ICAO

ENVIRONMENT

Sustainable Considerations for Airport Surface Access

ECO AIRPORT TOOLKIT

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1. INTRODUCTION

Airport stakeholders and the public rely on efficient surface access **to and from,** as well as **around** the airport, to transport people, goods and vehicles. Surface access has to be managed properly to fulfil its purpose, and to reduce and avoid negative impacts on the environment and society. The extent of issues will vary from one airport to another, but the size and location of the airport and the availability and quality of public transport facilities serving the aerodrome are particularly important[1]. Vehicle traffic and the emissions they generate are one of the largest contributing factors to environmental impacts around airports. Water usage, waste products, noise from road and rail traffic, and other types of air pollution are all elements of surface access that impact the environment.

Reducing the negative effects of surface movement at and around airports not only brings environmental benefits such as better local air quality, better management of resources, or reduction in noise pollution; it also provides social and economic advantages, increasing an airport's overall sustainability.

The transformation of the ground surface access to become more sustainable is not under the direct control of the airport, but airport operators can engage with relevant authorities and the private sector to encourage best practices and solutions that are an integral part of their sustainable infrastructure plans. For instance, the public and private investments made in developing airport infrastructure, particularly on-airport, may benefit the local communities and the airport socially and economically by providing skilled labor for construction in addition to long-term regional benefits from improved surface access and employment[2].

Other examples of positive social impacts include the improvement of customer experience through convenient, affordable, and accessible means to get to and from the airport. Innovation and technologies can identify ways to facilitate, improve and incentivize passengers to use public transportation and the vehicles serving the airport to use biofuels or transition to electric or hydrogen. For example, the integration of different modes of transportation into a compatible sustainable ecosystem can improve passenger experience and become a competitive advantage for the airport.

Providing a more environmentally friendly airport surface access also depends on the availability of a resilient sustainable transportation network available where the airport is located, which requires combined action from the public and private sectors to address challenges. One challenge is the fact that the ground transportation network will continue to grow and adapt to respond to the

[1] See Sections 2.3 and 4.5.2 of ICAO Airport Planning Manual, Part 2, Fourth edition, 2018.
[2] https://aviationbenefits.org/

increased population, users' expectations (sustainable mobility) and efficiency required. In addition, as climate change continues to impact and test existing infrastructure with more extreme events, resilience is an essential consideration. Flooding from storms or rising sea-levels, for example, can disrupt and even halt public transit and other modes of transportation operations, cutting off all access to the airport. Such a strong interdependency between airports and other stakeholders affects airports' resiliency, whilst it also provides them with an opportunity to work with cities to develop resilience and adaptation plans addressing the risks associated with the region that goes beyond the airport boundary; as the interface of different modes of transportation, airports are well placed to facilitate collaboration, and increase their resilience and support the broader network or community to increase theirs as well.

While airports are not in control of all the issues around surface access, this paper aims to help airports and other stakeholders consider relevant aspects proposed while planning and implementing a more environmentally friendly and sustainable ground surface access.

2. AIRPORT PLANNING

Surface access is a primary consideration in the airport planning process[3]. Through the master planning process, airports identify the needs of airport users for facilities such as access to the terminal curb, parking, and rental car facilities. At the same time, transportation planning agencies for a city or an area will study and implement solutions to improve access to the airport and develop transportation plans that include the airport as a significant origin and destination of many regional trips.[4]

Planning often includes looking at factors such as average trip time, the numbers of passengers a day, the airport circulation road and number of parking facilities. Planning of surface access and on-airport circulation should explicitly include environmental goals such as minimizing wait times for vehicles to reduce emissions and providing or encouraging public transportation and other options to reach the airport. The better the volume of traffic, the number of parking spaces needed, roadway exit patterns, and other key driving decisions are accurately calculated, the more likelihood of congestion decreases. Factors such as signage and ease of use are important. Roadway congestions can result from unfamiliarity with the driving procedures, causing stress among drivers and passengers. In addition to studying road service level needs, the access routes should be planned in a 'user friendly' manner that is quickly and easily understood by drivers.

