DELIVERABLE

D4.5 Digital Twin CS data integration and prototype 3

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List of Abbreviations

Abbreviation	Definition
AR	Augmented Reality
API	Application Programming Interface
CS	Citizen Science
CRUD	Create, Read, Update, Delete
CSV	Comma Separated Values
CO2 Dashboard	Carbon Footprint Simulation Dashboard
CS	Citizen Science
DEVA	Dynamic Exposure Visualisation App
dev-d	Dynamic Exposure Visualisation Dashboard
Fig	Figure
GUI	Graphical User Interface
GPS	Global Positioning System
ID	Identification
MS	Milestone
M	Month
PMD	Policy Monitoring Dashboard
OGC	Open Geospatial Consortium
PO	Product Owner
REST	Representational State Transfer

Abbreviation	Definition
UAQI	Universal Air Quality Index
UI	User Interface
URL	Uniform Resource Locator
WP	Work Package
3D	Three Dimensional

Executive Summary

This document describes the open public version of the **COMPAIR** prototype. This is the final version of the prototype that includes a full set of functionalities covering all project pilots. It also incorporates feedback received during the evaluation periods and of course, encapsulates all the achievements and updated tools and components coming from the other work packages.

The components comprising the open public version of the **COMPAIR** prototype are the following: 1) The Policy Monitoring Dashboard (PMD); 2) The Dynamic Exposure Visualisation Dashboard (DEV-D); 3) the Carbon Footprint Simulation Dashboard (CO2); 4) the Dynamic Exposure Visualization App (DEVA).

The open public version has been built via Sprint iterations taking into account the list of epics as defined by the Pilot partners in cooperation with the Product Owners (POs).

The deliverable provides an overview of the current functionalities in the form of a user guide. The scope of this document is to act as an appendix to the final version of the **COMPAIR** open public prototype.

1. Introduction

This deliverable aims to provide an overview of the open public version of the **COMPAIR** prototype. To this end, the report describes the current functionality which is explained in the form of a user guide.

Following the implementation of the individual tools in WP3 (Sensor Development and Technical Innovation), this WP delivers the open public version of the **COMPAIR** prototype The content presented in this deliverable is based on the progress of the technical work packages taking into account the feedback received from the evaluation phases.

Taking into account the prioritisation of the requirements and the Pilots' needs based on the Agile principles[1] we are following, we focus our work on the implementation of the final versions of the Policy Monitoring Dashboard (PMD), the Carbon Footprint Simulation Dashboard (CO2 dashboard), the Dynamic Exposure Visualisation App (DEVA) and the Dynamic Exposure Visualisation Dashboard (DEV-D).

This document reports on the activities and effort placed in the implementation of the various technologies and tools provided by the WP3 towards delivering the final release of a functional **COMPAIR** prototype. The integration effort is guided by the Agile Software Development methodology, aiming to progress the development work in parallel teams and regularly integrating their output, based on a well-defined design.

The scope of this document is to act as an appendix to the current version of the **COMPAIR** open public release and it is structured as follows:

- Section 2 provides an overview of the development aspects of the **COMPAIR** prototype;
- Section 3 presents a user guide with the main functionality of the PMD;
- Section 4 presents a user guide with the main functionality of the DEV-D;
- Section 5 presents a user guide with the main functionality of the CO2 dashboard;
- Section 6 presents a user guide with the main functionality of the DEVA;
- Section 7 concludes this report

Note for the reader: it has to be noted that the Digital Twin aspect of the project is covered in the D3.6: Digital Twin CS Integration.

[1] https://en.wikipedia.org/wiki/Agile_software_development

2. Development of the COMPAIR open public version

The **COMPAIR** open public version has been implemented via Sprint iterations following the agile process, as described below, in concrete steps:

- The Pilot Users along with the assigned Product Owners (POs) agreed on specific epics (described in Table 1);
- The selected epics were broken down in Stories / Tasks by the POs and the technical team;
- The Prioritized Stories became available in **COMPAIR** Jira from the POs;
- The technical **COMPAIR** team organized bi-weekly Sprints (sprint planning meetings) where team members came together in order to lay out the components for the upcoming round of work;
- The POs reviewed the finished user stories and provided early and constructive feedback;
- Monthly Sprint Reviews were organized with the rest of the Consortium partners with the aim to present the working software to the Pilots;
- Pilot partners tested the provided functionalities and provided their feedback;
- POs translated the feedback provided into Jira stories / tasks.

Taking into account the list of epics as defined by the Pilot partners in cooperation with the POs, the list of epics for the open public version (taking into account the comments/ feedback provided during the evaluation phase) as refined and given in the technical team is presented in table 1.

Table 1: List of epics identified and used for the open public version

ID	EPICS
AllUMa	**User Management**
	Story: As a logged in citizen I want to be able to reset my password
AllExp	**Export Data**
	Story: As a citizen, I want to be able to export the elements of the dashboard (e.g. to png), so I can share the information via mail, social media etc
	Story: As a citizen, I want be able to export the data of the Carbon Footprint Simulation Dashboard (e.g. to csv), so I can share the information via mail, social media
	Story: As a citizen, I want be able to export the data of a project from the PMD to xslx , so I can share the information via mail, social media etc
AllL&f	**Look and Feel**
	Story: As a citizen, I see a footer, header, logos on the Carbon Footprint Simulation Dashboard, so I get some general information about COMPAIR
	Story: As a visitor, I can switch the language of the PMD to my language
	Story: As a visitor, I can switch the language of DEVA to my language
	Story: As a visitor, I can switch the language of the CO2 dashboard to my language
	Story: As a citizen, I can open a project dashboard in a new window outside the container
	Story: As a citizen I can read an explanation of each graph of the PMD, so I understand what they mean

ID	EPICS
	Story: As a user, I get an indication when loading data in the PMD takes long, so I know I need to be patient
AllSha	**As a User I can copy the current state of the tool or dashboard, so results of my analysis can be communicated**
	Story: As a user of the PMD, I can copy a URL that allows recreating the complete status of the PMD so I can share that in reports, emails etc
BackCAL	**Calibration Engine for Air pollution sensors**
	Story: As a developer, I can ingest sensor observations from SODAQ Air so that I can develop a component that sends OGC-formatted data to the Data Manager.
	Story: As a developer, I can send the output of calibration data to ATC according to the agreements stated in integration document
	Story: As a developer, I can create a calibration model database: every week we update the model(s) used for calibration base on the acquired data, we need to keep the history of the models used to calibrate for reproducibility
	Story: As a developer, I can develop the calibration pipeline: this is responsible to retrieve historical data from OGC, train the model and store it in the calibration model database
PMDproj	**As a citizen I can use a dashboard created for a certain project, so I can assess impact of policy changes**
	Story: As a citizen, I can go to a specific project dashboard so I can inspect policy impact
	Story: As a citizen, I can indicate 2 periods to take into account for the graphs
	Story: As a citizen, I see a QuickScan box, with the dates of the 2 periods in blue and yellow
	Story: As a citizen, I see graphs depicting the daily average of the different measurements
	Story: As a citizen, I see graphs depicting the total values of the different measurements
	Story: As a citizen, I can add and remove a box to contain advanced graphs
	Story: As a citizen, I can see the detailed traffic counts in a graph
	Story: As a citizen, I can see detailed air pollution in a graph
	Story: As a citizen, I also see air pollution data coming from the IMEC calibration engine in the quickscan box
	Story: As a citizen, I can see bcmeter in the project dashboards
	Story: As a citizen, I get meaningful names for the traffic sensors, so I can more easily relate them to the map
	Story: As a citizen, the dates of the project dashboards are filled in, so I do not need to worry about it
	Story: As a visitor, I am not confused by unused selection boxes
	Story: As a citizen, I know the graphs are using only the period the schoolstreet is blocked and not when it is open so I have a good view of the impact of the closure
	Story: Allow to show relative differences for air and traffic measurements
	Story: As an admin, I want to enable measuring for full days in my project
	Story: As a citizen, I also see air pollution data coming from the IMEC calibration engine in the advanced graph box
	Story: As a citizen, I see sensor.community data in the project dashboards
	Story: allow to show relative differences for air and traffic measurements
	as a citizen, I can sort the sensors in a project by clicking on the headers of the

ID	EPICS
	table
	Story: As a citizen, I can see the relative increase/decrease of values measured instead of absolute so I have a better view on the impact of a policy measure
PMDGam	Story: As a citizen, I can see a graph in my project that shows how close we are to the target of nr of bicycles (gamification)
PMD Con	As a citizen I want to see context data like weather, roadworks so I can take this context into account when assessing the impact of policy decisions
	Story: As a citizen, I can see the weather information with the advanced graphs in project mode, so I can take the impact of weather into account in my analysis
PMDMan	**Dashboard Management**
	Story: As an admin, I can create a project dashboard so citizens can assess the impact of policy changes
	Story: As an admin, I can delete a project dashboard
PMDAir	**Air in PMD**
	Story: As a citizen, I can see and access the BCMeter sensors, so I know about black carbon air quality
	Story: Show NO2 data in the browse mode
	Story: Show calibrated SODAQ data in PMD mode
	Story: Show NO2 data in project mode
PMDTra	**Traffic in PMD**
	Story:Telraam to send more granular data (every 15 minutes)
	Story: As a citizen, I can get extra information about the Telraam sensor through the dashboard so I can inspect
PMDMap	**Map in PMD**
	Story: As a citizen, I type in the name of a street to position the map to that location
	Story: As a visitor, I can select the source together with the parameter to be used in the browse mode so I can decide to see sensor.community data, SODAQ, etc.
Co2Cal	**Carbon Footprint Calculator**
	Story: As a citizen, I can keep a history of my previous calculator results, so I can see how my carbon footprint changes over time
	Story: As a citizen I can read explanations about the Carbon Domains, so I can better understand how to use the calculator.
	Story: As a citizen, I can see only my calculator results in my Profile, after I have logged in.
	Story: As a citizen, I can add multiple vehicles for the calculation of my carbon footprint
	Story: As a citizen, I can include the energy efficiency of my appliances in the calculation of my carbon footprint
	Story:As a citizen, I want to be able to see recommendations for the calculation I select on my Profile
Co2Sce	**Scenario Simulation**
	Story: As a citizen, I can keep a history of my previously submitted scenarios, so I can see how my understanding of how emissions can be reduced changes
	Story: As a citizen, I can see only my scenarios in my Profile, after I have logged in.
	Story: As a citizen, I can read explanations about the Scenario Simulation, so I can better understand how to use it.
	Story: As an admin, I can add links to information sources for each recommendation I create, so users can get informed on how to apply those

ID	EPICS
	recommendations
	Story: As a citizen, I can choose government actions at a local (e.g. municipal) level
Co2RRe	**Carbon Footprint Reduction Recommendations**
	Story: As a citizen, I want to get links to information sources for each recommendation, so that I understand how I can adopt a recommendation
Co2Man	**Management**
	Story: As an admin, I can read explanations about the Admin Page, so I can better understand how to use it.
	Story: As an admin, I want my input to be validated, so it is easier for me to create new scenarios, actions, and recommendations.
	Story: As an admin, I can have access to the Admin Page of the CO2 Dashboard
	Story:As an admin, I can add scenario actions at a local (e.g. municipal) level
DEVAViz	**Visualise data in 3D Space**
	Story: As a citizen/researcher, I want to get access to the Sensor Community data, so I can see AQ data in the case where there are poor data or I'm not in a pilot area
DEVAAnn	**Annotate Measurements**
	Story: Create field to add SODAQ sensor ID in the Trip window, either manually or via QR-code scan
	Story: Record basic trip features: personalised user ID, trip name and trip description
	Story: As a citizen, I can do data annotation about my current activity or the context (e.g. start trip, type of trip, end trip) as well as my health status
	Story: Calculate average speed and present very simple visualisation
	Story: Measure trip distance (in order to ensure that users are moving)
DEVAMan	**Management**
	Story: As a researcher, I can monitor whether a device is measuring effectively during the experiment by getting a signal when the device is on, but not measuring data
DEVAUI	**User Interface**
	Story: Link GUI buttons featured with web-links to the corresponding COMPAIR web pages
	Story: Change/create login screen
	Story: As as citizen, I want to record my trip
DEVARea	**Real-time communication and information visualisation**
	Story: New sensor data has to be requested according to the movement of the user
	Story: New sensor data has to be requested after the user change some sensor type filtres e.g. by the equalizer
DEVAUsI	**Update user information**
	As a citizen, I want to see an instruction window, so I know how to use the app
DEDHis	**Display Historic Information about Trips**
	Story: As a citizen, I can see the trips that are made with a SODAQ device on a map so I know where people went
	Story: As a citizen, I can see a graph showing the exposure of a single trip so I can inspect the exposure
	Story: As a developer, I can access the trips recorded by the SODAQ devices, so I can build dashboards on that data
	Story: As a researcher, I want to filter the available trips (on pilot and AQ

ID	EPICS
	parameter) so I get a better overview
	Story: As a citizen/researcher, I want to see where trips have an overlap so I get a better overview
	Story: As a citizen/researcher, I want to have a short trip-reference in the trip list that also appears on the map so I can connect both easily.
	Story: As a citizen/researcher, I can click a trip segment on the map, it will show me a balloon with information so I know the measured AQ and speed at that spot.
	Story: As a citizen/researcher, I get an impression of the AQ levels by looking at the colors of each trip segment, so I can easily see where trip AQ was good or bad.
	Story: As a citizen/researcher, I get a better impression of the AQ levels by looking at the colors and reference points (same as shown on the map) integrated into the graph, so I can easily see where trip AQ was good or bad.
	Story: As a citizen/researcher, I want to see where I paused my trip and where the GPS-connection was interrupted, so I have a better overview (DEV-D version 1).
	Story: As a citizen/researcher, I want to see the air quality in function of time and distance, so I can better understand the trip (DEV-D version 1).
	Story: The average speed indicated in the DEV-D when clicking a trip segment is too high (DEV-D version 1).
	Story: As a citizen/researcher, I want to see my full trip in the DEV-D so I can include small trips and I have a global overview (DEV-D version 1).
	Story: As an admin, I want to get user statistics (DEV-D version 1).
	Story: As a citizen/researcher of f.i. Plovdiv/Sofia, I want to see model data on my DEVA trip in DEV-D so I have an idea about the air quality (DEV-D version 2).
	Story: As a citizen/researcher I want to see my exposure to air quality parameters, so I have an idea how a trip affects my health (DEV-D version 3).
	Story: As a citizen/researcher I want to have my temporal working space in DEV-D, so I can compare different trips (DEV-D version 2).
	Story: As a citizen/researcher I want to see a selection of trips in DEV-D map, so I can compare their trajectory (DEV-D version 2).
	Story: As a citizen/researcher I want to see a selection of trips in DEV-D graphs, so I can compare their air quality measurements (DEV-D version 2).
	Story: As a citizen/researcher I want to see my personal exposure to air quality parameters in a graph, so I have an idea how a trip affects my health (DEV-D version 3).
	Story: As a citizen/researcher I want to see information about exposure to air quality parameters on the map and in the clipboard list, so I have an idea how a trip affects my health (DEV-D version 3).
HrdwImp	**Hardware Improvements**
	Story: As a researcher, I want to rely on the accuracy of the SODAQ Air PM sensor to meet the indicative requirement of VMM.
	Story: As a developer, I can access the sensorthings api through grafana so I can easily build technical dashboards

The components comprising the open public version of the **COMPAIR** prototype are the following: the Policy Monitoring Dashboard (PMD), the Carbon Footprint Simulation Dashboard (CO2), the Dynamic Exposure Visualisation App (DEVA) and the Dynamic Exposure Visualisation Dashboard (dev-d).

Screenshots of the main pages of the Open public release are presented in the following subsections and describe the platform's main functionalities. By opening a web browser and entering the platform's Uniform Resource Locator (URL) https://monitoring.wecompair.eu/, the user gets into the Homepage of the **COMPAIR** Prototype.

Via the landing page (Figure 1), the user is able to access information about the **COMPAIR** offerings. General information about the offerings as well as access to the dashboards is provided. It should be noted that the tools act as standalone components as well.

The Admin of Container Dashboard has the authority to perform certain actions like adding / editing / removing users and giving them roles as Users or Administrators. The User management functionality is located in the main menu on the left of the Container Dashboard / Monitoring Application.

For administrator users of the platform, the Matomo analytics tool has been integrated, providing them with comprehensive insights into user interactions, traffic patterns, and engagement metrics.

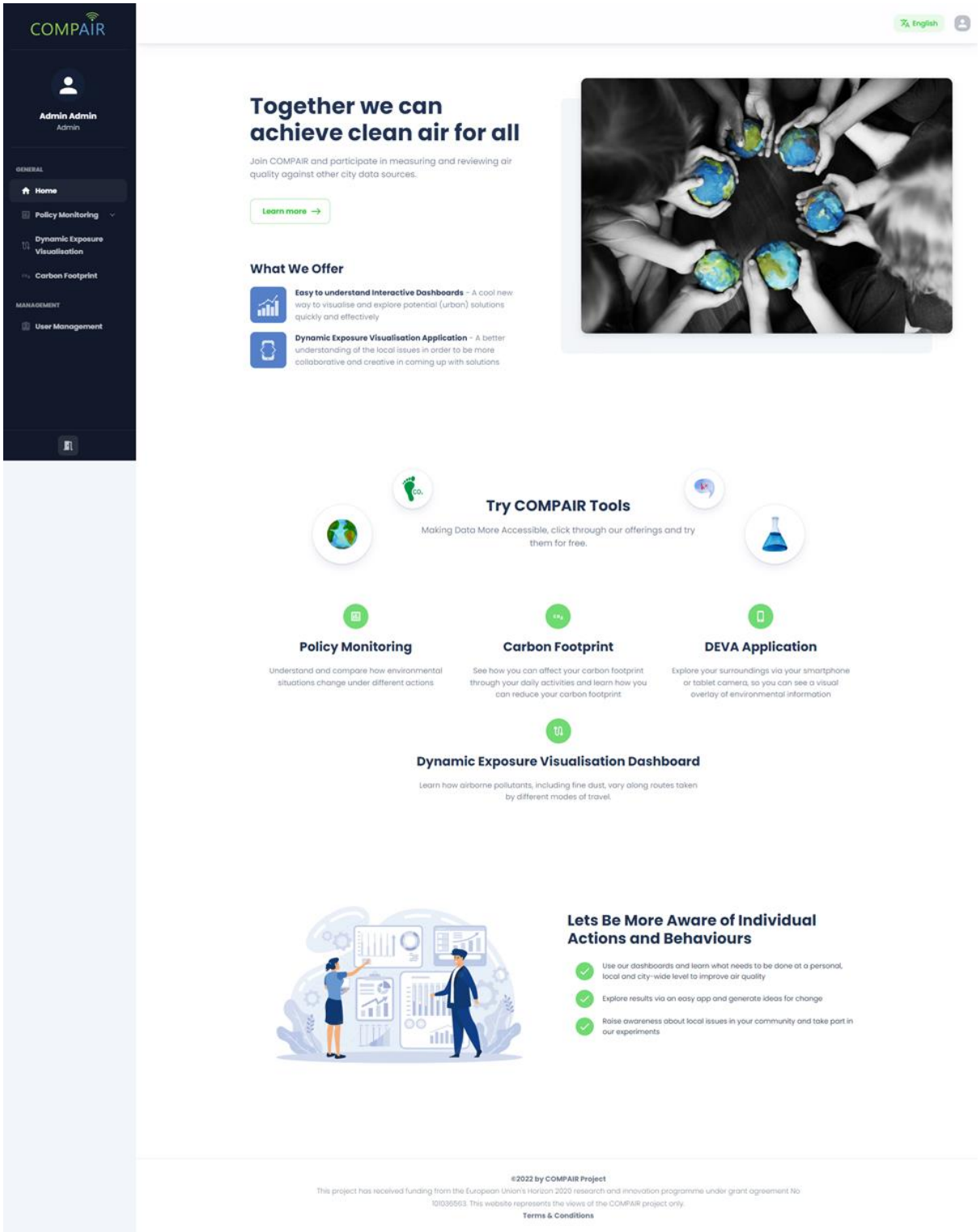


Figure 1 The ***COMPAIR*** Landing Page

3. Policy Monitoring Dashboard (PMD)

The Policy Monitoring Dashboard (PMD) helps users understand and compare how environmental situations change under different actions. By collecting a large amount of Citizen Science (CS) information in a particular setting, the Dashboard will be able to show the impact of different policy implementations on traffic and air quality.

List of epics implemented for the PMD open public version

The following table presents the list of epics implemented for the open public version

Table 2 List of epics implemented for the open public version of the PMD

ID	EPICS
PMDproj	**As a citizen, I can use a dashboard created for a certain project, so I can assess impact of policy changes**
	Story: As a citizen, I can go to a specific project dashboard so I can inspect policy impact
	Story: As a citizen, I can indicate 2 periods to take into account for the graphs
	Story: As a citizen, I see a QuickScan box, with the dates of the 2 periods in blue and yellow
	Story: As a citizen, I see graphs depicting the daily average of the different measurements
	Story: As a citizen, I see graphs depicting the total values of the different measurements
	Story: As a citizen, I can add and remove a box to contain advanced graphs
	Story: As a citizen, I can see the detailed traffic counts in a graph
	Story: As a citizen, I can see detailed air pollution in a graph
	Story: As a citizen, I also see air pollution data coming from the IMEC calibration engine in the quickscan box
	Story: As a citizen, I can see BCmeter in the project dashboards
	Story: As a citizen, I get meaningful names for the traffic sensors, so I can more easily relate them to the map
	Story: As a citizen, the dates of the project dashboards are filled in, so I do not need to worry about it
	Story: As a visitor, I am not confused by unused selection boxes
	Story: As a citizen, I know the graphs are using only the period the schoolstreet is blocked and not when it is open so I have a good view of the impact of the closure
	Story: Allow to show relative differences for air and traffic measurements
	Story: As an admin, I want to enable measuring for full days in my project
	Story: As a citizen, I also see air pollution data coming from the IMEC calibration engine in the advanced graph box
	Story: Allow to show relative differences for air and traffic measurements
	Story: As an admin, I want to enable measuring for full days in my project
	Story: As a citizen, I also see air pollution data coming from the imec calibration engine in the quickscan box
	Story: As a citizen, I see sensor.community data in the project dashboards
	Story: As a citizen, I can sort the sensors in a project by clicking on the headers of

ID	EPICS
	the table
PMDMan	**Dashboard Management**
	Story: As an admin, I can create a project dashboard so citizens can assess the impact of policy changes
	Story: As an admin, I can delete a project dashboard
	Story: As an admin, I can edit a project dashboard
PMDAir	**Air in PMD**
	Story: As a citizen, I can see and access the BCMeter sensors, so I know about black carbon air quality
	Story: Show calibrated SODAQ data in PMD mode
	Story: As a citizen, I can get extra information about the air quality sensor through the dashboard so I can inspect
	Story: As a citizen, I can select a longer period to show in the group graphs in browse mode
	Story: Show NO2 data in project mode
	Story: Show NO2 data in the browse mode
	Story: As a citizen, I can select a longer period to show in the graphs in browse mode
PMDTra	**Traffic in PMD**
	Story: Telraam to send more granular data (every 15 minutes)
	Story: As a citizen, I can get extra information about the Telraam sensor through the dashboard so I can inspect
PMDMap	**Map in PMD**
	Story: As a citizen, I type in the name of a street to position the map to that location
	Story: As a visitor, I can select the source together with the parameter to be used in the browse mode so I can decide to see sensor.community data, SODAQ.
	Story: As a citizen, I can get extra information about the Telraam sensor through the dashboard so I can inspect
	Story: As a developer, I can get extra information about the Telraam sensor so I can display it to users
PMDCon	**As a citizen, i want to see context data like weather, roadworks, So I can take this context into account when assessing the impact of policy decisions**
	Story: As a citizen, I can see the weather information with the advanced graphs in project mode, so I can take the impact of weather into account in my analysis
PMDGam	**As an admin, I can trigger behavior using the dashboard by using gamification techniques, so I can increase take up of the dashboard**
	Story: As a citizen, I can see a graph in my project that shows how close we are to the target of nr of bicycles (gamification)

User Guide

The following section presents a User Guide for the third release (Public version) of the Policy Monitoring Dashboard. The **COMPAIR** consortium has acquired the following url for accessing the dashboard: https://pmd.wecompair.eu/.

Screenshots of the main views of the PMD are presented in the following sub-sections, which describe the functionalities of the PMD implemented for the third release.

Browse mode - Parameters and sources

On the homepage/browse mode (figure 2) https://pmd.wecompair.eu/, the user can now select and view air and traffic sensor data based on the selected sensor type (parameter) and data source. These observation values are depicted as hexagons on the map, in which the user can zoom in, zoom out, pan and view more information about them from the sensor menu popover option.

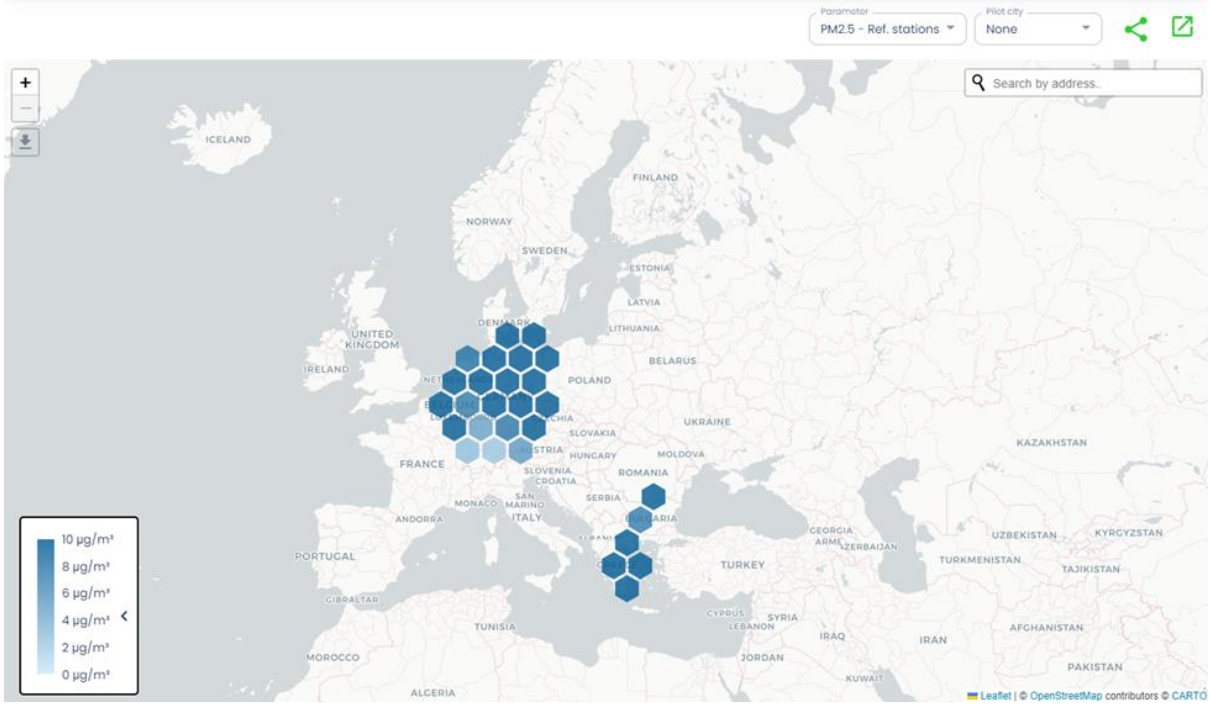


Figure 2: Browse mode (map view)

As displayed in figure 3 the user can select a parameter from the list (PM2.5, PM10, NO2, BC, Pedestrian, Bike, Car and Heavy vehicle) that is also linked with a source that is displayed next to each parameter (Reference Stations, SODAQ, Sensor.community, Telraam, OnePlanet).

On the Home page (figure 3), the user can view air and traffic sensor data based on a specific parameter. Sensor locations are grouped and visualized as hexagons placed as an overlay on top of a map.

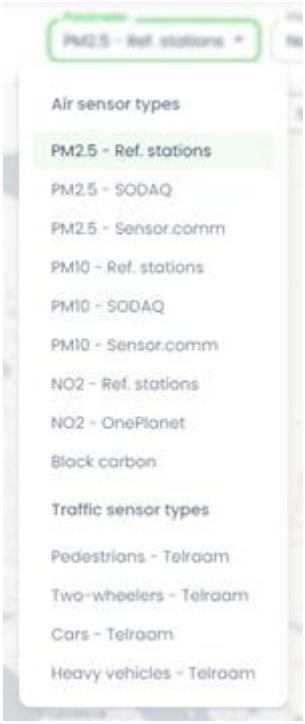


Figure 3: Parameter and source dropdown selection

The fill colour of an individual hexagon represents the median value of all sensors included in that hexagon and is based on a gradient scale of the active parameter layer (figure 4).

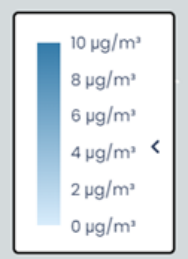


Figure 4 Hexagon value gradient scale for air quality

The user can interact with the map by zooming in and out, using the plus '+' and minus '-' icon respectively (placed on the top left corner of the map), using the mouse wheel or by 'pinching' the screen on tablets/mobiles. While zooming in, the initial hexagons are broken down into smaller hexagons that include fewer sensors than the previous zoom level (as shown in figure 5).

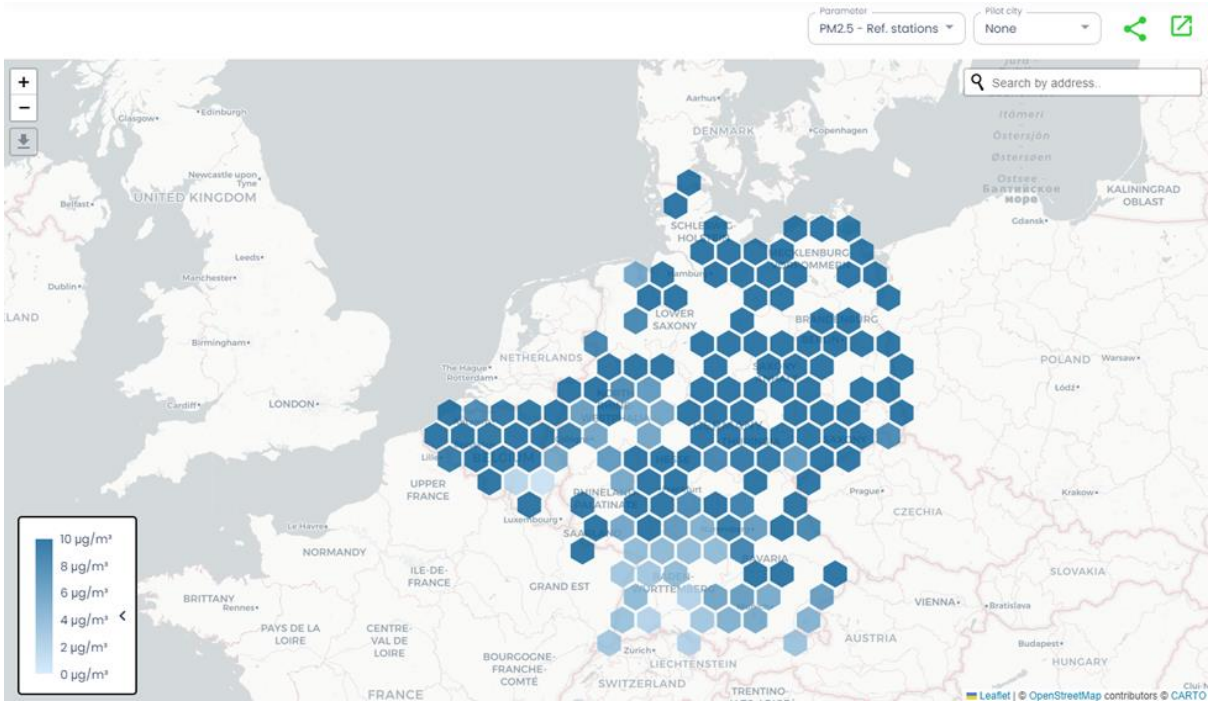


Figure 5 Zoomed-in map with a more granular view

When the user hovers over a hexagon, information about the number of sensors present in that specific hexagon is displayed (figure 6).

