

Innovative Strategies for Sustainable Transformation in the Airport

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Table of Contents

1. Executive Summary	2
2. Global Air Traffic and Future Outlook	4
3. Sustainability: Overview, Importance and Frameworks.....	5
3.1 Definition	5
3.2 ESG adds value to business through	6
3.3 Global ESG Guidelines and Frameworks	6
4. Existing Sustainability Challenges at Airports	8
5. Sustainability Frameworks Implemented at The Airports	10
5.1. Availability of ESG reporting frameworks and guidelines for Airports	10
5.2. ESG Frameworks and initiatives implementation at Airports	11
6. Strategy to Improve Sustainability Targets of Airport Community	13
6.1. How airports should equip its business and operations with capabilities to enhance overall sustainability targets.....	13
6.2. Inclusiveness of All Stakeholders in The Vision.....	17
7. Future Prospects on Sustainability Transformation	20
7.1. Use Case 1: Electrification of whole airport community with renewable energy	20
7.2. Use Case 2: Inclusiveness of all employees from top level to lowest level and Gamified Employee Sustainability Engagement.....	21
7.3. Use Case 3: Mandatory criteria of qualification in Procurement and Contract process while appointing any vendor or concessionaire at the airport.....	22
7.4. Use Case 4: Circular Economy Marketplace for Waste at Airports	23
7.5. Use Case 5: Use of technology to improve operational efficiency resulting improvement in ESG parameters	23
7.6. Other Recommendations which can be explored to achieve ESG goals	24
8. Concluding Remarks	26
9. Abbreviations	27
10. References	28

1. Executive Summary

Global air traffic is expected to reach 22 billion passengers and 165 million aircraft movements by 2050, doubling current volumes. Airports face the dual challenge of driving economic growth and connectivity while ensuring sustainability and resilience.

This paper examines strategies to achieve holistic ESG goals—environmental stewardship, social responsibility, and governance integrity—beyond carbon neutrality. Key issues include emissions, renewable energy adoption, water and waste management, climate resilience, noise, and workforce welfare. While airports contribute modest direct emissions, indirect impacts through energy use and supply chains are significant. Adoption of SAF remains limited, and reliance on fossil-based electricity persists.

Beyond environmental benefits, sustainability initiatives deliver measurable economic value. Energy optimization through HVAC and BMS systems can cut operational costs by up to 20%, while electrifying ground support equipment reduces fuel expenses and mitigates carbon tax risks. Renewable energy adoption not only lowers electricity bills but also shields airports from grid price volatility. Circular economy practices generate savings on waste disposal and create new revenue streams. Furthermore, ESG-linked financing instruments such as green bonds offer favourable interest rates, enhancing capital efficiency.

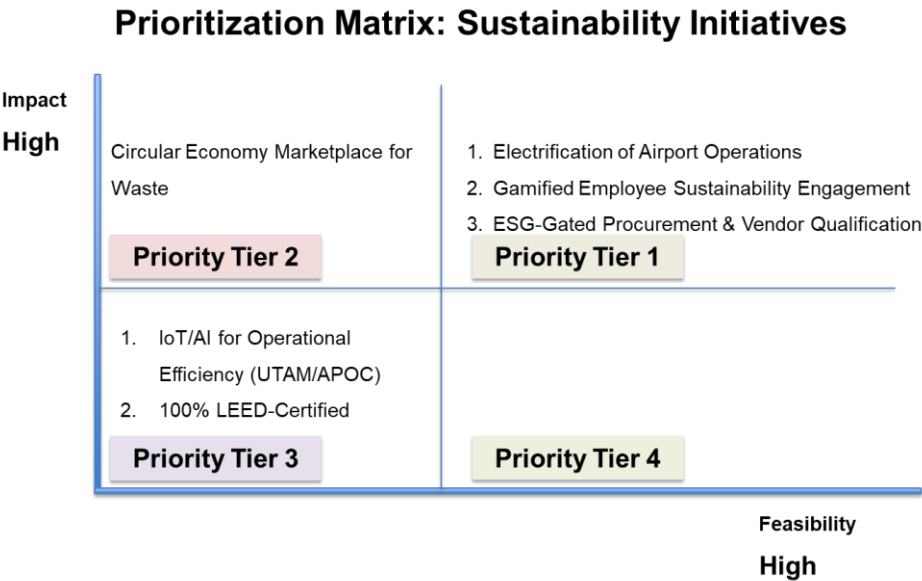
This paper not only examines these challenges but also proposes actionable strategies and innovative use cases to accelerate sustainability transformation across the airport ecosystem.

The research proposes a seven-step roadmap for airports to implement and continuously improve their ESG strategies with inclusiveness of all stakeholders.



A key recommendation is the need for inclusive stakeholder engagement at all 7-steps of the proposed ESG frameworks. Airports must bring together airlines, ground handlers, concessionaires, employees, and passengers on a common platform to align ESG objectives and reporting. This collaborative approach ensures that sustainability is embedded across the entire airport ecosystem, not just within the operator’s direct control.

Looking ahead, the paper identifies several transformative opportunities for airports which can be prioritized as

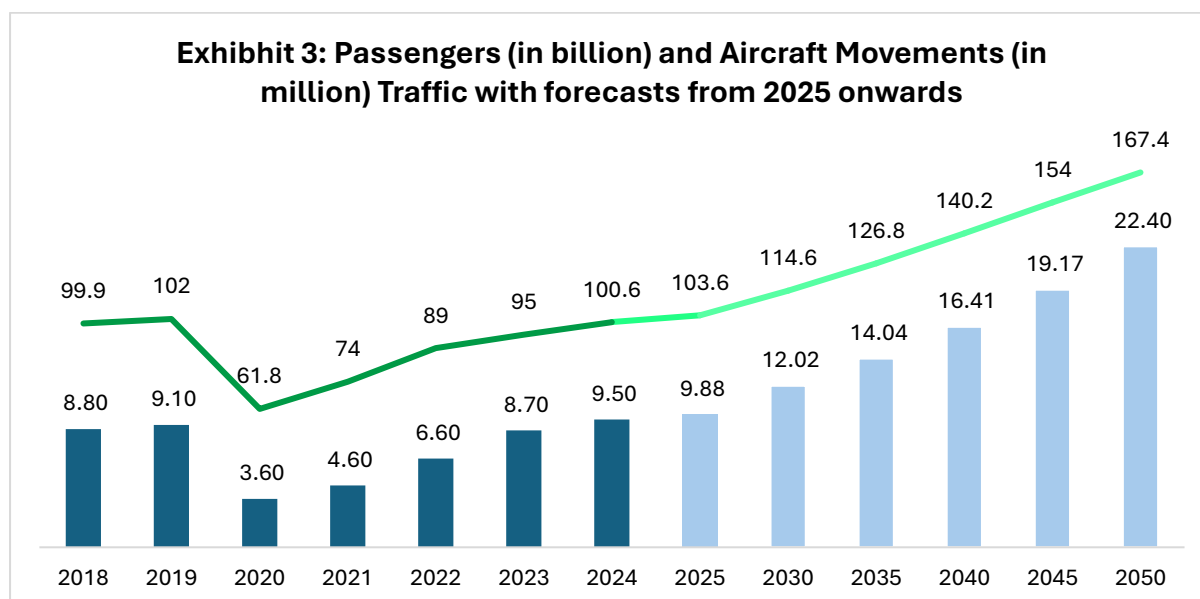


In conclusion, airports stand at the forefront of the global sustainability transformation. By embracing comprehensive ESG frameworks, leveraging technology, and fostering a culture of inclusiveness and continuous improvement, airports can achieve their net-zero ambitions, enhance operational resilience, and maintain their critical role as enablers of global connectivity and economic growth.