Indeed, the design of surfaces for vehicle access has dependencies with other environmental impacts, making effective planning an important step. For example, water management is

[3] See ICAO Airport Planning Manual Part 1
[4] http://onlinepubs.trb.org/onlinepubs/acrp/acrp_rpt_216Contractor.pdf

important for airports,[5] and paved surfaces contribute to surface water runoff at the airport. Surfaces should be planned with adequate water runoff systems to support.

Apart from master plans considerations, airports may decide to conduct an independent ground access study to identify near-term and long-term improvements for traffic management.

To reduce automobile traffic, airports can also employ techniques to manage demand. In some large metropolitan areas where traffic congestion is a problem, some commercial-service airports have implemented strategies or policies, to reduce the number of single-occupant private vehicle trips and encourage greater use of high-occupancy vehicles.

In fact, many methods have emerged to reduce driving times at the airport and thereby reduce engine emissions. 'Cell phone parking lots' allow a driver that is picking up passengers to park, turn off their engine, and wait for a phone call that their passenger has their bags and is ready for pick up. Sometimes it is a challenge for a driver to quickly find a parking spot in an airport garage. Many airports now have systems in which lights show drivers where open parking space are, allowing them to park more quickly; others offer reserved parking spaces.

Another strategy is the implementation of low, or ultra-low, emission zones. "Low emission zones (LEZs) and clean air zones are at the centre of many cities' efforts to tackle the related problems of air pollution, greenhouse gas emissions and congestion."[6] Airports can implement such a strategy as a mitigation measure for local air quality, by encouraging a greater proportion of visitors, passengers, and employees to use sustainable transport to access the airport. For example, London's Heathrow Airport (LHR) developed an Ultra-low Emission Zone (ULEZ). Vehicles need to meet the different emission standards for the Ultra-Low Emission Zone (ULEZ) based on their vehicle type, which includes cars, motorcycles, and vans. Vehicle that do not meet the low emission standard pay a fee ranging from £10-15. The heavier trucks and buses pay a higher charge. The entrance fees will be allocated within the community and for airport expansions. The plan is to move towards significant investment towards advanced public transportation to and from the airport - benefiting both the economy and the environment.

Like any other initiatives, airports should engage the neighboring communities and other airport stakeholders to understand and address needs and concerns, and effectively convey all the associated benefits of the project.

[5] https://www.icao.int/environmental-protection/Documents/Water%20management%20at%20airports.pdf
[6] https://www.c40knowledgehub.org/s/article/How-to-design-and-implement-a-clean-air-or-low-emission-zone?language=en_US

3. PUBLIC TRANSPORTATION

A primary way to reduce automobile emissions and impacts is to provide public transportation access to the airport. Public transportation reduces roadway congestion, reduces the amount of land required for automobile parking, and reduces total air pollutant emissions and other environmental impacts. Public transportation options are often examined as part of an airport master plan and can include scheduled bus and passenger rail services, as well as other alternate modes of transportation. Coordinating public transportation to the airport with other regional planning organizations such as the local transport authorities is a good practice.

Good connectivity between an airport terminal and the various modes of transportation is essential and can make the difference as to whether people use public transportation options. Public transportation should be assessed for frequency, reliability, travel time, cost, regional coverage, number of segments (e.g., connections), and type of intermodal facilities available at the airport to provide convenient connections for passengers on the next leg of their journeys.

Several large airports offer direct rail service, namely subway/metro systems that connect local transit rail systems such as at Reagan National (DCA) and Dulles International (IAD) airports in Washington D.C., as well as more substantial passenger rail systems such as Baltimore/Washington International Thurgood Marshall Airport (BWI) and Newark Liberty International Airport (EWR). Increasingly, airport operators are leading the push to plan, finance, and manage rail access to their facilities. A recent example is the LaGuardia AirTrain in New York City, a 2.4 kilometer spur of rail that connects LaGuardia airport (LGA) with the New York City Subway and Long Island Rail Road (LIRR).[7] The Port Authority of New York and New Jersey, which operates the airport, also will construct and operate the rail line in conjunction with the Metropolitan Transit Authority. Another good example is the efforts by Los Angeles World Airports (LAWA) to improve the access to Los Angeles International airport (LAX). LAWA recognized that the city's traffic made access a major issue for customers, and they developed the Land Access Management Plan.[8] The centerpiece of the plan is an Automated People Mover, which is a 3.62-kilometer elevated guideway train system that connects the airport to the regional LA Metro transportation system. In addition to the rail access, the LAMP also included construction of an Intermodal Transport facility to improve parking, development of a Consolidated Rent-a-Car facility to consolidate rental facilities into one place, and roadway improvements to reduce traffic congestion.