Figure 6: Hexagon sensors count

At the top of the screen, the user can find a list of drop-down options, such as Language, Parameter and Pilot city (figure 7).

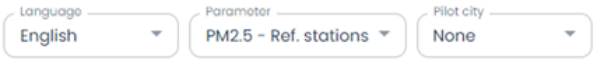


Figure 7 Map header/dropdown options for users

In addition, the user is allowed to download the PMD hexagon data for the selected parameter in a Microsoft Excel spreadsheets (xlsx) format by clicking the download button (figure 8).

Figure 8 Download button

The user can export the data of the sensors that are part of the screen and belong to the parameter value previously selected from the drop-down. In case the data is over 1 million rows (in the xlsx file), then the user must zoom in more to be able to download the file.

Sensor info

To see more information about the individual sensors present in a hexagon, the user can click on a hexagon, where a popup context menu will appear (figure 9).

Figure 9 Hexagon popup/context menu

After selecting ‘Sensor info’ from the popup, a sensor menu modal appears on the screen (figure 10). On the left side of this panel, the user can see a list of all the sensors that are included in this hexagon. For each sensor the user can see its ‘id’(identifier), current value of the sensor, as well as the group which it is assigned to (if any).

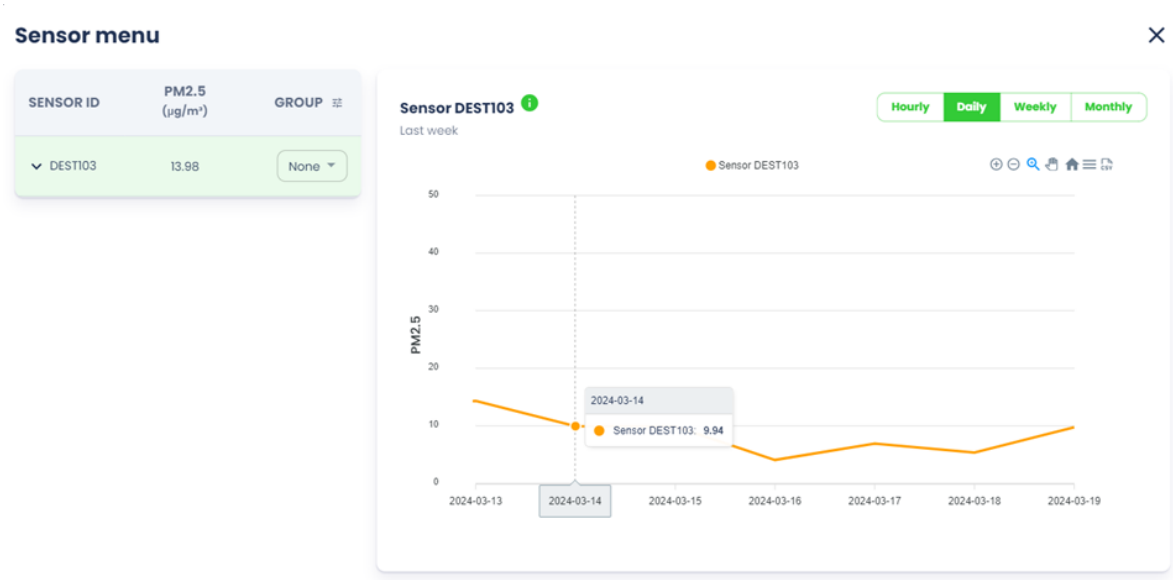


Figure 10 Sensor info menu

Upon clicking a sensor from the list, four graphs (Hourly, Daily, Weekly, Monthly) will be displayed in a tab menu on the right side of the panel showing the fluctuation of the parameter value for the selected sensor in a specific period (Last 24 hours, Last week, Last month, Last year) (figure 9). If the user clicks on the home icon on each graph 'all data' (historical data) will be available on the respective graph.

Additional sensor information

The user can also see more information about the sensors on the sensor menu list by clicking the expand icon located in the beginning of each item row. They can view the sensor id, the sensor type, the source, the parameters the sensor is measuring, when the sensor data was last updated, the location of the sensor, the availability of the sensor data as well as the sensor value distributions (figure 11).

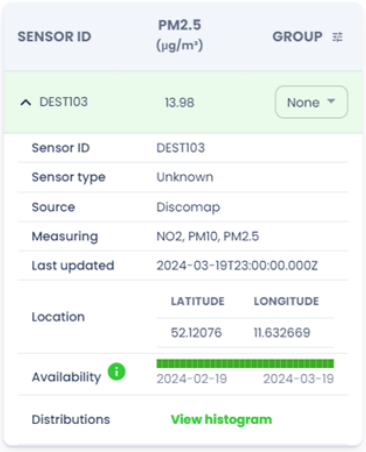


Figure 11: Expandable additional sensor information

The distributions are accessed by clicking on the view histogram text button, where the user can view all histograms per measuring parameter (figure 12). The histogram view allows a quick overview of the range of measured values in the selected period.

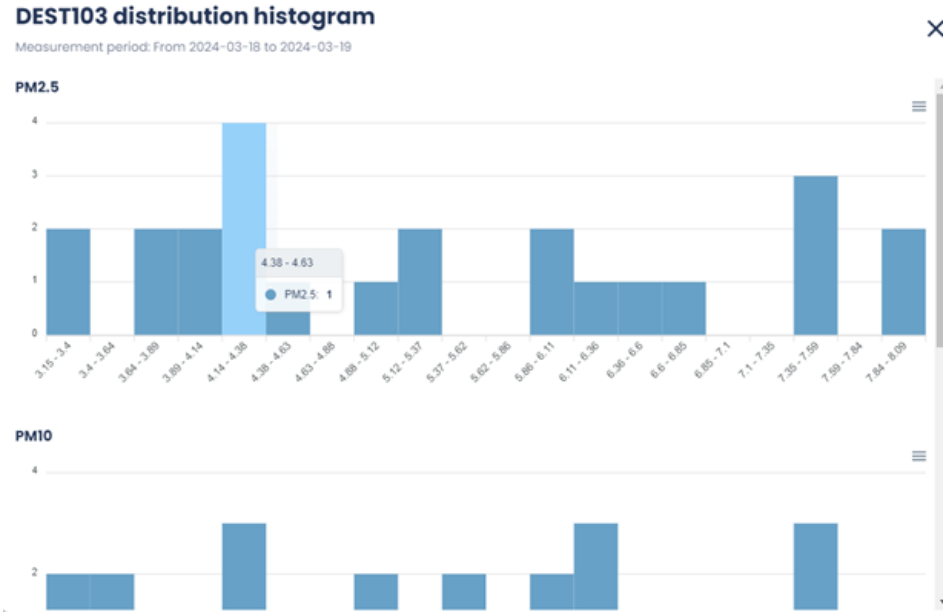


Figure 12 Distribution of sensor data (histograms)

Sensor groups

Each sensor can be assigned to user-defined groups, so that the user can visually distinguish these sensors on the map and to compare the sensor data from different groups.

The user has the ability to create one or two new groups per session. To create new groups, the user should click on the button next to the 'Group' column on the sensor list table. After that, a new modal entitled 'Groups management' appears, where the user can define a unique name for this new group (figure 13). Note here that each newly created group will be assigned a predefined colour (green, yellow).

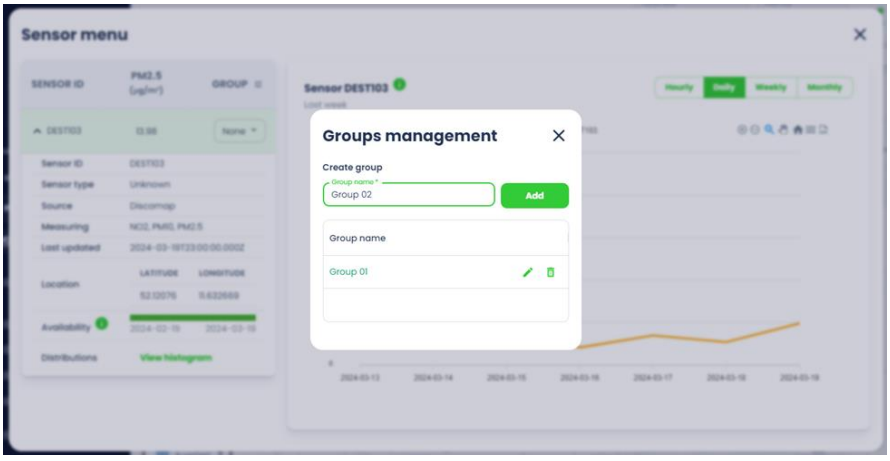


Figure 13: Create new sensor group

After creating a new group, the user can assign a sensor to a group from the dropdown list that appears by clicking the dropdown on the Group column of a sensor (figure 14).

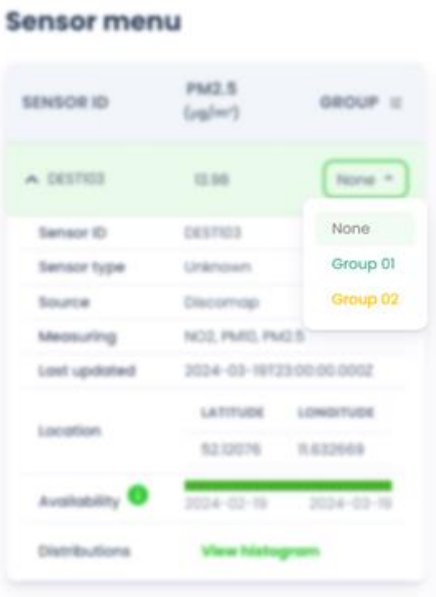


Figure 14 Select sensor group

By closing the menu and navigating back to the map view, the user may now see different colours on the outside border (stroke) of certain hexagons (figure 15).

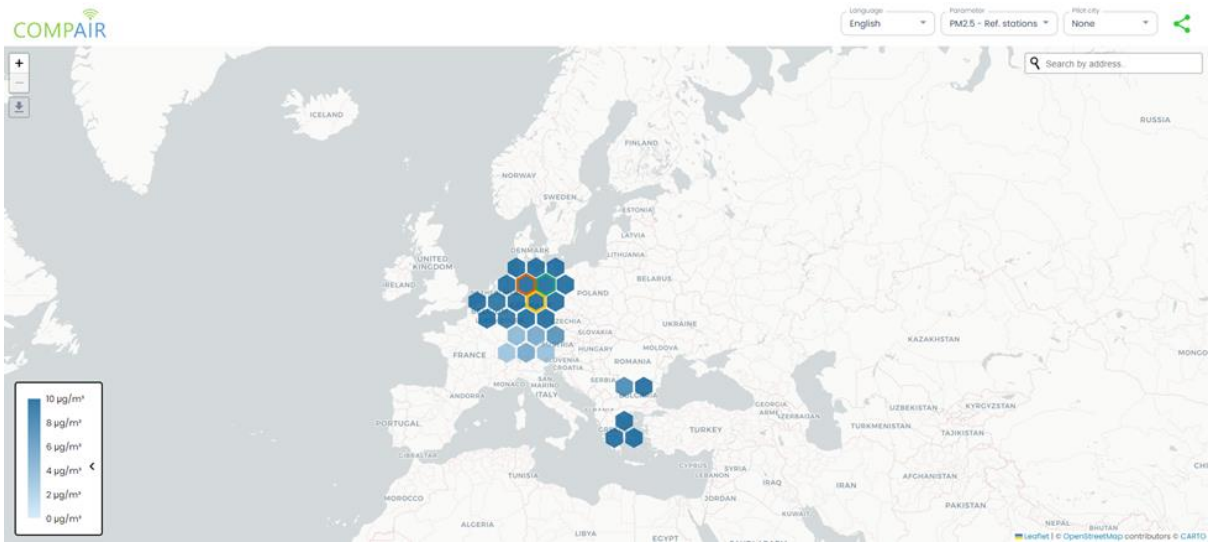


Figure 15: Hexagons with sensor groups

When a hexagon encapsulates sensors that have been assigned to the same group, the hexagon stroke colour will be the colour of the group.

When a hexagon encapsulates sensors that have been assigned to multiple groups, the hexagon stroke colour will be a specific orange colour.

Sensor group info

For the hexagons that have a stroke colour and therefore have sensors in them that are assigned to at least one group, the user can view additional group graphs. To display these graphs, click on a hexagon that has a stroke colour and select ‘Sensor group info’ from the context popup menu that has been introduced previously as well (figure 8). A graph like the one in figure 16 will now appear.

Figure 16 Sensor group graph

In this graph, the user can see different lines for all sensors that are assigned to a group and additionally a line for the median of each group. The individual sensors are displayed as dashed lines while the median values for the groups are displayed as a solid line. The colour of each line represents the colour of the group that each sensor is assigned to. While hovering over the graph, a tooltip appears for this specific timestamp showing information about the values of each line (sensor/median) (figure 17).

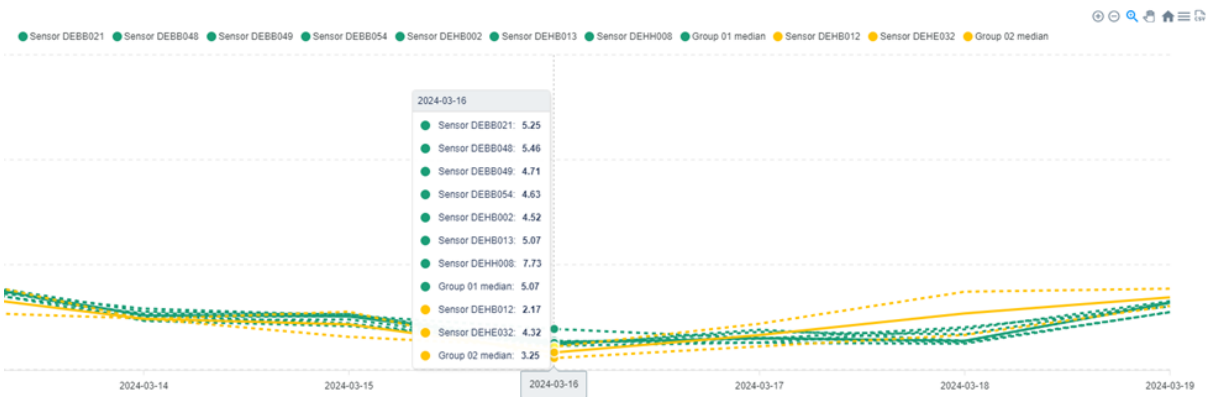


Figure 17 Sensor group graph tooltip

At the top of the chart, the user can also find an option to select and deselect specific lines to display them or not on the graph respectively (figure 18).

Figure 18 Sensor group graph legend

Additionally, the user can find various options at the top right corner of the graph, such as the option to export and download the data displayed on the graph (figure 19).

Figure 19 Toolbar of each graph

Map - Search address

Aside from panning and zooming in/out the map to browse for sensors, the user is able to search a specific location to fly to on this map. This search bar is located on the top right corner inside the map container. When a user searches a street name, a list will appear where they can select the most relevant result (figure 20).

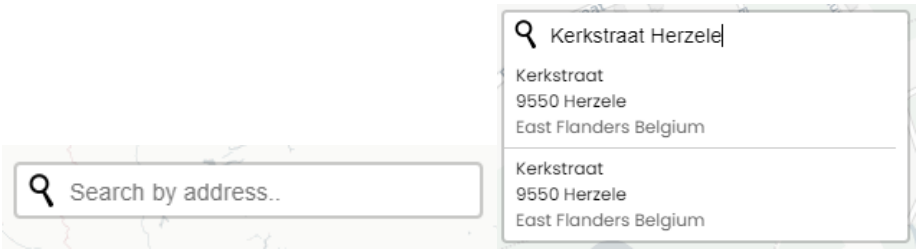


Figure 20 Search by address bar

Upon clicking a result, the user will navigate to that location and a marker will be placed on the map (figure 21) with a popover showing more information about that location/marker.

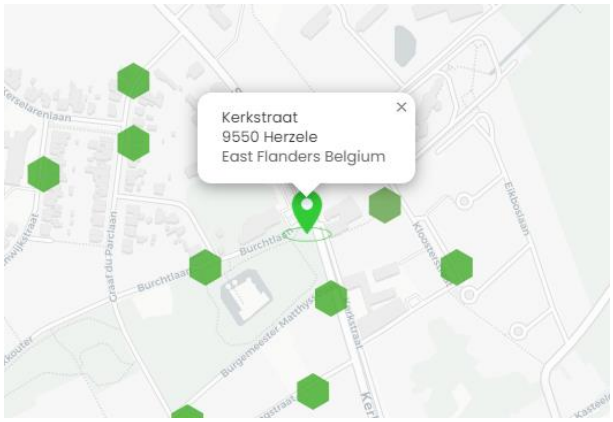


Figure 21: Address result on map

Project dashboards - View

In the sidebar of the Container Dashboard (https://monitoring.wecompair.eu/) application the user can view a list of project dashboards as shown in figure 22.

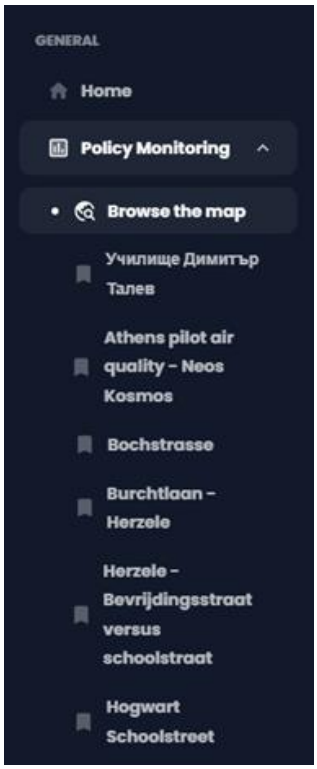


Figure 22 Project dashboards list in Container Dashboard application sidebar

These dashboards are created by the platform admins and their aim is to provide users with the ability to assess the air and traffic impact of policy measures in certain areas. The intent is to let visitors investigate the intended impact of policy measure in a target area while also measuring the potential negative impact in the surroundings of that target area. This is done by assigning sensors to two user-defined groups (e.g. Neighbourhood and School Street). The dashboard consists of a title and some context like a description of the project and the general functionality of the dashboard.
Next, the sensors are depicted on the map on the left side and the sensor list on the right side (figure 23). On the sensor list, the user can also see the name of the street where the sensor is located, the sensor type and the group it belongs to. The process of creating and updating such dashboards will be thoroughly explained in the next section.

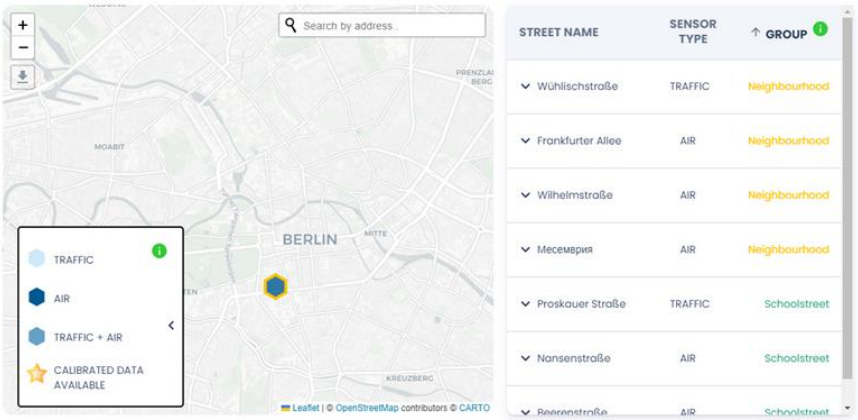


Figure 23 Project sensors on map and sensor list

When the user selects a sensor from the list, the sensor is highlighted with a black stroke around the hexagon it belongs to. Likewise, when the user clicks on a hexagon the sensors that belong to that hexagon are highlighted with a light green background and a black stroke at the top and bottom of each sensor in the sensor list (figure 24).

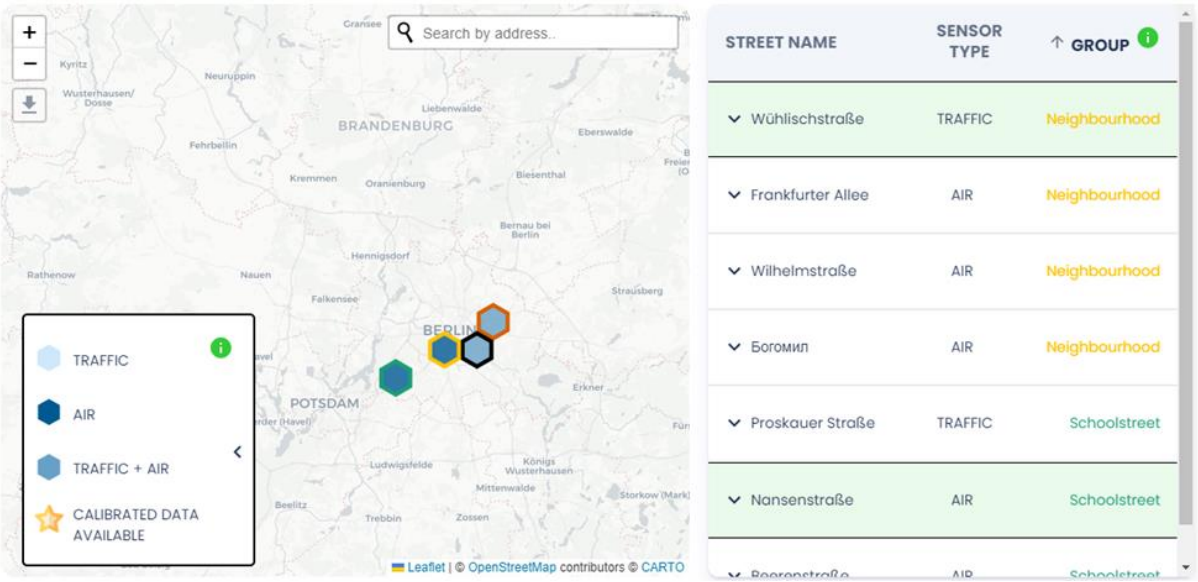


Figure 24 Selected hexagon showing selected sensors on the list

In Project mode the user has the ability to export the data of the sensors that are part of the project in a xlsx file (list and pivot table), separated in two periods (1st period and 2nd period).

In case the data is over 1 million rows, the user gets a message to limit the number of days in both periods to a specific number to be able to export (figure 25).

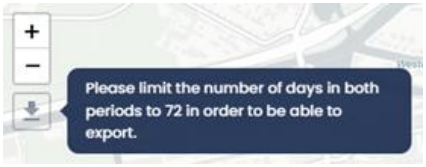


Figure 25 Export message in case the export is unavailable

Below this section, the user can view some graphs (quickscan and advanced) with data coming from the IMEC calibration engine, BCmeter [6] and Telraam [7] that are based on two period dates (figures 26, 27 and 28). These dates are either automatically generated based on the project start of measurement and policy change date, or explicitly set by the Admin of the project in the admin/create dashboard page.

In the quickscan graphs, the user is presented by default with the deltas of each group and has the ability to show and hide other options as well (before/after of each group). In the quickscan box, the user can quickly investigate traffic and air quality data before and after introducing a policy measure for both the target and neighbourhood zones (figure 26).

Figure 26 :Quickscan graphs

The user can also select the option <Group Name> - difference (relative in %) to see relative differences for air and traffic measurements in % (figure 27). These measurements are depicted as a line with the matching colour of each group. The Y-axis for the relative graphs is on the right side of the diagram.

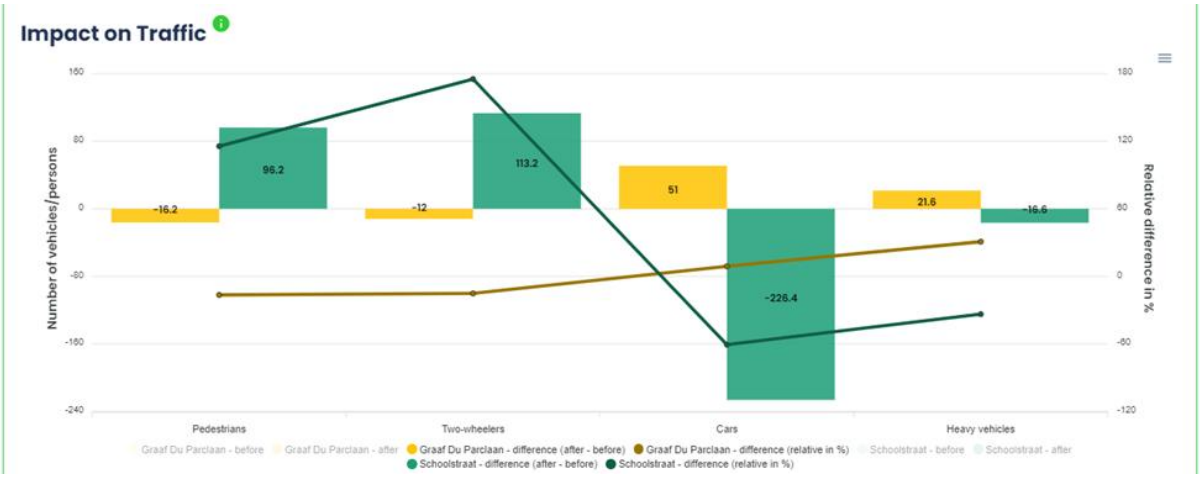


Figure 27 Quickscan graphs with the option relative difference in %

By clicking on the “Show advanced graphs” button, the user is provided with more advanced graphs, where they can visually compare two vertically aligned graphs combining air/traffic data of the two groups (figure 28). The user, by hovering their mouse pointer over one plot, can reveal detailed information for both graphs at that date, allowing thorough inspection (figure 28).

Figure 28 Advanced (deep dive) graphs

As it is displayed in figure 29 the user can check the weather indication on the advanced graphs. The weather indication is provided with a description and a weather icon. When the user hovers over the icon, the description comes up.

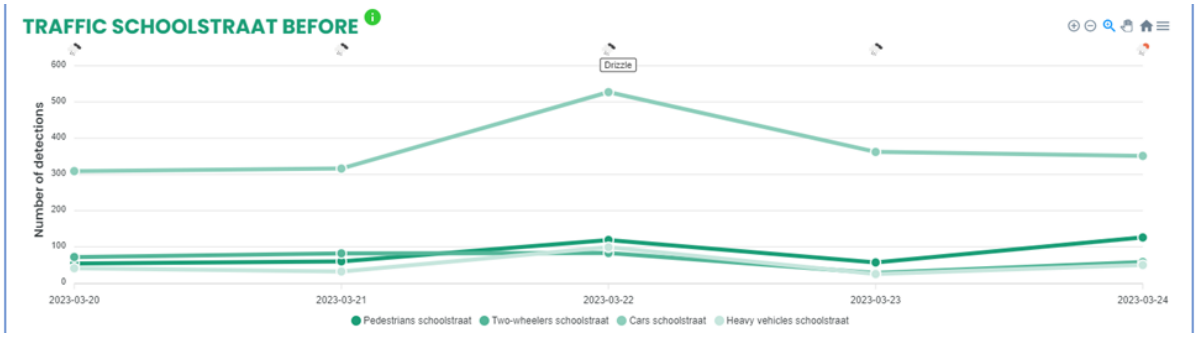


Figure 29 Weather indication on Advanced (deep dive) graphs

To show weather indication the source open-meteo[2] was used.

Additionally, the user can select different options and parameters that affect the data shown in the charts (figure 30). The user can select the visualisation (before, after, delta), the sensor type and the group to display in each graph.

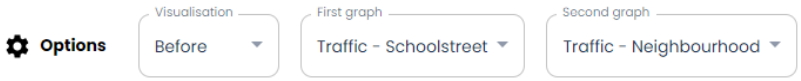


Figure 30 Advanced graphs options

The Users have the ability to overrule the dates of the 2 timewindows per session (figure 31). By clicking on the pencil icon button on Quickscan sections or Advanced Graphs section, the two periods change. This functionality will be explained in detail in the next section.

Figure 31 : Custom Periods on Graphs

Gamification Graph

The idea of Gamification is for the project participants to see how close/far they are on a daily basis from reaching their target per period. This period can be different from any period of the project. This graph is a cumulative graph, and it is displayed in the figure below (figure 32). As shown in the figure the green bar is the 'Below the Goal' measurement which means that the cyclists are less than the desired goal. In addition, the yellow bar is the 'Above the Goal' measurement which means that the cyclists are more than the desired goal and the project participants are rewarded with a crown icon. The goal is depicted as a red line.

[2] https://open-meteo.com/en/docs/historical-weather-api

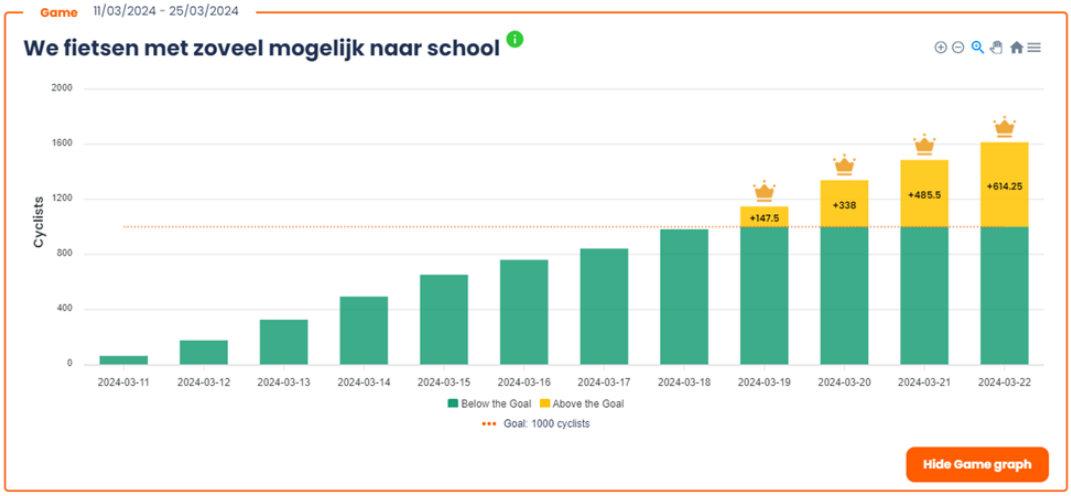


Figure 32 Game Graph

Project dashboards - Create

Inside the monitoring application, the Admin can create the previously mentioned project dashboards and also update the existing ones.

In the first part of the form (figure 33), the Admin can specify a unique title for the project, the project start and policy change date, the native language, the descriptions and the project homepage (if any).

