ICAO

ENVIRONMENT

Greenhouse Gas Management and Mitigation at Airports

ECO AIRPORT TOOLKIT

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1. INTRODUCTION

The aviation industry is taking action to reduce its impacts on climate, including a Net Zero Carbon goal by 2050. According to the Intergovernmental Panel on Climate Change (IPCC), aviation is responsible for between 2-3% of total current global human-induced carbon emissions, with airports accounting for approximately "2% of total global share" (ACI World, 2021, p.8). Although airports contribute a smaller percentage of emissions than air traffic operations, every portion of the sector must look to mitigate and manage Greenhouse Gas (GHG) emissions to ensure aviation reaches global climate change targets.

In addition, 41st International Civil Aviation Organization (ICAO) Assembly resulted in historic outcomes in the area of Environmental Protection. The Assembly has adopted a goal of net-zero carbon emissions for international aviation by 2050, which aligned international aviation with the Paris Agreement. It is one of the only global sector-specific climate goals and a significant milestone with governments backing up the industry goal on net-zero carbon by 2050. The long-term goal sets a common policy framework at the international level and provides opportunities for individual governments to start working on their own emissions reductions policies to complement it.

The aim of this e-publication is to provide an overview of the issue of GHG management at airports, including reasoning and advantages related to active reduction and management. This is followed by practices for how airports can mitigate and manage their GHG footprint, including concrete and practical actions. Implementing and financing emission reduction programs is also discussed, with examples of funding provided.

2. OVERVIEW AND TYPES OF GHG EMISSIONS

The term 'greenhouse gases' refers to certain types of gaseous emissions that contribute to increases in the earth's average temperature through a phenomenon called the "greenhouse effect." The Sun is continuously shining on the Earth, and some of the solar radiation that strikes the Earth reflects back out into space – except when atmospheric gases trap it in. This trapping of solar radiation by atmospheric gases is generally called the greenhouse effect and is considered to be the primary cause of global warming.

The gases that cause this are therefore referred to as greenhouse gases (GHGs). They come primarily from the combustion of fossil fuels, decomposition of waste materials, and deforestation,

among other things. Experts have identified six primary GHGs that are the biggest contributors to the greenhouse effect:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)
- Sulphur hexafluoride (SF_6)[1]

The GHG most relevant to aviation is CO_2.[2] At an airport, it is the aircraft that are the largest emitters of GHGs, and most of that is CO_2. N_2O constitutes a very small percentage of aircraft emissions. Modern aircraft do not emit CH_4.HFCs, PFCs, and SF_6 are not products of aircraft engine combustion.

At modern airports, there are many other sources of emissions. GHG emissions come from ground support equipment and passenger vehicles, boilers and furnaces, waste management activities, de-icing substances, electrical usage, refrigerant loss, and other sources.[3]

There are international standards for accounting and reporting of GHGs. The Greenhouse Gas Protocol is one of the primary sources of information for measuring emissions, while ISO 14064 provides standards with which an emissions inventory can be compared.[4] CO_2 is the most prevalent of the GHGs. It should be acknowledged that different GHGs have different contributions to greenhouse gas effect, as well as different lifetimes in the atmosphere, with some having the ability to remain there for decades or centuries.

It is common, when reporting GHGs, to show other gases as they relate to carbon dioxide. By showing the different gases as carbon-equivalent (CO_2-eq), it is easier to compare emissions and their impacts from different sources.

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[1] See: Kyoto Protocol to the United Nations Framework Convention on Climate Change, Annex A https://unfccc.int/documents/2409

[2] See: Aircraft Engine Emissions https://www.icao.int/environmental-protection/pages/aircraft-engine-emissions.aspx

[3] See for example, the latest Annual Report of the Airport Carbon Accreditation https://www.airportcarbonaccreditation.org/aca-media/annual-reports.html

[4] See https://www.iso.org/standard/66453.htm

The GHG Protocol categorizes emissions into three broad scopes based on whether they are direct or indirect emissions:

- Scope 1: All direct GHG emissions. These would include emissions under the direct control of the airport operator.
- Scope 2: Indirect GHG emissions from consumption of purchased electricity, heat or stream.
- Scope 3: Other indirect emissions not under the control of the airport operator. For example, aircraft emissions or ground access vehicles.

3. GHG MANAGEMENT: Drivers and Benefits

The primary benefits of managing GHGs at a facility result from reducing their contribution to climate change. However, most actions that reduce emissions have co-benefits. Carbon is a measure of cost – operational efficiencies at an airport reduce fuel burn and electricity use, and therefore reduce GHG output and fuel costs simultaneously. Operational efficiencies include ground support equipment (GSE), and airport processes such as water and waste management. It can also include efficiency of aircraft movements such as reduced hold times, taxi out, etc. Furthermore, local air quality around the airport can be improved for the benefit of airport employees and residents of areas adjacent to the airport premises.

In 2021, the Airport Cooperative Research Program (ACRP) provided six benefits of GHG mitigation for airports, including the following:[5]

1. Improved Bond Rating

   Elimination of the dependence on fossil fuels at an airport decreases the risk of price shocks, and therefore reduces the risk to prospective revenue streams. Increases in credit rating could facilitate attracting and granting of finance. Additionally, lack of GHG management has been linked to lower bond ratings by credit rating agencies.

2. Improved Public Relations

   An active GHG mitigation program appeals to an increasingly environmentally conscious market and is also crucial for nearby neighborhoods sensitive to air pollution. Active management makes the airport part of the solution to decarbonize and improves local air quality. Overall, these benefits provide enhanced

[5] See Guidebook for Developing a Zero- or Low-Emissions Roadmap at Airports |The National Academies Press

opportunities for airport communications. Additionally, solid tracking of emissions data can avoid potential litigation claims and other similar risks.

3. Carbon Pricing Risk Mitigation

   Lowering carbon emissions could reduce the increased costs associated with carbon. Airports must plan now to avoid locking-in carbon intensive infrastructure and operations in future years. Markets put a price on carbon, such as ICAO's Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) and the European Union's Emissions Trading System (EU ETS), and that price is expected to grow.[6]

4. Attracting Airport Partners

   An effective GHG management plan can improve attractiveness and increase business opportunities (e.g. Amazon's Shipment Zero Initiative). Airports can identify common benefits and interests from stakeholders in the airport GHG reduction measures, and support and recognize stakeholders who successfully reduce their GHG emissions.

5. Improved Employee Health and Relations

   Reducing GHGs means improved and cleaner labor environments for airport employees. A successful program will support the development of a sustainable work culture and increase employee motivation and engagement.

6. Energy Resiliency and Efficiency

   Energy efficiency can reduce an airport's operational costs. Additionally, energy plays a crucial role in resiliency efforts. Self-sufficient airports are less exposed to energy rationing or blackouts. An effective GHG management plan will provide opportunity to combine energy mitigation with measures to develop more resilient renewable energy infrastructure. Airports are important partners to regional climate adaptation, and efforts to drive innovation and collaboration can provide support for broader regional decarbonization efforts.

A successful GHG management system can be a 'win-win' program providing direct cost benefits, as well as an array of co-benefits for public outreach, resiliency, and stakeholder partnering.

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[6]See https://www.icao.int/environmental-protection/CORSIA/Pages/default.aspx; and https://ec.europa.eu/clima/eu-action/eu-emissions-trading-system-eu-ets_en

4. HOW TO EFFECTIVELY IMPLEMENT GHG MANAGEMENT AND MITIGATION

Airports can manage GHGs similar to how they manage other environmental impacts. A GHG management plan can be developed and included in an environmental management system or other airport plan. Additionally, there are programs such as the *Airport Carbon Accreditation* (ACA) designed to help airports manage GHGs and work towards continuous improvements. More information on the accreditation programs is provided in the next section of this document.