A consideration when planning rail or other public transportation access is that it does not inhibit future aviation needs. The flexibility to accommodate future development is important, especially airside needs.

[7] https://www.anewlga.com/airtrain/
[8] https://www.lawa.org/connectinglax

4. ON-AIRPORT CIRCULATION

On-airport roadways are shared by a wide range of users having different trip purposes, and come with a range of facilities and equipment, such as staging areas, parking facilities, etc. These include:

1) ***Arriving and departing travellers and visitors*** who most often arrive at the airport in a private vehicle, but may also use a taxicab, limousine, courtesy bus, mass transit, charter bus, door-to-door shuttle, rental car, or bicycle.

2) ***Employees*** who travel to and from the airport each day using private vehicles, public transportation, shuttles from remote parking facilities, or bicycles.

3) ***Airport tenants, contractors and airlines*** who receive deliveries to supply the goods and materials consumed or purchased at the airport or on-board the aircraft. These vehicles can range from private automobiles to vans to trucks of various lengths up to tractor trailers.

4) ***Others*** who use vehicles that may require access to air cargo facilities, general aviation facilities, support facilities, and other activity centres.[9]

Each transportation mode will have various arrival and departure times and places that require different considerations, such as:

- walking distances between the transit stop/platform and the airline ticket counters and baggage claim areas
- the number of level changes between the transit stop/platform and the airline ticket counters and baggage claim areas
- the accessibility for passengers with baggage to pass through turnstiles and enter/exit transit stations, both at the airport and other stations

Other factors include:

- walking distances to parking garages
- frequency of shuttles to rental car facilities and nearby hotels on and off airport
- amount of curbside for vehicle staging should be examined for passengers not using public transportation

Planners should examine the various components of the airport's ground access system to identify where environmental improvements can be made. Many large airports have constructed rail systems and other infrastructure to move people from terminal to terminal quickly. These systems help eliminate the need for fossil-fuel burning vehicles.

[9] FAA Advisory Circular 150/5070.6 Airport Master Plans.

5. INNOVATION

a. Materials

There may be alternative materials that can be used for surface transportation that have environmental benefits. Aircraft movement areas that are paved must meet certain safety requirements. However, airports may be able to use other materials, such as porous asphalt paving for parking lots or roadways. Porous asphalt allows water to percolate down into the ground, but in order to be used, individual State policies and practices have to be considered.

There are many innovations in storm water collection and treatment systems that provide environmental benefit. Storm water management is related to surface access issues because the design of surfaces effects the behaviour of storm water runoff. The ICAO e-publication *Water Management at Airports* describes some of these technologies.[10] As stated above, surfaces and storm water systems must work together efficiently to move water away and allow passenger access.

Airfield pavements are another source of pollution at airports. Safety should remain the primary concern, but its environmental impact can be reduced by acting at different levels: using more sustainable materials or rationalizing the maintenance for example. Using more sustainable materials will lead to a decrease in carbon emissions during the construction of an airfield pavement. It can be achieved by favouring the recycling and re-use of materials coming from a local source. The integration of bio-sourced materials in the pavement structure is another option that has been studied in roadworks and could be transposed for airfield pavements. Improved maintenance can include the monitoring of the pavement by means of temperature and/or mechanical sensors within the pavement structure. The information provided may help airport operators to better manage their pavements and extend the service life.

b. Digitalization

Digitalization, by providing enhanced data exchange and connectivity of resources, can facilitate the integration of several modes of transport, and make it easier for airport customers to find, plan, book and use public transportation and/or lower carbon options such as car- and ridesharing or electric vehicles. It can also increase efficiencies that reduce emissions, by providing, for instance, more direct routes, less vehicle idle time, etc.