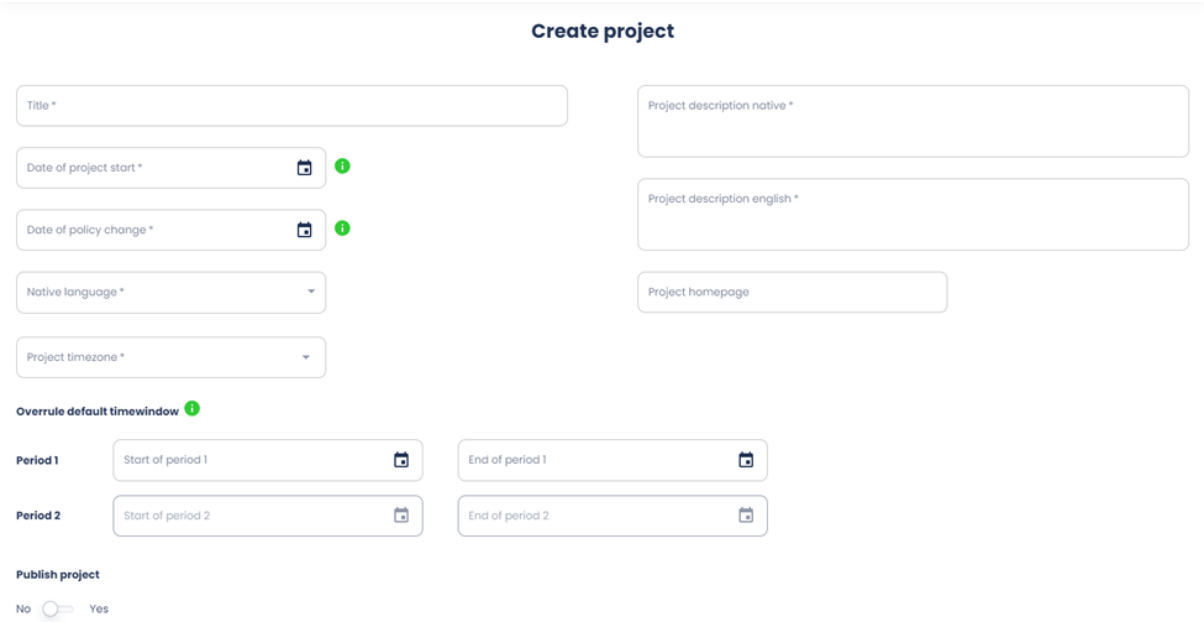


Figure 33 Create project form - Basic info

The Admin can also override the default period dates calculation mentioned previously and define two equal in length starting on the same day of the week periods. Additionally, they have the option to publish the dashboard that they have just created. If the dashboard is set to be published, then the dashboard will be accessible by everyone and will also get placed in

the sidebar of the container application for everyone. In the above step of the form, the Admin can view all the sensors on the map and add some of them to the project (figure 34).

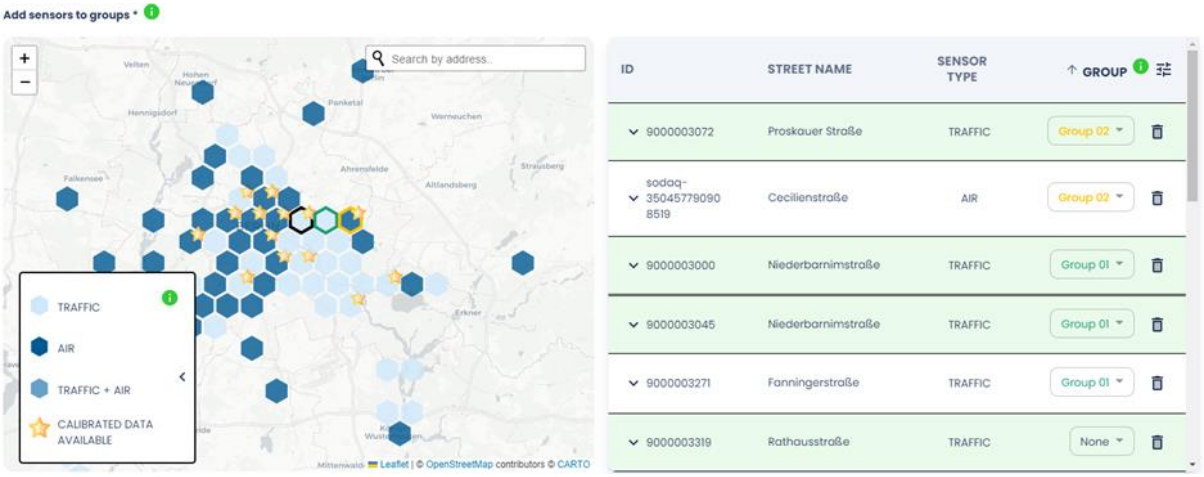


Figure 34 Create project form - Sensors selection

Upon clicking a hexagon, the sensors inside that hexagon get added to the list. Here the Admin can create two groups, just like in the browse mode, and add some sensors in these two groups from the drop-down list in each list item. Additionally, the current location and zoom of the map will be saved and used in the view mode of this project dashboard.
In the final step, the Admin can configure the measurement time windows for each day of the week (figure 35).

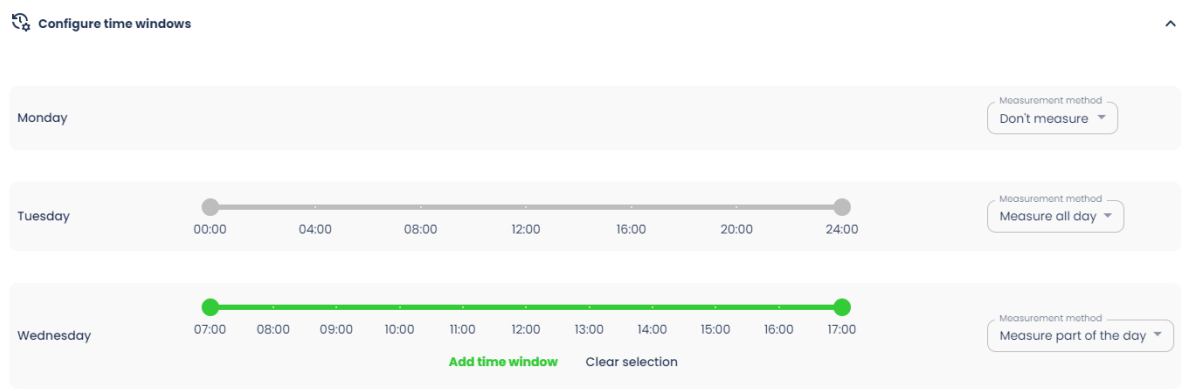


Figure 35 Project time windows - Measurement methods

The Admin is presented with three options for each day to choose from. The Admin can either select not to measure during a specific day of the week at all, measure all hours of the day or partially measure that day (figure 36). In the latter case, the Admin can add more windows/sliders in the day, can delete an added window by clicking on the discard icon and clear all selections for that day and reset to the default time window (7:00 to 17:00).

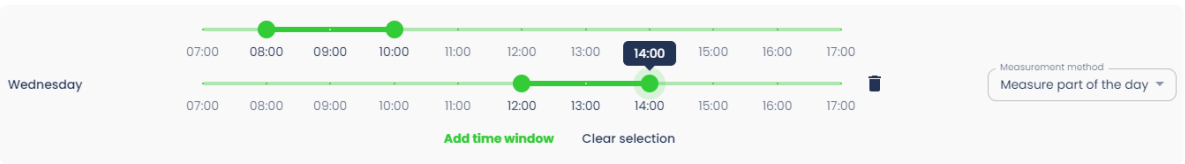


Figure 36 Project time windows - Day range adjustments

In the Game Section the Admin can create a cumulative graph (gamification) for a project. As you can see below in figure 37, the project lead should fill in the necessary fields to create the gamification graph. Those fields are the Title, the Explanation, the Group (groups will appear only if each group includes at least one Telraam sensor), the Start Date of measured period, the Stop Date of measured period and the Goal (the goal refers to the target number of cyclists). In order to display the graph in view mode the Game is On box should be ticked.

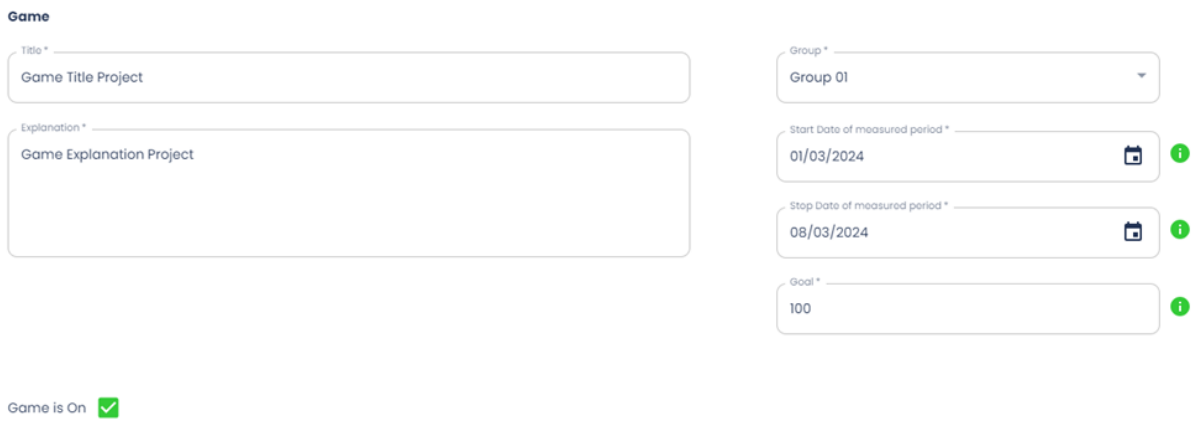


Figure 37 Project Gamification - fields

After clicking on the create project button on the bottom of the screen, and if all form fields are valid, the Admin gets redirected to the created project page (figure 38). From there, the Admin can navigate to the project created or navigate to the container homepage.

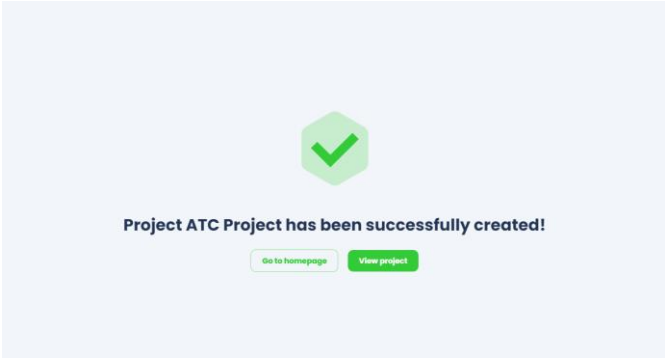


Figure 38 Successful project creation page

Project dashboards - Update

After creating and visiting a project, the Admin can choose to update the existing details and sensors of this project by clicking on the pencil button (figure 39).

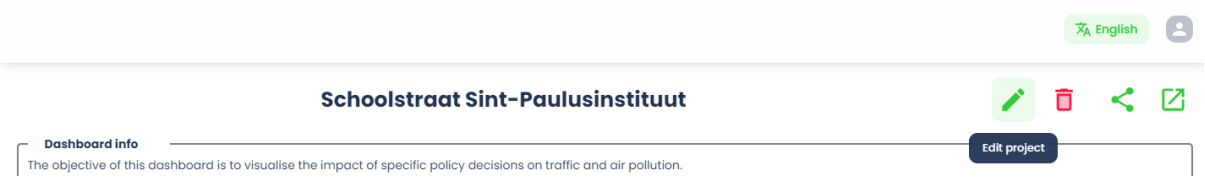


Figure 39 Project dashboard options - Update

The Admin will get navigated to the previous form with all the data filled in, thus can easily edit them and update the corresponding project (figure 40).

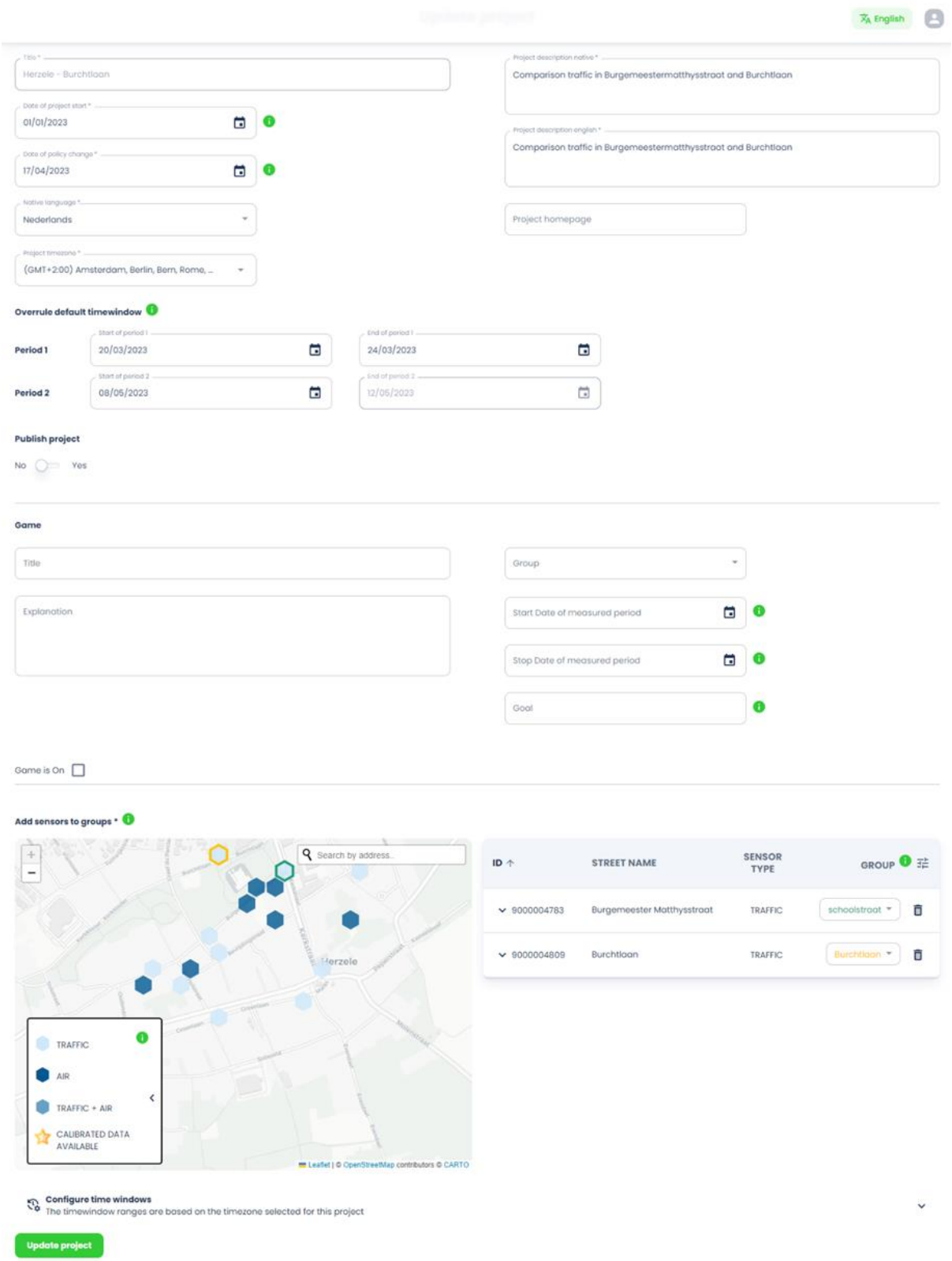


Figure 40 Update project dashboard page

Project dashboards - Delete

When the Admin visits an already created dashboard, they can permanently delete the dashboard by clicking on the red delete icon. After clicking on it, a dialog will appear with a confirmation message and a button to delete the project (figure 41).

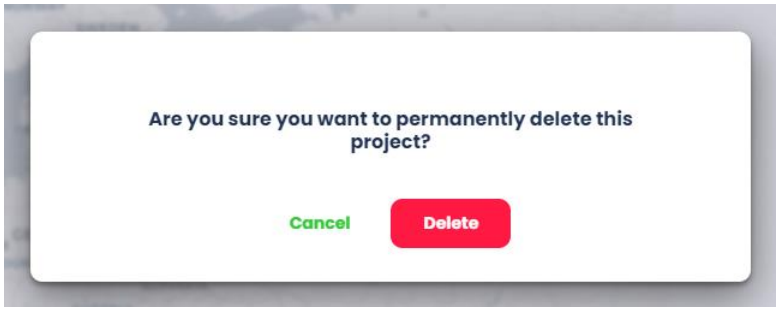


Figure 41 Project deletion confirmation dialog

After a successful deletion, the admin will get redirected to the homepage and the project will get removed from the project list container sidebar.

Sharing dashboard view

Both in the project mode and the browse mode, the user has the option to share the current dashboard view by clicking on the share icon that is located on the top right corner of the screen (figure 42).

Figure 42 Share dashboard view button

This action will open a popover dialog with a unique URL that includes all of the settings of the application at the current state (figure 43).

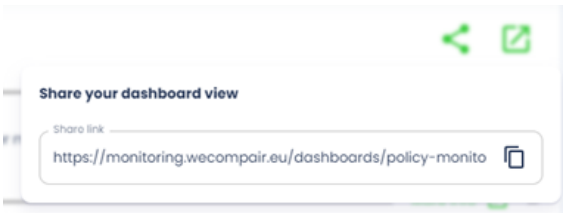


Figure 43 Share dashboard view link clipboard

Such settings may include: the map zoom level and location, the list of selected sensors, the sensor groups, the active map parameter, the current language, the pilot city, the timespan, the active zoom and the options of the graphs, etc. Thus, by sharing this link with other users/policy makers, all the settings will be applied to the UI when they open the URL in their

browser and reflect the initial view of the shared UI. This way, citizens can share their exact view with other citizens which will help when evaluating effectiveness of policy changes.

Open in a new tab

When the user visits the browse mode or a project dashboard from the container app, an icon button is presented, that when clicked, opens the dashboard in a new tab (figure 44). As with the sharing dashboard functionality all user settings at that time are shared and applied on the isolated PMD view that is opened in the new tab.

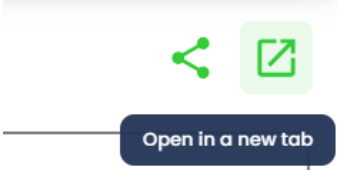


Figure 44 Open in new tab button

Explanations

Across the UI some explanations about the specific sections of the PMD are provided for a better user experience. This is done with a different set of elements. One explanation element is a green info button located usually next to texts and headings. When the user clicks on this button, a popover appears with more information about that section (figure 45).

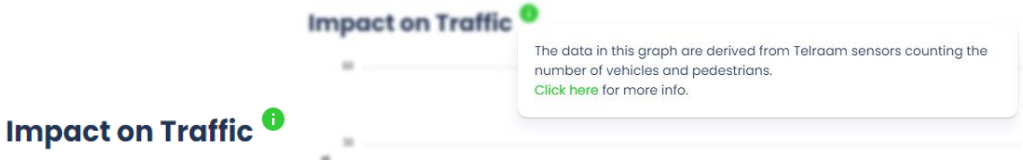


Figure 45 Icon button explanation popover

When a dashboard project of the PMD is accessed from the container dashboard, the user can get more information about the purpose of these dashboards in general as well as information about that specific project in such boxes shown in figure 46.

Figure 46 Dashboard explanation boxes inside the container app

The user can also open informational links provided by the project admins by clicking on the ‘more info’ text.
Lastly, the user can find more information about the quickscan and deep dive graphs by expanding the boxes as shown in figure 47.

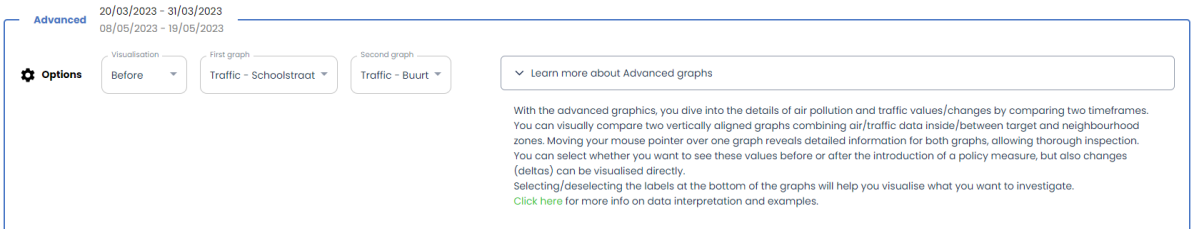


Figure 47 Explanation boxes inside quickscan and advanced graphs

Translations

The PMD has also been translated in each of the pilot’s languages (English, Greek, German, Bulgarian and Dutch). The user can change the language either from inside the container dashboard (figure 48), or by selecting the language from the dropdown inside the PMD itself when in isolation (figure 49). Both language switchers are located on the top right corner of each page.

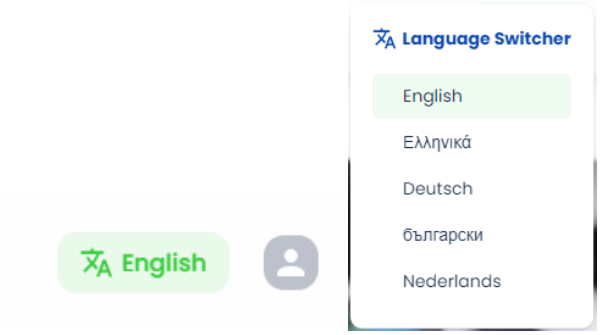


Figure 48 Container language switcher and options

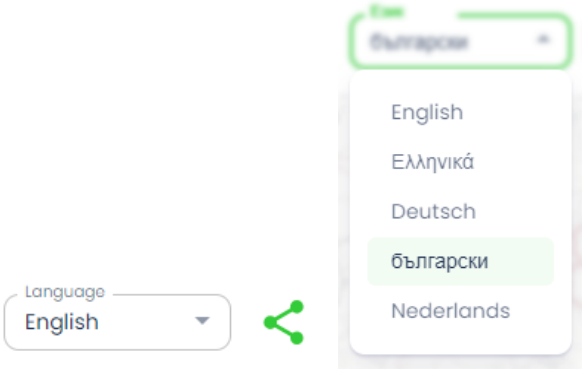


Figure 49 PMD language switcher and options

An example of what the page will look like when the user visits a project dashboard and changes the language to German can be found in figure 50.

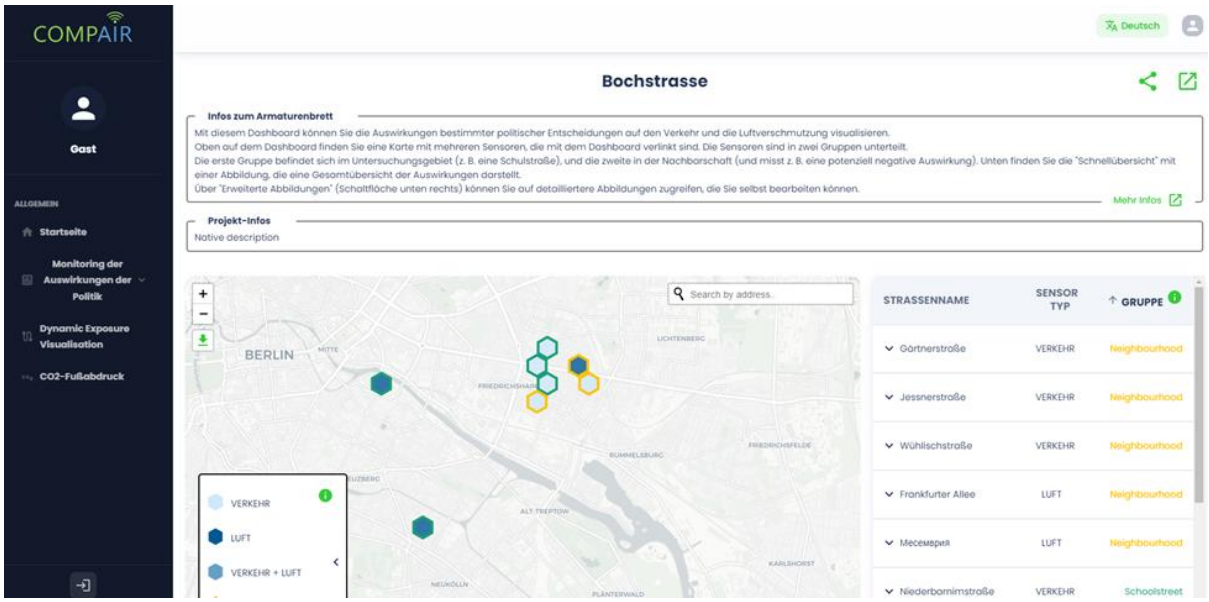
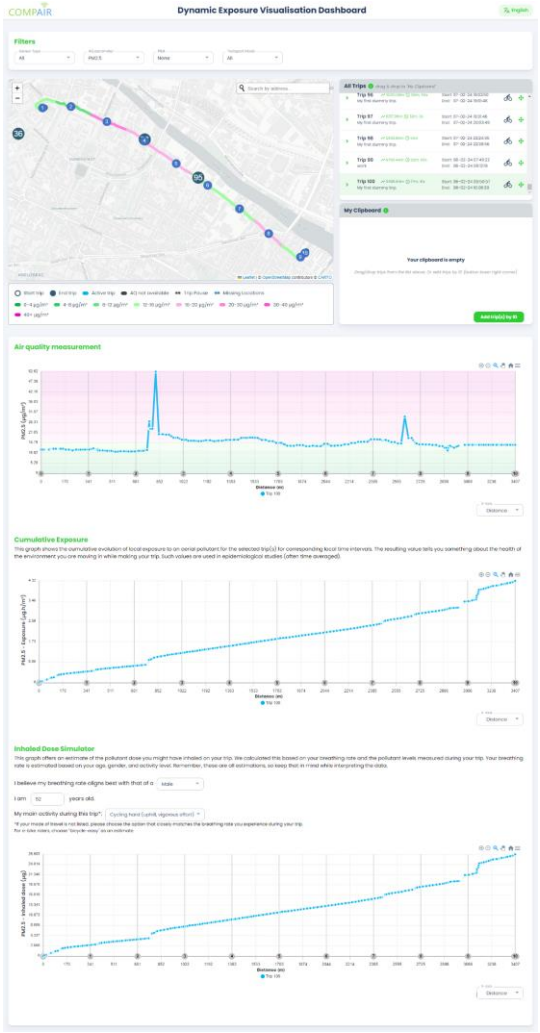


Figure 50 Translated project dashboard in German

4. Dynamic Exposure Visualisation Dashboard (DEV-D)



The Dynamic Exposure Visualization Dashboard (DEV-D) assists users in comprehending and interpreting data gathered from a diverse range of mobile air quality sensors. This tool visualises a combination of geometric information from trips/routes recorded by the trip recorder, a key component of the Dynamic Exposure Visualization App (DEVA), and air quality data collected by mobile sensors like the SODAQ fine dust sensor measuring PM1.0, 2.5 and 10.

Users can view colour-coded air quality data along their trips (as well as trips made by others in the vicinity) on a map, allowing for detailed observation of air quality fluctuations. Additionally, they can see the detailed evolution of air quality along their route on a customisable graph in function of trip duration, distance, or absolute time. The dashboard also provides estimates of user exposure to air pollutants and allows interactive estimation of inhaled pollutant doses during trips by inputting gender, age, and activity. Furthermore, users can compare various trip graphs to identify the healthiest option among alternative trips in the neighbourhood.

List of epics implemented for the DEV-D open public version

The following table presents the list of epics implemented for the open public version.

Table 3:List of epics implemented for the open public version beta release of the DEV-D

ID	EPICS
DEDHis	**Display historic information about trips**
	Story: As a citizen/researcher I want to see information about exposure to air quality parameters on the map and in the clipboard list, so I have an idea how a trip affects my health (DEV-D version 3).
	Story: As a developer, I can access the trips recorded by the SODAQ devices, so I can build dashboards on that data

ID	EPICS
	Story: As a citizen, I can see a graph showing the exposure of a single trip so I can inspect the exposure
	Story: As a citizen, I can see the trips that are made with a SODAQ device on a map so I know where people went
	Story: As a citizen/researcher, I want to see where trips have an overlap so I get a better overview
	Story: As a citizen/researcher, I want to have a short trip-reference in the trip list that also appears on the map so I can connect both easily.
	Story: As a citizen/researcher, I get an impression of the AQ levels by looking at the colours of each trip segment, so I can easily see where trip AQ was good or bad.
	Story: As a citizen/researcher I want to see my personal exposure to air quality parameters in a graph, so I have an idea how a trip affects my health (DEV-D version 3).
	Story: As a citizen/researcher, I want to see mobile BC-data in DEV-D, so I have an idea about the BC levels along my trip.
	Story: As a citizen/researcher, I can click a trip segment on the map, it will show me a balloon with information so I know the measured AQ and speed at that spot.
	Story: The average speed indicated in the DEV-D when clicking a trip segment is too high (DEV-D version 1).
	Story: As a researcher, I want to filter the available trips (on pilot and AQ parameter) so I get a better overview
	Story: As a citizen/researcher, I get a better impression of the AQ levels by looking at the colours and reference points (same as shown on the map) integrated into the graph, so I can easily see where trip AQ was good or bad.
	Story: As a citizen/researcher, I want to see where I paused my trip and where the GPS-connection was interrupted, so I have a better overview (DEV-D version 1).
	Story: As a citizen/researcher, I want to see the air quality in function of time and distance, so I can better understand the trip (DEV-D version 1).
	Story: As a citizen/researcher, I want to see my full trip in the DEV-D so I can include small trips and I have a global overview (DEV-D version 1).
	Story: As an admin, I want to get user statistics (DEV-D version 1).
	Story: As a citizen/researcher of f.i. Plovdiv/Sofia, I want to see model data on my DEVA trip in DEV-D so I have an idea about the air quality (DEV-D version 2).
	Story: As a citizen/researcher I want to see my exposure to air quality parameters, so I have an idea how a trip affects my health (DEV-D version 3).
	Story: As a citizen/researcher, I want to filter the available trips on travel mode so I get a better overview of the trips I'm interested in (DEV-D version 2).
	Story: As a citizen/researcher I want to have my temporal working space in DEV-D, so I can compare different trips (DEV-D version 2).
	Story: As a citizen/researcher I want to see a selection of trips in DEV-D map, so I can compare their trajectory (DEV-D version 2).
	Story: As a citizen/researcher I want to see a selection of trips in DEV-D graphs, so I can compare their air quality measurements (DEV-D version 2).

User Guide

In this section, we present a comprehensive User Guide of the Dynamic Exposure Visualisation Dashboard (DEV-D).

In the following sections, you will find visual representations of the primary interfaces of the DEV-D. These illustrations accompany detailed descriptions of the functionalities integrated into the DEV-D.

On the DEV-D homepage, users have access to a comprehensive list detailing the trips that have been completed, as shown in Figure 51. This list, labelled 'All Trips,' provides essential trip details such as the total trip length and distance covered. Additionally, users can access information about each trip, including its description, start and end times, and the mode of transportation utilized. By clicking on the chevron located on the left side of each trip entry, an additional information menu unfolds, revealing the cumulative exposure to an airbornepollutant, expressed in µg*h/m^3.--

Figure 51 : 'All Trips' clipboard

Another trip list, labelled 'My Clipboard,' offers users the flexibility to drag and drop one or more preferred trips from the 'All Trips' list to this initially empty clipboard. Users can also transfer a trip from the 'All Trips' list to 'My Clipboard' by clicking the 'drag & drop' button located on the far right of the trip row. A button labelled 'Add Trip(s) by ID' (Figure 52) is also provided to enable users to add trips to 'My Clipboard' using their preferred sensor ID. Notably, when a trip is added to 'My Clipboard,' it is automatically removed from the 'All Trips' list. If a user wishes to remove a trip from 'My Clipboard,' they can do so by clicking on the 'delete' button (depicted as a trash can icon) located on the far right of the trip row. Subsequently, the deleted trip will be relocated back to the 'All Trips' list, ensuring that it is not permanently deleted. In the 'My Clipboard' list, an additional row labelled 'TOTAL' is displayed at the bottom of the list. This row offers details regarding the cumulative duration and length of all trips included in the 'My Clipboard' list.

