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IO2 - Development of a CO_2 visualisation tool to reduce the Erasmus+ carbon footprint

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Introduction

The Erasmus Goes Green (EGG) Project aims at lowering the impact the Erasmus+ programme has on the environment. Its main objective is to find solutinos to reduce the transport-related carbon footprint of higher education students taking part in Erasmus mobility within Europe and that of staff participating in transnational project cooperation activities.
Within its framework, a dedicated website was produced that helps Erasmus+ beneficiaries (students, academic stuff and administrative stuff) and anyone interested to calculate their carbon footprint of their transportation. This work was assigned to Intellectual Output 2 (IO2). This report is intended to present the work done by IO2 in a coherent and simple way to allow the use of the developed tool and its dissemination. The report consists of the following chapters:

1. Inventory of visualization tools
2. Technical Blueprint and use cases of the CO_2 footprint visualisation tool
3. Tool Testing
4. User Handbook
5. Conditions for further scalability and deployment

1. Inventory of visualisation tools

1.1 Introduction

This chapter is intended to present the main tools and methodologies that are used for the calculation of the carbon footprint and are publicly available online, in order to pave the way for the development of a visualisation tool to reduce the Erasmus+ carbon footprint, as it is described in the Intellectual Output 2 of the project.
The calculators presented in this report are widely used and aim at providing information regarding the impact of one's lifestyle in CO_2 emissions, free of charge.

1.2 Available carbon footprint calculators

1.2.1 Carbon Footprint

The "Carbon Footprint" calculator was developed by the Carbon Footprint Ltd., a private company, consisting of environmental consultants, climate change engineers and scientists, which provides expert support on carbon reductions and sustainability management. Among else, the company has developed several tools to calculate the carbon footprint of individuals and small or large businesses. The use of the calculator is free for individuals who wish to calculate their carbon footprint and understand their impact on the environment.

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Figure 1 The trademark of the Carbon Footprint calculator

The free calculator for individuals, is structured as a form consisting of the following eight (8) tabs:

- ***"Welcome"***, in which the user enters their country and the period for the calculation.
- ***"House",*** which addresses the energy consumption of the user's household.
- ***"Flights",*** which calculates the carbon dioxide equivalent (CO_2e[1]) of the user's flights.
- ***"Car",*** which allows the user to choose up to two (2) cars available at their car database or simply enter their efficiency.
- ***"Motorbike",*** in which the user is allowed to enter up to two (2) motorbikes and their mileage and type or their efficiency.
- ***"Bus & Rail"***, in which the user can fill the miles they used for various means of public transport (bus, coach, local train, long distance train, tram, subway and taxi)
- ***"Secondary"***, in which the user enters an estimation of the amount spent in various activities, in order to calculate their secondary carbon footprint. The activities vary from food products to pharmaceuticals and from clothes to recreational activities.
- ***"Results",*** where the calculator results are presented. Finally, the user can compensate their emissions by funding a CO_2e saving elsewhere, via "Carbon Offset Projects".

The methodology used by the Carbon Footprint calculator is aligned with the "Greenhouse gas reporting: conversion factor 2020" by the UK Government with a few exceptions, as it is described in detail by the website.

[1] Carbon dioxide equivalent (CO_2e) is a metric measure used to compare the emissions from various greenhouse gases on the basis of their global-warming potential (GWP), by converting amounts of other gases to the equivalent amount of carbon dioxide with the same warming potential. (https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Carbon_dioxide_equivalent)

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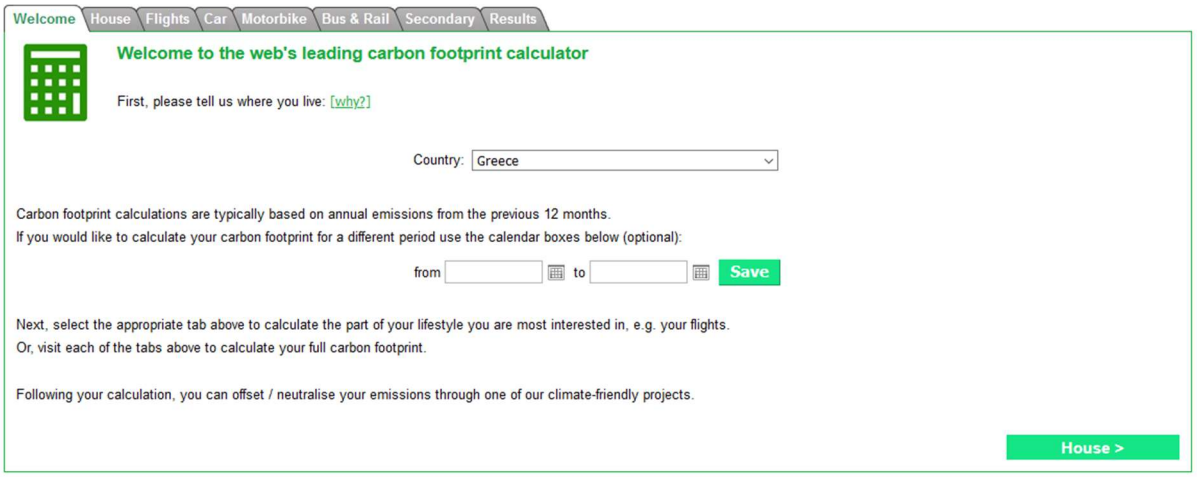

Image 1 The "welcome" tab of the Carbon Footprint calculator

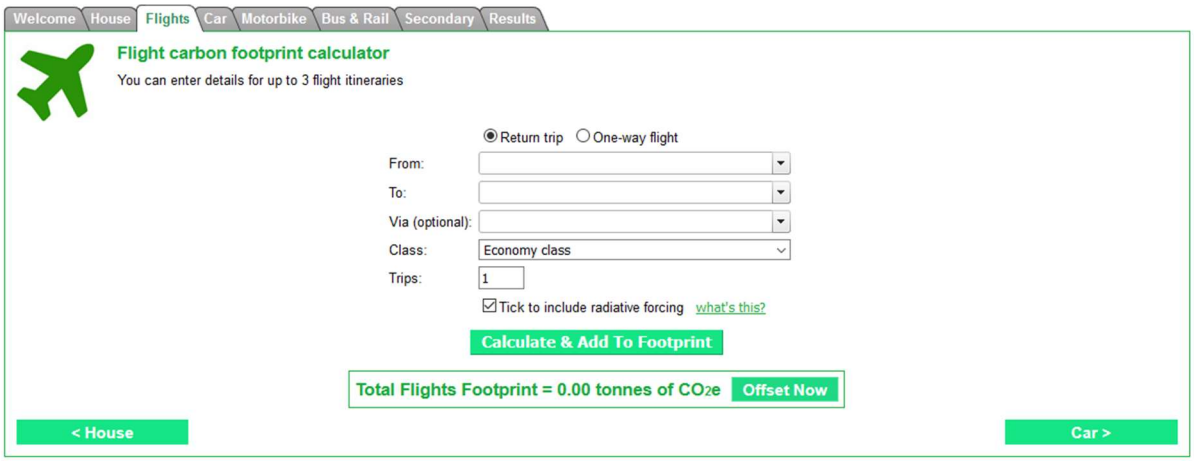

Image 2 In the "Flight" tab the user is prompted to enter details regarding their flight itineraries (max. 3). Such details are the departure/arrival airport, whether they have any stops and ticket's class.

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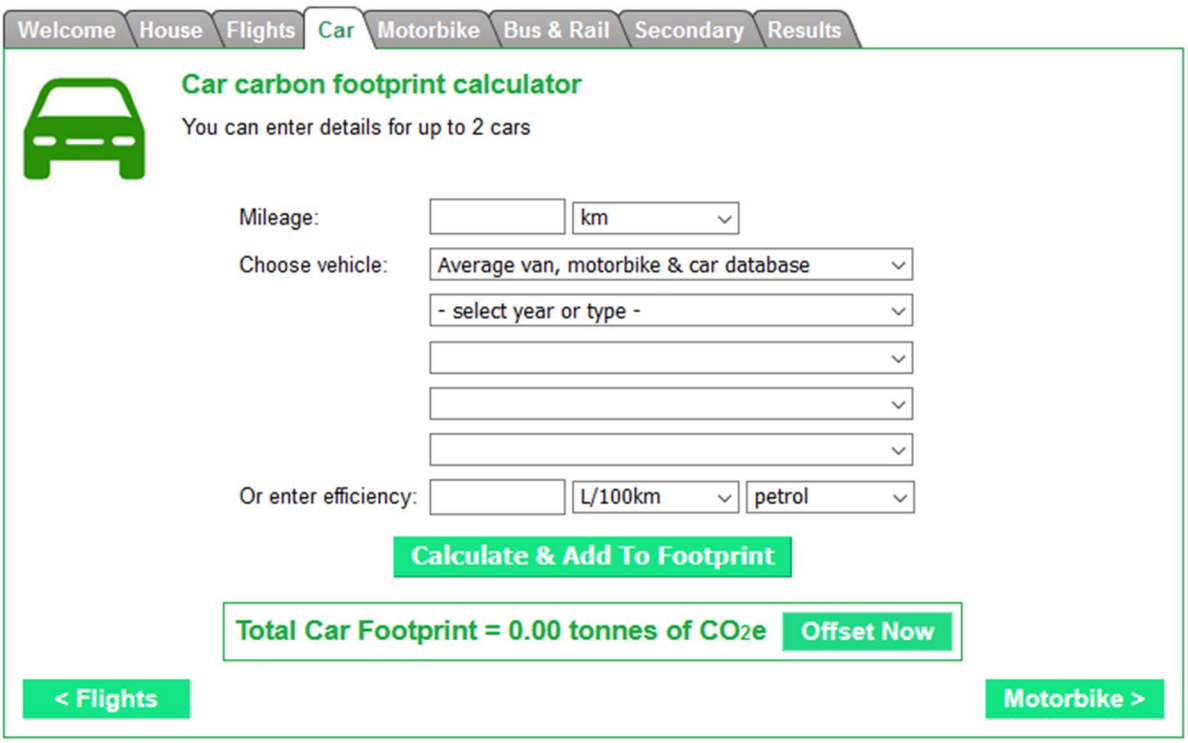

Image 3 The "Car" tab as seen by a visitor. As input the user enters the vehicle's type or its efficiency and its mileage.

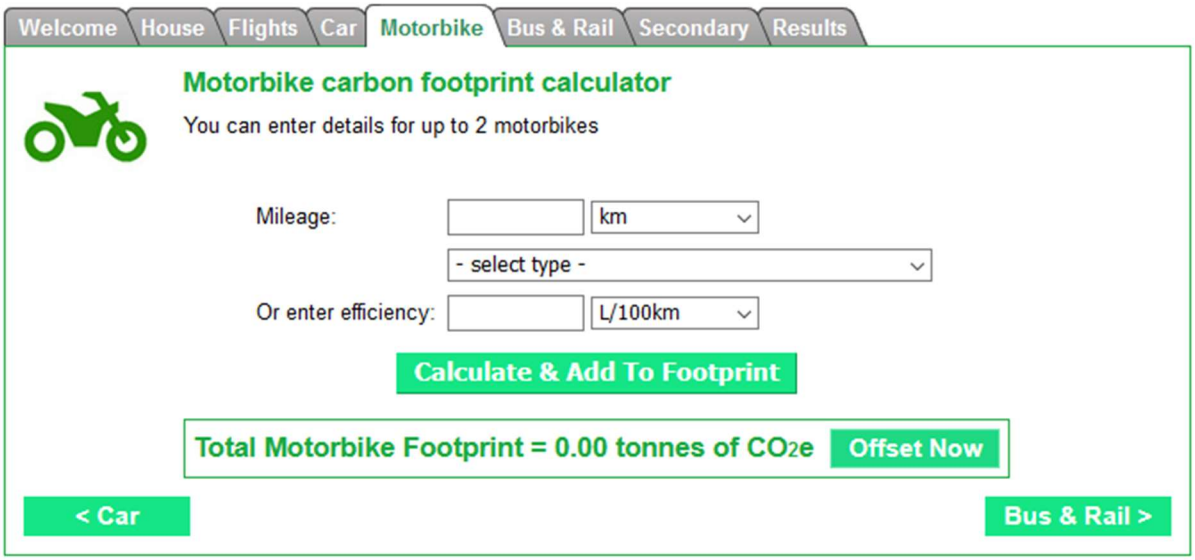

Image 4 Similar to the "Car" tab, the "Motorbike" tab allows users to enter the mileage of their motorbike, its type or its efficiency.

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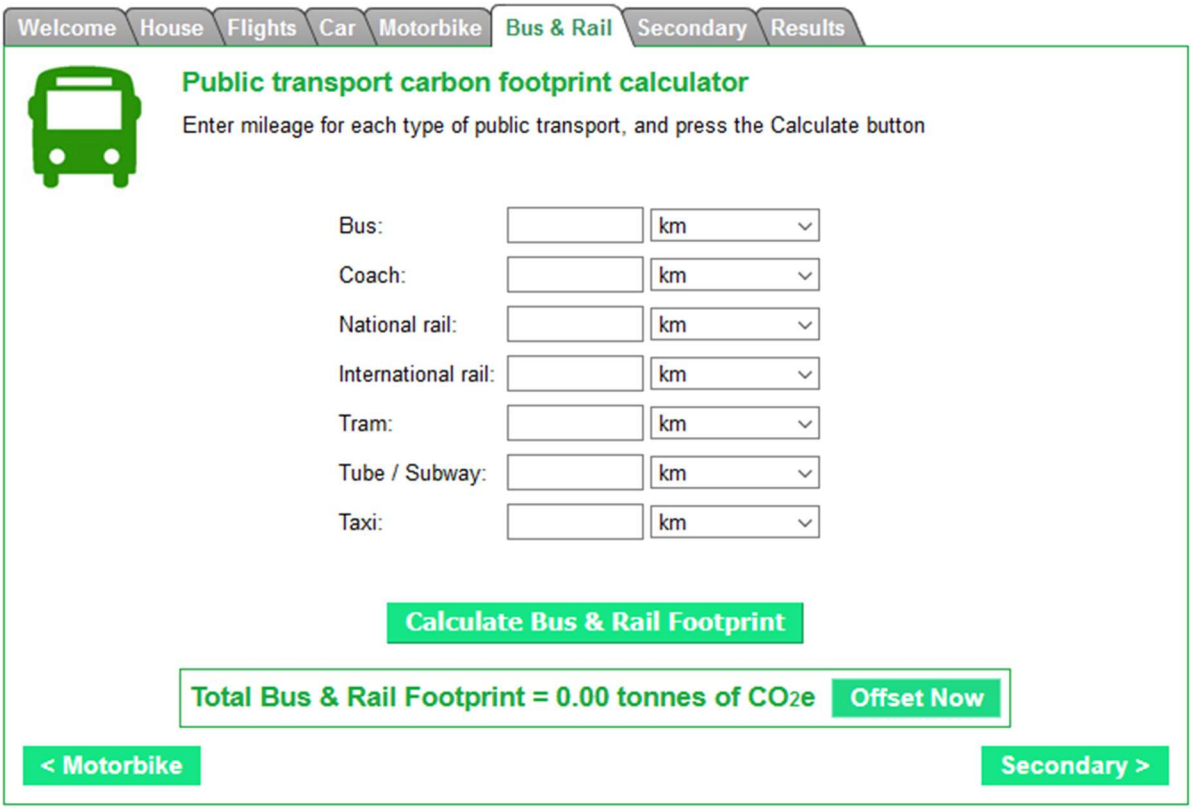

Image 5 The "Bus & Rail" tab prompts the user to enter the distance covered by various public means of transport, such as bus, coach and tram.