[10] https://www.icao.int/environmental-protection/Documents/Water%20management%20at%20airports.pdf

Mobility as a service (MaaS)

In a new business landscape where passengers will come to expect fluidity both from an infrastructure standpoint and from a data standpoint, airports may have the opportunity to act as enablers or intermediaries.

MaaS could mean, for instance, having one app where individuals can search for transport options, book the selected option for the service, and have one single ticket for several modes of transport. This could be taken even further, by allowing users to select the most environmentally friendly route with the help of carbon calculators.

While shared mobility services may create more congestion and pollution, there is an opportunity to develop this technology in an efficient, sustainable, and economically profitable manner. For example, with new technologies that combines passenger demand with similar onwards or final destinations and offers shared-ride services, reducing overall emissions and costs for users[11]. The demand for ride pooling services is increasing and at certain airports, this demand can represent as much as 30% of their Uber rides (e.g., Los Angeles International Airport)[12].

c. Urban Air Mobility / Air Taxis

Urban, or advanced air mobility, is becoming a reality. With innovation in the fields of electric propulsion and increased battery capacity, electric vertical take-off and landing (eVTOL) aircraft will transport cargo and passengers alike. This new technology can reduce congestion on the ground, thereby lowering GHG emissions and noise levels. UAM could also be integrated into the ride-sharing services ecosystem, to provide an even more seamless passenger journey experience.

Despite offering major benefits, challenges remain around the development of urban air mobility, in relation to the development of the required infrastructure and related costs, the added demands on the airspace as well as on the electricity grid, the perception and acceptance of the public, etc.

d. Connected and Autonomous Vehicles

A connected and autonomous vehicle (CAV) lets the vehicle control at least some of the driving functions, replacing the human driver with sensors, controllers, on-board computers, and advanced

[11] https://www.internationalairportreview.com/article/111166/surface-access-airport-development-mag/
[12] https://www.lek.com/insights/ei/future-airport-car-parking

software; depending on the features installed, it can communicate with its occupants (e.g., through their mobile devices), with other vehicles and road users, and with the surrounding transportation infrastructure (e.g., roadways, traffic lights).[13]

These vehicles will be present on both the landside and airside surfaces of the airport. Their environmental impact will depend on whether they run on zero emission fuel, and on whether the fleet is comprised of mostly shared, or privately owned vehicles. For instance, if most of these vehicles are privately owned, they will increase congestion and intensify the need for renewable energy sources.

e. Inter-modality

Inter-modality has the potential to optimize the sustainability of the entire mobility network. Using more sustainable transportation options to go to and from the airport can complement air travel, help reduce CO2 emissions, and in certain cases, increase the airport's catchment area. Another innovation on inter-modality could also be the integration of all-electric seagliders into the transport network, to serve regional coastal airports and intra-island routes, and which could additionally well pair with e-VTOL operations, for instance[14].

f. Zero emission vehicles

Zero emission vehicles will require new infrastructure to provide charging stations for renewable energy (this includes charging stations for e-bikes). Airports should plan for and work with relevant stakeholders to build accordingly.

6. POLICY

Policy can be a barrier or enabler for the development of more sustainable infrastructure. Considerations should be given to the social, environmental, and economic benefits of specific policy developments, and airport ownership's frameworks, which differ from place to place.

In the state of California in the United States, a new policy known as the Innovative Clean Transit regulation is part of a state-wide effort to reduce emissions from the transportation sector. The measure, initiated by the California Air Resources Board, requires public transit agencies in the state to transition to 100% zero-emission buses by 2040. As airports in California replace buses, they will be required to purchase zero-emission buses.

[13] https://tc.canada.ca/en/road-transportation/innovative-technologies/connected-automated-vehicles
[14] https://www.regentcraft.com/

7. COLLABORATION

As mentioned previously, on-airport roadways are shared by a wide range of users, from arriving and departing travellers and employees, to delivery vehicles and others that need access to various parts of the airport's facilities. Airports are complex and multifunctional, and part of a large network that includes stakeholders even beyond the aviation sector.