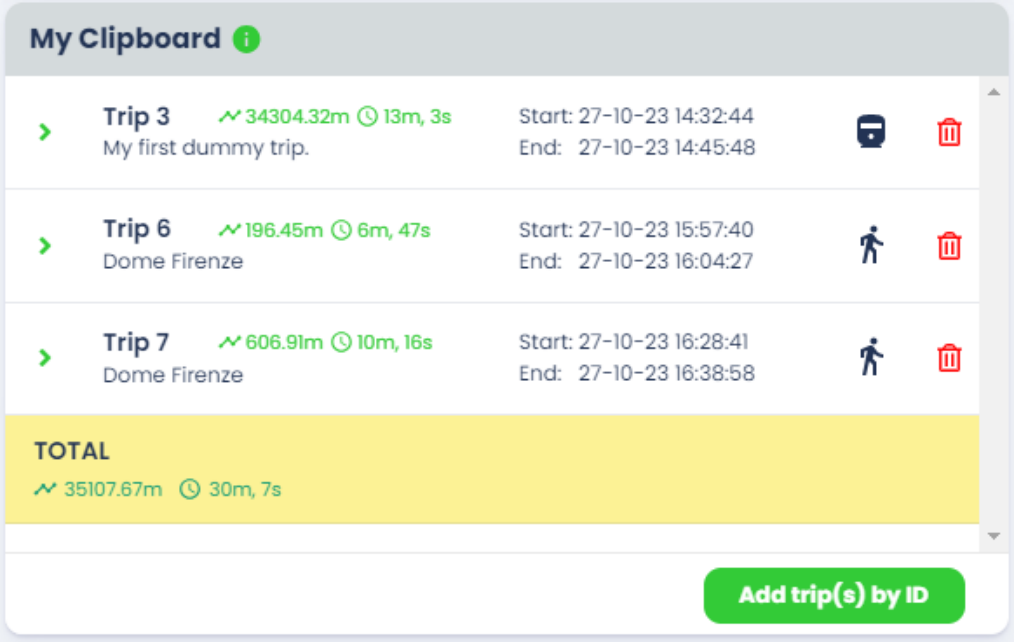


Figure 52 'My Clipboard' trip list

The DEV-D homepage also features an interactive map (Figure 53) where users can visualize the geographical locations of the trips listed in the available clipboards. Each trip is depicted on the map with a corresponding number, corresponding to the number in the clipboard lists; for example, 'Trip 23' from the clipboard list is represented with the number 23 on the map.

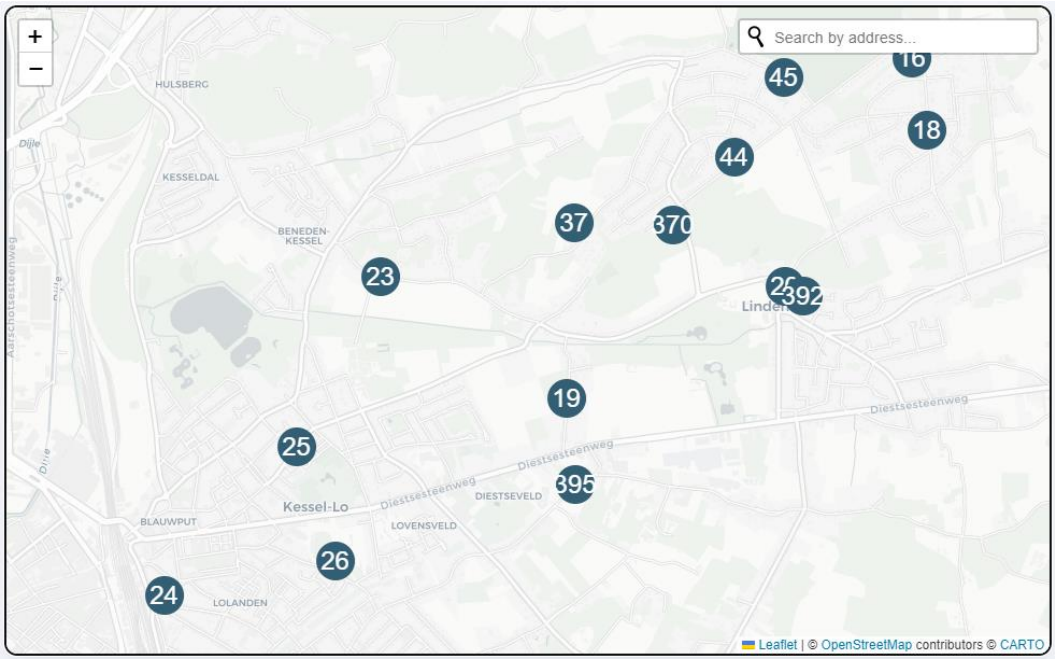


Figure 53 Interactive map where the geographical locations of the clipboard trips are shown

Clicking on a trip, whether on the map or in the clipboard lists, triggers the drawing of the entire route of that trip on the map, as shown in Figure 54. Each trip route is equally segmented into ten sections based on distance. A map legend is provided to assist users in interpreting the

color-coded routes displayed on the map. The routes are colorized based on the average air quality (AQ), allowing users to discern the air quality conditions associated with each segment of the trip.

The start and end points of the trip route are marked with a hollow or filled circle, respectively, while segments where no measurements were recorded by the DEVA application are represented by solid dark gray lines, indicating the absence of average AQ data for these segments. Pauses in measurements are represented by dotted gray lines, denoting instances where the user chose to pause taking measurements during a part of the trip. Additionally, light blue dotted lines highlight parts of the trip where no measurements were taken for a duration significantly longer than the average measurement period (Missing Locations sections). These visual cues enhance the user's understanding of the trip data and its quality.

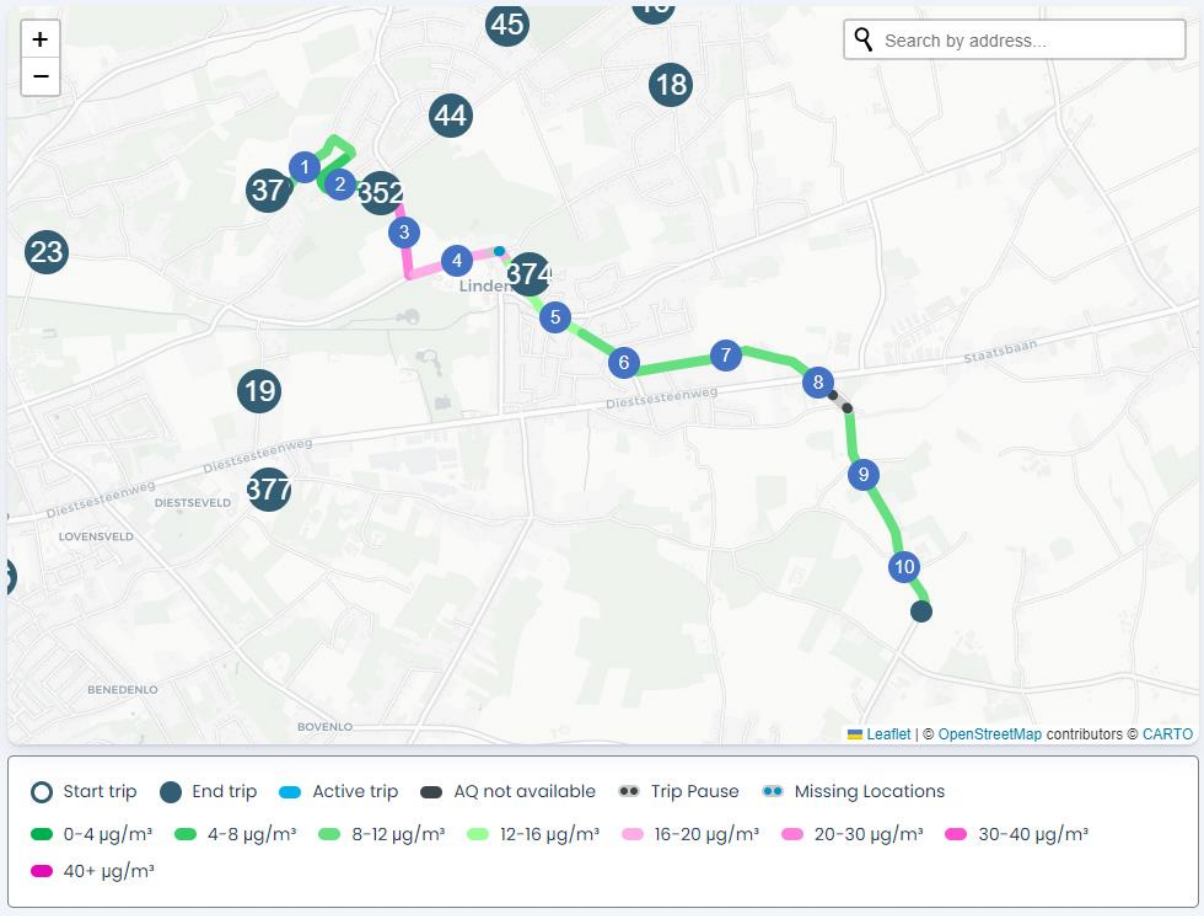


Figure 54 Selected trip route displayed on the map with accompanying legend explanation

The segment numbers, ranging from 1 to 10, are visibly displayed at the center of each segment along a trip route. By clicking on any of these numbers, users can access pertinent information about the segment, including the Average AQ measured in µg/m^3, the Average Speed recorded in km/h, and the Average Cumulative Exposure expressed in µg*h/m^3, as shown in Figure 55 below.

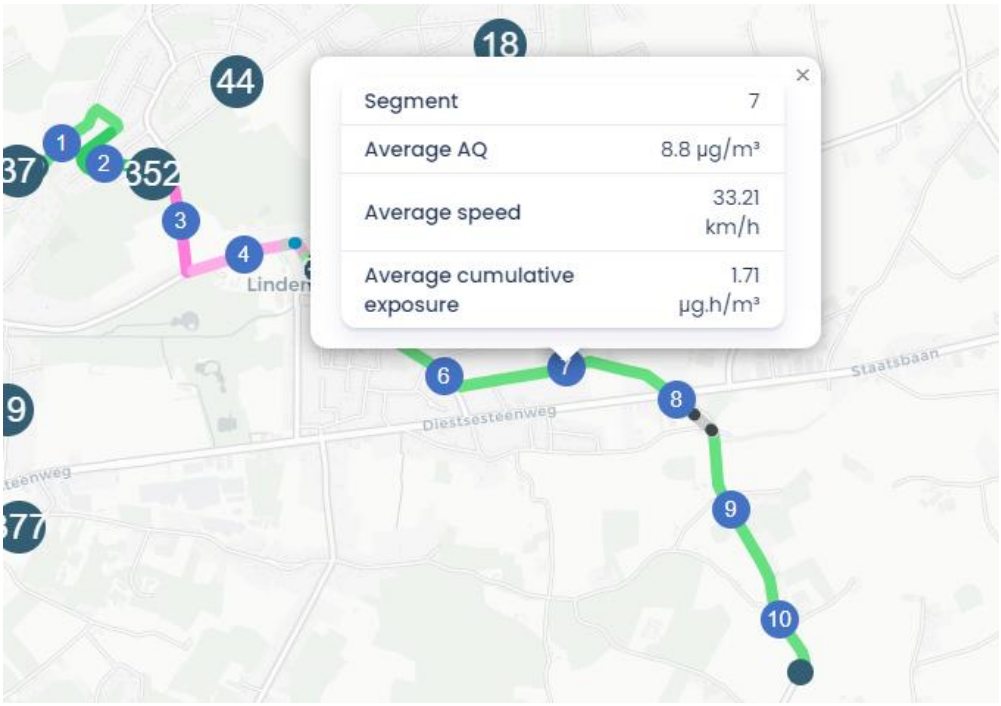


Figure 55 Information displayed upon clicking on the segment number

As described earlier, there are multiple ways to select a trip within the DEV-D interface. Users can directly select a trip on the map by clicking on its corresponding number or by clicking on the respective row within either of the two clipboards available on the homepage. These rows are identifiable by their background color, which is light green. Upon selecting a new trip, the map automatically zooms in to display the area where the selected trip route is located. To select multiple trips simultaneously, users must first transfer these trips to 'My Clipboard' and then click on the 'TOTAL' row within that clipboard, situated at the bottom of the trip list, as shown in Figure 56. Subsequently, the map adjusts its view to encompass the geographic area where all selected trips are situated, ensuring that all chosen trips are clearly displayed for the user's convenience. By selecting multiple trips, users get the opportunity to compare their trajectories on the map and analyze the Air Quality measurements along the route. This comparison is facilitated by the coloring of segments for each trip, providing visual indications that allow users to get an idea of the variations in AQ across different trip routes.

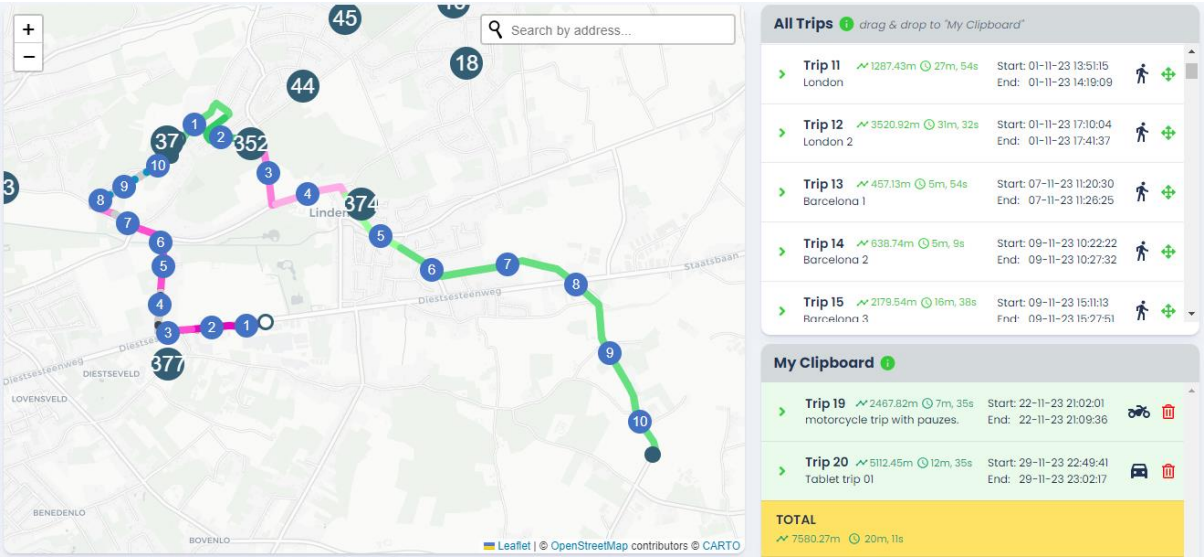


Figure 56 Selecting multiple trips using the 'TOTAL' row in the 'My Clipboard' trip list

At the top of the page, users can access various filters to refine the trips displayed in the clipboards and subsequently on the map (Figure 57). These filters include options to select the sensor type (SODAQ, BCmeter, or All), the AQ parameter (PM1.0, PM2.5, or PM10), the pilot region (Athens, Berlin, Plovdiv, Sofia, Flanders, or None), and the transport mode used during the trip (Pedestrian, Motorbike, Heavy Vehicle, Train, Bicycle, Car, Bus, Other, or All). When the pilot filter is applied, the map automatically zooms in to the specific region associated with the selected Pilot, providing users with a more focused view of the relevant data.

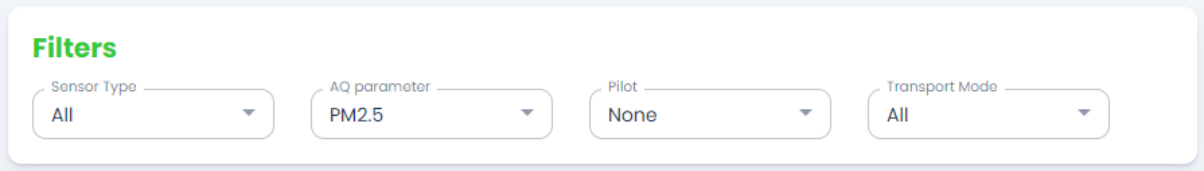


Figure 57 Trip filtering

Once one or more trips are selected, an AQ Measurement Graph is generated. The vertical axis (y-axis) of the graph corresponds to the AQ parameter chosen in the relevant filter located at the top of the screen. Meanwhile, the horizontal axis (x-axis) can be customized to display data based on either 'Distance' (in meters), 'Duration' (in minutes), or 'Timeline', allowing users to specify their preference by selecting one of these options from the dropdown menu situated below the graph on the right side of the screen, as shown in Figure 58. The background of this diagram is colored in gradation, providing users with a quick visual understanding of the Air Quality levels, employing the same color scheme as seen on the map. When hovering over a measurement point on the graph, a tooltip appears, displaying information such as the name of the trip (e.g. ‘Trip 19), the AQ measurement and the corresponding value on the x-axis.

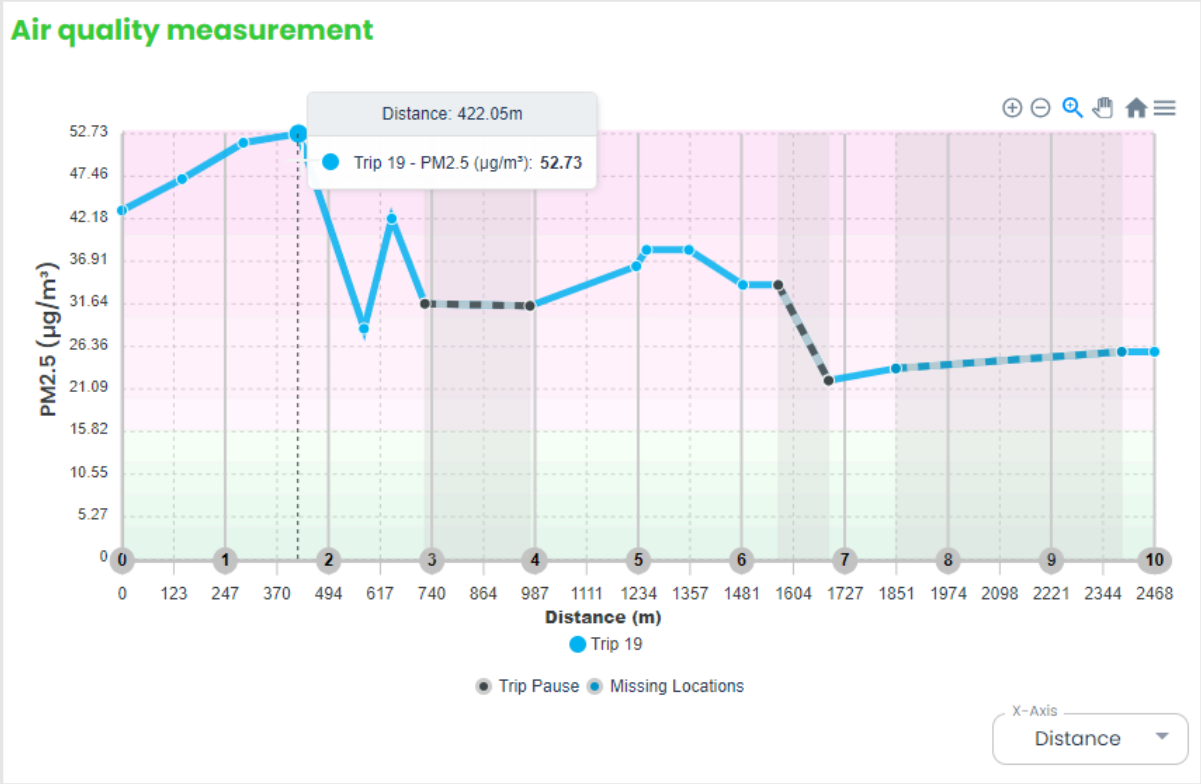


Figure 58 'Air Quality Measurement' graph (x-axis: Distance)

A second graph called 'Cumulative Exposure' is also drawn when a trip is selected (Figure 59). This graph depicts the progressive accumulation of the exposure to aerial pollutants within a specific geographic area over time, corresponding to selected travel routes and their respective local time frames. The cumulative value portrayed in the graph offers insights into the environmental conditions encountered during the trip, serving as an indicator of environmental health along the route. These values are used in epidemiological research, frequently utilized as time-averaged metrics to study the impacts of pollutant exposure on public health. The y-axis of the graph represents the cumulative exposure (µg*h/m^3) based on the chosen AQ parameter specified in the top-page filter. The x-axis offers user-selectable options, accessible through the dropdown menu positioned beneath the graph. These options, similar to those in the AQMeasurement Graph detailed earlier, include 'Distance', 'Duration', or 'Timeline', enabling users to customize the visualization according to their preference and analytical needs.

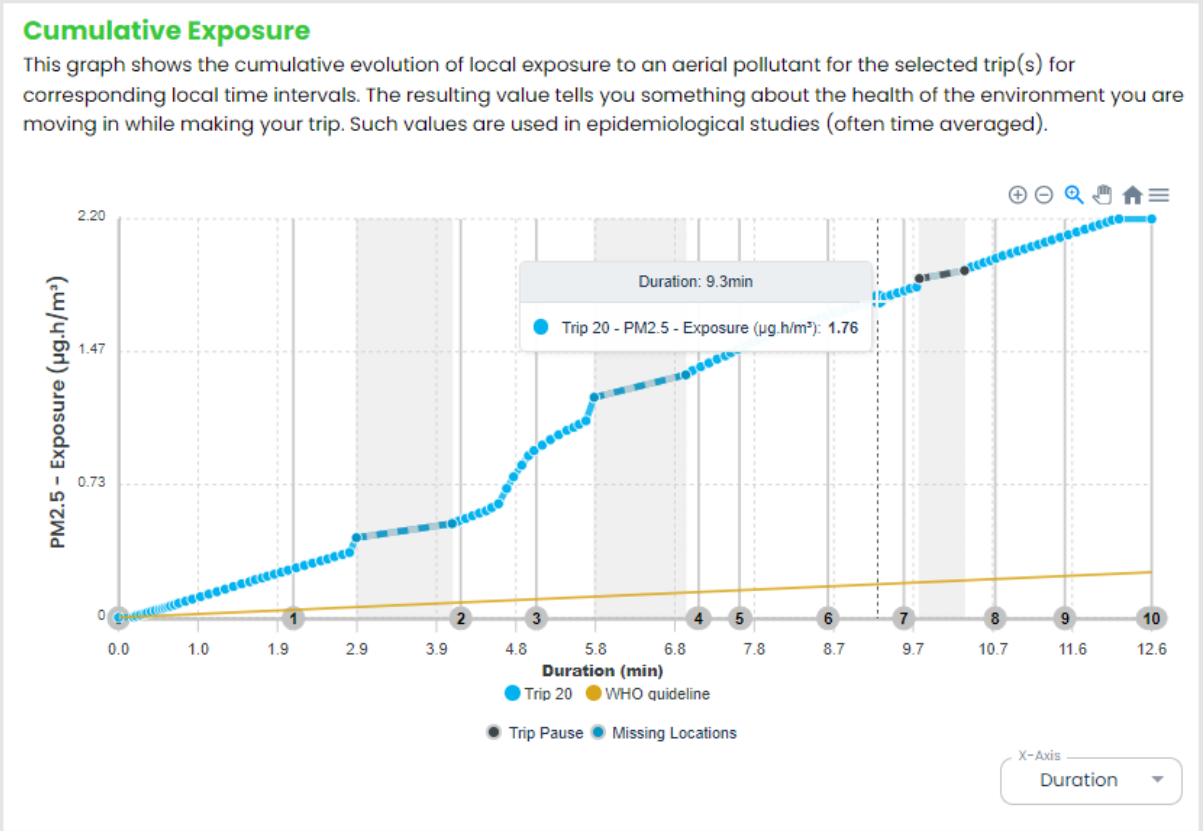


Figure 59 'Cumulative Exposure' graph (x-axis: Duration)

In addition to the primary data lines, an additional line denoting the World Health Organization (WHO) guideline threshold is included on this graph. This additional line serves as a reference point for users, offering insight into the level of cumulative exposure to the environment along the selected trip route in relation to established health guidelines. By comparing the cumulative exposure against the WHO guideline threshold, users can gauge the potential health implications of their exposure to the specific environment during their journey.

An additional graph, known as the 'Inhaled Dose Simulator', can be generated upon user request. This graph provides an approximation of the pollutant dosage the user may have inhaled during their journey, calculated by considering their breathing rate alongside the measured pollutant levels throughout the trip. Their individual breathing rate estimation is derived from factors such as age, gender, and activity level, which users may input through the relevant dropdown menus and input fields provided. Once users have provided these parameters, they can view the graph by clicking the 'Create Graph' button (Figure 60). It is essential to note that these estimations are based on various assumptions, so users should interpret the data with caution and awareness of its estimative nature.

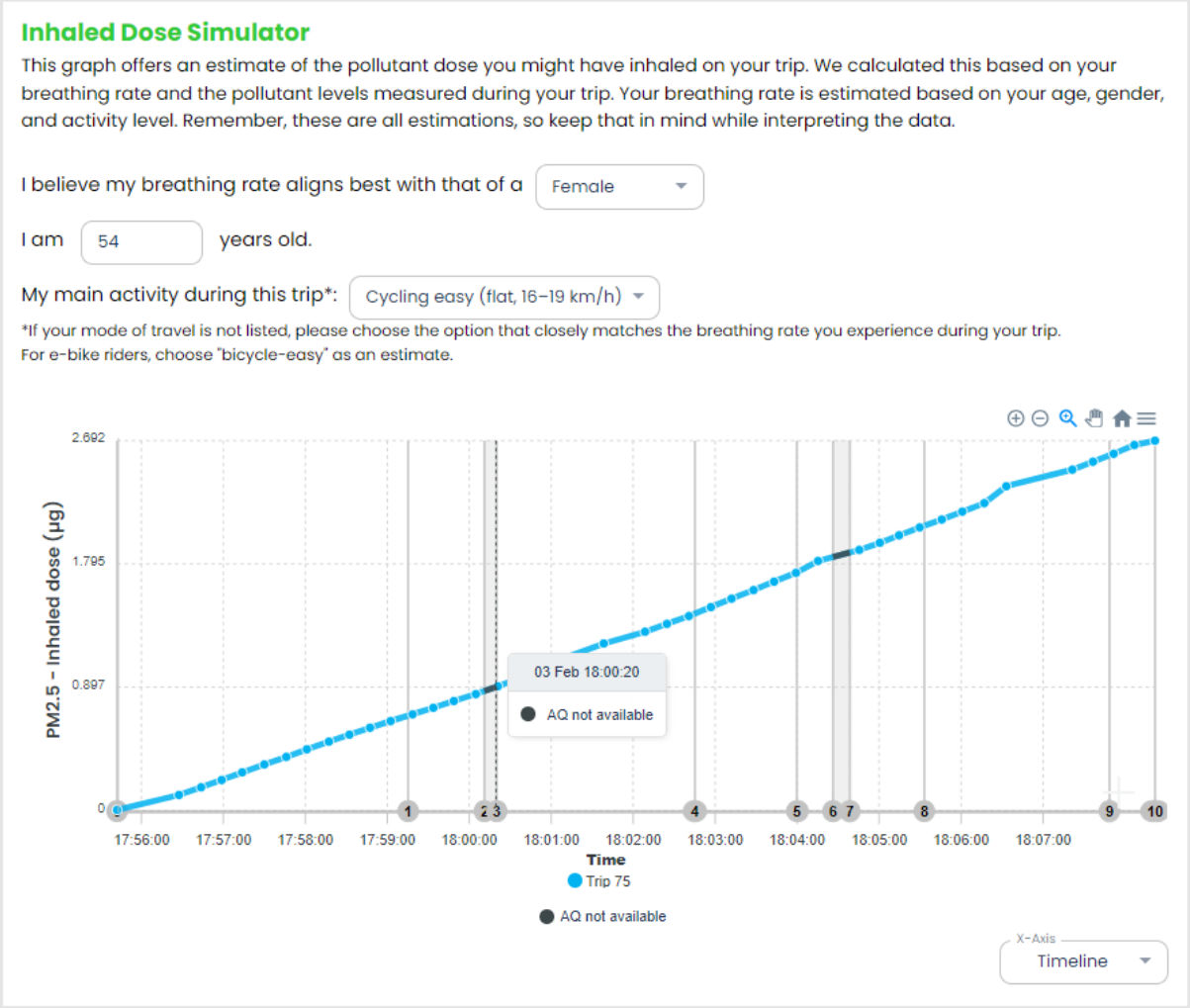


Figure 60 :'Inhaled Dose Simulator' graph (x-axis: Timeline)

Users are given the option to select their gender (male or female) according to what aligns best for themselves, as well as provide their age (ranging from 10 to 100 years old). They can additionally specify the main activity during their trip from the following options, or choose the one that best reflects the breathing rate experienced during their journey:

- Riding passive (car, bus, train, truck)
- Driving active (car, bus, train, truck)
- Driving active (motorbike)
- Walking slow (3.2 km/h, flat)
- Walking moderate (4.5 - 5.2 km/h, flat)
- Walking brisk (5.6 km/h, flat)
- Jogging (8 km/h)
- Cycling easy (flat 16 - 19 km/h)

- Cycling middle (not flat 19 - 22.5 km/h)
- Cycling hard (uphill, vigorous effort)

Upon the user's click on the 'Create Graph' button, the y-axis of the generated graph displays the Inhaled dose (in µg), determined by the chosen AQ parameter specified in the relevant filter. Similar to the previous graphs, users have control over the x-axis selection (Distance, Duration, Timeline), which can be adjusted via the corresponding dropdown menu positioned below the graph.

In all three graphs, when a single trip is selected, the x-axis is divided into ten sections, as shown in Figures 58, 59 and 60), each representing a corresponding segment depicted along the trip route displayed on the map. However, this segmentation is not applied when multiple trips are selected simultaneously via the 'TOTAL' row clicking on the 'My Clipboard' trip list.

When one or more trips are selected, various features are incorporated into the graph to ensure accurate representation and interpretation. Segments along the x-axis where no measurements were recorded by the DEVA application (AQ not available) are denoted by solid dark gray lines, mirroring their representation on the map. Additionally, 'Trip Pauses' and 'Missing Locations' sections are depicted by dashed lines in gray or light blue, respectively, as outlined in the graph legend and illustrated in Figure 61. Selecting multiple trips provides users with the opportunity to compare their AQ Measurements, Cumulative Exposure, and Inhaled Dose of aerial pollutants across the respective graphs. This comparative analysis allows gaining insights into variations in air quality, cumulative exposure levels, and inhaled doses experienced across different trip routes.