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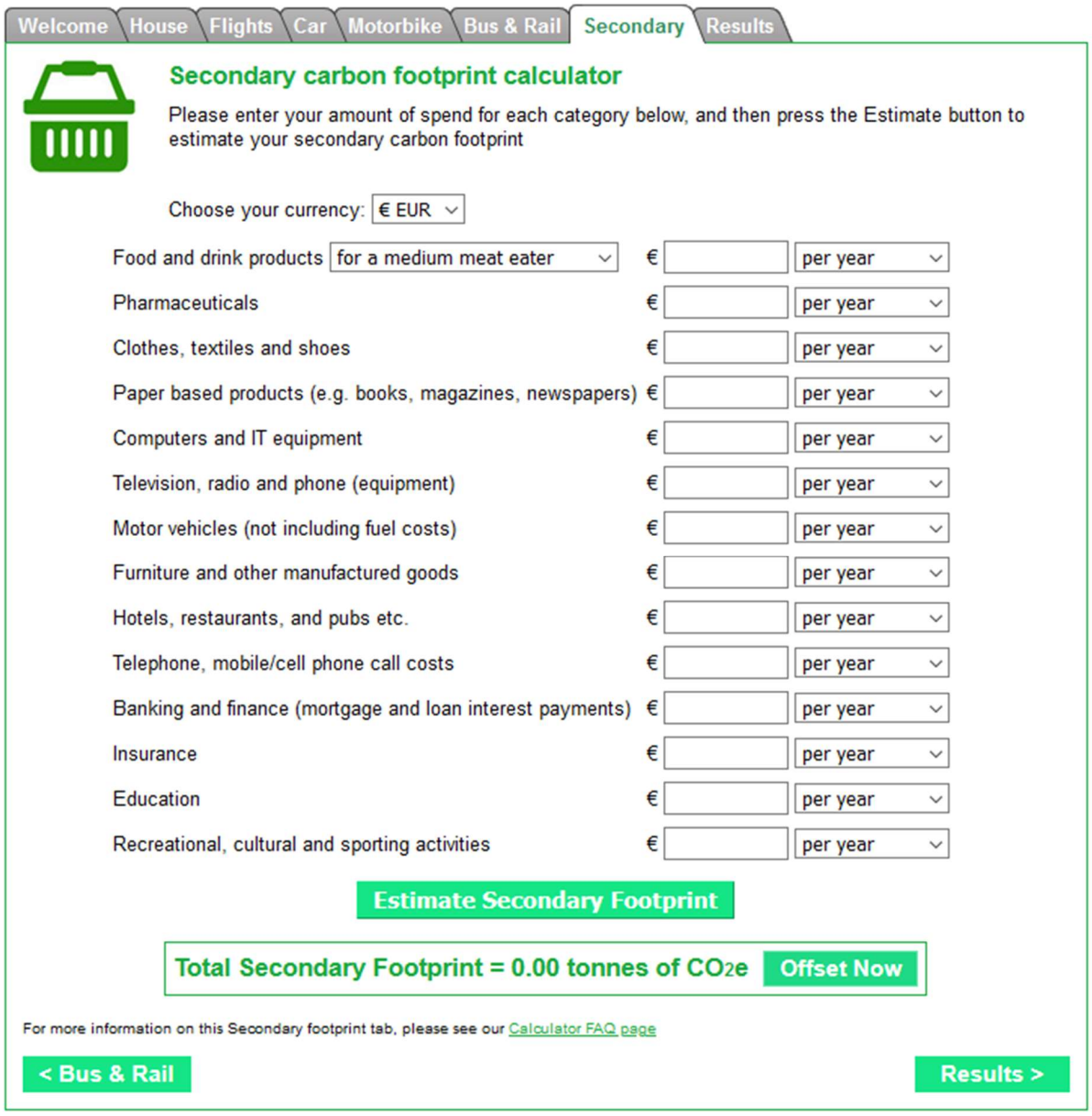

Image 6 In the "Secondary" tab, the user enters information regarding various purchases they make, such as Food and drink products, computers and IT equipment etc.

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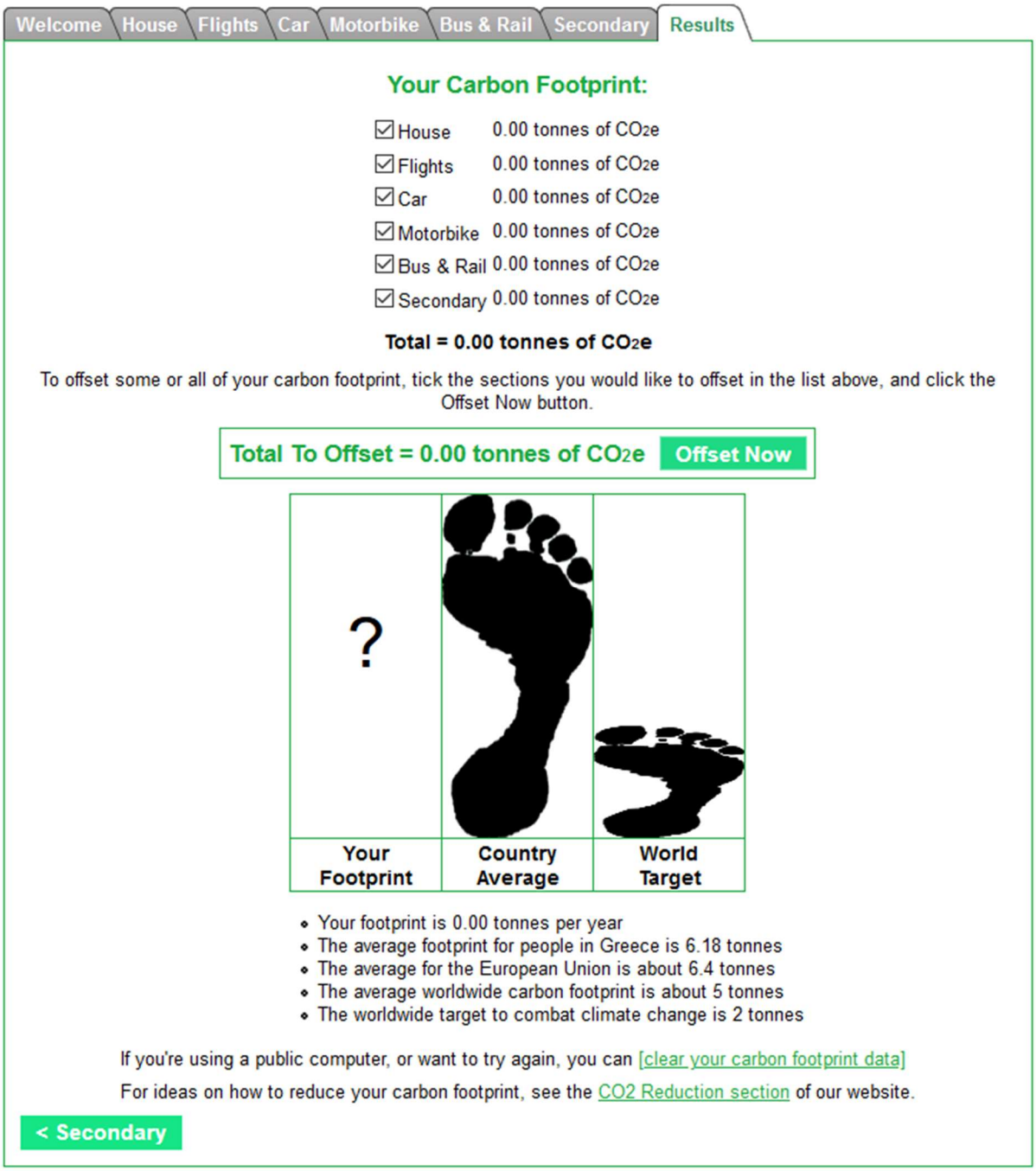

Image 7 In the final tab of the Carbon Footprint calculators, results are presented in a way that the user can easily review how much does each aspect of their choices (House, Flights, Car, Motorbike, Bus & Rail, Secondary) contributes to the user's total carbon footprint and how their results compare to their country's average and the world target.

In conclusion, the Carbon Footprint calculator is characterised as an easy-to-use calculator that allows users to understand comprehensively how their habits contribute to their carbon footprint. The calculator can be found by visiting the following link: https://www.carbonfootprint.com/calculator.aspx. The calculator can be added to a website as it is promoted by Carbon Footprint Ltd, developer of the calculator.

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1.2.2 WWF Footprint Calculator

WWF UK has developed an easy-to-use calculator that allows its user to calculate their footprint and compare it to the score of the average UK citizen. The calculator is designed as a simple questionnaire, in which the user chooses in each question one of the given answers.

The questionnaire is divided into four (4) main sections-categories: Food, Vehicle, House, and Stuff. The questions and answers are descriptive, minimizing the need for manually entering data and simplifying the procedure (from the user's perspective). Examples of questions and answers are:

- **How would you best describe your diet?** (Meat in every meal, Meat in some meals, Meat very rarely, No beef, Vegeterian, Vegan)
- **What kind of vehicle do you travel in most often as a driver or passenger? (if any)** (Car, Motorbike, Neither – I walk, cycle or use public transport for all my journeys)
- **What kind of house do you live in?** (Detached, Semi-detached, Terrace, Flat)
- **In a typical month, how much do you spend on clothes and footwear?** (£0, £1-£50, £50-£150, £150+)

In the end the user sees the calculated result and has access to an analytical report for each of the four (4) main categories mentioned above. Moreover, they have access to tips on how they can reduce their overall impact in every category.

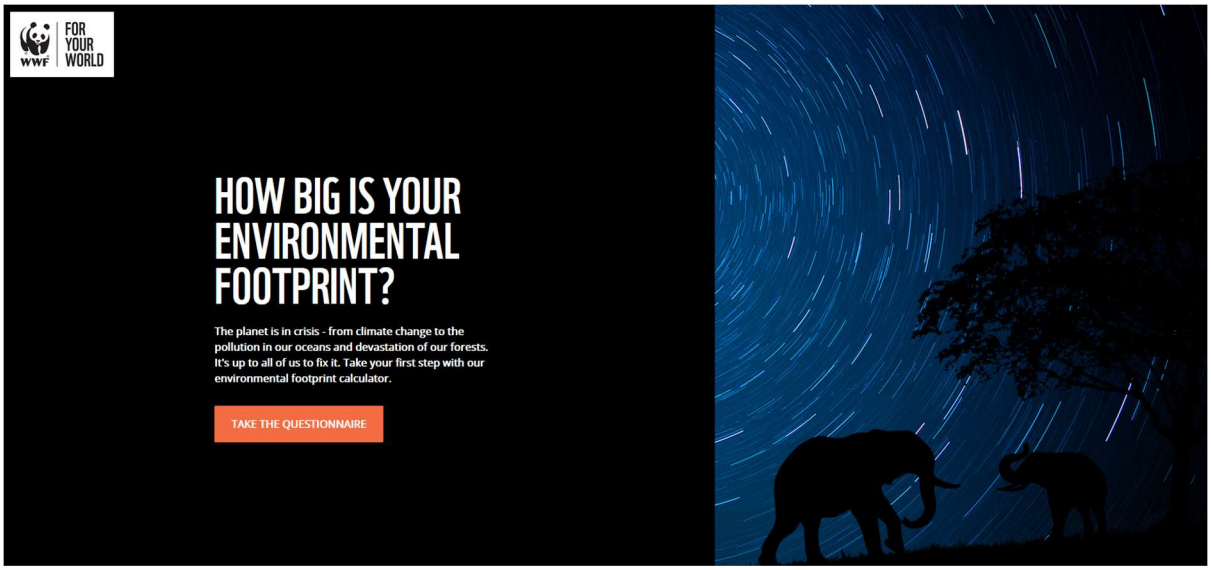

Image 8 Calculator's welcoming page.

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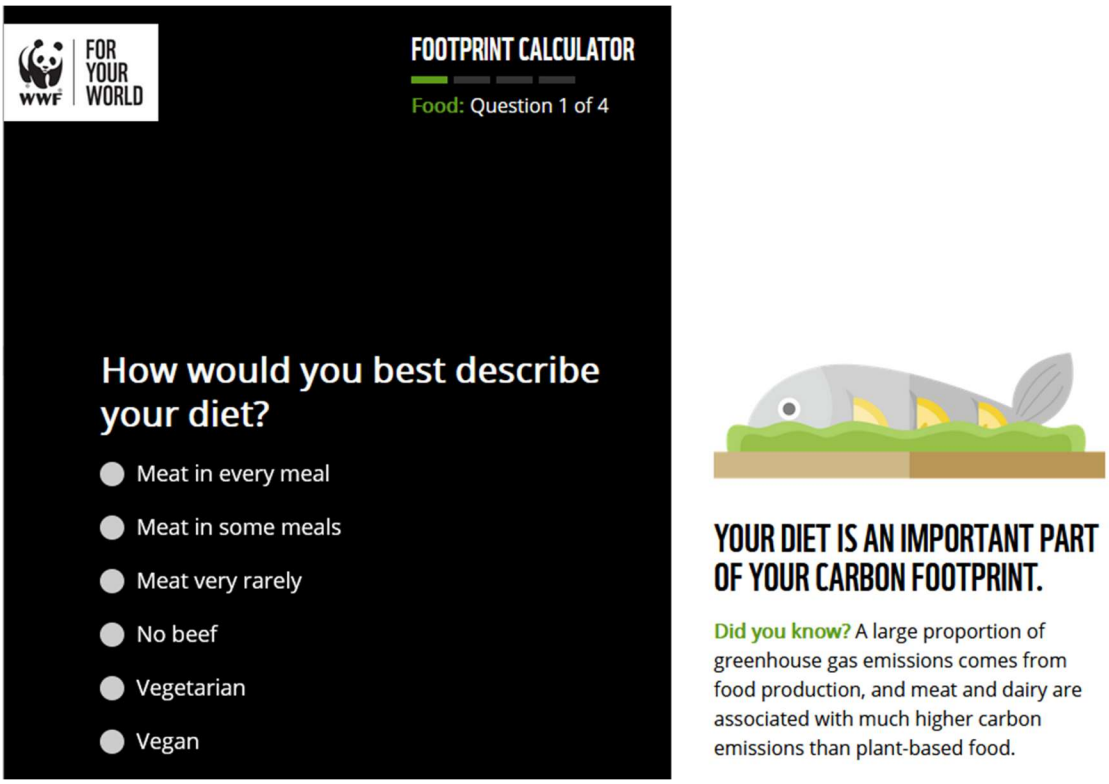

Image 9 The first question of the section "Food".

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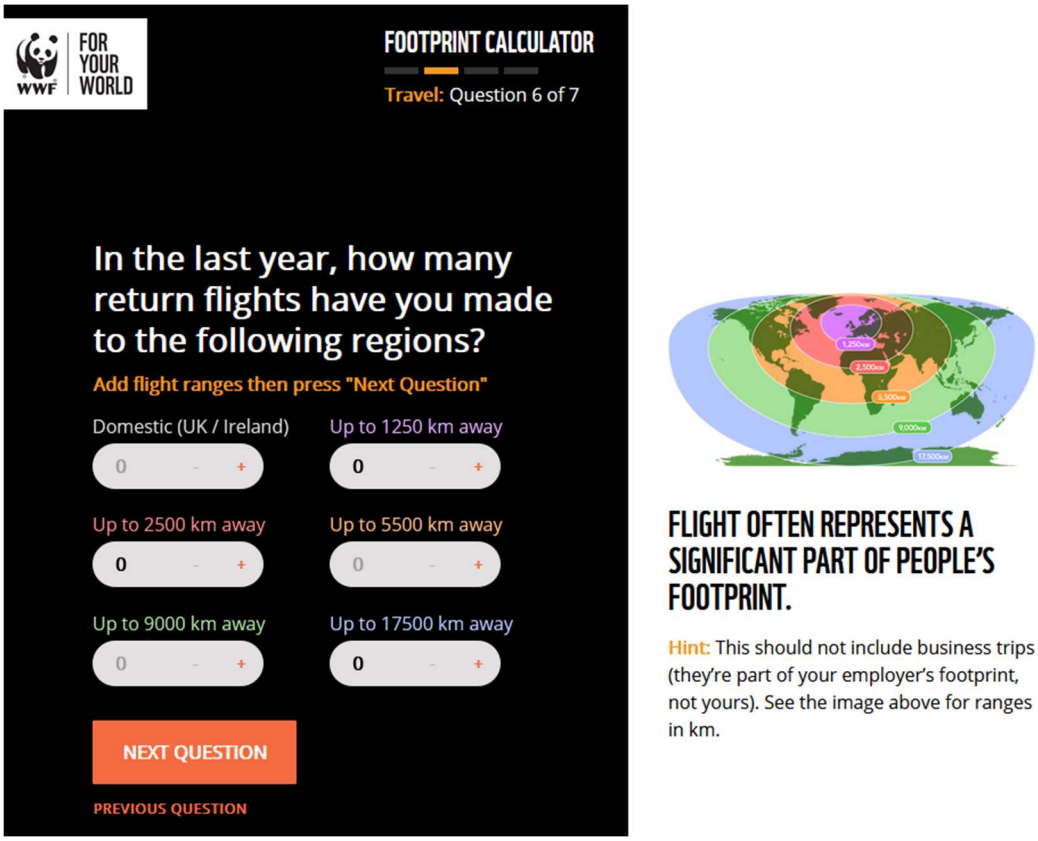

Image 10 Example question of the "Travel" section. Users add the number of flights they make in each range by clicking on the "+" or "-" signs of each range.

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Image 11 Question from the "Home" section.

