Green mobility data models and services for smart ecosystems

D5.1 Requirements for the data sets and mobility services

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Table of Contents

List of Tables

List of Figures

List of Acronyms

Abbreviation / acronym	Description
AEMET	Agencia Estatal de Meteorología
AVG	Average
cd.sr	Candela
dB	Decibel
Dx.y	Deliverable number y belonging to Activity x
EC	European Commission
GTFS	General Transit Feed Specification
h	Hours
hPa	HectoPascal
km	Kilometer
KPI	Key Performance Indicator
l	Liter
ml	Number
MNCA	Metropole Nice Côte d'Azur
N/A	Not Applicable, Not Available
OSLO	Open Standards for Linked Organisations
OSM	Open Street Map
Pa	Pascal
SDM	Smart Data Models Program
Veh	Vehicle
W	Watt
Wh	Watt hour
WHO	World Health Organisation
µg	Microgram
°C	Celsius degree

Executive Summary

This deliverable compiles the data requirements across the different use cases of the GreenMov project. These main use cases will be implemented respectively in Flanders, Murcia/Molina de Segura, and Nice and will all aim to reduce the carbon footprint of transportation in three different locations. To achieve these goals, it is required to gather and exchange specific real-time data in a specific format. This document includes the different data requirements as listed by all the project use cases.

Therefore, an exhaustive list of the data needed for each use case is proposed. This document also includes a description of this data, and highlights if the data is already proposed in existing Smart Data models or if it is required to extend existing Smart Data models or to create new ones. The subjects covered by GreenMov's use cases are the noise, air quality and traffic characteristics.

As a summary this deliverable has identified a limited need for new data models, especially around noise and traffic identification. This document also demonstrates that despite the difference between the three use cases, many data requirements are shared between the different use cases. This showcases the replication of GreenMov's use cases to other locations and green mobility solutions.

1 Introduction

GreenMov project aims to improve green and smart mobility for citizens, companies and public administrations pivoting around three purposes: The definition of smart data models and a core vocabulary to harmonize different data sets, the development of cross-services to connect diverse data sources and to promote shared functionality and the cost and environmental efficiency due to enhancing a better coordination between cities and regions through data portals.

Additionally, GreenMov will project these purposes on three real-life pilots or use cases: noise and air pollution monitoring for more efficient mobility (Nice, France), sustainable enabler for smart and green mobility data reuse (Flanders Region, Belgium) and improvement of mobility flows, intra-modality, and environmental parameters (Murcia/Molina de Segura, Spain).

This deliverable compiles the data requirements across the different use cases of the GreenMov project. The GreenMov project regroups three main use cases that will be implemented respectively in Flanders, Murcia/Molina de Segura, and Nice. These implementations will aim to reduce the carbon footprint of transportation or to ease the use of alternative transport solutions in the three use cases locations. To achieve these goals, it is required to analyse available data sets, to forecast the short-term future situation, and to take a decision in terms of transport recommendation based on accessible transportation alternatives. All these steps require specific data exchanges, storage and processing that could strongly benefit from standardisation. As a result, each use case proposes a list of requirements for all the data needed. These requirements aim to assess the suitability of existing data models in FIWARE and OSLO (Open Standards for Linked Organisations) standards, and to identify the need to create novel data models that will facilitate the deployment of innovative green transportation solutions. This document is structured as follows.

The second section of this document presents a description of each use case implemented within this project. In the third section, we list the existing data sets required for each use case and link these to the existing Smart Data Models Program [1], to the European Data Portal [2], but also to other local resources identified in the considered use case. In the fourth section, GreenMov's innovative mobility services are listed and associated with each use case. Finally, the last section proposes a list of the use cases key indicators to assess the performance of the deployed solutions.

This document is completed with the activity 2 document (deliverable 2.1), therefore, some changes to the data sets and the data models identified or extended could be noticed.

The results presented are not final as long as the use cases have not completed their implementation and therefore, new versions are expected during the coming 6 months (August 2022). Eventually those changes could affect some of the data models presented in this document.

2 Use Cases Description

The purpose of this section is to give a general presentation of each use case in a few paragraphs. These use cases presentations include the aim of the implementation foreseen within GreenMov, as well as a detailed description of the technical implementation architecture. Different scenarios are also described for each use case to ease the understanding of the GreenMov's services implemented within the project.

2.1 Murcia/Molina de Segura

By providing a set of green services Murcia and Molina de Segura cities want to promote public transport and rent bike points to mitigate the impacts of traffic on air quality. To aim this objective, we will report the citizens the necessary information to decide to leave the car and search for green alternatives. We will also report to the public administration the knowledge to make intelligent mobility, a critical point for Molina de Segura and Murcia, two relevant cities in the south of Spain that share a lifestyle - companies, universities, shopping centres, etc.

So, in this context, GreenMov takes an essential role in the city necessities to obtain the green services for this use case. To delimit a bit, our pilot will focus on Espinardo, a shared university area that also hosts a lot of companies and commerce. Thus, the Campus of Espinardo is a hot spot in terms of mobility and a place with a good combination of public transport.

Figure 1 : Murcia/Molina de Segura use case: Perimeter from Google Maps (Left), Tram from TDM [3] (Right Top) and MiMurcia [4] bike station (Right Bottom).

For this reason, we propose three green services that help to understand the impacts on air quality and provide alternatives. The first one is related to air quality and consists of the European Air Quality Index to understand the impacts of the air quality on health. In addition, we propose to develop a service to estimate the equivalent CO2 emission related to the traffic to quantify the effect of the mobility into the climate and, finally, a service to provide zero-emissions alternatives. This last one predicts bikes' availability in the stations' points.

