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Deliverable D.T1.2.1 Low carbon/low energy plan

Version n. 1

Sustainable reduction of carbon footprint level in programme AiRports",

Podgorica, Montenegro – Reference no: 492-2022-2

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1 Introduction

The world has a rapidly closing window of time to avoid the most catastrophic effects of climate change. Since 1990, global annual greenhouse gas (GHG) emissions have increased by 50 percent, rising from a little less than 40 gigatons (Gt) of carbon dioxide equivalent (CO2e) to just under 60 Gt of CO2eq. According to the Intergovernmental Panel on Climate Change (IPCC) 1.5°C special report (https://www.ipcc.ch/sr15), the world only has 8 years to reduce carbon emissions by 45%, and only 28 years before net zero emissions must be reached, if global average temperature rises to only 1.5°C has to be kept. The Paris Agreement under the United Nations Framework Convention on Climate Change established a global action plan to reduce the impacts of climate change by limiting global warming to below 2°C and pursuing efforts to keep warming below 1.5°C above pre-industrial levels. Keeping the global average temperature increase to within 1.5°C requires all sectors of the economy to achieve net zero emissions by 2050.

Global concern about the effects of climate change and the impact on infrastructure is becoming increasingly prevalent. It is estimated that inclement weather results in around 70 per cent of annual flight delays and future weather changes could exacerbate these challenges. (US data 2018, Fact Sheet – Inclement Weather, https://www.faa.gov/newsroom/inclement-weather-0?newsId=23074). From sea level rise to changes in temperature, weather, wind and storm patterns, the impacts of climate change are predicted to pose a serious risk to airport operations if unaddressed.

2 Transportation emissions

Transportation powered by fossil fuels, from ships to cars, and trucks to jet fuel airplanes is essential to the functioning of our modern economy. Transportation as a sector accounts for around 16% of global emissions (IPCC Sixth Assessment Report 2022). Ground transport has made significant progress in its journey toward zero carbon mobility, but air transport has been lagging well behind. The development of low-emission aviation fuels, including biofuels, hydrogen, and electric-powered aircraft is well underway, but will take time. Beyond the aircraft itself, the entire aviation infrastructure and services must also undergo a green transition. Total GHG emissions in transportation sector in Montenegro amounted 883.29 Gg CO2eq in 2019.

3 Aviation emissions

While the global aviation industry currently accounts for only 2.0-2.8 percent of the world's total greenhouse gas emissions, the IPCC expects this to rise to approximately 15 percent if no action is taken. In fact, the International Air Transport Association (IATA) forecasts that global passenger traffic will grow by 1.5 to 3.8 percent over the next 20 years, to 10 billion passengers by 2050. As a large contributor of greenhouse gas emissions and a difficult-to-abate sector, aviation is coming under increased scrutiny, from non-governmental organisations and activists, as well as regulators, to transform. In terms of overall aviation CO2 emissions, while the majority is produced from flying aircraft, airports' ground operations can become more sustainable. Airport-controlled activities account for around 3.0-4.0 percent (Airport Carbon Accreditation Annual Report 2017-2018, ACI-Europe).

There is a global movement toward climate neutrality within the aviation industry. In June 2019, the Airport Council International Europe committed to net zero carbon emissions by 2050 (Europe's airports commit to zero CO2 emissions by 2050, http://www.airport-world.com/news/general-news/7225-europe-s-airports-commit-to-zero-co2-emissions-by-2050.html). Launched by the French Presidency to the EU on the February, 4th 2022, the so-called Toulouse Declaration is the first-ever public-private initiative supporting European aviation's goal to reach net zero CO2 emissions by 2050. This is also the first joint initiative of its kind globally, aligning all EU stakeholders on the principles and actions needed to decarbonise and transform Europe's aviation sector, representing a true breakthrough. The Toulouse Declaration, sets out the roadmap for European aviation to reach net-zero carbon emissions by 2050. Several European airports and airport associations have already endorsed the initiative, with 89 airport operators of 311 airports pledging their support. Airports of Montenegro Company operating two Montenegrin airports has endorsed this declaration, among others.

As global initiatives toward the objective of reducing or eliminating carbon emissions continue to grow, technologies designed to do so have also grown and become more financially feasible. The investment in infrastructure and new technologies to support that objective needs time to plan. Developing a roadmap towards ambitious objectives allows an airport to identify its policies and technologies in advance of their need so that they can plan and budget accordingly. Total GHG emissions in domestic aviation sub-sector in Montenegro amounted 59.48 Gg CO2eq in 2019, while total GHG emissions in international aviation sub-sector in Montenegro amounted 285 Gg CO2eq in 2019.

4 Airport sustainability

An airport is a complex ecosystem of environments, services, vehicles and supporting systems, which all consume a mix of energy and resources, so airports should grow without damaging nature and biodiversity. Becoming more sustainable in terms of health and wellbeing means taking a fundamentally human-centered design approach to aviation infrastructure, operations and environments. There is likely to be growing expectation that airports commit to the concept of setting limits to environmental and climate impacts while continuing to grow economically. It would mean agreeing mutually acceptable methods of monitoring and enforcement regarding issues like noise, carbon emissions, surface access impacts, air quality and so on, but would also represent a spur to innovation. From wealth and employment to cultural exchange, airports have always made a considerable contribution to both national economy and surrounding communities.

Airports are vital national resources. They serve a key role in transportation of people and goods and in regional, national, and international commerce. Airports are connectors of multiple transportation modes: airport transfers, car rentals, pick up and collections. They are where the nation's aviation system connects with other modes of transportation and where responsibility for managing and regulating air traffic operations intersects with the role of state and local governments that own and operate most airports.

Since airports are one of major employers, the sustainable airport can play a larger role in the community than merely providing jobs, besides being healthier for employees, communities and users and producing more wellbeing. The low-carbon airport requires long planning horizons and can be achieved by reducing or eliminating carbon emissions at airports. In such way, airports have an opportunity to act as an active participant in the shift to a net-zero economy. Ultimately, once airports are more vocal about their climate commitments, and making progress on a path to net zero, they will strengthen their social license to operate.

5 Scopes of airport emissions

The challenge of decarbonising an airport's activities goes far beyond its ground infrastructure. For airports, it is a question of measuring greenhouse gas emissions throughout the airport value chain and working to reduce them concomitantly. The airport's direct emissions (known as Scope 1), but also the direct emissions linked to its energy consumption (Scope 2). And finally, and this is undoubtedly what has the greatest impact, the indirect emissions, both upstream and downstream (Scope 3). So, it is necessary to use incentives to get airlines, passengers, service providers and airport partners to change their habits and reduce their carbon emissions.

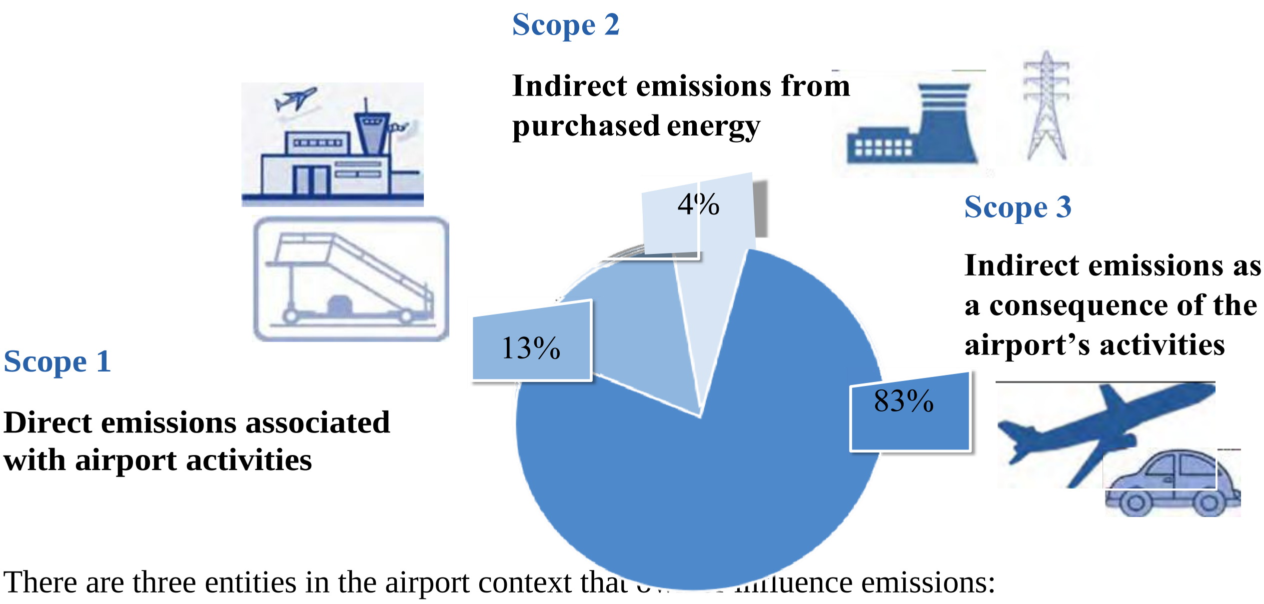
In most airport settings, airport operators typically have direct control over 20% or even less of an airport's total GHG emissions, while airlines, caterers, cargo handlers, retailers, freight companies, and passengers are responsible for the large majority. To help standardize boundaries and emissions reporting, most airports use the three "scopes" (Scope 1, Scope 2 and Scope 3) defined by the Greenhouse Gas Protocol (WBCSD and WRI 2015), an internationally recognized standard for quantifying and tracking GHG, shown in Figure 1.

• Scope 1. Airport operator emissions associated with vehicles and ground support equipment belonging to the airport, on-site waste management, on-site wastewater management, and on-site power generation, freighting exercises, boilers, and furnaces.

• Scope 2. Indirect emissions from on-site purchased electricity and steam.

• Scope 3. Indirect emissions as a consequence of airport activities including aircraft landing and take-on (under 3,000 feet), aircraft ground movements, auxiliary power units, third-party vehicles, ground support equipment, passenger travel to and from the airport, staff commute, on-site waste management, on-site water management, and staff business travel.

Figure 1 Average airport emissions, by scope



There are three entities in the airport context that own or influence emissions:

- Airport operators,
- Tenants (primarily airlines, concessionaires, and aircraft operators), and
- General public.

Table 1 gives examples of emissions sources by scope, type, and ownership versus influence category. Scope 1 and Scope 2 emissions at an airport are owned by the airport operator, while Scope 3 emissions are owned by tenants and the general public but influenced by the airport operator. Since Scope 3 emissions are not airport controlled, they are generally the most difficult for an airport operator to reduce directly.

