Horizon 2020

OLGA

D1.1: Standard for the assessment of Green Airports impacts

Grant Agreement number: 101036871

Project acronym: OLGA

Project title: HOListic & Green Airports

Funding scheme: Innovation Action (IA)

Start date of the project: 1st October 2021

Duration: 60 months

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Disclaimer: This document is the first version of the evaluation framework. Work is still in progress. KPIs attribution to innovative solutions and KPIs way of calculation may be modified in a next revision of the document.

DOCUMENT INFORMATION

Document Name	**Standard for the assessment of Green Airports impacts**
Version	V1
Version date	10/10/2022
Author	Patrick MONROY (BV)
Security	Public

APPROVALS

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Coordinator	Virginie PASQUIER	ADP	10/10/2022	
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DOCUMENT HISTORY

Version	Date	Modification	Authors
V01	19/07/2022	Initial version	P. MONROY
V02	24/09/2022	WP leaders comments integration	P. MONROY
V03	04/10/2022	Tasks leaders comments integration	P. MONROY
V1	10/10/2022	Final version: qulaity control	A. Hoque

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List of Abbreviations

AB	Advisory Board	**HSE**	Health, safety and Environment
A-CDM	Airport CDM (certification)	**IA**	Innovation Action
ACI	Airport Council International	**IDEP**	Interactive Data Exchange Platform
AI	Artificial Intelligence	**IP**	Intellectual Property
API	Application Programming Interface	**IPR**	Intellectual Property Rights
APU	Auxiliary Power Unit	**LCA**	Life Cycle Assessment
AQ	Air quality	**LH2**	Liquid Hydrogen
ASTM	American Society for Testing and Materials	**LIDAR**	Light Detection and Ranging (camera)
BEMS	Building Energy Management System	**LTO**	Landing and Take-off
BES	Building Energy Simulation	**MaaS**	Mobility as a Service
BEV	Battery Electric Vehicle	**MDO**	Multidisciplinary Design Optimisation
BIM	Building Information Modeling	**ML**	Machine Learning
bioNGV	bio- Natural Gas Vehicle	**MXP***	Malpensa airport
CA	Consortium Agreement	**MRV**	Measurement, Reporting and Verification
CAGR	Compound annual growth rate	**NGV**	Natural Gas for Vehicle
CAV	Connected and Autonomous Vehicles	**OEM**	Original Equipment Manufacturer
CDG*	Paris-Charles de Gaulle airport	**OMS**	Operation Management System
CDM	Collaborative Decision Making	**PAX**	Passenger
CFS	Certificate on the Financial Statement	**PC**	Project Coordinator
CLJ*	Cluj Airport	**PMC**	Project Management Committee
CNG	Compressed Natural Gas	**POBT**	Predicted Off Block Time
DL	Deep Learning	**R&D**	Research and Development
EAQM	Emissions and Air Quality Monitoring	**RES**	Renewable Energy Source
EC	European Commission	**RGB**	red, green, and blue (camera)
EoL	End of Life	**SAF**	Sustainable Aviation Fuel
EPC	Engineering Procurement and Contract	**SC**	Steering Committee

EU	European Union	**SME**	Small and Medium Enterprise
(P)(H)EV	Plug-In hybrid Electric Vehicle	**TRL**	Technology Readiness Level
FLW	Food Loss and Waste	**UAV**	Unmanned Aerial Vehicle
FMS	Fleet Management systems	**UFP**	Ultra-fine Particles
FP	Framework Programme	**VOC**	Volatile Organic Compounds
GHG	greenhouse gas	**WG**	Working Group (of the AB)
GIS	geographic information system	**WP**	Work Package
GPU	Ground Power Unit	**WPL**	Work Package Leader
H2020	Horizon 2020	**XOPS**	Operation / Fleet Management System (RMP4 product)
HEFA	Hydroprocessed Esters and Fatty Acids	**ZAG***	Zagreb airport

1 Executive summary

1.1 Introduction

The objective of OLGA Evaluation Framework is to justify for the whole OLGA project the environmental impact of new environmental solutions.

1.2 Brief description of the work performed and results achieved

76 key performance indicators have been identified for OLGA project innovative solution. These KPIs can be split in 11 main categories.

This report explains which KPI shall be assessed for each innovative solution. It describes also the methodology to assess the KPI in order to make comparison between innovative solutions and therefore to assess the impact of OLGA project with and without the innovative solutions.

The methodology will afford to assess the impact of innovative solutions for replication to other airports.

2 Introduction

2.1 Objectives of the impacts of environmental improvements

The objective of OLGA Evaluation Framework is to justify for the whole OLGA project the environmental impact of new environmental solutions.

The assessment is limited to the perimeter of the OLGA project by evaluating quantitatively or qualitatively the evolution of environmental criteria for each Work Package that are part of the OLGA Project. The results are then aggregated to field levels (transport, air, terminal, energy) and up to OLGA project level.

Thus, the objective is not to define the environmental impact of the airport and the associated transport, but only to determine the environmental impact with and without each of the solutions or each of the Projects proposed for the improvement of the environment of the OLGA project.

An impact assessment of each identified solution may be given in relation to the airport facilities as a whole. This can be done only if the data is available and consistent with the assessment method for each of the criteria defined in this note. For example, the assessment of the greenhouse gas balance of the OLGA Project could be compared by concatenating all the improvements made by each Project and compared to the balance of the whole airport, if available, since the airport perimeter includes other activities than those studied in the OLGA Project perimeter, such as utilities production, catering, shops, hotels, offices, etc.

In the following, a Project is defined as the improvement solution considered in a Work Package to bring about an environmental improvement within the framework of the overall OLGA project which encompasses all 46 solutions selected to improve the environmental impact of airport terminals.

A Project may consist of a change to a small part of a system, such as a change in the type of lighting, or a change to a much larger system, such as a change of fuel for a fleet of vehicles.

The list of projects is given in the Table 1.

2.2 Scope of Work

The OLGA Scope of Work defines three main categories of interest to be assessed, which are further subdivided into several sub-criteria:

- General environmental performance of OLGA project identified solutions,
- Flight Operations environmental performance,
- Passenger and freight handling environmental performance.

In order to assess the performance of the measures taken in the OLGA project, it is proposed to examine the OLGA project and each of its Environmental Improvement Projects under the following themes (when relevant):

- Emissions of gases leading to adverse effects on people or the environment,
- Energy consumption,
- Low carbon transport share,
- Waste production,
- Consumption of natural resources,
- Biodiversity,
- Societal impact,
- Economic aspects,
- Safety of passengers, employees and third parties,
- Passenger comfort,
- Noise.

Table 1 explains which KPIs have to be studied regarding OLGA solutions implementations. The choice was pragmatically made by the OLGA project team regarding technical description of each solution to reduce environmental impact.

For some Projects it does not seem relevant to study certain themes. Table 1 also summarises the themes to be studied for each Project ("Y" stands for "yes – to be studied").

Table 1: OLGA Project identified solutions

			KPIs fields												
SOW ref	**Title**	**Environmental innovation description**	Green House Gases	Air Quality	Energy consump-tion	H2 production / usage	Modal share of low carbon transport	Waste	Natural resources	Biodiversity	Societal impact	Economic impact	Safety	Passenger comfort	Noise level
WP2 - Transport Landside, access and multimodal:															
WP2.1	Low-carbon connection with cities	Previously developed software solution for design and planning city bus transport electrification will be further improved and extended for e-buses connections to airport and surrounding areas, and charging stations deployment and management.	Y	Y	Y		Y				Y	Y		Y	Y
WP2.2	Traffic flow optimization	An IT solution for multimodal traffic optimization will be developed, including large-scale validation and replication.	Y	Y	Y		Y				Y	Y			Y
WP2.3.1	On-demand mobility for remote parking, parking and terminal connection	Deploy on-demand mobility on the Paris-CDG airport to improve the shuttle services transporting passengers and employees between parking and terminals.	Y	Y	Y		Y				Y	Y			
WP2.3.2	Mobility as a Service (MaaS) for Olympic Games	The travel planning tool will help passengers plan their journey from MXP to Olympic sites and reverse, showing information on routes and all available integrated and multimodal transport services to reach the venues, thus enhancing the sustainable mobility and fostering passengers to choose public and collective transport.									Y	Y			
WP2.3.3	Cargo export spare capacity optimization	Contributing the optimization of the transport of goods from inland to the airport (export process), by reducing number of trucks and pollutants emissions.	Y									Y			
WP2.4	Autonomous landside mobility	Possibility and limitations of using a Connected and Autonomous Vehicles (CAV) application.	Y	Y	Y		Y				Y	Y			
WP2.5	Waste as alternative fuel for bioNGV buses	Adaptation of diesel-powered trucks operating at the airport to Compressed Natural Gas (CNG) working engine. The conversion will be performed on different engines.	Y	Y	Y		Y	Y	Y		Y	Y	Y		
WP2.6.1	PAX rail-air intermodality	ADP will conduct a study to improve its quality of service in order to simplify the journey of connecting passengers between rail and air.	Y	Y			Y				Y	Y		Y	
WP2.6.2	Cargo delivery by train connecting the airport to the city centre	Smart delivery of small air freight via rail from Malpensa airport to Milan and vice versa, using the existing Malpensa Express train for passengers that connects the airport to downtown.	Y				Y				Y	Y			Y
WP3 : Transport airside															
WP3.1	Biodiesel 100% for Heavy-duty Vehicles	Feasibility study to switch to 100% biodiesel a part of the fleet of heavy-duty vehicles circulating airside and then a 10-month experimentation on 10 vehicles (runway sweepers-degreasers).	Y	Y	Y				Y			Y	Y	Y	
WP3.2	Low-carbon airside GSE	Transforming the current fleet of WB diesel-powered tractors into electric-powered tractors.	Y	Y	Y			Y				Y	Y	Y	
WP 3.3	Low-carbon airside mobility infrastructure	Develop a multi-energy station airside to allow low-carbon mobility using bioNGV and other energies at CDG airport.	Y	Y	Y				Y			Y	Y	Y	
WP3.4	Low-carbon airside electrification optimization software	Optimize the locations distribution and electric power capacities of charging points, in order to support the targets of greening Ground Support Equipment at CDG.	Y		Y								Y		
WP3.5.1 a	Green Apron at CDG - APU usage	Reduce the APU (Auxiliary Power Unit) usage time by monitoring its use through automatic detection and alerts.	Y		Y							Y			
WP3.5.1 b	Green Apron at CDG - Leakage detection	Reduce leakages/spillages of environmentally harmful substances by using automatic detection.						Y				Y	Y		
WP3.5.1 c	Green Apron at CDG - Predictive Off Block Time	Predict automatically the POBT (Predictive Off Block Time) in order to have improved synchronization in the departure sequence leading to a reduced taxi time.	Y	Y	Y							Y	Y		Y
WP3.5.2	Drones and Green Apron	In order to determine the infrastructure condition, to detect cracks or any objects on the operational areas, the application of unmanned aerial vehicle (UAV) for both photogrammetry purposes and visual inspection of the infrastructure will be applied.	Y	Y				Y					Y	Y	
WP3.6	APU substitution	This task will investigate APU-off modes to use the APU to the strict minimum at CDG airport.	Y	Y	Y							Y			
WP3.7.1 a	Taxiing reduction time by optimization of CDM @CDG	New procedures and software for decreasing arrival taxi time by better link between PDS and Arrivals	Y	Y	Y							Y		Y	