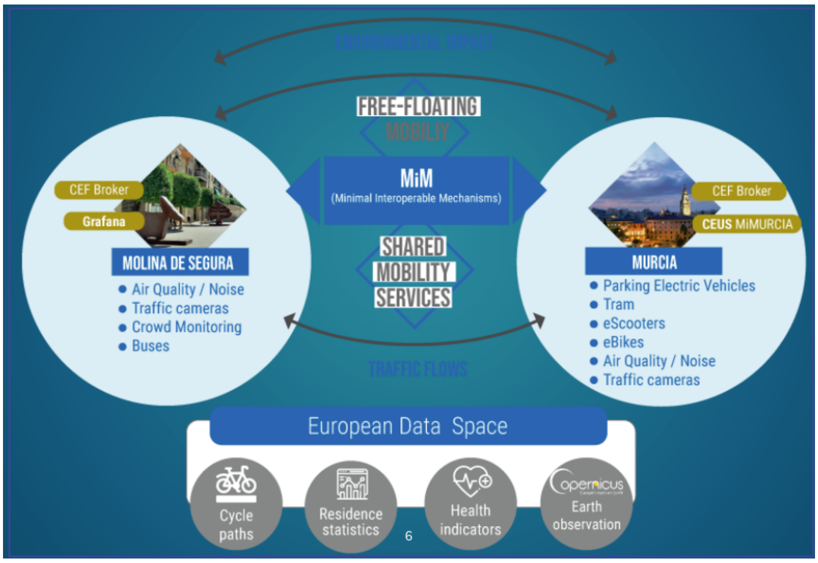

Figure 2: Murcia and Molina de Segura use case architecture.

The use case architecture is based on injecting the different data sources provided by the different entities involved in the use case and open portals into a context broker, which provides contextual information in real-time. This information is used to feed the services and the Smart Data models defined in deliverable 2.1. This service will be integrated into the Green Mobility app, the tool used to interact with the citizens. Another critical component in our architecture is artificial intelligence. The model is trained with historical data provided by the cities and stored in an Excel file. Once trained, the model will feed the bike availability service.

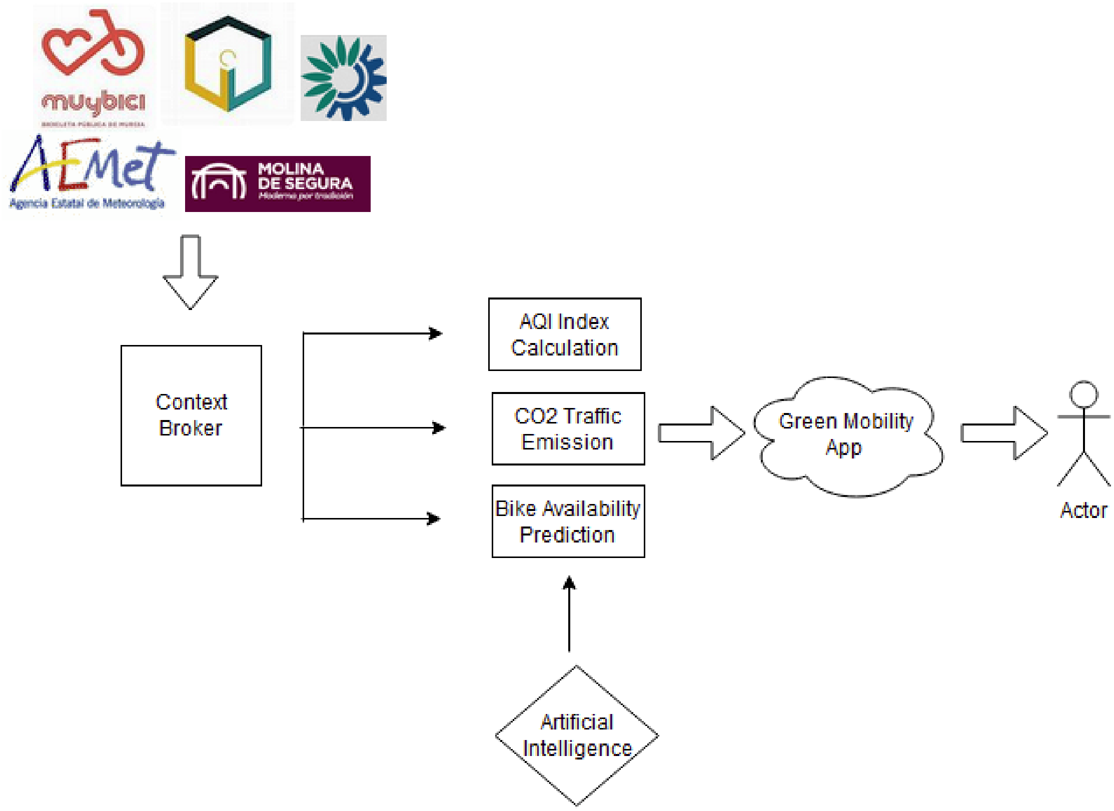

Figure 3: Architecture Molina/Murcia pilot.

Scenario

Option 1: A student wants to take his car from Murcia/Molina to attend his lessons. To make the correct decision, he uses our services to check the air quality on the campus and the availability of bikes to move from Molina/Murcia to the campus.

Option 2: The city of Molina wants to study the necessity of implementing a new tram line between Molina and the campus. To take the correct service, they can check the CO_2 emissions of the last months and decide using quantifiable data if this line is necessary.

Option 3: The campus authorities want to implement some restrictions in the access to the campus. They can check using the AQI index (Air Quality Index) in different locations and decide which access is restricted to cars.

2.2 Flanders

Shared bike mobility and public transportation

By providing an availability forecasting for shared bikes, we aim to improve the combined use of shared bike mobility and public transportation. We want less waiting time at transport modality cross-over points and avoid non-availability of shared resources at cross-over points. In Flanders such places are being branded as "Hoppin

Points” [5]. Places where you can easily transfer between one means of transport to another. Depending on the location, you will find bicycle parking spaces, tram and bus stops, shared vehicles, a Park & Ride, etc.

Figure 4: Hoppin Point with Blue-bike station (Leuven - Heverlee).

Figure 5: Train station with Bleu-Bikes (Antwerp – Noorderdokken).

