<tr>
<td>RPK</td>
<td>Revenue Passenger kilometre</td>
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<tr>
<td>STP</td>
<td>Sewage Treatment Plant</td>
</tr>
<tr>
<td>tCO₂e</td>
<td>Tonnes of Carbon Dioxide Equivalent</td>
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<tr>
<td>VVVF</td>
<td>Variable Voltage Variable Frequency</td>
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Executive Summary

India is one of the largest domestic aviation markets in the world and handles the third-largest domestic traffic after the USA and China. Airports Authority of India (AAI) is India’s leading airport operator and sole air navigation service provider. It manages more than 100 airports and provides air navigation services for over 2.8 million square nautical miles of air space. In line with the Hon'ble Prime Minister’s goal of achieving net zero emissions by 2070, AAI is committed to conserving the environment and resources, and has instituted the “Environment Policy” that reflects its commitment to sustainable development by implementing cost-effective carbon mitigation actions to preserve the environment and thus contribute to sustainable development goals. AAI has set a plan to switch from fossil fuel-based electricity to green electricity and achieve 100% energy through RE in all airports.

Towards AAI’s decarbonisation efforts, energy performance and emission benchmarking exercises were conducted at multiple airports in India. It is important to note that airports’ energy and emission intensities are a function of the climate zone in which they are located since very hot and very cold climate warrant high HVAC energy consumption and GHG emissions. The GHG emissions from the Top-25 AAI-managed airports amounted to a total of 227 thousand tCO₂e in 2019 (Pre-Covid year). The emission intensity of the top 25 AAI-managed airports was calculated to be between 0.3-3.6 kgCO₂e/PAX/year.

Infrastructural initiatives by AAI at its airports include the adoption of green buildings and installation of solar power plants alongside technological initiatives, such as the replacement of previous light fixtures with LED light fixtures, installation of energy-efficient HVAC systems and adoption of innovative renewable energy technologies. Simultaneously, advancements in operational efficiency efforts, including improvement in Air Traffic management through the integration of strategies including Airport-Collaborative Decision Making (A-CDM) and Performance Based Navigation (PBN), will significantly augment operational energy efficiency. Concurrently, AAI is participating in the Airport Carbon Accreditation program launched by Airports Council International (ACI) to follow best practices in GHG emission reduction and has obtained ACI-ACA Level-2 accreditation certificates for four airports.

In the context of renewable energy, AAI is already meeting about 30% of its energy requirement through renewable sources and has a total installed solar capacity of around 40 MWp as of March 2022. AAI is committed to enhancing the solar capacity to 100 MWp by 2024. Going forward, AAI aims to achieve net zero emissions by 2050 to contribute to GoI’s goal of achieving net zero emissions by 2070.
Energy & GHG Emissions from Airports

Airports are among the largest and busiest places globally, with large daily passenger flows. The passenger traffic in AAI-managed airports was about 159.6 million (15.96 crores) in 2019-2020 (Airport Authority of India, 2020). India is the third-largest domestic aviation market globally and is predicted to become the world’s third-largest air passenger market by 2030 (GoI, 2019).

To cater to the needs of such a large and growing passenger base and flight and freight traffic, airports consume large amounts of energy. Electricity accounts for the largest share of the total energy consumption, with substantial contributions from heating, ventilation, air conditioning (HVAC), ground field lighting, and baggage handling systems. The electricity consumption of airports in tier 1 cities ranges from 80-90 MU per year, while that in tier-2 cities ranges between 1-4 MU per year.

The large consumption of fossil-fuel-based energy emits greenhouse gases (GHG) such as carbon dioxide (CO₂). Airports account for only 5% of total emissions by the global aviation industry (DGCA, 2013). The emissions from activities undertaken at airports need to be mitigated in order to achieve net zero carbon emissions.

As defined in the GHG protocol, the emissions of greenhouse gases must be divided into three scopes:

Scope I for direct emissions from fixed or mobile assets located within the Airport’s perimeter, over which an airport operator has independent control. They include emissions from the airport operator’s vehicles, emergency power backup, fire extinguishers, refrigerants, waste disposed at the airport site and other GHG emitting activities.

Scope II for indirect emissions associated with the production of energy (electricity, heat or steam) which include emissions from electricity procured from power utility at the airport.

Scope III for other indirect emissions which include emissions generated by stakeholders such as airlines, concessionaires, taxi operators, and other third parties operating at the airport.

Scope I and II emissions form a small part of total emissions and the largest share of airport emissions however is from Scope III. AAI targets to reduce Scope I and II emissions by 5% per passenger per year and to reduce direct emissions by 75% by 2030 (over the 2015 baseline) at its airports.