Table 1: OLGA Project identified solutions

			KPIs fields												
SOW ref	**Title**	**Environmental innovation description**	Green House Gases	Air Quality	Energy consump-tion	H2 production / usage	Modal share of low carbon transport	Waste	Natural resources	Biodiversity	Societal impact	Economic impact	Safety	Passenger comfort	Noise level
WP3.7.1 b	Taxiing reduction time by optimization of CDM @CDG	New procedures and software for decreasing departure taxi time (better integrate de-icing process, more accurate data)	Y	Y	Y							Y		Y	
WP3.7.1 c	Taxiing reduction time by optimization of CDM @CDG	New procedures and software for increasing n-x engine procedure usage for Taxi Out by better predictability and reliability of the Target runway Arrival Time & integrated Taxibot process in the PDS	Y	Y	Y				Y			Y		Y	
WP3.7.2B	Taxibot to allow engine-off taxiing	Investigate engine-off modes to use the engines during taxiing to the strict minimum, by use of the Taxibot with innovative business model.	Y	Y	Y				Y			Y	Y		Y
WP3.8	Green logistics	Deployment of autonomous electric freight transportation between warehouses, or between plane and warehouse, replacing diesel trucks at CDG.	Y	Y	Y				Y			Y	Y		Y
WP4 - Terminal area															
WP4.1.1	Dynamic apron lighting	Optimizing the lighting control of aircraft stands by actions related to the presence of aircraft on the aprons.	Y		Y					Y	Y	Y			
WP4.1.2	Terminal innovative lighting	Development of the conceptual design of 10 solutions of innovative, replicable and generic lighting, perfectly suited to terminals.	Y		Y				Y		Y	Y		Y	
WP4.1.3	Improving energy consumption and passenger experience in airport passenger pre-boarding bridge	Screen-printed glazing which filters the sun in summer and lets it pass in winter, will be installed and tested.	Y		Y			Y				Y		Y	
WP4.1.4	Solar installation on passenger bridge	Installation of renewable energy supply (photovoltaic panels) on surfaces currently unused such as roofing of boarding bridge.	Y		Y			Y	Y			Y			
WP4.1.5	Energy and CO2 efficiency in complex existing airport Terminals	Develop an innovative methodology based on a software platform integrating building energy simulation and life cycle assessment.	Y		Y			Y	Y	Y		Y		Y	
WP 4.2	Green deconstruction and light CO2 material	Green runway renovation: a methodology to reduce the environmental impact of the heavy renovation of the pavement structures of runway 09R/27L and linked taxiways	Y		Y			Y	Y	Y		Y			
WP4.2.2	Boosting CO2 decrease in concrete	Experimental constructions using a light CO2 concrete	Y		Y			Y	Y			Y	Y		
WP4.2.3	Increasing Circular Economy in Construction / Deconstruction	Definition of a specific methodology of digital deconstruction for airport based on the BATI approach	Y		Y			Y	Y			Y			
WP4.3	BiodiversIT	IT tool for biodiversity management and improvement: system for monitoring and assessing biodiversity to better manage it in airport operations and support local biodiversity improvement.								Y					
WP4.4.1	Waste management	The aim is to foster circularity in MXP Airport area using previous European M3P Life project results to optimize waste management: map waste produced by each industrial entity located in the airport: registration in M3P database, with waste characteristics (composition, quantity, etc.) necessary to identify possible alternative uses in B2B processes						Y							
WP4.4.2	Waste management prevention	Developing waste prevention systems for the Olympic Games						Y							
WP5 - Energy, Hydrogen															
WP5.1	Waste valorisation towards biofuels	Demonstrate the effectiveness of valorising organic wastes to gaseous biofuels and provide scalable solutions to large airports.	Y	Y	Y			Y			Y	Y	Y		
WP 5.2	H2 Airport Design – Paris Case study	Develop an overall integrated “H2 airport master-planning”	Y		Y	Y	Y		Y				Y		
WP5.3	Green hydrogen production in Malpensa	A PV-Driven Electrolyser will be designed, installed and operated providing green-H2 to local purposes (e.g. buses – WP2 - and operating vehicles (trucks, GSE etc.)	Y		Y	Y	Y						Y		
WP5.4	Using hydrogen in Paris airport	ADP acquires a H2-powered vehicle which will drive both landside and/or airside.	Y		Y	Y						Y	Y		Y

Table 1: OLGA Project identified solutions

			KPIs fields												
SOW ref	**Title**	**Environmental innovation description**	Green House Gases	Air Quality	Energy consump-tion	H2 production / usage	Modal share of low carbon transport	Waste	Natural resources	Biodiversity	Societal impact	Economic impact	Safety	Passenger comfort	Noise level
WP5.5.1	Traceability and Sustainability of SAF	Traceability and sustainability of SAF (e.g. guarantees of origin), using blockchain technology									Y				
WP5.5.2	Use case: Advanced SAF for Olympic Games	Allocation of advanced SAF to AF flights during the opening day of the Paris 2024 Olympics in order to cover 100% of the LTO cycle at CDG for these flights.	Y								Y	Y			
WP5.5.3	Use case: Decarbonized AF flight between CDG and MXP	Allocation of advanced SAF to one AF flight between CDG and MXP, in order to reach the maximum carbon neutral roundtrip possible for that flight.	Y								Y	Y			

2.3 Evaluation Framework

This document provides a description of the proposed KPIs for the OLGA project.

The KPIs are organised as per specific thematic detailed in Section 2.2. Each indicator is identified with a label tag, a name, a description, and a way to measure it. For the purposes of a scoping document, the KPIs are generic, and not associated to a specific activity.

Each proposed KPI is provided with a label tag, a name, a mathematical formulation, a detailed description. If applicable, targets and uncertainty levels are provided. Any numeric value in this document is only a placeholder, as their accurate identification depends on the interaction with the active partner in the particular work package or sub-work package and their inputs provided.

Table 2: Letters used in KPIs calculation formulas

Letters used in formulas	Description
C	Cost
$\boldsymbol{M}$	Mass
N	Number / quantity
Q	Flow
R	Ratio / percentage
V	Volume

3 OLGA Project Key Performance Indicators

The OLGA project will be evaluated in two distinct phases through KPIs.

First, the project will be assessed directly for the end of the project as foreseen by the European Commission's funding. The objective of this first evaluation is to demonstrate the real impact of what has been funded.

The OLGA project will then be evaluated in a medium-term vision. This theoretical evaluation should allow to consider the solutions proposed in the OLGA project as if they were applied more globally to the airport and its environment. WP leaders will have to propose for each solution a possible level of dissemination. The project management will have to make an arbitration when several future solutions are competing. The estimation of the investment cost will necessarily be part of this evaluation.

In all cases, this evaluation will be carried out at iso-perimeter, i.e., with the same passenger flows, the same weather conditions, the same functionalities, etc. The reference year for defining the airport's activity has been set at calendar year 2019, a year in which the activity was not yet affected by the COVID-19 pandemic.

The evaluation of the OLGA project must show concretely the consequences of the choices made in the project while considering the parallel regulatory evolutions. For example, the increase in the share of biofuel for aviation use is imposed by European directives and results in a technical evolution of the aviation fleet that will not be the result of a choice made by the OLGA project for the medium-term vision.

To show OLGA project impact, each WP Project or solution has to supply raw data in order to assess the variation regarding criteria. The template given in the Appendix shall be used for each WP to fill in the data and give the explanation or justification of the origins of these data.

In order to compare or to replicate KPIs for other airports, KPIs will be normalised by:

- number of people who accessed the airport during the year;
- number of flights during the year;
- area of the airport (km2).

Standardisation of KPIs shall be made only with common figures for number of passengers, flights and airport area.

General observation: several KPIs are normalised in respect to the number of airport users. This includes not only the departing/arriving passengers, but also airline crews, airport workers, meet-and-greeters. In absence of better estimations, subcontractors are 30% of the number of airport employees, 25% of this sum being present at the airport at any time; meet-and-greeters can be estimated as 50% of the passengers [1].

3.1 Gaseous Emission KPIs

Gaseous and PM emissions are a major indicator of environmental impact as they reflect the impact of the activity locally with direct release in the air in the area of the project and also at an international level with air pollutants release for equipment design, raw materials preparation.

Direct release to the atmosphere leads to local pollution and also to global warming. For the OLGA project it is possible to assess local pollution and potential global warming impact.

On the basis of project process description, pollutants released into the atmosphere can also be estimated during design and during raw material preparation, but it is not possible to assess local pollution impact.

It is proposed to assess the global warming impact for the whole life cycle of a project through GHG assessment and to assess local impact only for operating lifetime of the project.

3.1.1 GHG KPIs

The attention of public opinion on the problem of the increase of greenhouse gas emissions into the atmosphere has grown strongly in recent years and is likely to continue to grow.

Airports have a variety of sources of GHG emissions that affect the air quality.

For this reason, the use of GHG KPIs could be functional to the activities of many WPs.

As regards the quantification and reporting of greenhouse gases, the main reference standard that can provide useful methodological indications is **ISO 14064-1:2018** "*Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals*".

Further methodological indications can be obtained from the **GHG Protocol**:

- "The Greenhouse Gas Protocol – A Corporate Accounting and Reporting Standard" (Revised Edition).
- "Global Protocol for Community-Scale Greenhouse Gas Inventories", Version 1.1.

Of course, the specific calculation methods valid within the **EU ETS** can also be used.

In International Standards about quantification and reporting of greenhouse gas emissions (e.g., ISO 14064-1:2018, ISO 14067:2018) it is requested that all GHGs must be considered (CO_2, CH_4, N_2O, HFC, PFC, SF_6).

Naturally, the various WPs will be able to select only some of these gases, justifying their choices.

The quantity of each type of GHG shall be converted to tonnes of CO_{2e} using appropriate GWPs. The latest IPCC's GWP shall be used. The GWP time horizon shall be 100 years.

The impact of GHG assessment will afford to show the GHG avoided by the project.

Label	**GHG1**
Name	GHGs
Description	This KPI affords to assess the GHGs production for a solution regarding: • Manufacturing. • Installation of the system. • Use (Fuel consumption, Electricity consumption, etc.). • Maintenance. • Uninstallation. • End-of-life treatment.
Data / Formula	$M_{fuel\ consumption}[kg];\ EF_{components}[kg\text{CO2e /kg of components}]$ **GHG1:** $$\boldsymbol{M_{GHG}\ [kg\text{CO2e}] = \sum (M_{component} \times EF_{components}) + M_{GHG\ Fuel} + M_{GHG\ Elec} + \sum (M_{GHG\ other\ uses})}$$
Methods	In a life cycle approach, the emission contributions related to upstream and downstream emissions arising from fuel generation and fuel transportation/distribution also have to be considered; in ISO 14064-1:2018 these are "Category 3" emissions (Indirect GHG emissions); possible source for these emission factors : ECOINVENT. GHG assessment for fuel and electricity consumptions are given here after.
Usable for	WP4.1

When a solution has only an impact on the energy consumption of a system, focus can directly be made on the fuel or electricity consumption. But if the solution requests also to modify the type of combustion system for example then a full life cycle assessment shall be done for the Project to assess the impact of the changes.