In the digital world Hoppin Points go hand in hand with the emergence of Mobility-as-a-Service. To enable such services all data regarding the different transport modes, by all the different public and private providers should be available in an interoperable way. This means that several semantic OSLO data models (time tables & schedules [6], trips & offers [7]) were co-created with all public and private stake holders in Flanders. To support the Hoppin Points a new OSLO-data model “Hoppin Points” [8] is being developed (in Dutch) and is near completion.

The objective within this project is to develop a city service that enables the shared bikes' availability forecasting for a given's bikes sharing station at a specific time. The focus of the use case is Hoppin Points at train stations with "Blue-Bikes"[9]. Blue-Bikes are one specific bike sharing system, provided by the Blue-mobility company. If the availability forecasting works for Blue-Bikes it could also work for other bike sharing systems from other providers. The OSLO Hoppin-model will be translated from Dutch in English and will be extended if the business needs of GreenMov partners require so.

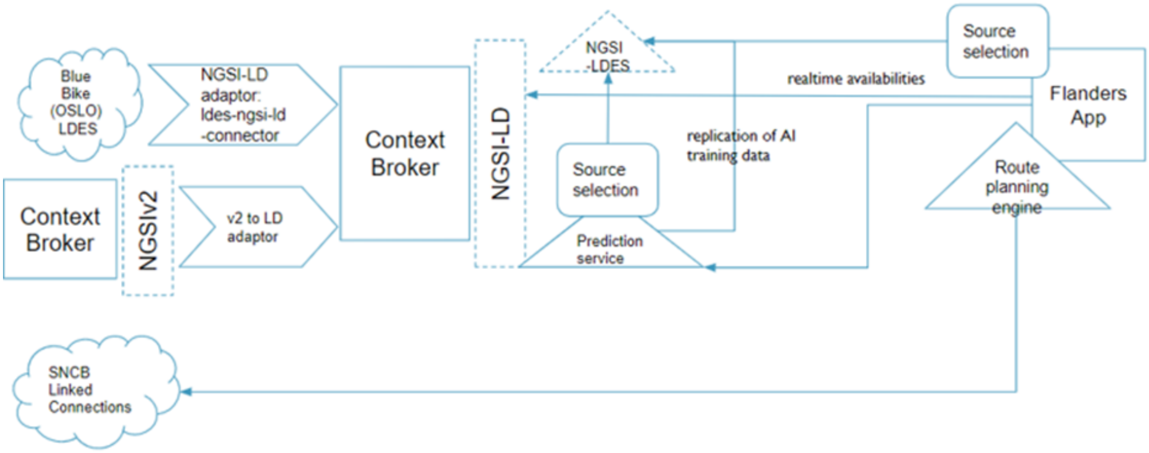

Figure 6: Architecture Flanders pilot.

Scenario

Option 1: Clement P. is a musician in Antwerp and has to play a concert at 16:00 in Ghent. Clement goes by train to Ghent and then by shared bicycle to the venue. If no shared bikes are expected to be available at the station at the time of arrival, Clement will have to take an earlier train and then walk to the venue. Clement uses an app to help him with the departure time of the train.

Option 2: Clement P. is a musician in Antwerp and has to play a concert at 16:00 in Ghent and has already boarded the train to Ghent (trip no. x) and then goes to the venue by bike. If there are no shared bikes available at the station at the time of arrival, Clement should be informed that he will come a little later (he must then go on foot instead of with the shared bike). Clement uses an app to help him with the departure time of the train.

2.3 Nice

The correlation between climate change and the increase in greenhouse gases, in other words, human activities, has become a certainty. This evolution of the climate influences our ecosystem and our way of life, in Nice as well as everywhere else in the world.

The data on greenhouse gas emissions presented in this chapter comes from the inventory carried out by AtmoSud as part of its local air quality monitoring activities and on behalf of the ORECA (Observatoire Régional Energie Climat Air de la région Sud Provence-Alpes-Côte d'Azur). AtmoSud is the AASQA (Association agréée de surveillance de la qualité de l'air) or the air quality monitoring partner of the MNCA (Métropole Nice Côte d'Azur).

The inventory consists of quantifying the greenhouse gases (GHG) directly emitted on the territory by all the actors and divided by sectors of activity. Upstream GHG emissions, linked to the use of imported electricity, are also considered.

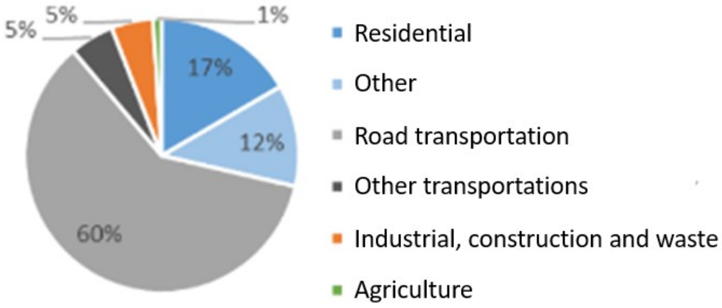

Figure 7: GHG emissions repartition in Nice.

However, it is necessary to go beyond what is already being done to make sustainable mobility more and more democratized. This is the reason why the Nice use case was proposed. Based on the predictive capacity of a CO² emission model, added to the qualification and optimization of a car mix present in the area, the model will simulate potential scenarios and their results in supporting the decision of traffic managers.

Scenario

Option 1: Honorat plans to drive to work next Friday morning at 9AM from Cannes to Nice. On Thursday evening, he receives a message on Nice-Traffic App with a recommendation that specifies that the air quality will be degraded on Friday morning in the city of Nice where he goes to work, therefore it is suggested that he uses public transportation or bikes that will be available at this specific time. Public transport or bikes will be offered by the city of Nice.

Option 2: The city of Nice checks Friday 's Air quality index forecast due to a traffic forecast. Given the forecast, the city appoints extra electric buses and bikes to transport people commuting to Nice by car and send specific messages to people usually driving to Nice on Fridays.

Through improved information and modeling the potential of different scenarios, the decision support service has the potential to change behavior and support the fight against climate change. Public information, traffic information, and traffic planning act together to reduce the emission of greenhouse gas.