For a GHG mitigation project to be successful, it is essential to get the buy-in of senior management from the outset. This both legitimizes/endorses the project as well as facilitates access to the resources (human and financial) required. To obtain such support, it will be necessary to demonstrate why the project is important and the benefits of taking action. The drivers and benefits above can be used to support this. A cost-benefit analysis and overview of the return on investment (ROI) can be useful tools to demonstrate the rationale for the project. Win-win benefits such as improved energy resilience should be highlighted. The potential consequences of not taking action can also be demonstrated, such as public disapproval, and making investments that lock in carbon intensive infrastructure and operations into the future.

Once leadership support has been secured, it is important to engage with both employees and key stakeholders to get their buy-in and support. As with senior management, it is important to explain the rationale for the project and emphasize any benefits for employees and stakeholders such as improved working conditions or reduced fuel costs/improved operating procedures.

Consider the purpose of GHG management prior to doing any planning. This will help you define the scope, objectives, and Key Performance Indicators (KPIs) of the project. If the focus is mainly management goals for environment and sustainability, there will be some discretion in how to develop a program for the airport. If the effort is meant to satisfy climate change initiatives such as a state climate action plan, or to disclose emissions for regulatory purposes, then you must ensure you meet any special requirements for preparing and reporting GHG data.

The first step to manage GHGs is understanding the sources and amounts emitted at the facility. Airports are comprised of aircraft movements, surface transportation, and various other technical operations such as waste disposal or power generation. All of these will have some emissions associated with their operation. An inventory of airport GHGs can be developed by airport staff. Airports can use ACI's Airport Carbon and Emissions Reporting Tool (ACERT), a self-contained

Excel spreadsheet that enables an airport operator to calculate its own GHG emissions. The tool is available at no cost to airports and can be used without emissions or environmental expertise by inputting readily available operational data.[7]

Additionally, one can use the ACA Application Manual as a guide to measure emissions. It is ideal for the GHG inventory to be based on the guidelines of the GHG Protocol.[8]

Once the GHG footprint of the airport is known, use the information to develop a plan for management and mitigation of GHGs. The majority of a GHG management plan will be the specific actions that are to be taken to reduce or eliminate carbon and other GHGs output. Ensure coordination with relevant departments/stakeholders when developing the plan. A main element of reducing GHGs is making operations more efficient. This generally has the benefit of reducing fuel costs. Another aspect of emission reduction includes replacement of equipment at the facility. Newer equipment is generally more efficient and has fewer emissions. Some sources of GHGs may be easier to reduce than others, depending on several factors, including airport size, location, availability of finance, policy and regulatory framework. For example, the airport may plan to change over shuttle buses and other vehicles from diesel fuel to electric within five years.

As there are many sources of GHG emissions at the airport, each will have different options for mitigation, as well as different costs and schedules. Set performance goals that reflect the organization's objectives and develop reasonable timelines for completing the actions. Use the performance indicators to track progress towards meeting the goals.

It is important to monitor and verify progress in reducing emissions so these can be reported to management and any authorities that may require it. Consider reporting data annually using accepted international standards (GHG protocol, ISO 14064, etc.).[9] Annual reporting allows for a review of progress towards mitigation goals, and an opportunity to focus resources where they are most needed.

More detailed information about planning a GHG management program that targets carbon neutrality can be found in Appendix A, Net Zero Carbon Roadmap Development, including step by step process overview.

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[7] See https://aci.aero/wp-content/uploads/2021/08/ACERT-Brochure.pdf
[8] See https://ghgprotocol.org/
[9] See https://www.iso.org/standards.html and https://ghgprotocol.org/

5. RECOGNIZING THE PROGRESS

Recognition programs provide a way for airports to get guidance in managing and reducing GHG and see their achievement celebrated. These programs provide opportunities to showcase and communicate an airports' efforts in reducing their environmental footprint.

The principal global carbon management certification program for airports has been established by Airports Council International EUROPE (ACI EUROPE). Over 400 airports in 79 countries worldwide currently participate in the ACA program, representing almost 50% of global air passenger traffic. ACA uses six levels of certification to "independently assess and recognize the efforts of airports to manage and reduce their carbon emissions."[10] ACA has been designed specifically for airports and provides a common framework for active carbon management with measurable goals.

The levels of certification in ACA start with mapping emissions at the airport. Higher levels of certification include working towards net zero emissions and offsetting residual scope 1 and 2 emissions. To participate in a program such as ACA, the GHG inventory is verified by an independent 'third-party'. Additionally, there are fees required. The program has become the industry standard, and airports worldwide can assess how their efforts to reduce GHG compare to others. Many airports use the ACA certification in their public outreach to let their community know they are taking action to minimize carbon output. There is also ongoing work on the development of a new level in ACA to certify that an airport has reached and is maintaining a net zero Carbon balance on scope 1 and 2, while further incentivizing reduction of scope 3 emissions sources that an airport can significantly influence on the pathway to net zero.

To further deploy carbon reduction initiatives to other aviation industry actors locally at airports, a voluntary program is being developed by ACI EUROPE for service providers. The aim is ultimately not only for the airport operator to become carbon free, but also other companies at the airport, providing services.

There are other programs that offer recognition for efforts to reduce GHGs. The Climate Registry offers the "Climate Registered™ recognition program.[11] While tracking and reducing GHGs must be done by the airport operator, membership in a certification program offers various benefits to

[10] See https://www.airportcarbonaccreditation.org/about/what-is-it.html
[11] See https://www.theclimateregistry.org/programs-services/voluntary-reporting/climate-registered/

assist including training and tools, networking opportunities, and assistance with reporting, which can help make reducing your carbon footprint a successful experience.

6. POSSIBLE GHG MITIGATION MEASURES AT AIRPORTS

Depending on airport operating context, different GHG mitigation measures can be considered. This section provides an overview of areas which can be looked at during GHG management plan development and provides examples of solutions implemented around the world and across all of the emissions scopes.

6.1. Energy Efficiency

Energy efficiency could be a measure considered first in the GHG management and mitigation strategy. Improvement actions include window and door sealing, wall and ceiling insulation, installing LED lighting for runways and taxiways, developing an energy conservation program for building users, more efficient HVAC systems (e.g. motion/light sensors or heat recovery), among others.

In 2021, El Dorado International Airport (BOG; Bogotá, Colombia) was the first one in the world to be certified as a LEED Platinum building in the operation and maintenance of existing buildings (version 4.1), granted by the United States Green Building Council. Energy efficiency was one of the aspects of the 12-month long evaluation to obtain certification. Energy efficiency has been also at the core of Helsinki airport terminal extension with new windowpanes installed. The new panes reflect the sun's radiation helping to keep the building cool and reducing the energy required for air conditioning.

Sharjah Airport (SHJ, United Arab Emirates) conducted a detailed energy audit as a part of carbon management plan. Based on this, a number of retrofit projects were planned as a part of the carbon reduction initiative to optimize energy consumption. As identified in the audit, 28% of energy consumption was used for lighting and the airport prioritized the replacement of old halogen and fluorescent lighting with the latest energy efficient LED lighting as a part of the SAA Carbon Management Plan. A total of 40 plus lighting projects were completed after 2017 and a few more are still in progress. For example, the cargo terminal lighting project reduced energy consumption while enhancing the coverage of lighting to five additional areas of the project location with an improved luminance level. It brought an annual savings of 617,773.32 kWh with a monitory saving of AED: 271,820/year. This will reduce 263 tons of carbon from SAA's total annual emission. More benefits are outlined in Figure 1 below.