Label	GHG2
Name	GHGs from fuels combustion (means of transport, thermal power plants)
Description	Knowing the fuel consumption, it is possible to calculate the emissions of thermal power plants and of the various types of means of transport (for any period for which consumption data are available). The comparison between the indicators, before and after the implementation of specific actions, allows to quantify the results obtained.
Data / Formula	CO_2 (or CO_{2e}) emissions from fuels, can be also quantified as in EU ETS: $M_{fuel\ consumption}[kg]$; Net Calorific Value $_{fuel}$[kWh $/kg$]; $EF_{components}[kg\text{CO2e}\ /\text{kWh}]$ **GHG2:** $\boldsymbol{M_{GHG\ Elec}\ [kg\text{CO2e}] = \sum\ (M_{fuel\ consumption}\ \times \text{Net Calorific Value}\ _{fuel} \times\ EF_{components}\ )}$
Methods	The standard parameters published by the national authorities of the EU member states can be used for the calculation (year by year). Usually, the ETS emission factors consider only the CO_2 released during the fuel use phase. In ISO 14064-1:2018 these are “Category 1” emissions (Direct GHG emissions). In a life cycle approach, the emission contributions related to upstream emissions arising from fuel generation and fuel transportation/distribution could be also considered; in ISO 14064-1:2018 these are “Category 3” emissions (Indirect GHG emissions); possible source for “upstream” emission factors for fuels: ECOINVENT. Biofuels should be considered as such only if they meet the requirements of the relevant European Regulations.
Usable for	WP2.1, WP2.2, WP2.3.3, WP2.6.2, WP3.1, WP3.2, WP3.3, WP3.7, WP3.8 WP5.1, WP5.2, WP5.3, WP5.4, WP5.5

Label	**GHG3**
Name	GHGs from electricity
Description	• Overall consumption. • Consumption of specific areas. • Consumption of electric vehicles. • Consumption for specific activities (e.g., lighting, heating). Also in this case, the comparison between the indicators, before and after the implementation of specific actions, allows to quantify the results obtained.
Data / Formula	CO_{2e} emissions from electricity, can be quantified using specific emission factors: $P_{electrical\ device}[kWh]; EF_{components}[kg\mathrm{CO2e\ /kWh}]$ **GHG3:** $\boldsymbol{M_{GHG\ Elec}\ [kg\mathrm{CO2e}] = \sum (P_{electrical\ device} \times EF_{components})}$
Methods	Possible authoritative "sources" of emissions factors for electricity: • National Authorities. • International Energy Agency. • Enerdata. Usually, the emission factors consider only the CO_2 released during the electricity generation phase; in ISO 14064-1:2018 these are "Category 2" emissions (Indirect GHG emissions from imported energy); the emission contributions related to the "upstream" phase (emissions due to the construction of the power plant, and emissions allocated to transport and distribution losses) could be also considered (also in this case, possible source of emission factors: ECOINVENT). Requirements about treatment of imported electricity in ISO 14064-1:2018 (Annex E, E.2.1): "*Emissions from imported electricity consumed by the organization shall be quantified by the organization using the location-based approach by applying the emission factor that best characterizes the pertinent grid, i.e. dedicated transmission line, local, regional or national grid-average emission factor. Grid-average emission factors should be from the emissions year being reported, if available, or from the most recent year if not. Grid-average emission factors for imported consumed electricity shall be based on the average consumption mix of the grid from which electricity is consumed*". The use of national grid-average emission factors is probably the most useful choice. Of course, if local, specific, emission factors are available, they can be used.
Usable for	WP4.1 WP5.1

3.1.2 Air pollutants

Air pollution can be assessed in a first and rough approximation by estimating the amount of substances released in gaseous and particulate matter emissions from the various project activities either by using recognised emission factors or by direct measurement of continuous emissions.

A specific focus can be made through KPI AP1.2 on main pollutants with their limit value.

Label	**AP1.1, AP1.2**
Name	Air pollutants emission and weighted variation
Description	The aim of this KPI is to estimate air pollutants emission on a local scale
Data / Formula	$M_i[kg]\ ;\ \boldsymbol{t_i}\ [\mu/m^3]$ $w_i = \frac{1/t_i}{\sum_i 1/t_i}$ $\textbf{AP1.1}: \ \boldsymbol{M}[\boldsymbol{kg}] = \sum_i \boldsymbol{M_i}\ [\boldsymbol{kg}]\ ;$ $\Delta M_{rel} = \frac{M - M_{ref}}{M_{ref}} * 100, [\%]$ $\textbf{AP1.2}: \ I = \sum_i (M_i * w_i)\ , [-];$ $\Delta I_{rel} = \frac{I - I_{ref}}{I_{ref}} * 100, [\%]$
Methods	List of gaseous and PM pollutants (i) emission to investigate is given after the chart. The quantity of each gaseous pollutant M_i is assessed for a full year. $\boldsymbol{I}$ is the index for gaseous pollutant with air quality thresholds $\boldsymbol{t_i}$. $\boldsymbol{I}$ is defined as the sum of these pollutant with air quality reference value ponderation coefficient $\boldsymbol{w_i}$. Gaseous pollutants without European air quality value are not included in this calculation. Air quality is assessed for local area during project lifetime. Gaseous emissions produced during design are not part of this KPI.
Usable for	WP3.3 WP3.5 WP4.1 WP4.2 WP4.4 (n/a for WP4.4.1), WP6

The list of air pollutants to be monitored for air pollution quantity (AP1.1 assessment) is given in the list here under.

- Carbon dioxide (CO_2).
- Sulphur oxides (SO_x).
- Nitrogen oxides (NO_x).
- Particulate Matter (PM10, PM2.5, PM1).
- Carbon monoxide (CO).
- Volatile Organic Compounds (VOC) total carbons.
- Polycyclic Aromatic Hydrocarbons (PAHs).
- Heavy metals (As: Se; Te; Pb; Sb; Cr; Co; Cu; Sn; Mn; Ni; V; Zn; Tl; Cd; Hg).
- Hydrofluoric acid (HF).
- Hydrochloric acid (HCl).
- Ammonia (NH_3).
- Dioxins and furans (PCDD, PCDF).

Table 3: List of specific gaseous pollutants with European reference values for AP1.2 calculation

Pollutant / substance	CAS number	Concentration (µg/m^3)	Reference
PM10	-	40	European limit value
PM2,5	-	20	European limit value
SO_2	7446-09-5	125	European limit value
NOx in $NO_{2\ equiv}$	10102-44-0	40	European limit value
CO	630-08-0	10000	European Maximum value for 8h exposition
Benzene	71-43-2	5	European limit values
PAHs	50-32-8	0,001	European reachable value for benzo(a)pyrene
Arsenic	7440-38-2	0,006	European reachable value
Cadmium	7440-43-9	0,005	European reachable value
Nickel	7440-02-0	0,02	European reachable value
Lead	7439-92-1	0,5	European reachable value

The index for gaseous pollutant I is a dedicated formula for OLGA impact assessment. It shall not be used to determine human health risk assessment.

3.1.4 Local Air Quality

Label	**AQ1, AQ2**
Name	Air pollutants concentration
Description	The aim of this KPI is to estimate local pollutants concentration variations (AQ1: weighted concentration variation, AQ2: number of measures above upper limit) per pollutant with a dedicated focus on NOx.
Data / Formula	$C_{i,j,k}[\mu g/m^3]; \; ; \; t_i \; [\mu/m^3]$ $w_i = \frac{1/t_i}{\sum_i 1/t_i}$ $\boldsymbol{C} = \sum_i \left[\frac{\mathbf{1}}{\boldsymbol{n_m}} \sum_j \left\{ \frac{\mathbf{1}}{\boldsymbol{n_h}} \sum_k \boldsymbol{C_{i,j,k}} \right\} \right] \boldsymbol{w_i}, [\mu g/m^3]$ **AQ1 :** $\Delta C = \frac{C - C_{ref}}{C_{ref}} * 100, [\%]$ $N_h = \frac{1}{n_p} \sum_i \left[\frac{\mathbf{1}}{\boldsymbol{n_m}} \sum_j \left\{ \frac{\mathbf{1}}{\boldsymbol{n_h}} \sum_k \boldsymbol{\Theta} \left(\frac{\boldsymbol{C_{i,j,k}}}{\boldsymbol{l_{i,h}}} - \mathbf{1} \right) \right\} \right] [-];$ **AQ2 :** $\Delta \boldsymbol{N_h} = \frac{\boldsymbol{N_h} - \boldsymbol{N_{h\,ref}}}{\boldsymbol{N_{h\,ref}}} * 100, [\%];$
Methods	List of gaseous pollutants (*i*) emission to investigate for Air Quality KPIs is given after the chart. For each pollutant (*i*), concentration is assessed $\boldsymbol{C_{i,j,k}}$ for each station (*j*) for each hour (*k*). Average concentration $\boldsymbol{C}$ is weighted by the contribution of pollutant limits thresholds according to European limit values given in the chart here after. The weights are normalised the calculation of $\boldsymbol{w_i}$ for each pollutant and $\boldsymbol{n_m}$ the number of measuring stations. N_h is the normalized value to represent the number of hours where the concentration is above limit values $\boldsymbol{l_{i,h}}$ for each pollutant and each measuring stations. Assessment shall be made according existing studies and use the same grid for air emission models. The grid shall be at least 20km wide around the airport and shall cover aircraft landing area (914m high). Impact is assessed for 6 locations according to OACI AQ manual (including a point at the highest concentration point around the project according sanitary impact assessment, near school area for example). Air quality is assessed for local area during project lifetime. Gaseous and PM emissions produced during design are not part of this KPI.

	$C_{i,j,k}$ hourly mean concentration of pollutant i at monitor station j and for the hour of the: • t_i limit value for pollutant i; reported in µg/m3; • year k, reported in µg/m3; • $l_{i,h}$hourly limit value for pollutant i; reported in µg/m3; • $n_p$number of considered pollutants; • n_m number of monitor stations; • n_h number of hours of a year; • Θ(x) is mathematical function which is 1 for x ≥ 0 and 0 otherwise.
Usable for	WP3.3 WP3.5 WP4.1 WP4.2 WP4.4 (n/a for WP4.4.1) WP5.1 WP6

The list of air pollutants to be investigated (direct emissions or modelled emissions) for Air Quality is given in the list here under:

Table 4: List of specific gaseous pollutants with European reference values for AQ1 and AQ2 calculations

Pollutant / substance	CAS number	Limit value t_i (µg/m³)	Hourly Limit value $l_{i,h}$ (µg/m³)
PM10	-	40	50
PM2,5	-	20	25
SO_2	7446-09-5	125	350
NOx in $NO_{2\ equiv}$	10102-44-0	40	200
O3	10028-15-6	120	180

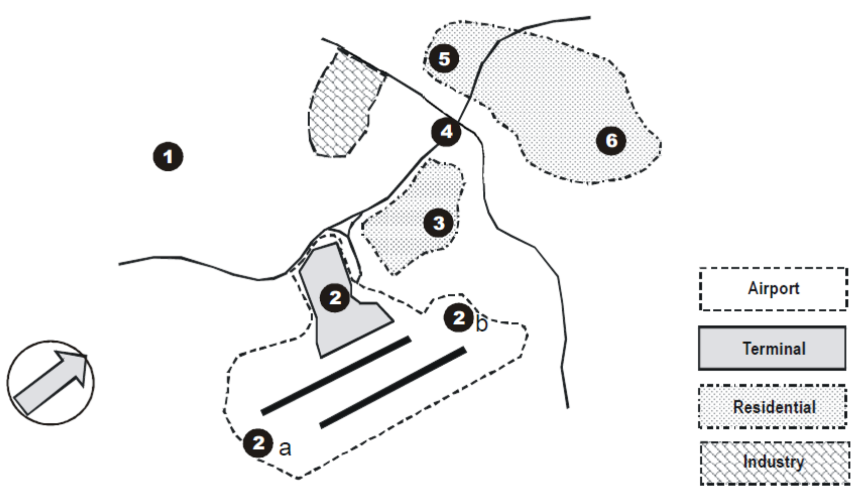

Figure 1: AQ measurement points locations as per OACI recommendations

3.2 ENERGY KPIs

3.2.1 General ENERGY KPIs

One of the main objectives of the OLGA Project is to support the transition to more efficient and less impactful energy models from an environmental point of view.

In relation to the measurement of energy consumptions, the main reference standards that can provide useful methodological indications are the following:

- ISO 50006:2014 "*Energy management systems - Measuring energy performance using energy baselines (EnB) and energy performance indicators (EnPI) - General principles and guidance*".
- ISO 50015:2014 "*Energy management systems - Measurement and verification of energy performance of organizations - General principles and guidance*".
- ISO 50001:2018 "*Energy management systems - Requirements with guidance for use*".