The Paris Climate Agreement aims to limit global warming to well below 2 degrees Celsius to prevent the worst impacts of climate change. According to Intergovernmental Panel on Climate Change (IPCC), this means achieving net zero carbon emissions globally by 2050 (IPCC, 2022).
At the 26th United Nations Climate Change Conference (COP26) at Glasgow, India presented a *Panchamrit* (five nectar elements) of climate action to intensify its actions towards a net zero economy. India’s new Nationally Determined Contributions (NDCs) translate the ‘Panchamrit’ announced at COP 26 into enhanced climate targets. As per the updated NDCs, India is committed to reducing the Emissions Intensity of its GDP by 45% by 2030 from the 2005 level and achieving about 50% cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030 (Union Cabinet of India, 2022). The NDCs are a step towards India’s long-term goal of reaching net zero by 2070. (GoI, 2022) The aviation sector is also actively contributing toward the attainment of these targets (Union Cabinet of India, 2022).

At the 41st ICAO assembly, India supported the adoption of long-term aspirational goal (LTAG) of net-zero carbon dioxide emissions from aviation by 2050 based on the State’s capability and special circumstances, maturity of the aviation market and national timeframe.

Globally, the aviation sector has taken many steps to comply with the Paris Climate Agreement. Airports Council International (ACI), in collaboration with members, has created a long-term carbon goal for their member airports:

“ACI member airports at a global level commit to reach net zero carbon emissions by 2050 and urge governments to provide the necessary support in this endeavor.”

Further, to encourage airports to follow best practices in GHG emission reduction, The Airport Carbon Accreditation by the ACI (ACI-ACA) developed in line with the GHG protocol and ISO 14064 principles, provides carbon management certification to the airports. It has six levels of accreditation with regard to carbon footprint (ACI, 2020), namely,

- LEVEL 1 | Mapping - Footprint measurement
- LEVEL 2 | Reduction - Carbon management towards a reduced carbon footprint
- LEVEL 3 | Optimisation - Third-party engagement in carbon footprint reduction
- LEVEL 3+ | Neutrality - Carbon neutrality for direct emissions by offsetting
- LEVEL 4 | Transformation - Transforming airport operations and those of its business partners to achieve absolute emissions reductions
- LEVEL 4+ | Transition - Compensation for residual emissions with reliable offsets

The accreditation aims to eliminate Scope I and Scope II emissions and, minimize Scope III emissions.

IGI Airport Delhi is Asia-Pacific’s first level 4+ accredited airport and is working towards achieving net-zero carbon emissions by 2030 (ACI Europe, 2022). AAI has also initiated carbon management programs at four airports: Kolkata, Varanasi, Bhubaneswar, and Trivandrum (Airport Authority of India, 2021). These airports have completed the first two levels of accreditation, “Mapping” and “Reduction.”

Net-zero carbon airports can be achieved using a combination of energy efficiency and renewable energy. Energy efficiency is often recognised as the “first fuel” and can help attain net-zero at a lower cost. According to the International Energy Agency (IEA), Sustainable Development Scenario, energy efficiency represents more than 40% of the emissions abatement needed by 2040.
Energy Efficiency & Renewable Energy Initiatives

An airport’s extensive infrastructure facilities are similar to small or medium-sized cities with high electrical energy demand. The main areas where significant electricity is consumed in airports are heating, ventilation, & air-conditioning, internal lighting, airfield & runway lighting, baggage handling, lifts and escalators, among others. The implementation of energy efficiency and renewable energy measures can help airports not only reduce their operational energy expenses but also reduce their carbon footprint.

2.1 Energy efficiency initiatives at airports

AAI is committed to promoting energy efficiency and carbon emission reductions in the design of airport infrastructure as well as in the selection of equipment (DGCA, 2021), (Airport Authority of India, 2021). The older facilities are being improved based on the latest technologies and processes, whereas the recent ones are constructed with maximum energy efficiency in mind. Some of the energy efficiency initiatives being undertaken at AAI Airports are as below:

**INFRASTRUCTURE**
- Green building design
- Electrification of ground transport
- Fixed Electrical Ground Power (FEGP)

**TECHNOLOGY**
- Building Energy Management System (BEMS)
- Pre-conditioned Air (PCA) units
- Occupancy sensors and dimmers
- Energy-efficient HVAC systems

**OPERATIONS**
- Integrated Airport Collaborative Decision-making (A-CDM)
- Optimisation of airport capacity utilisation
- Departure Slot Management (DSM)

**CERTIFICATION**
- Airport Council International - Airport Carbon Accreditation (ACI-ACA)
- GRIHA 5 star

*Figure 1: Energy efficiency initiatives*
Airport design and infrastructure

- AAI has taken initiatives and implemented various measures to minimize the carbon emissions at its airport terminals and committed to constructing all future terminals as Green Buildings with the highest GRIHA rating (5 Star) by adopting different green options for selecting materials, procuring energy efficient equipment, and following operations & maintenance best practices in the industry.

- Electrification of the ground fleet is being done at airports in-line with the Ministry of Civil Aviation’s order under which all airports handling more than 3.5 million (35 lakhs) passengers annually are required to replace old inefficient machinery with electric or fuel-efficient equipment.
  - Major airports like Chennai and Kolkata have already introduced Battery Electric Vehicles (BEVs) into their ground fleet.