2. Global Air Traffic and Future Outlook

As per ACI report, in 2024, global passenger traffic reached 9.5 billion which is expected to reach 9.9 billion in 2025 with a 4.8% year-over-year growth rate. Global aircraft movements are estimated to be around 100 million in 2024, representing a gain of 4.3% from 2023.

According to forecasts by ACI, ICAO, and IATA, global passenger traffic is expected to reach nearly 22 billion by 2050, with a CAGR of 3.5-4%. Aircraft movements are projected to reach 165 million.



Airports serve as centralized infrastructure that integrates essential services and facilities to ensure smooth passenger movement. **As global air travel demand continues to rise, airports face the dual challenge of expanding capacity while minimizing environmental and social impacts.** Airports are energy-intensive hubs, consuming vast resources for lighting, heating, cooling, and ground operations, and they contribute significantly to greenhouse gas emissions through both infrastructure and aircraft activity. Beyond environmental concerns, airports must also address community issues such as noise pollution, waste management, and water conservation. Embracing sustainability ensures compliance with evolving regulations, enhances operational efficiency, and strengthens stakeholder trust. By integrating sustainable practices - such as renewable energy, green building design, and carbon management - airports can secure long-term resilience and maintain their role as vital enablers of global connectivity and economic growth.

The upcoming sections of the research paper explains the definition of sustainability, sustainability challenges being faced by airports, frameworks available to integrate sustainability in the airport community and some use cases which can be implemented to meet sustainability targets.

3. Sustainability: Overview, Importance and Frameworks

3.1 Definition

Sustainability means meeting present needs without compromising the ability of future generations to meet their own. It encompasses environmental, social, and economic aspects. Sustainability is about creating systems that are resilient, regenerative, and balanced across these three dimensions.

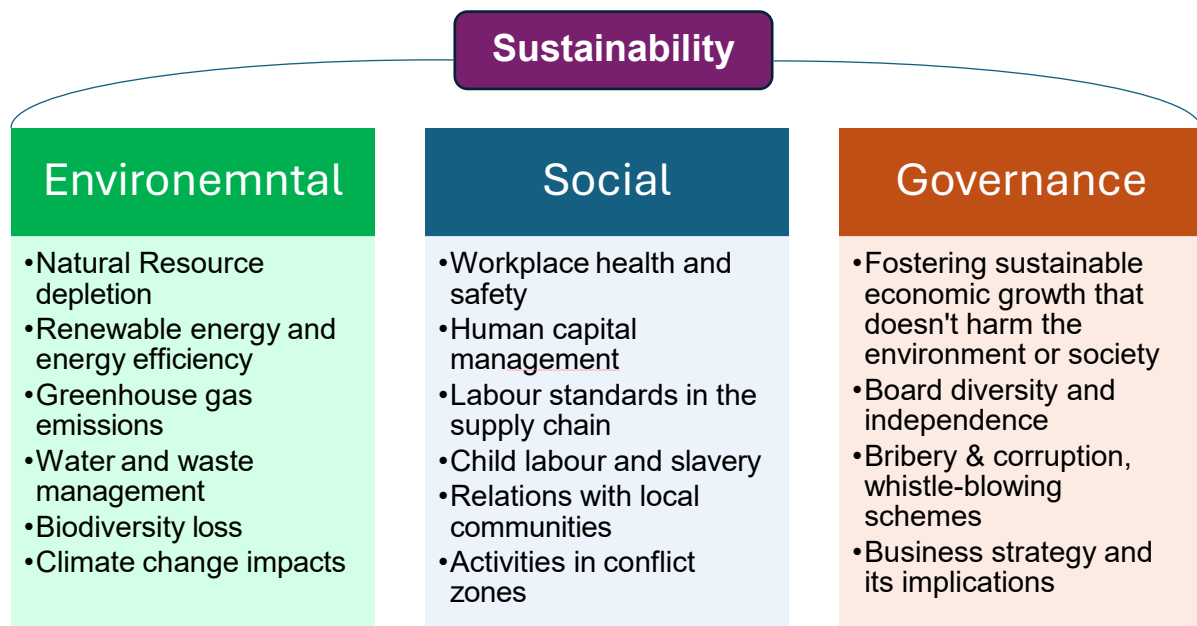
Sustainability goes beyond carbon neutrality because:

- It includes biodiversity protection, water conservation, waste reduction, and circular economy principles.
- It considers social factors like fair labour practices, health, and education.
- It emphasizes economic viability and long-term resilience.

Carbon neutrality means balancing the amount of carbon dioxide emitted with an equivalent amount removed or offset, resulting in net-zero carbon emissions. While this is important for climate change mitigation, it addresses only one aspect of environmental sustainability - greenhouse gas emissions.

Carbon neutrality is necessary, but **true sustainability** ensures **resource stewardship, social responsibility, and resilience** for future generations.

Therefore, for any organizational framework of sustainability, it is essential to divide the organization into 3 critical parts - the entire ecosystem outside it (**E**nvironment), the interface of the organization and the ecosystem (**S**ocial) and within the organization (**G**overnance), this gives us the pillars of sustainability as **E, S and G**.



By integrating all three pillars of ESG, businesses not only contribute to a sustainable future but also gain a competitive edge in today's market.

3.2 ESG adds value to business through

- Decreased operational costs through sustainable sourcing and reduced carbon emissions, which help enhance capital access on more favourable terms.
- Competitive advantage which improves brand reputation market differentiation
- Long term resilience through climate adaptation and governance strength
- Improved investor sentiment
- Regulatory compliance with global standards
- Improved engagement with internal and external stakeholders due to inclusiveness of all.

Therefore, to achieve these benefits, businesses worldwide strive to integrate sustainability into their core strategies, Environmental, Social, and Governance (ESG) frameworks have emerged as essential tools for guiding and standardizing these efforts. These frameworks provide structured guidelines for measuring, reporting, and improving ESG performance, ensuring transparency and comparability across industries and regions. By adopting recognized global standards, organizations can align with investor expectations, comply with regulatory requirements, and demonstrate their commitment to responsible and sustainable practices.