As such, combined action by different actors and sectors, can give leverage with local and national authorities and financial institutions, to support airport expansion or encourage and facilitate innovative projects and solutions that can reduce, mitigate or remove the negative impacts associated with airport surface access. Collaboration is also key to help avoid duplicating initiatives.

A simple and good example of collaboration at the airport could be to develop a carpooling system. Because an airport can contain numerous employers, the airport operator may be able to develop and provide a system that matches potential carpoolers (across multiple employers) based on their residence and work schedule. At airports dominated by a single air carrier, collaboration with that carrier on such a system could provide the critical mass to make the system attractive for use by other, smaller employers.

8. TABLE OF MITIGATION MEASURES

Eco-friendly surface access can take several forms including operational changes, technical improvements, and economic incentive programs. Each of these areas offers ways that could be considered to mitigate the impacts of surface access systems.

The table below provides some examples that airports, in collaboration with other stakeholders, can include in their mitigation efforts to support a sustainable access to and around the airport.

OPERATIONAL *Operational improvements generally focus on efficiency and making processes of surface access quicker and easier.*	**TECHNICAL** *In some cases, mitigation measures require upgrades to technologies and infrastructure at the airport.*	**ECONOMIC** *Encouraging the public, passengers, and tenants to do their part to mitigate impacts can be accomplished with various types of economic and policy incentives.*
Consolidation of hotel and rental car shuttle buses	Road layout and design that reduces distances and congestion	Parking pricing and trip-fee subsidies for low emissions vehicles
Idling restrictions, especially at peak hours	Dedicated public transit lanes to keep bus service moving swiftly	Public transit subsidies and incentives for employees and public
Employees rideshare and cycling options	Enhanced public transit and inter-modal connections	Employees rideshare and cycling incentives
Priority queuing for low emissions taxis	Providing infrastructure such as electrical charging stations for alternative fuel vehicles and e-bicycles	Encouraging ridesharing and third-party taxi cabs
Discouraging single passenger drop-off including one-way taxi trips; discouraging "deadhead" taxi, Transport Network Companies, and limousine trips where a vehicle arrives/departs without a passenger	Encouraging public transit access to non-terminal employment centres	Encouraging long-term parking for passengers where public transit is not an option
	Integrated and simplified ticketing	Providing female-only services[15]
	Providing real time information on public transit	Marketing and promotions
		Improve frequency and consider 24-hour operations if needed
		Implement zones within which passengers can travel for free

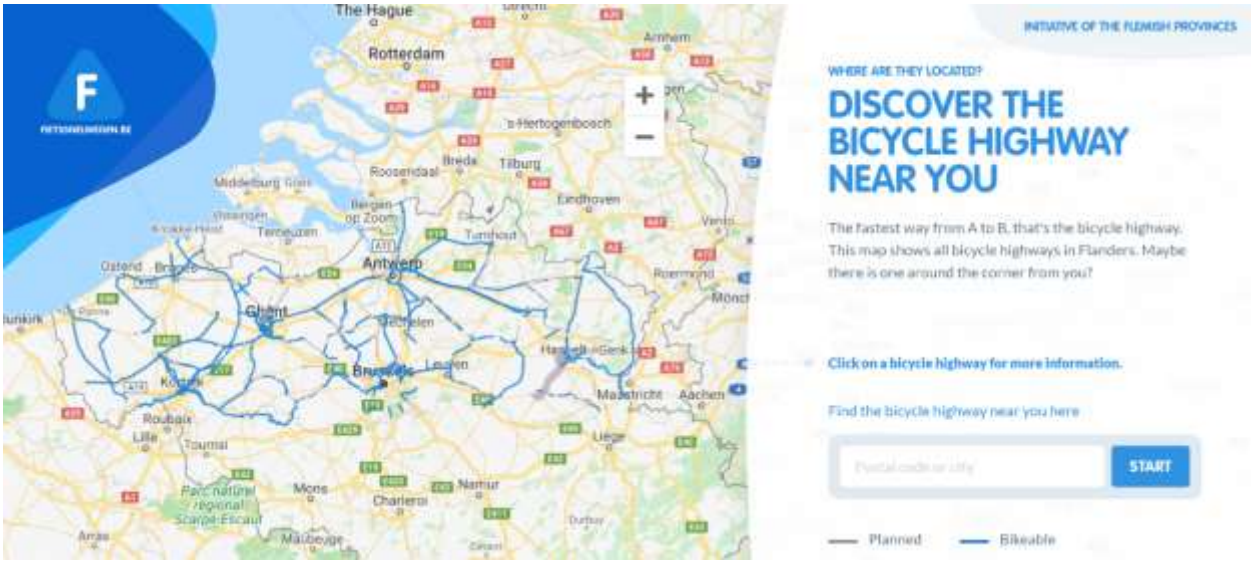
[15] https://core.ac.uk/download/pdf/74410339.pdf