The scenario consists of reporting to the citizens the necessary information to decide to leave the car and potential mobility alternatives.

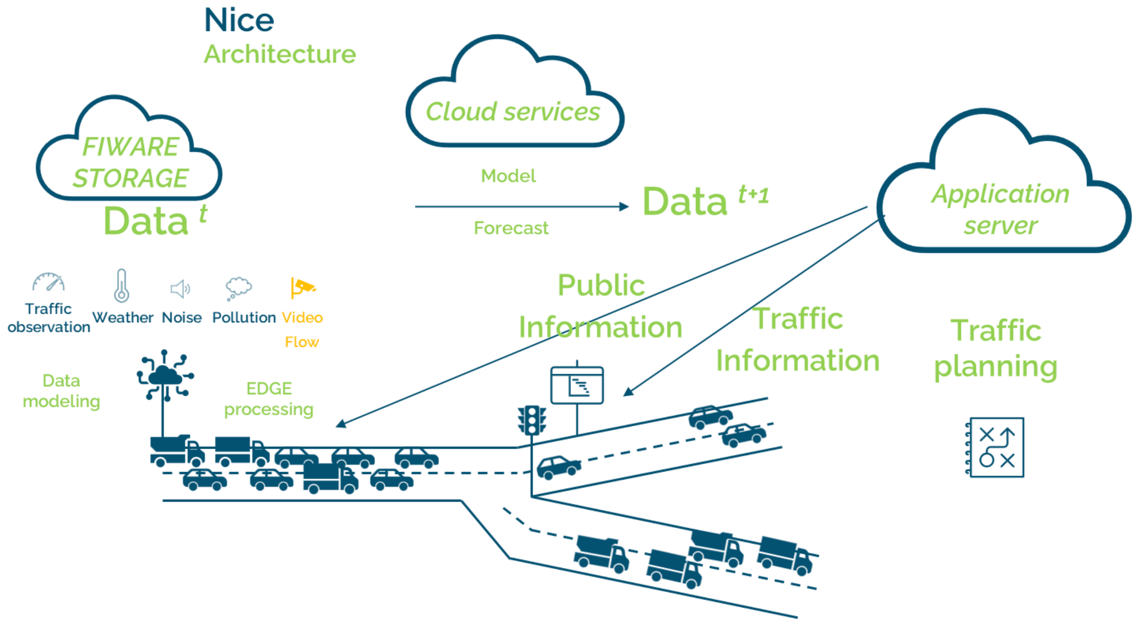

Figure 8: Architecture Nice Pilot.

3 Use Cases Data Sets

This section highlights and identifies the data sets and their associated attributes required for the implementation of each one of the use cases. For each use case, we list the data needed for the implementation, and highlight each data attribute type, source, unit, and frequency of collection as well as a brief description.

The provided data sets will serve as an input for GreenMov's mobility services.

The data sets identified are represented in the tables below and defined separately for each use case:

3.1 Murcia/Molina de Segura

Murcia/Molina use case is fed by 3 main different data sets, that can be regrouped in two main classes. The first class corresponds to the open data stored in the European Open Data Portal. It includes one main dataset used for GreenMov operational decisions and one dataset used mostly for historic data and reporting .

- AEMET [12]: that is the meteorological data reported by the Spanish "Agencia Estatal de Meteorología". This data is accessible via REST API [13] and report hourly meteorological data.
- European Air Quality Portal [10]: is an open source dedicated to the Air Quality e-Reporting system established by the European Commission (EC) [11] and run by the European Environmental Agency (EEA) [11]. It contains technical details and services that facilitate the reporting of official air quality information from EU Member States and other EEA member and co-operating countries. It also provides access to different tools which allow to visualize the collected data and statistics as well as to download them, as an official API that will be used to collect data into the project. Unlike AEMET, this data source will mostly be used for historical data, visualisation and reporting.

On the other hand, this use case will also leverage 2 datasets provided by the cities that participates in the use case. In this sense, it is necessary to note the presence of the following data.

- Molina Smart City Platform [14]: This data source collects data generated by IoT devices installed by HOPU in the city of Molina, which measure data related to air quality - NO_2, O_3, CO, SO_2, PM1, PM2.5 and PM10 - as well as noise - LAeq. These sensors report data in near-real time, which allows working with minute data. This data will be accessible through the API that HOPU uses to access data from its devices.
- MiMurcia Bike's Availability [4]: MiMurcia public service aims to offer the citizens of the city of Murcia a green alternative to private transport, based on bicycle rental. To this end, different points were installed where users can pick up and drop off a bike. The city of Murcia collects data on the number of bikes available at each point on an hourly basis. Therefore, this data will be accessible through an internal API of the city council of Murcia that will be open for the participants in the use case.

Table 1: Data Description and requirements for Murcia/Molina de Segura.

Name of the attribute	Source	Attribute type	Unit	Frequency of collection	Description
airTemperature	AEMET	number	°C	1 / hour	The instantaneous temperature of the measured air
referenceTemperature	AEMET	number	%	1 / hour	Reference temperature of the measured air
atmosphericPressure	AEMET	number	hPa	1 / hour	Observed atmospheric pressure (hP)
relativeHumidity	AEMET	number	%	1 / hour	Humidity in the air. Observed instantaneous relative humidity (water vapor in the air)
windSpeed	AEMET	number	m/s	1/ hour	Wind speed
windDirection	AEMET	number	º	1 / hour	Wind direction
precipitation	AEMET	number	L/m^2	1 hour	Amount of rainwater measured
solarRadiation	AEMET	number	W/m^2	1 hour	Observed solar radiation measured in Watts per square meter
no2	Molina de Segura Smart City	number	$\mu g/m^3$	1 min	Nitrogen dioxide detected
o3	Molina de Segura Smart City	number	$\mu g/m^3$	1 min	Ozone detected
co	Molina de Segura Smart City	number	$\mu g/m^3$	1 min	Carbon Monoxide detected