3.3 Global ESG Guidelines and Frameworks

1. Sustainable Development Goals (SDGs)

SDGs are a set of 17 global goals with 169 targets adopted by all United Nations Member States in 2015 as part of the 2030 Agenda for Sustainable Development. They provide a universal framework to address critical global challenges such as poverty, inequality, climate change, environmental degradation, peace, and justice.

2. United Nations Global Compact (UNGC)

UNGC is a voluntary initiative launched in 2000 by the UN to encourage businesses worldwide to adopt sustainable and socially responsible practices. It is the world's largest corporate sustainability initiative. It aligns business strategies and operations with 10 universally accepted principles in the areas of Human Rights, Labour, Environment and Anti-Corruption. It has 15,000 companies and organizations from 160+ countries and Participants commit to publishing an annual **Communication on Progress (COP)** report.

3. Global Reporting Initiative (GRI)

The GRI is an international independent organization that provides a standardized framework for sustainability reporting aligning (SDGs). Its main purpose is to help businesses, governments, and other organizations understand and communicate their environmental, social, and governance (ESG) impacts. It aligns with stakeholders' inclusivity including investors, employees, regulators, and communities.

4. Task Force on Climate-related Financial Disclosures (TCFD)

TCFD was established by the Financial Stability Board (FSB) in 2015 to develop a framework for companies to disclose climate-related financial risks and opportunities. Its goal is to improve transparency and help investors, lenders, and insurers make informed decisions. It provides consistent, comparable, and decision-useful climate-related disclosures.

5. Sustainability Accounting Standards Board (SASB)

SASB develops industry-specific standards to guide companies in disclosing financially material sustainability information to investors. It focuses on financial impact of sustainability issues and improves comparability and decision-making for investors. Standards for 77 industries, covering topics like energy management, emissions, labour practices, and data security.

There are many other ESG frameworks available and some organizations have developed their own frameworks to implement and report ESG parameters. Organizations have developed industry specific ESG frameworks taking reference with global frameworks. Similarly, airports are implementing ESG frameworks which are aviation specific either developed by international aviation organizations or developed in-house.

Next section talks about these frameworks after highlighting sustainability challenges being faced by the airports.

4. Existing Sustainability Challenges at Airports

 Green House Gases	• In 2023, aviation accounted for 2.5% of global energy-related CO₂ emissions; cumulative warming effect is ~4% of total warming to date when non-CO₂ effects are considered. • Airports' direct contribution to emissions is limited; however, they contribute indirectly with non-renewable resources for electricity, auxiliary power units (APUs), air conditioning, ground handling equipment, and diesel generators.
 SAF Adoption	• In 2024, Sustainable Aviation Fuel (SAF) production volumes reached 1 million tonnes (1.3 billion litres) and accounted for 0.3% of global jet fuel production and 11% of global renewable fuel. • Limited airports have the automated fuel distribution facility in compliance with SAF and SAF blending facility.
 Renewable Energy	• Large terminals require continuous operation of Heating, Ventilation, and Air Conditioning (HVAC), lighting, baggage systems, and airside services. • Most airports still rely heavily on grid electricity, which, in many regions, is primarily generated from fossil fuels.
 Water & Waste Management	• As per study by ICAO, there is significant discrepancy of water usage at different airports which varies from 10 litre to 60 litre per passenger • As per study by IATA and ICAO, around 2kg of waste per passenger is generated in its trip
 Climate Change	• <i>Extreme weather & flooding</i> – Airports globally face heat, non-seasonal extreme rains, cloudbursts, hurricanes, and coastal flooding • Studies warn that airports at risk from sea-level rise could more than double by 2100, risking ~10% of routes
 Noise Pollution	• Noise pollution has immediate social impact like sleep disturbance, stress, and potential cardiovascular risks to people living nearby airports • Airports face legal issues to reduce noise and hence, reduce flight operations especially during night

 Employee Welfare	• <i>Gender Diversity</i> – ICAO and IATA highlighted that progress toward gender equality remains limited and slow. • Fatigue-related incidents contribute to 21-23% of major aviation accidents; Musculoskeletal injuries are common for ground handlers; Hazards include collisions, noise, chemical exposure, extreme weather, and vehicle risks
 Passengers	• No uniformity of experience among airports even in same region having similar processes • Basis the complaints data by regulators, passengers' complaints have increased higher than traffic growth mainly constitutes of flight related (cancellations/delay/denied boarding), baggage delays/damage, refund issues
 Society Development	• For safety, displacement of wildlife in the vicinity of airports is required which effect the biodiversity of the area • Airport expansion projects can displace homes or businesses, fragment neighbourhoods, and disrupt local development plans
 Economic Aspects	• Despite higher traffic growth, revenue shortfalls and high debt levels inhibit robust capital programming and infrastructure expansion. • ACI estimates US \$2.4 trillion of capital investment will be required by 2040 to support expected global passenger growth (17.7 bn by 2043 and 22.3 bn by 2053).
 Governance	• Large infrastructure projects attract procurement irregularities and corruption risks. Weak oversight in vendor selection and contract management can lead to inflated costs and delays. • <i>Cybersecurity & Data Governance</i>: Airports handle massive passenger data and breaches can lead to GDPR violations and reputational damage.

5. Sustainability Frameworks Implemented at The Airports

5.1. Availability of ESG reporting frameworks and guidelines for Airports

Various international organizations in aviation have released ESG reporting and measuring frameworks which cover all three pillars of ESG.

- **ACI Global Reporting Framework & Guidance**
 - Provides clear definitions, scopes, and reporting guidelines for each pillar.
 - Harmonized with frameworks like GRI, ISSB, and CSRD to ensure comparability and investor confidence.
 - Adaptable for airports of different sizes, ownership models, and regulatory environments.
 - Encourages airports to integrate ESG into strategic planning and public disclosures.
- **ACI North American ESG Metrics White Paper**
 - Developed by ACI – North America, tailored for North American airports to meet investor, regulator, and stakeholder expectations.
 - Aligns with global standards such as GRI, SASB, and TCFD, while considering regional regulatory requirements.
- **ICAO CAEP-13 Committee Recommendations**
 - The Committee on Aviation Environmental Protection (CAEP) is ICAO's technical body responsible for environmental standards and guidance.
 - At its 13th meeting (CAEP/13), held in March 2025, the committee adopted 31 recommendations to advance aviation sustainability. Some of the recommendations are :
 - Improvements to the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) for better transparency and compliance.
 - Stricter limits for aircraft noise and engine emissions to reduce environmental impact.
 - Updated methodologies for tracking CO2 emissions reductions and supporting ICAO's long-term net-zero goal.
 - Climate adaptation & resilience recommendations for airports and operations
 - Operational efficiency measures (airports & flight operations) for emissions reduction
 - Endorsed SAF certification pathways and sustainability criteria aligned with ICAO's 2030 SAF targets.