Table 1 Emissions sources by scope, type, and ownership versus influence category

Category	Emissions Sources	Scope 1	Scope 2	Scope 3
		Ownership		Influence
Electricity	On-site electricity generation	x		
	Purchased grid electricity		x	
	Electricity consumed by tenants, partners, subcontractors, grid power, and other third parties			x
Stationary Sources	Airport-owned or airport-leased boilers, furnaces, burners, turbines, heaters, incinerators, engines, firefighting exercises, flares, generators, and other	x		
	Tenant-owned or tenant-leased boilers, furnaces, burners, turbines, heaters, incinerators, engines, firefighting exercises, flares, generators, and other			x
	Airport-owned or operated shuttle buses, maintenance vehicles, security vehicles, and emergency vehicles	x		

Vehicle Travel	Airport staff business travel			x
	Tenant-controlled vehicles, such as ground support equipment, passenger ground transportation, third-party owned vehicles, and Other			x
	Airport staff commute			x
	Passenger private vehicles			x
Waste Management	On-site waste management, wastewater management, and other	x		
	Off-site waste management by third-party operators			x
Aircraft	Aircraft ground movements, taxiing, auxiliary power units (APUs), and landing and take-off			x
Other	Leaks from fire suppression activities, refrigerants, and construction emissions	x		

5.1 Short methodological structure

The methodological approach for active reduction of the airport’s own carbon emissions has been taken over from Airport Carbon Accreditation (ACA) Guidance on Reducing Emissions before Offsetting (Issue 1)

https://www.airportcarbonaccreditation.org/airport/technical-documents.html.

The flow diagram (Figure 2) describes the process that airports could follow, and the steps are set out in more detail in the subsequent text. The steps below could be carried out regularly, i.e. on a 12-monthly cycle, to ensure continued improvement and reduction of emissions. Once offsets have been purchased, further efforts to reduce emissions could still be investigated and implemented on an ongoing basis. Table 2 for airports to fill out is also provided.

Step 1: Identification – airports must map their carbon footprints for each reporting year. This would allow the airports to understand what their key emission sources or ‘carbon hotspots’ are and would allow them to understand how the airport and its operations can contribute to global emissions.

Step 2: Planning – the identification of hotspots is an important part of the planning process as it allows the airport to then establish what opportunities they have for reducing their carbon footprint. This allows for the development of a carbon management plan and other strategies such as monitoring plans. The plan could identify ways to reduce the carbon footprint and limit emissions from future activities and airports could fill out the table provided at the end of this document.

Step 3: Prioritisation – continuing on from the planning step, which sets carbon reduction targets and identifies possible efficiency measures to implement, these actions could be prioritised. There are a number of different factors that could be assessed or analyses carried out to determine this.

Step 4: Implementation – before implementation, senior stakeholders could be consulted on the carbon management plan to understand their views on specific measures, discuss any concerns they may have that could be addressed and obtain approval to proceed where necessary. Once initiatives have been prioritised and ranked, implementation could begin.

Step 5: Monitoring and Improvement – airports could have a process in place for undertaking periodic assessments of performance against the carbon management plan. Following monitoring, airports could implement corrective actions for improvement to ensure that targets are achieved for any initiatives that are not delivering the projected reductions.

Step 6: Determination – the airport could establish, through calculations, that they have implemented or have a plan to implement all the reduction options that are available to them. The methodology to establish this could include the amount and type of GHG emissions that have been reduced and the time period that this was achieved. This reduction can be quantified in absolute terms or expressed in emission intensity terms.

Step 7: Justification – airports could also be able to justify the reasoning behind any carbon reduction initiatives that were identified in the planning stage but not implemented during Step 4. If they are able to do this, they can progress to Step 8.

If initiatives have been considered but not implemented and the reasoning cannot be justified, airports could return to Step 4. An action plan could be useful as a structured approach to understanding the barriers to implementation (financial, physical, etc), and what needs to be done to overcome those barriers in order to invest and potentially revisit those carbon reduction opportunities in the future. The status of these initiatives can then be updated once they have been implemented.

Step 8: Demonstration – once the airport has followed all these steps, they could therefore be able to demonstrate that they have implemented all reasonable possible measures and can purchase offsets.

This entire process could be repeated on a yearly basis to ensure continual improvement and reductions in emissions. The carbon management plan could also be updated at least every 12 months to implement any changes needed.

Figure 2 Flowchart that Airports Could Follow to Reduce Emissions 'as Much as Possible'

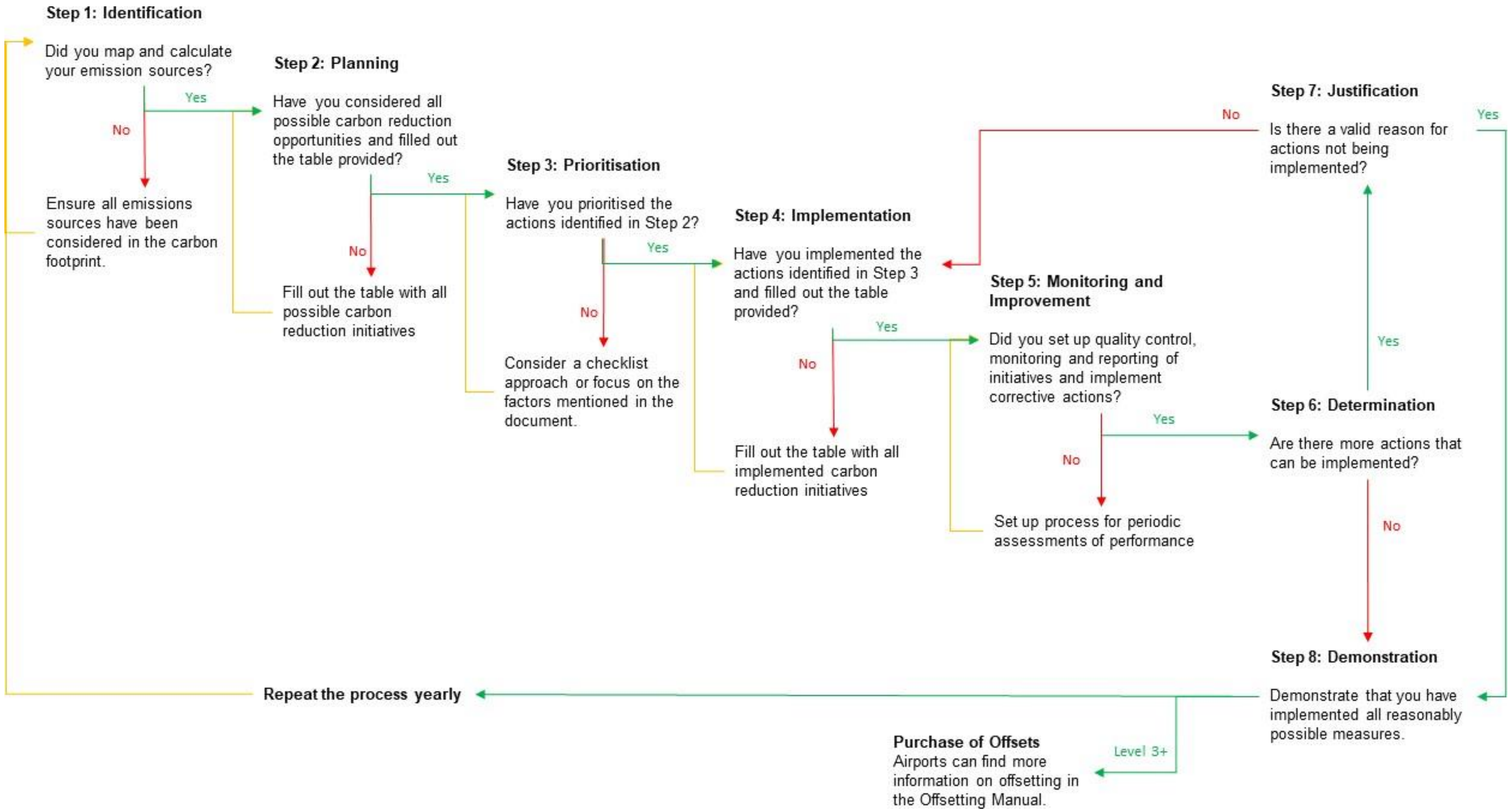


Table 2 Table that Airports Could Use to Fill Out During the Planning and Implementation Stages

PLANNING								IMPLEMENTATION	
SCOPE	GROUP	DETAILED SOURCE	TECHNICAL	OPERATIONAL	REGULATORY	ECONOMIC	OTHER	STATUS	REASONING
SCOPE 1									
SCOPE 2									
SCOPE 3									

6 Designing and operating airports with lower GHGs

Building the low-GHG airport means choosing building materials with a lower environmental impact for terminals, hangars, runways, etc., from the outset, such as buildings using recycled materials, the choice of more efficient, low-carbon heating and ventilation systems, less energy-intensive LED lighting, and a fleet of 100% electric vehicles. As in other resource heavy infrastructure, airports could shift to a 360-degree lifecycle approach to the design, construction and operation of new and existing physical assets. This would enable to embody a circular economy approach to their built assets, adopting materials passports and other measures to enable the reuse of materials when facilities reach their end of life, lowering lifetime emissions and retaining the value of building products and assemblies as a result. On the other side, surface access is a major emissions factor at airports. Prioritising public transport can reduce surface access related emissions, so to identify ways to improve the speed, reliability and sustainability of travelling to and from the airport.

The airport includes a multitude of organisations that need to work together in synchronicity, including airlines, air traffic control, ground handling companies, fixed-base operators, security, customs and immigration, health control and police, catering, fueling, aircraft engineering and maintenance, as well as the entire consumer retail network of food and beverage, duty free shopping, tourism and transport. Supporting the airport sector in its green transformation also requires encouraging airport users, both passengers and employees, to adopt responsible behaviour. The development of multimodal hubs to encourage access to public transport, and the provision of charging stations for electric or hydrogen vehicles are some of the valuable incentives.