Name of the attribute	Source	Attribute type	Unit	Frequency of collection	Description
so2	Molina de Segura Smart City	number	$\mu g/m^3$	1 min	Sulfur Dioxide detected
pm1	Molina de Segura Smart City	number	$\mu g/m^3$	1 min	Particulate matter 1 micrometer or less in diameter
pm2.5	Molina de Segura Smart City	number	$\mu g/m^3$	1 min	Particulate matter 2.5 micrometers or less in diameter
pm10	Molina de Segura Smart City	number	$\mu g/m^3$	1 min	Particulate matter 10 micrometers or less in diameter
LAeq	Molina de Segura Smart City	number	dB	1 min	Average sound level (equivalent) recorded during the measuring time
Fluency	Murcia City and Molina de Segura City	string	Without unit	1 day	A string describing the fluency of the traffic
Intensity	Murcia City and Molina de Segura City	number	Veh	1 day	Total number of vehicles detected during this observation period

Name of the attribute	Source	Attribute type	Unit	Frequency of collection	Description
Ocuppancy	Murcia City and Molina de Segura City	number	Veh/h	1 day	Fraction of the observation time where a vehicle has been occupying the observed lane
averageVehicleSpeed	Murcia City and Molina de Segura City	number	km/h	1 day	The mean speed of the vehicles
VehicleEmissionLabel	DGT Murcia (Traffic General Direction)	string	Without unit	1 day	A string that matches the vehicle with the emission label
num_bikes_avaiable	MiMurcia	number	Bikes	1 hour	Number of current available bikes in the station

3.2 Flanders

The Flanders use case require 2 main data sources. The first one corresponds to the availability of Blue Bikes, whereas the second one consists in the timetable of trains. These datasets are published through the European Data Portal (https://data.europa.eu) [2], managed by the Publication Office of the European Union.

Availability of Blue Bikes : A data feed with real-time availabilities from all the Blue-Bike stations, provided by the data owner, the Blue-mobility company, will be used as source data.

This data gives real-time (update every 5 minutes) information about the Blue Bike bicycle storage at the given station. The main attributes are:

- the number of bikes in use;
- the number of available bikes;
- the id, name and x, y coordinates of the bike station.

Currently, only metadata of data in the greater city area of Ghent is published through the European Data Portal. This is done for each train station, with one or more Blue Bike facilities:

- Blue Bike sharing bikes Ghent Sint-Pieters (M. Hendrikaplein) [15]

- Blue Bike sharing bikes Ghent Sint-Pieters (St. Denijslaan) [16]
- Blue Bike sharing bikes Ghent Dampoort [17]
- Blue Bike sharing bikes Merelbeke — Drongen — Wondelgem [18]

We will ask the data provider to document the full feed. If needed, we will offer to assist them to enable that the source data is fully documented and findable through the European Data Portal.

Planned actual timetable of trains

Train data from the Belgian railroad company will be used. Both the scheduled timetable and the real-time data are available. There are two GTFS (General Transit Feed Specification) feeds:

- The scheduled data which are updated daily.
- The real-time data which are updated every 30 seconds.

Metadata: SNCB GFTS - scheduled timetable and real-time data [19].

Table 2: Flanders data set description.

Name of the attribute	Source	Attribute type	Unit	Frequency of collection	Description
SNCB GFTS - scheduled timetable and real-time data [19]	NMBS/SNCB (The Belgian Railways)	number, string	N/A	Real-time (30 min)	Both the scheduled timetable and the real-time data are available to you for free. There are two GTFS feeds available: • The scheduled data which are updated daily • The real-time data which are updated every 30 seconds
Blue Bike sharing bikes Ghent Sint-Pieters (M. Hendrikaplein) [15]	City of Ghent/Blue-Mobility Company	number, string	N/A	Real-time (5min)	This data gives real-time (update every 5 minutes) information about the Blue Bike bicycle storage at the station Gent Sint-Pieters (M. Hendrikaplein): Number of bicycles in useNumber of bicycles still available at this location there is a maximum capacity of 35 Blue Bike bikes. The data can be used, for example, to monitor the use of Blue Bike and to analyse the frequency of the loan. This data is made available by Blue Bike.

3.3 Nice

Nice 's data sets to be used in the use case implementation are available either on the European Data Portal or on other European and local city portals. The use case require data to assess the air quality at specific location, but also to assess noise pollution, traffic activity, and finally to assess the available alternative transportation solutions in real time. Therefore, 5 main datasets categories are needed (air quality measurement, weather measurement, noise measurement, traffic measurement and public transportation and bikes availability). For some of these datasets, it was decided to use several data sources in order to increase the accuracy and the location of measurements. As a consequence, 6 sources of data have been identified for this use case, as shown below:

- European Data Portal [2] for air quality measurement: The European Union's services package to promote the reuse of open data from its institutions and EU Members. Among others, the air quality data [20] from Nice will be used for environment data such as PM10, PM2.5, O3, CO, NO2 and SO2.
- AGORA Platform [21] for weather, noise and air quality measurement: A web platform and an interface for all available applications linked to Nice's outdoor measurement stations installed by the city, the extracted data are in standardized formats (CSV files).
- Open data - ATMOSUD [22] for air quality measurement: The Air quality monitoring French association, approved by the Ministry of the Environment, data is standardized in formats that meet international standards through REST APIs or CSV files.
- MNCA API's [23] for weather, traffic measurement and public transport and bikes availability: The Nice Metropolis web platform dedicated for retrieving NGSI standardised data via a list of APIs. It will be used for traffic flow observation, air quality monitoring, noise pollution and public transportation availability.
- Other external data sources : Web services that can be used via REST API's : TomTom developer platform [24] will be used as an alternative source for traffic measurement, whereas Copernicus [25] will be used to enhance weather measurement at specific locations.

The main data models that characterize the data collected are:

- Traffic Flow Observed;
- Vehicle Emission Label;
- Air Quality Observed;
- Air Quality Monitoring;
- Weather Observed;
- Noise level observed;
- Noise Pollution;
- Public Transportation;
- Bikes availability.