- AAI plans to implement TaxiBots (semi-robotic, pilot-controlled electric towing tractors) at major airports to save ATF and reduce emissions.

- Implementation of Building Energy Management System (BEMS) at existing airports. Building Management System (BMS) is being implemented in the construction of new terminals. This enables monitoring and identifying opportunities for optimum utilisation of energy.

- Steps are being taken to install Fixed Electrical Ground Power (FEGP) & Pre-conditioned Air (PCA) units which allow for the usage of electricity instead of high GHG-emitting Aviation Turbine Fuel (ATF) when flights are docked at the airport.

Technology

- Energy efficient cooling systems, including high ISEER room and split air conditioners, are being used across airports.

- LED fixtures are being proposed for lighting in all new projects. AAI has replaced almost all of its conventional light fittings with LED light fittings in existing buildings.

- Energy Efficient Chillers and Variable Speed Drives are being installed to improve the efficiency of systems like air-conditioning plants and pumps.

- Automatic sliding doors and air curtains are being used to minimize the loss of conditioned air.

- Machine-room-less elevators, which are energy efficient and lighter, are being used, thereby conserving approximately 40% more energy than conventional elevators.

- Escalators with Variable Voltage Variable Frequency (VVVF) drives, and sensors are being provided at terminals to save energy.

- Works are being undertaken for the replacement of taxiway and apron edge lights with LED lights at airports.

- Sensors for Baggage location and occupancy are being installed in Baggage Conveyor Systems for automatic stoppage of baggage system in case of no load.

Operational

- Integration of Airport- Collaborative Decision Making (A-CDM) with Air Traffic Management (ATM) is being implemented at many airports. A-CDM is developed in-house by AAI and promotes on-time performance by airlines, thereby having a significant impact on carbon emissions caused by aircrafts on-ground. Integration of A-CDM with ATM has drastically reduced departure congestion.
and long queues of aircraft awaiting their turn for take-off, in turn reducing both fuel burn and carbon emissions.

- Central Air Traffic Flow Management (CATFM) technique is helping AAI to manage air traffic flow strategically in the Indian sky. This has helped ensure reduced delays and holding along with optimisation of capacity, leading to a reduction in fuel consumption and GHG emissions.

- Performance Based Navigation (PBN) supports the development of air routes, arrival-departure paths/ or approach procedures. This help optimize track miles, and descent and climb profile, thereby enhancing airspace capacity. Such measures improve the operational efficiency of aircraft operations and lead to a reduction in fuel consumption and GHG emissions.

- Development of adequate airfield capacity & optimisation of capacity utilisation

- Coordination with the Air Force for civilian use of military airspace to reduce the travel path

- Continuous Descent Operations (CDOs) have been implemented to permit aircraft to maintain a relatively fuel-efficient arrival flight path. This reduces not only fuel burn but also on-ground noise generation.

- Employment of Departure Slot management (DSM) in operations in operations has resulted in the improvement of on-time performance of airlines resulting in the reduction of departure congestion and queueing of aircrafts and in turn fuel consumption and GHG emissions.

- AAI is taking strong measures in waste management and has successfully implemented a single-use plastic ban. AAI is the first PSU in India to set up a Paper Recycling Unit in line with GROW (Government Recycled Office Waste) initiatives. AAI is also in the process to have a solid waste management system at its airports for recycle, reuse and proper disposal of waste.

- AAI has taken initiatives on water management by minimizing the wastage of potable water by processing wastewater and reusing treated water. Sewage Treatment Plants (STPs) and Rainwater Harvesting Systems are provided/planned with existing/new projects.

**Accreditation and certification**

- In line with global climate change initiatives, Airports Council International - Airport Carbon Accreditation (ACI-ACA) programme is being undertaken and has already been completed at three AAI airports namely, Kolkata, Bhubaneswar and Varanasi.

- Regular energy audits by specialised agencies are conducted at airports for taking up energy-saving measures consistently under identified short-term and long-term measures as per the Energy Conservation Act, 2001, issued by the Ministry of Power.

**2.2 Renewable energy at airports**

Airports hold significant potential for solar power generation owing to the availability of large, flat, and shadow-free chunks of rooftops at terminals, hangars, and car parks, along with buffer land around the runways. Typically, these lands are unsuitable for other activities due to regulatory requirements.

The solar power generated at airport premises helps complement the power requirement of terminals, leading to both lower electricity bills and carbon emissions. Moreover, during peak summer months, the surge in air-conditioning load coincides with solar generation, thereby compensating for the increase in power demand.
AAI has utilised its available rooftop areas and surplus land at several of its locations to generate renewable energy by installing rooftop & ground-mounted solar power plants. The following table presents the status of renewable energy at AAI airports, as on March 2022.