6.1 Reducing Scope 1 and Scope 2 emissions

In order to reduce direct emission (Scope 1 and Scope 2) from airports, several following categories are recognized (Guidebook for Developing a Zero- or Low-Emissions Roadmap at Airports (2021) – ACRP Airport Cooperative Research Program), shown in Table 3:

Table 3 Categories of measures and description

Category	Description
Energy efficiency in buildings	• Energy efficiency improvements in airport-owned buildings (building upgrade technologies, low energy baggage handling systems, airfield lighting upgrades, terminal initiatives) • Aircraft and airside upgrades
Heating and cooling technologies	• Upgrading of heating and cooling technologies in airport-owned buildings that lower airport energy consumption (ground source heat pumps, central utility plant)
Renewable electricity consumption and storage	• Conversion of electricity to renewable sources through on-site renewables generation (onsite solar PV, wind, biomass and/or hybrid) • Conversion of electricity to renewable sources through off- site renewable electricity purchases • Onsite battery energy storage
Airport-owned and airport- operated vehicles	• Electrification of ground support equipment by procurement of zero-emission vehicles for airport-owned fleet vehicles

	• Use of low GHG fuels (e.g. biodiesel, renewable diesel) in airport-owned fleet vehicles • Reduction in discretionary trips • Sustainable aviation fuel • Surface access improvements
Waste management	• Implementation of a composting program for food waste, etc. • Implementation of a recycling program • Energy-from-waste • Waste minimization
Other	• Carbon sequestration (e.g. forest carbon management)

6.2 Energy efficiency in airport buildings

Inefficient airport building infrastructure contributes to GHG emissions and can be costly to replace. Performance degradation, poorly tuned controls and heating, ventilation and air conditioning system malfunctions are estimated to waste up to huge per cent of whole building energy. Fault detection and diagnosis, or automatic building analytics, provides an opportunity to ensure an airport is operating efficiently. Early detection of poor equipment performance or inefficiencies, faults and identifying opportunities to improve energy efficiency can reduce emissions and energy consumption, manage peak demand, lower maintenance and repair costs and improve asset life cycles.

Optimising operations and energy efficiency will be a key as competition between airports intensifies and regulations tighten around their carbon emissions. Airports in search of emissions reduction strategies with low costs and short payback periods should first consider energy efficiency improvements to their existing facilities. Such measures include improving insulation of the airport building envelope, installing LED lighting for runways and taxiways, installing automated building control systems or variable frequency drives, and developing and marketing an energy conservation program for building users.

Innovation, from sustainable materials in the built environment to the use of artificial intelligence and finance will be instrumental in upgrading airports into low carbon connectors. Improving energy efficiency remains a priority. This includes improving the insulation and ventilation of terminals, recycling thermal energy where possible, or upgrading to energy efficient lighting systems as well as using more natural light.

Baggage Handling Systems (BHS) are generally conveyor systems that primarily function to sort and transport passenger luggage to the correct airport location, both before and after the flight. BHS can vary in length and can reach up to several kilometres at major airports. Typically, the conveyor tracks are propelled by hundreds of small motors and can be very energy intensive, accounting for as much as 20 per cent of an airport's total electricity consumption per annum. Low energy BHS technologies include Independent Carrier Systems and Multi-Carrier Systems that typically enable faster baggage movement, enhancing the efficiency of the entire system. The technologies often include lighter baggage carry-trays to lower the carry-load and reduce friction between conveyors and belts. They work in tandem with automated check-in services to further improve efficiency.

Terminals typically contribute to over half of an airport's energy use. Many energy efficiency measures relating to terminal energy efficiency include:

- Colour and reflectivity of external materials
- External shading
- Enhanced daylighting
- High performance glazing
- LED lighting and daylight dimming
- Sub-metering systems
- Building management systems

As with any other building, passive terminal design can lead to significant energy savings and therefore should be prioritised in the architectural design for new terminal buildings.

Airfield lighting is the system of lights that aid in aircraft navigation during landing, take-off and taxiing. Types of airside lighting include, but are not limited to, obstacle lighting, high- intensity approach lighting systems, precision approach path indicator systems and visual approach slope indicator systems, runway and taxiway lighting, and apron floodlighting. Airfield lighting can account for up to 10 per cent of an airport's total energy consumption. Airfield lighting technology has continuously evolved with the increased use of energy-efficient LEDs and smart fixtures controlling light intensity. Lighting systems are also starting to complement aircraft vision systems through infrared energy radiation. Efficient and increasingly intelligent lighting systems have the potential to reduce lighting emissions by up to 50 %.

6.2.1 Energy efficiency in buildings at the Airport Podgorica

The Airport Podgorica area contains several facilities out of which 4 are identified as significant energy consumer which have potential for energy efficiency improvement:

- Airport Terminal Building
- Office Building
- Control Tower Building
- Customs Warehouse

In general, all buildings except Customs warehouse have good energy performance and potential for energy efficiency improvement is limited. More detailed information regarding envelope and lighting for all buildings, as well as external lighting is given below. Also, opportunities for improvement of energy efficiency are identified and concrete measures are proposed and evaluated.

Airport Terminal Building	
Description: Airport Terminal building is the largest building at the airport (conditioned area 4,750 m^2). It serves for passengers transfer between ground transportation and the facilities that allow them to board and disembark from an aircraft. It is also the newest building in the Airport, erected back in 2005. It has a modern design, tailored to its main operation.	
Number of floors	1
Useful area (m^2)	4,750
Roof area (m^2)	6,000 (estimated)
Working time	from 6.00 until 23.00 h (during summer even longer)
Walls	Main structure is done from metal poles and beams which form arched roof above the ground. Walls are designed from the sandwich panels but eastern (entrance) and western side of the building are characterized by large transparent areas with double-glazing. Transparent areas are of good quality although there are not data on the U-value. External shading protection is implemented at all transparent areas.
Transparent areas	Transparent areas are of good quality; low-e double glass is applied (estimated U-value 1.8 W/m2K). External shading protection is implemented at all transparent areas, except the roof.
Roof	Roof construction is made of metal beams covered by trapezium sandwich panels with 15 cm of insulation (estimated U-value 0.25 W/m2K). Around 30% of the roof are transparent areas with double-glazing with aim of larger use of the daylight in the building. Due to the specific design of the roof installation of PV panels could be challenging.
Lighting	Although there is a lot of daylight available inside airport terminal building (through transparent areas on the wall and on the roof) need for artificial light is large due to the fact that internal space is divided in several sections.

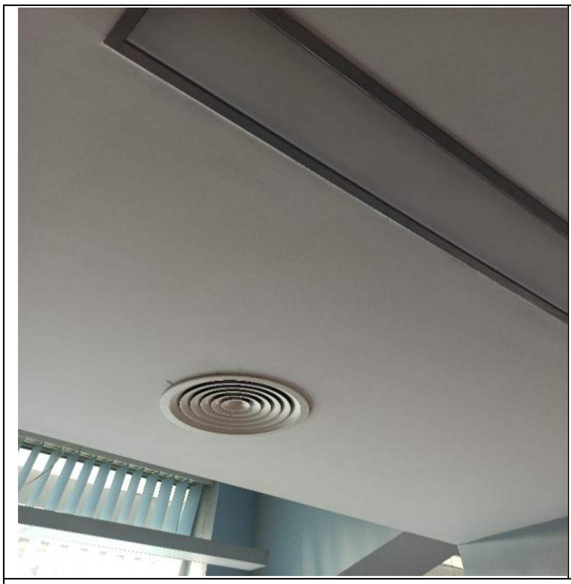
	Most of the lighting sources in the building are based on fluorescent and halide-metal technologies which were available at the time of the building construction. No major intervention on the lighting system were performed. Control of the lighting is done manually from the central board or individual switches for the rooms. There are around 450 lighting sources based on fluorescent technologies (tubes and CFL) with total install power around 15 kW and 20 lighting sources based on halide-metal with total installed power of 40 kW. Potential for energy saving in lighting is large. The Airport Podgorica has already started testing phase for replacement of mercury reflectors with LED.
	

Potential for EE improvement:

- **Building envelope is in good shape and there are no much opportunities for EE improvement.**
- **Large transparent areas cause high thermal loses/gains which can be affected only by change in design and construction of opaque external walls with insulation with a lower U-value.**
- **Thermal losses can be reduced by improvement of the construction of vestibule area (double door system) and installation of the air curtains.**
- **Lighting system based on halogen lamps has to be improved. Also, replacement of the fluorescent light sources with LED is highly recommended. Improved control of lighting has to be introduced.**

Office Building

Description: Office Building is the old terminal building which is in 2009 adapted to be used as office space by airport staff, customs and national airline operator. Part of the building used by the national airline operator Montenegro Airlines is not in use since 2020. Building has a very complex design which is initially to be passenger terminal and later converted to the office space.	
Number of floors	U+G+1
Useful area (m^2)	4,000 (estimated)
Roof area (m^2)	2,500 (estimated)
Working time	from 6.00 until 16.00 h
Walls	Main structure is done from concrete which major part is decorated by the stone (also from the inside). Building's design is preserved.
Transparent areas	Transparent areas are made from aluminum frame with double-glazing (est. U-value 1.8 W/m2K).
Roof	Roof construction is made from concrete with applied thermal insulation and cover form metal sheets. Roof is characterized by large number of small structures with aim of increase of the daylight in the internal space. Due to the specific design of the roof, it is not very suitable for installation of PV panels.
Lighting	Although there is a lot of the daylight available inside the building (through transparent areas on the wall and on the roof) need for artificial light is large. Most of the lighting sources in the building are based on fluorescent, halogen and mercury technologies which were available at the time of the building renovation. Some off lighting sources are gradually replaced by LED. Control of the lighting can be done manually from the central board or individual switches for the rooms. Estimation of the total number/installed power of the lighting sources is not done. Potential for energy saving in lighting is significant.

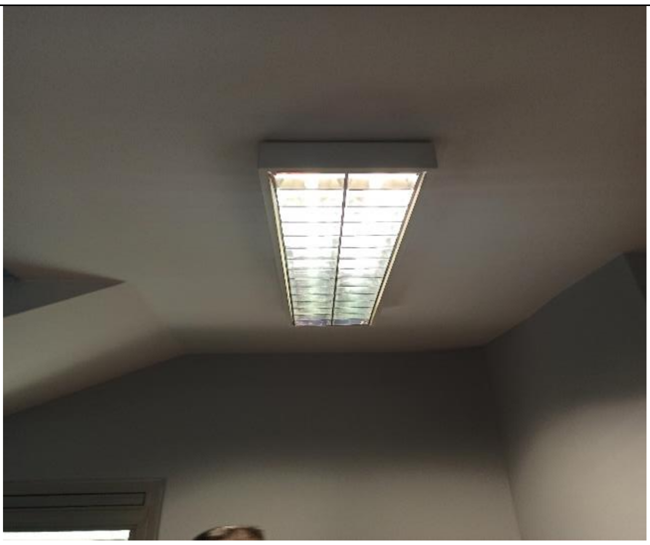
 

Potential for EE improvement:

- **Building envelope is in good shape and there are no much opportunities for EE improvement.**
- **Bearing in mind that building's anticultural design is preserved, its walls can't be further thermally insulated from the outside. Installation of additional thermal insulation could be considered for some areas inside the building.**
- **Installation of solar protection devices (e.g sunshades) is not allowed. Solar gains in summertime could be reduced by installation of solar protection foils or natural shadings (e.g vegetation).**
- **Replacement of halogen and fluorescent light sources with LED is highly recommended. Improved control of lighting has to be implemented.**

Control Tower Building

Description: Control Tower is building used by another entity (Serbia and Montenegro Air Traffic Services – SMATSA). Building is renovated and extended (2nd floor is added) during reconstruction back in 2009. Construction of the new annex of the Control Tower is under preparation. Within planned works also partial renovation of the existing building is planed manly related to technical systems and electrical installations.	
Number of floors:	2 (tower is higher)
Useful area (m²):	950 (estimated)
Roof area (m²):	450 (estimated)
Working time:	07-15 h (cca. 90%) and remaining 0-24 h (flight control room)
Walls:	It is a two-story building with a control tower in the middle. Main structure is done from concrete which is covered by sandwich panels. The 2nd floor is built as metal construction which is also covered by sandwich panels.
Transparent areas:	Transparent areas are made from aluminum frame with double-glazing (est. U-value 1.8 W/m2K). External sun protection is applied on the windows.
Roof:	Roof construction is made from metal structure containing thermal insulation and protective membrane for hydro insulation at the top. Due to the specific design of the roof, it is not very suitable for installation of PV panels (fixing of PV panels is difficult).
Lighting:	Most of the lighting sources in the building are based on fluorescent technologies which were available at the time of the building renovation. Control of the lighting can be done manually from the central board or individual switches for the rooms. Estimation of the total number/installed power of the lighting sources is not done. Potential for energy saving in lighting is significant.