Table 3: Data Description and requirements for Nice.

Name of the attribute	Source	Attribute type	Unit	Frequency of collection	Description
airQualityIndex	AGORA/Copernicus	number	Without unit	15 min	The number used to report air quality
airQualityLevel	AGORA	string	Without unit	15 min	Overall qualitative level of health concern corresponding to the observed air quality
airTemperatureAVG	AGORA/Copernicus	string	°C	8 h	Average temperature measured on a datum
atmosphericPressure	AGORA/Copernicus	number	hPa	15 min	Observed atmospheric pressure
aqiMajorPollutant	ATMOSUD	string	Without unit	24h	Major air quality index (AQI) pollutant
UVIndexMax	MNCA	string	Without unit	24 h	The maximum UV Index for the period, based on the WHO’s UV Index measurement
airTemperature	AGORA/Copernicus	number	°C	15 min	The instantaneous temperature of the measured air
relativeHumidity	AGORA/Copernicus	number	%	15 min	Observed instantaneous relative humidity
Wind type	AGORA	string	Without unit	8 h	Description of the dominating wind type during the last 8h
co2	ATMOSUD	number	ppm	24 h	Carbon dioxide detected
co	ATMOSUD	number	ppm	24 h	Carbon monoxide detected
as	ATMOSUD	number	ppm	24 h	Arsenic detected

Name of the attribute	Source	Attribute type	Unit	Frequency of collection	Description
no	ATMOSUD	number	ppm	24 h	Nitrogen monoxide detected
no2	ATMOSUD	number	ppm	24 h	Nitrogen dioxide detected
o3	ATMOSUD	number	ppm	24 h	Ozone detected
sh2	ATMOSUD	number	ppm	24 h	Hydrogen sulfide detected
so2	ATMOSUD	number	ppm	24 h	Sulfur dioxide detected
pm10	ATMOSUD	number	ppm	24 h	Particles with a diameter of 10 micrometres or less
pm25	ATMOSUD	number	ppm	24 h	Particles with a diameter of 2,5 micrometres or less
nox	ATMOSUD	number	ppm	24 h	Other Nitrogen oxides detected
hc	ATMOSUD	number	ppm	24 h	Hydrocarbon gases detected
nh3	ATMOSUD	number	ppm	24 h	Ammonia detected
chci	ATMOSUD	number	ppm	24 h	1,2-Dichloroethene detected
weatherType	AGORA/Copernicus	string	Without unit	8h	Type of observed weather and amount of clouds (Clear skies, medium clouds, cloud cover, …)
windDirection	AGORA	number	°	15 min	Observed instantaneous direction of the wind
windSpeed	AGORA	number	m/s or km/h	15 min	Observed instantaneous speed of the wind

Name of the attribute	Source	Attribute type	Unit	Frequency of collection	Description
precipitation	AGORA	number	L/m²	15 min	Amount of rainwater recorded
visibility	MNCA	string	Without unit	1 h	Instantaneous category of visibility (fog, mist, haze, …)
illuminance	AGORA	number	cd.sr.m−2	1 h	Observed instantaneous ambient light intensity
temperatureForecast	MNCA	number	°C	N/A	Forecast of the temperature for a specific period in the future
humidityForecast	MNCA	number	%	N/A	Forecast of the humidity for a specific period in the future
precipitationForecast	MNCA	number	L/m²	N/A	Forecast of the quantity of rain for a specific period in the future
windSpeedForecast	MNCA	number	m/s or km/h	N/A	Forecast of the wind speed for a specific period in the future
weatherAlert	MNCA	string	Without unit	N/A	A bulletin warning of impending hazardous weather phenomena
LAeq	AGORA	number	dB	24 h	Average sound level (equivalent) recorded during the measuring time
LAeq_d	AGORA	number	dB	16 h	Average sound level recorded during the day (6h-22h)
Lamax	AGORA	number	dB	24 h	Maximum sound level recorded during the measuring time

Name of the attribute	Source	Attribute type	Unit	Frequency of collection	Description
sonometerClass	AGORA	string	Without unit	N/A	Sound level meter class (1,2 or 3)
LAeq24	AGORA	number	dB	24 h	Average sound level over 24 hours
Lamax24	AGORA	number	dB	24 h	Maximum sound level recorded for 24 hours
Noiselevel	AGORA	string	Without unit	8 h	A description of the acoustic environment during a time period
Lanight	AGORA	number	dB	8 h	Average sound level recorded during the night 22h-6h
Laf	AGORA	number	dB	15 min	Average sound level recorded for a certain frequency range (e.g., La50hz, La100hz)
acousticPressure	AGORA	number	Pa	15 min	Noise sound pressure
miMask	AGORA	number	s/min/h	12/24 h	Percentage of time for which the noise level exceeded a certain threshold (e.g., 65dB for 12h/24h)
intensity	AGORA	number	W/m^2	15 min	Intensity noise level measured
noiseType	AGORA	string	Without unit	1 h	Recorded noise type (Continuous noise, intermittent noise, impulsive noise, low frequency noise, …)
roadSegmentId	MNCA/OSM	string	without unit	N/A	Concerned road segment on which the observation has been made

Name of the attribute	Source	Attribute type	Unit	Frequency of collection	Description
roadType	MNCA/OSM	string	Without unit	N/A	Type of the road (Freeways, Expressways, Highways, Arterials, Local Streets, ...)
Fluency	MNCA/TomTom	string	Without unit	1h	A description of the fluency of the traffic (fluent traffic, average traffic, heavy traffic, …)
Intensity	MNCA/TomTom	number	Veh	N/A	Total number of vehicles detected during this observation period
averageVehicleSpeed	MNCA/TomTom	number	km/h	1 h	The mean speed of the vehicles
Occupancy	MNCA/TomTom	number	Veh/h	1 h	Fraction of the observation time where a vehicle has been occupying the observed lane
co2AVG	AGORA	number	ppm	24 h/12 h	The average amount of CO2 emitted by traffic during 24h/12h
noiseAVG	AGORA	number	dB	24 h/12 h	The average noise level detected during 24h/12h
fuelAVG	MNCA	number	ml/s	24 h/12 h	The average fuel consumption during 24h/12h/8h
electricityAVG	MNCA	number	Wh/s	24 h/12 h	Average electricity consumption during 24h/12h
timeLostAVG	MNCA	number	s	24 h/12 h	Average time lost during 24h/12h
accidentsYear	MNCA	number	Without unit	1 Year	Average yearly number of accidents