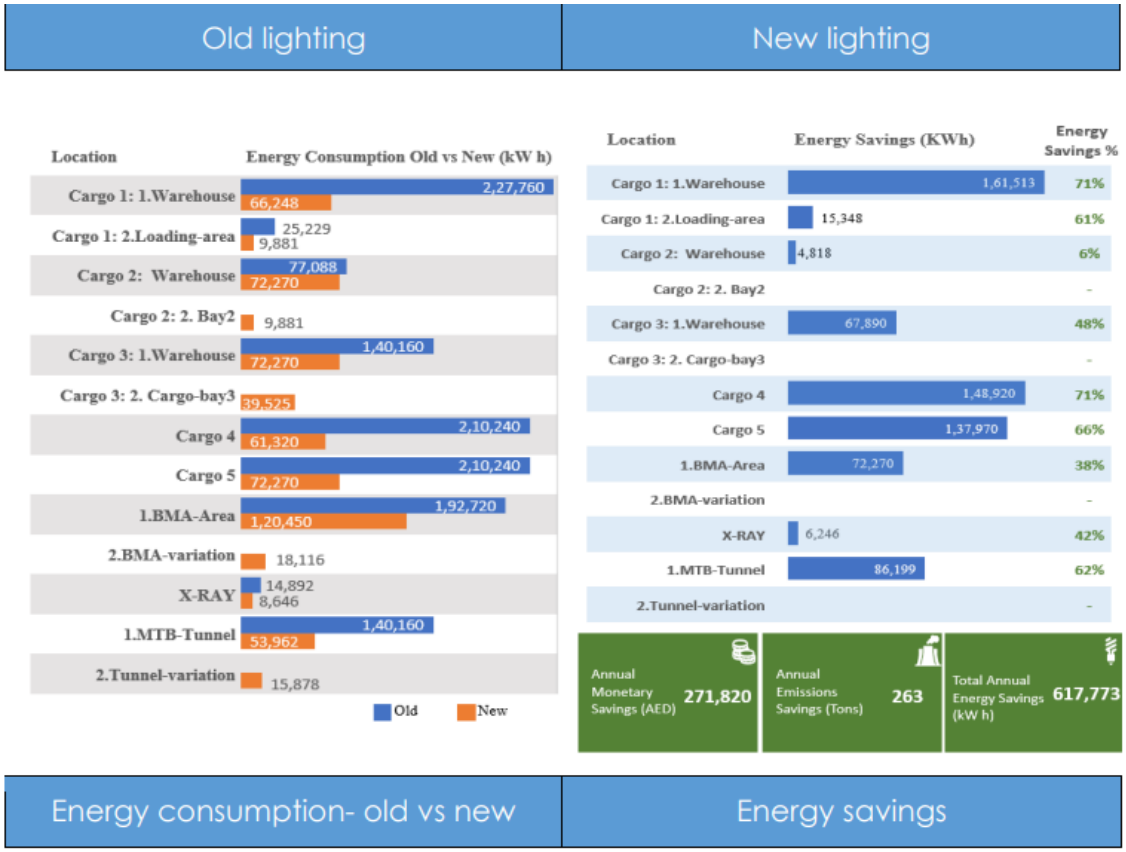

Figure 1. SAA's benefits of lighting improvement projects
Source: [ACI APAC Green Airports Recognition 2022 Publication]

6.2. Heating and Cooling Technologies

Heating, cooling, and ventilation improvements should be approached by working from downstream to upstream - from the end to the source. In addition, airports can deploy innovative solutions and data analytics to optimize the working of such systems, increase energy efficiency and reduce carbon emissions. Hong Kong International Airport (HKG) in collaboration with local stakeholders developed and implemented in 2021 Weather Forecast for Air-conditioning Control System (Weather FACTS). It collects hourly data including HKG's passenger flow from flight information and weather data, such as temperature, humidity, cloud amount, wind direction, wind speed and solar radiation, from the Hong Kong Observatory and half-hourly electricity consumption of HKG. By employing big data analytics and machine learning, the system can forecast the terminal's cooling demand with 90% accuracy over the following 24 hours. Based on the forecast, the chillers can deliver the appropriate amount of cooling volume needed, eliminating unnecessary energy consumption while also maintaining travelers' comfort.

HKIA is the first of its kind in the world to implement a predictive control system for air-conditioning based on real-time passenger flow and weather information. Weather FACTS can save an estimated 1.7M kilowatt-hours (kWh) of electricity, which is approximately 4% of the total energy consumption of the chiller plant and 630 tons of carbon emissions reduction. Since the system does not require any modification of existing equipment, the initial investment cost is relatively low.

6.3. Renewable Electricity Consumption

Installation of renewable energy is becoming more attractive not only because of its declining costs, but also due to the additional benefits it can offer of protection against outages and blackouts. Common onsite renewable energy systems at airports include solar arrays. Other renewable energy sources include geothermal heating and cooling, biomass/ waste-to-energy production, building-mounted wind turbines, hydrogen fuel-cells, and more. When renewable energy cannot be produced on the location of the airport, another option is to purchase power that has been generated from renewable sources, through power purchase agreements. Many utility companies now offer this as an option for customers.

Stuttgart Airport (STR; Germany) purchases 100% electricity from renewable sources, as well as running solar power plants with a total of 15,000 square meters and a yield of 2.5 Gigawatt hours (GWh). The airport plans to increase the mix of renewables used and is building a smart grid to ensure stability and continuous flow of energy[12].

Christchurch Airport (CHC; New Zealand) pioneered the use of innovative ground source heat systems which was shared with others in their region to enhance the wider region's decarbonization, increasing overall resilience and sustainability of operations through carbon and climate risk management.[13]

Use of Low GHG Fuels and Electricity

Airport fleet vehicles constitute one of the main sources of emissions at airports. Reductions could be achieved through modernization of fleet vehicles and ground support equipment (GSE), use of alternative fuels for buses, cars and other air and land side vehicles, including compressed natural gas (CNG), biodiesel, renewable diesel, biogas, hydrogen, compressed air and hybrid vehicles.

[12] See the Eco Toolkit: A Focus on the production of renewable energy at the Airport site

[13] See https://www.christchurchairport.co.nz/about-us/who-we-are/media/2021/net-zero-2050---christchurch-airport-announces-innovative-and-world-leading-renewable-energy-park/

Airports can also introduce incentives to encourage companies operating at their premises to reduce and limit the use of fossil fuels. Stockholm and Göteborg Swedavia introduced incentives for the use of hydrotreated vegetable oil (HVO). Price is differentiated by HVO and diesel encouraging stakeholders at the airport to refuel with more environmentally friendly option.

Additionally, and depending on availability, airports can implement use of fuel cell-powered GSE equipment to achieve zero-emissions operations. That also includes energy efficiency gains when compared to diesel-fueled operations, and lower maintenance costs. Hydrogen fuel cell powered GSE equipment, for example, are operational at FedEx World Hub in Memphis (MEM).

Gimpo International Airport (GMP; Korea) has recently replaced its five CNG buses with electric buses, reducing carbon dioxide emissions by 180 tonnes per year, which is calculated to have a reduction effect of 91% compared to CNG buses. It was also investigated that there was an effect of reducing methane gas by 2 tonnes per year. In addition, fuel and repair costs are reduced by 75% from $138,000 USD to $34,000 USD per year, or about $104,000 (see Figure 2 below). Besides, passengers can enjoy the airport shuttle experience more comfortably through the use of electric buses with much less noise and vibration.