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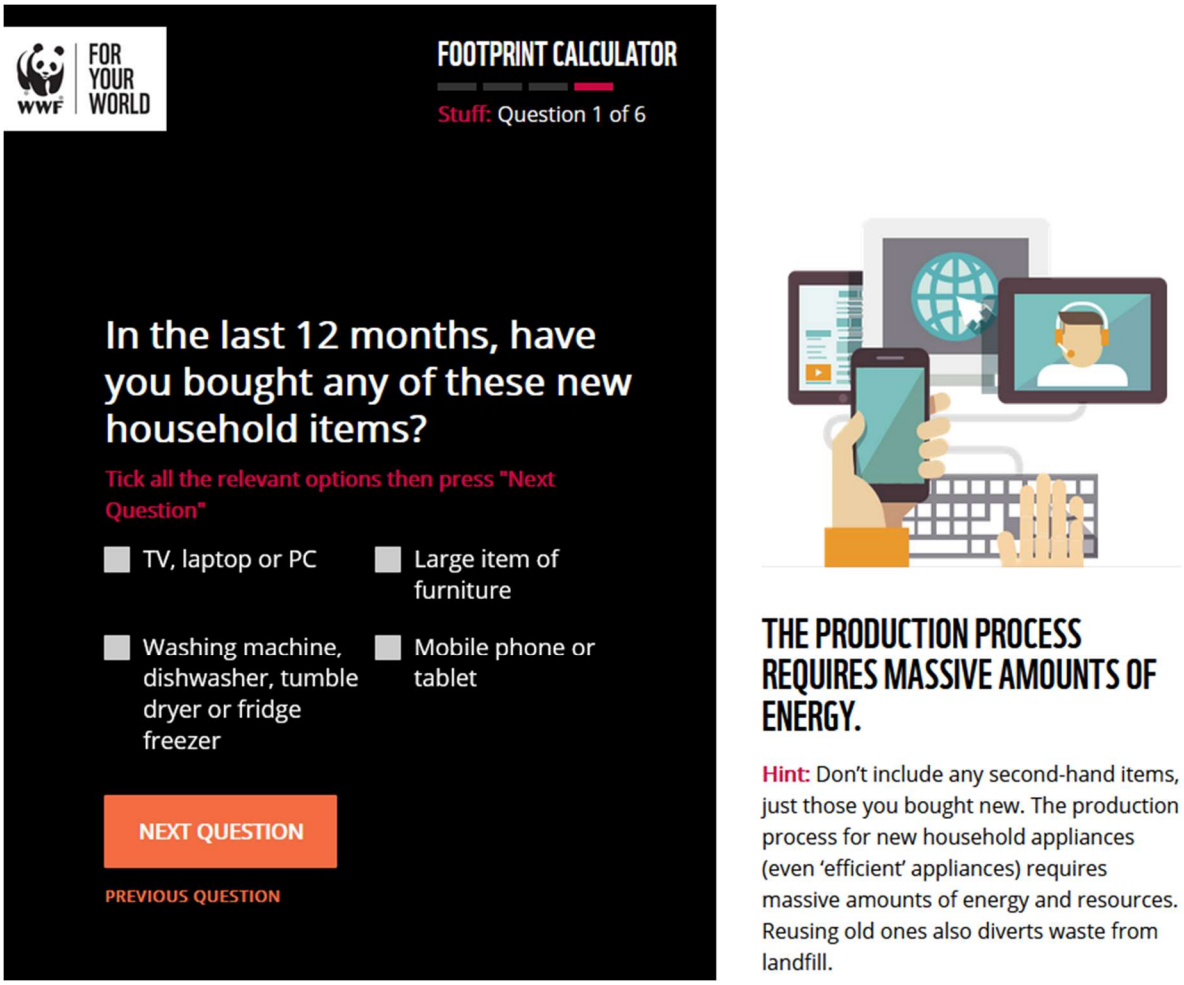

Image 12 Question about the purchases made last year in the "Stuff" section.

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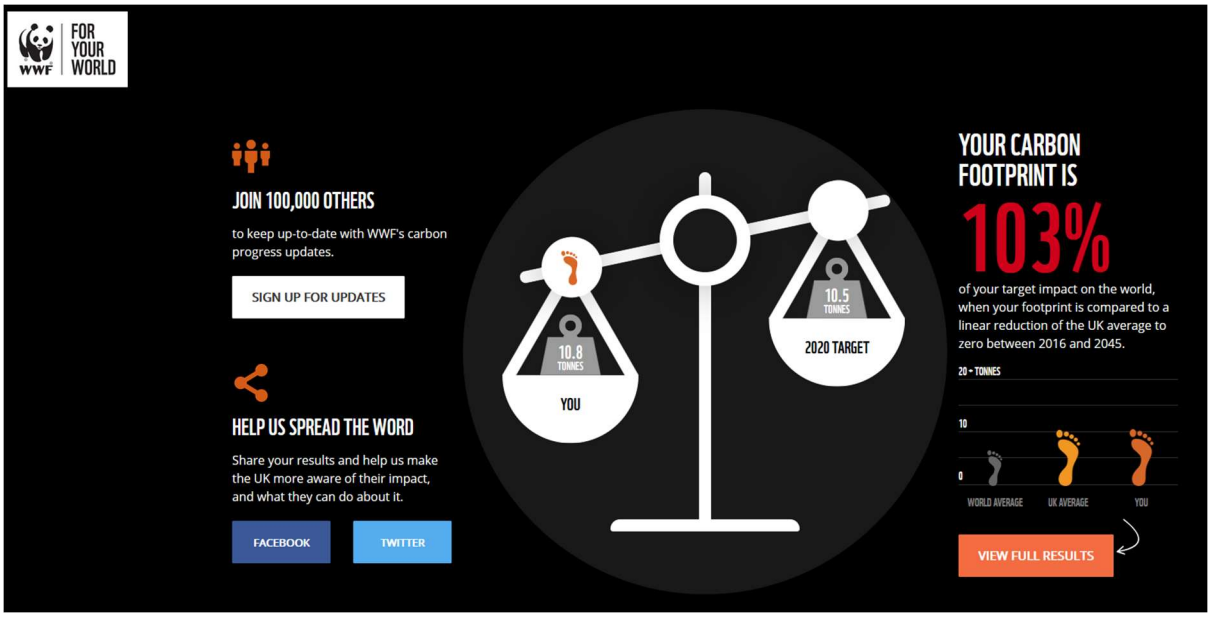

Image 13 By completing the questionnaire the user can view their results compared to the global 2020 target and the UK average and has the choice to view their full results and how they can alter their lifestyles to reduce their footprint.

As it can be seen from the above images, the calculator has a modern and elegant interface that is user-friendly and provides useful information in each question that connects the question asked to the carbon footprint. Although one can understand how their lifestyle contributes to their carbon footprint, they cannot get direct information about how their travel and mobility choices are linked to their footprint. Furthermore, the calculator is focused on the United Kingdom and cannot easily be implemented in a broader area.
The calculator can be accessed by visiting this link: https://footprint.wwf.org.uk/.

1.2.3 Footprint Calculator by Henkel AG & Company KGaA

Henkel AG&Company KGaA has developed a Footprint Calculator in cooperation with the Wuppertal Institute. The user has to answer a questionnaire divided into four (4) main categories: “Housing”, “Nutrition”, “Mobility” and “Holiday & Leisure”, which can be characterized as extensive but simply to answer . Questions include:

- **How big is the house or apartment in which you live?**
- **How do you wash your dishes?**
- **What is your diet usually like?**
- **How many cups or glasses (0.25l) of each beverage do you drink per day?**
- **What kind of car do you own?**
- **How often do you engage in the following sports?** (list of sport activities given)
- **Use of online streaming services for music.**

In the end, the user can view their annual calculated footprint and compare it with the global target, the global average, and the European average. Furthermore, the calculator provides the equivalent of the user’s footprint to “times traveled around the world by car”, while it

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helps the user understand their impact by providing the “amount of soccer fields covered with trees needed” to store their CO_2 annual emissions.

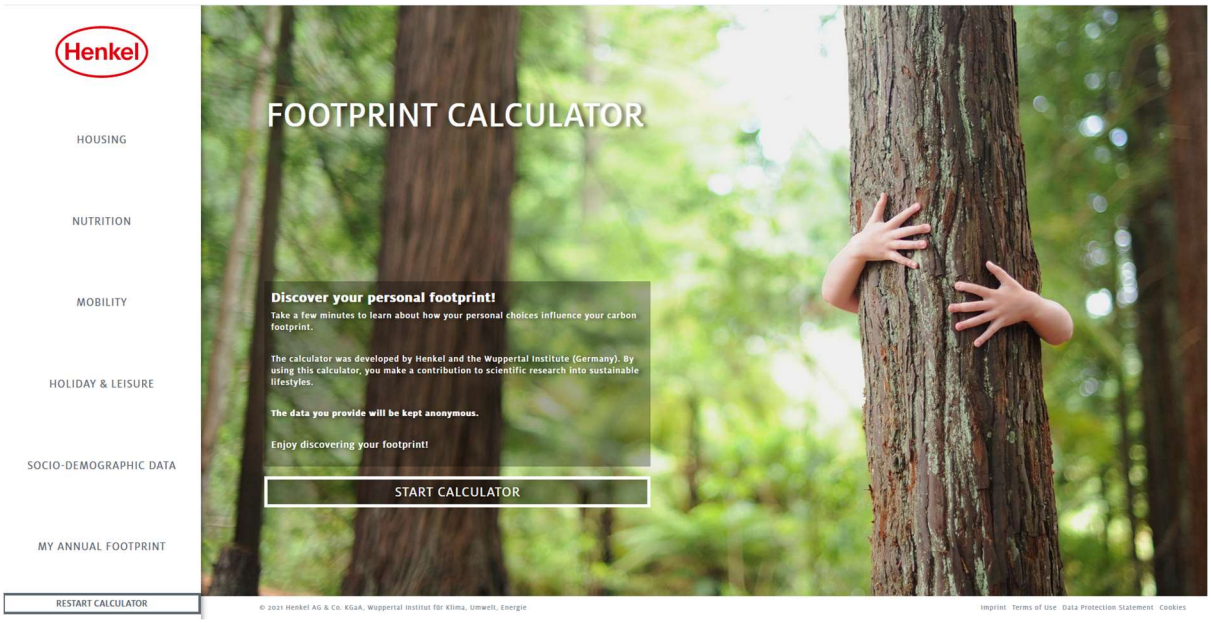

Image 14 The calculator's introductory page. On the right side of the webpage, one can select one of the four (4) main categories to begin with.

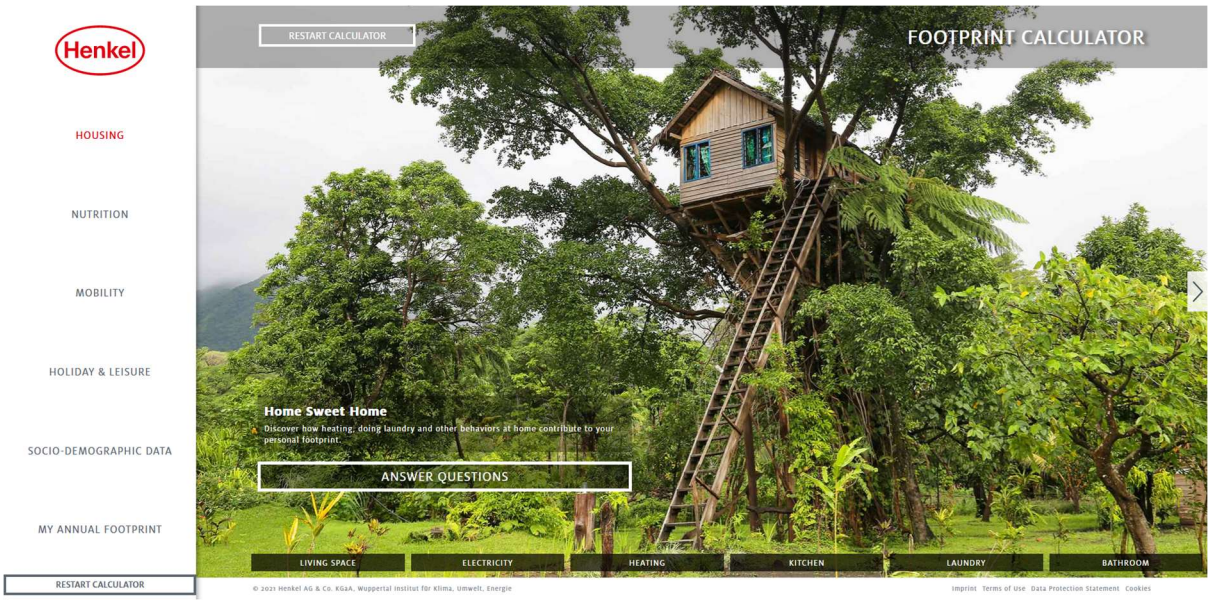

Image 15 The introductory page of the "Housing" category.

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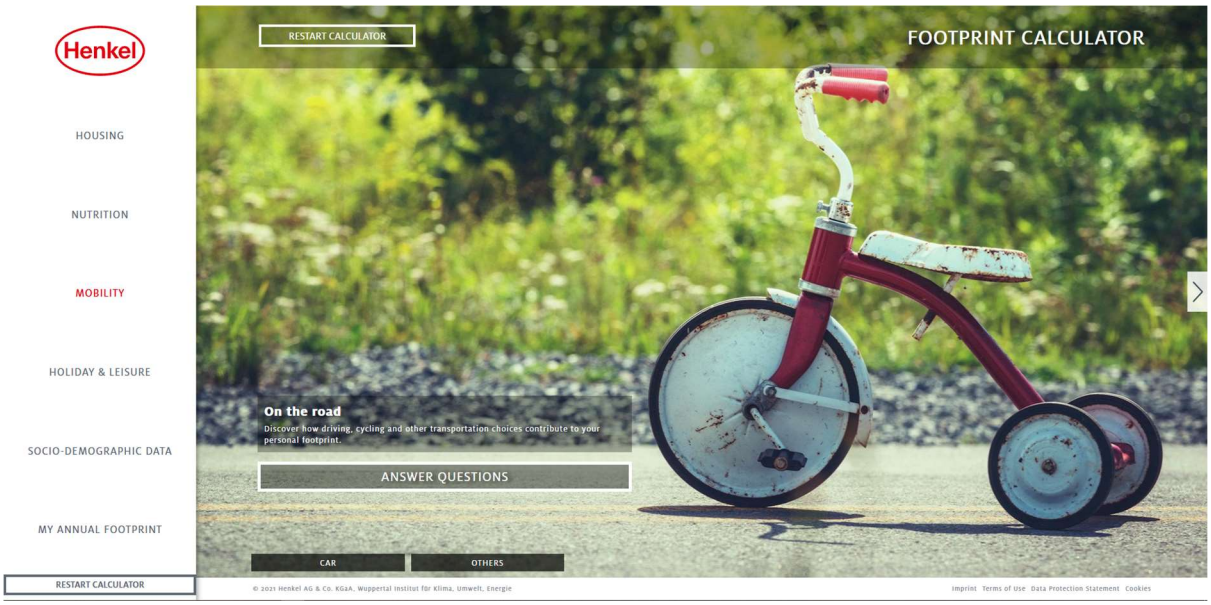

Image 16 The introductory page of the "Mobility" category. The user can directly select the tab "Answer Questions" or the tabs "Car", "Others" found at the bottom of the page.

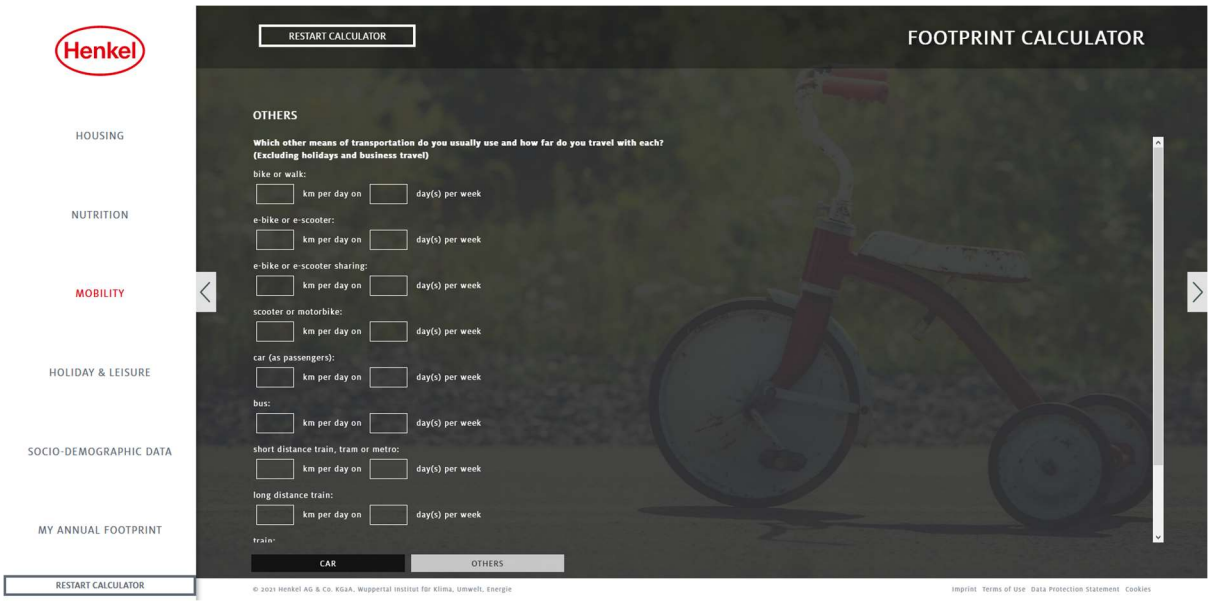

Image 17 For instance, by selecting "Others", users must enter km per day or km per week made by a list of vehicles given below the question.