Label	**EN1 and EN1.1 to EN1.10**
Name	Overall Energy KPIs
Description	This type of indicators makes it possible to provide information on the overall “performance” of an airport by auditioning all energy consumption by end user (electrical devices, cars, air-conditioning, etc).
Data / Formula	**EN1 : Total annual consumption by end user (kWh)** $$Q_{energy} = \sum Q_{energies}, [kWh]$$
Methods	Data collection from energy consumption for all Project devices by assessing: • consumption of specific areas (e.g., terminals), that can be normalized by surface (m2), volume (m^3), number of passengers; • consumption of electric vehicles, that can be normalized by km travelled or people transported. Consumption for specific activities (e.g., lighting, heating), that can be normalized by m^2, m^3, number of people, degree days, etc. List of energy type for OLGA project are regrouped as follow (in kWh): • EN1.1 Electricity from renewable energy (wind turbine, solar panel, hydroelectricity, biomass, etc.). • EN1.2 Electricity from fossil energy (natural gas, Gas-Oil, coal). • EN1.3 Electricity from nuclear energy. • EN1.4 Aircraft fuels from fossil origine (Jet A1, etc.). • EN1.5 Aircraft fuels – SAF. • EN1.6 Motor fossil fuels (Gas-Oil, Mogas, LPG, LNG). • EN1.7 Biofuels for vehicles (ethanol, bio CNG, etc.). • EN1.8 Hydrogen from renewable energy (wind turbine, solar panel, hydroelectricity, biomass, etc.). • EN1.9 Hydrogen from fossil energy combustion (natural gas, Gas-Oil, coal). • EN1.10 Hydrogen from nuclear energy. This KPI focus only on operational energy consumption. Specific energy use for regular maintenance or regular operation shall be assessed. Energy used for conception and project dismantling are not part of the KPIs.
Usable for	WP4.1

In order to show the impact on decarbonisation of the project, renewable energies share shall be assessed.

Label	**EN2.1, EN2.2, EN2.3**
Name	Renewable energy shares evolution regarding other energy share
Description	In addition to overall energy consumption KPIs, energies share shall be assessed to assess the evolution of environmentally friendly energy sources uses. Total energy consumption by final user can be split in 3 main categories: • annual consumption from renewable energies ($Q_{renewable}$); • annual consumption from fossil energies (Q_{fossil}); • annual consumption from nuclear power plant origin ($Q_{nuclear}$).
Data / Formula	$Q_{renewable}\ [kWh]; Q_{fossil}\ [kWh]; Q_{nuclear}\ [kWh];$ $Q_{energies}\ [kWh] = Q_{renewable} + Q_{fossil} + Q_{nuclear}$ **EN 2.1:** $\boldsymbol{R_{renewable} = \frac{Q_{renewable}}{Q\ energies} * 100}, [\%]$ **;** **EN 2.2:** $\boldsymbol{R_{nuclear} = \frac{Q_{nuclear}}{Q\ energies} * 100}, [\%]$ **;** **EN 2.2:** $\boldsymbol{R_{fossil} = \frac{Q_{fossil}}{Q\ energies} * 100}, [\%]$ **;**
Methods	List of energy types for OLGA project are regrouped as follow: • Electricity from renewable energy (wind turbine, solar panel, hydroelectricity, biomass, biogas, etc.). • Electricity from fossil energy (natural gas, Gas-Oil, coal). • Electricity from nuclear energy. • Aircraft fuels from fossil fuel (Jet A1, etc.). • Aircraft fuels – SAF. • Motor fossil fuels (Gas-Oil, Mogas, LPG, LNG). • Biofuels for vehicles (ethanol, bio CNG, etc.). • Hydrogen from renewable energy (wind turbine, solar panel, hydroelectricity, biomass, etc.). • Hydrogen from fossil energy combustion (natural gas, Gas-Oil, coal). • Hydrogen from nuclear energy.
Usable for	WP5.3

An interesting KPI is the amount of energy locally produced in order to show the implication of all OLGA actors to reduce the constraints of external factor and monitor in energy production environmental impacts.

Label	**EN3.1 EN3.2**
Name	Local energy production and share of renewable produced energy regarding total renewable energy consumption.
Description	Part of energy that can be produced locally in OLGA perimeter.
Data / Formula	$\mathbf{EN3.1}: Q_{renewable\ produced}\ [kWh]$ **EN 3.2:** $R_{renewable\ produced} = \frac{Q_{renewable\ produced}}{Q\ renewable} * 100, [\%]$;
Methods	List of energy types is the same as used for energy consumption assessment.
Usable for	WP5.3 (EN3.1) - WP5.1[1].

3.2.2 Focus on H_2 KPIS

Hydrogen is highly versatile; it can be used:

1. to produce electricity through a fuel cell;
2. to produce heating blended with other gases;
3. to refuel vehicles.

Hydrogen can be transported through mobile storage to the end-use site.

Hydrogen can also be produced on site through the installation of an electrolyser whose size depends on the end-use site needs.

Different more or less renewable modes of production can be implemented (see § 2.2.1); in case the electricity used to feed the electrolyser derives from solar panels, the hydrogen produced is green.

Hydrogen appears to be an essential vector of energy. As such, two types of indicators can make it possible to monitor the evolution of the use of this means: the amount of hydrogen used in the installations and the number of equipment allowing to use this energy.

As hydrogen is a particularly dangerous product, special precautions must be taken (see § 3.9).

[1] WP5.1 may contribute to this KPI by indicating the biomethane produced by the pilot

Label	**HYD1, HYD2, HYD3**
Name	H_2 production (in absolute and relative terms).
Description	These indicators make it possible to quantify the project ability to self-produce the hydrogen necessary to meet its needs.
Data / Formula	**HYD 1: H_2 production [t /year].** **HYD 2: H_2 consumption [t /year].** **HYD 3: H2 self-production ratio [%]: H_2 production [t /year] vs H_2 consumption [t /year].**
Methods	---
Usable for	WP 5.2, WP5.3 (HYD 1, HYD 2), WP 5.4.

Label	**HYD4, HYD5**
Name	H_2 uses inside airport perimeter.
Description	These indicators make it possible to quantify the number of sectors of use among airport services and the number of kind of devices.
Data / Formula	HYD4: H2 sector usage ratio = N sectors where H2 can be used vs N sectors eligible ones. HYD5: H2 Number of H2 devices inside airport.
Methods	The number of sectors can be determined according to airport activities. Number of devices will be determined only in airport perimeter.
Usable for	WP 5.2, WP5.3, WP 5.4

3.3 NATURAL RESOURCE CONSUMPTION KPI

3.3.1 Land transformation KPI

Some solutions have a direct impact on soil quality when using direct soil resources. Other solutions have an indirect impact when using natural resources during conception or raw material preparations.

Soil transformation must be studied for solutions having a direct impact on the soil, but also for solutions using in their process raw materials using agricultural resources or potentially agricultural land for industrial purposes, especially for SAF production.

Label	NR1
Name	Land transformation.
Description	Assess land transformation through soil carbon flow assessment (in kg SOM ha^{-1}).
Data / Formula	NR1: $\boldsymbol{SOM}\ \left[\frac{kg}{ha}\right]$; $\Delta SOM_{rel} = \frac{SOM - SOM_{ref}}{SOM_{ref}} * 100, [\%]$
Methods	The Soil Organic Matter (SOM) model is used through a life cycle assessment of the project in order to consider the impact on land transformation of the natural resources used for conception and raw products preparation. The indicator gives a mass equivalent of organic carbon.
Usable for	WP

3.3.2 Water KPI

The Earth's water resource is an unequally distributed and unequally managed resource.

The water consumption of each project must be studied to demonstrate that water use does not worsen the local situation.

Each project should therefore consider its impact on water consumption both during its operational life and in the design and preparation of the raw materials required for operation.

The results can be analysed in the light of the regulations and locally available information on water consumption and discharge patterns.

Label	NR2
Name	Water consumption
Description	Fresh water consumption assessment used for conception and Project lifetime
Data / Formula	NR2: $\boldsymbol{V}\ [\boldsymbol{m^3}]$; $\Delta V = \frac{V - V_{ref}}{V_{ref}} * 100, [\%]$
Methods	The methodology consists of the study of the project water consumption through a life cycle assessment to take into account water use for design, process water, raw product preparation, project maintenance (cleaning water) and wastewater flows, on a yearly basis in order to take into account Project/ product lifetime.
Usable for	WP5.2

3.3.3 Fossil mineral resources KPI

In order to analyse the impacts on fossil mineral resources, the antimony equivalent is used. All projects using precious metals and rare earths must analyse their project according to this criterion to ensure the lowest environmental footprint.

Although these products are essential to economic activity due to their particular chemical and mechanical properties, their use should be as moderate as possible.

Indeed, the issues linked to the use of such products are both local for reasons of pollution in the absence of recycling channels, but also international with regard to extraction channels which are both energy consuming for extraction, but above all they are dramatic for the degradation of environmental matrices.

Antimony is a resource considered exhaustible to the human scale and has a value of 1 by convention. A value greater than 1 for a resource indicates that one consumes a resource rarer than antimony.

Products that contain the following elements have to be part of Antimony equivalent assessment: Al; Sb; As; Ba; Be; Bi; B; Br; Cd; Cl; Cr; Co; Cu; Ga; Ge; Au; In; I; Fe; K; Pb; Li; Mg; Mn; Hg; Mo; Ni; Nb; Pd; P; Pt; Re; Se; Si; Ag; Na; Sr; S; Ta; Te; Tl; Sn; Ti; W; U; V; Y; Zn; Zr.

These elements can be found in batteries, LED, permanent magnets, photovoltaic panels, fuel cells, etc.

Label	**NR3**
Name	Resource depletion – mineral fossil (kg antimony (Sb) equivalent).
Description	Mineral fossil products consumption is assessed by using the antimony (Sb) equivalent (kg).
Data / Formula	$W_{Sb\ eq}\ [kg/year];\ \ \Delta W_{Sb\ eq\ rel} = \frac{W_{Sb\ eq} - W_{Sb\ eq\ ref}}{W_{Sb\ eq\ ref}} * 100, [\%]$
Methods	A life cycle assessment of the project affords to identify the fossil product used in the project design and lifetime and determine the Sb equivalent on a yearly basis in order to take into account Project/ product lifetime.
Usable for	WP2.5, WP2.6.1

3.4 BIODIVERSITY KPI

Biodiversity is an essential element for the protection of the environment, since it contributes through these exchange networks to carbon sequestration in a sustainable way. Photosynthesis affords to trap large quantity of carbon in plants and trees, but these plants could not develop, feed and reproduce without the entire surrounding ecosystem contributing to their prosperity.

Two kinds of KPIs can be studied: KPIs regarding fauna and KPIs regarding plants.