**Table 1: Status of renewable energy implementation at AAI airports**

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>RE from open access (2021-22)</td>
<td>44 MU¹</td>
</tr>
<tr>
<td>RE from On-site solar (2021-22)</td>
<td>41 MU</td>
</tr>
<tr>
<td>RE from Hydropower (2021-22)</td>
<td>15 MU</td>
</tr>
<tr>
<td>Total RE consumption (2021-2022)</td>
<td>100 MU</td>
</tr>
</tbody>
</table>

AAI has developed and commissioned in-house Solar Power Plants of a total capacity of around 40 MWp at 38 airports across India as of March 2022.

To emphasize its commitment towards the adoption of RE, AAI has developed a year-on-year roadmap for all the airports under their operation to move towards 100% electricity share through RE in electricity consumption by Dec 2024.

The share of renewable energy at AAI airports grew from 37 MU in 2017-18 to 98 MU in 2020-2021; by a significant 165%. In fact, as of December 2022, the entire electricity requirements of 25 AAI airports are being met through renewable energy resources.
Airport Energy Consumption Analysis

Any initiative towards the improvement of energy efficiency and reduction of GHG emissions would require an extensive understanding of energy use and consumption. Airport terminal buildings consume a large amount of energy during day-to-day operations.

3.1 Scope of the analysis

The airport energy-use benchmarking analysis considered 105 Indian airports of which 98 are AAI-managed and the rest are JV & PPP airports. The energy data of Joint venture (JV) and Public-Private Partnership (PPP) airports - Delhi, Bengaluru, Mumbai, Hyderabad, Nagpur, Chandigarh (Mohali) and Cochin were analysed. A category of ‘top 25’ airports has been formed to investigate the interaction between the size of the airport and its energy use. This category includes airports that were chosen based on annual passenger traffic in 2019-2020. Business metrics data i.e., annual passenger traffic and aircraft movement include both domestic as well as international values.

3.2 Data sources

All data collected was considered for the pre-pandemic year (2019-2020) and the pandemic year (2020-2021). Energy consumption and other energy-related data were sourced from individual stations. These data sets entailed variables like solar capacity, solar generation and electricity consumption data. Variables like total connected load, total terminal building floor area, end-use energy system data, annual diesel consumption and others have been used in this study.

3.3 Observations

The segregation for the analysis was performed at two levels: airport management and airport traffic. In the first level, airports were distinguished based on management as AAI-managed airports and JV & PPP airports. In the second level, 25 airports with the most passenger traffic were categorised into the ‘top 25’ and the remaining were categorised as the ‘rest’.

Business metrics

The annual passenger traffic in 2019-2020 was about 304 million (30.4 crores) which dropped by 66% to about 102 million in 2020-2021 during the pandemic (Fig. 3). AAI airports hosted nearly 40%
of the total passenger traffic in 2019-2020. The decline in passenger traffic in the pandemic year was slightly lower in AAI airports (63%) as compared with JV & PPP airports (68%). In 2019-2020, the passenger traffic handled by the top 25 airports accounted for more than 90% of the total passenger traffic, while passenger traffic in the top 10 airports accounted for 79% of the total passenger traffic. The corresponding proportions were around 89% and 74% during the pandemic year.

Figure 3: Annual passenger traffic for 2019-2020 and 2020-2021

The annual aircraft movement in 2019-2020 was nearly 2.3 million which declined by 54% during the pandemic year 2020-2021 to 1.1 million (Fig. 4). AAI airports accounted for nearly 44% of this total aircraft movement traffic. Yet again, the reduction in aircraft movements in AAI airports (63%) was slightly lower than in privately-managed airports (69%) during the pandemic year. The top 25% airports accounted for almost 88% and the top ten airports accounted for 74% of the total aircraft movements in 2019-2020. The corresponding proportions were 85% and 71% in 2020-2021.

Figure 4: Annual aircraft movement for 2019-2020 and 2020-2021
Airport size

Airport terminals across India span a total floor area of about 2.9 million m², out of which AAI-managed airports account for 41% (Fig. 5). Further, the top 25 airports occupy almost 88% of the total floor area, whereas the rest of the airports account for only 12%. The top ten airports account for roughly 75% of the total floor area of all Indian airports.

![Distribution of terminal building floor area](image)

**Figure 5: Distribution of terminal building floor area**

Airports with large terminal building area and extensive operations require significant energy to function. The total connected load of these airports amounted to 314 MW in 2020-2021 of which the AAI-managed airports comprise 28% (89 MW) (Fig. 6). The connected load of the top 25 airports is nearly 87% whereas that of the rest of the airports is only 13%. The top 10 airports had a connected load of 241 MW.