Name of the attribute	Source	Attribute type	Unit	Frequency of collection	Description
contractingCompany	MNCA	string	Without unit	N/A	Name of the contracting company responsible for the exploitation of the public transportation
contractingAuthority	MNCA	string	Without unit	N/A	Name of the contracting authority of the public transportation
locationGTFS	MNCA	string	Without unit	N/A	Location of all stations from a GTFS file
frequency	MNCA	string	Without unit	1 h	Frequency of public transportation per hour
typeTrasportation	MNCA	string	Without unit	N/A	Type of public transportation services available (tram, metro, bus, train, TOD ...)
serviceStart	MNCA	number	hh:mm:ss	N/A	Service start time
serviceEnd	MNCA	number	hh:mm:ss	N/A	Service end time
princingAVG	MNCA	number	Euro	N/A	Average price of public transportation
routes	MNCA	string	Without unit	N/A	List of routes covered with public transportation
BikestationName	MNCA	string	Without unit	N/A	The names of the bike hire docking stations around the observation area
openingHours	MNCA	number	Without unit	N/A	Opening hours of the docking stations

Name of the attribute	Source	Attribute type	Unit	Frequency of collection	Description
status	MNCA	string	Without unit	1 h	Status of the bike hire docking stations 'working, outOfService, withIncidence, full, almostFull, empty, almostEmpty'. Or any other application specific.
num_Bikes	MNCA	number	Without unit	1 h	Number of bikes available to hire

4 Green Mobility Services

The global green mobility policy goal aims to reduce the environmental impact of mobility in terms of greenhouse gas (GHG) emissions, air pollution, noise and to improve the life quality of the citizens, which is aligned with the aims and goals of the GreenMov project.

This section provides a framework of the innovative mobility services proposed by the project partners and within use cases presented previously in this document, The adoption of these services should contribute to the decarbonization of the mobility sector and the improvement of the citizens mobility experience.

The list of the proposed services, the data required for the deployment of these services and a brief explanation of the services for each use case are described in the tables below. The services have been split between primary services, that are providing a service that can directly be used by the use case stakeholders, and secondary services, that are required to implement primary services.

4.1 Murcia/Molina de Segura

Murcia/Molina primary services are listed in the table below:

Table 4: Innovative primary services for Murcia/Molina de Segura.

Proposed Service	Dependencies, sub-services	Data required	Description
AQI Index Forecast	AQI Index Calculation, Machine Learning tools and software libraries	pm1, pm2.5, pm10, no2, o3, co, so2, LAeq	Forecast of the Air Quality Index in different areas in the perimeter of the use case (Campus of Espinardo) using sensor data
Traffic pollution forecasting	Traffic forecasting, numpy, pandas, bentoml	Fluency, Intensity, averageVehicleSpeed, type of vehicles	Determination of the polluting emissions due to traffic using the emission factors related to the vehicle label
Bike Availability Forecasting	Machine Learning tools and software libraries	num_bikes_avaiable, airTemperature, referenceTemperarue, atmosphericPressure, relativeHumidity, windSpeed, windDirection, precipitation, solarRadiation	Forecasting of bike's availability in the next 24 hours in the hire station. AI model to predict availability based on actual and historical data

These primary services depend on secondary services that are listed below:

Table 5: Innovative secondary services for Murcia/Molina de Segura.

Proposed Service	Dependencies, sub-services	Data required	Description
AQI Index Calculation	software libraries	pm1, pm2.5, pm10, no2, o3, co, so2, LAeq	Determination of the European Air Quality Index in different areas - defined as polygons - in the perimeter of the use case (Campus of Espinardo) using sensor data
Traffic forecasting	Machine Learning tools and software libraries	Historic Fluency, Intensity, averageVehicleSpeed, type of vehicles	Determination of the short term traffic using the historic traffic data

4.2 Flanders

Flander's primary services are listed in the table below:

Table 6: Innovative primary services proposed and their requirements for Flanders.

Proposed Service	Dependencies, sub-services	Data required	Description
Bike Availability Forecasting	Machine Learning tools and software libraries	num_bikes_avaiable (Blue_Bikes LDES stream), airTemperature, referenceTemperarue, atmosphericPressure, relativeHumidity, windSpeed, windDirection, precipitation, solarRadiation	Forecasting of bike's availability in the next 24 hours in the hire station. AI model to predict availability based on actual and historical data

4.3 Nice

Nice's primary services are listed in the table below:

Table 7: Innovative primary services proposed and their requirements for Nice.

Proposed Service	Dependencies, sub-services	Data required	Description
Air Quality Index forecast	Air quality index calculation, Traffic pollution forecasting, Python libraries.	Historic pm1, pm2.5, pm10, no2, o3, co, so2, type of day, time, weatherType, windspeed, temperature, Fluency, Intensity, AVG	Short term forecast of Air Quality Index in the use case area.