9. EXAMPLES OF ACTIONS

Brussels Airport (Belgium)

A bike path connecting Brussels Airport to the cycle highway F3 between Brussels and Leuven was inaugurated at the end of March 2021. The path goes through several railway stations and allows riders to enter the capital city and go directly to the airport via bicycle. The airport collaborated with the surrounding Flemish region, the province of Flemish Brabant, the municipality of Zaventem. [16]

Passengers and visitors can walk or cycle along a safe, fenced-off path to the terminal, and have access to free parking for bikes, motorcycle or moped, in a carpark equipped with camera surveillance and located just in front of the Departures and Arrivals halls. Charging stations for e-bikes are also provided.[17]



Manchester Airport Group-MAG (United Kingdom)

As cited in International Airport Review in 2020[18]: "At Manchester Airport, MAG is working with Transport for Greater Manchester (TfGM) on a number of pilot projects. These include projects to

[16] https://www.brusselstimes.com/news/belgium-all-news/161955/cycle-highway-f3-leuven-bike-path-to-brussels-airport-completed/
[17] https://www.brusselsairport.be/en/passengers/access-parking/by-bike-motorcycle-or-on-foot
[18] https://www.internationalairportreview.com/article/111166/surface-access-airport-development-mag/

develop mobility service platforms through to autonomous vehicle trials. But, perhaps even more importantly, we are working with them and the national government on the delivery of fast rail infrastructure across the North and Midlands of England. Manchester is the Global Gateway for the North – the only UK airport offering a full network of long-haul and regular business destinations outside of London, and this connectivity is critical to the economy and driving growth. In this future, mobility itself will remain reliant on traditional technologies, but will be enhanced by innovations to ensure travel information is integrated and dynamic, and ticketing is convenient and flexible. In this context, technology is about encouraging and simplifying the switch for passengers to public transport modes."

Dallas Fort Worth International (United States)

Dallas Fort Worth International (DFW) aspires to be the global standard for sustainability, and therefore, it established an ambitious goal of achieving Net Zero Carbon by 2030. As part of the green energy contributor and footprint plan, DFW airport will purchase six electric sedan vehicles and install three-vehicle charging units. The benefits of receiving the Zero Emission Vehicle and Infrastructure Pilot Program Grant (ZEV) from the US FAA allow DFW to accelerate its strategy to electrify the airport vehicle fleet. Additional benefits include supporting a new wave of environmentally friendly initiatives and welcoming travellers to use electric vehicles and charging stations. Additionally, DFW has uncovered a breakthrough to converting the entire bus fleet to electric buses as it lowers its carbon footprint. Over the last 15 years, DFW reduced its annual energy costs by more than 50% by shifting towards purchasing 100% renewable wind electricity and advancing energy efficiency measures throughout the campus. The airport's green investments have proven good for people, the environment, and business.

Aéroports de Paris (France)

In 2015, Aéroports de Paris started the deployment of charging stations for electric vehicles. At the end of 2020, 225 charging stations, i.e. 437 charging points, were available on the three Parisian platforms (Paris-Charles de Gaulle, Paris-Orly and Paris-Le Bourget). They are divided between the public parking lots for passengers, the taxi waiting areas, the airside and landside parking lots for service vehicles, and the parking lots of the Real Estate Department buildings.

Approximately 50% of these charging stations are connected to the telecommunication network, which gives access to their usage statistics and allows to remotely carry out some maintenance work. From one year to the next, it is possible to see the progression of charges thanks communications with the charging stations.