Potential for EE improvement: • **Building envelope is in good shape and there are no much opportunities for EE improvement.** • **Central part of building (tower) is built from the concrete without applied thermal insulation but it mainly belongs to stairs and halls which are not heated.** • **Replacement fluorescent light sources with LED and improved lighting control is also envisaged under planned renovation of the building.**

Customs Warehouse

Description: Customs Warehouse is more than 40 years old building which has not been renovated in the previous period.	
Number of floors	1
Useful area (m^2)	900 (estimated)
Roof area (m^2)	900 (estimated)
Walls:	Main structure is done from concrete without any insulation applied.
Transparent areas:	Transparent areas are made from metal frames with single-glazing with very low thermal performance.
Roof:	Two slopes roof construction is made from metal structure covered by metal sheets.
Lighting:	Lighting sources in the offices is based on fluorescent tubes. Lighting in the warehouse is based on old mercury lamps. Control of the lighting can be done manually from the central board or individual switches for the rooms. Estimation of the total number/installed power of the lighting sources is not done. Potential for energy saving in lighting is significant.
	

Potential for EE improvement:

- **Building envelope has a very poor energy performance and should be improved. However, only to 15% of the overall space is heated/cooled (3 offices) which means that improvement of the envelope will not result in significant energy savings.**
- **Lighting system based on halogen lamps has to be improved. Also, replacement of the fluorescent light sources with LED is highly recommended. Improved control of lighting has to be introduced.**

External lighting

Lighting Runway

The lighting alongside the runway is an important safety device for the airport. It guides landing air- crafts during nights and cloudy or foggy days. With 675 of these lights installed runway lighting has an important share on operating costs. The characteristics of the current lighting solution for the runway is shown in the below table:

Parameters	**Existing**
Description	Halogen lamp
Specific power per lamp [W]	30, 48, 100, 150, 200
Lumen/W	60
Lumen/lamp	9,000
Control device	Manually
Operating hours[h/a]	2555
Life time [h]	500-1000

Lighting Apron

For the Apron powerful light sources are required since they have to illuminate a wide area. Light is currently provided by 51 lamps attached to 10 poles. Long lasting lamps may decrease maintenance costs substantially since changing lamps requires special equipment due to the height of the poles.

The following table shows the characteristics of the current and the suggested lighting solution for the Apron based on replacing the existing sodium lamps by LEDs.

Parameters	**Existing**

Description	Sodium lamp
Specific power [W]	400
Lumen/W	100
Control device	Manually
Operating hours [h/a]	2.555
Life time [h]	12.000


Lighting in front of the terminal

Area in front of the terminal together with roads and parking has to be properly illuminated in order to create a welcoming atmosphere at night and make passengers visible to approaching vehicles. This area contains three types of light sources:

- Street lights – 49 HPS lamps (275 W)
- Indirect lights – 6 HPS lamps (275 W)
- Decorative lights – 70 HPS lamps (70W).

Light in front of the terminal building is provided by five light poles with two lamps with reflectors each.

Description	Sodium lamp
Specific power [W]	500
Lumen/W	100
Control device	manually
Operating hours [h/a]	2.555
Life time [h]	10.000-20.000

Total install power of the existing lighting in this area, which is above 20 kW, can be significantly reduces by installation of LED light sources. This will not result only in energy savings but the maintenance costs will be reduced due to the longer lifetime of LED.

Potential for EE improvement:

- **Replacement of all external light sources with controlled LED is highly recommended.**

Based on the previous analysis of the buildings' envelope and both internal and external lighting systems, the following energy efficiency measures (M1-M10) are recommended (Montenegrin electricity grid emission factor (GEF) in 2019 equaled 0.361 kg/kWh):

M1: Improvement of energy and water monitoring	
Description: Any action that leads to energy efficiency improvement should be based on reliable data on energy and water consumption. Currently, the Airport Podgorica doesn't have system which enables monitoring of energy and water consumption with aim to support identification of losses, determination of consumption patterns and optimization of operation. Central metering of energy and water consumption at the level of airport complex is not sufficient for any detailed analysis and this needs to be improved. Energy monitoring is also necessary for setting up energy management system.	
Estimated investment (€)	20,000-30,000
Expected annual energy savings (kWh)	100,000
Annual GHG reduction (tCO2)	36.10
Priority	High
Time frame	Short-term

M2: Improvement of the entrance vestibule (double door system) on the Airport Building
Description: Key measure for prevention of the conditioned air leaving the terminal building is related to redesign/repair of the entrance vestibule (double door system). Current design is not adequate and it is not used according to practice (used as a single door system). Improvement means that zone between doors should be increased or internal space has to be equipped with air curtains.

Estimated investment (€)	10,000-12,000 (repair of the existing entrance)
Expected annual energy savings (kWh)	25,000
Annual GHG reduction (tCO2)	9.02
Priority	High
Time frame	Short-term

M3: Improvement of lighting system in the Airport Terminal	
Description: Lighting sources in the Airport Terminal are mainly based on fluorescent technologies which was installed during building erection. The total installed power of the lighting sources is around 24 kW. In case that this lighting sources are replaced by corresponding LED this can affect with significant energy savings, and also another benefit could be achieved through longer lifetime, better control and lower maintenance costs. In addition to replacement of lighting sources it is recommended that improvement of lighting control is implemented with lighting dimming and occupancy function. Anyhow due to the special purpose of building it is necessary that photometric calculation is done for redesign of the lighting system.	
Estimated investment (€)	25,000
Expected annual energy savings (kWh)	48,000
Annual GHG reduction (tCO2)	17.33
Priority	Medium
Time frame	Short-term

M4: Replacement of inefficient HQI lamps in the Airport Building	
Description: The existing main lighting in the Airport building is composed of 20 reflectors based on halide-metal lamps (HQI) with total installed capacity of 40 kW. Existing lighting system is vulnerable in terms of maintenance and that the components are quite costly. Similar performances can be easily achieved by LED reflectors with installed power of 350 W which also provide much longer lifetime, better control and lower maintenance costs.	
Estimated investment (€)	15,000-20,000 (depending on the design)
Expected annual energy savings (kWh)	100,000 (for operation of 3,000 h)
Annual GHG reduction (tCO2)	36.10
Priority	High
Time frame	Short-term

M5: Improvement of lighting system in the Control Tower Building
Description: Lighting in Control Tower Building is mainly based on fluorescent and halogen technologies which is installed during building renovation.

In case that this lighting sources are replaced by corresponding LED this can affect with significant energy savings but also other benefits could be achieved such as longer lifetime, better control and lower maintenance costs. Data on lighting sources are not available and calculation is based on the estimated installed power of the lighting system. Any future action for lighting system improvement requires detailed screening of the existing situation. In addition to replacement of lighting sources it is recommended that improvement of lighting control is implemented with lighting dimming and occupancy function.	
Estimated investment (€)	24,000
Expected annual energy savings (kWh)	52,000
Annual GHG reduction (tCO2)	18.77
Priority	Medium
Time frame	Short-term

M6: Improvement of lighting system in the Office Building	
Lighting in Office Building is mainly based on fluorescent and halogen technologies which is installed during building reconstruction. In case that this lighting sources are replaced by corresponding LED this can affect with significant energy savings but also other benefits could be achieved such as longer lifetime, better control and lower maintenance costs. Data on lighting sources are not available and calculation is based on the estimated power of the lighting system. Any future action in lighting system improvement requires detailed screening of the existing situation. In addition to replacement of lighting sources it is recommended that improvement of lighting control is implemented with lighting dimming and occupancy function.	
Estimated investment (€)	65,000
Expected annual energy savings (kWh)	67,000
Annual GHG reduction (tCO2)	24.12
Priority	High
Time frame	Short-term

M7: Replacement of inefficient mercury lamps in the Customs Warehouse	
Description: The main lighting in the Customs Warehouse is composed of 15 mercury reflectors with total installed capacity of 7.5 kW. Existing lighting system is vulnerable in terms of maintenance due to the short lifetime of the lamps. Required illuminance can be easily achieved by LED lamps with installed power of 125 W which also provide much longer lifetime, better control and lower maintenance costs. Estimated annual energy savings (for operation of 3,000 h) are 17,000 kWh.	
Estimated investment (€)	400-1,500 (depending on the solution)
Expected annual energy savings (kWh)	17,000 kWh
Annual GHG reduction (tCO2)	6.14
Priority	High

Time frame	Short-term

M8: Replacement of inefficient runway lighting	
Description: The existing halogen lamps in the runway lighting solution should be replaced with efficient and robust LEDs (120 W, 60 lumen/W), with at least 20 times longer life time. The upgraded lighting system will decrease energy and maintenance cost while increasing the reliability. The existing number of lamp fittings can be used, so the replacement costs are low. Finally, the visibility of the runway will be much better, since the LEDS produce more lumen.	
Estimated investment (€)	50,000
Expected annual energy savings (kWh)	50,000 (for operation of 2,555 h)
Annual GHG reduction (tCO2)	18.05
Priority	High
Time frame	Medium-term

M9: Replacement of inefficient apron lighting	
Description: In the case of the lighting apron, the sodium lights have to be replaced with modern LEDs (360 W, 100 lumen/W), with at least 4 times longer life time) to produce the same amount of lumen, so the electricity consumption will be lower, because the existing lamps are already very efficient. In case of LED apron lamps, significant energy savings can be achieved together with other benefits: longer lifetime, better control and lower maintenance costs.	
Estimated investment (€)	13,000
Expected annual energy savings (kWh)	40,000 (for operation of 2,500 h)
Annual GHG reduction (tCO2)	14.44
Priority	Medium
Time frame	Medium-term

M10: Replacement of inefficient lighting in front of the terminal	
Description: For the future lighting in front of the terminal, the LED (270 W, 100 lumen/W), with at least 2 times longer life time illumination which provide intense light and have much longer life-time compared to the current sodium lamps is recommended.	
Estimated investment (€)	30,000-35,000 (depending on the required design)
Expected annual energy savings (kWh)	38,000 (for operation of 3,000 h)
Annual GHG reduction (tCO2)	13.72
Priority	Medium
Time frame	Medium-term

6.2.2 Heating, Ventilation and Cooling (HVAC) Technologies

Traditional heat pumps are often air source heat pumps that use air as a heat source or heat sink (absorbing heat), for example reverse cycle air conditioners. A ground source heat pump uses the earth's relatively stable ground temperature to provide heating and cooling. The system consists of a heat pump and loops of refrigerant or water buried underground (ground loops). The heat pump transfers the heat between the ground loop and the building to provide hot water, cooling and heating. Ground source heat pumps consume less energy than conventional systems and can be twice as efficient. Their efficiency is more stable throughout seasonal temperature changes and installation prices are gradually decreasing due to ongoing technical improvements.