Label	**BD1, BD2, BD3**
Name	Fauna endemic species and number of individuals.
Description	This indicator affords to assess the impact of the project on the number of fauna species and on the number of individuals.
Data / Formula	**BD 1:** $\boldsymbol{N_{fauna\ species}}$; $$\Delta N_{fauna\ species} = \frac{N_{fauna\ species} - N_{fauna\ \ species\ ref}}{N_{fauna\ species\ ref}} * 100$$ **BD2:** $\boldsymbol{N_{fauna\ endemic\ species}}$; $$\Delta N_{fauna\ endemic\ species} = \frac{N_{fauna\ endemic\ species} - N_{fauna\ endemic\ species\ ref}}{N_{fauna\ endemic\ species\ ref}} * 100$$ **BD3:** $\boldsymbol{N_{fauna\ individuals}}$; $$\Delta N_{fauna\ individuals} = \frac{N_{fauna\ individuals} - N_{fauna\ individuals}}{N_{fauna\ individuals}} * 100$$
Methods	Site counting affords to identify fauna species and quantify individuals.
Usable for	WP4.1.5 WP4.2 WP4.3

Label	**BD4, BD5, BD6**
Name	Flora endemic species and surface of individuals.
Description	This indicator affords to assess the impact of the project on the number of flora species and on the surface of individuals.
Data / Formula	**BD4:** $\boldsymbol{N_{flora\ species}}\ [-];$ $\Delta N_{flora\ species} = \frac{N_{flora\ species} - N_{flora\ species\ ref}}{N_{flora\ species\ ref}} * 100, [\%]$ **BD5:** $\boldsymbol{N_{flora\ endemic\ species}}\ [-];$ $\Delta N_{flora\ endemic\ species} = \frac{N_{flora\ endemic\ species} - N_{flora\ endemic\ species\ ref}}{N_{flora\ endemic\ species\ ref}} * 100, [\%]$ **BD6:** $\boldsymbol{S_{flora}}\ [\boldsymbol{m^2}]\ ;$ $\Delta S_{flora} = \frac{S_{flora} - S_{flora\ ref}}{S_{flora\ ref}} * 100, [\%]$
Methods	Site counting affords to identify flora species and quantify individuals.
Usable for	WP4.1.5 WP4.2 WP4.3

3.5 WASTE KPIs

3.5.1 WASTE quantity KPIs

Reduction of waste and its management is a pillar of projects focusing on circular economic and environmental awareness, despite its more recent introduction in evaluation frameworks. Its reduction leads to lower environmental impact and less costs. OLGA considers waste to monitor actions related to infrastructure development, resources consumption, and waste produced by airport utilisation.

As gaseous emissions impacts are already monitored in emissions KPIS (see § 3.1), they are not reassessed here. Wastes KPIs focus only on solid and liquid wastes.

Label	**WA1**
Name	Total quantity of waste
Description	Assessment of the amount of waste induced by a Project. This can refer to the material disposed during the design or construction or removal of a Project (W_{design}, or to the waste produced by the project during its lifetime normalised over the lifetime of the project ($W_{operational}$, or to the total of the two (WA1)
Data / Formula	$W_{design}[kg]; W_{opertional\ wastes}\ [kg];$ **WA1:** $\boldsymbol{W = W_{design} + W_{opertional\ wastes}\ [kg]};$ $\Delta W_{rel} = \frac{W - W_{ref}}{W_{ref,}} * 100, [\%]$
Methods	W_{design} is tracked from the log of material disposed form the life cycle assessment of the project. Similarly, the operational waste. All quantities are benchmarked against a reference scenario.
Usable for	WP3.3 WP3.5 WP4.1 WP4.2 WP4.4 (n/a for WP4.4.1) WP5.1

Label	**WA2, WA3**
Name	Quantity (WA2) and ratio (WA3) of hazardous wastes during operation.
Description	The operational waste produced during Project lifetime can be split between hazardous waste ($W_{hazardous\ wastes}$- WA2.1) and non-hazardous ($W_{non\ hazardous\ wastes}$ - WA2.2). Quantity and ratio of hazardous operational wastes can be monitored.
Data / Formula	**WA2:** $\boldsymbol{W_{hazardous\ wastes}[kg]};$ $W_{non\ hazardous\ wastes}\ [kg];$ $W_{opertional\ wastes} = W_{hazardous\ wastes} + W_{non\ hazardous\ wastes}\ [kg];$ **WA3:** $\boldsymbol{R_{hazardous\ wastes} = \frac{W_{hazardous\ wastes}}{W_{opertional\ wastes}} * 100}, [\%]$ $\Delta W_{rel} = \frac{W_{hazardous\ wastes} - W_{ref}}{W_{ref,}} * 100, [\%]$
Methods	Hazardous wastes are identified according to waste tracking forms and European Wastes list. The KPI is against expressed as fractional variation. Operational wastes are defined as the waste during project lifetime. Wastes from raw material involve in daily or regular consumption shall be assessed. Wastes produced during design are not part of this KPI.
Usable for	WP3.3 WP3.5 WP4.1 WP4.2 WP4.4 (n/a for WP4.4.1)

3.5.2 Recycled wastes KPIs

Airport activities generate wastes that need to be treated by giving priority:

- preparation for reuse;
- recycling and recovery of organic waste by returning it to the soil;
- any other recovery, in particular energy recovery;
- elimination.

Recycling can be defined according to the level of degradation of the material. Two types of recycling can be distinguished:

- closed-loop recycling: use of the recycling raw materials for an identical use and destination without functional loss of the material: recycling of a PET bottle into a PET bottle, recycling of container glass into container glass, recycling of road mix into the manufacture of new mix, etc.
- open-loop recycling: use of the recycled material for a different purpose, but as a substitute for a virgin raw material: recycling of a PET bottle into fleece, recycling of paper into insulation products, etc.

Recycled wastes are considered for OLGA project as the wastes or the fraction of waste that are not sent to landfill or to incinerator.

Label	WA4
Name	Fraction of recycled waste
Description	Capability of a Project / solution to recycle the material (sum of paper, plastics/aluminium, paper, biodegradable items, hydraulic oils, etc), and minimise the material destined to landfill ($W_{landfill}$) and incinerator ($W_{incinerated\ wastes}$).
Data / Formula	$W_{plastics}[kg]; W_{paper}[kg]; W_{wood}[kg]; W_{glass}[kg]; W_{metal}\ [kg]; W_{inert\ construction\ wastes}\ [kg];$ $W_{landfill}\ [kg];\ W_{incinerated\ wastes}\ [kg];$ $$W_{wastes} = \sum W_{plastics} + W_{paper} + W_{wood} + W_{glass} + W_{metal} + W_{landfill} + W_{incinerated\ wastes} + \cdots$$ **WA4:** $$\boldsymbol{R_{recyclable\ waste}} = \left(\mathbf{1} - \frac{\boldsymbol{W_{landfill}} + W_{incinerated\ wastes}}{\boldsymbol{W_{wastes}}}\right) * \mathbf{100}\ [\%]$$ $$\Delta R_{rel} = \frac{R_{recyclable} - R_{recyclable,ref}}{R_{recyclable,ref}} * 100, [\%]$$
Methods	The recycled waste rate is measured over a sampling period (for example 1 year) for reporting only for lifetime of the project or the solution. Recycling can generate a fraction of product that will be sent to landfill or incinerator. This fraction shall be assessed.
Usable for	WP4.1, WP4.2 WP4.4 WP5.1

3.5.3 WASTE management KPIs

For OLGA project a dedicated KPI has to be assessed regarding Waste Management Passenger information.

Label	WA5
Name	User information on waste management.
Description	Number of airport users that receive information on recycling options available within the airport (terminal aera) following initiatives on waste management.
Data / Formula	**WA5:** $\boldsymbol{N_{user}}$ $$\Delta N_{user,rel} = \frac{N_{user} - N_{user,ref}}{N_{user,ref,}} * 100, [\%]$$
Methods	The KPI is estimated considering of the number of informative boards, either fixed (posters and labels near or above the bins) or electronics (advertisements on screens), plus the number of events organised by and within the airports on waste management. The number of visualisations is obtained by multiplying these by an estimation of the audience reached (equal to passengers as first-order approximation) over a reference time period. The number of initiatives to showcase waste management includes events at the airport or advertising campaigns on waste/environmental sustainability.
Usable for	WP4.4.2 WP5.1

3.6 SOCIETAL IMPACT KPIs

Societal aspects involve the public perception of OLGA Project, particularly for the people who frequently work or live around airports. Societal KPIs are related with landside transportation, upgrade of infrastructure.

Some of the identified KPIs may suffer from lower accuracy, as they measure factors that are difficult to assess objectively (example: anything related to customer satisfaction, as interviews are not planned).

Label	**SOC1**
Name	Job creation
Description	Number of jobs created following the implementation of OLGA measures, considering direct and indirect jobs, e.g., supply chain and subsidiaries). Both absolute number and number per year can be calculated.
Data / Formula	$N_{direct\ jobs}[-]$; $N_{indirect\ jobs}[-]$; **SOC1:** $\boldsymbol{N_{jobs}}[-] = \boldsymbol{N_{indirect\ jobs}} + \boldsymbol{N_{direct\ jobs}}$
Methods	The number can be derived from annual reports of airports, see [2,3]. The number is inclusive of subcontractors and external companies related to OLGA (e.g., delivery services for WP2, subcontractors of hydrogen network and other supply chain stakeholder). Number of working hours created can be used to assess job creation regarding local legal working time.
Usable for	WP2.3.2 WP2.6.2 WP5.1

Label	**SOC2**
Name	Social attractiveness of airports.
Description	Number of people who reach the airport for purposes related to other than travelling.
Data / Formula	$N_{ev}[-]$, **SOC2:** $\boldsymbol{N_{att}} = \frac{\sum N_{ev} * \boldsymbol{people_i}}{\boldsymbol{time}} [\boldsymbol{1/year}]$
Methods	The number of events per year (N_{ev}) can be used to assess the attendance (N_{att}) for people coming to the airport for other purpose than travelling. Consultation with airports to decide which one to use according to suitability. People commuting to airports for work (crews, air traffic controllers, regular airport workers, sellers, etc.) are not considered in this KPI. Use of aggregate telecom data allow to measure the time that people spend at airports and estimate their purpose.
Usable for	WP2.2 WP5.5 - if acceptance of SAF or H_2 is a concern, WP2.3, WP6.1 WP6.4

Label	**SOC3**
Name	Traffic around airport.
Description	Vehicles circulating around (entering/existing) the airport, on an hourly basis.
Data / Formula	$$NV[-/hour];\ \Delta nv = \frac{NV_{meas} - NV_{ref}}{NV_{ref}}[-];$$
Methods	Recording of vehicles can be performed at the airport barriers, or by an array of cameras located along the main roads accessing the airports for data collection. The assessment considers both public and private vehicles. Measures of traffic mostly relies on aggregate GPS tracking (where available), cameras, traffic sensors or log of departure/arrival of selected "representative" routes.
Usable for	WP2.1 WP2.2

3.7 ECONOMIC IMPACT KPIS

Economic impact is the most essential indicator to measure the performance of any project or activity. Therefore, it seems easily measurable. Economic aspects are faced in both airside and landside transportation, and when alternative energy sources and the development of their supply chain are considered. OLGA focuses more on the costs associated with the proposed environmental measures, rather than profits.

Label	**EC1**
Name	Direct cost.
Description	Quantification of the cost of the implementation of a given measure.
Data / Formula	ECO1: C_{meas} [€] $$\Delta C = \frac{C_{meas} - C_{fore}}{C_{fore}}[-]$$
Methods	Costs are monitored in the financial reporting of certain actions. The indicator applies to maintenance costs, projected dismantling costs etc., where available. Costs are measured over a defined time frame. The actual cost is normalised against the forecasted one.
Usable for	WP2, WP2.1, WP2.3.2, WP2.3.3, WP2.6.2, WP3, WP5.1, WP5.5, WP5.4,

Label	**EC2**
Name	Generated revenues.
Description	Where available, the revenues associated to an innovation measure are calculated. An example is the profitability of a new service. The revenues can be absolute (EC3.1) or specific to the number of passenger or the cargo weight-distance (EC3.2), according to the particular project action.
Data / Formula	EC2: $Rev\ [€]$ $\Delta Rev = \frac{Rev - Rev_{pre}}{Rev_{pre}}\ [-]$
Methods	The revenues are calculated over a period of time (e.g., a yearly basis). Those indicators do not account for other types of benefit – such as the CO2 reduction or a shorter duration of a process. These are calculated under different thematic areas and can be converted into economic figures if conversion factors are provided. Such factors are often empirical and situation specific.
Usable for	WP2, WP2.1, WP 2.6.2, WP3, WP5.5,

Label	**EC3.1 EC3.2**
Name	User-specific cost
Description	This indicator considers the specific cost of a measure for the end user. Those include cost of a journey per km or per fare (EC2.1 for passenger transport), and the cost per kg and km for cargo (EC2.2). The indicator is compared to traditional alternatives.
Data / Formula	EC3.1 $(PAX):\ C_{spec} = \frac{C}{pax}\left[\frac{€}{pax}\right]$ EC3.2 $(Cargo):\ C_{spec} = \frac{C}{dist*time}\left[\frac{€}{km*kg}\right]$ $\Delta C = \frac{C_{spec} - C_{pre}}{C_{pre}}\ [-]$
Methods	For measures destined to passenger transport, this can be easily considered equal to the ticket price. In alternative, the costs of the company that provides the service can be considered.
Usable for	WP2.6.2, MS7.1, MS7.2

3.8 MODAL SHARE OF LOW CARBON TRANSPORT KPIS

This category of KPIs is relevant to monitor the development of alternative form of transportation, which contribute to the satisfaction of the green targets of the project. Intermodal low carbon transportation addresses activities related to landside transport and to the use of vehicles with alternative energy (hydrogen, electricity, biofuels).