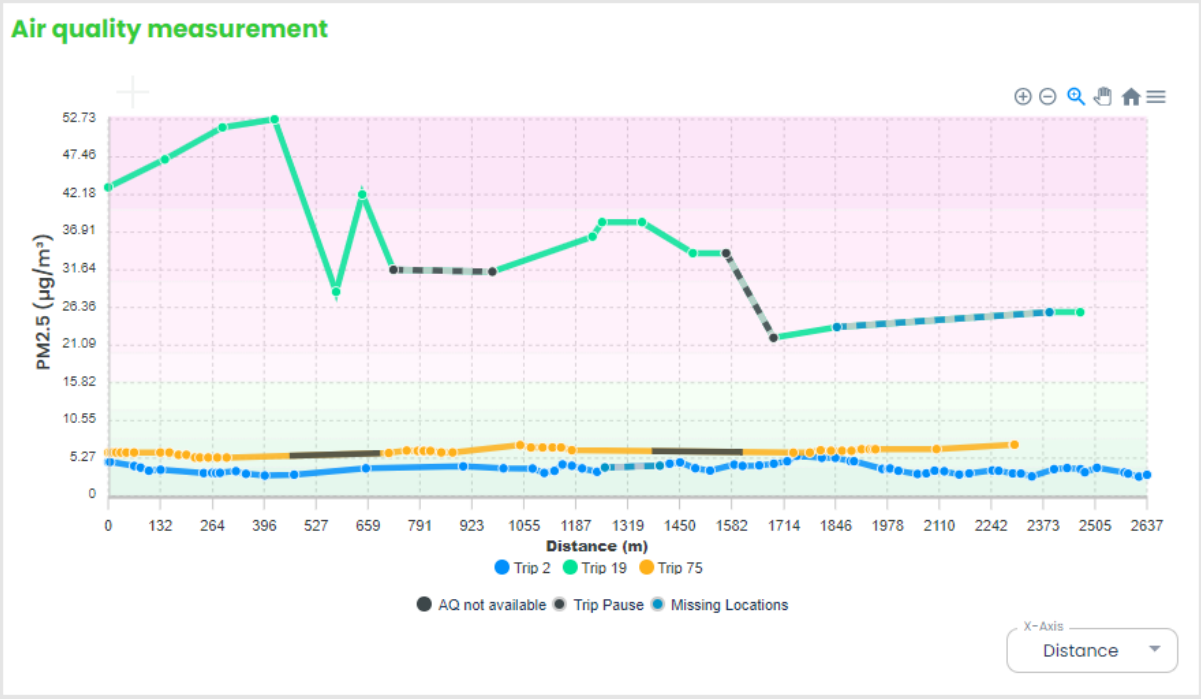


Figure 61 Selection of multiple trips with no segmentation applied on the x-axis; display of 'AQ not available', 'Trip Pause' and 'Missing Locations' sections according to the graph legend

Users can easily share their current view of the DEV-D homepage by following a straightforward process. They need to click on the share icon located at the top right of the screen (Figure 62), then copy the 'Share link' provided by clicking on the 'copy' icon situated on the right side of the pop-up window containing the link (Figure 63).

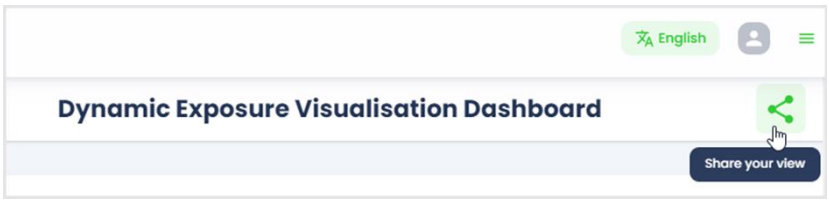


Figure 62: 'Share Link' button

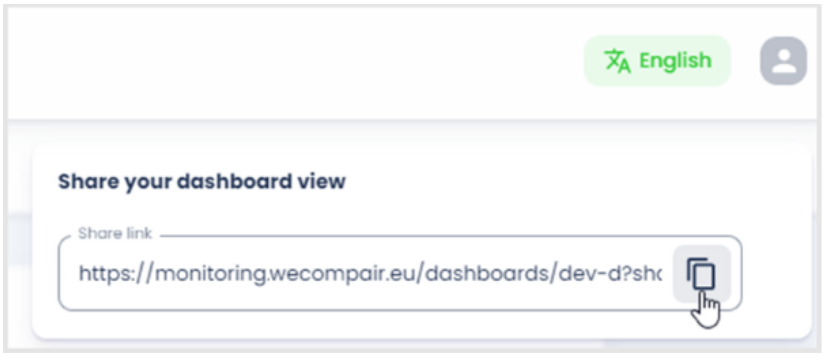


Figure 62 'Share Link' copy

When the share link is copied and opened, the DEV-D homepage will display all the configurations made in the primary view. This includes filtered trips, clipboard lists containing the same trips, the map showcasing the same trips, and the graphs generated for the same selected trip(s) as in the primary view. In essence, the shared link ensures that the recipient sees precisely the same information as the original user.

5. CO2 Dashboard

The purpose of the Carbon Footprint Simulation Dashboard (CO2) is to guide users to improve their behaviours through more environmentally friendly choices, regarding their carbon footprint.

List of epics implemented for the CO2 open public release

The following table presents the list of epics implemented for the open public release of the CO2 Dashboard.

Table 4 List of epics implemented for the open public release of the Carbon Footprint Simulation Dashboard

ID	EPICS
CO2Cal	**Carbon Footprint Calculator**
COM-255	Story: As a citizen, I can add multiple vehicles for the calculation of my carbon footprint
COM-375	Story: As a citizen, I want to be able to see recommendations for the calculation I select on my Profile
COM-355	Story: Filter cities based on the selected country in the calculator
COM-288	Story: Update the Trains domain based on pilot feedback
COM-358	Story: Improve the visualisations in the results page of the calculator
COM-398	Story: Incorporate the demographic data requested by the pilots
COM-372	Story: Improve mobile friendliness of the calculator
COM-369	Story: Improve descriptions and tooltips of the calculator
CO2Man	**Dashboard Management**
COM-258	Story: As an admin, I can add scenario actions at a local (e.g. municipal) level
COM-371	Improve descriptions and tooltips of the admin page
COM-399	As an admin, I want to be able to see statistics regarding the calculator results of SES groups in my city/country.
COM-419	As an admin, I want to be able to filter the users' calculator statistics based on the submitted demographic data.
COM-395	As an admin, I want to be able to see statistics regarding the calculator results of users in my city/country.
COM-396	As an admin, I want to be able to see statistics regarding the submitted scenarios of users in my city/country.
COM-420	As an admin, I want to be able to filter the users' scenario statistics based on the submitted demographic data.
COM-400	As an admin, I want to be able to see statistics regarding the submitted scenarios of SES groups in my city/country.
COM-446	As an admin, I want be able to export the statistics for the calculator in csv in order gain better insights
COM-445	As an admin, I want be able to export the statistics for the scenarios in csv in order gain better insights
COM-455	Investigate map visualization options for CO2 data
COM-466	Load averages by municipal community on a map
CO2Sce	**Scenario Simulation**

ID	EPICS
COM-257	Story: As a citizen, I can choose government actions at a local (e.g. municipal) level
COM-373	Improve mobile friendliness of the scenario simulation
COM-290	Add additional government actions for the scenario simulation
COM-291	Add additional citizen actions for the scenario simulation
COM-409	Analyse new suggested Local Government Actions
COM-408	Analyse new suggested Government Actions
COM-407	Analyse new suggested Citizen Actions
COM-357	Add additional local government actions for the scenario simulation
COM-370	Improve descriptions and tooltips of the scenario simulation

User Guide

The following section presents a User Guide for the third release (Open Public version) of the Carbon Footprint Simulation Dashboard. The Dashboard can currently be accessed on the following URL: https://co2.wecompair.eu

By entering the URL for the Carbon Footprint Simulation Dashboard, the user is led to the homepage of the Dashboard (Figure 63). It contains information regarding the **COMPAIR** project, as well as information about the Dashboard itself.

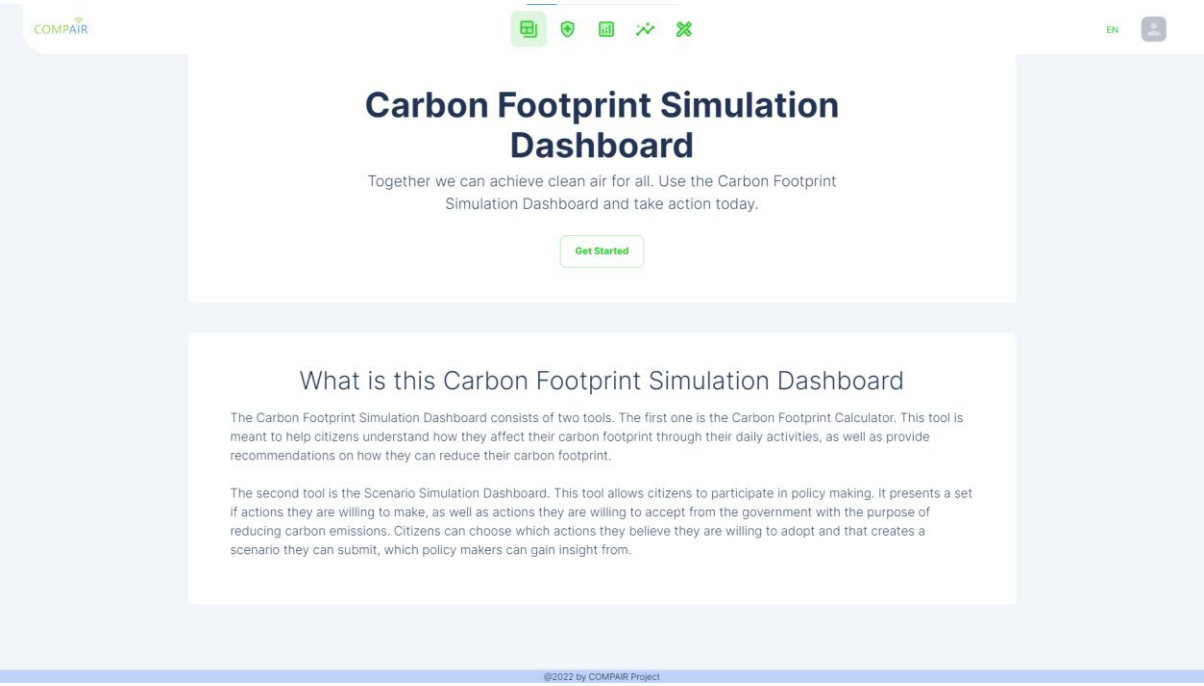


Figure 63 : Carbon Footprint Simulation Dashboard home page

At the top of the page, a menu is available which is how the user can navigate through the various pages of the Dashboard (Figure 64). The first option on the menu leads to the homepage. The second option leads to the Carbon Footprint Calculator, which is the first tool available on the Dashboard. The third option leads to the Scenario Simulation, which is the second available tool on the Dashboard. The fourth option leads to the user's Profile Page

that is specifically about the Carbon Footprint Simulation Dashboard. The fifth option leads to the dashboard's Admin Page. Finally, the sixth option leads to the Data Map, which is a feature that presents the dashboard's data on a map based on municipal communities. The fourth and fifth options are features that will be available to administrators of the Dashboard. The first three options are visible and available to anyone, regardless of whether they have created a user account or not. The Profile Page is available to users who have created an account and have logged into the dashboard. Finally, the Admin Page and Data Map are available only to users who have created an account, have logged in, and have the administrator role.

Figure 64 Navigation menu of the Dashboard

Translations

The Carbon Footprint Simulation Dashboard has currently been translated to English, Greek, Bulgarian, German, and Dutch, covering each of the pilot's languages. The user can change the Dashboard's language by using the dropdown menu that is available on the top right corner of the screen (Figure 65).

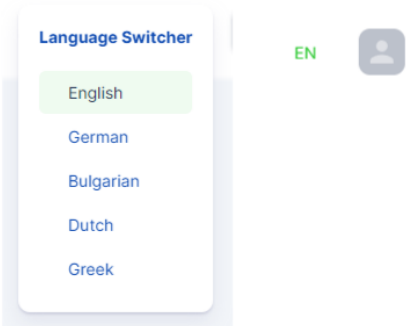


Figure 65 The dropdown language menu

Carbon Footprint Calculator

Choosing the second option on the navigation menu, the user is led to the Carbon Footprint Calculator, which allows the user to calculate their carbon footprint (Figure 66). This page consists of various tabs, each with different questions the user has to answer. There are eight

tabs and from left to right they are named: Welcome, Demographic, Cars, Flights, Trains, Buildings, Waste Management, and Results. The questions of each tab may change based on additional feedback from users.

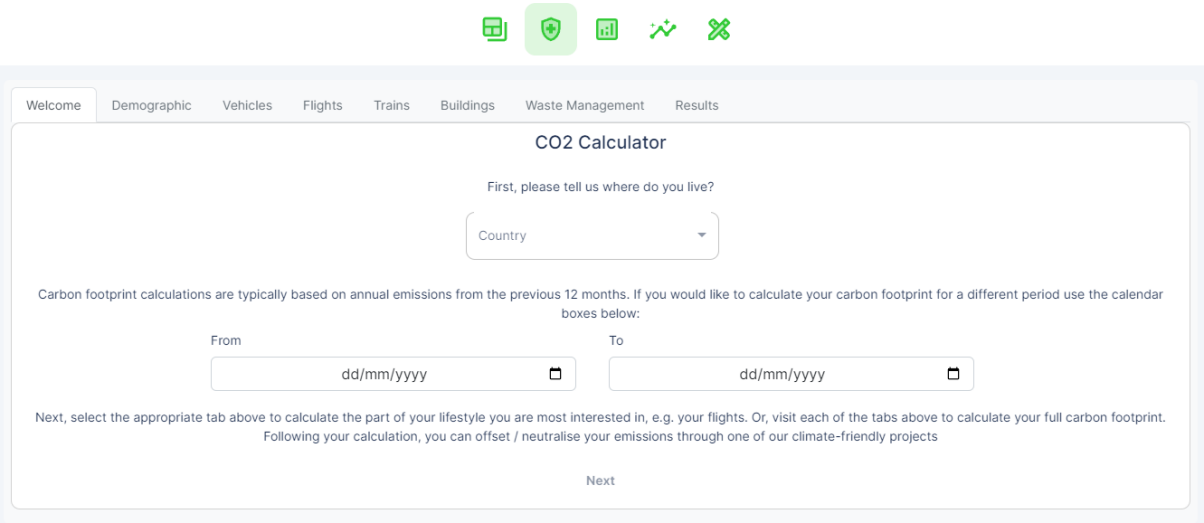


Figure 66 : Carbon Footprint Calculator - Welcome tab

When first visiting the page, only the first tab (the Welcome tab) can be browsed. The rest of them, except for the Results tab, can be accessed once the user has selected the country they are living in. The user's country is required because it is used for the calculation of their carbon footprint, as well as the presentation of data relevant to them at the Results tab. The Results tab becomes accessible only when all the questions on the rest of the tabs have been answered, since those questions are crucial for the calculation of the user's carbon footprint. On the Welcome tab, the user can also choose the period for which they are going to calculate their carbon footprint. This is not mandatory since carbon footprint is typically calculated on an annual basis.

The second tab, Demographic (Figure 67), contains questions about the user that are not directly related to their carbon footprint. They are not mandatory, but they can help with the calculation of the carbon footprint, as well as the presentation of the results.

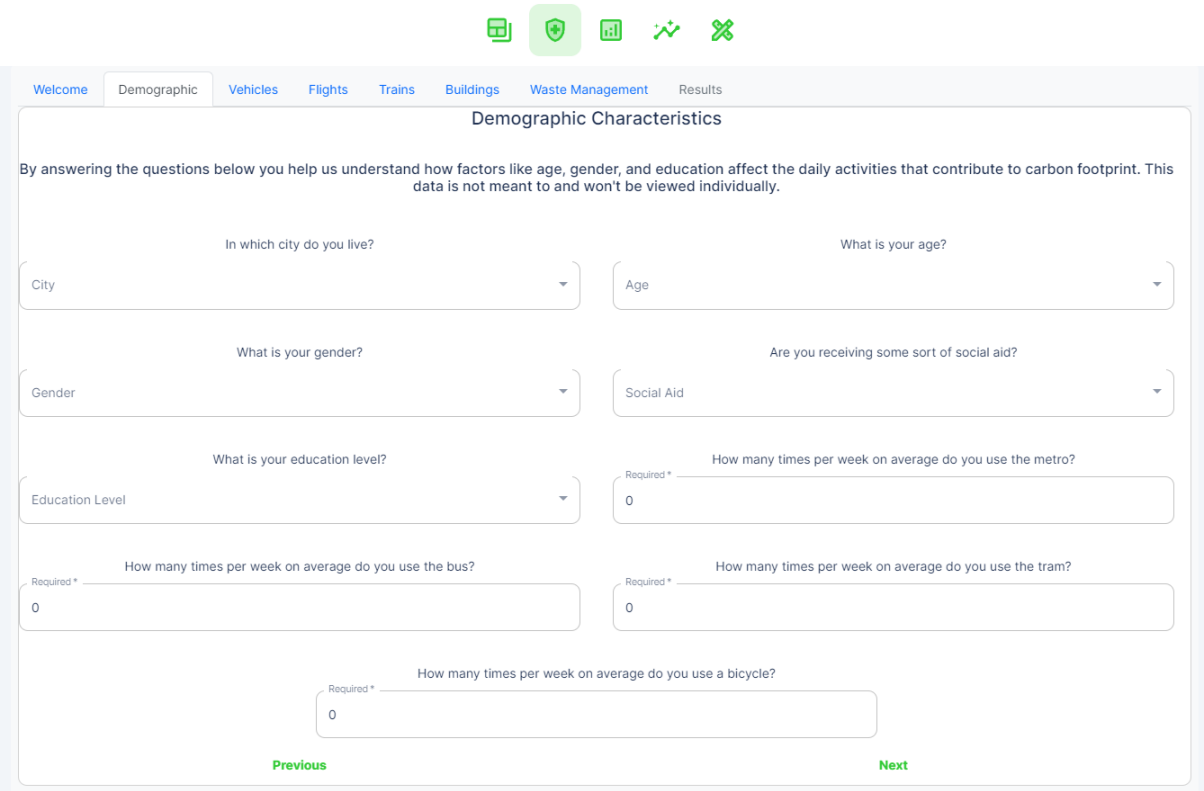


Figure 67 Carbon Footprint Calculator - Demographic tab

On the Cars tab (Figure 68), the user fills in information regarding the usage of their vehicle(s). The information required is the distance they have travelled the previous year (or in the time period they have designated in the Welcome tab), the consumption of their vehicle(s), as well as the type of fuel the vehicle(s) uses. There is the option to add multiple vehicles and also to remove the last vehicle they have added.

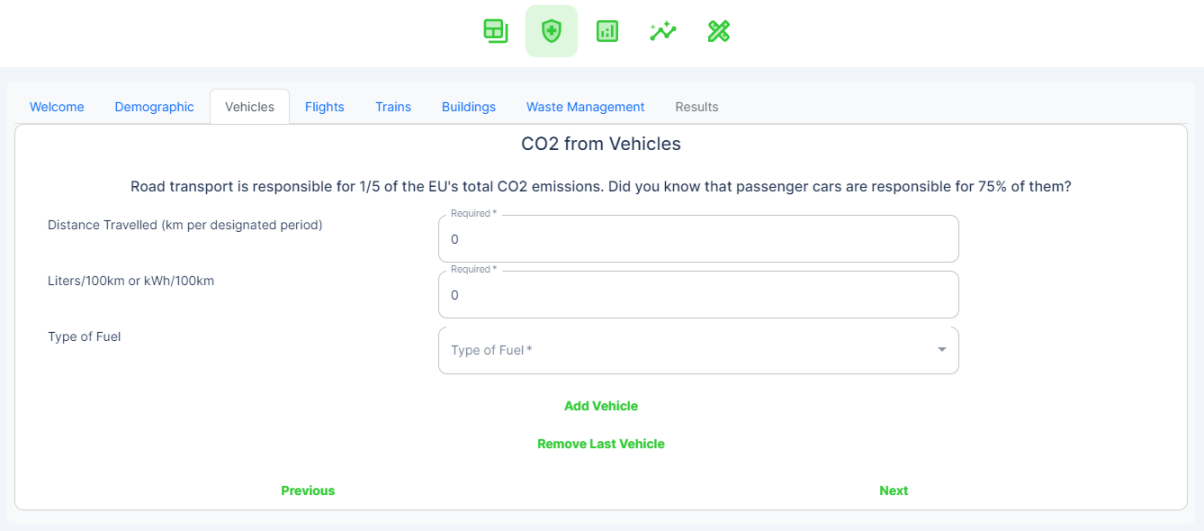


Figure 68 Carbon Footprint Calculator - Cars tab

The next tab is the Flights tab (Figure 69), in which the user fills in information regarding their flights. There are four types of flights presented here, based on their duration and average distance. The user needs to fill in how many flights of each type they have had during the designated time period, which is the one the user has provided in the Welcome tab.

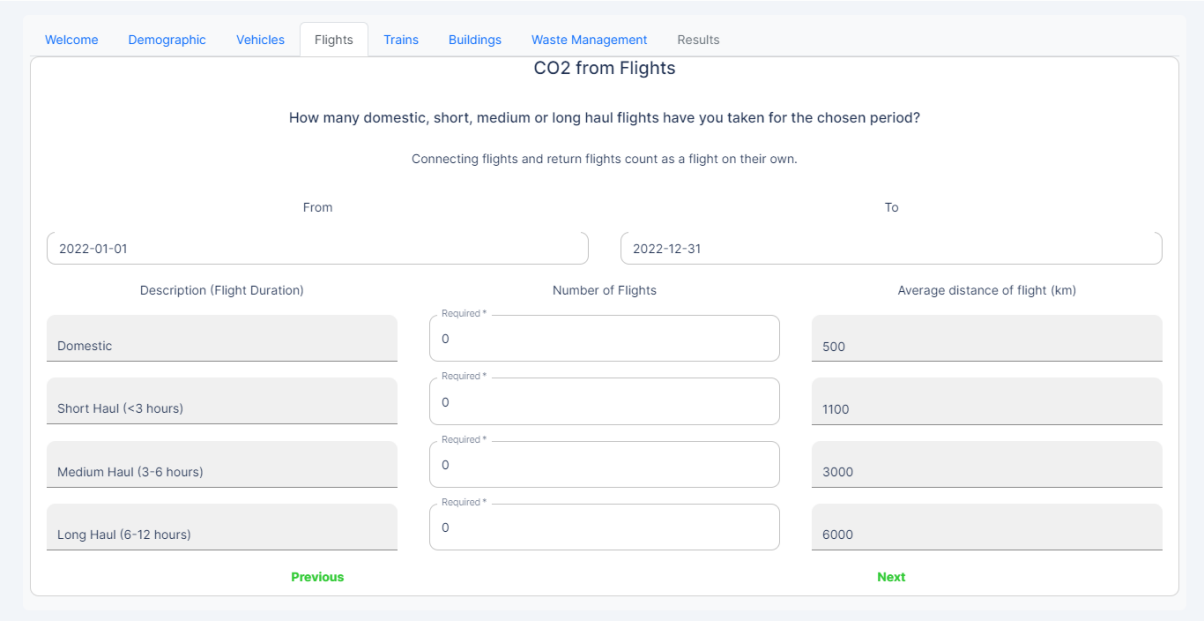


Figure 69 Carbon Footprint Calculator - Flights tab

The next tab is the Trains tab (Figure 70). The user can fill in information regarding the use of trains. What the user needs to provide is the number of trips they have taken and the average distance of the trips. The time period is pre-filled with the one provided in the Welcome tab.

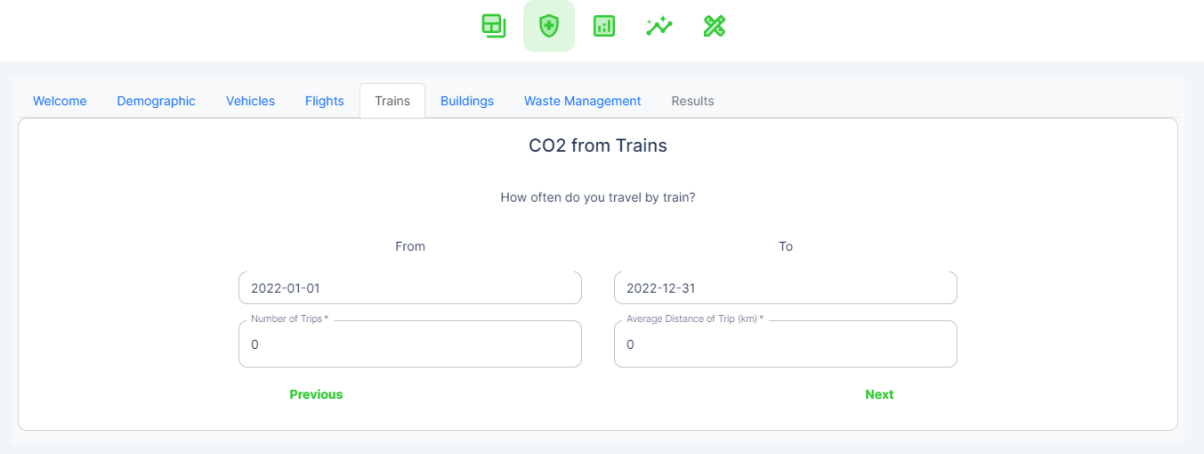


Figure 70 Carbon Footprint Calculator - Trains tab

The Buildings tab (Figure 71) is next. The user has to fill in information regarding the use of energy in their home: the amount and type of fuel they have used, as well as the amount of electricity they have used. Moreover, there are two checkboxes that represent the use of solar thermal energy and the use of a heat pump, which the user can check if they use any of the two. Next, there are four questions regarding the energy efficiency of appliances the user may have in their home, which are a refrigerator, a washing machine, a dishwasher, and an oven.

The user can choose the level of energy efficiency of each appliance. The options are “No”, “Semi-efficient”, “Yes”, and “I don’t own one”. Each of these options also correspond to specific energy efficiency levels that can be found on the appliance’s EU Energy Label. Furthermore, because the Energy Efficiency Labels for appliances changed on the 1st of March 2021, there is a simple matching table to help users match their appliance's energy class if it has been bought before the 1st of March 2021.

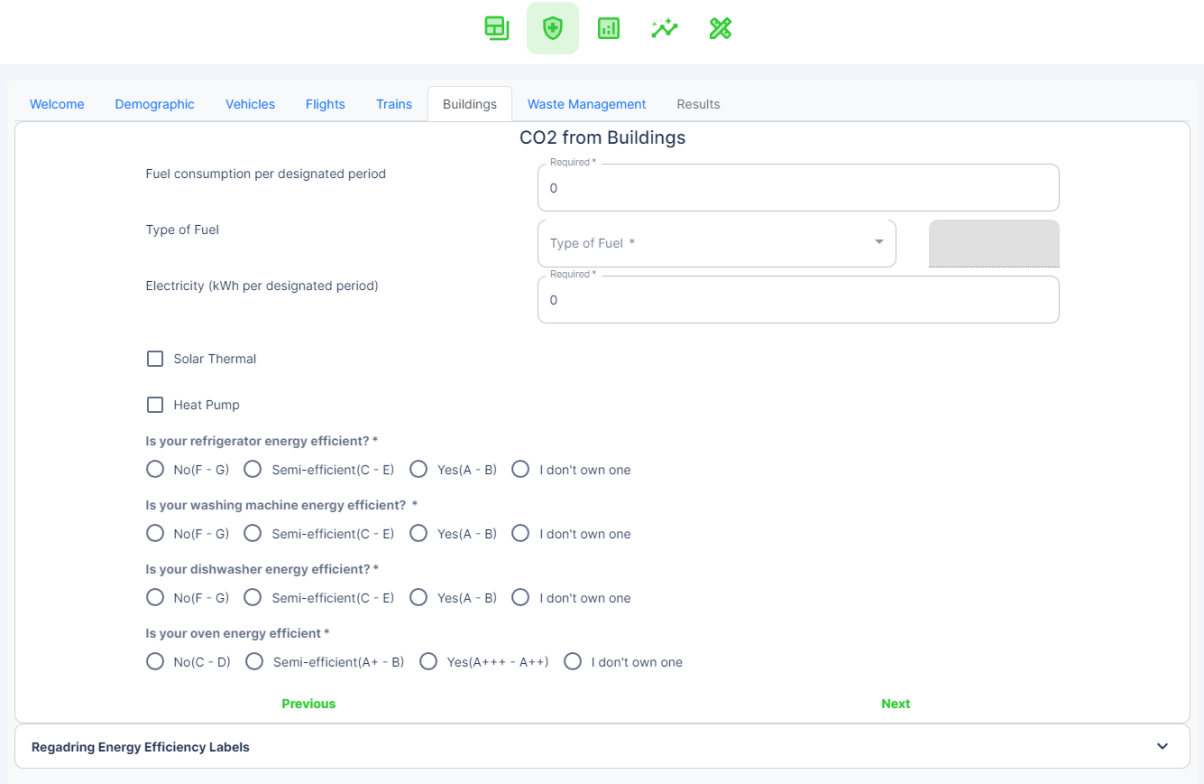


Figure 71 Carbon Footprint Calculator - Buildings tab

The final tab, in which the user has to provide input, is the Waste Management tab (Figure 72). The user is presented with the amount of recycling and composting done by the average citizen of their country. Then, through two dropdown menus, they can choose whether they recycle and compost more, the same, or less than the average. There is also the option of not recycling or composting at all.

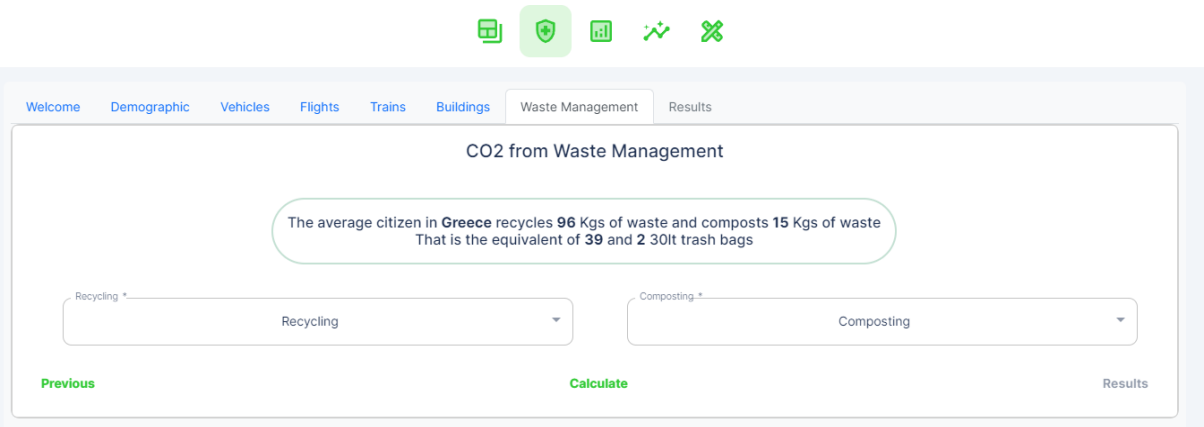


Figure 72 Carbon Footprint Calculator - Waste Management tab

If the user presses the Calculate button without filling in all the required fields, an error message will appear informing them that they have missed some fields (Figure 73). If they have filled in all the fields, then they are informed that they can proceed to the Results tab (Figure 74).