5.2. ESG Frameworks and initiatives implementation at Airports

Most airports have begun implementing ESG frameworks, North America and Europe have more mature ESG reporting practices, while the Middle East, Asia Pacific, and Africa are rapidly advancing. Most of the airports follow Global Reporting Initiative (GRI), Task Force on Climate-Related Financial Disclosures (TCFD) and United Nations Global Compact (UNGC), however, some of the airports in Asia Pacific and Middle East follow their own format.

According to a study by ACI, among the three pillars of ESG, the environment is the primary focus for airports, with multiple initiatives implemented in this area. Second preference is given to Governance excluding Asia Pacific where it is more preferred than Social.

Some of the initiatives being implemented at airports are:

Environmental

- Over **600 airports** are enrolled in **ACI's Airport Carbon Accreditation (ACA)** program. Around 30 airports globally have already achieved Level 5 Transition status.
- Level 5 is the topmost level in ACA programme, setting high standards for airports to significantly reduce their absolute carbon emissions by collaborating with their entire ecosystem.

LEED-certified by terminals at multiple airports which reduce the energy consumption, reduced carbon footprint, water conservations, improved indoor air quality.

Oslo Airport (Norway) – First airport in the world to offer SAF through its regular fuel supply system (since 2016). SAF is blended with conventional Jet A-1 fuel at its fuel farm.

Los Angeles International Airport (LAX) hosts World Energy's SAF production facility in Paramount, California. SAF is delivered and blended for airlines operating at LAX.

100% Solar Powered Airports

- Cochin International Airport, India – World's first fully solar-powered airport.
- Boise Airport (Idaho, USA) – It purchases **100% solar energy** through Idaho Power's

Social

San Francisco International Airport hosts multiple Employee Resource Groups (AAPI, BIPOC, LatinX, Out@SFO, Parents@SFO, Vets@SFO, Women@SFO) to empower diverse staff and foster inclusive culture

Denver International Airport operates Structured Diversity, Equity and Inclusion programs, including ACDBE and mentor-protégé schemes to diversify airport concessions, plus extensive accessibility and inclusion services for employees and passengers

Richmond International Airport – Over 22% of procurement goes to SWaM/DBE businesses. Invests in career development, employee recognition, plus community assistance via food drives and blood donations

Austin-Bergstrom International Airport – Its ESG report highlights community support initiatives, though specifics are light in the snippet.

Columbus Regional Airport Authority (CRAA publishes annual ESG reports featuring a “Culture of Belonging,” emphasizing local hiring, training, and small business opportunities

Governance

Airports are setting up dedicated ESG Committees & Governance Structures and publishes annual **ESG reports** aligned with **GRI** and **SASB** standards.

- Setting up anti-corruption and fair-trade guidelines
- Implementing supplier diversity programs and ethical procurement policies
- Climate resilience and operational continuity planning embedded in governance.

Linking ESG to Finance

- Dallas Fort Worth Airport issued green bonds for renewable energy and efficiency projects.
 - Rome Fiumicino Airport secured sustainability-linked loans tied to ESG performance metrics
-

6. Strategy to Improve Sustainability Targets of Airport Community

6.1. How airports should equip its business and operations with capabilities to enhance overall sustainability targets

Airports are identifying, measuring and reporting ESG parameters to achieve Net-zero carbon emissions, positive water usage, reduce dependency on non-renewable energy, setting up ESG committees and many more. To equip airport business and operations with capabilities that enhance overall sustainability targets, airports should focus on **integrated strategies across governance, artificial intelligence, technology, and stakeholder engagement**.

Basis the study of ESG frameworks by ACI, IATA and GRI, a refined 7-point list is proposed that airports can follow.



Step 1 Define Clear Vision and goals

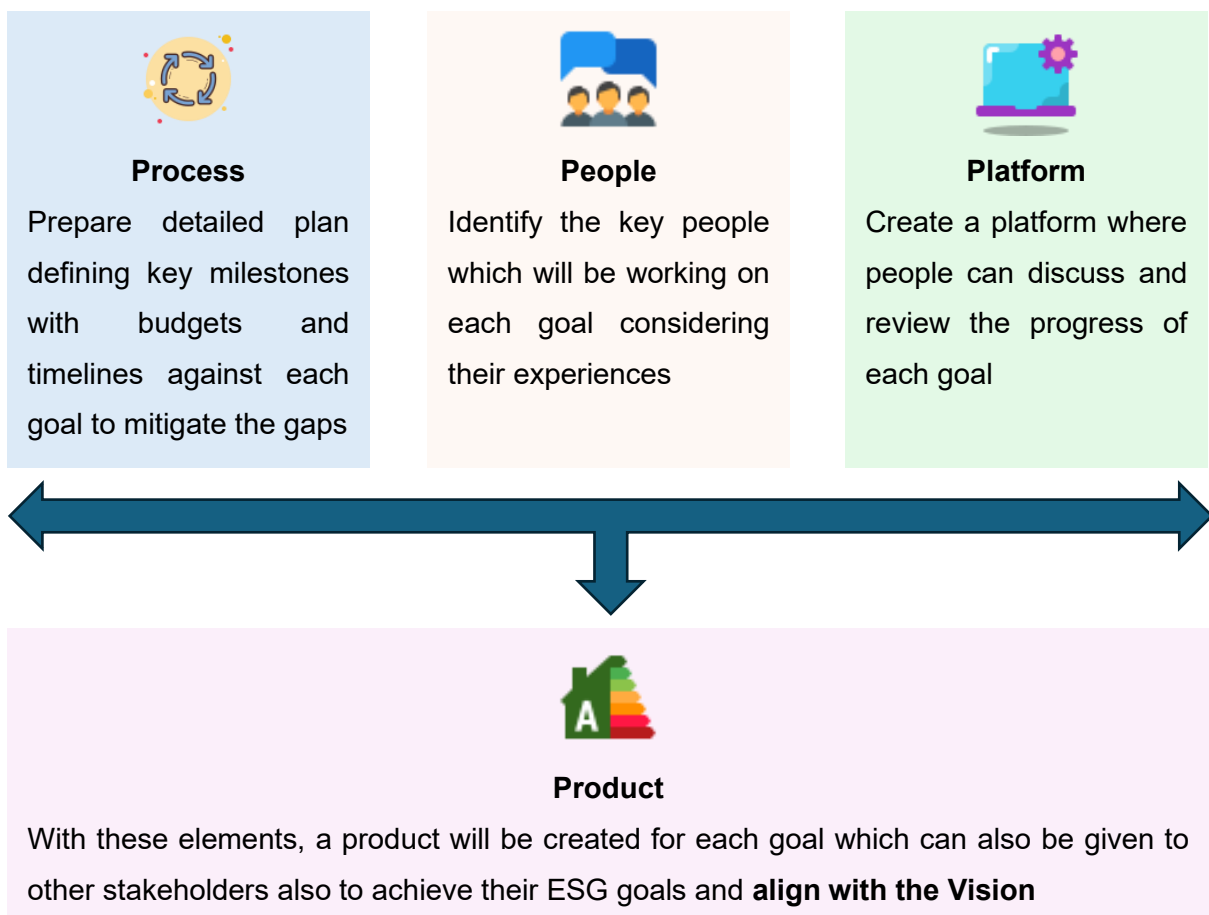
- 1 • **Form a cross-functional team to identify and define measurable goals for tracking and reporting**
 - The team may include members from Environment, Operations, Engineering, Finance, Procurement, Human Resources (HR), and Strategy departments.
- 2 • **Study international and national ESG guidelines and frameworks, universal and specific to airports.**
 - **Identify goals with measurable KPIs** against each pillar of ESG pertaining to the organization.
- 3 • **Prioritization of goals** considering factors like impact, complexity and financials and alignment with Board and internal stakeholders.
 - ***Define the ESG Vision and communicate to all within the organization and other stakeholders in the airport.***