At Paris-Charles de Gaulle, Aéroports de Paris has experimented a charging point booking system for passengers, to guarantee them the availability of a charging station when they arrive in the parking lot.

Aéroports de Paris are already planning to increase the number of charging stations in both landside and airside. This will contribute to:

- the energy transition of ADP's fleet of service vehicles;
- the deployment of electric vehicles in the 'Ile de France' region for passengers and employees who invest in this type of vehicle for private use; and,
- the greening of airside activities, in particular ground handling.

The deployment of charging stations is an integral part of the actions taken by Aéroports de Paris to reduce CO_2 emissions and atmospheric pollutants at and around the airports.

Rail Baltica

Rail Baltica is a green-field rail transport infrastructure project with a goal to integrate the Baltic States into the European high speed rail network and will include connections to airports and

seaports to facilitate multi-modality. It will be fully electrified and use the newest technologies and materials to reduce environmental impacts such as noise and CO_2 emissions. The line is planned so that it avoids the Natura 2000 protected areas as to the extent possible and avoid significant impacts to other environmentally sensitive protected areas. For example, noise protection barriers will be installed, and animal passages will be built through the embankments[19].

Geneva-Zurich Airtrain (Switzerland)

Since August 2020 Swiss International Air Lines (SWISS), Switzerland's national air carrier, has expanded its air-rail service by providing an Airtrain link between Geneva's main railway station (Geneva Cornavin) and Zurich airport. There are up to ten Airtrain services a day in each direction, all of which are allocated Swiss flight numbers. This is in addition to the Airtrain service already provided between Lugano and Zurich and Basel and Zurich. Airtrain connections are bookable on the airline's website[20].

San Diego International Airport (United States)

San Diego International Airport provides a great example of how access roads and parking areas can be turned into environmental assets, instead of being environmental liabilities. The airport is currently in the environmental review stage of a proposed project to relocate its main entrance, allowing for the creation of a nearly mile-long, three-lane entry road that would reduce traffic on surrounding surface roads outside the airport and facilitate airport ground access by eliminating the number of signalled intersections passenger and visitor traffic has to go through. This would reduce vehicle delays and idling at red lights, and emissions.

The airport also incorporated a stormwater capture and reuse project at its Terminal Two Parking Plaza. The project collects stormwater runoff from the parking garage's upper deck to be treated for reuse at the airport's central utility plant. The 7.6-acre Parking Plaza can collect and store 107,000 gallons of storm water, in drainage pipes that were purposely upsized to also function as storage. It is estimated that this project will collect up to 2,000,000 gallons of rainwater per year for reuse. In addition, the airport constructed a 3-million-gallon cistern near its rental car facility. This cistern was sized to collect up to 80 acres of runoff from roadways and parking areas, as well as other impervious surfaces on the airport's northside, which will eventually be reused in the car rental facility's car washing system.

[19] https://www.railbaltica.org/about-rail-baltica/
[20] https://www.businesstraveller.com/business-travel/2020/08/18/swiss-introduces-geneva-zurich-airport-airtrain/

El Dorado Airport (Columbia)

At El Dorado Airport in Bogota, modes of transport have been identified for workers, visitors, and passengers accessing the airport and connecting in turn with the city. One of the tools employed to identify this behavior was the El Dorado application, which had to be used to enter the building as part of the COVID-19 biosecurity protocols. The information gathered included the following data:

- Employees who have shifts at dawn and at night use door-to-door service and avoid using private cars for more comfort.
- Visitors and employees have shorter trips given the proximity to various neighbourhoods in the city of Bogotá, compared to other airports in the world that are located on the outskirts of the city.

There are multiple services to get to and from El Dorado airport. Shuttle buses connect between the terminals and one kilometer outside the airport, where travelers or visitors can connect with hotels or other forms of transportation. Buses also serve some shopping centers so that passengers or travellers can connect or make their purchases outside the airport. Public transport is quite easy for travellers who have little luggage; it is much faster than using a private vehicle. The public system (*Transmilenio*/*Alimentador*) provides an application where the traveller or visitor can access it and trace the route they need, take the correct bus, in addition to being connected to google maps; the El Dorado app also connects to WAZE and the *Transmilenio* app.