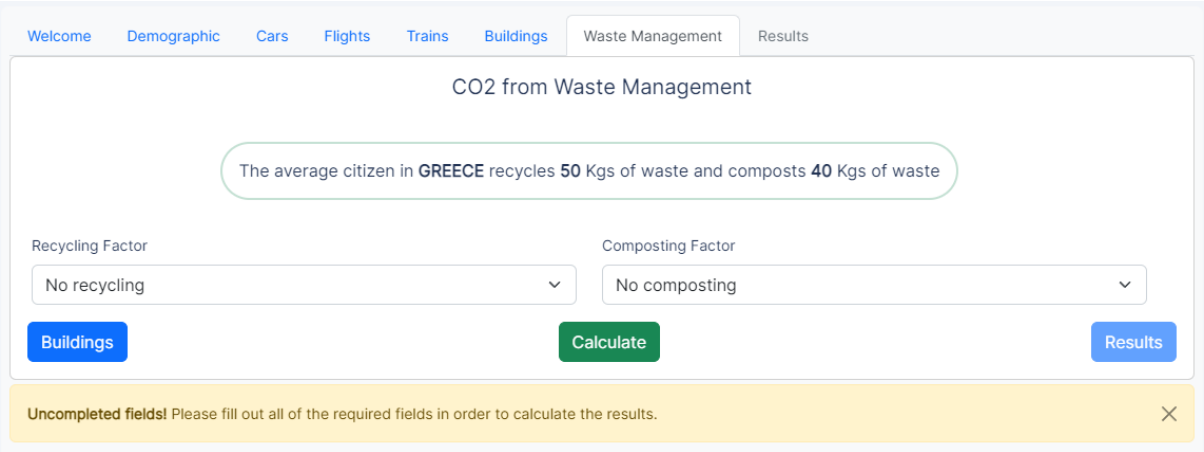


Figure 73 Error informing some fields have not been filled in

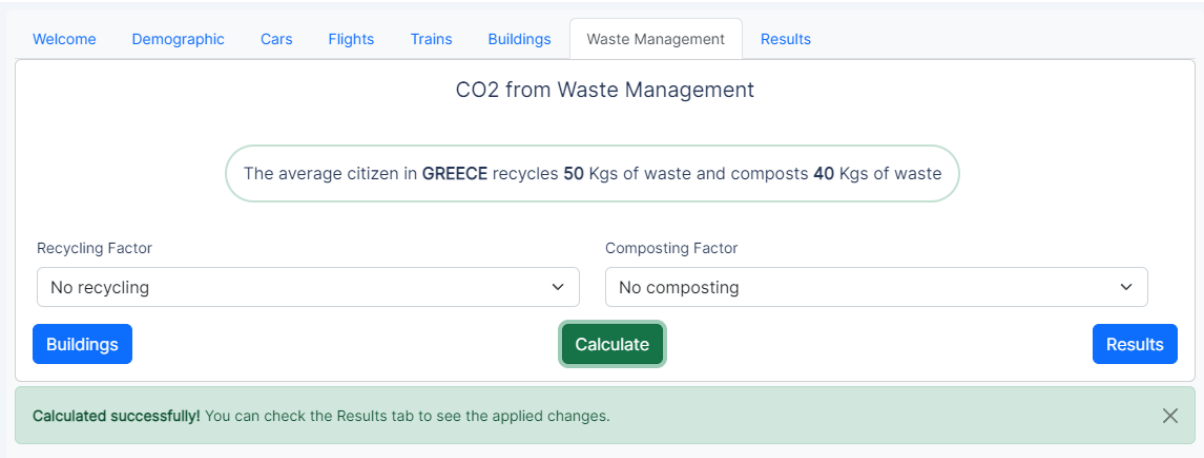


Figure 74 : Calculation Successful

On the Results tab, the user receives information regarding their carbon footprint. At the top of the tab, there are four bars (Figure 75). The topmost bar provides the user's carbon footprint. The second one provides the average carbon footprint of the user's country. The third one provides the EU carbon footprint average. The bottom one provides the average carbon footprint of the users registered on the dashboard. This allows the user to compare their results with various averages, so they can understand where there may be room for improvement for them.

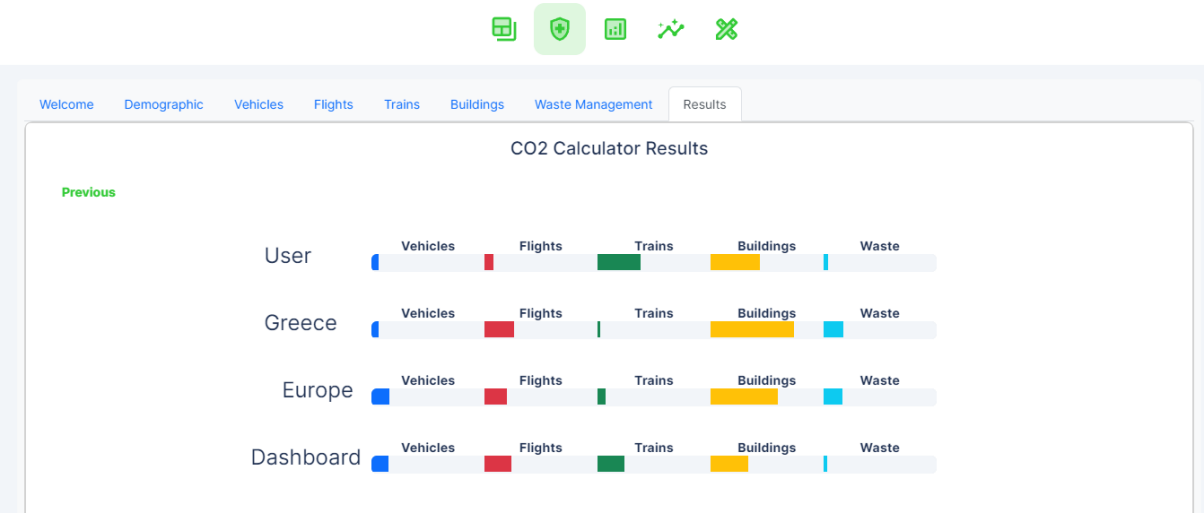


Figure 75 User's results comparison

Furthermore, each colour on the bars represents a different carbon footprint domain, which corresponds to one of the tabs they have previously visited. By clicking on a domain (Figure 76), a message appears that shows the user how much that domain takes up from their total carbon footprint. If they click on the domain again, the message disappears.

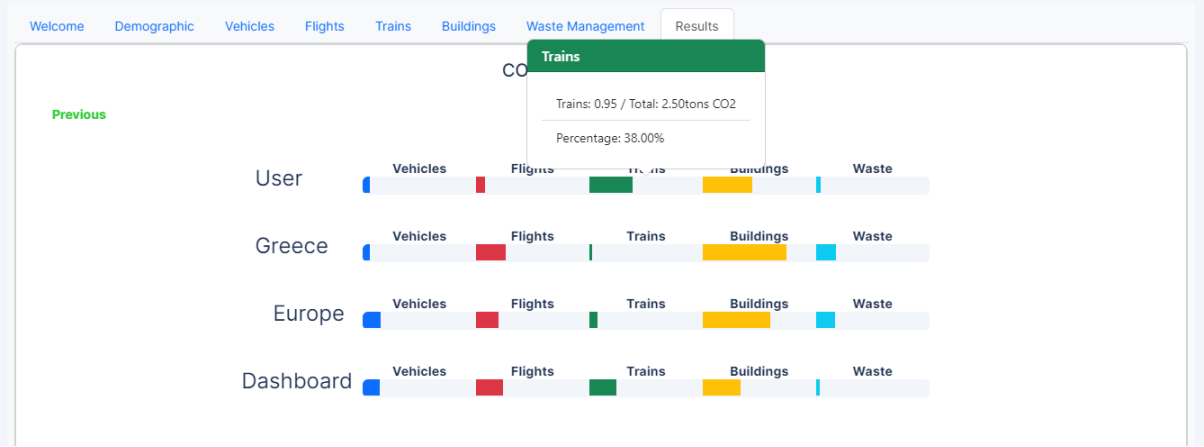


Figure 76 Information about each carbon footprint domain

Right below the barplots, there are various graphs (Figure 77) that provide visualisations that help the user understand their carbon footprint.

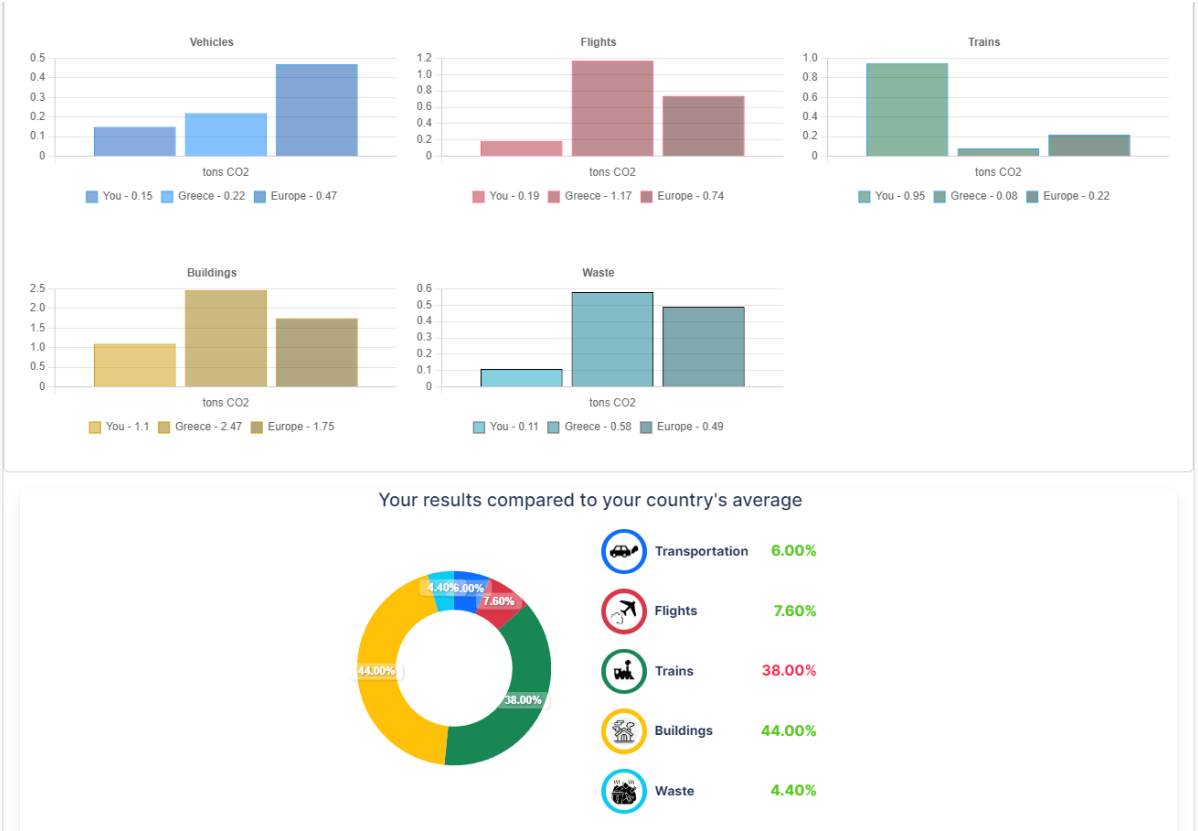


Figure 77 Visualisation options

At the bottom of the tab, the user also has access to recommendations on how they can reduce their carbon footprint (Figure 78). There is one recommendation category for each domain. The recommendations that appear here depend on what answers the user has provided in the previous tabs.

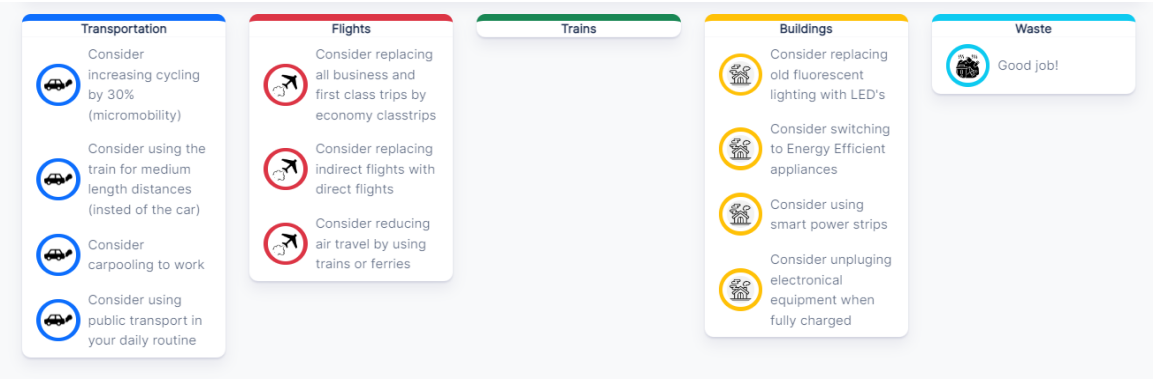


Figure 78 Recommendations by domain based on user's results

By clicking on a recommendation, the user is presented with information links (Figure 79) that can provide additional insight regarding that recommendation and how they can begin adopting it. These links are country-based so the user will receive links that are relevant to the country they have chosen on the Welcome Tab of the calculator.

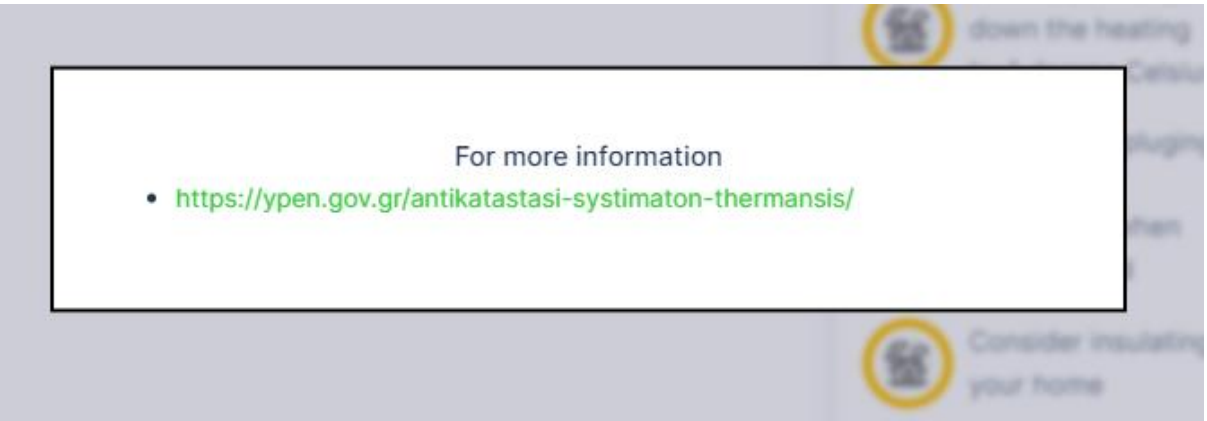


Figure 79 Information link related to a specific recommendation the user clicks on

Scenario Simulation

Choosing the third option on the navigation menu, the user is led to the Scenario Simulation (Figure 80). The Scenario Simulation allows the user to submit their opinion in the form of scenarios regarding a specific quantified environmental goal. For example, a goal can be the European Commission's target of a 55% net reduction in greenhouse gas emissions by 2030. The goal is visible on the top of the page. The purpose of the tool is to allow the users to see how various actions can affect their carbon footprint. Moreover, summaries of these scenarios will be later available to policy-makers, giving them insight on the opinions of the citizens that will allow them to take them into consideration when making decisions.

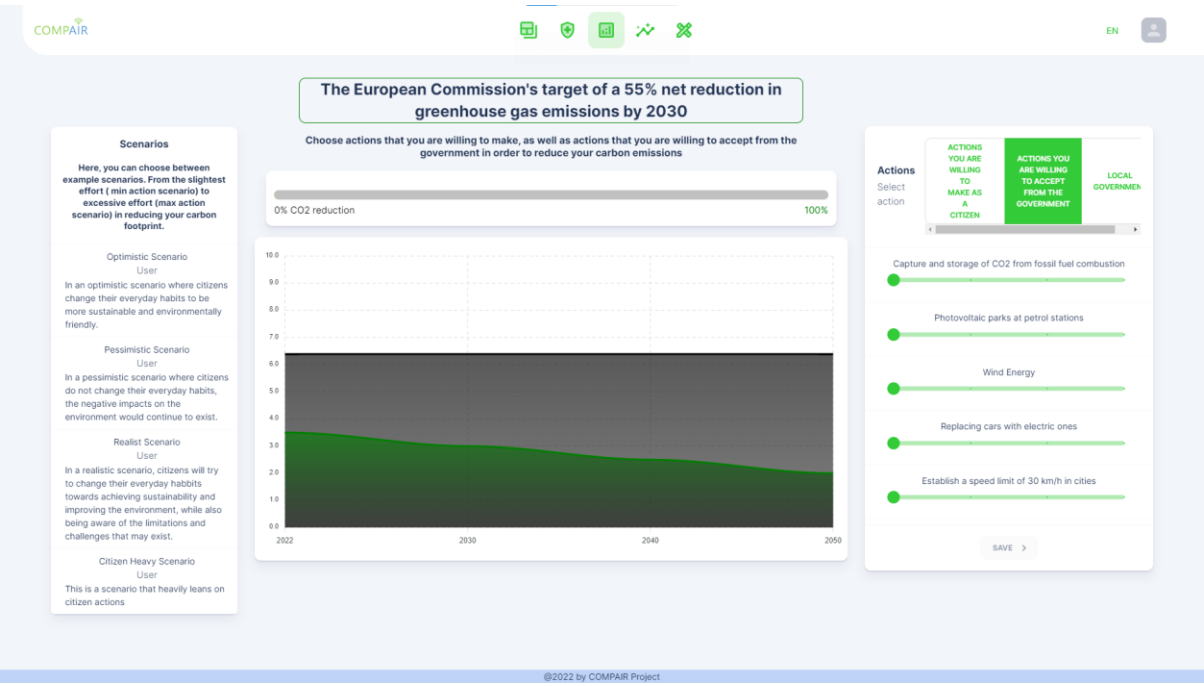


Figure 80 Scenario Simulation

Below the goal there is a progress bar and a graph. The progress bar shows the emissions reduction caused by the actions chosen by the user. It changes colour from yellow to green if the target is reached. The graph shows the current and the target emissions.

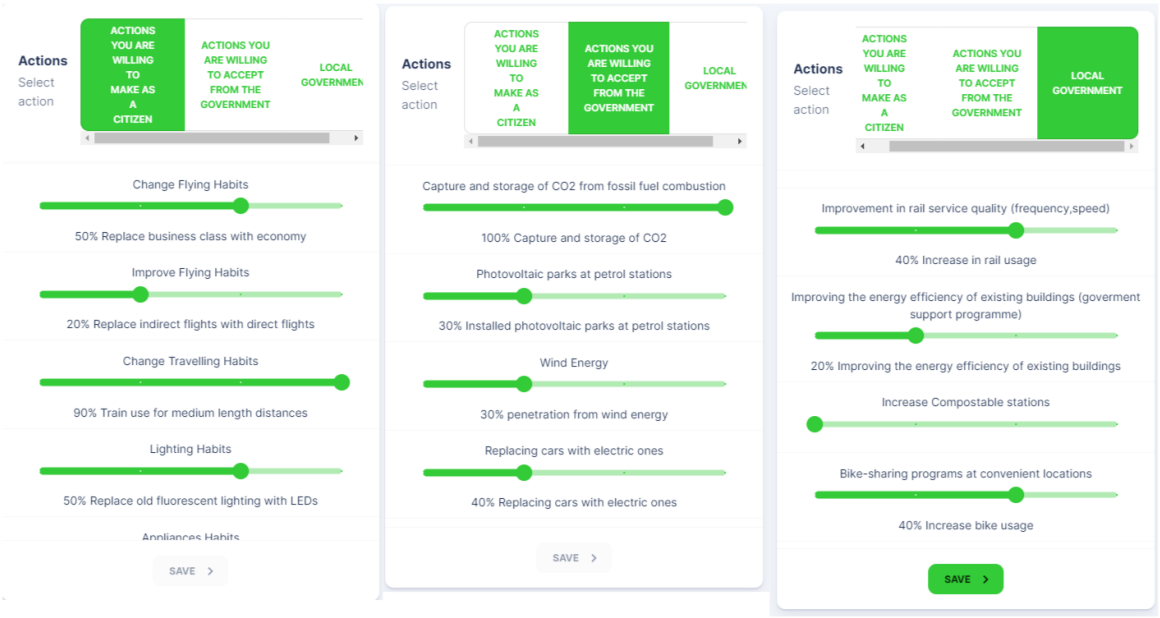


Figure 81 :Action sliders

To create scenarios, the user can choose between three types of actions (Figure 81). These actions can be found on the right side of the page and they are actions they can adopt on their own initiative, actions they are willing to accept from the central government, as well as actions they are willing to adopt from the local government. Each action has four available levels, which corresponds to a different level of adoption. The user can choose the level they want by moving the slider of the action. Moreover, an explanation of each level is provided when the user chooses it. When a user's scenario reaches the set goal, the user can submit their scenario.

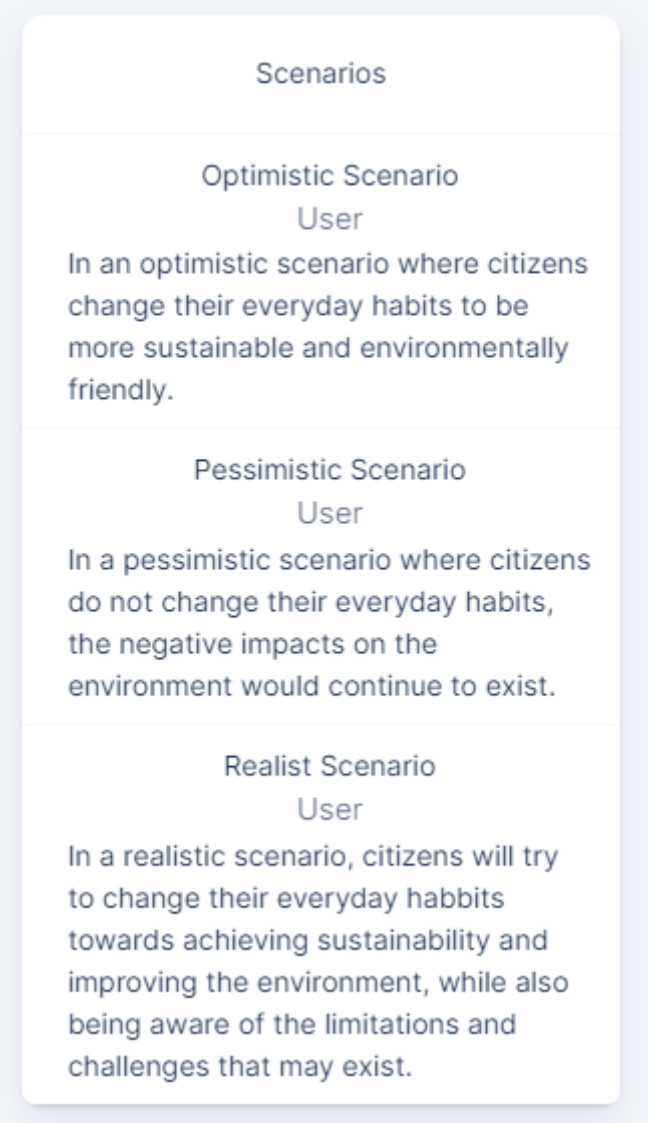


Figure 82 Example Scenarios

In addition, on the left side of the page, there are example scenarios (Figure 82). These can be viewed by the users so that they can get a better idea on how various actions affect carbon footprint and what strategies governing bodies are considering in order to reach the set goal.

Profile Page

Choosing the fourth option on the navigation menu, the user is led to their Profile Page (Figure 83). This profile page is dedicated only to the Carbon Footprint Simulation Dashboard and provides the user with the history of their results on the Carbon Footprint Calculator and submitted results of the Scenario Simulation.

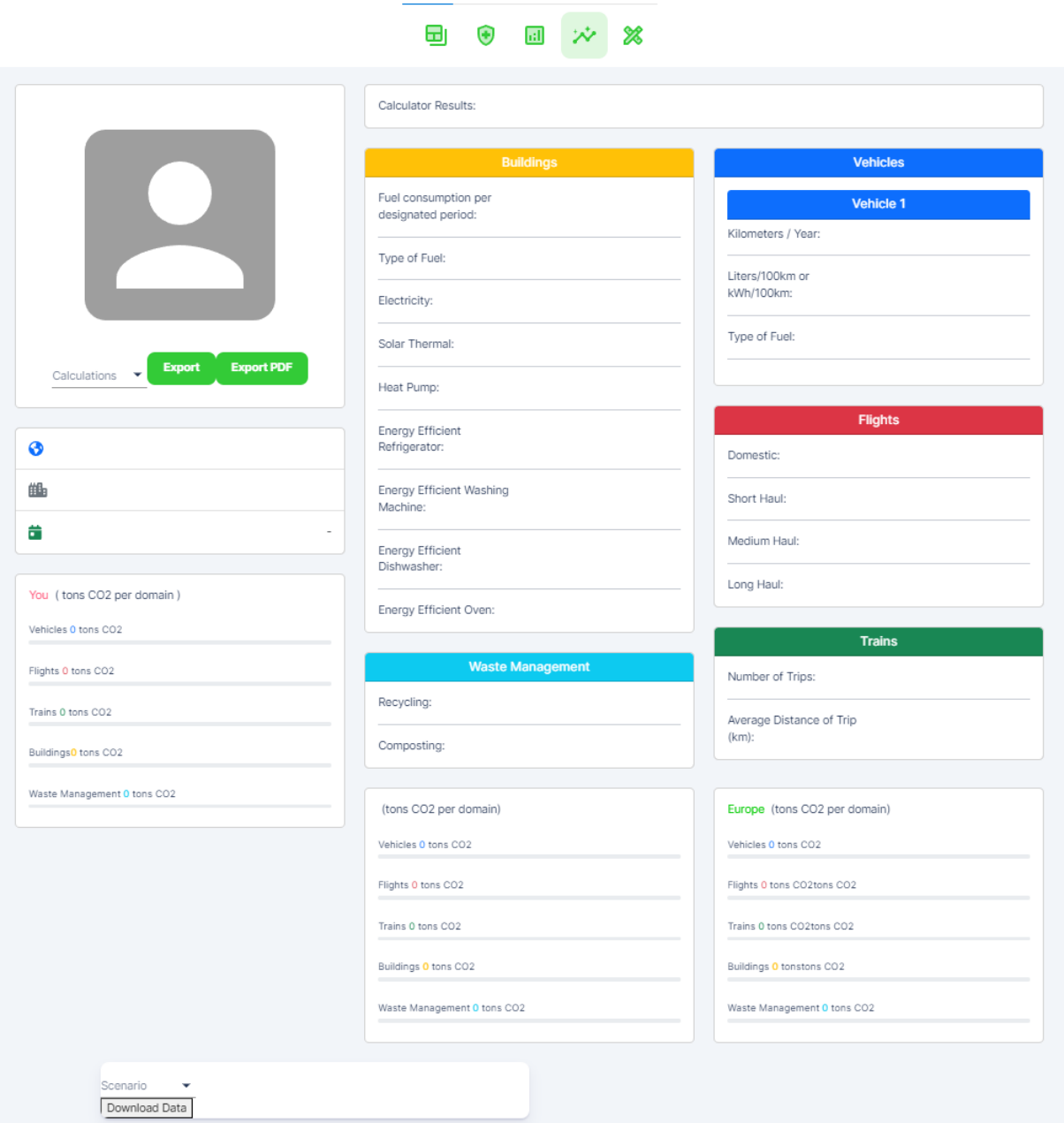


Figure 83 :Profile Page

The user can choose which calculation they want to browse from the dropdown menu that is available (Figure 84) on the top left part of the screen. This dropdown menu will present only calculations of the user. The identifier for each calculation is the date and time that the calculation took place.

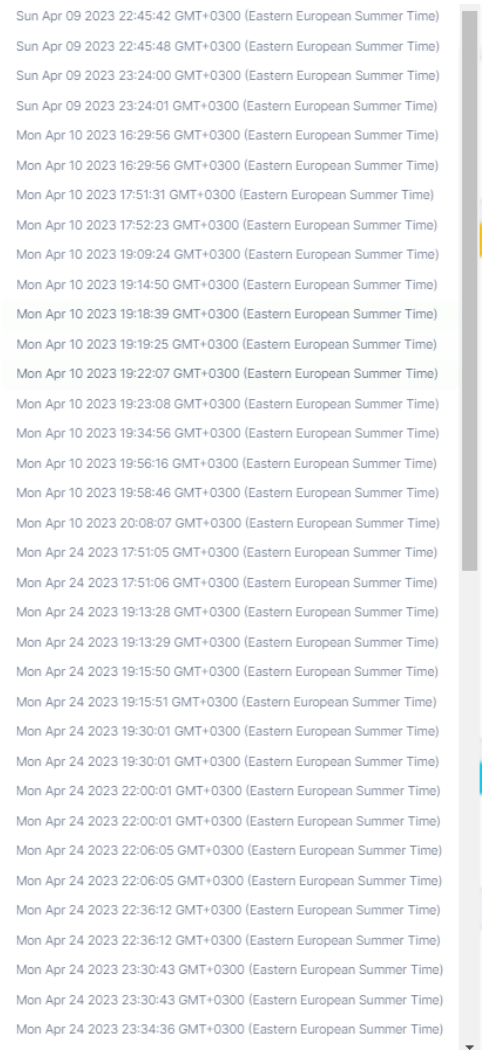


Figure 84 Calculations dropdown menu

Once the user chooses which calculation they want to browse, the data is presented on the rest of the screen and is distributed appropriately (Figure 85). There is a box for each of the calculation's carbon domains that shows how the user has replied to each of the answers. Apart from the answers, the user can also see the distribution of their carbon footprint just like on the results tab of the Carbon Footprint Calculator, as well as the comparison with the carbon footprint average of their country and the EU.