Step 2 Identify the gaps against each goal

- Identify the goals to be implemented by airport operator and other stakeholders in the vicinity of the airport to achieve the vision.
- Compare current performance against each goal across all the areas and help stakeholders to do the same.

Step 3 Develop ESG Strategy and Roadmap

This stage involves translating the organization's ESG vision into actionable plans that are both ambitious and achievable. The strategy should be comprehensive, integrating environmental, social, and governance objectives into every aspect of airport operations. By establishing clear milestones, allocating resources, and fostering collaboration across departments and partners, airports can ensure that their ESG initiatives are not only well-structured but also adaptable to evolving industry trends and regulatory requirements. This strategic approach sets the stage for effective implementation through coordinated processes, empowered people, innovative platforms, and impactful products.



Step 4 Capability Building

- **Identify the trainings for each employee** of the organization basis their involvement in achieving the ESG Vision.
- **Train the people**, first within the organization and then can be extended to the stakeholders, basis the maturity of ESG.
- **Deploy the people** to achieve the goals once they are certified and include ESG KPIs in employee evaluations.

Step 5 Implement the ESG Strategy

Each identified goal will be implemented with integration into procurement & HR policies like

- **Energy & Carbon:** Install solar panels, electrify ground support equipment, optimize HVAC.
- **Water & Waste:** Implement rainwater harvesting, recycling, and circular economy practices.
- **SAF Infrastructure:** Facilitate SAF blending and supply chain partnerships.
- **Gender Diversity:**
 - Enforce non-discrimination and equal pay policies across all departments
 - Use gender-neutral job descriptions with diverse interview panels
 - Partner with aviation schools to attract women into engineering, operations, and management roles.
- **Governance:**
 - **Code of Conduct:** Cover ethics, anti-corruption, and sustainability principles.
 - Update procurement policy for sustainability & diversity.
 - **Board-Level Oversight:** Assign ESG responsibilities to a dedicated Board committee.

Step 6 Measure and Monitor

- Environmental parameters can be tracked through
 - **Carbon emissions:** IoT sensors and Emission monitoring software (e.g., ICAO CORSIA tools).
 - **Energy Consumption: Smart meters** for electricity and heating systems and Building Management Systems (BMS), SCADA systems.
 - **Water Consumption & Quality:** IoT water sensors and flow meters for potable and recycled water systems.
 - **Waste Management:** Track waste segregation with IoT sensors and RFID tags and recycling rates.

Innovative Strategies for Sustainable Transformation in the Airport Industry

- o **Climate change study** with its impact can be conducted with detailed action plan and review period.
- Social KPIs involves monitoring workforce diversity, employee well-being, passenger accessibility, and community engagement.
 - o **Air Quality & Noise:** Deploy air quality sensors for PM2.5, NOx, CO₂ and noise monitoring stations (ICAO-compliant) around airport perimeter.
 - o **Gender equality and diversity:** Annual diversity audits to be conducted by HR team and identify the gaps and prepare a mitigation plan.
 - o **Health & Safety:** Safety incident reporting systems and Employee wellness program by HR team.
 - o **Passenger Experience:**
 - Implement passenger complaint and feedback systems at different areas of airports which will help areas of concerns. Reduction in number of complaints will reflect improvement in the area.
 - Conduct regular passenger surveys by itself or through ACI, Skytrax or other international or national agency.
 - o **Biodiversity and Land use:** GIS-based mapping of green areas and wildlife habitats and regular ecological audits.
- Governance KPIs at airports ensures transparency, compliance, and accountability in ESG implementation.
 - o **Ethical procurement** by checking sustainability and ethical standards of suppliers and concessionaires and their regular audits.
 - o ESG risks being included in Enterprise Risk Management (ERM).
 - o Amount of green bonds or sustainability-linked financing raised.
 - o Stakeholder engagement to understand their operational issues and any ethical issues being faced.
 - o Internal audits and publish quarterly governance reports.
 - o Annual audit of ESG KPIs and reports by ESG rating Agency.
- Airports can also enrol for ACI Airport Carbon Accreditation Program launched by ACI to help airports measure, manage, and reduce carbon emissions. It is recognized by United Nations Framework Convention on Climate Change (UNFCCC) and aligned with global climate goals. It has 7 levels of accreditation in which last level includes all stakeholders.

Step 7 Continuous Improvement Plan (CIP)

- Do the root cause analysis for any deviation and set the plan for course correction.
- During CIP, all three aspects of the product should be reviewed, and new products can be designed as needed to achieve the desired goals.
- Update frameworks based on new regulations and industry best practices.
- **Once the stated vision is achieved, organization can plan for higher ESG Goals with increased inclusivity of the airport.**

This proposed framework will help the airports to achieve their sustainability goals. This means integrating advanced technologies, fostering a culture of continuous improvement, and ensuring ESG principles are embedded in daily operations. By strengthening internal expertise and establishing clear measurement systems, airports can drive real progress on environmental, social, and governance targets. **These efforts lay the groundwork for broader stakeholder engagement and lasting transformation.**

6.2. Inclusiveness of All Stakeholders in The Vision

ESG performance within the airport vicinity depends on the actions of multiple stakeholders, who often operate independently except for interactions with the airport operator. Therefore, it is the airport operator who can unite all stakeholders on a single platform to achieve the ESG vision for the area.