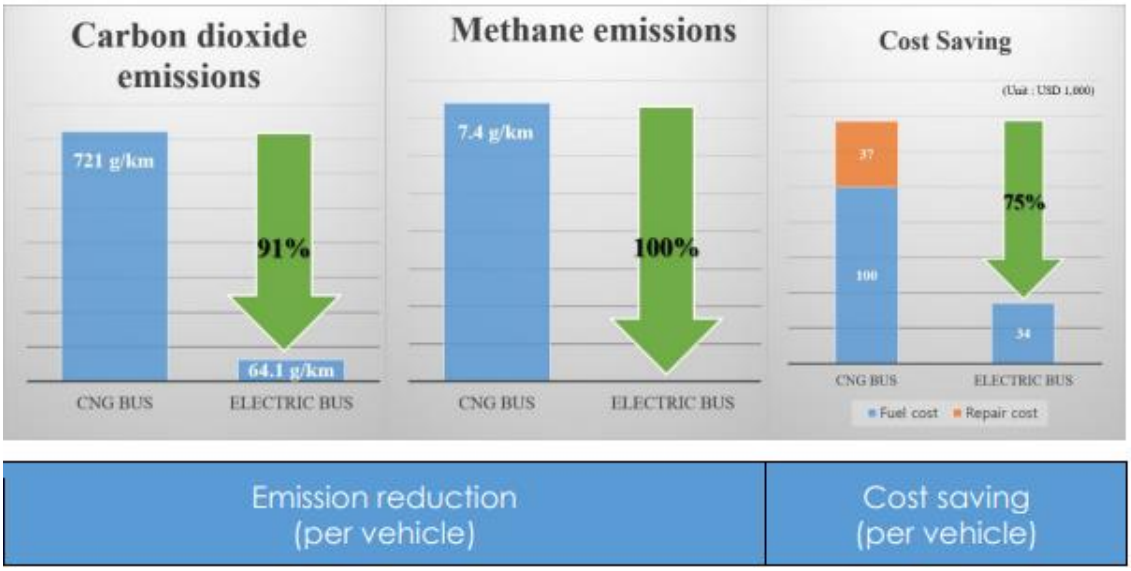

Figure 2. Benefits of bus fleet electrification- emissions and cost savings
Source: ACI APAC Green Airports Recognition 2022 Publication

Improvements in Ground Operations and ATM

There are many options available to reduce emissions from ground operations. As mentioned above, airports have deployment low-, or no-emission GSE. These include hybrid and electric tugs and baggage loaders. Another step is to ensure the optimization of ground vehicle movements, reducing unneeded trips and emissions. For aircraft operations ground operations can be optimized through reduced taxi times, operational towing, and the use of pre-conditioned air (PCA) at the gate as a substitute for running the aircraft auxiliary power unit (APU). Optimized ATM also reduces emissions. For the airport, this generally includes landing and take-off procedures, such as continuous descent operations.

Amsterdam Schiphol Airport (AMS; Netherlands) conducted a trial of Taxibot, a towing vehicle that takes a plane from the gate to the runway and is controlled by the pilot. Taxibot uses fuel but allows the aircraft to keep its engines off while taxiing, which greatly reduces overall emissions. The airport estimates 50-65% reduction in fuel consumption from taxiing, resulting in reductions of CO_2 and NOx emissions, as well as noise. Indira Gandhi International Airport (DEL; India) and Paris Charles de Gaulle (CDG; France) airport also are testing the solution. Improvements in ground operations and ATM can be also achieved through implementation of Airport Collaborative Decision Making (A-CDM). It contributes to improvement of resource efficiency and resilience of operations. ICAO Document 10013 *Operational Opportunities to Reduce Fuel Burn and Emissions* could be also referred to, as it includes information on current practices implemented by aircraft operators, airport operators, air navigation services providers (ANSPs), other industry organizations and States, which are intended to minimize fuel use and reduce aviation emissions.

Waste Management

Managing waste efficiently also helps reduce GHG emissions. These improvements largely include reduction of landfill waste which releases GHG through incineration or decay. Effective waste reduction, recycling, and composting often requires stakeholder engagement and partnering with tenants. Gatwick Airport (LGW; England) has an on-site incinerator which converts waste into usable energy.

Cairns Airport (CNS; Australia) has a goal to halve their waste to landfill and contribute to a circular economy by 2025.[14] To achieve these environmental and social goals, they have installed an industrial food waste macerator, custom-built food waste separation bins, as well as compostable coffee cups. The project resulted in considerable reductions in waste, as well as scope 3 emissions reduction for the airport.

[14] See https://www.cairnsairport.com.au/corporate/environment-and-sustainability/2021-2025-environmental-goals/

Carbon Capture, Storage and Sequestration

Removing CO_2 from the atmosphere, and storing it, can be achieved with Negative Emissions Technologies, which can include natural and/or technological solutions. Projects can involve afforestation and reforestation, biochar-based initiatives, soil carbon sequestration, restoration of marine and coastal habitats. Technological solutions involve direct air capture, as well as bioenergy with carbon capture and storage. Airports can support development of the solutions mentioned, with some of them also relevant for production of synthetic aviation fuel.

Nature based solutions were also deployed in some airports' strategies towards achieving net zero emissions. For example, VINCI airports launched a reforestation and carbon sink program to reduce emissions at Lyon's airports. Christchurch Airport is also investing in permanent native forestry restoration to remove carbon from the atmosphere beyond the airport's own footprint.

Offsetting Emissions

Not all emissions can be eliminated at an airport. When absolute reductions are not possible, offsets provide an option to mitigate, or offset, the impacts of emissions. Offsetting involves payments made to other actors to reduce their emissions, in lieu of reducing your own. For example, someone may pay to preserve an acre of forest in order to offset the GHG emissions from their facility. There is a growing industry of offset providers that offer an array of opportunities. Offsets are usually purchased for compliance reasons, but may also be used to achieve certain goals for GHG reduction. The ACA program has an Offsetting Manual that provides more information.[15] Things to consider when purchasing offsets include additionally and permanence criteria, transparency, and using verified programs.

Perth Airport (PER; Australia) has a partnership with Carbon Neutral to offset its bus fleets through purchasing offsets from within the Western Australian Yarra Yarra biodiversity corridor project. [16]

Enabling Industry-wide Emissions Reductions: Sustainable Aviation Fuel (SAF), Hydrogen and Electric-Powered Aircraft

For many airports, the goal of reducing emissions includes options for increasing use of SAF by carriers. Amsterdam Airport Schiphol has announced a new initiative to encourage the use of Sustainable Aviation fuel. The airport "will provide a total of €15 million in funding to airlines

[15] See https://www.airportcarbonaccreditation.org/component/attachments/?task=download&id=189

[16] See https://www.passengerterminaltoday.com/news/sustainability/perth-airport-to-offset-its-bus-fleets-carbon-emissions.html

refuelling with SAF which will be allocated on the basis of consumption in metric tonnes." Other strategies include waivers on landing charges for zero-emission aircraft (e.g. Manchester Airports Group, Stuttgart Airport). SAF-fuelled operations yield also benefits for local air quality around the airports producing, for example, less sulphur oxides or particulates.

Airports can also play broader role as catalysts for decarbonization and enablers for hydrogen and electric aviation development. Depending on airport operating conditions, as well as government policies and industry stakeholders' interests in hydrogen and electric aviation, airports can cooperate and participate in development of plans for such new forms of aviation operations. That includes for example involvement in research, assessments, and pilot projects such as the holistic green airport project (OLGA)[17] in the European Union, identifying requirements, as well as safety and risk aspects for operations with hydrogen aircraft. Driving work with local and national stakeholders to identify opportunities and future interests, as well as develop plans could be also a viable strategic option. That will also help airports to prepare for the future, including potential operations with multiple fuel types.

7. Incentivizing GHG Management and Funding for Mitigation Efforts[18]

While costs of decarbonization and energy transition can seem to be high, as indicated by IPCC, costs of inaction can significantly exceed the investment required in emissions abatement. There are many funding options to support airport carbon reduction activities. These incentives can be broken down into public funding, airport-based funding, and third-party funding, and can include grants, tax breaks, financial instruments, and creative contracting; examples of these are provided below. Note that these incentive programs are very specific to location, as different states have differing financial and regulatory processes. Climate funding could be also available through United Nations programs or multinational and regional development banks and schemes. For example, ICAO, in collaboration with UNDP, developed a guidance material on *Financing Aviation Emissions Reductions,* which provides insights on financing for renewable energy projects to reduce CO_2 emissions.