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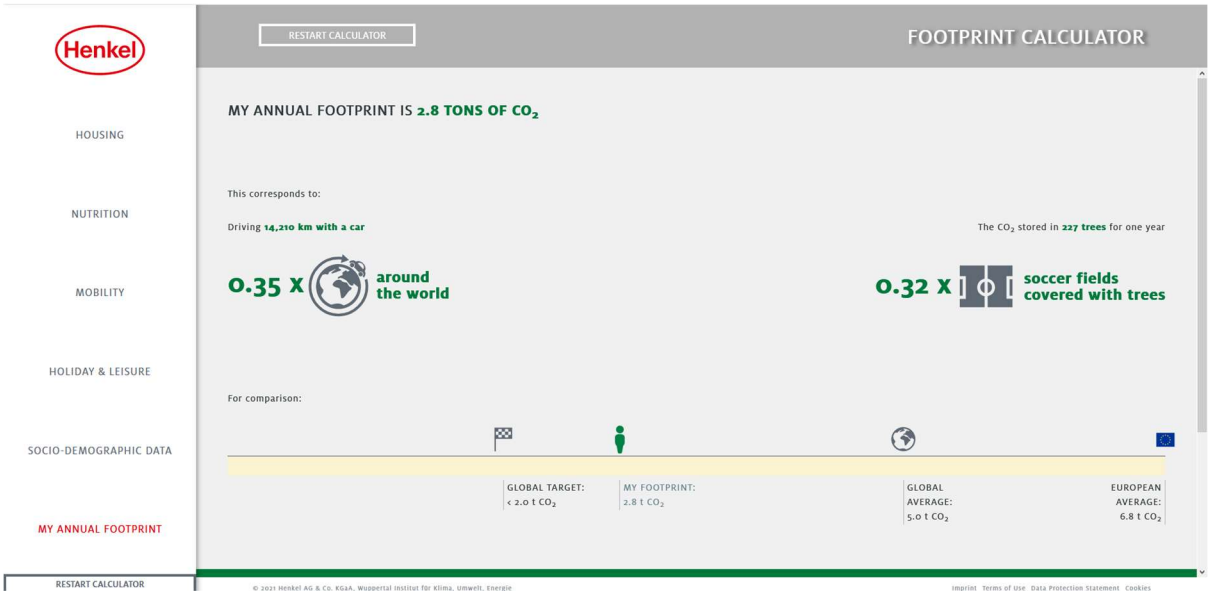

Image 18 After filling all the questions of each section, the results page presents the user's annual footprint and compares it with the global target, the global average and the European average. Furthermore, the calculator provides the equivalent of the user's footprint to "times travelled around the world by car", while it helps the user understand their impact by providing the "amount of soccer fields covered with trees needed" to store their CO_2 annual emissions.

Although the calculator is simple and quite analytical regarding the lifestyle of the user, it does not provide detailed information regarding each section. Moreover, one cannot simply fill in the "mobility" section and get results regarding their input. The calculator may be accessed here: https://footprintcalculator.henkel.com/en.

1.2.4 ICAO Carbon Emissions Calculator

The International Civil Aviation Organization (ICAO) has developed a methodology to calculate the carbon dioxide emissions form air travel. The simple-to-use ICAO Carbon Emissions Calculator allows passengers to estimate the emissions attributed to their air travel, by filling in the following information about their flight:

- One Way or Round trip
- Cabin Class
- Number of Passengers
- From City/Airport – To City/Airport

By entering the above, the user can view their emissions. The methodology used is freely available.

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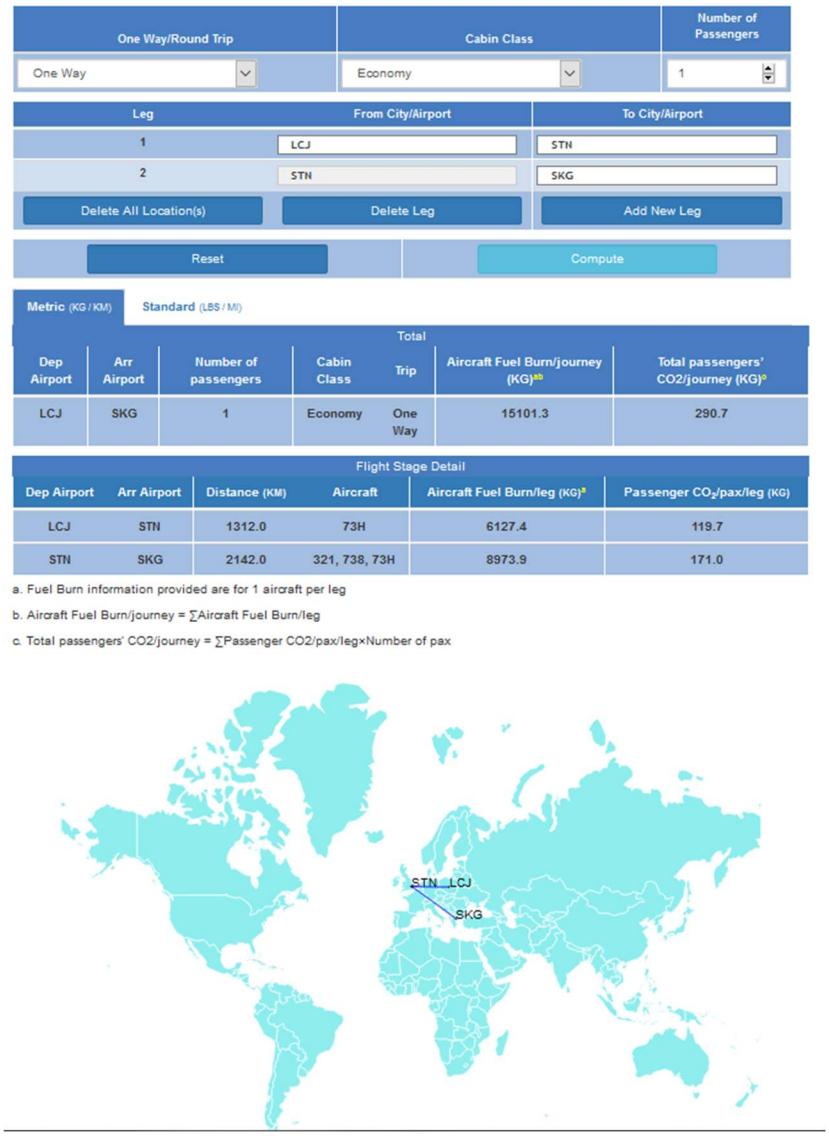

Image 19 The ICAO Carbon Emissions Calculator. The user selects the type of their trip, their cabin class, the number of passengers and their destination details. For instance, in the example presented above, a passenger from Lodz, Poland to Thessaloniki, Greece, with a stop in London, UK produces 290.70kG of CO_2.

The calculator is simple and easy to use and one can enter only valid information regarding their destination. For instance, in the example presented in the image above, one cannot enter a direct flight from Lodz, Poland to Thessaloniki, Greece, as there is not yet a direct connection.

The calculator can be accessed here: https://www.icao.int/environmental-protection/Carbonoffset/Pages/default.aspx

1.2.5 Ecological Footprint Calculator by GFN

The Ecological Footprint Calculator was created and is managed by the Global Footprint Network, a research organisation that responds to climate change that tries to change how

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the world manages its natural resources. The calculator is based on “National Footprint and Biocapacity Accounts” data for selected nations. Specifically, as it is stated on the Global Footprint Network’s site “the national per person Footprint can be allocated to different end-use categories (food, shelter, mobility, goods and services), and land types (forest, cropland, energy, fish, grazing land). This results in a matrix that uses a country’s average consumption profile to distribute Ecological Footprint into these different categories.”. The personal calculator increases or decreases different parts of the matrix relative to national average behaviour. The calculator is aligned with the international Ecological Footprint Standards, according to which, it is calculated how much biologically productive area is required to produce the resources for the human population and to absorb its carbon dioxide emissions. The calculator is divided subtly into three (3) main sections: Food, Housing and Transportation, each containing a set of short questions answered by sliding a bar from the worst to the best choice. In some questions, the user can add more details if they wish to improve the accuracy of their calculations, whereas on the bottom right corner there is a “learn more” button that shares useful trivia related to the question asked.

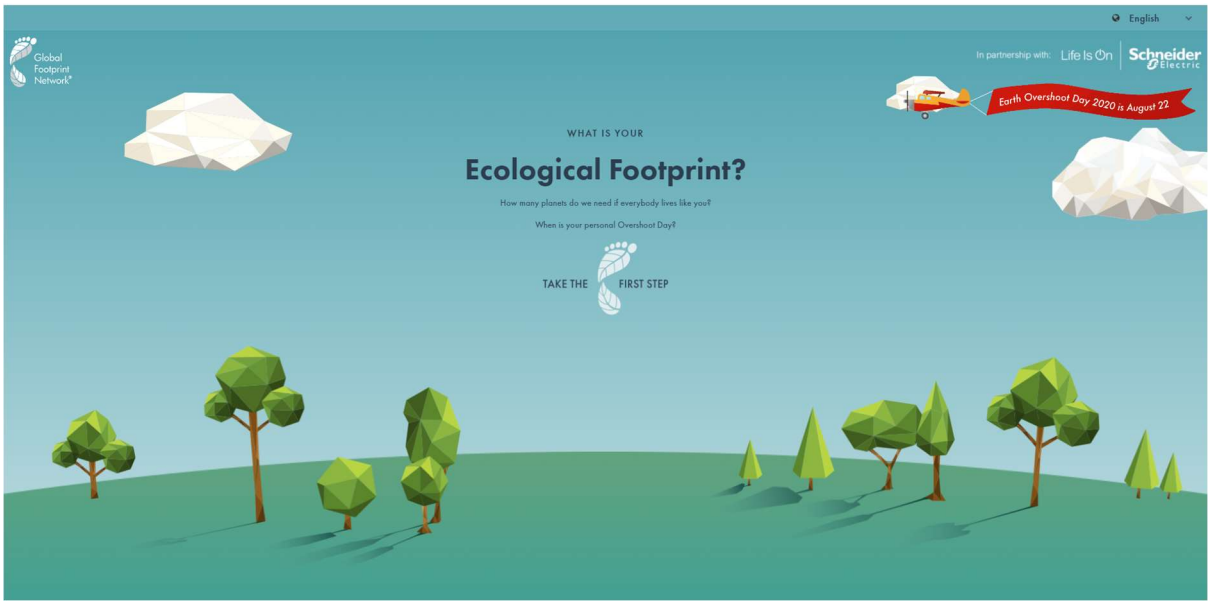

Image 20 The introductory page of the calculator

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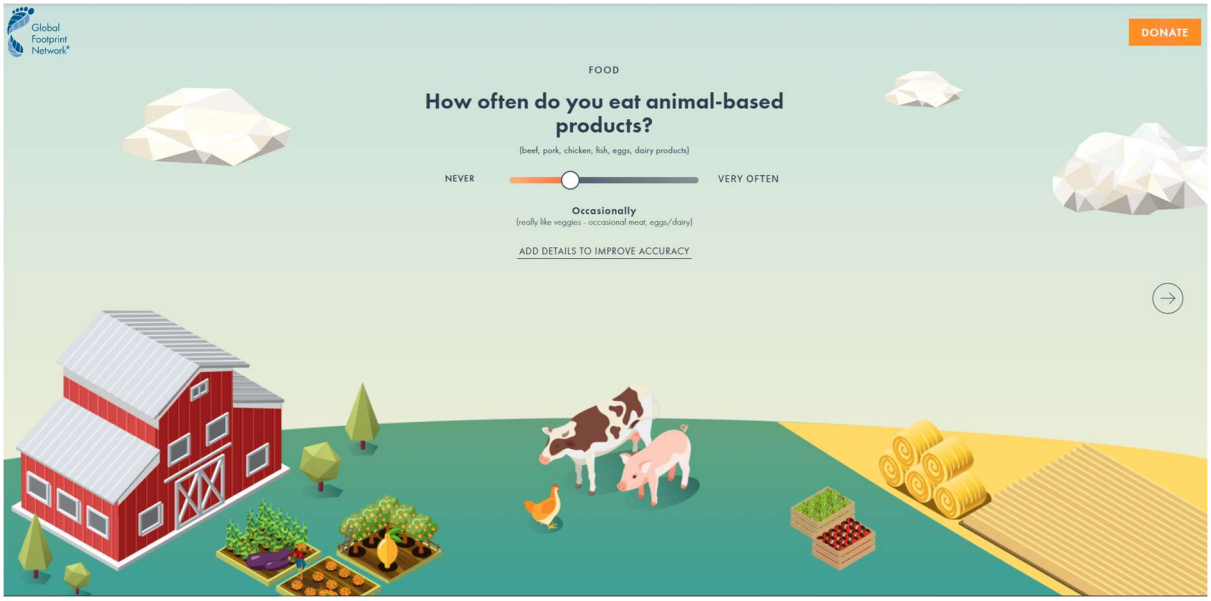

Image 21 A question asked in the "Food" section that allows to add more details to improve the accuracy of the calculations

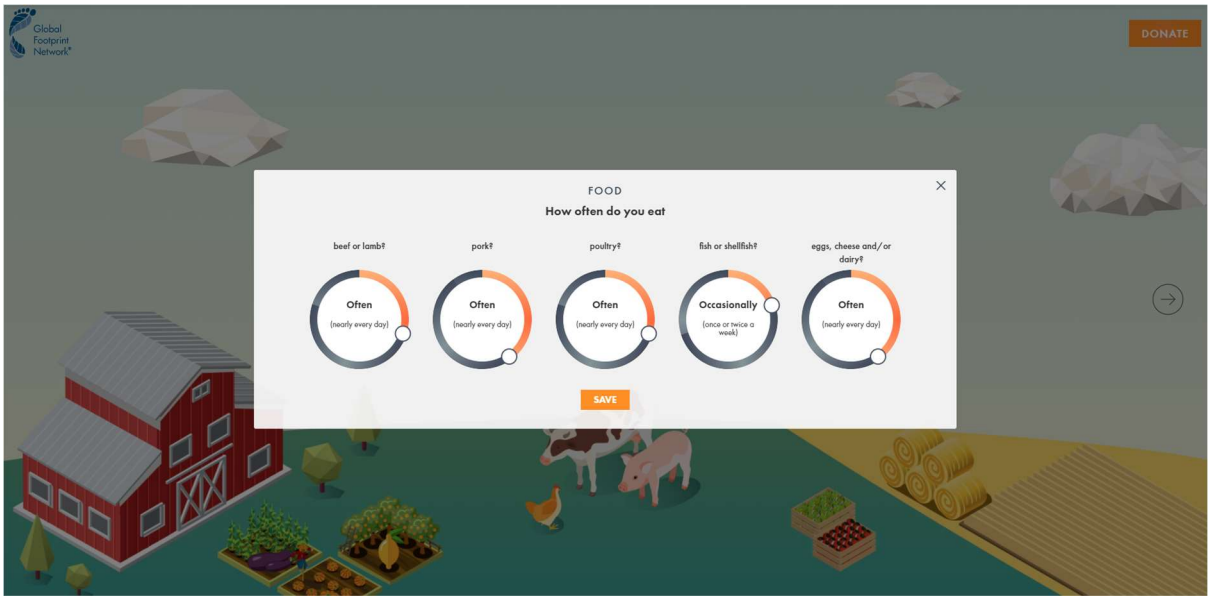

Image 22 By clicking the button "add more details" one can easily add more information regarding the question by sliding the most representing answer

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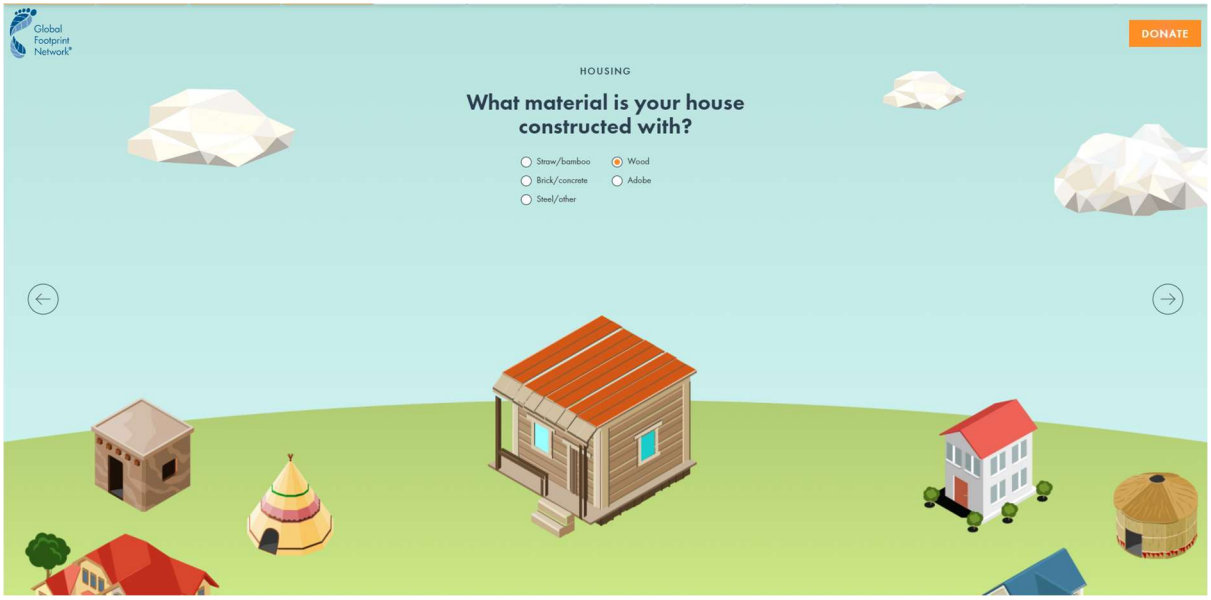