Airports must include all stakeholders in their ESG goals by fostering a collaborative and transparent approach. The airport operator should engage with stakeholders of all sizes—from major airlines, which are among the largest contributors to carbon emissions, to individual passengers, whose direct contributions may be small but collectively significant. Excluding any stakeholder, no matter how minor their contribution, can delay progress toward achieving the vision.

Basis my understanding of ESG frameworks by ACI and IATA and aviation ecosystem, I would suggest that airport operators can take the following steps to ensure inclusiveness when defining their ESG vision and establishing supporting processes:

Engage and identify while defining its ESG Vision

Engage with all stakeholders and identify their contributions to ESG, such as fuel consumption by airlines and ground handlers, waste generation by airlines and food & beverage outlets, and similar factors for other groups.



Help stakeholders to define their ESG goals align with its Vision

Based on the identified ESG contributions of each stakeholder, the airport operator can work with them to clearly define their ESG frameworks and measurement mechanisms. These should be based on available industry or global frameworks, or custom frameworks aligned with the airport's ESG vision.



Formation of Steering Committee of stakeholders

- Once each stakeholder has designed its ESG framework, a Steering Committee can be formed, comprising representatives from all organizations or businesses, and chaired by the airport operator.
- The committee identifies common ESG goals that need to be tracked centrally, such as achieving net-zero carbon emissions, which involves the airport operator, airlines, ground handlers, in-flight kitchen operators, cargo operators, and others. Other centrally tracked goals may include electricity consumption, gender equality, and passenger experience.



Provide a common Platform for training and brainstorming

- The airport operator can develop a digital platform to track KPIs and facilitate brainstorming solutions for any gaps. Stakeholders can use this platform to discuss their goals and seek assistance from others as needed.
- The airport operator can also establish common ESG training programs for all stakeholders to train employees directly involved in defining and achieving ESG goals.

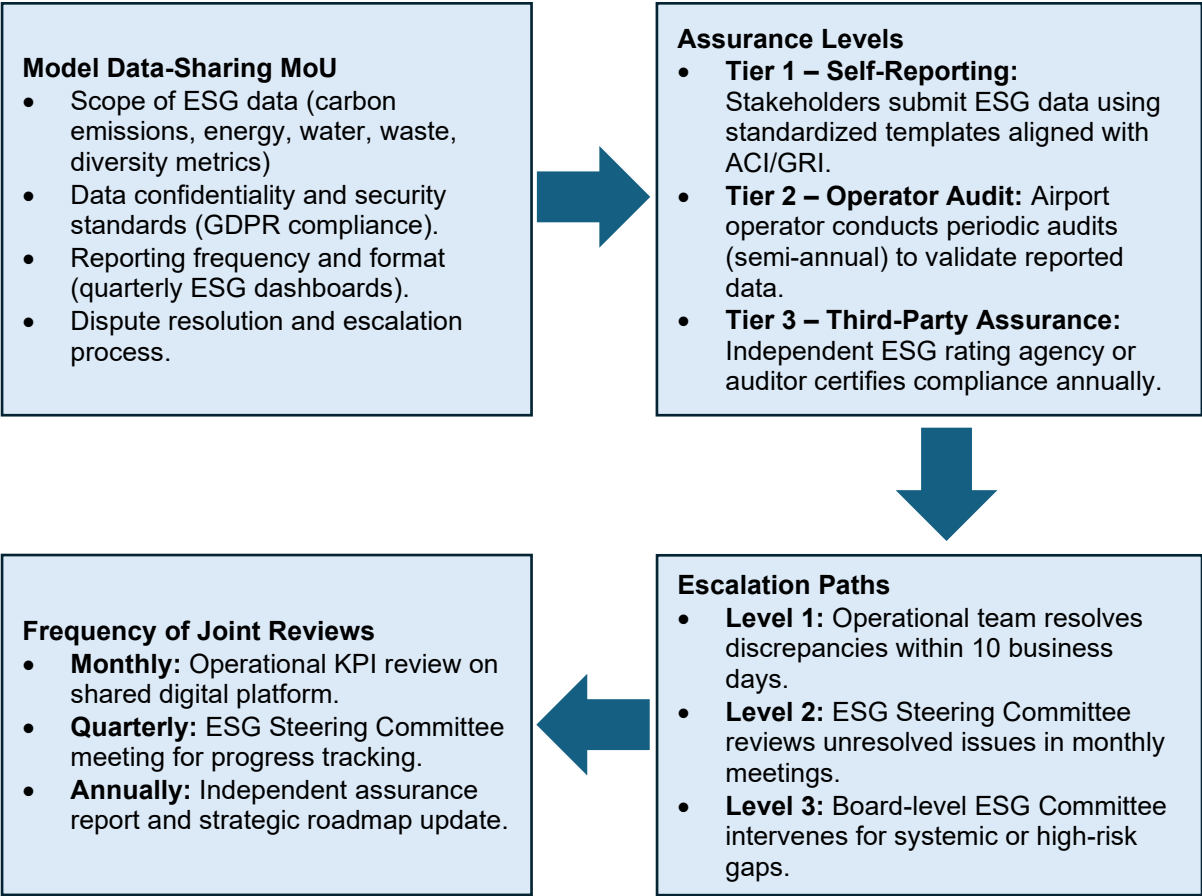


Common ESG Reporting

- Some smaller stakeholders may lack the resources to develop their own ESG frameworks and reporting mechanisms. The airport operator can include their ESG parameters within its own reporting.
- The airport operator can also design a methodology for common ESG reporting, incorporating the ESG parameters of all stakeholders.

Proposed Governance Framework for ESG Collaboration

To ensure durable and transparent collaboration among airport operators and stakeholders, the following governance mechanics are recommended:



This proposed approach not only strengthens accountability and transparency but also accelerates progress by leveraging diverse perspectives and resources. Building a unified platform for stakeholder participation lays the groundwork for innovative solutions and long-term success in sustainability transformation.

7. Future Prospects on Sustainability Transformation

As aviation evolves, airports are well-placed to lead sustainability progress. Addressing today's challenges requires innovative, holistic strategies that go beyond compliance, integrating advanced technologies and ESG principles throughout airport operations. Inclusive stakeholder engagement is key. The following use cases showcase practical initiatives that can accelerate the shift toward more sustainable and resilient airports.

7.1. Use Case 1: Electrification of whole airport community with renewable energy

By replacing fossil-fuel-based energy with renewable based electric infrastructure and technology like IoT sensors and predictive analytics, airport community can significantly reduce their carbon footprint while improving operational efficiency.

Key Components of Electrification

- *Landside Operations*
 - EV Fleets: Airport shuttles, taxis, and staff vehicles transitioned to electric.
 - Smart Traffic Management: Reducing congestion and idle emissions through digital systems.
- *Terminal and Facility Systems*
 - Electrified HVAC and lighting systems powered by renewable energy.
 - Integration of battery storage for peak load management.
- *Airside Operations*
 - Electric Ground Support Equipment (GSE): Baggage tugs, pushback tractors, and catering trucks powered by electricity.
 - Charging Infrastructure: High-capacity chargers strategically located across aprons and hangars.