[17] See OLGA | hOListic Green Airport (olga-project.eu)
[18] See https://pubsindex.trb.org/view/2021/M/1681500

7.1. Public Funding

Greenhouse Gas Markets

Started in 2002, the United Kingdom established a national greenhouse gas market to place a cap on GHGs and require payment from entities that produce above a specified threshold of those gases. These programs allow companies to buy and sell carbon allowances, and therefore eases the burden of reducing carbon emissions. Similar programs exist in Canada, the United States, and the European Union.[19]

State Grants and Energy Efficiency

Depending on the region or state, governments may provide tax credits, grants, rebates and bonds to encourage energy-efficiency actions. Many states offer clean energy incentives such as grants for converting to low-emission technologies. Airports should refer to databases or governments for information regarding possible incentives.[20]

FAA Sustainability Planning Grants

As part of the effort to reduce GHG emissions at airports in the United States, the FAA offers grants from the Airport Improvement Program to encourage airports to develop comprehensive Sustainability Master Plans.[21] The master plans encourage airports to fully integrate sustainability into their long-range planning, including GHG reduction activities. These master plans identify sustainability objectives that will reduce environmental impacts, realize economic benefits, and improve community relations. Approximately 50 airports have benefited from the FAA's sustainability grants.[22] The European Union has considered a similar grant program. However, many airports in Europe are already carbon neutral, and there are limits on state aid for larger airports, so it is unclear whether such a program will move forward.

FAA Voluntary Airport Low Emissions Program[23]

Another program offered by the FAA is the Voluntary Airport Low Emissions Program (VALE). Developed in an effort to help airport operators meet state-related air quality responsibilities under

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[19] See https://www.c2es.org/wp-content/uploads/2002/03/trading.pdf
[20] See https://pubsindex.trb.org/view/2021/M/1681500
[21] See https://docs.wixstatic.com/ugd/e73097_b5761cccc59c46e986ddc4b8c62cf885.pdf
[22] See https://www.faa.gov/airports/environmental/sustainability
[23] See : https://www.faa.gov/airports/environmental/vale

the Clean Air Act, VALE allows airports to use Airport Improvement Program (AIP) funds and Passenger Facility Charges to finance low emission technologies such as vehicles, refueling and recharging stations, gate electrification and other airport air quality improvements. Eligible projects include electrification of ground support equipment, geothermal systems for building heating and cooling, solar thermal, and installation of fuel hydrant systems for aircraft. As of September 2021, VALE grants have funded 133 projects at 59 airports. To access these funds, airports are required to submit a brief description of the proposed project, an estimate of what the current emissions are estimated reductions, and an estimate of the AIP funding request.

FAA Zero Emission Vehicle Programs

The FAA's zero emissions vehicle (ZEV) and Infrastructure Program offers funding for up to 50% of the cost for airport zero emissions vehicles and for equipment to recharge or refuel the cars, trucks, and buses. Vehicles could be electric or hydrogen powered. The grant's purpose is to cover the price premium an alternative vehicle may carry over a conventional vehicle, and to address upfront investments necessary to power the vehicle. Airports in poor air quality zones are given first priority for grant consideration.

Similar programs also exist outside of the United States. Transport Canada announced C$547.5 million over four years for the incentives for medium- and heavy-duty zero emission vehicles.[24] Although this program is not explicitly reserved for airports, it signals a commitment to reduce GHG emissions.

Microgrid technology

Generally, airports are reliant on the local utility grid for the supply of continuous electricity. In cases of power failure, they must have in place emergency power systems to continue to provide critical operations and services. Traditional emergency systems usually run on diesel, producing GHG emissions. The use of microgrids using self-generating renewable energy can address this issue, with the added benefit of enhancing the airport's resilience and lowering its vulnerability to the increasing number of climate change impacts. Microgrids can also be used under normal operating conditions, either separate to the grid or connected to it. In the U.S., John Wayne airport, in Orange County, California (SNA, US) developed a microgrid to overcome repeated loss of power from their utility supplier.[25] The project took advantage of an incentive program by the state of California called the California Self-Generation Incentive Program.[26] Similarly Canada offers

[24] See: https://tc.canada.ca/en/road-transportation/innovative-technologies/zero-emission-vehicles/medium-heavy-duty-zero-emission-vehicles/incentives-medium-heavy-duty-zero-emission-vehicles

[25] See https://www.arup.com/perspectives/microgrids-for-resilient-airports

[26] See https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/demand-side-management/self-generation-incentive-program

the Canadian Green Fund for Microgrids, designed "to provide unique funding solutions to accelerate the development of micro grid projects."[27]

Global Mechanisms and Programmes

Some airports can benefit from international cooperation and development programs and projects. For example, Rarotonga Airport benefited from Cook Islands Renewable Energy Project through a grant provided by Global Environment Facility to develop solar capability and solar panel installation at Rarotonga Airport. Other projects can inform airports about potential funding sources and pilots which can be developed. For example, ICAO-UNDP-GEF collaboration on solar-at-gate project at Norman Manley International Airport in Kingston, Jamaica, generated information on steps airports can take to replicate similar initiatives. The snapshot of the flyer below provides outline of actions associated with such project development.

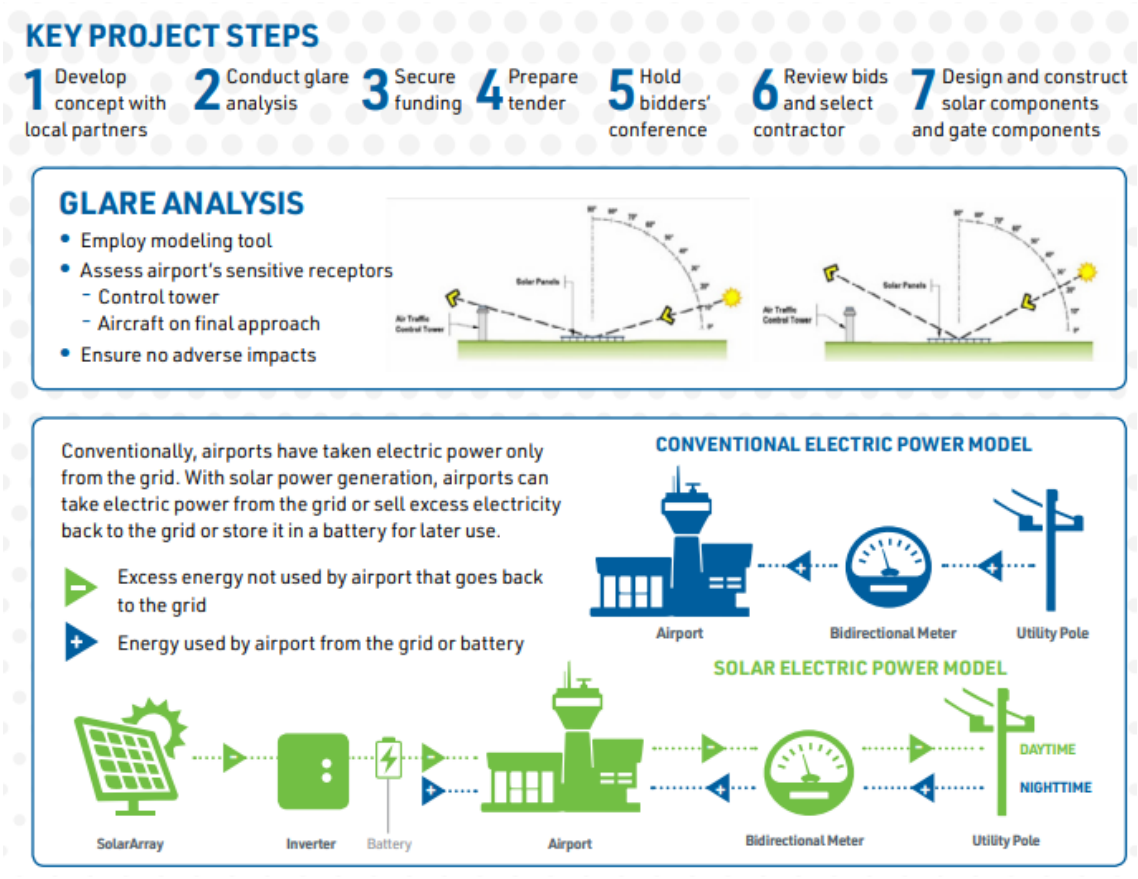

Figure 3. Solar project at airports: overview

[27] See https://www.canadiangreenfund.com/microgrids

Source: ICAO-UNDP-GEF Solar-at-Gate Pilot Project leaflet

Table in Appendix B provides further details and examples of public climate financing programmes, which could be used to support aviation emissions reduction.