![Distribution of total connected load in 2020-2021](image)

**Figure 6: Distribution of total connected load in 2020-2021**

Annual energy consumption

The energy consumption analysis was carried out for solar and grid electricity and electricity from open access. The annual electricity consumption in 2019-2020 was 884 MU (Fig. 7). AAI-managed airports consumed 292 MU of grid-based electricity and 81 MU of solar electricity in 2019-2020, which is lower than the total electricity consumed by JV & PPP airports. The amount of grid-based and solar electricity consumption was nearly 612 MU and 188 MU, respectively, for the top 25 airports as shown in (Fig. 7).
The electricity consumption for the pandemic year 2020-2021 declined to 753 MU for all airports (Fig. 8). AAI-managed airports consumed 240 MU of grid-based electricity and 83 MU of solar electricity in 2020-2021. The amount of grid-based and solar electricity consumed by the top 25 airports was 369 MU and 316 MU, respectively in 2020-2021.

Annual electricity consumption experienced a 15% fall during the pandemic year 2020-2021 vis-à-vis 2019-2020 (Fig. 9). AAI-managed airports alone witnessed a drop of 14% in consumption. The top 25 airports experienced a 14% decline in electricity consumption whereas the top 10 airports saw a fall of 13%. During the pre-pandemic year of 2019-2020, 22% of all electricity consumed by Indian airports was from solar. Concurrently, for AAI-managed airports and JV & PPP airports, 22% and 23% of their respective electricity consumption were from solar.
Apart from the regular electricity supply, a backup power solution is required in airports for their continuous and uninterrupted operations. Typically in India, standby generators run on diesel, to protect airport operations from the adverse consequences of power failure. The airports under analysis consumed 1,614 kilolitres of diesel in 2020-2021 of which AAI-managed airports consumed 79% (Fig. 10)

AAI manages a considerable number of airports in smaller cities. The lower power quality and reliability at these locations due to recurrent power failures necessitate higher dependency on diesel-based standby power generators. This reflects in the higher share of AAI-managed airports in the total diesel consumption.
3.4 Airport energy benchmarking

The energy efficiency of airports has been evaluated using energy performance indicators in recent research. They capture the energy consumption generated in relation to indicators based on economic or thermodynamic principles (Alba & Manana, 2016). The measures highlighted in the current analysis for each financial year (2019-2020 & 2020-2021) are energy intensity of passenger traffic (kWh/passenger/year), the energy intensity of aircraft movement (kWh/aircraft movement/year) and energy intensity per unit floor area (kWh/m²/year).

Energy intensity of passenger traffic

The energy intensity\(^2\) of passenger traffic for all airports in 2019-2020 was 2.9 kWh/passenger/year (Fig. 11). This sharply increased to 7.3 kWh/passenger/year during the pandemic year 2020-2021. The energy intensity for AAI-managed airports was 3.1 kWh/passenger/year for 2019-2020. An increase in the energy intensity of passenger traffic was observed during the pandemic year (2020-2021) with the energy intensity of AAI airports increasing by 129% to 7.1 kWh/passenger/year. This increase was however lower than the increase in JV & PPP airports which saw a 168% (2019-2020: 2.8 kWh/passenger/year, 2020-2021: 7.5 kWh/passenger/year) rise in energy intensity of passenger traffic in 2020-2021. The top 25 airports experienced an increase in the energy intensity of passenger traffic from 2.8 kWh/passenger/year to 7.4 kWh/passenger/year. Meanwhile, the top ten airports experienced a hike from 2.9 kWh/passenger/year to 8 kWh/passenger/year.

![Figure 11: Energy intensity of passenger traffic](image)

Energy intensity of aircraft movement

The energy intensity of aircraft movement increased from 384 kWh/aircraft movement/year in 2019-2020 to 712 kWh/aircraft movement/year in 2020-2021 as the number of aircraft movements reduced significantly (Fig. 12). AAI-managed airports saw an increase in energy intensity of aircraft movement from 365 kWh/aircraft movement/year to 671 kWh/aircraft movement/year during 2020-2021. On the other side, JV & PPP airports experienced an increase from 399 kWh/aircraft movement/year to 746 kWh/aircraft movement/year during the same period. The top 25 airports saw an upswing in energy intensity of aircraft movement from 396 kWh/aircraft movement/year to 758 kWh/aircraft movement/year. The corresponding figures for the top ten airports were 405 kWh/aircraft movement/year and 801 kWh/aircraft movement/year, respectively.

\(^2\) Energy intensity includes electricity from the grid, onsite-solar and open access renewables. It does not include other forms of energy.
Overall, the energy consumed per unit of area declined from 309 kWh/m²/year in 2019-2020 to 263 kWh/m²/year in 2020-2021 (Fig. 13). The energy consumed per unit of area at AAI-managed airports was 322 kWh/m²/year in 2019-2020 which dropped to 277 kWh/m²/year in 2020-2021. For the top 25 airports, the energy consumed per unit of area was 318 kWh/m²/year and 272 kWh/m²/year for 2019-2020 and 2020-2021, respectively.
With a closer look at the benchmarking analysis, it can be observed that decrease in energy consumption at airports is not proportionate to the decrease in passenger traffic due to the fixed baseload of airport infrastructure such as navigation equipment which is always operational irrespective of the passenger movement. At the same time, the lighting and HVAC operations have to meet certain indoor environmental parameters irrespective of the number of passengers inside the airport. Implementation of more flexible systems and enhancement of operations with system-level monitoring could increase energy efficiency within airports.