After investing in insulation and other building envelope efficiency measures, an airport should consider addressing forced air duct leakage and possibly adding heating zones. It is relatively inexpensive to limit those losses by sealing leaks and, where feasible, insulating ducts. Zoned heating systems can save energy if parts of an airport building have different temperature requirements and can be closed off from one another. A zoned system can provide a different amount of heat to each zone, depending on its usage. A building can be zoned in several ways. Some multi-zone systems have only one furnace/boiler and use electrically controlled dampers, which can open or close depending on the heating needs of different zones. Other systems have separate furnaces/boilers for each zone.

HVAC can make up a substantial portion of Scope 1 emissions at most airports. In general, an airport should approach heating, cooling, and ventilation improvements by beginning with the end state and progressing toward the source. In other words, the first step should be to reduce heating or cooling demand through building envelope improvements. The next step should be to pursue retrofits, from the end points all the way back through the distribution system (e.g. fixing leaky ducting and adding zones). The final step would be to retrofit or replace the sources, such as purchasing a new furnace or converting a constant volume to a variable volume system.

In the final step of source replacement, airports should consider switching to cogeneration (also known as combined heat and power or CHP), which uses an engine to generate electricity and recovers the waste heat for use. Tri-generation (also known as combined cooling, heat and power or CCHP) is the simultaneous production of electricity, heat, and cooling from a single energy source. Similar to CHP, the waste heat by-product that results from electricity generation is captured and used for heating or cooling. Cogeneration and tri-generation systems are typically more efficient than purchased electricity or fuel because they use waste heat and avoid transmission losses. Ground-source, or geothermal, systems can be used either to heat water or to heat or cool indoor space. These systems use the ground as a heat source during the winter and a heat sink during the summer because ground temperatures remain relatively constant. Geothermal systems can significantly reduce the amount of electricity or fuel needed to heat or cool a building, thus reducing associated GHG emissions. Additional strategies to consider for clean heating and cooling, include solar desiccant air conditioning systems, on-site biomass energy systems, sewer heat recovery systems, and using natural bodies of water for cooling. Airports are encouraged to review the description and considerations included for each strategy to determine which ones may be feasible for their facilities.

6.2.3 HVAC at the Airport Podgorica

Airport Terminal Building

Heating and cooling: Heating/cooling is provided by the 3 air-water heat pumps (brand: Trane) with individual heat capacity of 220 kW. Heating facility is located on the northern side of the passenger terminal from which heated/cooled water is transferred to air handling units located on the northern and southern side of the passenger terminal.

Heating is supported by electric boiler (installed power 160 kW) which is operated automatically, in case that necessary temperature regime can't be achieved (e.g. low outside temperature in the winter morning). Heated/cooled air is further transferred to the building through the system of channels and ducts. Heat recovery is not implemented.

Heating/cooling system is equipped with automatic control system (brand: Sauter) which is led by experienced technicians. Electric motors for water and air circulation are equipped with variable speed drive control. System is in very good condition bearing in mind its age (from 2005), meaning that it is proper maintained.

Type of the system	Air-to-water heat pump
Heating/cooling capacity (kW)	3x225
Heating/Cooling Efficiency	2.48/2.68
Age	2005
	

Potential for EE improvement:

Although installed heat pumps still operate, more efficient heat pump have to be installed. This is not urgent measure but it should be considered due to the age of the existing system. Besides that, mechanical ventilation which is the most important energy consumer in the terminal building, has to be improved on order to better fits real needs of the space.

Office Building

Heating and cooling: Heating/cooling is provided by the 2 air-water heat pumps (brand: Daikin) with individual heat capacity of 200 kW. Heating facility is located on the northern side of the building from which heated/cooled water is transferred to air handling units located on the roof on the southern side. Heating/cooling is provided directly by the water which is circulating through inside units (fan-coil units). Also heated/cooled air is further transferred to the building through the system of channels and ducts. Heat recovery is not applied.

Heating/cooling system is equipped with automatic control system which is led by experienced technicians. Electric motors for water and air circulation are equipped with variable speed drive control. System is in very good condition meaning that it is proper maintained.

Type of the system	Air-to-water heat pump
Heating/cooling capacity (kW)	2x200

Heating/Cooling Efficiency	2.1/2.5
Age	2009
	

Potential for EE improvement:

Installation of more efficient heat pumps is recommended at the end of lifetime of existing ones. Possibilities for heat recovery to be analyzed due to the space constraints.

Further automatization and control of heating/cooling for different zones have to be implemented.

Control Tower Building	
Heating and cooling: Heating/cooling is provided by the 2 air-water heat pumps (brand: Carrier) with individual heat capacity of 96 kW. Heating facility is located on the southern side of the building from which heated/cooled water is transferred to air handling units located on the ground floor. Heating/cooling is provided directly by the water which is circulating through inside units (fan-coil units). Also heated/cooled air form the air-handling units is further transferred to the building through the system of channels and ducts. Heating recovery is not applied. Heating/cooling system is equipped with automatic control system and individual control is available in the rooms. Electric motors for water and air circulation are equipped with variable speed drive control. System is in very good condition meaning that it is proper maintained. Individual split systems are also installed to support heating/cooling of critical areas (technical room, control tower etc.).	
Type of the system	Air-to-water heat pump
Heating/cooling capacity (kW)	2x96
Heating/Cooling Efficiency (ESEER)	3,47
Age	2009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Potential for EE improvement: Installation of more efficient HVAC system is envisaged under planed renovation of the building. Further automatization and control of heating/cooling for different zones will be also implemented.	

Customs Warehouse	
Heating and cooling: Heating/cooling is provided only to 3 offices (15% of the overall space). Heating is done directly by the electric heaters and cooling single split units. Heating/cooling is controlled individually in the rooms.	
Type of the system	Direct electrical heaters/ single split-system
	
Potential for EE improvement: Building envelope have to be improved in order that transmission losses are reduced. After the building is well insulated, efficient split system should be sufficient for heating and cooling of the offices (without usage of direct electric heaters).	

Possibilities for energy efficiency improvement are more significant in technical systems. Although most of the HVAC are operational and well maintained they are rather outdated (installed 15-20 years ago). This means that installation of the new, more efficient systems is justified and the following efficiency measures in HVAC systems (M11-M12) are recommended:

<table>
<tr><td colspan="2">M11: Improvement of HVAC system in Airport Building</td></tr>
<tr><td colspan="2">Description: This measure has to be carefully analyzed in order that proper HVAC solution is selected for the terminal building.
Although installed heat pumps still operate, newer comparable heat pumps have better efficiencies, with saving potential up to 30%.
On the other side he HVAC system is based on the mechanical ventilation which is the most important energy consumer in the terminal building (more than 80% of the energy consumption). Normally ventilation systems are sized to supply a maximal demand, but this is not needed all the time. The aim of ventilation optimisation is to reduce the air change in the terminal building, in order to avoid a ventilation when no demand is existing. This can be done by:
– installation of CO2 sensors which measures air quality and steer ventilation system accordingly and
– introduction of partial heat recovery, depending on the available space in the technical rooms/zones.</td></tr>
<tr><td>Estimated investment (€)</td><td>650,000-1,200,000 (depending on the system)</td></tr>
<tr><td>Expected annual energy savings (kWh)</td><td>up to 800,000 kWh
(up to 70% of the energy consumption in Airport Building)</td></tr>
<tr><td>Annual GHG reduction (tCO2)</td><td>288.80</td></tr>
<tr><td>Priority</td><td>Medium</td></tr>
<tr><td>Time frame</td><td>Medium-term</td></tr>
</table>

<table>
<tr><td colspan="2">M12: Improvement of HVAC control in Office Building and Control Tower</td></tr>
<tr><td colspan="2">Description: Heat pumps in Office Building and Control Tower have slightly better performance compared to those in the Airport building. Anyhow installation of more efficient heat pumps is recommended at the end of lifetime of existing ones.
What can be done in short term is related to improvement of regulation of HVAC by definition of conditioned zones and its central control. Namely, in order to avoid a “misuse” of conditioned air (heated or cooled), it is suggested to introduce specific zones which are centrally controllable.
Currently most of the space is used between 7.00-15.00 h but some services require conditioning of some areas by 23.00 h. This requires more sophisticated HVAC control system which can be easily implemented by installation of additional sensors in different zones in other to meet the demand as effective as possible. Also, awareness raising of the users can bring additional benefits.</td></tr>
<tr><td>Estimated investment (€)</td><td>20,000-30,000 (depending on the solution)</td></tr>
<tr><td>Expected annual energy savings (kWh)</td><td>30,000 kWh</td></tr>
<tr><td>Annual GHG reduction (tCO2)</td><td>10.83</td></tr>
<tr><td>Priority</td><td>High</td></tr>
<tr><td>Time frame</td><td>Short-term</td></tr>
</table>

6.2.4 Renewable electricity generation and consumption

Airports occupy large areas that can be used for infrastructure to produce renewable energy. Photovoltaic power plants already exist in many airports, where concessionaires have become private producer of electricity from renewable sources. They not only provide airports with carbon-free energy for their own operations, but also inject the electricity produced into the local grid to support the energy transition in areas where energy can sometimes be produced mainly from fossil sources. Given airports' typical physical footprint, and with renewable infrastructure continuing to fall in cost, there are also possibilities to develop on-site hybrid energy generation from solar, wind, biomass and hydrogen sources. So, airports will need to comprehensively switch to renewable energy and invest in energy efficiency and energy storage to reduce carbon emissions. Besides, mapping and modelling energy use across airports' complex estates, including optimising airfield layout, is a vital step towards sustainable airports.