7.2. Airport-Based Funding

Capital and Operational Budgets

Airports should consider budget adjustments to prioritize projects that reduce GHG emissions. By implementing projects in the near-term, airports can leverage the benefits of third-party and public funding in addition to the potential of reduced future costs from the implementation of more efficient systems and infrastructure.

Cross Subsidies within Airport

Cross subsidies at an airport also offer the opportunity for airports to generate funding towards the reduction of GHG emissions. For example, a percentage of the revenue from car parking could be used to subsidize public transport services to airports.

Green Revolving Funds

Green revolving funds (GRFs) are a type of financial tool that take advantage of environmental cost savings. Many projects to reduce GHGs improve operational efficiency and offer an environmental benefit. With the GRF, the cost savings from the initiatives financed are subsequently rolled back into the fund for future projects. Hartsfield-Jackson International Airport in Atlanta, Georgia and the Virginia Department of Aviation have both implemented GRFs and provide a model for future airports to follow.[28]

Power Management Opportunities

Through effective power management, airports can generate revenue without the need to invest in additional infrastructure. Back-up power generation and microgrids provide airports the opportunity to store excess power using batteries and thermal storage. This reduces energy consumption and cuts costs during times of peak demand. In some places, power generated on-site can be 'sold back' to the grid supplier during periods of peak need when their energy generation is not sufficient.

Tax Exempt Financing

"Airports with functional status as a utility can leverage tax-exempt funding from bonds" (Barrett 2015). The airport can purchase an electricity volume over a long-term period. The duration can

[28] See https://nap.nationalacademies.org/download/25567

extend 20 years or more, and that funding can be used to capitalize a renewable energy project at an airport. The airport with utility authority can recoup costs by selling the electricity to its tenants.

Partnerships for financing

Airports can also seek to develop partnerships for financing of GHG reducing solutions and implement joint solutions with their stakeholders. Alaska Airlines & Seattle Tacoma Airport for example developed a partnership for electric GSE implementation and use. More precisely, Sea-Tac constructed charging stations at the airport and Alaska Airlines purchased 204 electric GSEs.

Green bonds

Green bonds can be used to finance big infrastructure projects such as green airports. Royal Schiphol Group issued $910 million in green bonds specifically to finance clean transportation and sustainable buildings at Amsterdam and other airports it operates around the Netherlands. Swedavia was another airport group which issued SEK $1 billion green bond to finance green buildings, energy efficiency measures, renewable energy, pollution management and cleaner transportation solutions.

7.3. Third-Party Funding

Power Purchase Agreements

Under the arrangements of a Power Purchase Agreement, an energy provider installs, owns and operates an energy system on the airport for a predetermined amount of time. This allows the airport to receive stable and low-cost electricity without the upfront costs of installing a new energy system. Although a system may not be purely renewable, it can allow an airport without sufficient capital to transition to low GHG emitting alternatives.[29]

Energy Saving Contracts

"An energy savings contract (or performance contract) is a method allowing airports to leverage external engineering upgrades, combined with third-party financing. Energy savings contracts are a low upfront cost strategy that reduces overall energy consumption at specific buildings across an airport. In general, an energy service company (ESCO) creates a package of building-specific upgrades with an extended payback (typically around 10 years) and secures a loan from a bank to

[29] See https://betterbuildingssolutioncenter.energy.gov/financing-navigator/option/power-purchase-agreement

cover the labor and equipment costs to implement these upgrades. Efficiency gains can range between 20% and 35%, and individual projects include HVAC system replacement, retro-commissioning, and lighting improvements."[30]

Public-Private Partnerships

Public-private partnerships allow public entities to access private funding to complete projects. Public-private partnerships have allowed for terminal projects at JFK and LaGuardia, the Great Hall project at Denver International and the newly privatized terminal at Paine Field in Everett, north of Seattle.

Green Leases

Internal to an airport, green leases encourage airport concessionaires and airlines to acquire and install more energy efficient equipment. By including incentives and establishing baseline usage values for electricity, fuel and water, airports can shift some of the burden of cost related to reducing GHG emissions to tenants.

Passenger Voluntary Contributions

Passenger voluntary contributions give passengers the opportunity to address the emissions associated with their travel. By paying a modest fee, a third-party purchases carbon credits on behalf of the passenger.[31]

[30] See https://pubsindex.trb.org/view/2021/M/1681500
[31] See https://pubsindex.trb.org/view/2021/M/1681500

8. Conclusions

Reducing GHGs has become standard operating procedure for airport planning worldwide. Airports that are not actively managing emissions should consider their goals and begin the planning process described in this document. Actions that reduce GHGs lead to more efficient operations, reduced fuel costs, and an overall benefit to the environment. Many new technologies, such as low-emission vehicles, are being rapidly developed, and there are numerous options to finance these improvements. Programs such as ACA provide a proven process for managing reductions and have an array of resources to facilitate the process. Most airports have found that managing GHG emissions is a 'win-win' situation that results in cost savings, improved resilience against stressors, positive public engagement, and other benefits that set them on a confident path for future growth.

Additional Resources

National Academies of Sciences, Engineering, and Medicine. (2021) Airport Microgrid Implementation Toolkit. Washington, DC: The National Academies Press. https://doi.org/10.17226/26165.

National Academies of Sciences, Engineering, and Medicine (2021). Guidebook for Developing a Zero- or Low- Emissions Roadmap at Airports. Washington, DC: The National Academies Press. https://doi.org/10.17226/25677.

US Airport Cooperative Research Program (ACRP) "Report 11 – Guidebook on Preparing Airport Greenhouse Gas Emissions Inventories" (2009).

US Airport Cooperative Research Program (ACRP) Airport Energy Efficiency and Cost Reduction (2010)

US Airport Cooperative Research Program (ACRP) Report 56: Handbook for Considering Practical Greenhouse Gas Emission Reduction Strategies for Airports

World Resource Institute (WRI) & World Business Council for Sustainable Development (WBCSD) - "Greenhouse Gas Protocol, a Corporate Accounting and Reporting Standard" (WRI 2004)

ACI APAC Green Airports Recognition 2022 Publication.

International Civil Aviation Organization (n.d.). Solar-at-Gate Pilot Project- Leaflet.

International Civil Aviation Organization (2017). Financing Aviation Emissions Reductions.

International Civil Aviation Organization (2014). Operational Opportunities to Reduce Fuel Burn and Emissions (Doc 10013).

Appendix A

Net Zero Carbon Roadmap Development

Timely climate action to reduce carbon in line with the Paris Agreement's goal of limiting global warming to close to 1.5° C, and ultimately achieve net zero carbon emissions, can make airport operations more cost-efficient and resilient. Achieving net zero carbon requires an airport to reduce their own Scope 1 and 2 emissions as close to zero as possible and neutralizing remaining Scope 1 and 2 emissions through carbon removal.