Concurrently, it has to be noted that the AAI-managed airports at several smaller cities (Tier-2 and Tier-3) have been developed keeping in mind the socio-economic development and connectivity needs of the vast demography and geography of India. They have not reached their peak potential in terms of passenger or aircraft movement traffic. The major component of energy consumption at these airports is the fixed load, hence, improvement of the energy performance of these airports is a challenge.
Capacity Utilisation

4.1 Scope

This passenger capacity utilisation analysis was conducted for 77 AAI-managed airports for 2019-20. The top 25 Indian airports based on passenger traffic for 2019-2020 are considered to have a better understanding of emissions in airports with higher passenger footfall.

4.2 Data Sources

Data for annual passenger capacity in million passengers per annum (MPPA) was collected along with the designed capacity of the airport. Annual passenger traffic for 2019-2020 was considered for the analysis.
4.3 Observations

On average, Indian airports used around 81% of their total designed passenger capacity in 2019-2020. The passenger capacity utilisation in 2019-2020 for the top 25 airports based on passenger traffic is as below: (Fig. 14).

![Figure 14: Passenger capacity utilisation of top-25 airports in 2019-2020](image)

The passenger capacity utilisation of 77 AAI-managed airports in 2019-2020 was 77% while that of privately-managed airports was 85%.
Figure 15: Total passenger capacity utilised in AAI-managed and privately-managed airports in 2019-2020

Typically, optimum energy intensity performance is achieved at a full capacity utilisation of the terminal building. Most of the AAI-managed airports have not reached the peak of their designed passenger handling capacities and have further scope for improvement in energy performance with an increase in passenger flow.
Airport GHG Emissions Analysis

5.1 Scope

This emission benchmarking analysis was conducted for 80 AAI-managed airports for the 2019 (January 2019 – December 2019). The top 25 AAI-managed airports based on passenger traffic for 2019 were grouped together to have a better understanding of emissions in airports with higher passenger footfall. Scope 1 and 2 emissions were considered for the analysis.

5.2 Data source

All data collected was for 2019. Scope 1 and 2 emissions for 80 airports were collected from individual airports. Wherever unavailable, scope 1 emissions were calculated through approximations.

5.3 Observations

AAI-managed airports emitted a total of 227 thousand tCO$_2$e in 2019. Of this, the top 25 AAI-managed airports contributed to 81% of the emissions.
The emission intensity of the top 25 AAI-managed airports ranges between 0.3-3.6 kgCO₂e/PAX/year (Fig. 16). For the top 5 airports (based on passenger traffic) the average emissions intensity is 1.3 kgCO₂e/PAX/year and for the rest of the 20 airports, the average emissions intensity is 1.8 kgCO₂e/PAX/year. Annexure I contain the emission intensity of passenger traffic for 46 AAI-managed airports.

The average emission intensity of passenger traffic was 1.81 kgs of CO₂e/PAX/year for 274 ACA-accredited airports across the world as of May 2019 (ACI, 2019). The average emission intensity of the top 25 AAI-managed airports is 1.81 kgs of CO₂e/PAX/year which is well below the average for the Asia-Pacific region (Table 2). The average emission intensity of the top 5 AAI-managed airports is 1.32 kgs of CO₂e/PAX/year which is lesser than the average emission of North America’s airports.
### Table 2: Region-wise average emission intensities

<table>
<thead>
<tr>
<th>Region</th>
<th>GHG emission intensity (kgCO₂e/PAX/year) for 2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europe</td>
<td>1.31</td>
</tr>
<tr>
<td>Asia-Pacific</td>
<td>2.51</td>
</tr>
<tr>
<td>North America</td>
<td>1.59</td>
</tr>
<tr>
<td>Latin America and the Caribbean</td>
<td>0.76</td>
</tr>
<tr>
<td>Africa</td>
<td>3.87</td>
</tr>
</tbody>
</table>

*Source: (ACI, 2019)*

AAI-managed airports are making continued efforts to become carbon neutral. Apart from the 3 AAI-managed airports that have already achieved ACA level 2 accreditation, AAI is gearing towards getting 23 more airports accredited by the end of this year. Furthermore, it is planned to leverage solar generation at airports to offset carbon emissions. AAI-managed airports are currently generating approximately 33,000 carbon credits worth of renewable energy per year. Projects worth 14,000 carbon credits at Bhubaneswar, Hubli and Agartala airports are projected to be completed by 2022-2023.
AAI intends to develop and implement the renewable energy roadmap across all AAI-managed airports. The goal is that these airports minimize their contribution to the overall greenhouse gas emissions produced by their operations. The roadmap emphasizes strengthening and implementing the National Green Aviation Policy developed by the Ministry of Civil Aviation, GoI. Cumulatively, as of Dec 2022, AAI-managed airports had a solar installed capacity of 54.3 MWp and plans to reach up to 100 MWp by Dec 2024 (Airport Authority of India, 2021).