Solar photovoltaic (PV) panels capture and convert sunlight into electricity. They can be either roof-mounted or ground-mounted, with both often feasible in most Australian airports due to the airports' large footprint. Building Integrated PV (BIPV) systems also present an alternative opportunity to maximise solar PV generation in new terminal/building design. BIPV integrates photovoltaic technology into the building envelope, replacing conventional building materials and generating electricity. Airports have a predictable baseline electricity load that can be aligned to solar PV generation. Depending on the size and design of the PV system, excess generation can be stored in batteries. The stored energy can be used during times of low energy generation or used to manage peak electrical demand. Battery systems also provide resilience as a back-up power supply for critical assets during brownouts or blackouts. Traditionally, most (over 70 percent, often over 90 percent) airport-controlled emissions are Scope 2 emissions from purchased off-site electricity. Onsite solar PV systems, coupled with battery storage, can reduce these emissions by as much as 100 per cent, subject to the size of system and demand of the airport.

Purchasing renewable energy works much the same as purchasing any kind of electricity from a utility provider, however the electricity source can be up to 100 percent renewable. Power Purchase Agreements (PPAs) are long term agreements for energy buyers to purchase electricity generated by offsite renewables. They can assist an airport to reduce up to 100 percent of these emissions through agreements with an energy retailer.

Installation of on-site renewable electricity generation is increasingly attractive, given the declining costs and added protection against short-term blackouts or long-term utility outages. The most common on-site renewable electricity systems are solar powered, although on-site biomass energy production, building-mounted wind turbines, geothermal heating and cooling systems, or geothermal snow and ice melting systems are also potential options at airports. Finally, waste-to-energy systems and gas produced from local landfills are other ways to recycle waste and produce valuable low-carbon electricity. Purchase of off-site renewable electricity is another option for lowering Scope 2 emissions. Depending on its location, the airport may be able to buy a green pricing product or green marketing product from the electricity provider. Airports may also conclude power purchase agreements (PPAs), either for renewable energy generated on site or in some cases off site (requiring certification and issuance of renewable energy credits or RECs).

When evaluating renewable electricity projects, it is vital to consider the electricity grid mix. If the grid mix includes large amounts of electricity generated by burning coal, then projects improving efficiency or switching to renewable electricity will have an outsized impact compared to if the grid mix were heavily produced through emission-free hydropower.

6.2.5 Renewables at the Airport Podgorica

The airports of Montenegro announced the focus on renewable energy sources in December, 2022 and established the cooperation with state-owned electricity supplier EPCG, in order to diversify its electricity supply portfolio (https://montenegroairports.com/novosti/posjeta-elektroprivredi-u-fokusu-obnovljivi-izvori-energije/). Using its huge areas on the main building roof, as well as parking lot areas to install PV power plants, the Airport Podgorica would benefit in huge electricity costs savings, it would be useful renewable energy source (RES) measure to reduce significantly CO2 emissions. Finally, such installation should be in line with its commitment stated in Environmental Policy Statement of Airports of Montenegro JSC (https://montenegroairports.com/en/airports-of-montnegro/business-information/environmental-policy-statement-of-airports-of-montenegro-jsc/).
Such measure could be of highest priority. The following RES measure (M13) has been envisaged for the Airport Podgorica:

M13: Photovoltaic power plant cca. 1.5 MW	
Description: Based on a preliminary calculation of the Airport Building' rooftop surface, using Google Earth, it seems the roof could be quite interesting for PV power plant construction. Considering its useful surface of cca. 3500 m^2 (without the skylights), it is roughly enough for 500 kW of PV installed power. Besides, the parking lot seems to be a better solution to even install a larger PV plant. However, a canopy (where PV panels could be installed) should be built all over the outdoor parking lots. Namely, several parking lot places should be left for electric vehicles chargers. The parking lot with a total surface of (3600 m^2 + 3000 m^2) would enable the installation of a 1.0 MW PV power plant. The grid connection could be immediately possible, due to recently upgraded network in the area and getting a more reliable power supply. The annual generation from such PV power plant (around 1.5 MW) could cover at least 50% of the annual electricity consumption of the airport facilities and reduce an equivalent share in CO2 emission.	
Estimated investment (€)	1.0-1.5 M€ (depending on the equipment)
Expected annual energy savings (kWh)	1,900,000 kWh
Annual GHG reduction (tCO2)	685.90
Priority	High
Time frame	Mid-term

6.2.6 Airport-Owned and Airport-Operated Vehicles

Policies to encourage the use of electric vehicles within their estates and ground power to aircraft can bring down air pollution, supporting local air quality goals. Reductions in light pollution and adoption of indoor air quality monitoring, limiting the use of toxic substances, introduction of biophilic design architecture, as well as measures to reduce the risks of creating heat islands, would also all strengthen an airport's sustainability credentials.

Airport-owned or operated cars, trucks, and buses are a major Scope 1 emission source for most airports. These vehicles (and their emissions) fall under the control of the airport and are different from Scope 3-related vehicles such as airline-owned ground support equipment, externally owned ground transportation vehicles (e.g. taxis, limousines, city transit buses), and personal vehicles. At many airports, airport-owned and operated vehicles can number in the hundreds or even thousands and include work trucks, office pool vehicles, emergency service vehicles, security vehicles, and shuttle buses (e.g. between terminals).

Options to lower emissions from these vehicles include swapping fuels to a less-carbon intensive fuel (e.g. fleet electrification), reducing the amount of vehicle travel, or shifting to more efficient vehicles (i.e. towards vehicles with lower fuel economy). Fleet electrification is emerging as the preferred strategy in recent years due to the financial savings and elimination of all tailpipe emissions. However, other fuel-swapping strategies are common, including use of renewable natural gas, conventional natural gas, biodiesel, and renewable diesel.

6.2.7 Airport-owned or operated vehicles at the Airport Podgorica

The following airport diesel/petrol engine vehicles are owned by the Airport Podgorica: 1 air starter with truck, 11 tractors, 5 conveyor belt loaders, 3 boarding stairs, 2 cargo loaders, 1 water truck, 1 forklift, 1 toilet service vehicle, 8 runway (passenger, crew, staff and follow-me) vehicles (including 1 bus), 3 fire fighting vehicles, 1 crane - platform, 1 aircraft deicer and 2 ambulance vehicles, as well as 12 official cars. Ground Power Units (GPU) as well as Auxiliary Power Units (APU) are also diesel-fueled. As a result of the poor efficiency of this unit (8-14%), the APU is a major contributor to pollutant emissions and noise at airports and their environment. Besides, there is no push back truck. Finally, the airport is not equipped with fixed electrical ground power. Measure M14 proposes the gradual airport-owned vehicle fleet electrification, as follows:

<table>
<tr><td colspan="2">M14: Electrification of airport-owned vehicle fleet</td></tr>
<tr><td colspan="2">Description: The Airport has to prepare plan for gradual vehicle-fleet electrification (green/clean/low-emission vehicles, as well as solar powered passenger stairs) and phasing-out fossil-fueled vehicles. Since the Airport owns around 50 vehicles, mostly fueled by diesel, but also by petrol, this measure can be implemented in medium – to long – term. Once replaced, used cars can be sold on a public auction. The vehicle electrification plan should also include green taxiing (electric push back trucks and electric tow trucks), as well as fixed electrical ground power (FEGP), along with pre-conditioned air (PCA), since these are areas where the Airport Podgorica can influence the fuel consumption of the aircrafts, Besides vehicle fleet electrification, the plan shall envisage reduction of number of vehicles, since currently a few vehicles are quite old and out of use and operation. With this measure, the airport would significantly reduce fuel costs. The implementation of this measure makes particular sense in combination with the previous measure (M13), when the Airport generates its own electricity from solar power plant, covering most of its own electricity needs.</td></tr>
<tr><td>Estimated investment (€)</td><td>3.0-4.0 M€ (depending on the equipment, without FEGP and PCA, which amount around 2.0 M€)</td></tr>
<tr><td>Expected annual energy savings (kWh)</td><td>789,000 kWh</td></tr>
<tr><td>Annual GHG reduction (tCO2)</td><td>210.40</td></tr>
<tr><td>Priority</td><td>Medium</td></tr>
<tr><td>Time frame</td><td>Mid- to long-term</td></tr>
</table>

6.2.8 Waste Management

As waste materials decay in landfills or get burned in incinerators releasing GHGs, by reducing waste, improving recycling, using on-site waste-to-energy and anaerobic digestion systems to improve performance, airports are committing to zero-waste-to-landfill commitments. Airports can adopt waste management tactics to reduce emissions from the waste stream, including recycling, composting, waste reduction efforts, and improvements to wastewater treatment facilities, where applicable. Strategies may include a solid waste management plan, a waste reduction and recycling program, separating and composting food waste, and others that can help reduce methane (CH4) and other GHGs from the waste stream. As a first step, airports should focus on source reduction and reuse, since generating fewer waste materials reduces emissions associated with waste collection, transportation, and disposal. Source reduction and reuse avoid emissions regardless of whether materials would have been processed for disposal or recycling. In addition to materials management, airports with wastewater treatment facilities have opportunities to reduce emissions by converting output gases to usable energy. Airport wastewater treatment systems that have anaerobic digesters to treat de-icing fluids may use the methane generated from the digesters to produce heat or electricity instead of venting the methane to the atmosphere. In the future, airports may be able to supply their solid waste as jet fuel feed- stock.

Waste and recycling may not be a typical area to consider when addressing airport emissions. However, resource use (and the associated embodied energy) and landfill disposal are major contributors to GHG emissions. An airport can play an influential role in reducing waste from tenants and airlines. Co-mingled, soft plastic, organic, paper and e-waste are all common sources of waste in airports. Reducing waste and reusing resources not only reduces emissions but also operational costs. Source-separated recycling, bio-degradable packaging, organic food reuse and composting are all available waste minimisation options for airports. Airports can also influence customer behaviour by providing re-use opportunities, through simple measures such as water bottle refilling stations.

6.2.9 Other

Other emissions sources at airports might include construction activities, firefighting training exercises, refrigerant leaks, and others. Even relatively small emission quantities of GHGs like methane and refrigerants have significant outsized climate impacts due to their higher global warming potentials, about 2,000 times higher in the case of common refrigerants, compared to CO2. Construction activities result in GHG emissions through many of the same mechanisms: fossil fuel combustion by construction vehicles, processing and disposal of construction waste, and lighting and other energy uses.

Airports can reduce construction emissions through policies that require the use of low-emission construction vehicles and equipment, recycling and reuse of construction materials, and use of energy efficient lighting during the construction process.