The ACI guidance document Developing a Net Zero Carbon Roadmap[32] proposes a methodology in 5 steps:

1- Map your carbon footprint
2- Explore measures
3- Analyze pathways and refine your target
4- Develop your roadmap
5- Deliver

The ACRP has also published a resource for airports zero- and low emissions roadmap development with similar steps to those outlined above, and includes guidance for stakeholder engagement, exploring funding mechanisms, monitoring progress, and conducting outreach[33]

[32] See **Error! Hyperlink reference not valid.**

[33] https://cac-word-edit.officeapps.live.com/we/wordeditorframe.aspx?ui=en%2DUS&rs=en%2DUS&wopisrc=https%3A%2F%2Faciworldmtl.sharepoint.com%2Fsites%2FEnvironmentSustainability%2F_vti_bin%2Fwopi.ashx%2Ffiles%2F7f0b7e92ed8c4feaa50fb92c40b71672&wdenableroaming=1&mscc=1&hid=DD32D39D-40FD-4C71-9389-AAC1A48E9FD9&wdorigin=Outlook-Body&wdhostclicktime=1664560626538&jsapi=1&jsapiver=v1&newsession=1&corrid=b7fc8a72-aa1f-49e2-bfa9-ee8ba1bad7d5&usid=b7fc8a72-aa1f-49e2-bfa9-ee8ba1bad7d5&sftc=1&cac=1&mtf=1&sfp=1&instantedit=1&wopicomplete=1&wdredirectionreason=Unified_SingleFlush&rct=Medium&ctp=LeastProtected - _ftnref1https://www.aci-europe.org/downloads/roadmap/Guidance - Developing an Airport Net Zero Carbon Roadmap.pdfhttps://cac-word-edit.officeapps.live.com/we/wordeditorframe.aspx?ui=en%2DUS&rs=en%2DUS&wopisrc=https%3A%2F%2Faciworldmtl.sharepoint.com%2Fsites%2FEnvironmentSustainability%2F_vti_bin%2Fwopi.ashx%2Ffiles%2F7f0b7e92ed8c4feaa50fb92c40b71672&wdenableroaming=1&mscc=1&hid=DD32D39D-40FD-4C71-9389-AAC1A48E9FD9&wdorigin=Outlook-Body&wdhostclicktime=1664560626538&jsapi=1&jsapiver=v1&newsession=1&corrid=b7fc8a72-aa1f-49e2-bfa9-ee8ba1bad7d5&usid=b7fc8a72-aa1f-49e2-bfa9-ee8ba1bad7d5&sftc=1&cac=1&mtf=1&sfp=1&instantedit=1&wopicomplete=1&wdredirection

Figure A – ACI guidance document Developing a Net Zero Carbon Roadmap

While each airport's net zero carbon roadmap will be unique, some common characteristics should be that the roadmap:

- Is **target-oriented**, with a specific deadline for reaching net zero carbon
- **Outlines the steps and milestones** to achieve the goal
- **Engages stakeholders** in the development, communication and assessment process

Creating a Net Zero Roadmap

1 - Develop a Carbon Footprint

The first step in creating a net zero roadmap is to develop a carbon or GHG emissions inventory if the airport has not already done so, using frameworks described earlier in this appendix including the GHG Protocol or ACI's ACERT. The inventory must include all scope 1 and 2 emissions, and while scope 3 emissions are typically not included in airport net zero plans, it can be useful to include some or all scope 3 emissions sources in the inventory to assist the airport in identifying potential opportunities and partners for wider reduction activities. Third-party verification or auditing of the emissions inventory is not always required but is a best practice to ensure the inventory is as thorough and accurate as possible.

reason=Unified_SingleFlush&rct=Medium&ctp=LeastProtected_-_ftnref2See **Error! Hyperlink reference not valid.**

Next, the airport should determine the baseline year and a target year. ACI-Europe's guidance recommends the use of 2010 as the baseline to align with the IPCC's decarbonization scenarios, though if data is not available for 2010 the airport should select another baseline year with an explanation of why that year is chosen. The target year should be as early as possible while still providing a reasonable amount of time for the airport to implement the roadmap successfully, as earlier target years provide greater climate mitigation benefits.

2 – Identify and Assess Emissions Reduction Measures

Once the emissions inventory is complete, the airport can see the largest sources of scope 1 and 2 emissions, and reduction identify measures. For most airports, purchased electricity and heat (scope 2) are the largest source of carbon emissions, so measures to increase energy efficiency such as lighting and HVAC equipment upgrades, and/or the procurement or generation of renewable electricity often have the greatest potential reductions. Airport fleet vehicles are often another large source of emissions and measures such as converting to electric vehicles or switching to renewable fuels may be considered. Additional example emissions reduction measures are listed in the Mitigation Measures section of this document, ACRP Report 220: Guidebook for Developing Zero- to Low- Emissions Roadmaps at Airports, and the ACI World Long-Term Carbon Goal Study for Airports. Other airports are also sources of information on best practices for decarbonization.

The airport should take into consideration existing facilities and future demand when identifying and analyzing decarbonization measures. Once identified, the measures can be categorized and prioritized by timeframe (short-, medium-, and long-term actions), cost, emissions reduction potential, and technical feasibility for example.

Engaging with airport stakeholders in this step is important to gather ideas for emission reduction activities. Airport staff in different departments as well as tenants will be critical sources of information.

3 – Analyze Pathways and Confirm Target

Once decarbonization measures have been identified, categorized, and prioritized, the airport should assess different pathways to achieving their goal based on relevant factors (i.e. financial, regulatory and technical feasibility or dependencies). The pathways will depict what level of decarbonization is achievable and on what timeline based on the collection of measures implemented. The different scenarios can then be compared to a business-as-usual trajectory (future emissions levels if no actions are taken). Together, these scenarios or pathways are helpful as airport decision makers when finalize the target. The final target should include both an absolute GHG emissions reduction target as well as carbon removal target for any residual emissions.

Because achieving decarbonization requires a significant investment of resources (staff time, expertise, funding, etc), this step requires the involvement of all key stakeholder groups, from airport executives to staff and tenants.

4 – Develop the Roadmap

At this step in the process, the airport will consolidate and summarize the work and analysis completed in earlier steps. The roadmap should include an executive summary, a commitment to net zero emission from the highest levels of airport management, a clear statement of the target, and a summary of steps the airport will take to achieve the target. The roadmap should identify responsible parties for implementing the various measures and any interim milestones identified.

The roadmap should include information on the airport's plan to remove residual carbon emissions – both the approach (nature based or technology based), the expected amount of carbon removals to be undertaken and the timeline.

A key component of the roadmap is the monitoring and reporting plan and schedule. This will guide the airport's approach to measuring process and provide accountability for achieving results.

5 – Deliver (Measure and Monitor)

As the airport implements the roadmap, conditions may change to alter the initial analysis of measures and pathways. For example, new technologies may become available, costs for certain measures may increase or decrease, more funding becomes available to speed process, etc. Regular reviews and reporting of progress, annual emissions inventory updates, and revisiting the pathways will help the airport stay on track.

Stakeholder Engagement

Devising a stakeholder engagement plan will help the airport to identify relevant stakeholders and strategize engagement based on priorities, objectives and expected outcomes. The stakeholder engagement plan will also help the airport communicate their approach to the public and identify allies and support.

Internal stakeholders might include:

- Airport executive leadership sponsoring, approving, and allocating funding for the roadmap

- The core sustainability or net zero team, responsible for overseeing the work and individuals or teams of people responsible for implementing the various roadmap components
- Airport tenants including airlines, concessionaires, ground transportation providers

External stakeholders may include:

- Passengers
- Surrounding communities
- Governmental officials, policymakers, regulators
- Environmental advocacy groups
- Financial partners / bond rating agencies

Engagement tools include tools could include public meetings, listening sessions, surveys, reports, multi-media (videos, webinars, newsletters), and press releases. Successful implementation of the net zero roadmap will likely require action from external stakeholders, such as policy or regulatory actions, funding / financing, infrastructure development, etc. Engagement with policymakers and regulators is therefore important to inform them of the airports plan and to advocate for interventions as appropriate.

Capacity Building

Examples of Actions:

Dallas-Fort Worth International Airport

- Dallas Fort Worth International Airport (DFW) was the first airport in North America to achieve ACA Level 4+ and has a next zero carbon plan with a target date of 2030 – without the use of carbon offsets. To date, DFW has reduced their scope 1 and 2 carbon emissions on an absolute basis by approximately 80%, and they purchase 100% renewable electricity. DFW plans to achieve this goal though continued facility and infrastructure efficiency upgrades, development of a new zero carbon central utility plant, electrifying their fleet, use of renewable natural gas and renewable propane for fire-fighting training activities, expanding electrical infrastructure and researching carbon removal technologies. See the recent ESG Report for more information here: **Error! Hyperlink reference not valid.**.