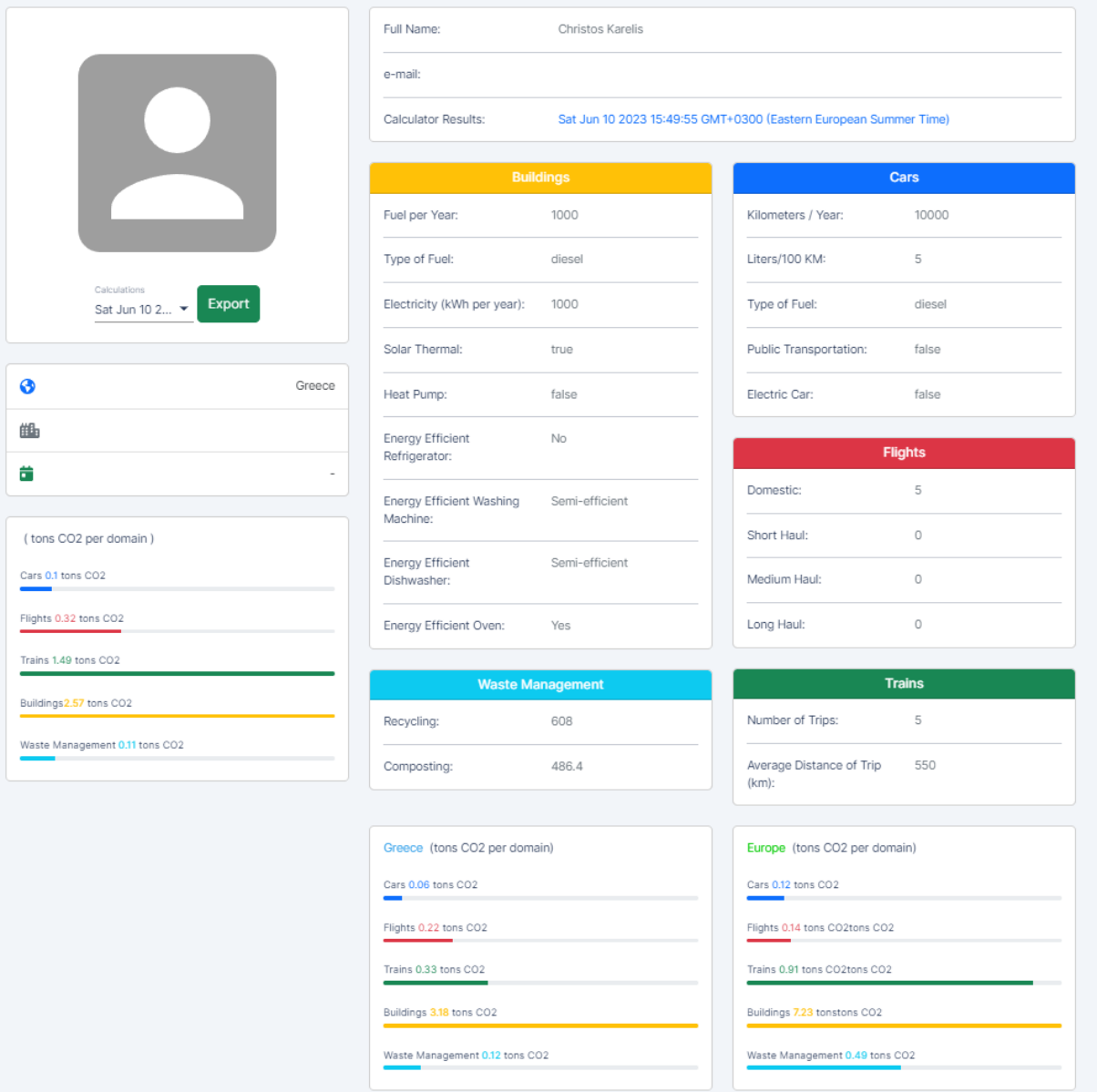


Figure 85 Browsing a calculation on the profile page

When the user selects a calculation from the menu, a button appears next to the calculation selection menu that allows them to also view the results page of the Carbon Footprint Calculator based on the selected calculation. There is also the option to download the selected calculation data in csv and PDF format.

Below the Carbon Footprint Calculator results, the user can also browse the scenarios they have created on the Scenario Simulation. Similarly with how they can browse the Carbon Footprint Calculator results, there is a dropdown window that shows them their created scenarios (Figure 86).

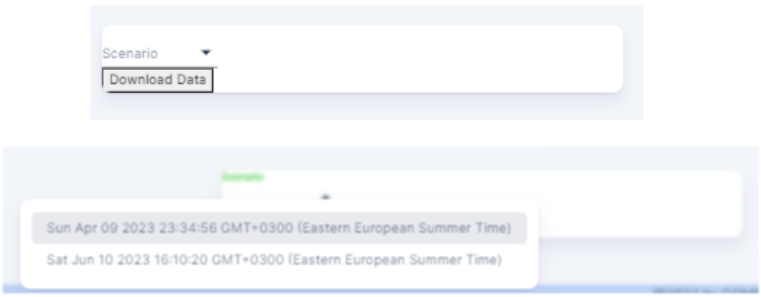


Figure 86 Scenarios dropdown menu

Once the user picks which scenario they want to browse, a list appears with the actions of the scenario set at the level the user has chosen (Figure 87). The actions cannot be edited here, since the scenario has been submitted and this is a feature that allows the user to see a previously submitted scenario. If they want to make a change, they have to create a new scenario on the Scenario Simulation and submit it again.

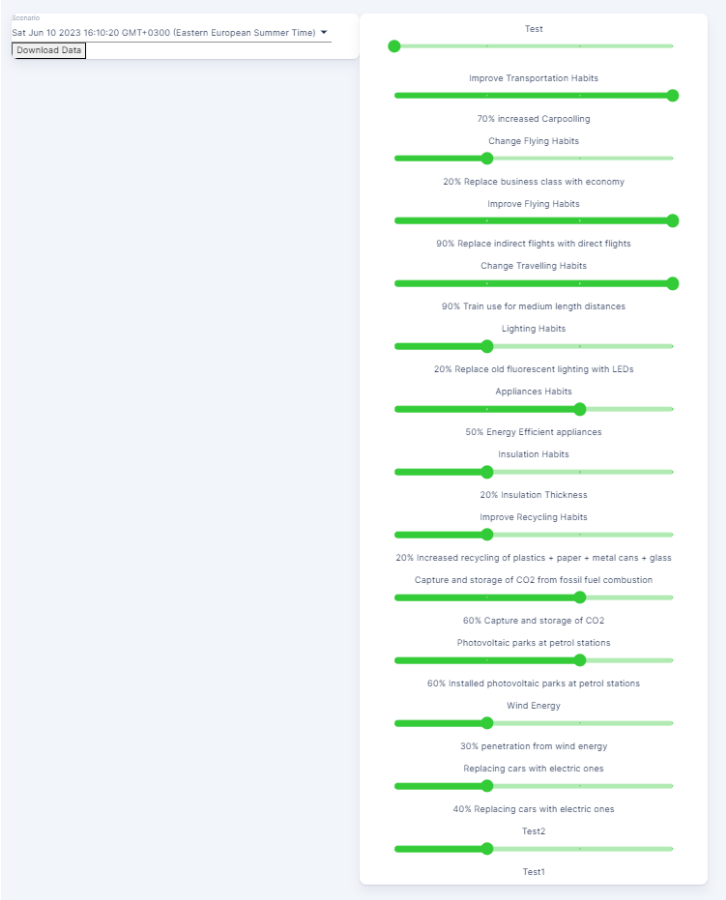


Figure 87 Browsing a scenario on the profile page

Administrator Page

Choosing the fifth option on the navigation menu, the user (if an administrator) is led to the administrator page (Figure 88) which provides various tools to the administrators of the Dashboard. Administrators are meant to be policy-makers and city officials that are going to gain insight on citizens' opinions on what actions they are willing to perform towards the achievement of a policy target and the probability of achievement. The Admin Page is under development so only the currently available features are presented below.

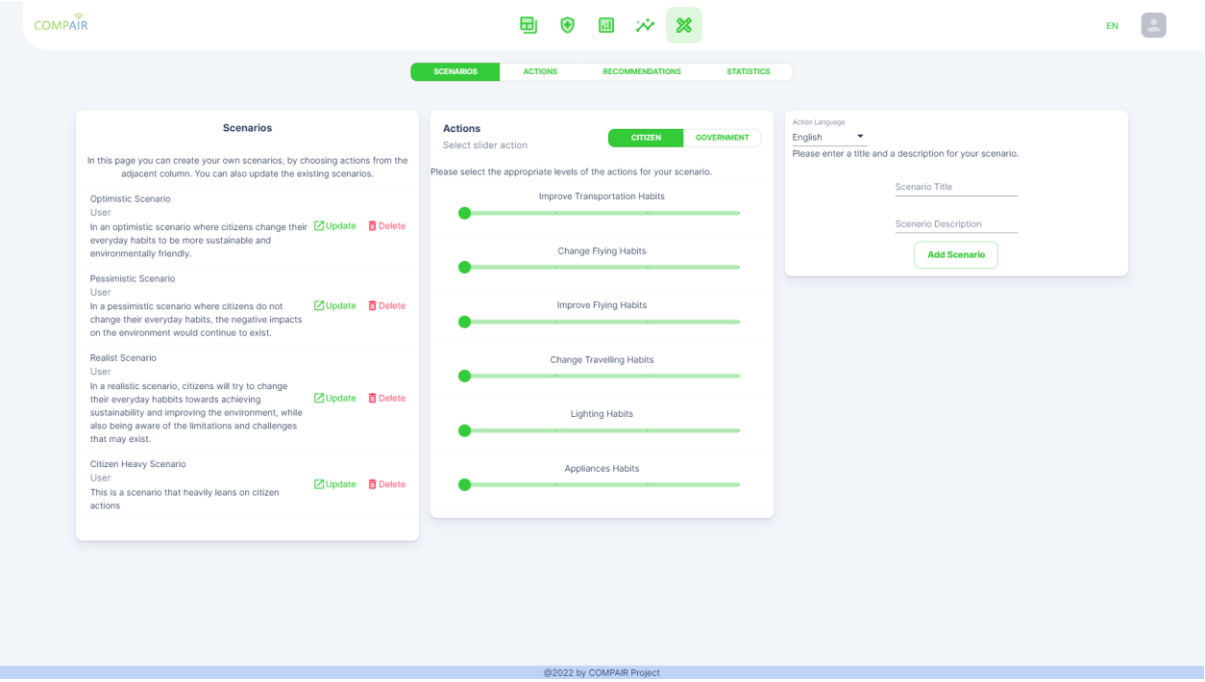


Figure 88 Admin Page

The admin page has its own navigation menu below the main navigation menu. There are currently four options in the menu. The first option leads to the scenario creation page. In this page, an administrator can create, update, and delete example scenarios for the Scenario Simulation. On the left part of the screen, there is a list of example scenarios that are currently available. From there, the administrator can update or delete an example scenario.

In order to create a scenario, an administrator has to choose the level of each action for the scenario. This can be done from the list of actions that are available, which is located in the middle of the screen. Then they have to enter the scenario's name and description on the right part of the page (Figure 89). Finally, they can press the "add" button and their scenario is created.

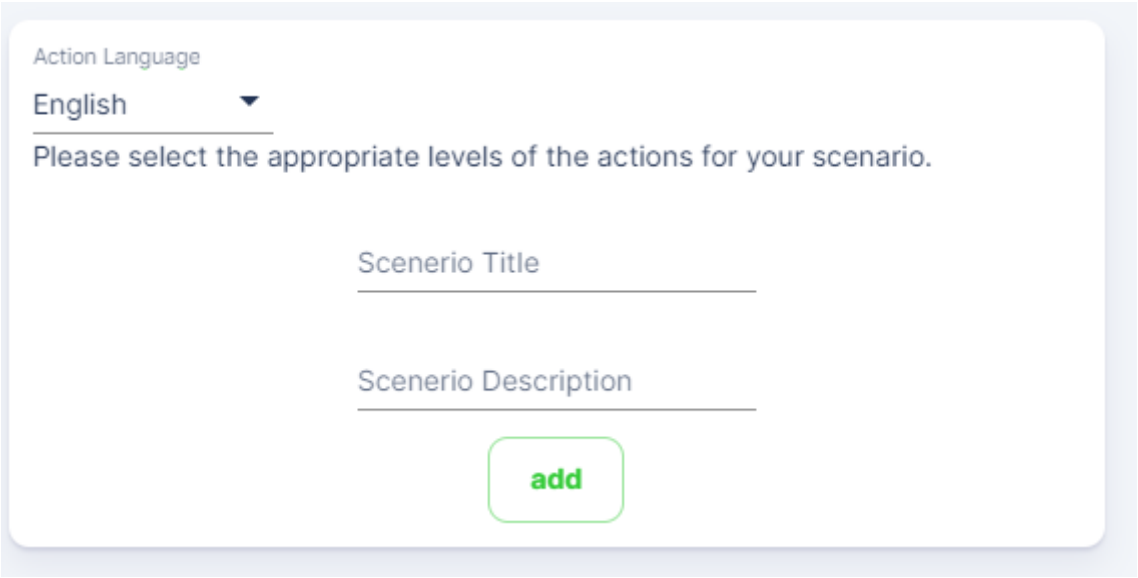


Figure 89 Add the title and the description of the new scenario

The second option in the admin page navigation menu leads to the actions page (Figure 90). This allows the administrator to create, update, and delete actions that are available in the Scenario Simulation. On the left part of the screen there is a list of the actions that are currently available. From there, the administrator can update or delete an action. They can switch between the citizen and government lists by pressing the “citizen” or “government” button.

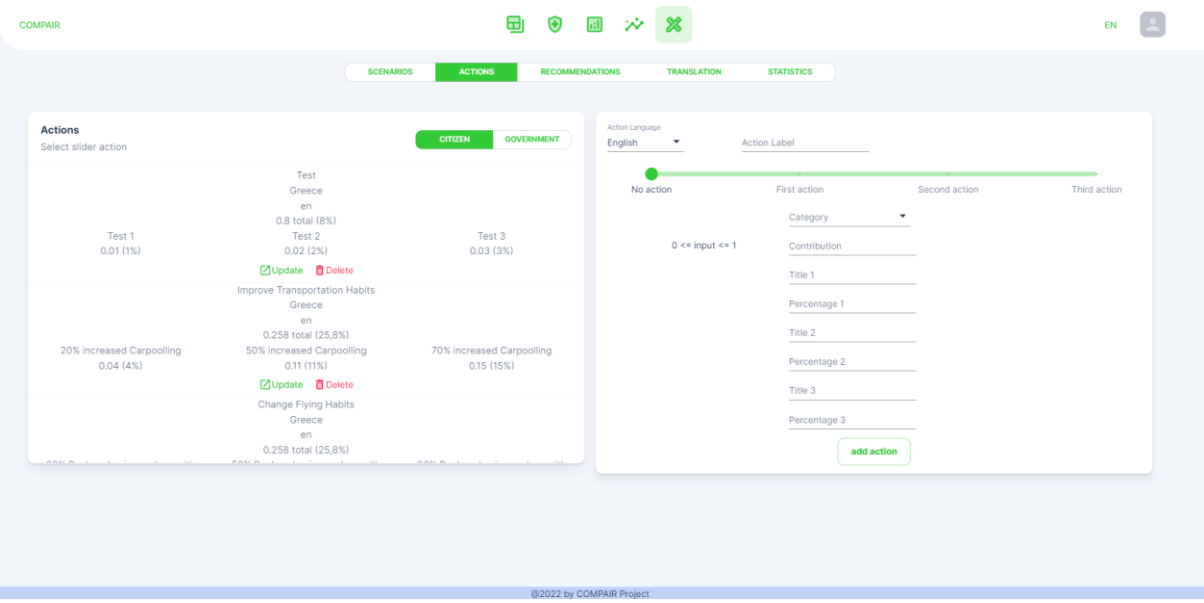


Figure 90 Admin page - actions

In order to create an action, first, the administrator has to give it a name by filling in the “Action Label” field. Then, they can choose whether the action is a citizen or a government action from the “Contribution Category” dropdown menu. The “Contribution” field allows the administrator to choose the percentage of emission reduction this action provides. Finally, they have to add a title and the percentage of contribution for each level of the action.

The third option in the admin page navigation menu leads to the recommendations page (Figure 91). This allows the administrator to create, update, and delete recommendations that are available in the Carbon Footprint Calculator. On the left part of the screen, there is a list of the recommendations that are currently available. From there, the administrator can update or delete a recommendation.

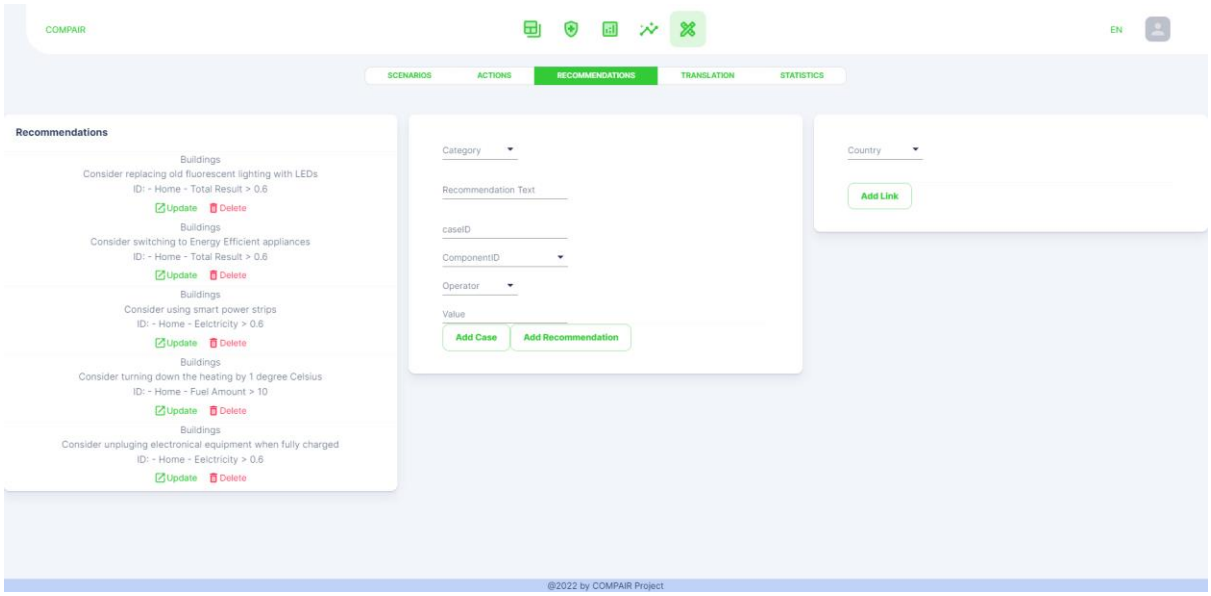


Figure 91 Admin page - recommendations

In order to create a recommendation, first, the administrator has to choose its Category. The categories available correspond to the carbon footprint domains from the Carbon Footprint Calculator. Then, they have to enter the text for the recommendation, which is the text the user will see. The caseID allows the administrator to add an identifier for their recommendation.

Finally, they have to provide the conditions for the recommendation to appear. The ComponentID dropdown menu contains a list of all the fields in the Carbon Footprint Calculator a user can fill in. The administrator can choose a field, an operator, and a value. A comparison between the chosen field's value set by the administrator and the value provided by the user, based on the operator that has been chosen, takes place. If the comparison is true, the recommendation will appear to the user. If the administrator needs to add more comparison cases for their recommendation, they can press the "Add Case" button and an additional set of fields appears (Figure 92).

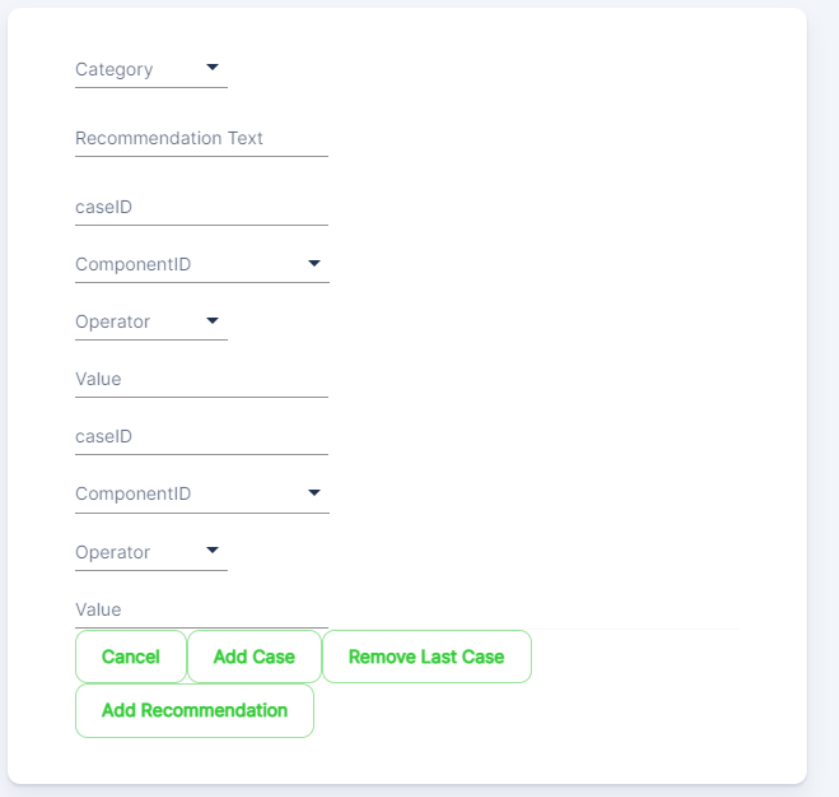


Figure 92 Adding more cases to a recommendation

Furthermore, if the administrator has information links they want to provide along with the recommendation, they can do it on the right part of the screen (Figure 93). They can choose for which country they want to add a link and can add multiple ones if there is a need to do so.

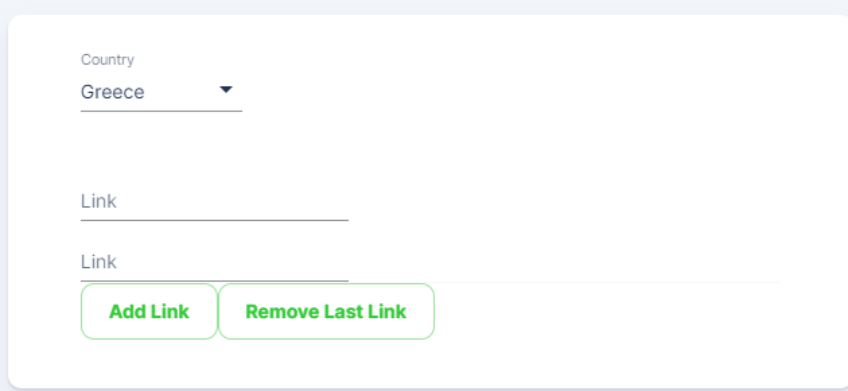


Figure 93 Adding information links to a recommendation

The fourth option in the admin page navigation menu leads to the statistics page (Figure 94). This allows the administrator to visualise the data of the Carbon Footprint Calculator and the Scenario Simulation in order to better understand them. This is done in the form of two graphs, one for the Carbon Footprint Calculator and one for the Scenario Simulation. The data is filtered based on the country, the city, as well as some of the initial questions asked in the demographics tab of the Carbon Footprint Calculator.

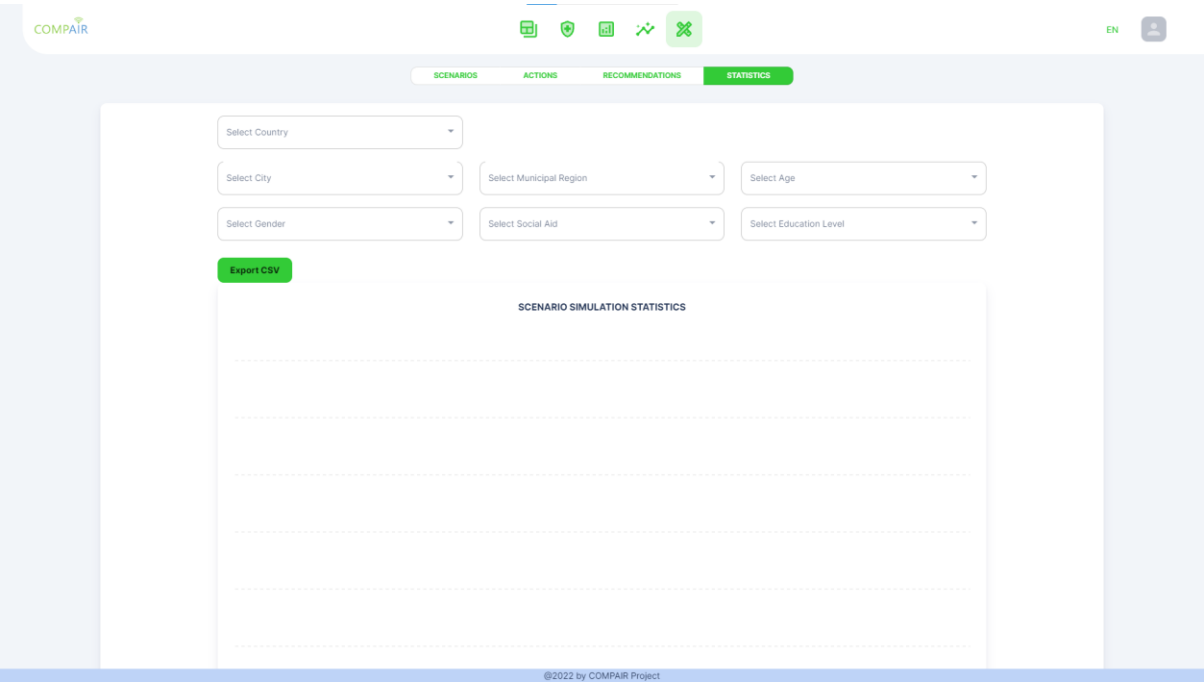


Figure 94 Admin page - statistics

When the country is selected, data appear on the graph and they can be further refined using the rest of the filters. For the Scenario Simulation, the graphs are presented as a bar chart that represents how many users selected which stage of each action (Figure 95). Each action is represented by a group of four bars, one for each stage of the action.

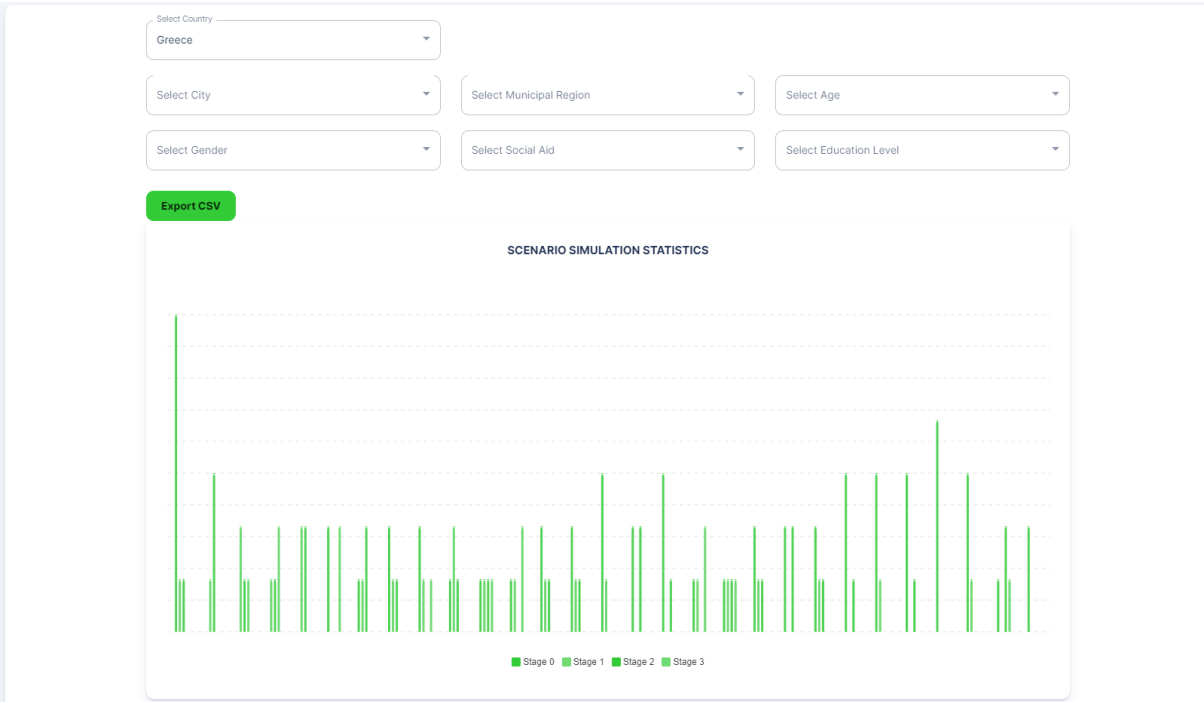


Figure 95 Admin page - Scenario Simulation Statistics

For the Carbon Footprint Calculator, the graph is also a bar chart (Figure 96). The bars on the graph represent the domains of the Carbon Footprint Calculator as well as the total carbon footprint. The data presented here are averages of the users selected based on the filters used.

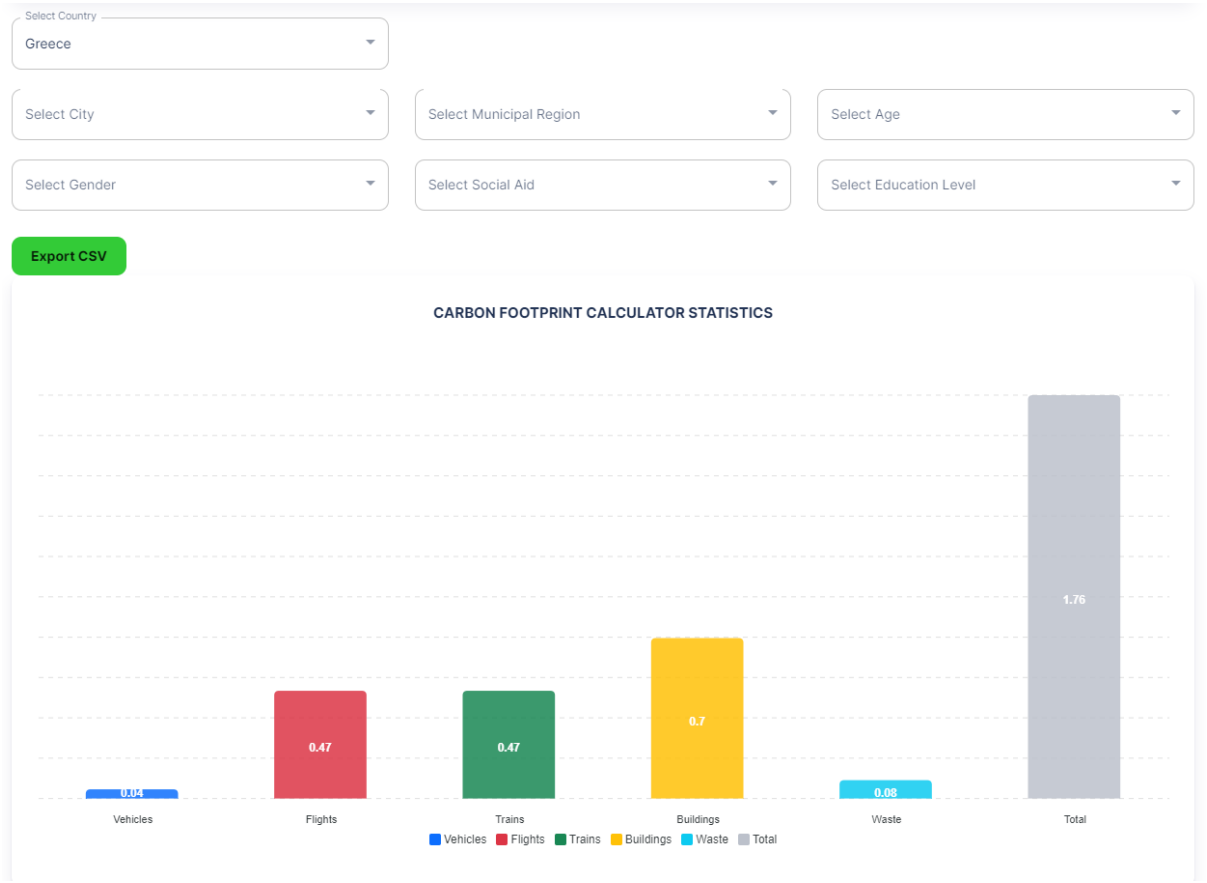


Figure 96 Admin page - Carbon Footprint Calculator Statistics

Finally, there is the option to export the filtered data in csv format.

Data Map

Choosing the sixth option on the navigation menu, the user (if an administrator) is led to the Data Map (Figure 97). This page allows the administrator to view the Carbon Footprint Calculator data on a map, based on municipal communities.