Firefighting exercises at airports typically involve firefighters training in a live-fire environment. These training exercises result in GHG emissions from fire suppression chemicals. Airports are encouraged to work with training staff to optimally plan exercises such that the minimum amount of fuel is used while still providing necessary training. The emissions reduction strategies should include adopting maintenance practices that reduce leakage as much as technically feasible, limiting discharge for system testing to what is essential for performance requirements or required by regulation, and ensuring that technicians who handle equipment containing HFCs and PFCs are trained to minimize emissions.

Hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs) are two GHGs used in refrigeration and air conditioning systems. HFCs and HCFCs are emitted during operation, repair, and disposal, unless recovered, recycled, and ultimately destroyed. Airports can take several steps to minimize the release of these GHGs, including utilizing natural refrigerants where possible, installing intelligent fault diagnosis systems to detect leaks, using vapor compression heat pumps, and installing microchannel components and heat exchangers to reduce the number of refrigerants used.

6.2.10 Offset Emissions

A carbon offset program reduces, avoids, or sequesters GHGs in order to compensate for emissions occurring elsewhere. These programs can be made up of myriad project types, from supporting forestry expansion to renewable energy. Often there are markets where entities can trade accredited offsets, essentially allowing them to purchase the right to say they reduced emissions without actually having undertaken the emissions reduction project. Being accredited is the official acknowledgement that 1 ton of CO2 emissions were displaced. Some regulating bodies use offsets as a way to regulate carbon emissions (as opposed to a flat tax on carbon, or other approaches).

Airports can adopt carbon offset projects voluntarily or in response to compliance measures. Compliance-based carbon reduction programs are regulated by mandatory international, national, or regional entities to require participants to reduce or offset CO2 emissions. Demand for compliance-based carbon offsets is created by a regulatory instrument. Carbon offset market participation and demand can be also driven voluntarily by national, regional, organizational, or individual interest in CO2 emissions reductions, though there are no rules or regulations established for voluntary offset trading.

Climate change and forest ecosystems are closely connected, with climate mainly affecting the rate, frequency, intensity and timing of air temperature, solar radiation and rainfall. Climate change impacts can be both positive and negative on forest structure, growth patterns, composition, productivity and functioning, depending on the location and type of forest. Modified climate conditions have already led to negative impacts such as changes in: forest species composition and biodiversity, growing rate, resistance to pest and disease, invasive species propagation, forest fire regime and forest susceptibility to fire.

Forests can act as carbon sink; they can accumulate atmospheric CO2 as carbon in vegetation and soils. However, human activities affecting land use and forestry characteristics can alter the carbon cycle between the atmosphere and the terrestrial ecosystems leading to more CO2 emissions. Since forests are able to act as carbon sink, they are included in international policies (EU LULUCF Regulation 2018/841) to address climate change both via mitigation and adaptation processes; linking these two aspects should be preferred.

Afforestation and reforestation projects can pursue this double role for forest ecosystems. Afforestation (i.e. converting long-time non-forested land into forest) refers to the establishment of forests where previously there have been none, or where forests have been missing for a long time, while reforestation refers to the replanting of trees on more recently deforested land (i.e. converting recently non-forested land in forest). If these two approaches are viewed as complementary, they may enable “win-win” policy options. However, if unsustainably managed, both practices may be controversial as they may lead to the destruction of original non-forest ecosystems (e.g. natural grassland).

At international level, afforestation and reforestation have been initially recognized as mitigation approaches, and have been promoted for carbon sequestration goals. However, they can also help forests to adapt to climate change by decreasing human pressures (for example by reducing the destruction or degradation of habitats) and enhancing landscape connectivity and reducing fragmentation (thus facilitating species migration under climate change conditions). Afforestation and reforestation may also contribute preserving biodiversity hotspots, avoiding soil degradation and protecting other natural resources (e.g. water).

The sustainable management of afforested or reforested land help in pursuing adaptation responses, since it maintains forests status and guarantees ecosystems services, especially at local scale, by reducing vulnerability to climate change and to biodiversity loss. In case of crop failure due to climate change, forests can provide safety nets for local communities with their products (e.g. with both wood or non-wood products, such as game animals, nuts, seeds, berries, mushrooms, medicinal plants). Forests also help in regulating water flow and water resources through their hydrological-related ecosystem services (e.g. base flow conservation, storm flow regulation and erosion control). In addition, planting trees can create new habitats for more tolerant species and enhance biodiversity, especially when multispecies plantations (choosing native species and avoiding invasive ones, less adapted to the habitat) are preferred. Afforestation and reforestation can also control soil degradation, hydraulic and landslide risks and encourage local communities towards agroforestry or silvo-pastoral systems, thus creating new income opportunities. Finally, forest management practices, such as sanitation harvest, can help in reducing pests and diseases attack.

6.2.11 The Airport Podgorica carbon offsetting

Taking into account that the Airport Podgorica covers big area, afforestation/reforestation could be also possible option for further CO2 reduction, through carbon sequestration and increasing CO2 sinks. Such projects implementation, close to the airport must fulfill all the aviation security requirements. Reforestation includes planting trees or allowing trees to regrow on land that had recently been covered with forest, while afforestation involves planting trees on land that has not recently been covered with forest. A carbon offset is any activity that leads to a reduction in emissions of carbon dioxide or other greenhouse gases to compensate for emissions made somewhere else. In other words, you pay someone else to cancel out your carbon emissions by investing in projects that reduce carbon dioxide or greenhouse gas emissions. Carbon offsetting is simply a way for individuals or organizations, in this case airline passengers and corporate customers, to “neutralize” their proportion of an aircraft's carbon emissions on a particular journey by investing in carbon reduction projects. Measure M15 tackles this important issues as follows:

<table>
<tr><td colspan="2">M15: Offsetting carbon emissions of the airport</td></tr>
<tr><td colspan="2">Description: The Airport should prepare plan for forestation/reforestation of areas in its own ground to absorb CO2 emissions from its own and to benefit from carbon offsetting. At the moment, it is not known how the Airport will address this issue. That is why costs as well as emission savings cannot be estimated.</td></tr>
<tr><td>Estimated investment (€)</td><td></td></tr>
<tr><td>Annual CO2 sinks (tCO2)</td><td></td></tr>
<tr><td>Priority</td><td>Low</td></tr>
<tr><td>Time frame</td><td>Mid- to long-term</td></tr>
</table>

6.2.12 Certified Emissions Reduction

A certified emissions reduction (CER) is a certificate issued by the United Nations to member nations for preventing 1 ton of CO2 emissions. United Nations Clean Development Mechanism (CDM) allows Annex I Parties, countries with developed or traditional economies, to purchase or trade CERs to help them achieve emissions reduction targets under the Kyoto Protocol while supporting sustainable development in developing countries. For projects to be CDM-accredited and eligible for CERs, they must create real, measurable, and long-term benefits to climate change mitigation and produce additional emissions reductions that would not have other- wise occurred. Companies can also purchase CERs to contribute toward their own emissions reduction targets under mandatory emissions trading schemes, such as the European Union Emissions Trading Scheme, or voluntary schemes.

6.2.13 Proprietary Verified Emissions Reduction

Unlike CERs and EUAs, verified emissions reductions (VERs) are exchanged in the voluntary market, which function outside and in parallel of the regulatory market. VERs can be created under CDM or under other standards (e.g. Gold Standard, Voluntary Carbon Standard, VER+) operating in the voluntary market. CERs can be accepted in both the regulatory and voluntary market, but VERs are accepted only in the voluntary market. Although the voluntary market is smaller and does not have established rules and regulations, its lower development and transaction costs enable entities to experiment with new methodologies and technologies under small projects.

6.2.14 Sequestration

When it is no longer possible to reduce CO2 emissions, they can be sequestered by patches of forest, so called forest carbon sinks. The reforestation projects around the airports, for example covering 3.6 hectares will make it possible to capture 500 tonnes of carbon dioxide and, so, absorb the most of the residual emissions of airports. To address biodiversity impacts, there are many already adopting practices like green roofs and expanded planting within their estates in ways that are compatible with aviation safety.

Airports are typically located in the outer reaches of urban areas, providing a potentially powerful set of connections in areas of often less-wealthy populations. So, there’s potential to develop low-emission agriculture on their surrounding land, helping the food industry to reduce ‘food miles’ and advance its own sustainability agenda.

7 Reducing Scope 3 Emissions

Scope 3 emissions are those under the control of tenants, passengers, employees, or other organizations at the airports and are typically the largest (by far) category of emissions at an airport. Addressing Scope 3 emissions can be challenging for a number of reasons. First, it can be unclear which entity is responsible for the emissions. Additionally, emission reduction programs require coordination and cooperation with third parties and/or tenants, which becomes more arduous as the number of partners increase. Partners may not be aligned toward the same social goals as the airport and may see any effort to reduce Scope 3 as an infringement.

Despite the various challenges, airports are increasingly finding creative and novel approaches for addressing Scope 3 emissions. In many cases where an airport cannot directly mandate emission reductions, it can encourage the reductions through positive reinforcement and awards. Another possible strategy is to reduce administrative and logistical barriers to support emissions reduction (such as installing electric vehicle chargers).

7.1 Airport Policy Measures

Airports can implement policies to encourage airlines and other tenants to adopt cleaner technologies and practices. For example, airport contracts for design and construction, concessions and tenant lease agreements, and janitorial service contracts are an opportunity to drive airport environmental practices. Green leases allow tenants and airports to come to an agreement that shares the cost of any improvements, allowing both parties to benefit by seeing reduced operating.

7.2 Ground Support Equipment (GSE)

Emissions from GSE can create more localised air quality impacts so these have been a concern of airport stakeholders and are subject to state emissions regulations. One set of strategies includes terminal gate electrification projects. Other strategies encourage converting GSE to alternative-fuel vehicles and reducing extensive idling common for some airports. Airports could undertake strategies to encourage or mandate cleaner GSE operations by airlines or other tenants, including through use of emissions fees and tenant lease agreements, though challenges are often associated with implementing such strategies.

Airports should be aware of space or infrastructure constraints that affect implementing GSE emissions reduction strategies. For example, some airports are space-constrained on the ramp and find it challenging to install enough chargers to fully electrify the GSE operation. Equipment typically must charge overnight and remain parked near the chargers. Highly congested airports may especially need to consider these constraints. Energy supply can also be an issue for older facilities, requiring the local utility to potentially upgrade substations feeding the airport.

7.3 Surface Access Vehicles (SAVs)

Airport SAVs refer to the non-aviation journeys vehicles used by and for airline passengers, greeters, farewellers, airport employees, airline or airport tenants, and freight delivery. These vehicles can include private vehicles, rental cars, taxis, transportation network companies, door-to-door vans, hotel shuttles, public transport, service and delivery vehicles, and air cargo vehicles. Strategies to reduce emissions from SAVs include improved public transit, walking, and bicycle connections; consolidated rental car facilities; incentives for employees to take public transit, walk, or bicycle to work; incentives for passengers, taxis, limousines, transportation network companies, or employees arriving in zero emission vehicles; conversion of vehicles like airport shuttles to alternative fuel vehicles. Airports can also encourage private ground transportation operators to implement strategies to decrease the number of empty rides, or trips without passengers, that drivers take.