Heathrow Net Zero Plan

- Heathrow has been carbon neutral since 2020, reducing their operational emissions from airport buildings and infrastructure by 93% from 1990 levels, and offsetting the remaining 7% of emissions. Heathrow has a more ambitious goal to be net zero by 2030, which includes reductions in scope 3 emissions from aircraft (15% reduction in carbon from

flying by encouraging use of SAF and research and development of zero emissions aircraft) and surface activity (45% reduction in carbon from surface access, supply chain, vehicles and infrastructure). Heathrow's plan includes carbon removal for residual emissions, from both nature-based projects such as tree planting and peatland restoration. See Heathrow Net Zero plan **Error! Hyperlink reference not valid.**.

Other examples of airport net zero roadmaps can be found on ACI Europe's Net Zero Repository[34].

[34] See Repository of Airports' Net Zero Carbon Roadmaps (aci-europe.org)

Appendix B

Table 1. Examples and summary of public financing programmes.

Adopted from: Working Paper 19 presented by Czechia on behalf of the European Union and its Member States and the other Member States of the European Civil Aviation Conference submitted to ICAO High Level Meeting on the Feasibility of a Long-Term Aspirational Goal for International Aviation CO2 Emissions Reductions, Montreal, 19-22 July 2022.

Fund name/Initiative	Purpose	Funding Type	Website
CLEAN TECHNOLOGY FUND (CTF)	Increase the development of low carbon technologies including renewable energy.	Financing, senior loans, convertible grants/contingent recovery grants, equity, local currency swaps and guarantees, contingent recovery loans, subordinated debt, plus technical assistance and capacity building.	www.climateinvestmentfunds.org/fund/clean-technology-fund
SCALING UP RENEWABLE ENERGY IN LOW INCOME COUNTRIES (SREP)	Increase the development of renewable energy in developing countries.	Concessional Financing, senior loans, convertible grants/contingent recovery grants, equity, local currency swaps and guarantees, contingent recovery loans, subordinated debt, plus technical assistance and capacity building.	www.climateinvestmentfunds.org/fund/scaling-renewable-energy-program
GLOBAL ENERGY EFFICIENCY AND RENEWABLE ENERGY FUND (GEEREF)	Provide attractive, low risk financial investments that will produce economic, environmental, and social benefits.	Provide attractive, low risk financial investments that will produce economic, environmental, and social benefits	www.geeref.com

Fund name/Initiative	Purpose	Funding Type	Website
THE GLOBAL ENVIRONMENT FACILITY (GEF)	To help developing countries and countries with economies in transition to meet the objectives of international environmental conventions and agreements.	Multilateral grants, contingent loans, loan to grant, mitigate technology specific risks, microfinancing for residences.	www.thegef.orghttp://www.thegef.org/
GREEN CLIMATE FUND (GCF)	To advance the goal of keeping the temperature increase on earth below two degrees Celsius by investing into low-emission and climate-resilient development.	Variety of financial instruments available, including grants, concessional loans, subordinated debt, equity, and guarantees, giving flexibility to match project needs. Risk-bearing capacity, allowing the Fund to support innovation and leverage and crowd in additional financing.	www.greenclimate.fund
GLOBAL CLIMATE CHANGE ALLIANCE (GCCA)	To help the most vulnerable and least developed countries address climate change through support of their national programmes.	National budget support with funds sent directly to the country in tranches with supplemental funds delivered on completion of first programme.	www.gcca.eu
NEIGHBORHOOD, DEVELOPMENT AND INTERNATIONAL COOPERATION INSTRUMENT (NDICI)	To support EU Development Policy and "Agenda for Change" including sustainability goals	Grants to organizations or projects being developed by them. Contracts through tendering process for goods and services. Budget support to countries through financial transfers to national treasuries. Funding directly to specific in-country sectors.	https://ec.europa.eu/international-partnerships/global-europe

Fund name/Initiative	Purpose	Funding Type	Website
PILOT AUCTION FACILITY FOR METHANE AND CLIMATE MITIGATION (PAF)	To support a market for carbon credits.	Grants to organizations or projects being developed by them. Contracts through tendering process for goods and services. Budget support to countries through financial transfers to national treasuries. Funding directly to specific in-country sectors	https://www.pilotauctionfacility.org/
AFRICA CLIMATE CHANGE FUND (ACCF)	To support low carbon development and climate resiliency.	Grants for capacity building, strategic planning, policy development, project implementation.	www.afdb.org/en/topics-and-sectors/initiatives-partnerships/africa-climate-change-fund
SUSTAINABLE ENERGY FUND FOR AFRICA (SEFA)	To support private sector-led small and medium scale renewable energy development in Africa.	Grant funding to target renewable energy development from feasibility to financial close. Grants for technical assistance and project preparation. Equity investments through the Africa Renewable Energy Fund, managed by Berkeley Investments. Grants to fund public activities that enable private investments	www.afdb.org/en/topics-and-sectors/initiatives-partnerships/sustainable-energy-fund-for-africa
INTERNATIONAL CLIMATE FUND (ICF)	As the United Kingdom's primary source of climate finance, it funds existing multilateral and national programmes focused on supporting private sector innovation and public-private	Project grants, investments in climate funds. Grants primarily provided for bilateral projects. Concessional loans provided to multilateral programs	www.gov.uk/government/publications/international-climate-fund/international-climate-fund

Fund name/Initiative	Purpose	Funding Type	Website
	partnerships, including renewable energy development in Africa.		
INTERNATIONAL CLIMATE INITIATIVE (IKI)	To mitigate GHG emissions, adapt to climate change, conserve carbon sinks, and conserve biodiversity.	Grants to support policy advice, capacity building and appropriate training measures, and also technological lighthouse projects and technological cooperation scheme	www.international-climate-initiative.com/en
NAMA FACILITY	Implement ambitious mitigation projects in developing and emerging economies.	Funding for transformational changes in sector development driven by in-country planning and implementation	www.nama-facility.org
GLOBAL CLIMATE PARTNERSHIP FUND (GCPF)	Use public funding to leverage private capital in order to mitigate climate change and drive sustainable growth in developing and emerging markets.	Dedicated funding to local institutions in the form of senior or subordinated debt; mid- to long-term financing with flexible schedules; direct financing for projects in the late stage of development through direct funding primarily in the form of senior debt; maturities of up to 10 years; equity or mezzanine debt, provided in smaller amounts where this strengthens the funding package	www.gcpf.lu/investing-in-renewable-energy-and-energy-efficiency.html
GLOBAL CLIMATE CHANGE INITIATIVE (GCCI)	Support plans and programmes to mitigate and adapt to climate change in developing countries.	Various measures from direct technical assistance, grant funding, and financial supports through partner agencies.	www.usaid.gov/climate

Fund name/Initiative	Purpose	Funding Type	Website
PRIVATE FINANCE ADVISORY NETWORK (PFAN)	Provide free business consulting services to early stage clean energy development projects in emerging economies	Free advisory services, networking to bring entrepreneurs in the developing world together with investors from the developed world.	www.cti-pfan.net
UAE SOUTH PACIFIC PARTNERSHIP FUND (UAE-PPF)	To diversify energy mix and advance sustainability.	Grants and technical assistance	www.masdar.ae
IRENA / ADFD PROJECT FACILITY	To overcome financial barriers to clean energy development.	IRENA provides technical assistance and capacity building, ADFD provides concessionary loans.	www.adfd.irena.org
PACIFIC ENVIRONMENT COMMUNITY (PEC) FUND	To install renewable energy and sea water desalination projects to solve energy and drinking water problems.	Grants for solar power generation systems and sea water desalination plants or a combination of both.	www.forumsec.org/pages.cfm/strategic-partnerships-coordination/pacific-environment-community-pec-fund
UAE-CARIBBEAN RENEWABLE ENERGY FUND	To diversify energy mix and advance sustainability.	Grants and technical assistance.	www.masdar.ae