Renewable Energy Integration

- *On-site Generation* of Solar energy by setting up farms on rooftops, car parks, and unused land.
- *Long-term renewable energy purchase* agreements with Hydro or Wind Turbine or Nuclear Power Plant or Solar Power Plan wherever land unavailability.

Benefits

- *Regulatory Compliance and Environmental Impact:* Alignment with global net-zero targets and Airport Carbon Accreditation programs.
- *Operational Efficiency:* Lower fuel costs, reduced maintenance, and improved reliability.

7.2. Use Case 2: Inclusiveness of all employees from top level to lowest level and Gamified Employee Sustainability Engagement

Achieving Environmental, Social, and Governance (ESG) goals in an airport ecosystem requires **active participation from every level of the workforce**—from senior leadership to frontline staff. Inclusiveness ensures that sustainability is not just a top-down directive, but a shared responsibility embedded in daily operations.

Why Inclusiveness Matters

- *Shared Ownership*: ESG success depends on collective action. Every employee influence energy use, waste management, safety, and community engagement.
- *Empowerment and Awareness*: Training and communication help employees understand how their roles contribute to environmental and social outcomes.
- *Innovation from All Levels*: Ground staff and operational teams often identify practical solutions for reducing emissions and improving efficiency.
- *Vigilance at ground level*: Ground staff and operational teams interact with all the stakeholders on daily basis; hence, they can act as vigilance for ESG parameters whether it is being followed by everyone and at each level.

Key Strategies

1. *Leadership Commitment*: Senior Management must set clear ESG targets and model sustainable practices.
2. *Employee Engagement Programs*: Workshops, sustainability champions, and recognition systems encourage participation.
3. *Transparent Communication*: Regular updates on ESG progress and open feedback channels foster trust.
4. *Skill Development*: Training on green technologies, safety, and ethical practices ensures readiness for transformation.

Rewards and Recognition through Gamified Employee Sustainability Engagement

While studying the ESG initiatives in other industries, this is one of the innovative initiatives being implemented in technology and retail industries. Gamification uses points, badges, and leaderboards to motivate employees to adopt sustainable practices. At airports, this can transform ESG goals into interactive challenges.

Implementation Steps

1. *Develop a Mobile App or Portal*: Employees log sustainable actions (e.g., switching off idle equipment, reducing paper use, optimizing GSE routes).
2. *Create Reward Mechanisms*:
 - Points for each action.
 - Badges for milestones (e.g., “Energy Saver,” “Waste Warrior”).

- Monthly leaderboards to encourage healthy competition.
- 3. *Integrate ESG Metrics*: Link actions to measurable ESG outcomes (energy saved, waste reduced) for transparency.
- 4. *Recognition & Incentives*: Offer perks like certificates, gift cards, or public acknowledgment for top performers.

7.3. Use Case 3: Mandatory criteria of qualification in Procurement and Contract process while appointing any vendor or concessionaire at the airport

To ensure compliance with **ESG principles**, airports can establish mandatory qualification criteria for all vendors and concessionaires during procurement and contracting processes.

Airport operator can design a common ESG compliance requirement for each area of operations like one common framework for Food and Beverages concessionaires and another one for Retail concessionaires. These ESG requirements can become part of RFP which can be mandatory or have a score which will be considered in final scoring. So, concessionaire having higher ESG score will qualify, even with equal score in other areas.

These criteria will ensure that all new members joining the airport community are ESG compliant and will fasten the growth to achieve the community's ESG Vision.

Key Mandatory Criteria which can be a part of the RFP

1. ESG Compliance

- Demonstrated commitment to environmental sustainability (e.g., waste reduction, energy efficiency).
- Social responsibility practices, including labour standards and diversity policies
- Transparent governance and ethical business conduct.

2. Regulatory and Safety Standards

- Full compliance with aviation safety regulations and local laws.
- Certifications for quality management (ISO 9001), environmental management (ISO 14001), and occupational health (ISO 45001).

3. Financial Stability

- Proof of financial health to ensure long-term service continuity.
- No history of bankruptcy or major legal disputes.

4. Technical Capability

- Proven experience in delivering similar services at scale.
- Ability to integrate with airport systems and sustainability initiatives (e.g., electrification, waste management).

5. Innovation and Sustainability Roadmap: Vendors should present plans for reducing carbon footprint and adopting renewable energy with commitment to continuous improvement aligned with airport ESG goals.

7.4. Use Case 4: Circular Economy Marketplace for Waste at Airports

A **Circular Economy Marketplace** is an internal or collaborative platform where waste streams from airport operations - such as decommissioned furniture, uniforms, packaging, and construction materials - are listed for reuse or resale. Instead of sending these items to landfills, they are repurposed by concessionaires, vendors, contractors, or local businesses. Similar kind of initiatives are already being followed in manufacturing and FMCG sectors.

Implementation Steps

1. *Digital Platform Setup*: Create an online marketplace accessible to airport stakeholders and approved partners.
2. *Waste Stream Identification*: Categorize reusable materials (wood, metal, textiles, electronics) and set quality standards.
3. *Partnerships*: Collaborate with recycling firms, NGOs, and local businesses for material recovery and upcycling.
4. *Tracking and Reporting*: Use data analytics to measure landfill diversion, cost savings, and ESG impact.

Benefits

- Reduces landfill waste and carbon footprint.
- Generates revenue or cost savings from resale.
- Strengthens ESG compliance and community engagement.

7.5. Use Case 5: Use of technology to improve operational efficiency resulting improvement in ESG parameters

- **IoT Sensors**: Installation of IoT sensors on electrical equipment and vehicles enables real-time tracking of energy consumption. This data helps optimize operations, reduce wastage, and lower carbon emissions.
- **Artificial Intelligence (AI) and Machine Learning (ML)**: AI/ML is used to predict passenger loads and dynamically allocate resources. For example, instead of running all systems continuously, AI can optimize the operation of baggage handling, travelators, and food & beverage services, reducing unnecessary energy use.
- **Live ESG Dashboards**: Digital dashboards collect, report, and visualize ESG data in real time. They facilitate transparent communication, stakeholder collaboration, and immediate identification of deviations, enabling faster corrective actions compared to traditional audit cycles.
- By adopting IoT, AI and live dashboards, IGIA Delhi has developed integrated management platforms like UTAM and APOC.
 - **Unified Total Airside Management (UTAM)**

UTAM is an AI-driven platform at IGI Airport that uses machine learning, IoT, and radar to monitor all airside activities. It tracks aircraft, ground service equipment, and vehicles, automatically logs operational data, and provides real-time alerts for delays or deviations.