Proposed Service	Dependencies, sub-services	Data required	Description
		Vehicles Speed, types of vehicles .	
Noise annoyance forecast	Traffic forecasting, Python libraries.	Traffic Fluency, Intensity, averageVehicleSpeed, type of vehicles, Historic noise levels, area type (residential, industrial ...)	Short term forecast of noise pollution in the use case area.
Alternative transport availability forecast	Bike Availability Forecasting	Historic public transportation tables, GTFS files, num_bikes_avaiable, airTemperature, referenceTemperarue, atmosphericPressure, relativeHumidity, windSpeed, windDirection, precipitation, solarRadiation	Short term forecast of the availability of the alternative transport means (bus, tram, bike ...) in the use case area. It includes the Bike Availability Forecasting service. It consists in an AI model to predict availability based on actual and historical data
Mobility Recommendation	Traffic forecasting, Traffic pollution forecasting, Air Quality Index forecast, Localized Traffic forecast, City Traffic forecast, Python libraries, cameras, sensors.	Historic Fluency, Intensity, Vehicles Speed, types of vehicles for the use case areas, Public transportation tables, GTFS files, streets mapping (including cycle roads).	Short term forecast of the traffic density in the use case area and recommendations for alternative transportation solution due to traffic density and/or degraded air quality.

These services depend on secondary services that are listed below.

Table 8: Innovative secondary services proposed and their requirements for Nice.

Proposed Service	Dependencies, sub-services	Data required	Description
AQI Index Calculation	software libraries	pm1, pm2.5, pm10, no2, o3, co, so2, LAeq	Determination of the European Air Quality Index in different areas - defined as polygons - in the perimeter of the use case using sensor data

Proposed Service	Dependencies, sub-services	Data required	Description
Bike Availability Forecasting	Machine Learning tools and software libraries	num_bikes_avaiable, airTemperature, referenceTemperarue, atmosphericPressure, relativeHumidity, windSpeed, windDirection, precipitation, solarRadiation	Forecasting of bike's availability in the next 24 hours in the hire station. AI model to predict availability based on actual and historical data
Traffic forecasting	Machine Learning tools and software libraries	historic Fluency, Intensity, averageVehicleSpeed, type of vehicles	Determination of the short term traffic using the historic traffic data
Traffic pollution forecasting	Traffic forecasting, numpy, pandas, bentoml	Fluency, Intensity, averageVehicleSpeed, type of vehicles	Determination of the polluting emissions due to traffic using the emission factors related to the vehicle label

5 Use cases indicators

A set of indicators or Key Performance Indicators (KPIs) is a tool for the evaluation of the performance, impact, and acceptance of the previously proposed services.

These indicators are defined by the use cases leaders and will assess the performance of the deployed solutions from various perspectives including technical, social and economic standpoints, and will help continuously monitor and document the service performance over time, each indicator will contain a well-defined description and a target to be achieved,

The list of indicators for each use case are listed in the tables below.

5.1 Murcia/Molina de Segura

Identified indicators for the Murcia/Molina use case are as follows:

Table 9: Main identified indicators for Murcia/Molina de Segura.

Indicator name	Description	Computation description	Quantification range ([0-1], 1 is best)	Target
Air Quality Measurement accuracy	Measures the accuracy of a measurement from low cost sensors conforms to the correct value from a reference device.	The accuracy will be computed from a mean absolute value error computation between the level of air quality computed from low cost sensors measurements and the air quality level computed from a reference measurement source	[0-5] 0 is best	1.5
Bike availability forecasting variations	Measurement of bikes availability forecast Dispersion Coefficient R2. The coefficient determines the quality of the model to replicate the results, and the proportion of variation in the results that can be explained by the model.	The accuracy will be computed with the sklearn. metrics.r2_score implemented in the scikit-learn package	[0-100%] 100% is best	80%
Bike availability forecasting accuracy	Assessment of the accuracy of the bikes availability forecasting	Bikes available vs bikes forecasted	[0-100 %] 100 is best	75% or 6 bikes

5.2 Flanders

Identified indicators for the use case in Flanders are as follows:

Table 10: Main identified indicators for Flanders.

Indicator name	Description	Computation description	Quantification range ([0-1], 1 is best)	Target
Bike availability forecasting accuracy	Assessment of the accuracy of the bikes availability forecasting	Bikes available vs bikes forecasted	[0-100 %] 100 is best	75%

5.3 Nice

Identified indicators for the Nice use case are as follows:

Table 11: Main identified indicators for Nice.

Indicator name	Description	Computation description	Quantificatio n range ([0-1], 1 is best)	Target
AQI forecast model accuracy	Accuracy of the AQI forecasting model	Real measured Air Quality Index vs. Forecasted Air Quality Index: Evaluated using Euclidean norm	[0-100%] 100 is best	75%
Daily recommendatio n number	Refers to the number of recommendations provided by the service implemented in the Nice use case, based on the traffic density and air quality assessment. A recommendation can either be a short term recommendation to change transportation for public transport, or to not change anything	Number of recommendations per day averaged over two weeks' time of the experimentation	Highest is best	2
% of the city's traffic addressed	Refers to the percentage of the city's traffic addressed by the implemented solution.	Daily traffic measurement in targeted zones vs total traffic in the whole city	[0-100%] 100 is best	50%

Indicator name	Description	Computation description	Quantification range ([0-1], 1 is best)	Target
Noise annoyance forecast model accuracy	Accuracy of the noise annoyance forecasting model	Real noise vs. Forecasted noise: Evaluated using Euclidean norm	[0-100%] 100 is best	75%

6 Conclusion

In this document, we carried the identification of the use cases to be deployed in Murcia/Molina, Nice and Flanders cities, the data sets to be used and the green mobility services suggested for deployment. These scenarios are leveraging on high value open data sets provided by European cities in their public portals, in the European Data Portal or other open-source available data sets.

Also, new data models are expected to be identified in the different use cases as we go forward with the project.

The identified data sets will allow third parties to provide high value services in green and smart mobility for citizens, companies, and public administrations.

The main benefits of these use cases are the harmonization of the collected data from different sources (cities, data portals, sensors, Copernicus) to cross-services, to allow cities to share functionality by the combination of these data sets and the interoperability between different administrations (cities, regions, commercial mobility providers) which will allow cities to share data, services, and benefits (cost reduction, environmental commitment, citizens satisfaction, creation of local business).

Moreover, a study of the correlation of these data sets with the European open data portal will be carried out to identify and add the missing data sets which will be evoked in future deliverables.

The detailed information about the use of the data models is already pending when this deliverable is published, so further details are expected in the next version to be published in month 12 of the project.

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