6.1 Renewable energy implementation plans

The roadmap for the implementation of renewable energy at its airports has been prepared by AAI (Fig. 17). AAI aspires for a phase-wise plan for the incrementation of solar capacity/RE and the number of airports advancing towards the 100% renewable energy use target by 2024. Further, the electricity demand assessment of each airport has been done keeping in view the expected increase in electricity demand due to increasing passenger traffic in the coming years. The solar capacity is expected to increase up to 100 MWp by 2024 from 38.6 MWp in 2021. This increase in solar power along with other measures like procurement of green power from the grid, would help 96 AAI airports to switch over to 100% RE by the year 2024.
According to the roadmap, the share of renewables in the total energy consumption of AAI airports would increase from 30% in 2021 to 82% by 2024 (Fig. 18).

During the same period, renewable power generation will increase from 98 MU to 377 MU, illustrating a significant increase of 284% from 2021 to 2024. To meet the increasing electricity consumption of airports due to an increase in passenger growth, AAI is working to explore the feasibility of further expansion of RE sources. This would enable it to achieve the target of 100% share through RE.
6.2 Best practices from AAI airports

17 MWp solar plant at Netaji Subhas Chandra Bose International Airport, Kolkata

The solar power plant installed at NSCBI Airport is the biggest mega-project undertaken by AAI in this field. A 2 MWp roof-top solar plant was commissioned in the year 2016 which helped produce around 2.5 MU of green energy. It was then that AAI decided to take a step further and planned to install a ground-mounted solar plant on 67.5 acres of land available in the operational area, where the land could not be used for any construction due to operational restrictions.

AAI engineers took the task of planning and designing a 15 MWp solar plant and obtaining all statutory clearances for installation of the plant. The work was completed in a record time of 6 months and the 15 MWp plant, the largest plant capacity-wise at any airport in India at that time, was commissioned in November 2017.

With a total installed solar capacity of 17 MWp, Kolkata airport generates approximately 22 MU of green energy annually resulting in the removal of approximately 18,000 tCO₂ from the environment. This project has become a feather in the cap of AAI, which is continuously striving to adopt new technologies and strategies for a shift towards green energy and carbon neutrality.

Power procurement through open access at Chennai Airport

AAI has echoed its commitment to a greener future by reducing the carbon footprints of the airports, through open-access solar power procurement. In the first such project at Chennai airport, 44 MU of solar power is being procured through open-access which accounts for around 64% of the total electricity consumption at the airport (2021-2022).
Exemplar Green Initiative: Leh Airport towards Carbon Neutrality

AAI, being committed to a carbon-neutral future, has proposed a carbon-free geothermal system for space conditioning at the Kushok Bakula Rimpochee Airport at Leh. AAI is investing approx. INR 50Cr for the implementation of a hybrid geothermal system at Leh Airport, against the estimated cost of around INR 23Cr of a traditional system comprising chillers and boilers etc.

In a geothermal system, the earth can be used as both a source and sink for the exchange of energy in heating and cooling applications. A large amount of heat is stored under the earth, thus making it a huge natural battery where energy from the building could be stored or drawn from whenever needed.

For the energy exchange, borewells are dug, and high-density polyethylene (HDPE) pipes are inserted up to a depth of 100-140 meters below the ground level. Fluid with a proper mix of antifreeze is passed through these HDPE pipes for the exchange of energy/heat. This fluid brings the energy from the soil to the building in a heating cycle and sinks the building heat in a cooling cycle. With this, the HVAC system of Leh Airport’s terminal building will be almost carbon-free, with hybridisation between geothermal exchange and 1.6 MWp solar power. The extra solar electricity in the system produces hot water in hot water buffer tanks through the high-temperature gas-cooled reactor (HTR) technique and stores energy in liquid form. A geothermal system is a solution that can decarbonize heating and help airports shift away from fossil fuel-based sources.
A radiant floor heating system is proposed for heating the terminal building during winter by using this Geothermal System.

Some other unique green initiatives taken at the airport include:

1. **Roof Insulation**: To optimize heat loss during summer and winter, three layers of a roofing system are being implemented. The U-value of insulation is revised to 0.109 W/m²/K from the original U-value of 0.256 W/m²/K.

2. **Wall Insulation and sandwich wall construction**: 400 mm thick wall insulation using AAC block cavity wall is being implemented from the original 300 mm thick cavity wall. This revises the U-value of insulation to 0.16 W/m²/K from the original U-value of 0.62 W/m²/K.

3. **Glazing**: Triple Glazed Unit (TGU) having U-value of 1.15 W/m²/K W/m²/K has been proposed in place of a Double-Glazed Unit (DGU) having a U-value of 1.3 W/m²/K.
When developed, this will be a one-of-a-kind system in the Indian aviation industry and add new dimensions to mitigate carbon emissions at Indian airports.