Image 23 Question asked in the "Housing" Section

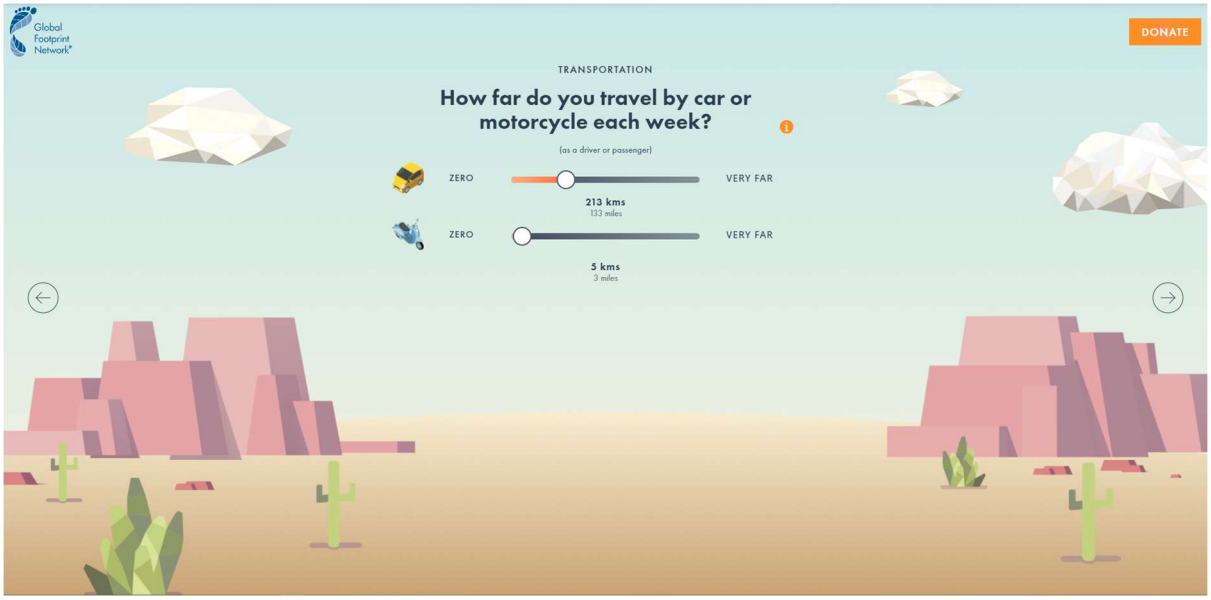

Image 24 Question asked in the "Transportation" section

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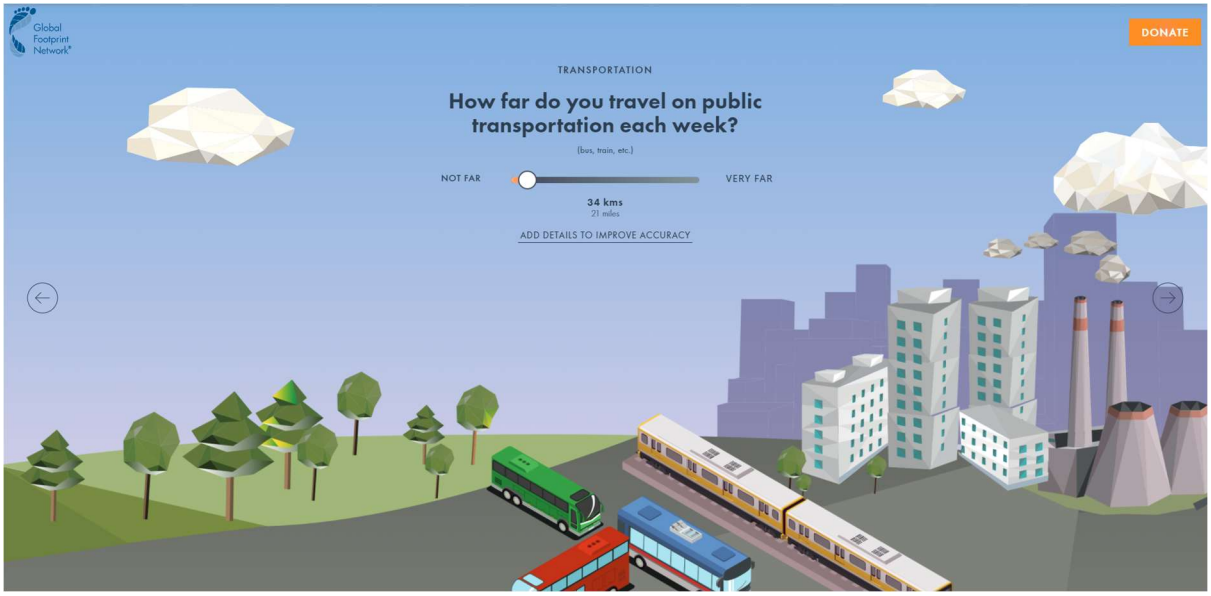

Image 25 Question from the "Transportation" section that refers to the use of public transportation weekly. It does not cover a lot of means of transport besides bus and train.

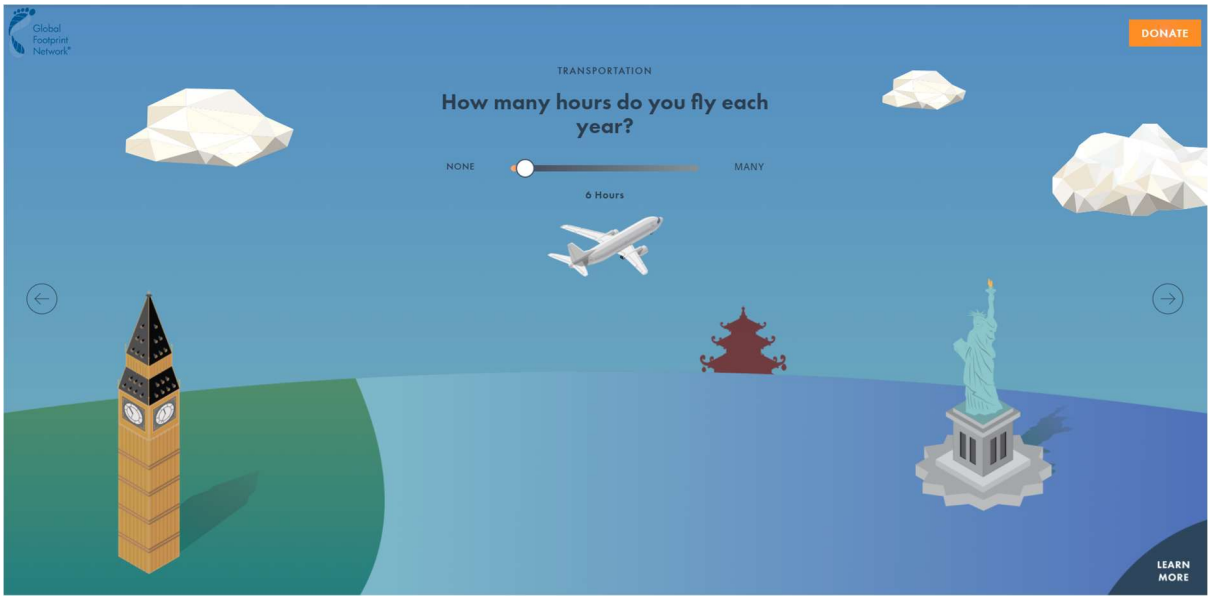

Image 26 Question referred to the number of annual flights. The difference between the previous calculators is that it uses the total flight hour per year rather than the distance between two or more destinations.

In the end, the "Results" section consists of four (4) sub-sections:

- Results Part 1, where the user's personal "Earth Overshoot Day" is presented, and the amount of the "planets" needed to sustain one's lifestyle if everyone lived as they do.
- Results Part 2, where they see how much each sector contributes, to their footprint.
- How do you feel, where the user chooses an emoticon regarding how they feel after they found out their results.

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- How do your results compare to your country, where the user views a global interactive map with each country's results, as they were calculated by using official datasets which comply to the Global Footprint Network quality standards?
- Solution to #Movethedate, where there are simple tips anyone can do to move the earth overshoot day[2].

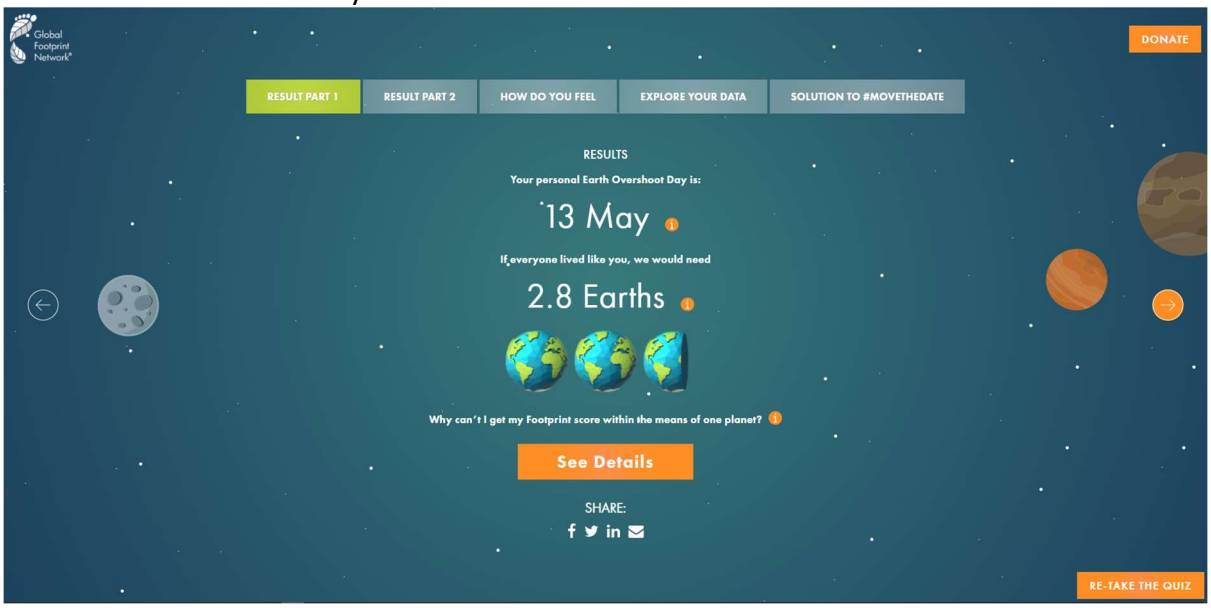

Image 27 "Results Part 1" page

Image 28 "Results Part 2" page

[2] Earth Overshoot Day marks the date when humanity's demand for ecological resources and services in a given year exceeds what Earth can regenerate in that year. (More information can be found here)

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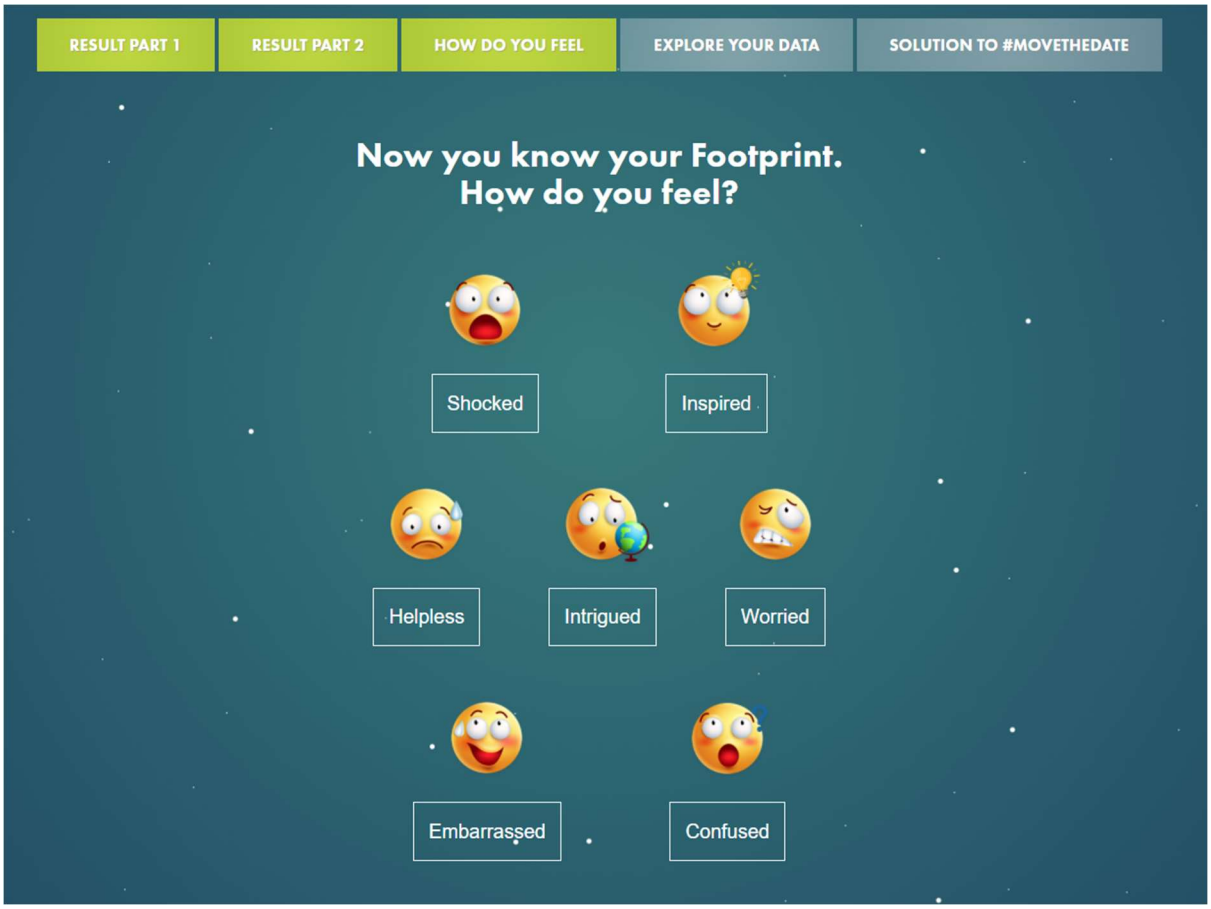

Image 29 The "How do you feel?" page

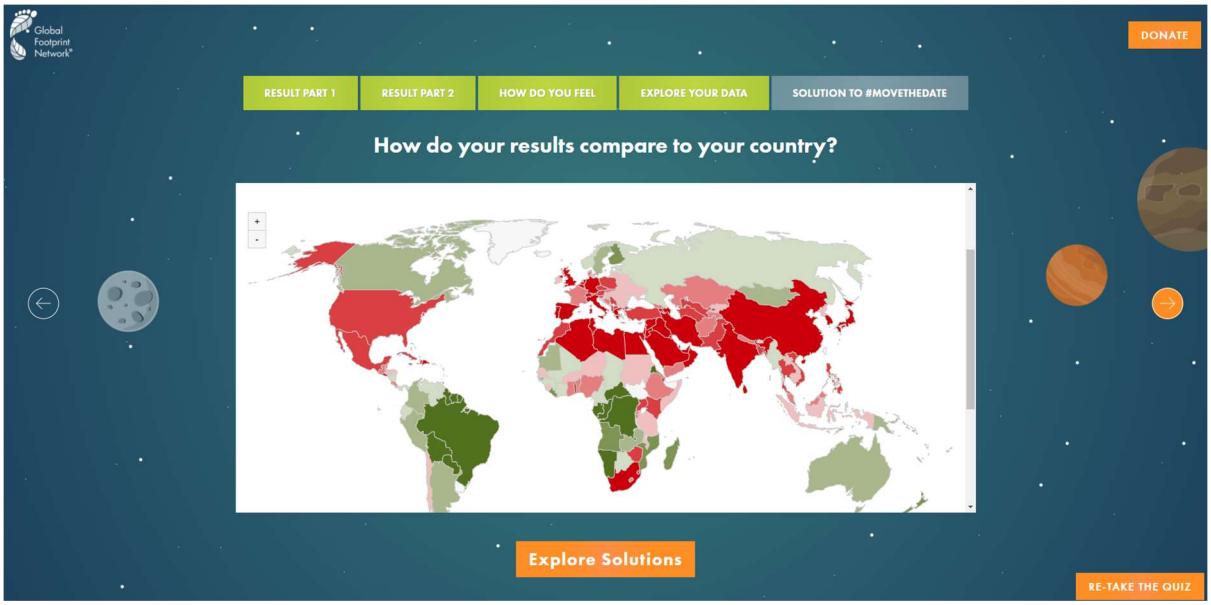

Image 30 The "Explore your Data" page

1.2.6 Other Calculators

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Several other calculators exist that can help someone understand their impact on the planet and calculate their carbon/ecological footprint. In this section, some of the many flight emissions calculators in existence are presented that can be used as a reference for the purposes of the project.

1.2.6.1 myclimate Flight Emissions calculator

Foundation myclimate is a foundation based in Zurich, Switzerland that offers advisory services, organizes educational programmes and creates its own projects as a non-profit organization. It provides several calculators which allow the users to offset their CO_2 emissions.

Their Flight Emissions Calculator is user-friendly and is similar to the ICAO Carbon Emissions Calculator. It prompts the user to enter the airports of departure and arrival, whether the trip was roundtrip or One way and if they were in the Economy, Business or First Class. The methodology used for the emissions calculation is freely available. The calculator can be accessed here: https://co2.myclimate.org/en/flight_calculators/new.

1.2.6.2 Offsetters flight emissions calculator and the Offsetters car emissions calculator

The Offsetters flight emissions calculator is a simple tool to calculate the emissions of a flight by entering as input the point of departure, point of arrival and topovers. Additional information includes the passenger class, the trip type (one way/return), and the number of travelers. The flight emissions are calculated by using the "2018 Government GHG Conversion Factors for Company Reporting" guide published by the UK Department for Business, Energy & Industrial Strategy (BEIS).

The Offsetters car emissions calculator allows the user to calculate the annual emissions of their car, by selecting the year, the make, the model, and the distance (km/year). The data used for the calculator are from the Fuel Consumption Guide of the Minister of Natural Resources Canada, while the emissions factors are sourced from Environment Canada.