Label	**MS1.1 MS1.2**
Name	Extension of multimodal transport network.
Description	A larger and ramified network area is beneficial for users as they can reach one destination, reduce their travel time, and have more choices of movement: Two key indicators are found: the extension of the network (MS1.1) and its maximum capacity (MS1.2).
Data / Formula	MS1.1: $Ext = Length[km]$; MS1.2: $Cap_{max} = N_{vehicles,max} * Cap_{vehicle} \; [\frac{pax}{h}]$
Methods	The linear length is a reliable quantity to measure the size of a transport network, as the area it insists on can be limited by geographical factors or the size of the airport considered. It is simply obtained from direct measurements (even from online sources). The maximum capacity (MS2.2) depends on the vehicles active at the same time and can be retrieved from information from network operators or direct observation.
Usable for	WP2.1 WP2.2 WP2.4 WP2.6.1

Label	**MS2**
Name	Density of link of multimodal transport network.
Description	Indicates the density of link of a public transport network.
Data / Formula	MS2: $\rho_A = \frac{N_{links}}{Area} \; [1/km^2]$
Methods	The density is assessed according identified multi-modal links. Directly related to MS1.
Usable for	WP2.4 WP2.6.1

Label	MS3.1 MS3.2
Name	Use of multimodal network for public (M2.1) and cargo (MS2.2) transport.
Description	Quantitative use of the multimodal transport network. The KPI measures either the number of passengers or the mass of transported cargo. High values of the indicator correspond to a good use of the transport network.
Data / Formula	$\text{MS 3.1}:\ N_{multimodal\ pax}\left[\frac{pax}{year}\right];$ MS3.2: $N_{multimodal\ cargo}\ [kg/year]$
Methods	Passenger use (MS3.1) can be defined from the local transport companies or estimated if such information is not available. Cargo use (MS3.2) can be calculated from deliver companies or direct monitoring. A 1-year period is chosen as time frame.
Usable for	WP2.1, WP2.3, WP2.6.2, WP3.3

Label	MS4.1 MS4.2
Name	Modal share of transport (passenger/cargo).
Description	Ratio indicator of the km travelled per mean of transport. Two indicators consider the passenger and cargo movement, respectively.
Data / Formula	$R_{pax,i} = \frac{pax * km_i}{pax * km_{tot}} * 100[\%];\ R_{cargo,i} = \frac{kg * km_i}{kg * km_{tot}} * 100[\%]$
Methods	The cumulative sum of all the fractions is 1. The data are gathered considering the mileage per year of each selected mean of transport, times the yearly number of passenger (MS4.1) or amount of cargo (MS4.2) that they carry. While the calculation is relatively easy for trains/trams/buses, trucks or smaller vehicles will likely rely on estimations.
Usable for	WP2.1, WP2.4, WP2.5, WP5.2 (Only for MS4.1)

Label	**MS5**
Name	Loading factor.
Description	Percentage of the occupied capacity (K) relative to the maximum for a mean of transport. Indicates how much low carbon transportation systems is effective in fulfilling their purpose. High LF correspond to lower emissions, and cost.
Data / Formula	$$LF = \frac{K}{K_{max}} * 100[\%];$$
Methods	The indicator is applicable to both a cargo and a passenger service. K_{max} is calculated from the number of vehicles deployed for an action time their nominal capacity. For cargo, K is derived from the log of the material transported, with the indication of weight or volume provided. Alternatively, passenger transports calculate K as the actual number of customer (or its estimate).
Usable for	WP2.4 WP2.6.1

Label	**MS6.1 MS6.2**
Name	Use of vehicles with alternative energy source.
Description	Indication of the percentage ($pctee$) of vehicles powered by alternative energy sources (NVE_{alt}) totally or partially, compared to the total number of vehicles (NVE_{tot}). Alternative energy sources include electricity, hydrogen, biofuels (MS6.1). The distance covered by these vehicles over a year ($sumdst$ MS6.2) express the extent to which these vehicles are used. It sums the total distance travelled be all the vehicles using alternative energy sources and can be related to the reduction in CO2 and other pollutants. The effective use of such energy sources for hybrid vehicles is difficult to monitor, therefore it is not accounted for.
Data / Formula	$$MS6.1 : \ pctee = \frac{NVE_{alt}}{NVE_{tot}} * 100[\%],$$ $$MS6.2 : \ sumdst = \frac{\sum_{i=1}^{modes} N_{trips,i} * dist_i}{time} * 100[km/year]$$
Methods	MS4.1: Information obtained from consultation of inventory of airports (airside) or local transport companies (landside) – via personal communication, press release, schedules, etc. MS4.2: use of schedules or GPS/log monitoring.
Usable for	WP2.5 WP3.7 WP5.3

Label	**MS7.1 MS7.2**
Name	Average (MS7.1) and variance speed (MS7.2) of journey.
Description	Quantifies the effectiveness in moving people or cargo in a timely manner. The KPI is evaluated on a series of pre-defined trips or scenarios, defined by the relevant project partners.
Data / Formula	$\text{MS7.1}: V_{avg}\left[\frac{km}{h}\right];$ MS7.2: $\sigma \quad [km/h]$
Methods	Recording of a series of journeys for the transport method under examination (via monitoring of arrival/departure time or GPS logs). The data are elaborated though the use of statistic to provide an estimation (and margins of uncertainty) as close as possible to reality. Relative change of the average velocity against the pre-OLGA scenario is considered for the KPI.
Usable for	WP2.4, WP2.6.1

Label	**MS8**
Name	Reliability of public transport.
Description	Indicates the reliability of a public transport network; ratio of trips arriving and departing within a tolerance (in minutes) on their scheduled time.
Data / Formula	MS8: $rel = \frac{N_{punct}}{N_{tot}}\ [-]$
Methods	The tolerance is defined a priori according to the mean of transport and the journey. GPS monitoring of public transport vehicles or a departure/arrival log can be used for the assessment. To reduce the data to analyse, selected routes can be chosen for monitoring.
Usable for	WP2.4 WP2.6.1

3.9 SAFETY KPIS

Maintaining an acceptable aviation safety performance is a prerequisite to any change happening in an airport and having an impact airside. It is regulated under European Regulation N° 139/2014 (Annex III – ADR.OR.D.005).

As an employer and as a public access building, airport management should also consider the exposure to specific hazards of any person using the airport or in the surrounding of the airport. In particular, for the use of hydrogen, jet fuel, diesel, etc. present at the airport may be affected by OLGA project.

Label	**SAF1**
Name	Variation in aviation safety risks.
Description	*The scope of this KPI is limited to WP with airside impacts and limited to the hazards under the responsibility of the airport.* *Risks are evaluated in terms of probability of unwanted events and severity of potential consequences.* *The values are defined based on the risk matrix defined by the airport within its safety management system (SMS). Each category of probability and severity is ranked on a linear scale (usually from 1 to 5).* *Reference probability and severity are considered pre-implementation of WP, and residual probability post implementation of WP and associated risk mitigation measures.*
Data / Formula	SAF1: $$Risk\ variation = \sum_i Ref\ Probability_i \times Ref\ Severity_i - \sum_i Residual\ Probability_i \times Residual\ Severity_i$$
Methods	*The risks considered are those related to occurrences listed in implementing regulation (UE) n°2015/1018 annex IV, especially:* • *Wildlife strike including bird strike (WP 3.5, 3.7).* • *Taxiway or runway excursion (WP 3.7).* • *Actual or potential taxiway or runway incursion (WP3.7, 3.8).* • *Aircraft or vehicle failure to follow clearance, instruction or restriction while operating on the movement area of an aerodrome (WP 3.7, 3.8).* • *Foreign object on the aerodrome movement area which has or could have endangered the aircraft, its occupants or any other person. (WP3.5).* • *Push-back, power-back or taxi interference by vehicle, equipment or person (WP3.5).* • *Significant failure, malfunction or defect of aerodrome equipment or system which has or could have endangered the aircraft or its occupants. (all WP3).* • *Significant deficiencies in aerodrome lighting, marking or signs (WP4.?).*

	• *Fire, smoke, explosions in aerodrome facilities, vicinities and equipment which has or could have endangered the aircraft, its occupants or any other person (WP 3.3, all WP5).* • *Significant spillage during fueling operations (WP 3.5).* • *Failure, malfunction or defect of ground equipment used for ground handling, resulting into damage or potential damage to the aircraft (for example: tow bar or GPU (Ground Power Unit)). (all WP3).* *The changes implemented can either increase/decrease the exposure to certain hazards leading to the above-listed events or increase/decrease the escalation of consequences should one of these occurrences happen.* *Each WP should evaluate scenarios that could lead to these events and assess impact in probability of occurrences as per the safety risk matrix defined by the airport Safety Management System.*
Usable for	All WP3, WP4, WP5.5

Label	**SAF2.1, SAF2.2, SAF2.3**
Name	Quantity of dangerous goods (flammable gas, flammable liquid, combustible products).
Description	*The scope of this KPI is to defined main hazardous substances quantities that are possible to be stored in normal operation considering directive 2012/18/EU on the control of major-accident hazards involving dangerous substances.*
Data / Formula	$SAF2.1\colon\ Q_{flammable\ gas}\ [\,t]$ $SAF2.2\colon\ Q_{flammable\ liquids}\ [\,t]$ $SAF2.3:\ \ Q_{combustible\ products}\ [\,t]$
Methods	Material Safety Data Sheets are used to define in which categories are regrouped the different substances according to Classification, Labelling and Packaging Directive classification (Rule CE n°1272/2008). The assessment is limited to 3 categories: • flammable gas: H220 and H221, such as hydrogen, LPG, LNG. • flammable liquid, H224, H225, H226 such as aircraft fuel, gasoline, gasoil. • combustible product: other products that can burn (wood, plastics, liquid hydrocarbons with flash-point above 60°C, etc…). Incombustible products (glass, sand, concrete, steel, etc) and fire-resistant products do not need to be assessed.
Usable for	All WP5

Label	**SAF3**
Name	Seveso threshold for airport area
Description	*The scope of this KPI is to defined Seveso level considering directive 2012/18/EU on the control of major-accident hazards involving dangerous substances.* *This directive segregates lower-tier establishments and upper-tier establishments based on quantity of dangerous substance and associated limits.*
Data / Formula	**SAF3: Seveso level regarding** $q_L = \frac{q_{H2}}{Q_{L,H2}} + \frac{q_{Fuel}}{Q_{L,Fuel}}$ **and** $q_H = \frac{q_{H2}}{Q_{H,H2}} + \frac{q_{Fuel}}{Q_{H,Fuel}}$ **criteria**
Methods	*The dangerous substance categories to be evaluated as part of OLGA project are:* • *Product (Lower-tier req. / Upper-tier req.).* • *Hydrogen (5t / 50t).* • *Petroleum products and alternative fuels (2500t / 25000t).*
Usable for	WP5.5

Label	**SAF4**
Name	Number of new potential major accidental scenarios
Description	*Accidental scenarios are defined according to major risks analysis made for operating permit authorisation.*
Data / Formula	**SAF4:** $N_{Major\ accidental\ scenarios}$
Methods	Major accident scenarios are defined in Seveso Directive (2012/18/EU) as the events involving one or more dangerous substances that can at least lead to people injuries with irreversible effects outside installation boundary limits. An accidental scenario can lead to thermal effects, blast effect and/ or toxic effects. Dedicated software shall be used to assess consequences analysis.
Usable for	WP5.1, WP5.5

Label	**SAF5.1, SAF 5.2**
Name	Individual Risk Per Annum (IRPA) for passengers and workers.
Description	*IRPA level assessment for passenger / worker that can be located in passenger areas / workers areas regarding consequences that these areas and regarding likelihood.*
Data / Formula	**SAF5.1:** $\boldsymbol{IRPA_{Passenger}}\ [\mathbf{1}/\boldsymbol{year}]$ **SAF5.2:** $\boldsymbol{IRPA_{Worker}}\ [\mathbf{1}/\boldsymbol{year}]$
Methods	IRPA is determined through very fine risk analysis and consequences analysis regarding population locations and likelihood assessment of major events to occur. Dedicated software shall be used to assess consequences analysis. Internationally recognized databases shall be used for likelihood assessment (OREDA, TNO, HSE UK, etc).
Usable for	WP5.1, WP5.5

It is also important that innovative solutions have as little impact as possible on human health throughout the creation, use and end of life of the innovative solution.