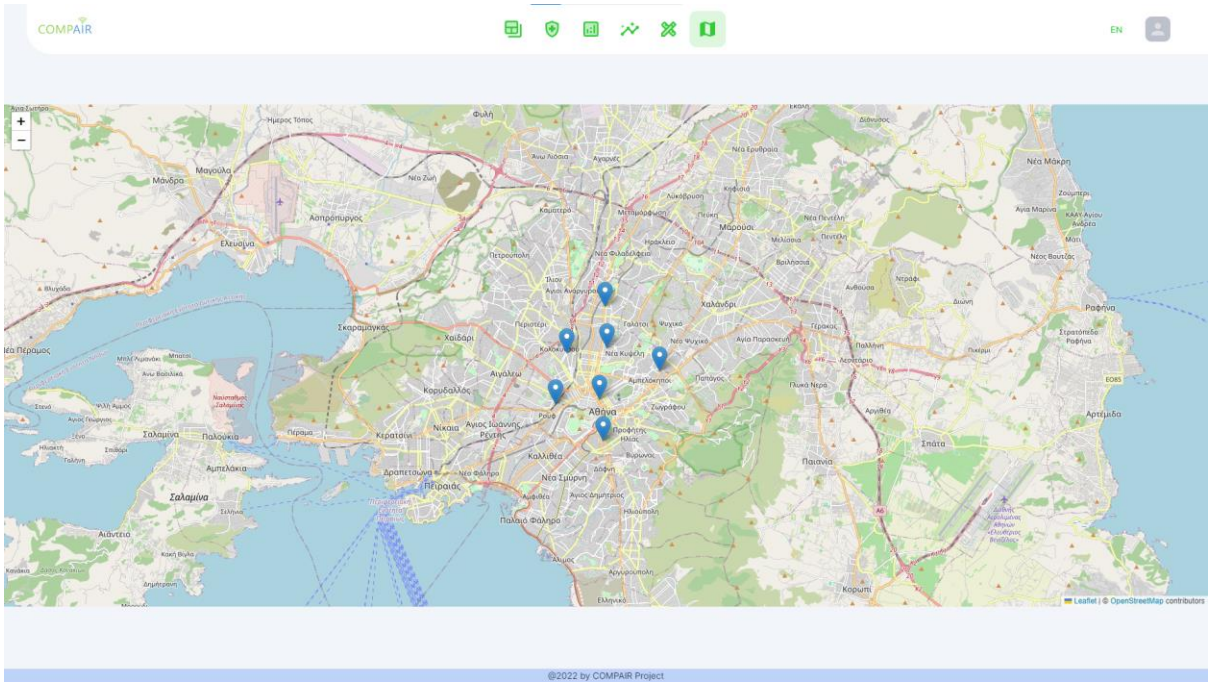


Figure 97 Data Map

The administrator can view the data of each municipal community by clicking on the marker on the map (Figure 98). The data presented are averages of the domains of the Carbon Footprint Calculator for each municipal community.

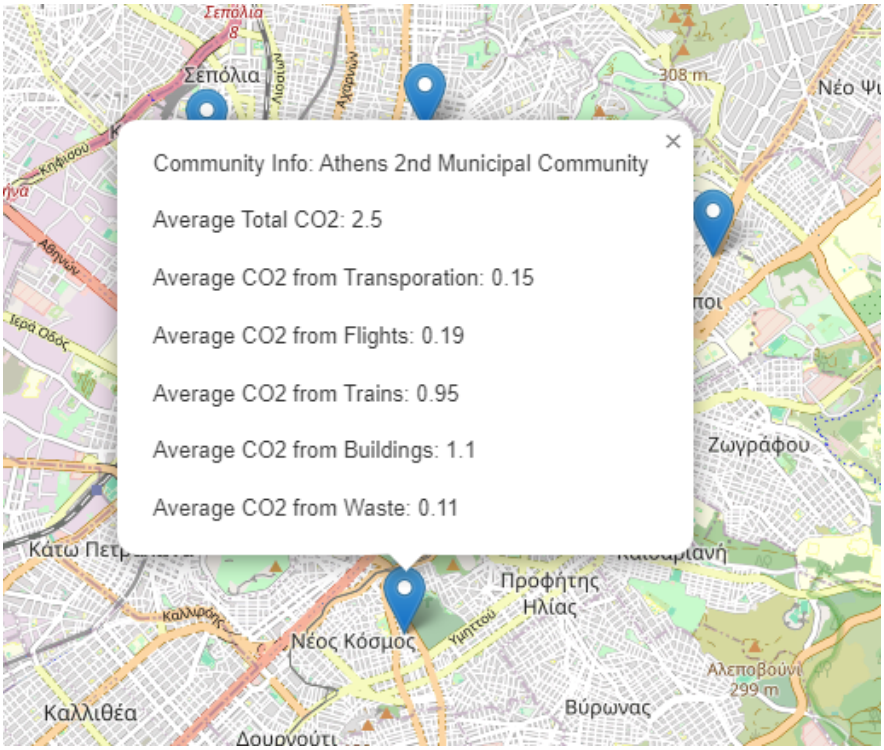


Figure 98 : Viewing the information of a municipal community

Data Validation

In order to help users and administrators, we have implemented a feature that does not allow them to input the wrong type of data that would result in the Carbon Footprint Simulation Dashboard working incorrectly. When a user tries to enter a wrong type of data in a field, they won't be able to do so and may get an error message with directions on what they are supposed to input (Figure 99).

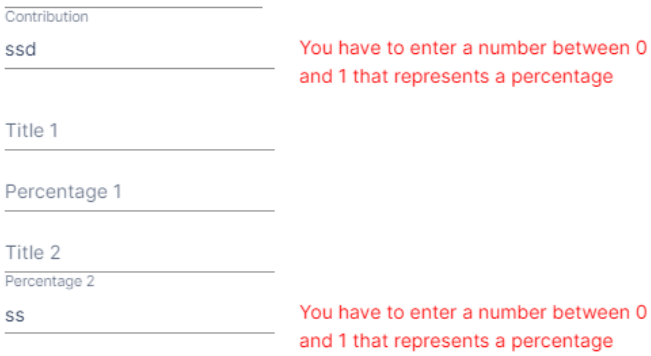


Figure 99 Error message when trying to add text in a number field

6. Dynamic Exposure Visualisation App (DEVA)

The Dynamic Exposure Visualisation Application (**DEVA**) is to enable citizens to explore the environmental conditions in their surroundings via their smartphone or tablet using Augmented Reality (AR). So they see a visual overlay of environmental information such as air quality or traffic information. The environmental information, which is accessible and can be visualised with DEVA is as follows:

- the SODAQ fine dust sensor measuring particulate matter (PM) of different granularity such as PM10, PM2.5, and PM1.0
- the OnePlanet NO2 sensor
- the BCMeter measuring black carbon
- the Telraam traffic counting sensor
- the publicly available sensors from sensor.community [8]
- The Breezometer air quality model data platform [9]

The latest open public release offers three main functionalities.

1. An Exploration mode to visualise air pollution and traffic data in a simple and easy way
2. An Expert mode that offers a wider range of functionalities in terms of visualisation and data selection
3. A Trip Recorder that allows recording GPS positional information along a trip. The recorded trip data are sent to the **COMPAIR** Data Manager, where it is merged with air quality information and used for the Dynamic Exposure Visualisation Dashboard (DEV-D) (see Section 4)

The app is available for the consortium members for Android devices as an .apk-file to allow testing in the public round. Until the end of June 2024, the DEVA will be made available on the two app stores, Google ÜPlay Store and Apple Store.

List of epics implemented for the DEVA open public release

The following table presents the list of epics implemented for the DEVA open public release.

Table 5 List of epics implemented for the open public release of DEVA

ID	EPICS
DEVAViz	**Visualise data in 3D Space**
1	Story: As a citizen/researcher, I want to get access to the Sensor Community data, so I can see AQ data in the case where there are poor data or I'm not in a pilot area
DEVAAnn	**Annotate Measurements**
1	Story: Create field to add SODAQ sensor ID in the Trip window, either manually or via QR-code scan
2	Story: Record basic trip features: personalised user ID, trip name and trip description
3	Story: As a citizen , I can do data annotation about my current activity or the context (e.g. start trip, type of trip, end trip) as well as my health status
4	Story: Calculate average speed and present very simple visualisation
5	Story: Measure trip distance (in order to ensure that users are moving)
DEVAMan	**Management**

	Story: As a researcher, I can monitor whether a device is measuring effectively during the experiment by getting a signal when the device is on, but not measuring data
DEVARea	**Real-time communication and information visualisation**
1	Story: New sensor data has to be requested according to the movement of the user
2	Story: New sensor data has to be requested after the user change some sensor type filtres e.g. by the equalizer
DEVAUsI	**Update user information**
1	As a citizen, I want to see an instruction window, so I know how to use the app
DEVAUI	**User Interface**
1	Story: Link GUI buttons featured with web-links to the corresponding COMPAIR web pages
2	Story: Change/create login screen
3	Story: As as citizen, I want to record my trip

In the following sections, the updates and developments since 1st July 2023 are described. In the next section, we revisit all the updates and new features that have been implemented in the **DEVA** on a general level. In each of the different topics, we refer to the related epics that were defined by the end users through short user-stories (see table 5).

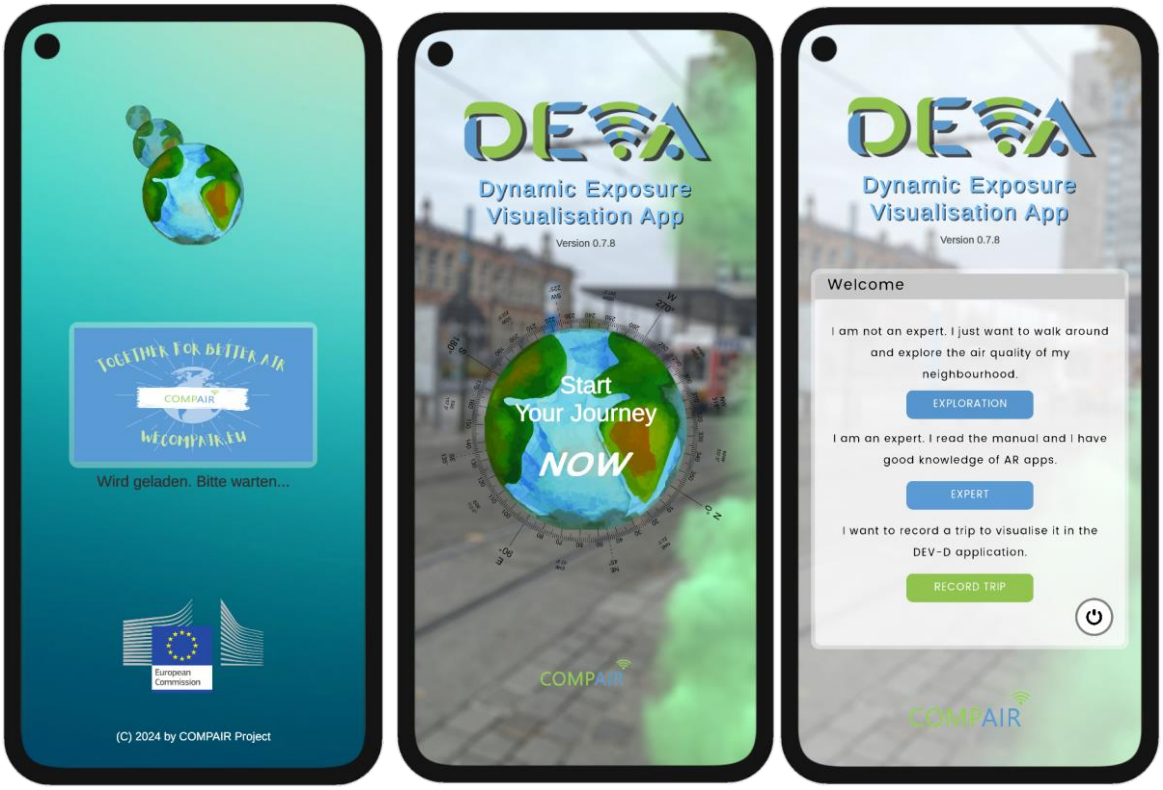
User guide and feature update

The development in the last phase of this work package focused on the following aspects and functionalities.

- One major update in the AR app development was the update of the AQ Framework and DEVA program to the new Unity release 2022 LTS. This long term support garanties a more sustainable development and publishing for DEVA by using the newest Android and iOS version (recommended from the stores);
- New GUI “round” design for the various windows, buttons and other UI elements. The design is a white design and is more lightweight. This design uses round-corners to draw windows, panels and buttons etc. The other designs (e.g. colourized) are accessible in the Expert mode via the GUI settings windows. The AQ Framework uses a UI skin system for this;
- Design and implementation of the “Exploration mode”, which represents a simplified user interface and a revised version of the “Expert mode”;
- The implementation of the Trip Recorder to allow the user to record GPS positions along the way for later use in the Dynamic Exposure Visualisation Dashboard (DEV-D);
- Integration of sensor.community data and Breezometer data
- A robust error handling to support the user during the use of the application especially to alarm, if there are issues with the localisation of the device (GPS) and accessibility to the Data Manager (Internet access);
- implementation of information/instruction windows concerning privacy, security and help
- A complete multi-language support for the relevant project languages, English, Dutch, German, Greek and Bulgarian. The language is set to the device language. In the Expert mode, the user has the possibility to switch to another language.

In the sections below, we present the User Interfaces and the updated features of the current open public version. In Figure 100, the different screens are depicted when starting the app. In Figure 100a, the splash screen is presented during the loading of the application. After complete load, the start screen is presented (see Figure 100b). After touch, the welcome screen is presented, where the user can select the three different main functionalities (see Figure 100c). With the new login system, the user does not need to create a local account on its device anymore. The user name can be changed, but is only informal.
The following three modes are accessible:

- The **Exploration mode** for non-experts offering simple user interface providing only the absolute necessary set of options
- The **Expert mode** for experienced users, which are familiar with Augmented Reality and interested to dive into a variety of functionalities and visualisation modes.
- The **Trip Recorder** offers tracking of GPS positions during a trip, which are later used for visualisation in the sister application DEV-D



a) b) c)

*Figure 100*a) Splash screen, b) start screen, c) welcome screen.

Exploration and Expert mode (**DEVAUI-2**):

A major development was the implementation of the “Exploration mode”, which offers a simplified UI with reduced functionality in order not to overwhelm the user with buttons and icons, but to let the user focus on the essential information.
This led to a simplified Hamburger Menu and a complete removal of the toolbox and related functionalities (see Figure 101). Furthermore, the top bar has been simplified as well displaying only the essential information. Many settings are specified already in this mode so that the user can directly experience the app. This mainly relates to the visualisation of the

sensor data, but also other settings are predefined e.g. the setups for the various AQ data servers. All menus and buttons to access the parameters were removed from the UI.

*Figure 101*SImplified Hamburger Menu (left), standard screen in exploration mode,(centre).

A simple UI allows the user to choose the desired environmental information such as air quality and/or traffic.To allow the user capturing immediately the air quality in its surrounding, the related sensor data values are colour coded. In the figure below, the sensor values are marked on the colour bar to get quickly an idea about the environmental situation (see Figure 102, right).

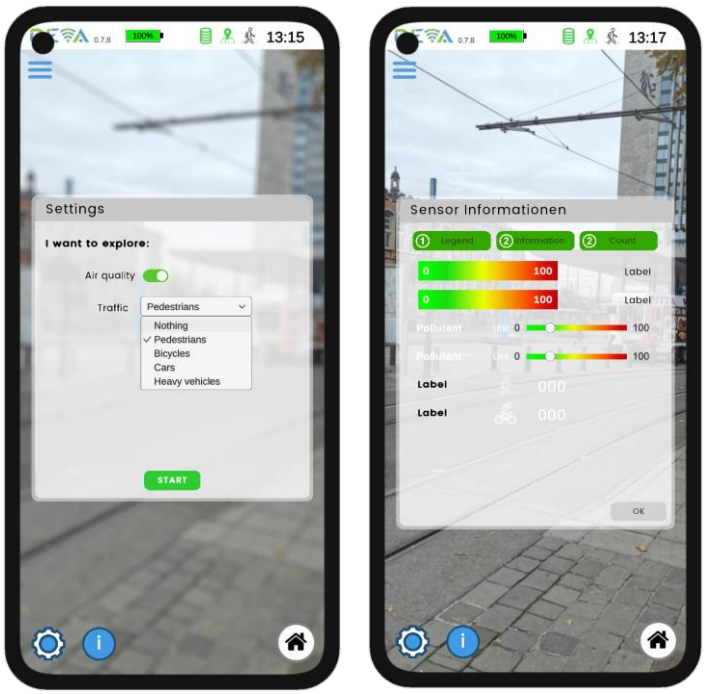


Figure 102 Exploration mode: UI for environmental info selection (left), sensor info with colour code (right).

In addition to the simplified “Exploration mode”, the “Expert mode” is still available. In this mode, the user has the capability to change a whole range of settings related to visualisation, sensor data selection and many more. The Hamburger Menu offers more functionalities and the toolbar provides more information.

In both modes, the user will receive important information (notifications, warnings and errors) via the old top message bar. For very important messages, the app will show a modal special window with a more clear message and an icon showing the current state. The AQ framework consists of a template with interactive buttons like OK, Cancel, YES, NO, Save, Accept, Reject, which allow the user to close the message window correctly.

The new Equaliser window from the Expert mode allows the user to select one or more AQ sensor types and also the types of traffic where the user is interested in (see Figure 102a). If the user was logged in in the simplest mode “Exploration” then the sensors are automatically selected like the user makes their choice in the info selection windows (see Figure 102, left).

The new Radar window (Expert mode) now proposes extra icons for third-party AQ data. Project internal data from the Data Manager are represented as before with a ball, sensor.community data with a square and Breezometer data with a triangle. In this way the user can better identify the source of the data in their surrounding space (see Figure 103b). The Hamburger Menu and the Toolbox are still available in the public version (see Figure 103c and 103d).

a) *b)* *c)* *d)*

Figure 103: Expert mode:a) Equaliser, b) Radar window, c) Hamburger Menu and d) Toolbox.

Furthermore, the expert mode also allows the user to perform various settings such as AR visualisation, data server and GUI (see Figure 104, f.l.t.r.).

Figure 104 Expert mode: different user settings (f.l.t.r.) AR, Data Manager, sensor.community server, GUI.

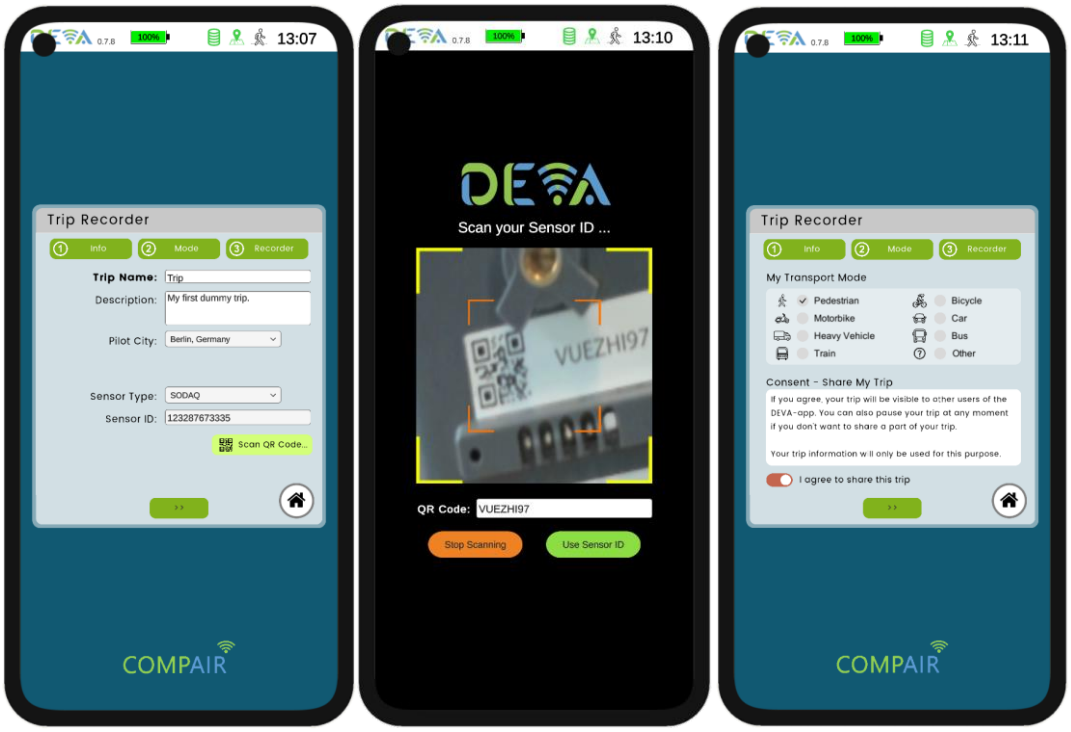
The Expert mode presents a new render mode for the data, the Cloud View. This mode should be separately activated in the dedicated toolbar (Revolver bar) and is only representative if there is enough AQ data in the environment. Single AQ data are aggregated with a cluster technique and a particle animated cloud will be rendered instead for that region. This dynamic visualisation should create fancy spatial effects where the user can directly immerse into the cloud when close enough.

Figure 105 Expert mode: Radar window (left) UI for environmental info selection (left), sensor info with colour code (right).

Trip recorder (**DEVAAnn-1 … DEVAAnn-5, DEVAUI-3**):

This functionality allows the recording of the GPS positions along a trip. During this mode, the AR functionality is disabled to save battery. In the Figure 106 below, the UI for this functionality is shown. Before a user starts a trip, they have to enter some information (see Figure 69a). The title, description of the trip and mode of transportation are facultative, but nice to have

when searching a trip in the DEV-D dashboard. The selection of the city, the sensor type and its ID are mandatory in order to assign the trip correctly in the Data Manager. To enter the sensor ID, the QR Code scan page of DEVA was optimised so that the QR code can be efficiently read (sharpness of the camera, size of the code etc.) (see Figure 106b). To access the recorder page, the user also has to consent to the usage of the data (see Figure 106c). All the information is locally stored for the next time and there is no need for the user to enter it again.



a) *b)* *c)*

Figure 106 Trip recorder: a) Trip information UI, b) SODAQ QR code scanning, c) transport mode selection and consent.

In Figure 107, left, the trip can be started, paused and stopped. After the start of the trip, the GPS positions are recorded in a defined time slot according to the speed of the user or their vehicle. The time slot begins by 1 second for a slow speed and grows up to 6 seconds for a fast driving vehicle. The system assumes that slow movements (i.e. from a pedestrian) demand more precision than such from a bike or car driving faster. This will also reduce the payload of the trip data sent to the server. After the stop of the trip, the recorded data is transferred to the Data Manager, the central **COMPAIR** data server that hosts all the sensor information from the different sensors. With the Dynamic Exposure Visualisation Dashboard (DEV-D), the stored trip can then be visualised in conjunction with the related pollution along the trip. This offers the user personalised environmental data and allows for changing behaviour, in this case for example to choose a different less polluted trip. In Figure 107, right, the notification of the state of the trip recorder is shown.

If the user forgot to send a running trip while exiting the Trip Recorder, a warning window will appear and the user can directly send the data, cancel the trip or go back to the recorder. This window is very important because otherwise the user will lose their current trip.

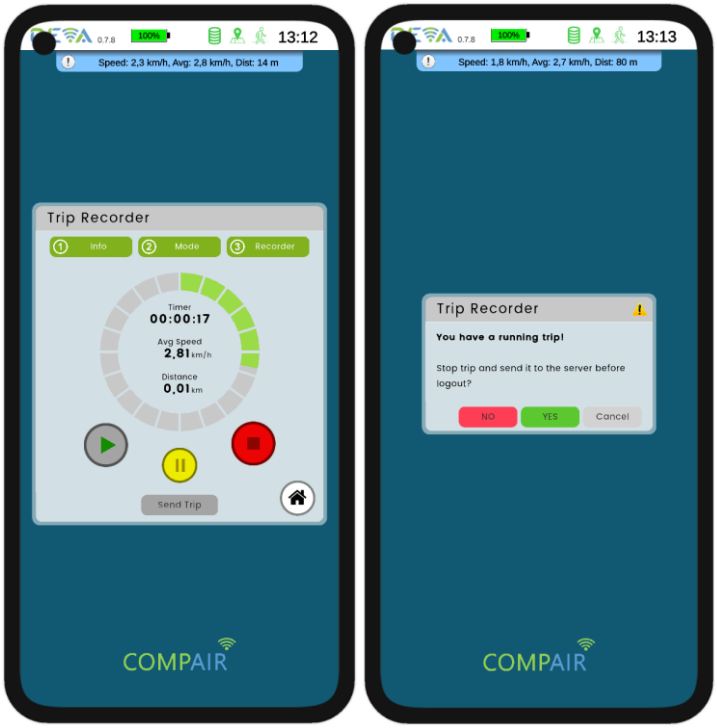


Figure 107 Trip recorder: Start/Stop UI (left) and notification about the current state (right).

Integration of sensor.community data and model data from Breezometer platform (**DEVAViz-1**):

Beside the sensors provided by the **COMPAIR** consortium, the app allows for a quick and easy integration of other sensor data. Hence, to provide more sensors to the user, the sensor data from sensor.community and Breezometer platform are also accessible.

The **sensor.community** is a contributors driven global sensor network that creates Open Environmental Data. It consists of more than 12,000 active sensors worldwide distributed among 79 countries. The community also offers a DIY sensor kit that can be purchased by citizens and integrated in the worldwide sensor network.

The **Breezometer** platform is owned by Google and offers worldwide model data of air quality. The model data are hourly updated and offered at spatial resolution of 500m x 500m. The provided API allows retrieval of the Universal Air Quality Index (UAQI) but also offers dominant pollution information of 13 different pollutants. A major advantage is that the air quality information from Breezometer is based on models. Due to this, DEVA is able to visualise environmental data in areas where nor physical sensor is installed. The drawback is that Breezometer is a paid service, where each request is accounted for.

To integrate third-party data in the AQ Framework, it was necessary to extend the provided API to access data substructures (values, localisations etc.) in a convenient way and to provide compatibility with OpenAPI and the open source code-generator used to produce the API code for DEVA. As each data server uses its own data format, it is necessary to convert all the incoming sensor data to the DEVA internal format, whichfollows an OGC compliant data

format. The sensor.community sensor data is mapped internally and then visualised in the app. The same holds for the Breezometer data.

Error handling:

A thorough error handling and notification schema was implemented to make the application more robust and to inform the user as soon as possible about the state of the application. The potential errors are related to GPS connectivity and internet connectivity:

- GPS was not allowed for DEVA (e.g. after first installation of the app);
- GPS is not on (e.g. deactivated by the user);
- GPS is on, data is valid, but GPS latitude and longitude is the same for a long period of time (especially when GPS is initialised by starting the app) ;
- GPS is on, but no data is received from the Data Manager (wrong GPS position or demo city mode is on);
- Requesting AQ data is not possible, because mobile data is disabled (no internet);
- Sending Trip data: path data is ok, but no connection to the server (no internet);
- Sending Trip data: connection is ok, but Trip Recorder receive failure from server (wrong or omitted serial ID of the device, wrong city, GPS path does not match the sensor path)
- Exiting the Trip Recorder without sending the current data: message window will alarm the user, see also the Trip Recorder section

The user receives immediate feedback from the application in order to take related measures such as switching on internet connection, going outside in the case of no GPS connectivity.

Implementation of information and instruction windows (**DEVAUsI-1, DEVAUI-1**):

To help and guide the user, a number of information windows are now presented to the user. The information is sparse over three windows and only appears the first time when a user is starting the AR experience. The safety instructions have to be consented by the user to enable the access to the last window and the “Start” button. These windows can be reviewed by the user from the entry “Instructions” of the Hamburger Menu.

Beside instructions, it is important to inform the user about the current state of the application. Hence, a loading symbol appears when requesting data from the AQ servers so that the user is always informed when AQ data is renewed. Receiving and initialising the data in the DEVA pipeline can take 1-2 seconds especially when downloading data for the three servers are enabled.

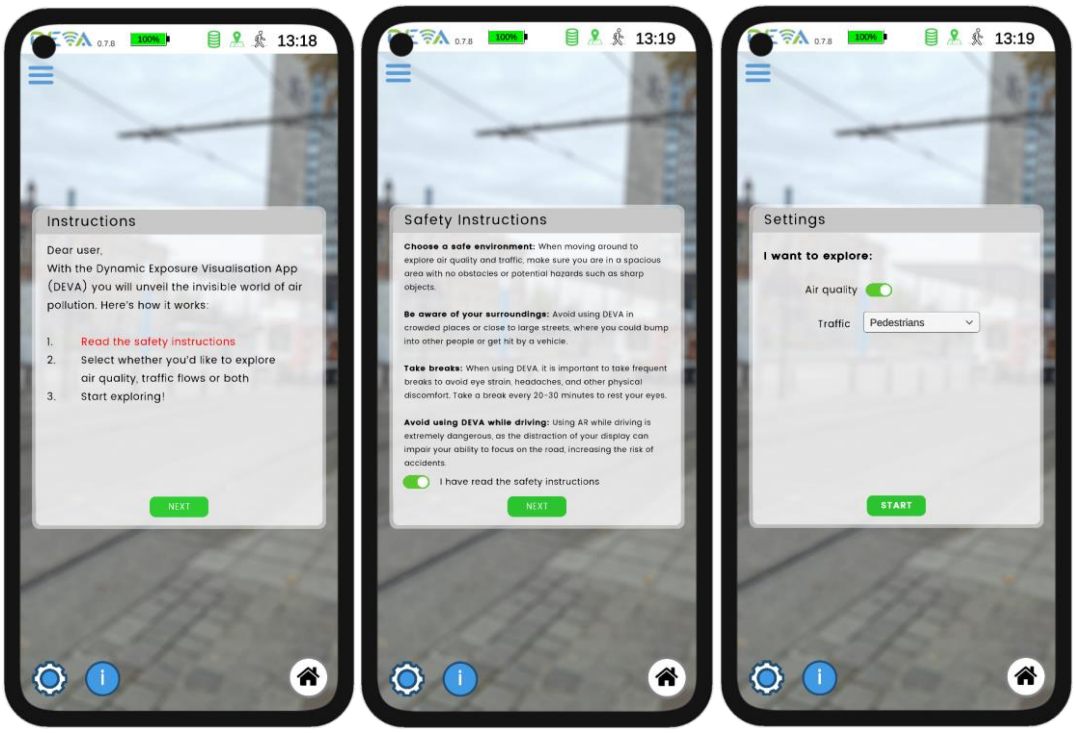


Figure 108 Information windows

Complete multi-language support:

Due to the complemented UI including additional information windows the multi-language support needed to be revisited as well. For the relevant project languages, English, Dutch, German, Greek and Bulgarian, the text is now available for all the UI elements including window titles, buttons and check/selection boxes. The language is selected from the OS as the phone/tablet was set up by the user. If the user uses the Expert mode, the user can still change the language of DEVA.

a) *b)* *c)* *d)*

Figure 109: Different languages: a,b) Safety Instruction in German and Dutch, c,d) Hamburger Menu in English and Greek (Expert mode)

7. Conclusion

This document describes the open public release of the **COMPAIR** prototypes: the Policy Monitoring Dashboard (PMD), the CO2 Footprint Simulation Dashboard, the Dynamic Exposure Visualization Dashboard (DEV-D) and the Dynamic Exposure Visualization Application (DEVA). This report represents the third working version of the prototype, offering a set of functionalities supporting the epics defined by the Pilots. The current developments will be used as a testbed for the **COMPAIR** stakeholders to assess the concepts and knowledge conveyed by the project.

8. References

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