Both calculators allow users to offset the carbon footprint of their flights and car use.

1.2.6.3 C-level Flight Carbon Calculator

C-level, a B Corp Certified business[3], has developed a Flight Carbon Calculator, that one can use to offset their flight's emissions by supporting reforestation and conservation projects. By providing the necessary information, one can view a flight's carbon footprint and easily understand its impact through a smooth Graphical User Interface. The calculator can be accessed here

1.2.6.4 Flight Emissions Calculators by airlines

Several airlines have developed their own flight emissions calculators, that allow their passengers to calculate their carbon emissions and offset them. For instance, the Scandinavian Airlines System (SAS) allows passengers to easily find out how much CO_2 and

[3] A B Corp business meets the highest standards of verified social and environmental performance, public transparency, and legal accountability to balance profit and purpose.

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greenhouse gases their flight generates, by entering their origin airport, their destination airport, the number of passengers and the type of the flight's plane.
Air France offers a similar calculator that can be accessed here. Lufthansa has partnered with Compensaid to develop their flight emissions calculator and offset their carbon emissions. Passengers have two options: either to purchase innovative sustainable aviation fuel or support reforestation projects. Another example includes Finnair, which gives the chance to their passengers to offset their flight's footprint by choosing how much they will support the Sustainable Aviation Fuel (SAF) and how much they will aid in climate projects that reduce, capture or avoid GHG emissions.

1.2.6.5 Several open-source projects

Several individuals and organizations have published the codes run from their calculators online, allowing access to anyone interested. For instance, anyone can view the Carbon footprint code developed by the Protea social network or alter this Flight CO_2 calculator developed for iOS and Android software. Finally, one can find some inactive projects, such as the "Air-Guardians" or read the article "Why we cannot decarbonise international conferences without virtual participation" by Milan Klöwer and dive into the Python code used within the purposes of the article.

1.2.6.6 Mobile phone applications

Numerous applications have been developed both in Android and in iOS, that offer carbon footprint calculating and offsetting.

- Capture | Carbon Footprint & CO_2 Tracker for Travel and Food by the Capture Club (iOS, Android)
  Capture is a carbon footprint tracker that provides information about the carbon emissions and carbon footprint of the user's daily lifestyle and offers offsetting options such as Tree Planting. To further enhance the user's experience, Capture can use GPS information to predict the produced CO_2 emissions and give insights regarding the Carbon footprint. Carbon emissions are estimated by the Capture Club's team of researchers and advisors based on data from the IPCC and UNFCC.
- Klima – Live carbon neutral by the Climate Labs GmbH (iOS,Android)
  Klima mostly targets on carbon neutralization, by allowing the user to calculate their carbon footprint and offset it through several projects. It offers Membership, meaning that the user can contribute on a monthly basis in offsetting projects to neutralize their carbon emissions.
- Earth Hero: Climate Change by Earth Hero (iOS, Android)
  Earth Hero targets in practical action in response to climate change, by suggesting personalized actions in a community of members. It offers a carbon footprint calculator.

1.3 Comparative Analysis of the presented calculators

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To pick the most suitable calculator for the purposes of the "Erasmus Goes Green" project, the four main calculators presented above (Carbon Footprint, WWF Footprint Calculator, Footprint Calculator by Henkel AG&Co, ICAO Carbon Emissions Calculator and Ecological Footprint Calculator by GFN) were graded according to the following criteria (from high to low importance):

1. Mobility oriented: Can the user easily get information regarding the connection between their means of transportation and their carbon footprint.
2. Methodology presentation: Is the methodology used comprehensively referred and presented?
3. Ease of use: How easy is for a non tech-savvy user to calculate their footprint?
4. Ease of adaptation-implementation: How easy is it for the calculator to be adapted to the purposes of the project?

1.3.1 Mobility- oriented

The project aims at reducing the transport-related carbon footprint of higher education students and staff taking part in mobility activities within Europe across the three key actions of the Erasmus programme. Therefore, the most important criterion for grading the aforementioned calculators is if they address CO_2 emissions as a total product of one's lifestyle or by easily providing information regarding the connection of the user's mobility and their CO_2 emissions. To rate each calculator the following sub-criteria were used:

1.1. Means of Transport Included. The more means of transport included within the calculator's framework the best it ranks.

1.2. Ease of use. How easy is for the user to provide information regarding the used means of transport.

Table 1 Calculators ranked according to the "Mobility oriented" Criterion

	Mobility oriented		
Calculator	**1.1 Means of transport included**	**1.2 Ease of use**	**Rank**
Carbon Footprint	The calculator offers separate tabs/calculations regarding: Flights, Cars, Motorbikes and Public Means of Transport.	Flights: The user enters up to 3 flight itineraries, their departure/destination airport and any stop they have. Car/Motorbike: The user can enter the mileage of their car or motorbike and if they are not aware of its efficiency, they can choose the vehicle's type by a long list of available manufacturers.	1

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Mobility oriented			
Calculator	**1.1 Means of transport included**	**1.2 Ease of use**	**Rank**
WWF Footprint Calculator	The calculator provides short questions with multiple-choice answers and is mostly time-based. Specifically, it refers in the hours spent per week on a means of transport, except for the flights made which are filled in as the sum of flights made within a domestic / 1250km / 2500km / 5500km / 9000km / 17500 range.	The user simply picks an answer in questions about vehicles and fills the ranges in flights.	2
Footprint Calculator by Henkel AG&Co	The user answers simple questions in two main categories: "Car" (What kind of car do you own?) and "Others", which includes bikes/walks, e-bikes/e-scooters, bus, trains, plane etc. For each of the provided means of transport the user must enter the number of km done per day on how many days per week.	Quite simple to fill in, yet it is quite difficult to provide such a detailed layout of transportation on a weekly basis.	4
ICAO Carbon Emissions Calculator	The calculator refers directly to flights and it does not include other means of transport.	Simple to fill in/Directly linked to the available flights, which is useful for the user not to provide false information.	5
Ecological Footprint Calculator by GFN	The calculator does include a section about transportation but is limited only to car, flight, bus and train as means of transport. The answers are more qualitative than quantitative.	Simple to choose and interact with the calculator.	3

1.3.2 Methodology presentation

This criterion refers to the ease of access to the methodology of each calculator. Open and free access to the methodology used builds trust and allows the cross-examination of the results provided.

Methodology presentation		
Calculator		**Rank**

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Carbon Footprint	The methodology used for the online calculator is based on the "Greenhouse gas reporting: conversion factors 2020" of the UK Government with a few exceptions. A FAQ page referring to the methodology and other related questions can be found here.	3
WWF Footprint Calculator	The methodology used was developed in cooperation with the Stockholm Environment Institute at the University of York and the University of Leeds. A Q&A page is provided by WWF UK and if there are any questions not answered, someone should e-mail WWF UK directly.	4
Footprint Calculator by Henkel AG&Co	The calculator was developed by Henkel AG&Co in cooperation with the Wuppertal Institute. The Methodology used is not directly provided by the calculator.	5
ICAO Carbon Emissions Calculator	The methodology used is freely accessible by all and is based on a "distance-based approach to estimate an individual's aviation emissions using data currently available on a range of aircraft types".	1
Ecological Footprint Calculator by GFN	The methodology used is freely accessible to all and is given in plain English. A whole webpage is dedicated to the resources used for the calculations.	2

1.3.3 Ease of Use

Regarding the "Ease of Use" the presented calculators were graded using the following sub-criteria:

3.1. Question and answer type. The questions given must be more straightforward, but descriptive, while multiple-choice answers are easier to be filled in.

3.2. Graphical User Interface. A developed Graphical User Interface is more attractive for the users and is considered user-friendly. Although, this sub-criterion is not as important as the type of questions and answers, as within the project's framework it can be altered.

3.3. Additional Information provided. If the calculator provides additional information regarding the users' choices, it is easier for them to understand why the questions are being asked and how their answers (hence their lifestyle) affect the size of their carbon footprint.

Table 2 Calculators ranked according to the "Ease of Use" Criterion

Criterion: Ease of Use				
Calculator	**3.1 Question/Answer Type**	**3.2 Graphical User Interface**	**3.3 Additional Information provided**	**Rank**

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Carbon Footprint	Short Questions/ User must enter values	Simple	Not directly provided	4
WWF Footprint Calculator	Descriptive Questions/ Mostly multiple-choice answers	Advanced Graphics are used / Eye-triggering sections	Hints and general information provided on the right side of each questions	1
Footprint Calculator by Henkel AG&Co	Short Questions/ User must enter values	Simple but beautiful	Not directly provided	3
ICAO Carbon Emissions Calculator	Short Questions/User must enter values	Too simple	Not directly provided	5
Ecological Footprint Calculator by GFN	Short Questions/Easily filled/User might get confused and in doubt regarding the preciseness of their answers	Advanced Graphics are used/Eye triggering sections	Information is provided by clicking the "Learn More" prompt on the bottom right corner of the site.	2

The most easy-to-use calculator is the WWF Footprint Calculator, as it contains a lot of graphics that attract the user's attention, while the answers are mostly given in a multiple-choice form. Furthermore, it provides useful information, which is easily found, about how each question is linked to carbon emissions.

1.3.4 Ease of adaptation – implementation

The criterion is used to grade the adaptability of a calculator. It is noted that from the calculators, only the Carbon Footprint prompts the use of its calculator on another webpage. Furthermore, it has to be noted, that the WWF Footprint Calculator is mostly UK-oriented, thus restricting its implementation to a majority of users.

1.3.5 Ranking Summary

Table 3 provides the ranking summary of the calculators regarding the criteria used in the analysis:

Table 3 Calculators' Ranking Summary

Ranking Summary					
Calculator	**Mobility oriented**	**Methodology presentation**	**Ease of Use**	**Ease of adaptation - implementation**	**Final Rank**

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Carbon Footprint	1	3	4	1	1
WWF Footprint Calculator	2	4	1	2	3
Footprint Calculator by Henkel AG&Co	4	5	3	2	4
ICAO Carbon Emissions Calculator	5	1	5	2	5
Ecological Footprint Calculator by GFN	3	2	2	2	2

As seen from the above, the Carbon Footprint calculator is ranked as first among the five (5) presented calculators, due to the following factors:

- It allows the user to easily identify the connection between carbon emissions and mobility and it offers a variety of vehicles used for the purposes of the calculation.
- It is based on an approved methodology used by the UK Government.
- It prompts the user to add the calculator to their site easily.

The biggest disadvantage of the Carbon Footprint calculator is its Graphical User Interface, which is very simple and does not easily attract the users' attention.

The Ecological Footprint Calculator is an easy-to-use tool with an interactive Graphical User Interface, which calculates the impact of someone's lifestyle according to the international Ecological Footprint Standards. Thus, it allows the user to easily understand their impact on the planet. Although the Ecological Footprint Calculator specifically refers to flights, car, bus and train as means of transport, it does not provide enough information about other means, such as team or coach. Finally, answers are given by "sliding" a bar between two values, which can lead to less accurate and doubtful answers.

WWF Footprint Calculator and the Footprint Calculator by Henkel AG&Co are easy to use calculators with an advanced user interface, which address carbon emissions as a total product of someone's lifestyle and do not easily provide information regarding separate uses.

Finally, the ICAO Carbon Emissions Calculator, though it provides a comprehensive document of the methodology used, it refers only to flights and does not address other means of transport.

2. Technical Blueprint and use cases of the CO_2 footprint visualisation tool

After choosing the Carbon Footprint Calculator as a trustworthy and up-to-date tool to aid in the purposes of the project, the team wanted to find ways to make the tool more useful and

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more appealing to the end- users of the developed tool. Before doing so, the following three core questions were identified and need to be addressed:

1. Who is the end- user?
2. Why should somebody use the tool?
3. How can someone upgrade the provided service?

As “end users” are characterized the visitors who are expected to use the final version of the developed product. Since the project focuses on the Erasmus programme, the end users belong to one of the four categories presented below:

- Academic Staff
- Administrative Staff
- Postgraduate Students
- Undergraduate Students

The end-users age ranges between 18 and 70, meaning that the end product should be easily used by both tech- savvy youths and by adults who are not very keen on new technologies.

The reason “why” someone would use the tool is currently based upon their own personal interests, such as protecting the environment, adopting a more eco-friendly lifestyle etc. As the need for climate action is imminent it is considered useful for the participating HEIs to include at least one question regarding the carbon footprint created by the Erasmus trave lers. This is expected to boost the interest in using the tool.

To detect the chances of upgrading the calculator and the provided service, the team started testing the tool using different scenarios of using multiple Means of Transport and not preferring the quickest route, considering that the calculator’s script cannot be altered. Although the calculator performed well, as expected, it was rather difficult to continuously search for alternative routes using a map service provider such as Google, Bing, or OpenStreet Maps. Furthermore, very few information was given regarding carbon footprint calculation, offsetting and the impact transportation has on the environment. Both drawbacks were considered of major importance especially for the grownups over 45 years old, since they seem to be harder to use new technologies, adapt by changing their habits and understand the reasoning behind carbon footprint calculation.

Thus, it was decided, that a map could be added near the calculator, that would suggest suitable routes and that would allow the user to insert interim stops and easily calculate their fuel cost. Furthermore, information should be given regarding the importance of carbon footprint measuring and the methodology behind it in an easy-to-access and simple way. Finally, considering the value of data, a form was added to allow users to directly communicate their results to a central database that can help in understanding the user preferences and ultimately be used in calculating the Erasmus footprint.

As a result, the final product should offer an environment in which the user can easily experiment with different means of transportation, with the help of addons. Consequently, a

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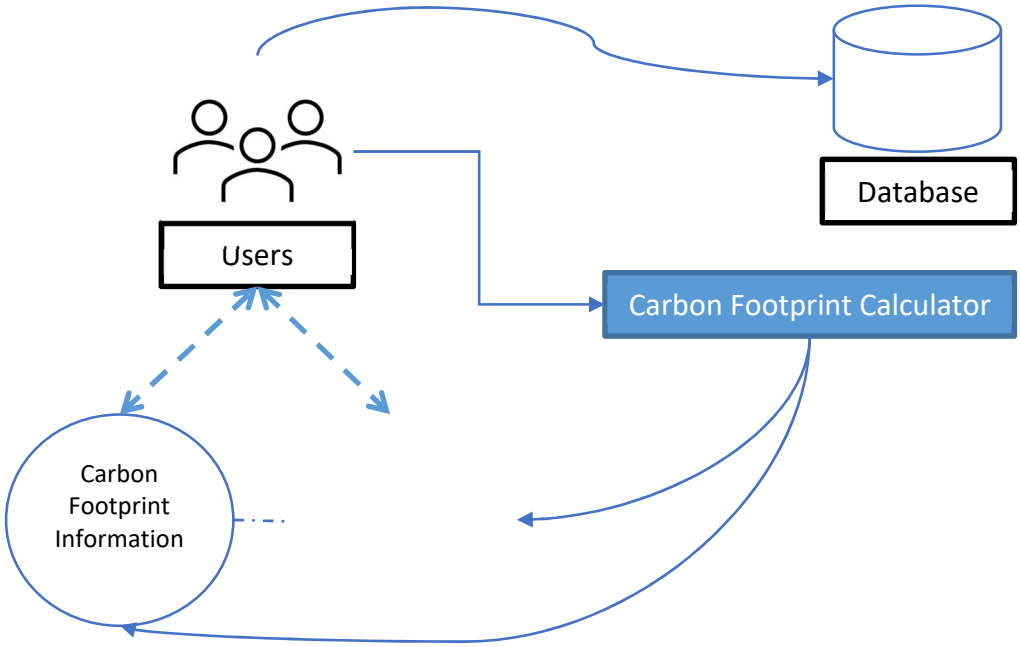
tool was developed consisting of the carbon footprint calculator, an interactive map that suggests a route and calculates its fuel cost, easy to access related information, and a submission form. Further analysis on the use of the tool is provided in Chapter 4 “User Handbook” of this report. The connections between the different parts of the tool can be seen in the following blueprint.



3. Tool testing

3.1 Introduction

All partners of the Consortium have organized testing groups to assess the developed tool in terms of usability and importance.
To do so, a questionnaire was developed using Google Forms. Google Forms was chosen because it provides easy data management and analysis. Furthermore, considering the pandemic mitigation measures that were in place, Google Forms allowed for online testing phase execution.
The questionnaire consisted of five (5) different sections:

- Welcoming – Introduction, during which the testing group was greeted by the facilitator and was introduced to the Project itself. They were also presented with the layout of the questionnaire
- Part I, which included user-profiling information
- Part II, during which participants evaluated the developed tool

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- Part III, during which participants were engaged to provide any additional feedback they had regarding their experience.

After inviting as many people as possible from each Erasmus category (Undergraduate, Postgraduate Students, Administrative Staff, Academic Staff), the facilitators allocated them in groups of 20-25 people. Each testing phase was estimated to last 50-60 minutes. Finally, it has to be noted, that the answers were anonymous and no personal data were provided, registered or kept during the testing procedure.