Impact: Improved turnaround efficiency, reduced delays, lower carbon emissions, and enhanced safety through compliance monitoring.

- **Airport Predictive Operations Centre (APOC)**

APOC is an advanced AI-powered command centre at IGI Airport that integrates real-time data from airside operations, weather forecasting and ground resources.

Impact: Enables predictive analytics for fog and low-visibility conditions, optimizes runway and resource utilization, reduces fog recovery time, and enhances safety, efficiency, and passenger experience. APOC also supports the airport's sustainability goals, contributing to the aviation sector's ambition for carbon neutrality by 2050.

7.6. Other Recommendations which can be explored to achieve ESG goals

1. Airports are inclusively designed so that PRM and non-PRM passengers benefit from the same accessible environment which is compliant with IATA, ICAO and other standards.

This will cover social factor of ESG by providing benefits as

- ***Inclusivity and Equality:*** All passengers experience the same level of comfort, dignity, and convenience, promoting social inclusion and equal access. It Accommodates a diverse range of passenger needs, including elderly travellers, families, and those with temporary injuries, without requiring further modifications.
- ***Operational Efficiency:*** Streamlined processes and maintenance, as there is no need to manage separate facilities or routes for different passenger groups.
- ***Cost Savings:*** Reduces capital and operational expenditure by eliminating the need for duplicate infrastructure and specialized maintenance.
- ***Enhanced Passenger Experience:*** Simplifies wayfinding and navigation for everyone, reducing confusion and improving overall satisfaction.

2. **100% LEED certified buildings at the Airports**

This approach means every terminal, concourse, and support facility is designed, constructed, and operated according to rigorous green building standards. This may increase the complexity and cost of construction, however, provides below benefits -

- Advanced systems (HVAC, lighting, water management) reduce maintenance needs and streamline operations, often compensating for the complexity of initial setup.

Innovative Strategies for Sustainable Transformation in the Airport Industry

- It improves air quality, natural lighting, and non-toxic materials contribute to occupant health and well-being, reducing absenteeism and boosting productivity.
- Many governments offer tax breaks, grants, or expedited permitting for LEED projects, helping offset certification and construction costs.
- LEED buildings are designed to meet or exceed current and future environmental regulations, reducing the risk of costly retrofits or penalties.

3. Climate Resilience and Adaptation Strategies

With increasing climate risks, airports should focus on developing and evaluating resilience and adaptation strategies tailored to airport infrastructure and operations, especially in regions vulnerable to extreme weather and sea-level rise. Climate adaptation is a key component of Environmental, Social, and Governance (ESG) strategies and supports airports’ ambitions to achieve net-zero emissions and long-term sustainability. Resilient airports are better prepared for evolving climate risks, ensuring their viability and competitiveness in a changing environment.

To effectively implement sustainability initiatives, airports must prioritize actions based on their potential impact and practical feasibility. While all proposed strategies contribute to ESG objectives, resource constraints and operational complexity require a structured approach to sequencing. The following prioritization matrix categorizes initiatives into tiers, enabling decision-makers to focus first on high-impact, high-feasibility actions that deliver quick wins, while planning medium-term and long-term projects for progressive transformation.

Prioritization Matrix: Sustainability Initiatives

Impact High	Circular Economy Marketplace for Waste Priority Tier 2	1. Electrification of Airport Operations 2. Gamified Employee Sustainability Engagement 3. ESG-Gated Procurement & Vendor Qualification Priority Tier 1
	1. IoT/AI for Operational Efficiency (UTAM/APOC) 2. 100% LEED-Certified Priority Tier 3	Priority Tier 4
		Feasibility High

8. Concluding Remarks

The aviation industry stands at a pivotal crossroads, where the imperative for growth must be balanced with the urgent need for sustainability. This research demonstrates that airports, as critical nodes in the global transportation network, have both the responsibility and the opportunity to lead the sector’s transformation toward a more sustainable future. By embracing comprehensive ESG frameworks, airports can address the complex challenges of environmental impact, social responsibility, and governance integrity.

Beyond environmental benefits, sustainability initiatives deliver measurable economic value such as below:

Initiative	Estimated OPEX Savings	Payback Period	Additional Financial Benefit
HVAC/BMS Optimization	15–20% reduction in energy costs	2–3 years	Improved asset life, lower maintenance
Electrified Ground Support Equipment	\$250K annual fuel savings per 50 units	4–5 years	Reduced carbon tax exposure
Renewable Energy Integration (Solar)	\$500K annual electricity savings	6–8 years	Hedge against grid price volatility
Circular Economy Marketplace	\$100K annual waste disposal savings	1–2 years	Revenue from resale of materials
Green Bonds / Sustainability-Linked Loans	N/A	Immediate	20–40 bps lower interest rates vs conventional debt

The path forward requires a holistic approach – one that integrates innovative technologies, stakeholder inclusiveness, and continuous improvement into every facet of airport operations. The adoption of renewable energy, sustainable fuels, circular economy practices, and robust governance structures will not only mitigate environmental risks but also enhance operational resilience and stakeholder trust.

Ultimately, the successful implementation of sustainability strategies will position airports as leaders in climate action and social progress, ensuring their continued relevance and competitiveness in a rapidly changing world. By fostering collaboration across the entire airport ecosystem and committing to transparent, measurable ESG goals, airports can secure long-term value for their communities, their partners, and the planet.

9. Abbreviations

ACI	Airports Council International
ACA	Airport Carbon Accreditation
APUs	Auxiliary Power Units
BMS	Building Management System
CIP	Continuous Improvement Plan
CO ₂	Carbon Dioxide
CRAA	Columbus Regional Airport Authority
CSRD	Corporate Sustainability Reporting Directive
DBE	Disadvantaged Business Enterprise
ESG	Environmental, Social, and Governance
EV	Electric Vehicle
FSB	Financial Stability Board
GHG	Greenhouse Gas
GIS	Geographic Information System
GRI	Global Reporting Initiative
HVAC	Heating, Ventilation, and Air Conditioning
ICAO	International Civil Aviation Organization
IATA	International Air Transport Association
IoT	Internet of Things
ISO	International Organization for Standardization
ISSB	International Sustainability Standards Board
KPI	Key Performance Indicator
LAX	Los Angeles International Airport
LEED	Leadership in Energy and Environmental Design
RFP	Request for Proposal
SAF	Sustainable Aviation Fuel
SASB	Sustainability Accounting Standards Board
SDGs	Sustainable Development Goals
SCADA	Supervisory Control and Data Acquisition
SWaM	Small, Women-owned, and Minority-owned (businesses)
TCFD	Task Force on Climate-related Financial Disclosures
UN	United Nations
UNGC	United Nations Global Compact
VHT	Vertical and Horizontal Travelators

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