To assess this impact throughout the whole life of an innovative solution, as per European commission recommendation 2013/179/EU, the Human Toxicity Assessment methodology should be used in a life cycle analysis of the innovative solution.

Label	**SAF6**
Name	Human Toxicity - cancer effects.
Description	Assess impact on human health leading to cancer effects (in Comparative Toxic Unit for humans, CTUh).
Data / Formula	**SAF6:** $\boldsymbol{HumTox}\ [\boldsymbol{CTUh}]$; $\Delta \boldsymbol{HumTox_{rel}} = \frac{\boldsymbol{HumTox} - \boldsymbol{HumTox_{ref}}}{\boldsymbol{HumTox_{ref}}} * 100, [\%]$
Methods	The effects on human health shall be assessed through a life cycle assessment of the project in order to consider the impact on human toxicity with ECOINVENT use.
Usable for	WP 4.2.2

3.10 PASSENGER COMFORT / AIRPORT SERVICE QUALITY KPIS

Quality of airport service is to be evaluated from the point of view of the two main users of the airports: passengers and airlines.

Label	**ASQ1**
Name	Rate of delayed flights.
Description	*This KPI has for goal to assess the impact of the project on the number of delayed flights regarding the reliability of the implemented solutions.*
Data / Formula	$N_{flights}\,[-]; N_{delayed\ flights}\,[-];$ **ASQ1:** $\boldsymbol{R_{delayed\ fligths}} = \frac{N_{delayed\ flights}}{N_{flights}} * \mathbf{100}, [\%]$;
Methods	Flights with more than 15 minutes delay have to be considered as “delayed flights”. Each solution to improve environmental impact of Airport have to ensure that redundancy of equipment and procedures have been identified not to impact passenger travel. Reliability rate of aircraft stands equipment can be used to demonstrate equipment impact on flight status with event tree analysis. Equipment reliability is given by supplier data or can be assess through European standards EN 61703.
Usable for	WP2, WP3, WP4.1

Label	**ASQ2**
Name	Score ACI ASQ Survey.
Description	*ACI World’s Airport Service Quality (ASQ) program provides ACI member airports with tools to measure passenger satisfaction, business performance, and airport service quality.*
Data / Formula	**ASQ2:** $N_{ACI\ score}$ *[-]*
Methods	Average score to questions 1 (on a five-point scale) regarding transport to/from airport.
Usable for	WP2, WP3, WP4.1

Label	ASQ3
Name	Average space per passenger (m2/passenger).
Description	*This KPIs affords to assess the impact of a solution regarding passenger space comfort.*
Data / Formula	$N_{passengers}\ [pass]; S\ [\boldsymbol{m^2}]$ ASQ3: $\boldsymbol{R_{comfort\ space}}\ [\boldsymbol{pass/m^2}\ -] = \frac{N_{passenger}}{S}$;
Methods	Number of passengers has to be assessed for nominal design of the building or the area where passengers can be present. The surface S is the utile surface of the building or the area where passengers can be present in a normal use of the space. Exceptional conditions shall not be assessed (flight delayed, strikes, extreme natural conditions, etc.).
Usable for	WP2, WP3, WP4.1

Keeping a comfort temperature regarding external variations generates energy consumption. A bias in environmental impact assessment would be to assess energy consumption without taking into account variations of comfort temperature for passenger.

Label	ASQ4
Name	Average temperature inside buildings or transport means.
Description	*ASQ4 is the average temperature regarding each nominal temperature at each step of passenger travel.*
Data / Formula	$T_i : T_{building}\ , T_{transport}\ [°C];$ $t_i : t_{building}\ , t_{transport}\ [h];\ t_{passenger\ travel}\ \ [h];$ ASQ4: $\boldsymbol{T_{average}} = \sum_i \frac{\boldsymbol{T_i}}{\left(\frac{\boldsymbol{t_i}}{t_{passenger\ travel}}\right)}\ [°\boldsymbol{C}]$
Methods	The average temperature is determined by using the ratio of the time $\boldsymbol{t_i}$ spent in each transport means or building regarding the total duration of passenger trip $\boldsymbol{t_{passenger\ travel}}$ inside perimeter area.
Usable for	WP2, WP3, WP4.1

In order to save energy and therefore reduce airport area environmental impact, it can also be a good opportunity to reduce lighting use. Modification of outdoor lighting can also have a positive impact on the local environment, but it cannot always be reduced below certain limits for safety reasons. Inside building lighting shall also be kept above a certain level for passenger comfort.

Label	**ASQ5.1 ASQ5.2**
Name	Level of luminosity – light pollution that negatively impact people or wildlife around
Description	Level of luminosity measured within in project area. The level is benchmarked against a threshold – or yield a reduction vs. the benchmark (non-OLGA levels). Level of luminosity on the installed light on the runway or external to the terminal.
Data / Formula	$\boldsymbol{ASQ5.1: \ L_{exc} = L_{meas,max}\ [lum]};$ $L_i : L_{building}\ , L_{transport}\ [lux];$ $t_i : t_{building}\ , t_{transport}\ [h];\ t_{passenger\ travel}\ \ [h];$ $\boldsymbol{ASQ5.2 : L_{average} = \sum_i \frac{L_i}{\left(\frac{t_i}{t_{passenger\ travel}}\right)} [lux]}$
Methods	The luminosity for the installed light for ASQ5 can be measured. Variation will be compared to pre-OLGA scenario. The luminosity level overnight (lumen) should not exceed the predefined limits. A methodology similar to air quality or noise assessment is possible, with the creation of a “pollution heatmap”, if lighting measures are available/carried out. Luminosity should be assessed at least for the same areas assess for air quality assessment KPI AQ1 (refer to 2.1.3). Measured in lux. The average level of internal enlightenment is determined by using the ratio of the time $\boldsymbol{t_i}$ spent in each transport means or building regarding the total duration of passenger trip $\boldsymbol{t_{passenger\ travel}}$ inside perimeter area.
Usable for	WP4.1

3.11 NOISE KPIS

This category of KPI can be measured to assess several aspects of OLGA impacts:

- Passenger comfort: exposure of noise within the terminal and while accessing the aircraft (on the apron).
- Human factor on the apron: exposure of noise for personnel working on the apron and the associated occupational hazards and impact on aviation safety.
- Comfort for airport nearby residents: exposure of noise in the surrounding residential areas of the airport.
- Comfort for airport access nearby residents: exposure of noise in the surrounding of the main roads and tracks leading to the airport.

The indicators selection to better assess each of the above will vary with parameters of duration of exposure, time of exposures, and emergences of noises.

Label	**NL1**
Name	A-weighted equivalent continuous sound pressure level.
Description	*Cumulative exposure to all sound events occurring during a period with a sound pressure filter compensating for hearing sensed by the human ear.* *Equivalent continuous sound pressure level. Indicator that accumulates all noise variations over a period of time under a single value expressed in dBA.*
Data / Formula	$\mathbf{NL1:}\ L_{Aeq,\tau}$**[dB(A)]**
Methods	Method for the measurement of noise is subjected to norms that may vary between countries. In order to provide a European-wide method, the main reference to be used is ISO 1996-2.
Usable for	WP2, 3, 4

Label	**NL2**
Name	Equivalent continuous sound pressure level for 24hour period.
Description	*The noise level, provided by this indicator, is a cumulative exposure covering an entire day.* *The indicator is corrected for 2 of the 3 periods, i.e., in the evening and during the night. The noise levels of these periods are increased respectively by 5 and 10 dBA to take into account the greater degree of nuisance felt.*
Data / Formula	**NL2:** $L_{den} = 10.log\frac{1}{24}[12 * 10^{\frac{L_{Day}}{10}} + 4 * 10^{\frac{L_{evening}+5}{10}} + 8 * 10^{\frac{L_{night}+10}{10}}$
Methods	L_{Day} is the A-weighted equivalent continuous sound pressure level during day (6 a.m. to 6 p.m). Respectively, evening is from *6 p.m. to 10 p.m. and night from 10 p.m. to 6 a.m.* Method for the measurement of noise is subjected to norms that may vary between countries. In order to provide a European-wide method, the main reference to be used is ISO 1996-2.
Usable for	WP2, 3, 4

Label	**NL3**
Name	Noise fractile index
Description	*Sound level reached or exceeded for x% of the time (Lx), over a period.* *Statistical indices, used with "A" weighting.* *The L90 and L95 indicators are used to clear ambient noise.* *The L1, L5 or L10 indicators are used to quantify particular noises, specific events.*
Data / Formula	*N/A*
Methods	Method for the measurement of noise is subjected to norms that may vary between countries. In order to provide a European-wide method, the main reference to be used is ISO 1996-2.
Usable for	WP2, 3, 4

Label	**NL4**
Name	Noise emergence level.
Description	*Difference between ambient noise (L90 or L95) and the residual noise when a particular installation (ex: drone) is active for a short period of time (L10 or L5).*
Formula	**NL4:** $\Delta L = L_X - L_{100-X}$
Methods	*Noise emergence should be calculated separately during day and night for at least the same areas assess for air quality assessment KPI AQ1 (refer to 3.1.3).*
Usable for	WP2, 3

Label	**NL5**
Name	Relative time of appearance of marked tone.
Description	*A marked tone corresponds to the emergence of a 1/3 octave band.* *It is detected when the level difference between the 1/3 octave band and the four nearest 1/3 octave bands (the two bands immediately below and the two bands immediately above) reaches or exceeds 10dB below 400Hz and 5dB above.* *The time during which a marked tone is measured is to compare to the total time of measurement.*
Data / Formula	$\mathbf{NL5:}\ T_{MT\%} = \frac{\int T_{MT}}{T_{total}} \times 100$
Methods	
Usable for	WP2, 3

4 References/notes

[1] F. Mesin (MZLZ), personal communication. Assumptions may be valid for ZAG only.

[2] https://www.aef.org.uk/uploads/PlanningGuide2.pdf.

[3] https://www.gatwickairport.com/globalassets/business--community/growing-gatwick/master-plan-2019/gatwick-master-plan-2019.pdf.