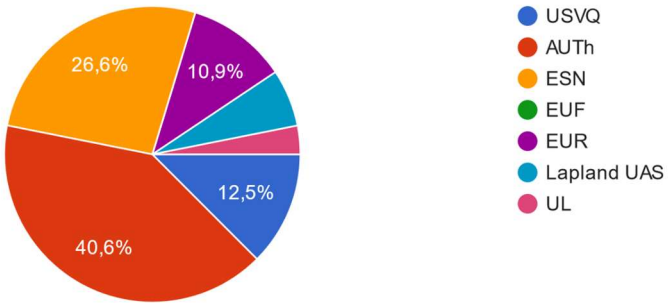
3.2 Results of the benchmark tests and the pilot phase

3.2.1 Questionnaire Results

Part I:General Information - User Profiling

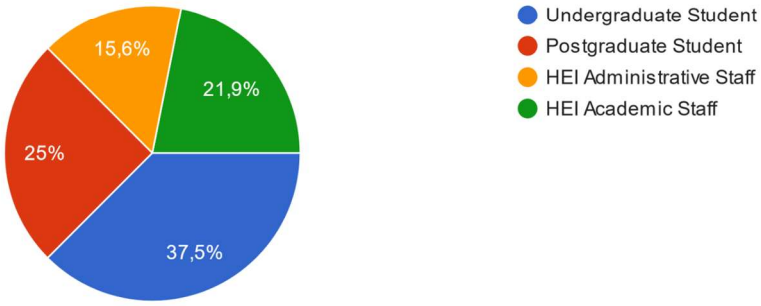
What is your organisation/institution?

64 απαντήσεις



In which group do you belong?

64 απαντήσεις



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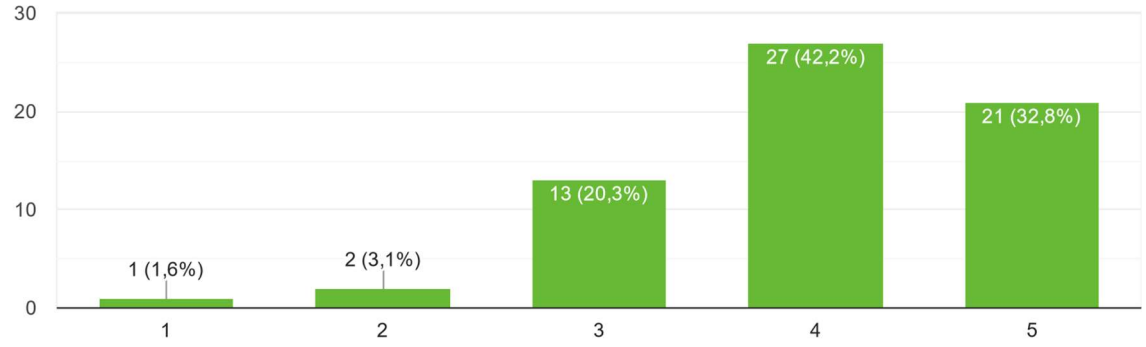
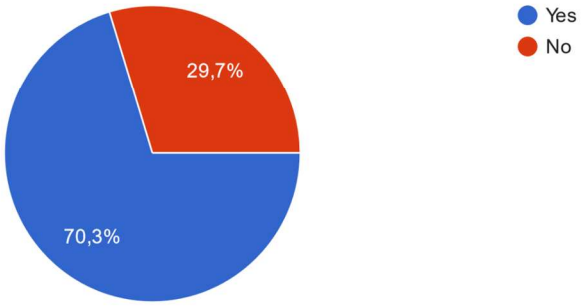
On a scale from 1 to 5 how environmentally conscious would you say you are?

64 απαντήσεις



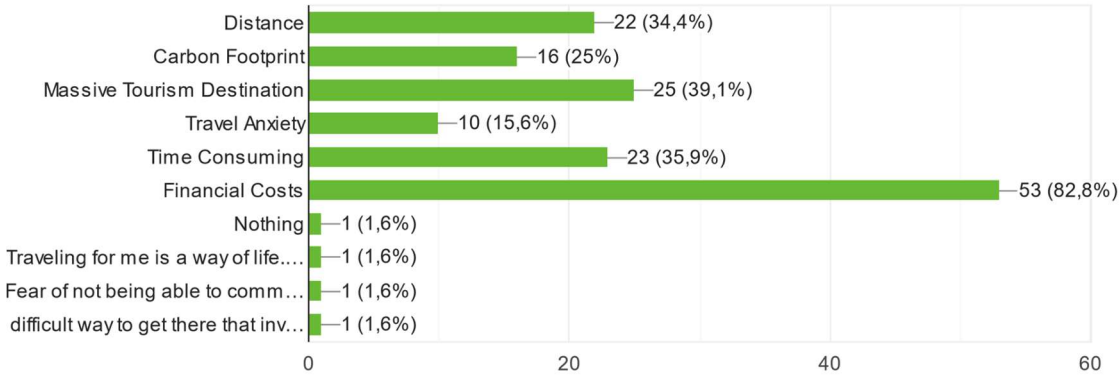
Is the protection of the environment a priority when travelling?

64 απαντήσεις



What are the negative criteria that affect your choice of destination for a mobility?

64 απαντήσεις



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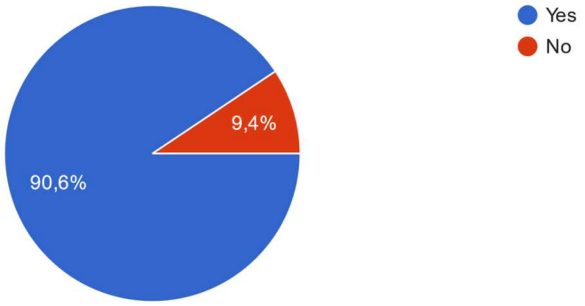
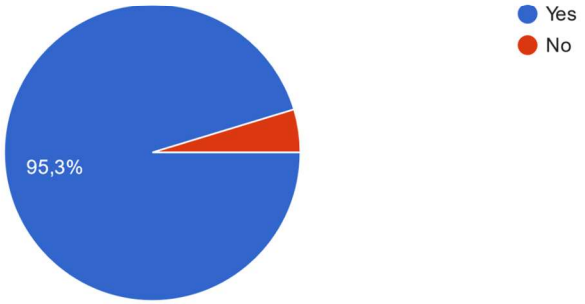
Have you heard about terms, such as “environmental footprint”, “water footprint”, “carbon footprint” before?

64 απαντήσεις



Would you care learning about your carbon emissions and reducing them?

64 απαντήσεις



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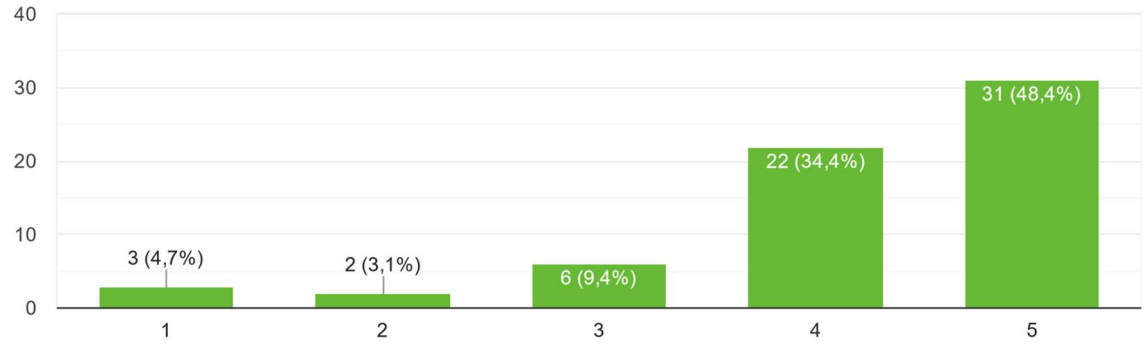
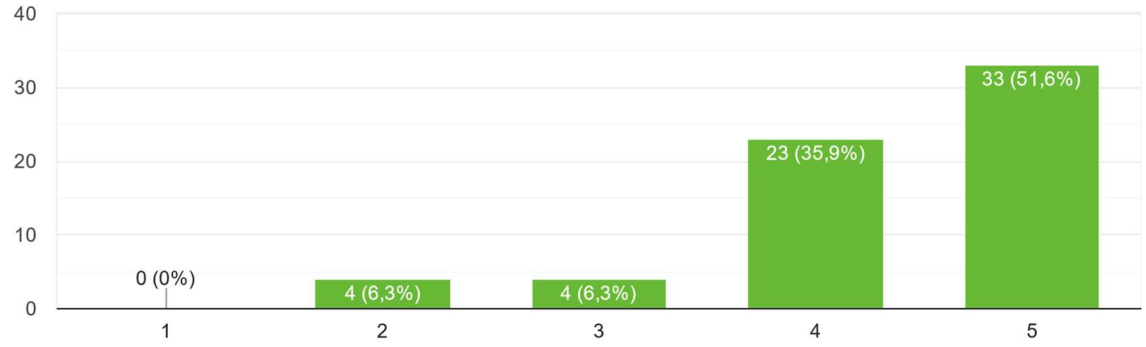
On a scale from 1 to 5, should your institution provide more information regarding carbon emissions and travelling?

64 απαντήσεις



On a scale from 1 to 5, how interested are you in using a tool that would help estimate your carbon emissions?

64 απαντήσεις



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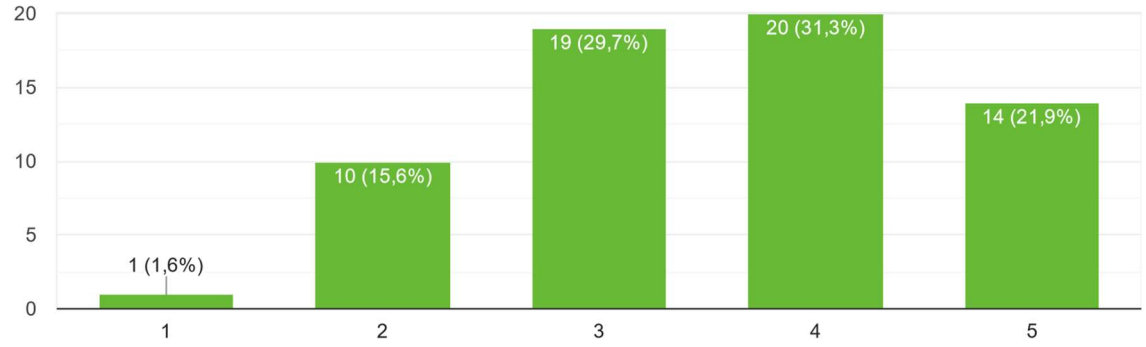
On a scale from 1 to 5, how willing would you be to offset your travel choice?

64 απαντήσεις



Part II: Evaluation of the Footprint Calculator Website

Part IIa: Website Evaluation

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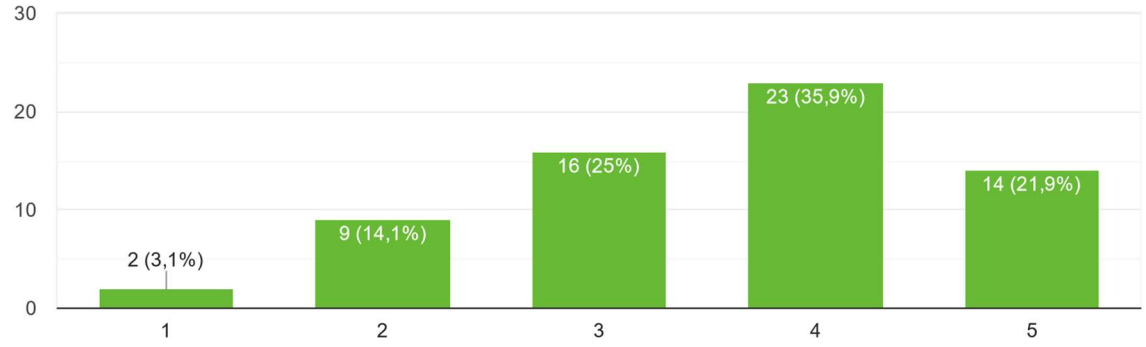
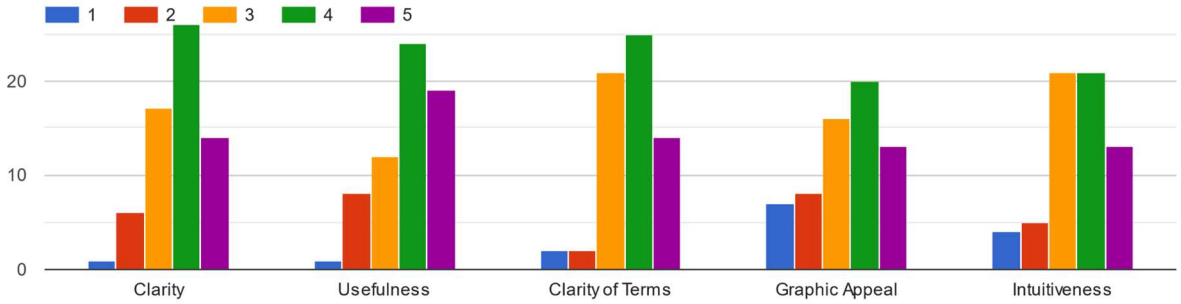
On a scale from 1 to 5, how easy do you find the use of the tool?

64 απαντήσεις



On a scale from 1 to 5, how useful do you find the tool in general?



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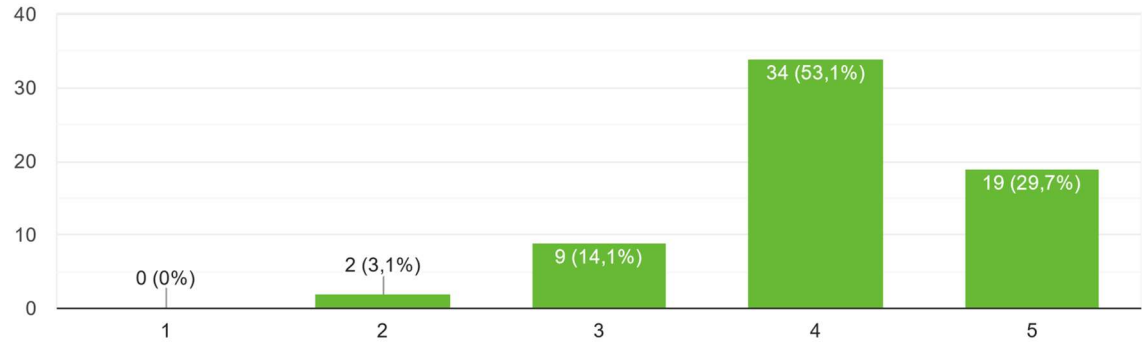
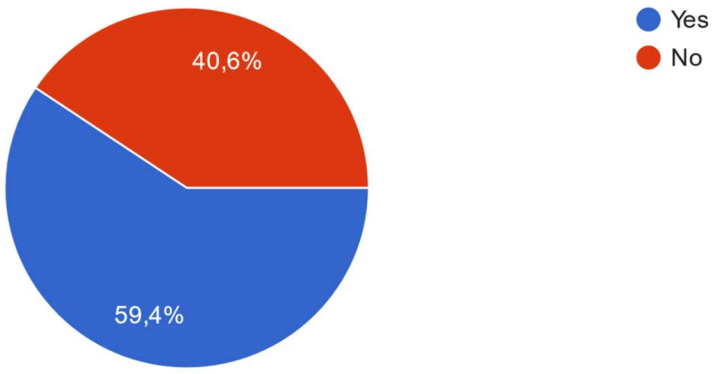
On a scale from 1 to 5, how understandable do you find the instructions/information of the webpage?

64 απαντήσεις



Would you like more information to be added regarding carbon offsetting?

64 απαντήσεις



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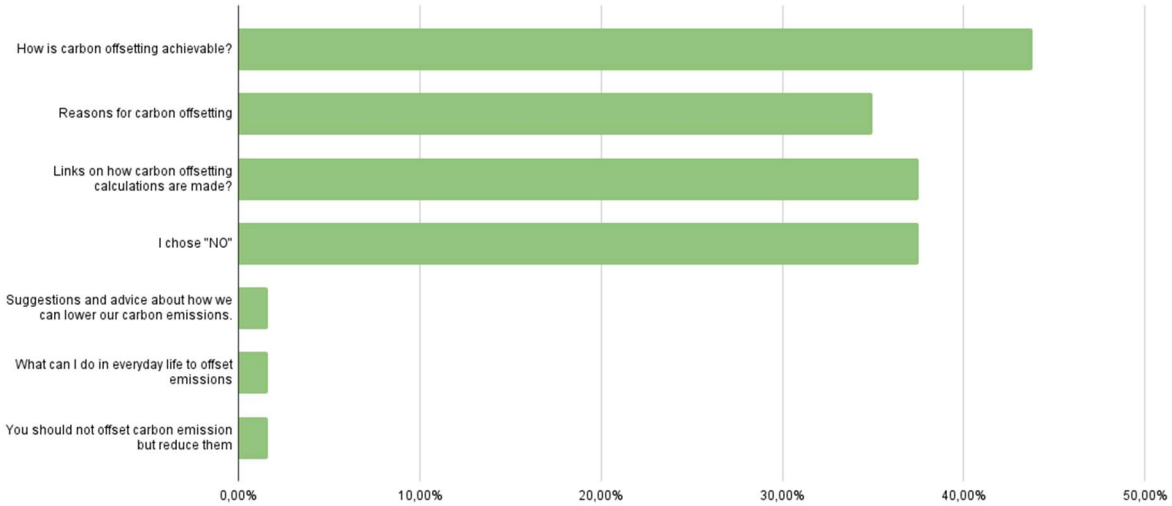
If you have answered "YES" in the last question: What would you specifically want to find/see regarding carbon offseting?