Major airports affect the traffic on roads surrounding them as surface access to most airports is dominated by cars. This contributes significantly to the airport's total carbon emissions (with estimates ranging from 25-50 per cent contribution to Scope 3 emissions). Upgrades to airport surface access and promotion of low emissions transport modes can have a significant impact on reduction of emissions and alleviate traffic problems. Access enhancements may include providing public transport interchanges, improved cycling and pedestrian connectivity, electric vehicle parking and charging infrastructure and road redesign, such as express lanes for electric vehicles.

7.4 Aircraft Emissions Strategies

The single largest source of emissions at airports is aircraft. Aircraft design and airline operational improvements have dramatically reduced fuel burn since the introduction of jet engines. However, total GHG emissions from aircraft are growing due to demand. Aircraft design consistently seeks to maximise fuel efficiency and reduce emissions and operating costs. This includes developing more efficient engines, lighter materials and enhancing aerodynamic design. Airports can facilitate these upgrades by ensuring their runways, taxiways, support services and terminals can service current and future aircraft needs. The three broad categories of mitigation options for aircraft emissions include: Taxiing, Landing, Takeoff; Sustainable Aviation Fuel; and Aircraft Technology.

7.4.1 Limiting CO2 emissions from aircraft on the ground (Taxiing, Landing, Take off)

Though airports do not have direct control of aircraft usage, they can influence industry emissions in several ways. Strategies to reduce aircraft emissions during these phases include reducing takeoff and climb thrust, increasing efficiency during airport taxiing such as through reducing engine use, improving operational efficiency through programs, and replacing main engines for taxiing with systems such as alternative aircraft-taxiing systems or equipment similar to aircraft pushback tractors. Single-engine taxi is the most prevalent approach to reducing taxiing emissions.

A review of alternative taxiing systems highlighted the potential for several technology and efficiency strategies to reduce GHGs and criteria pollutants, particularly electrified technologies, yet also noted that the operational and fiscal challenges airlines and airports may face in implementing such strategies. The technologies include dispatch taxiing (e.g. using existing aircraft pushback tractor technology), semi-robotic dispatch taxiing (i.e. similar to a pushback tractor but using a hybrid external large tractor developed specifically for taxiing), nose-wheel-mounted alternative aircraft-taxiing systems, and main landing gear alternative aircraft-taxiing systems. In the long run, airports can also incorporate more efficient design into airfield and runway layout to reduce congestion and delays.

Even if fuel consumption is lower on the ground, it can still be reduced by optimising taxiing and apron equipment. To achieve this, airports are offering new services and encouraging airlines to change their practices. For example, an aircraft can consume up to 300 kilos of aircraft fuel between the apron and the runway when both engines are running. A possible solution is to switch off half of the engines to move the plane on the ground. The "taxibot", a service already provided by some airports, remains the most effective solution for limiting emissions on the ground and optimising taxiing time. The aircraft is attached to an electric vehicle which moves it to the runway or boarding gate, thus avoiding significant fuel consumption. And even when the aircraft is standing, keeping the on-board system and air-conditioning working and firing up the engines drains a lot of aircraft fuel from the tanks. To address this, many airports have parking stands that allow aircraft to be powered with external electricity and air conditioning.

7.4.2 Replace jet fuel with greener fuels

The burning of aviation fuel is the main contributor to airport Scope 3 emissions. Every year approximately 1.5 billion barrels of jet fuel is burnt for global air travel. While today's jet aircraft are over 80 per cent more fuel efficient per seat kilometre than aircraft in the 1960s, over a third of airline operating costs are still spent on fuel, a proportion that is likely to rise with increased fuel prices in the future. This context presents an opportunity and incentive for airlines to explore fuel alternatives and for airports to support this transition.

Aircraft design aims to maximise fuel efficiency and increasingly to utilise more sustainable, alternative fuels. Sustainable aviation fuel or 'biofuels' can be made from a range of organic materials, including sugarcane bagasse, molasses, wood waste, animal fats, vegetable oils and agave. Some sources have been shown to reduce the carbon footprint of aviation fuel by up to 80 per cent. Airports can facilitate the transition to biofuels by ensuring that their fuel delivery infrastructure is compatible with biofuels. Biofuels can often be added into the existing fuel pipelines, including by blending biofuels with jet fuel as an interim measure. With this existing infrastructure in place, airports can further incentivise aircraft biofuel uptake by removing internal or contractual barriers to the use of biofuels.

Biofuels made from renewable raw materials such as waste cooking oil or animal fat reduce greenhouse gas emissions by 80% compared to conventional petroleum-based aircraft fuel. Some airports already offer this to airlines. Taking things a step further, an incentive system can be created for modulating landing fees: a bonus or malus applied to companies depending, among other things, on the age of their aircraft and their use of biofuels. Another promising candidate for the energy transition in aviation is green hydrogen. Although the technological challenges have not yet all been met, hydrogen is bulkier than aircraft fuel and means aircraft tank size and architecture need to be rethought and it is estimated that hydrogen-powered aircraft will be flying by 2035. For airports, this means that the infrastructure will be completely redesigned to store liquid hydrogen.

7.4.3 Aircraft Technology

In 2013, the International Air Transport Association (IATA) released a Technology Roadmap to identify possible technological improvements to the engine and the airframe (such as aero- dynamics, lightweight materials and structures, equipment systems) to support meeting the goal set by IATA, global associations of aerospace manufacturers, airports, and other partners of reducing aviation emissions by 50% by 2050 (IATA 2013). Through modeling, researchers estimated that existing technological improvements could increase fuel efficiency by 30% for the aircraft generation after

2020, but that more advanced technologies would be necessary to meet the 50% by 2050 goal. The roadmap also discusses emerging but not yet commercialized technologies, such as new wing designs to enable reduced weight, formation flight, battery-powered aircraft, and aircraft fuel from solar energy.

Electric aircraft can offer carbon-free air travel, zero criteria pollutant emissions, reduced noise, reduced operating costs, less frequent aircraft maintenance, avoidance of safety and supply chain issues associated with liquid fuels, and possible revenue generation from charging fees. Manufacturers such as Airbus have been working to develop electric aircraft models that could serve short haul flights as well as a newer concept for intra-urban air taxis. Norway is aiming to electrify all short-haul flights by 2040. Battery-powered electric aircraft could serve more than 20 short routes in Norway and will be able to accommodate flights of more than 500 kilometers, or 300 miles, by 2028–2030.

7.4.4 Reducing Scope 3 emissions at the Airport Podgorica

Considering all the Scope 3 emissions and suggested policies and strategies, the Airport Podgorica has to prepare a comprehensive plan of policies and actions to start reducing these emissions.

M16: Policies to tackle Scope 3 emissions	
Description: The Airport has to prepare plan of policies and actions to tackle Scope 3 emissions. Particular care should be given to Surface Access Vehicles (SAVs), which represents mostly part of the airport emissions. Besides, other Scope 3 emissions have to be considered, as well, in order to get more CO2 reduction. At the moment, it is not known how the Airport will address these emissions. That is why costs as well as energy and emission savings cannot be estimated.	
Estimated investment (€)	-
Expected annual energy savings (kWh)	-
Annual GHG reduction (tCO2)	-
Priority	Medium
Time frame	Mid- to long-term

8 Summary of the measures (M1-M16) for the Airport Podgorica

Retrospective of all 16 measures enclosed in this plan is provided in the following table:

Measure	Estimated annual CO2 savings (tCO2)	Estimated investment (k€)	Priority (low, medium or high)	Short-, medium- or long-term
M1 Improvement of energy and water monitoring	36.10	20-30	H	S

M2 Improvement of the entrance vestibule (double door system) on the Airport Building	9.02	10-12	H	S
M3 Improvement of lighting system in the Airport Terminal	17.33	25	M	S
M4 Replacement of inefficient HQI lamps in the Airport Building	36.10	15-20	H	S
M5 Improvement of lighting system in the Control Tower Building	18.77	24	M	S
M6 Improvement of lighting system in the Office Building	24.12	65	H	S
M7 Replacement of inefficient mercury lamps in the Customs Warehouse	6.14	0.4-1.5	H	S
M8 Replacement of inefficient runway lighting	18.05	50	H	M
M9 Replacement of inefficient apron lighting	14.44	13	M	M
M10 Replacement of inefficient lighting in front of the terminal	13.72	30-35	M	M
M11 Improvement of HVAC system in Airport Building	288.80	650-1,200	M	M
M12 Improvement of HVAC control in Office Building and Control Tower	10.83	20-30	H	S
M13 Photovoltaic power plant cca. 1.5 MW	685.90	1,000-1,500	H	M
M14 Electrification of airport-owned vehicle fleet	210.40	3,000-4,000	M	M
M15 Offsetting carbon emissions of the airport	-	-	L	M-L
M16 Policies to tackle Scope 3 emissions	-	-	M	M-L

9 Conclusions

Commercial service airports are large landowners and big consumers of energy and water. Cutting down on carbon emissions and achieving economy-wide net-zero carbon emissions by 2050 will require airports to convert their ground fleets to electric vehicles (EVs); electrify building systems; generate renewable energy on-site; and dramatically improve energy and water efficiency, including through water reuse. The pathways to net-zero includes also the electric or low carbon transfers from the airport to town, upgrading buildings and terminals, setting up low carbon transfers between terminals, and improving the energy efficiency of lighting and heating. Airports need to install charging stations, powered from renewable energy sources, on a much larger scale across car parks. Besides, they need also investing in waste-to-energy facilities, recycling waste from planes and terminals for heating, or transform the waste into biofuels.

Ordered by EBRD Sustainable Transport, Ecofys Germany GmbH developed **Energy Efficiency Audit and Feasibility Study for Solar Photovoltaic Project at Podgorica Airport**, in 2015. The study encompassed broad spectrum of measures for energy efficiency improvement and PV rooftop power plant construction, as well as provided a set of recommendations for investments to address both energy and climate issues at the airport. Although the study can be a good basis for further EE and RES investigation of the airport, is a bit outdated and has to be updated and extended with additional measures to tackle airport decarbonisation, towards climate-neutrality. According to the study, the projected growth of the passengers at the airport Podgorica is as follows:

Thousands	**2010**	**2015**	**2020**	**2025**	**2030**
Airport Podgorica	648	1,136	1,898	2,883	3,220

In line with such projections, when the number of passengers is growing each year, the energy/water needs and costs are also increasing, so the GHG emissions. The Airport Podgorica should develop comprehensive strategy or plan of policies and measures, with precise targets, deadlines and source of financing for each particular policy and measure.

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