A solar PV plant of adequate capacity (approximately 2.5 MWp) is being installed at the rooftops of all the buildings of the airport including the terminal building. Solar energy in hybridisation with the geothermal based HVAC system will cater to the complete energy requirement of the Leh Airport including operational loads & other utilities and make Leh Airport carbon neutral. With the implementation of the proposed geothermal energy-based HVAC system combined with the integrated solar power plant, Leh Airport will achieve an electricity intensity of ~66 kWh/m²/year as against ~248 kWh/m²/year with the conventional HVAC system.

It is estimated that approx. 4.8 MU of electricity will be saved annually by adopting a geothermal system in hybridisation with solar PV at Leh Airport, thereby saving around Rs. 3.3 Cr. annually and reducing the airport’s carbon footprint by 3800 tCO₂e per year.
Way forward

The Airports Authority of India is committed to Green House Gas (GHG) management and emission reduction to support India’s Nationally Determined Contributions (NDCs) for the reduction of adverse impacts on society, community and ecosystem. In 2019, the Ministry of Civil Aviation developed a White Paper on National Green Aviation Policy that sets out a strategic framework to address major environmental challenges the aviation industry faces. AAI being the sole Air Navigation Service (ANS) provider and operator of the majority of Indian Airports, plans to minimize and mitigate greenhouse gas emissions by promoting Net zero carbon airports through focused interventions including but not limited to the following:-

- Efforts are in progress to install Fixed Electric Ground Power (FEGP) unit and Pre-conditioned Air (PCA) equipment at existing airports.
- AAI plans to implement TaxiBots (semi-robotic, pilot-controlled electric towing tractor) at major airports to save ATF and reduce emissions.
- AAI further intends to promote and implement entirely, green transportation (EV) for ground support at all its airports.
- AAI is in process of installing EV charging facilities for the public at its airports.
- Work has already begun on the installation of a fuel hydrant system at Bhubaneswar airport.

Besides reducing emissions from sources over which airports have direct or indirect control (Scope I and Scope II), AAI aims to gather support and collaborate with all stakeholders to voluntarily reduce emissions under their control (Scope III) and to achieve carbon neutrality at its airports by 2050.

AAI also seeks to promote awareness and inspire the public to contribute towards a climate-friendly and cleaner path through steps such as use of public transport, judicious use of electricity, reduction of water wastage and segregation of waste, among others. Only concerted efforts from all stakeholders can help ensure a greener, cleaner and healthier environment for generations to come.
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# Annexure

## Annex I: Emission intensity of passenger traffic for 46 AAI-managed airports for 2019

<table>
<thead>
<tr>
<th>Airport Name</th>
<th>Emissions intensity (kgCO₂e/pax)</th>
<th>Airport Name</th>
<th>Emissions intensity (kgCO₂e/pax)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chennai</td>
<td>1.6</td>
<td>Hubli</td>
<td>2.4</td>
</tr>
<tr>
<td>Kolkata</td>
<td>1.9</td>
<td>Dibrugarh</td>
<td>4.3</td>
</tr>
<tr>
<td>Patna</td>
<td>0.8</td>
<td>Rajahmundry</td>
<td>5.1</td>
</tr>
<tr>
<td>Bhubaneswar</td>
<td>1.9</td>
<td>Aurangabad</td>
<td>8.5</td>
</tr>
<tr>
<td>Calicut</td>
<td>3.4</td>
<td>Jabalpur</td>
<td>2.4</td>
</tr>
<tr>
<td>Varanasi</td>
<td>1.1</td>
<td>Rajkot</td>
<td>2.5</td>
</tr>
<tr>
<td>Indore</td>
<td>1.2</td>
<td>Dimapur</td>
<td>2.1</td>
</tr>
<tr>
<td>Coimbatore</td>
<td>1.4</td>
<td>Porbandar</td>
<td>7.7</td>
</tr>
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<td>Amritsar</td>
<td>3.6</td>
<td>Kandla</td>
<td>3.3</td>
</tr>
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<td>Ranchi</td>
<td>1.3</td>
<td>Bhavnagar</td>
<td>10.5</td>
</tr>
<tr>
<td>Raipur</td>
<td>1.7</td>
<td>Diu</td>
<td>4.2</td>
</tr>
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<td>Tiruchirappalli</td>
<td>3.1</td>
<td>Jalgaon</td>
<td>13.3</td>
</tr>
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<td>Surat</td>
<td>2.0</td>
<td>Barapani (Shillong)</td>
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</tr>
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<td>Agartala</td>
<td>0.8</td>
<td>Pune</td>
<td>0.6</td>
</tr>
<tr>
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Annexe II: Average emission intensity of passenger traffic across globe for 2019

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<th>Region</th>
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Annexe III: Capacity utilisation of Indian airports (2019-2020)

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<th>Airport</th>
<th>Capacity utilisation (%)</th>
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