[4] to be agreed in WP6

[5] "*Government defines the noise impact around UK airports by reference to the area covered by the 57dB(A)Leq contour (measured between 7am and 11 pm). The 57 Leq contour was chosen by Government as being representative of high levels of annoyance based on social survey work undertaken in the 1980s*", https://www.aef.org.uk/uploads/PlanningGuide2.pdf Note: Equivalent Continuous Sound Level (Leq) is the average sound level, which over a given period of time has the same total energy as the fluctuating noise.

[6] note this link https://blog.adbsafegate.com/new-led-apron-lighting-at-denver-international-airport-saves-energy-and-reduces-glare-at-atct/.

[7] Airport Air Quality AOCI Doc 9889 CAEP10 Steering Group 2015 Approved Revision (Based on the First Edition - 2011).

5 Appendix – Evaluation framework template

Below are some example of the screen shots from the evauliation framework template used to collect the KPIs inputs.

5.1 SOW EP vs KPIs

		KPIs												
		GHG	AQ	Noise level	Waste	Waste Management passenger	Energy consumption	H2 production	H2 usage	Natural ressources consumption	Biodiversity	Societal impact	Economic impact	Modal share of low carbon
	General environmental performance:													
GEP1	Interim performance assessment of OLGA, notably based on field measurement of energy consumption, GHG and AQ (EPC1; EPPF1, EPFO2)	Y	Y				Y							
GEP2	Long lasting impacts at a societal, environmental and economic level are likely to occur across a range of timeframes.	Y	Y	Y	Y					Y		Y	Y	
	Flight Operations environmental performance:													
EPFO1	Traceability process and system is in place to create transparency in the level of SAF use	Y								Y	Y			
EPFO2	Demonstration of 'net zero' CO2 turnaround with APU reduction, low carbon taxiing and GSE, and SAF	Y												
EPFO3	Airport as "Hydrogen hubs" for ground vehicles (short term) and aircraft (long term) by demonstrated: (a) H2 production with an electrolyser, (b) H2 usage in mobility and (c) master planning of an H2 airport design	Y			Y		Y	Y	Y		Y		Y	
	Passenger and freight handling environmental performance:													
EPPF1	Increased modal share of low carbon transport for airport <-> city													Y
EPPF2	Intermodal air-rail: (a) passenger luggage flight check-in at train stations; (b) new freight business models													Y
EPPF3	100% of the passengers are provided means and awareness for waste reduction during the Olympic Games				Y	Y								
EPPF4	Measurement of energy savings						Y							
	Community and Local environmental performance:													
EPC1	Improved air quality at airport landside and airside		Y											
EPC2	-60% electricity consumption in aircraft stand lighting						Y							
EPC3	Equal or improved biodiversity index at the airport										Y			

5.2 Solutions vs KPIs

			KPIs fields												
SOW ref	**Title**	**Environmental innovation description**	Green House Gases	Air Quality	Energy consump-tion	H2 production / usage	Modal share of low carbon transport	Waste	Natural resources	Biodiversity	Societal impact	Economic impact	Safety	Passenger comfort	Noise level
WP2 - Transport Landside, access and multimodal:															
WP2.1	Low-carbon connection with cities	Previously developed software solution for design and planning city bus transport electrification will be further improved and extended for e-buses connections to airport and surrounding areas, and charging stations deployment and management.	Y	Y	Y		Y				Y	Y		Y	Y
WP2.2	Traffic flow optimization	An IT solution for multimodal traffic optimization will be developed, including large-scale validation and replication.	Y	Y	Y		Y				Y	Y			Y
WP2.3.1	On-demand mobility for remote parking, parking and terminal connection	Deploy on-demand mobility on the Paris-CDG airport to improve the shuttle services transporting passengers and employees between parking and terminals.	Y	Y	Y		Y				Y	Y			
WP2.3.2	Mobility as a Service (MaaS) for Olympic Games	The travel planning tool will help passengers plan their journey from MXP to Olympic sites and reverse, showing information on routes and all available integrated and multimodal transport services to reach the venues, thus enhancing the sustainable mobility and fostering passengers to choose public and collective transport.									Y	Y			
WP2.3.3	Cargo export spare capacity optimization	Contributing the optimization of the transport of goods from inland to the airport (export process), by reducing number of trucks and pollutants emissions.	Y									Y			
WP2.4	Autonomous landside mobility	Possibility and limitations of using a Connected and Autonomous Vehicles (CAV) application.	Y	Y	Y		Y				Y	Y			
WP2.5	Waste as alternative fuel for bioNGV buses	Adaptation of diesel-powered trucks operating at the airport to Compressed Natural Gas (CNG) working engine. The conversion will be performed on different engines.	Y	Y	Y		Y	Y	Y		Y	Y	Y		
WP2.6.1	PAX rail-air intermodality	ADP will conduct a study to improve its quality of service in order to simplify the journey of connecting passengers between rail and air.	Y	Y			Y				Y	Y		Y	
WP2.6.2	Cargo delivery by train connecting the airport to the city centre	Smart delivery of small air freight via rail from Malpensa airport to Milan and vice versa, using the existing Malpensa Express train for passengers that connects the airport to downtown.	Y				Y				Y	Y			Y
WP3 : Transport airside															
WP3.1	Biodiesel 100% for Heavy-duty Vehicles	Feasibility study to switch to 100% biodiesel a part of the fleet of heavy-duty vehicles circulating airside and then a 10-month experimentation on 10 vehicles (runway sweepers-degreasers).	Y	Y	Y				Y			Y	Y	Y	
WP3.2	Low-carbon airside GSE	Transforming the current fleet of WB diesel-powered tractors into electric-powered tractors.	Y	Y	Y			Y				Y	Y	Y	
WP 3.3	Low-carbon airside mobility infrastructure	Develop a multi-energy station airside to allow low-carbon mobility using bioNGV and other energies at CDG airport.	Y	Y	Y				Y			Y	Y	Y	
WP3.4	Low-carbon airside electrification optimization software	Optimize the locations distribution and electric power capacities of charging points, in order to support the targets of greening Ground Support Equipment at CDG.	Y		Y								Y		
WP3.5.1 a	Green Apron at CDG - APU usage	Reduce the APU (Auxiliary Power Unit) usage time by monitoring its use through automatic detection and alerts.	Y		Y							Y			
WP3.5.1 b	Green Apron at CDG - Leakage detection	Reduce leakages/spillages of environmentally harmful substances by using automatic detection.						Y				Y	Y		
WP3.5.1 c	Green Apron at CDG - Predictive Off Block Time	Predict automatically the POBT (Predictive Off Block Time) in order to have improved synchronization in the departure sequence leading to a reduced taxi time.	Y	Y	Y							Y	Y		Y
WP3.5.2	Drones and Green Apron	In order to determine the infrastructure condition, to detect cracks or any objects on the operational areas, the application of unmanned aerial vehicle (UAV) for both photogrammetry purposes and visual inspection of the infrastructure will be applied.	Y	Y				Y					Y	Y	
WP3.6	APU substitution	This task will investigate APU-off modes to use the APU to the strict minimum at CDG airport.	Y	Y	Y							Y			
WP3.7.1 a	Taxiing reduction time by optimization of CDM @CDG	New procedures and software for decreasing arrival taxi time by better link between PDS and Arrivals	Y	Y	Y							Y		Y	
WP3.7.1 b	Taxiing reduction time by optimization of CDM @CDG	New procedures and software for decreasing departure taxi time (better integrate de-icing process, more accurate data)	Y	Y	Y							Y		Y	
WP3.7.1 c	Taxiing reduction time by optimization of CDM @CDG	New procedures and software for increasing n-x engine procedure usage for Taxi Out by better predictability and reliability of the Target runway Arrival Time & integrated Taxibot process in the PDS	Y	Y	Y				Y			Y		Y	
WP3.7.2B	Taxibot to allow engine-off taxiing	Investigate engine-off modes to use the engines during taxiing to the strict minimum, by use of the Taxibot with innovative business model.	Y	Y	Y				Y			Y	Y		Y
WP3.8	Green logistics	Deployment of autonomous electric freight transportation between warehouses, or between plane and warehouse, replacing diesel trucks at CDG.	Y	Y	Y				Y			Y	Y		Y

5.3 KPIs

CDG			MXP			ZAG			CLJ			Relevant KPIs
Year 0	Year N	Variation	Year 0	Year N	Variation	Year 0	Year N	Variation	Year 0	Year N	Variation	
0	0											YES
0	0											YES
0	0											
0	0											? READY ?
0	0											
0	0											YES
0	0											
0	0											
0	0											
0	0											
0	0											YES
0	0											
0	0											
0	0											
0	0											
0	0											
0	0											
0	0											
0	0											
0	0											YES
0	0											YES

5.4 WP Datas

OLGA Environmental Impact Evaluation Framework Template

Workpackage	
WP	**WP 4**
Work package title	**Terminal area**
Sub WP	**WP4.1 Energy efficiency in Terminal targeting Green**
Measure and KPI definition	
Environmental measure	**Dynamic APRON lighting**
Description	**Switch to LED lighting instead of High-Pressure Sodium, through a**
Detailed description	
AIRPORT assessment	CDG
Risks assessment	Comments / justification
Environmental issues	
Climate change impact	
Ozone Depletion impact	
Flora and Fauna impact (Ecotoxicity for aquatic fresh water, etc)	
Waste generation	
Soil direct pollution	
Land transformation impact	
Light	
Noise impact	
Trafic impact	
Resource depletion (water, rare earthes use) use	
Potential side effects	
Health issues	
Potential immediate hazards on passengers	
Potential immediate hazards for airport operators	
Potential chronical effects / cancer effects	
Potential chronical effects / non cancer effects	
Potential chronical effects / Particulate Matter / respiratory inorganics	
Technical issues	
Potential hazards on aircrafts	
Potential hazards on buildings	
Measure link with other measure	
Is the measure related to other measures	
Is the measure used instead of another one that could lead to environmental improvement	
Comments	

KPI	KPI title	Units	Baseline Information				
			Value Year 0	KPI measurement uncertainty	Reference documents	Data collection date	Comments
GHG1	Green House Gas quantity	kgCO2e					
	CO2	kgCO2e					
	CH4	kgCO2e					
	N2O	kgCO2e					
	PFCs	kgCO2e					
	HFCs	kgCO2e					
	SF6	kgCO2e					
AP1.1	Gaseous pollutants quantity	kg					
AP1.2	Gaseous pollutants index	-					
	Carbon dioxide (CO2)	kg					
	Sulphur oxides (SOx)	kg					
	Nitrogen oxides (NOx)	kg					
	Particulate Matter (PM10, PM2.5, PM1)	kg					
	Carbon monoxide (CO)	kg					
	Volatile Organic Compounds (VOC) total carbons	kg					
	Polycyclic Aromatic Hydrocarbons (PAHs)	kg					
	Heavy metals (Cd+Hg+Tl; As+Se+Te ; Lead ; Sb+Cr+Co+Cu+Sn+Mn+Ni+V+Zn ; T	kg					
	Hydrofluoric acid (HF)	kg					
	Hydrochloric acid (HCl)	kg					
	Ammonia (NH3)	kg					
	Dioxins and furans (PCDD, PCDF)	kg					

KPI	KPI title	Units	Impact assessment Information				
			Value Year N	KPI measurement uncertainty	Reference documents	Data collection date	Comments
GHG1	Green House	kgCO2e					
	CO2	kgCO2e					
	CH4	kgCO2e					
	N2O	kgCO2e					
	PFCs	kgCO2e					
	HFCs	kgCO2e					
	SF6	kgCO2e					
AP1.1	Gaseous pol	kg					
AP1.2	Gaseous pol	-					
	Carbon diox	kg					
	Sulphur oxid	kg					
	Nitrogen ox	kg					
	Particulate M	kg					
	Carbon mon	kg					
	Volatile Org	kg					
	Polycyclic A	kg					
	Heavy metal	kg					
	Hydrofluoric	kg					
	Hydrochloric	kg					
	Ammonia (N	kg					
	Dioxins and	kg					