REFERENCES

ACI World (2020). Online Airport Environmental Management Course.

Air Transport Action Group, Aviation Benefits Beyond Borders. Available at: https://aviationbenefits.org/

ACRP report, Meyer et al. (2019), Integrating Airport Ground Access and Metropolitan Surface Transportation Planning Efforts. Available at: http://onlinepubs.trb.org/onlinepubs/acrp/acrp_rpt_216Contractor.pdf

Brussels Airport Company, By bike or motorcycle or on-foot. Available at : https://www.brusselsairport.be/en/passengers/access-parking/by-bike-motorcycle-or-on-foot

Budda, L., Isona, S., Buddb, T (2016). Improving the environmental performance of Airport Surface Access in the UK: the role of public transport. Available at: https://core.ac.uk/download/pdf/74410339.pdf

Business Traveller, McWhirter, A. (2020), Swiss introduces Geneva-Zurich airport 'Airtrain'. Available at: https://www.businesstraveller.com/business-travel/2020/08/18/swiss-introduces-geneva-zurich-airport-airtrain/

C40 Knowledge Hub (2019), How to design and implement a clean air or low emission zone. Available at: https://www.c40knowledgehub.org/s/article/How-to-design-and-implement-a-clean-air-or-low-emission-zone?language=en_US

Fiona Greer et al (2020). Environ. Res. Lett. 15 103007. Airports and environmental sustainability: a comprehensive review. Available at: https://iopscience.iop.org/article/10.1088/1748-9326/abb42a/pdf

EUROCONTROL (2021). Stakeholder Forum on intermodal transport and regional connectivity. Available at: https://www.eurocontrol.int/event/eurocontrol-stakeholder-forum-intermodal-transport.

Hoffman, A. (2021). The COVID-19 pandemic, an accelerator for airport digitalization. Available at: https://blog.aci.aero/the-covid-19-pandemic-an-accelerator-for-airport-digitalization/

ICAO (1987), Airport Planning Manual Doc 9184. Part 1 Master Planning, 2nd Edition. Available at: https://store.icao.int/en/airport-planning-manual-master-planning-doc-9184-part-1

ICAO (2018), Airport Planning Manual Doc 9184. Part 2 Land Use and Environmental Control, 4th Edition. Available at: https://store.icao.int/en/airport-planning-manual-land-use-and-environmental-management-doc-9184-part-2

ICAO, Eco-Airport Toolkit, Water Management at Airports. Available at: https://www.icao.int/environmental-protection/Documents/Water%20management%20at%20airports.pdf

International Airport Review, Roy, A. (2020), How the future of mobility at airports must change. Available at: https://www.internationalairportreview.com/article/111166/surface-access-airport-development-mag/

L.E.K. Consulting (2019), Executive Insights, Volume XXI, Issue 44. Where to Now? — The Future of Airport Car Parking. Available at: https://www.lek.com/insights/ei/future-airport-car-parking

LaGuardia Redevelopment, A Whole New LGA, AirTrain LGA. Available at: https://www.anewlga.com/airtrain/

Los Angeles World Airports, Connecting LAX, Landside Access Modernization Program (LAMP). Available at: https://www.lawa.org/connectinglax

Rail Baltica Global Project Rail, Baltica – Project of the Century. Available at: https://www.railbaltica.org/about-rail-baltica/

REGENT (2021), Coastal Travel, 100% Electric. Available at: https://www.regentcraft.com/

Ryley, T.; Elmirghani, J.; Budd, T.; Miyoshi, C.; Mason, K.; Moxon, R.; Ahmed, I.; Qazi, B.; Zanni, A. Sustainable Development and Airport Surface Access: The Role of Technological Innovation and Behavioral Change. Sustainability 2013, 5, 1617-1631. Available at: https://doi.org/10.3390/su5041617

The Brussels Times (2021), Bike path to Brussels Airport completed. Available at: https://www.brusselstimes.com/news/belgium-all-news/161955/cycle-highway-f3-leuven-bike-path-to-brussels-airport-completed/

Transport Canada (2021), Connected and automated vehicles. Available at: https://tc.canada.ca/en/road-transportation/innovative-technologies/connected-automated-vehicles