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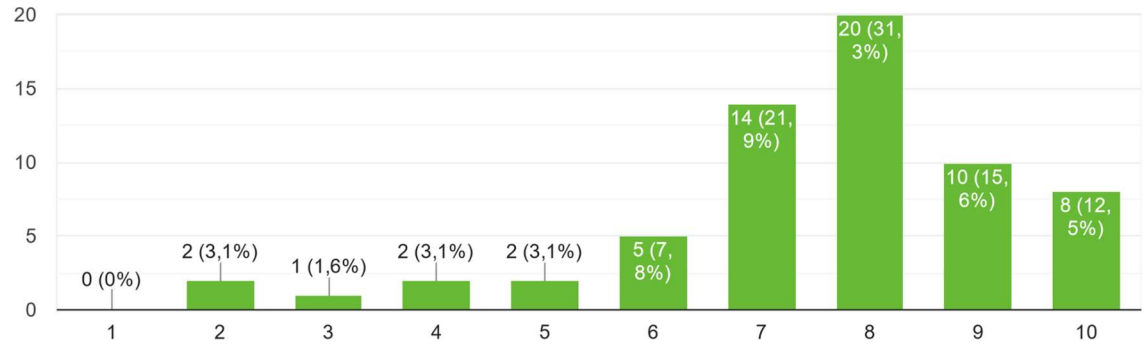
Part IIb- Tool Evaluation

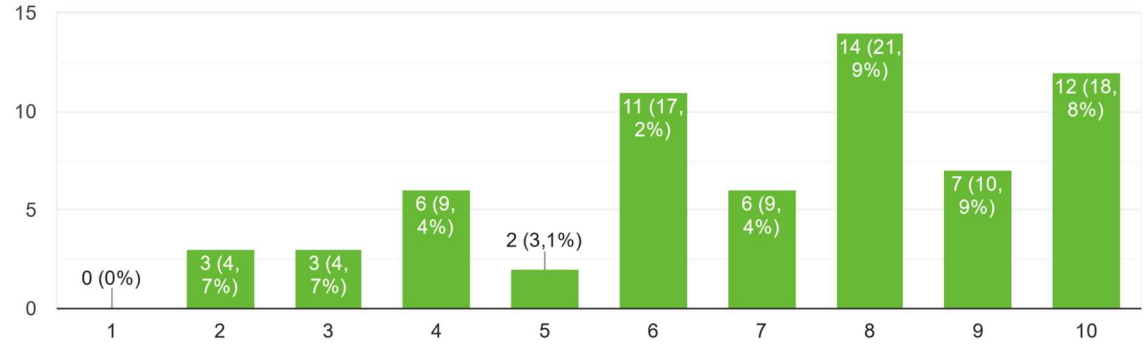
On a scale from 1 to 10, how would you rate the tool in terms of usability?

64 απαντήσεις



On a scale from 1 to 10, how would you rate the tool in terms of overall appearance?

64 απαντήσεις



Is there anything you would change and why?
No
No
No
Add the ferry option as mean of transport
Leave out House / Secondary - students are here to check on their mobility.
I was not able to submit my carbon footprint
possibility to change a language
A more user-friendly interface.
I don't have anything to add
No, it was great.

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No thank you
Maybe propositions on best way to travel
Nothing
I would make the appearance more enjoyable
Make design more modern, tool gives Windows 2008 vibe
Don’t ask for airport codes but just let people look for the airport. Also don’t ask for how much gas people use but how long they shower and what temperature their cv is on. People do not know by hard what they use
The font, it looks very old.
It just seems very 2000-esque with the basic menu/option style. I think it would already be an improvement if the tool covered more than just a sixth of the webpage.
I would add more information on what is the impact of the amount of carbon footprint resulted and how to offset it.
No
No
An average of bus or tram travels
I would only change the graphics, so that this platform will be aesthetically better.
I this works.
oblige to click on the proposed cities
Maybe not in the functions specifically, but the tool itself requires a lot of information that might be difficult to get (like electricity usage).
No, I personally think that the website is clear and easy-to-read
Maybe to add part of calculating km between places
Give some defaults or a slider on the personal opinion on how much energy in the house is used or how much one travels by car. I genuinely do not know the exact kWh of electricity used or other values. I also cannot provide a certain range. I can, however, give a statement on how I think I behave in comparison to others. I know how friends heat their house or how much they travel by car. It is always possible to ask for more detailed data, but not every person can give the detailed data currently requested. Hence, the tool is very inaccessible. (Also, the style is not appealing.)
i don't want to change anything
the aesthetic
I think it needs more clarity when it comes to some terms and also the functionalities of the tool, especially the first tab "home" is hard to figure out. I could not add the calculation of the gas usage, only electricity was calculated. Also, there are some issues with the text in Polish. Also, the fact that the calculator is embedded in the website and you need to scroll to get to the bottom part hampers user experience.
No
To get a bigger a visual instead of a smaller one.
I would change a little the appearance for something modern
results
The tool should be bigger and better organized with clear indications in order to understand the calculator
I think it should be easier to know the average values of kwh or l/km
I think the choices of the different kinds of cars / types and year are to many. Keep it more simple
The Graphic Character looks too old
No
Right now I can't think of something useful to make this tool better.
for the moment i think no , maybe in future .
Letters should be bigger
Probably the graphics
Nothing
Less 80’s appearance

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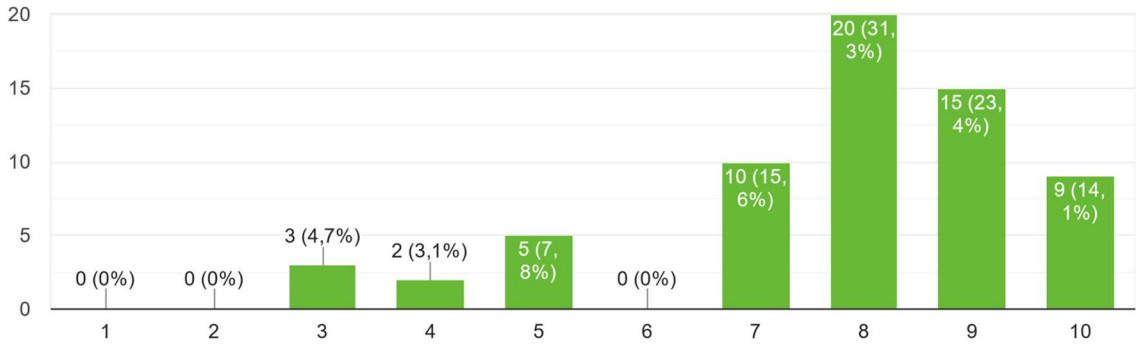
There are way better tools available. This tool didn't give me electric car for example, and it did not take into account that I am using 100% renewable electricity in my home.
No
More "clean" UI
I don't know for this moment

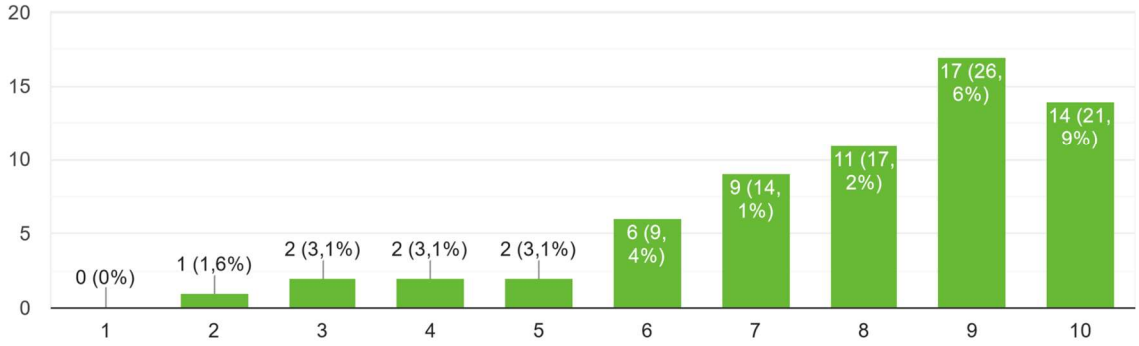
On a scale from 1 to 10, how would you rate the interactive map in terms of usability?

64 απαντήσεις



On a scale from 1 to 10, how would you rate the interactive map in terms of appearance?

64 απαντήσεις



Is there anything you would change and why?
No
No
-
The total cost of fuel should be popping up as a final result as well
I think very few students drive a car to their exchange destination, so a train or bus route would make more sense.
I do not understand why the first table is in French and the second part is in English
Appearance

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I don’t have something to add.
No, everything was great.
No thank you
Not at all!!!
I would change the appearence, because it is really simple and not enjoyable
Fuel price and consumption, not too sure about this (student without a car)
Nope, looks good
I found it very useful and easy.
Non
Again, I would only change the graphics, to make the platform aesthetically better.
Make it simpler.
Not for the moment
Choosing city/place is difficult, because results are misleading. For example, there is no "Łódź" (city in centre of Poland) - you need to type "Lodz" to get proper result.
No, I am satisfied with it
I was unable to select Rotterdam as the starting point.
As above
It did not show me a correct route, even though I chose the right city it showed the route to a different region of the country, so I had to point manually the destination. Also, the information about fuel price seems redundant cos it is not referenced in the results at all (only the number of kilometers, driving time and petrol usage) the same for carbon footprint and the offset measures - this is something that would be good to include.
There is an error after I filled the form "There was an error trying to send your message. Please try again later."
Not really, I think it’s pretty clear
No bugs
The appearance of the app is really old fashioned
A link with a table for fuel prices of the last 5-years and a table to calculate the relation between fuel consumption and distance.
Adding overall cost of the drive since fuel price is being asked. This would be a great comparison measurement for the user to compare the price of driving to his/her preferred way of public transport (especially now that the fuel prices are so high!).
Maybe it should be useful to add the current value of gas automatically
No, I like it.
Nothing
?
No
No
I don't know for this moment

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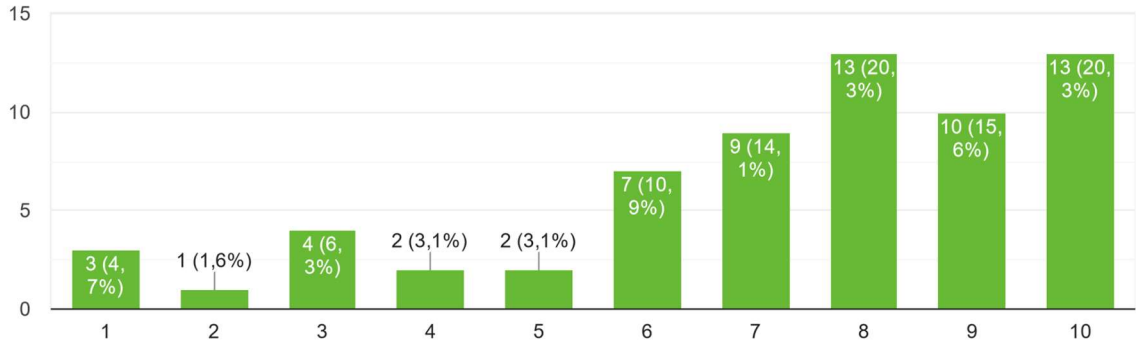
On a scale from 1 to 10 how would you rate the form in terms of usability?

64 απαντήσεις



Is there any other question that should be added to the form?
No
No
-
No
How much did you pay for your travelling ticket (if applicable)?
--
Doesn't work (can't send the message)
Όχι
No, it was all clear.
No thank you
Everything is fine, easy to use it,and i would like to use it in the next trip to Dijon France!!
Not necessary
It didn't work, there was an error message when clicking "submit". The message is the following one : "There was an error trying to send your message. Please try again later."
"why did you choose your mode of transport?(optional)"
The website gave me an error when I tried to submit my carbon footprint, hence I didn't manage to fill that part. I would add how the data collected through the form will be used.
Perhaps simpler information
No, for the moment
I would suggest that you could add questions that are related to other trips during the erasmus exchange (to nearby cities/countries or other ones that are far away). Because most of the erasmus students are travelling the whole time. That means, that they don't only have the carbon footprint that is related to the two trips when entering the exchange country and returning from there.
None, but maybe rephrase the current question.
Submit doesn't work
No, thank you
It's fine.
No, I think the form is done properly
Did not test

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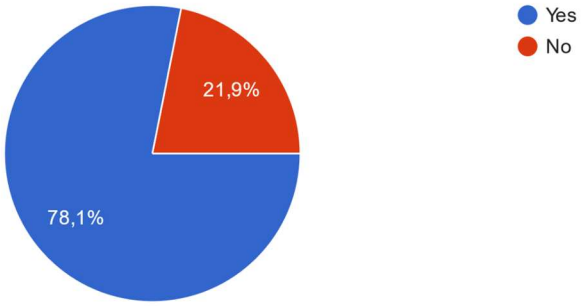
I am not able to say it
No
I wasn’t able to send my form, there was some kind of error
Seeing the number you got
I do not see what is the sense of this formular and how you deal with the results
I think it should be an automaticated button to send the results
No
No I think that everything is fine. It is short and to the point
no , its good
I think not
Submit button does not work
No
I don't know for this moment

Part III: Comments about the overall experience

If you were to go on mobility soon, would the tool help you decide on your means of transport?

64 απαντήσεις



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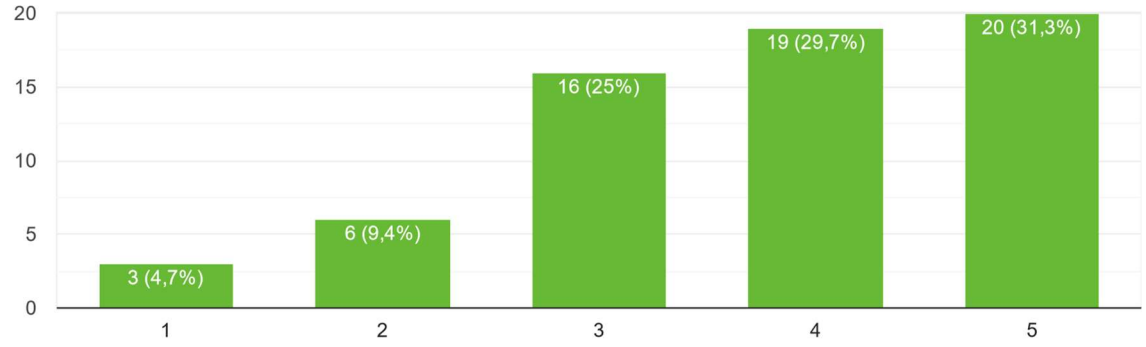
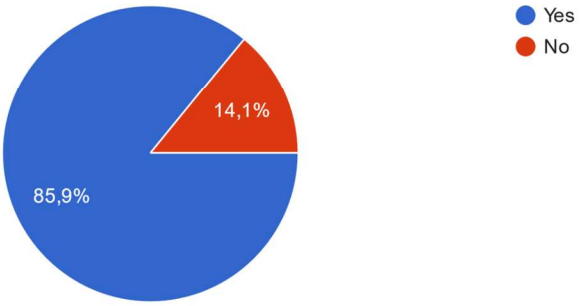
On a scale from 1 to 5, how possible is it to use the tool for your future journeys?

64 απαντήσεις



Would you suggest the tool to your friends, relatives, coworkers etc?

64 απαντήσεις



Was there any particular part that seemed difficult for you to use?
No
no
-
No it was pretty simple.
I think the footprint calculator is too broad for the purpose. Focus on mobility.
.
No
The part with the motorcycle and the calculation of the km.
No, not really
Not sure about costs/consumption. Hard to know exact numbers
Yes how do I know how many kilometres I travelled
some options require some extra knowledge that might not be readily available (e.g., mileage, gas usage, etc.)
I faced an error in submitting my carbon footprint.
Many information was asked

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Test
No , its not so much difficult
N
No, everything was very clear.
Not very user-friendly. No options. Need to manually input the data, especially for past data.
Submit doesn't work. It's quite difficult to have the result. I would be important to oblige to click on the proposed cities
The thing is that I'm already aware of the importance of choosing sustainable transport, so such tool is not that useful for me.
To remember every consumption of my vehicle
The carbon footprint calculator required too detailed data
No, it wasn't difficult
It is difficult to find all the requirements
The tool only calculates the distance and fuel not the carbon footprint. At least I haven't found this feature. And if I click "learn more" next to plant your tree there is 404 error.
No
To use the calculator was quite hard. I'm not going to lie I took more time than the other people.
Not really
Results
the first part on the foot carbon
to know the numbers of kwh or the km i have done
I am confused about the three choices I can add in the flight calculator. Also, I didn´t understand the sense of the formular at the end.
I think is really easy to be used
Needed to use another website to calculate distance
As an application it would obviously be handier.
No, in my opinion, the tool was user-friendly
No , because i have tried this caclulator before
No
As mentioned before, this is something that can be done much better with many other tools
No
No
I think that no

Do you have any other comments (positive or negative) about the platform and the experience in general?
No
No
No, I don't.
When calculating the bus/rail route it should like: we write the two cities that we're travelling to and it should be connected to google maps so the distance is automatically calculated so that the user doesnt have to check the distance on google maps beforehand
I've commented during the zoom meeting.
No
Thank you I am excited
The platform has a good intention, but the total carbon footprints won't be the reason of young people to decide when to travel for their erasmus+.
Make design more appealing! Then it is more fun to fill it in!

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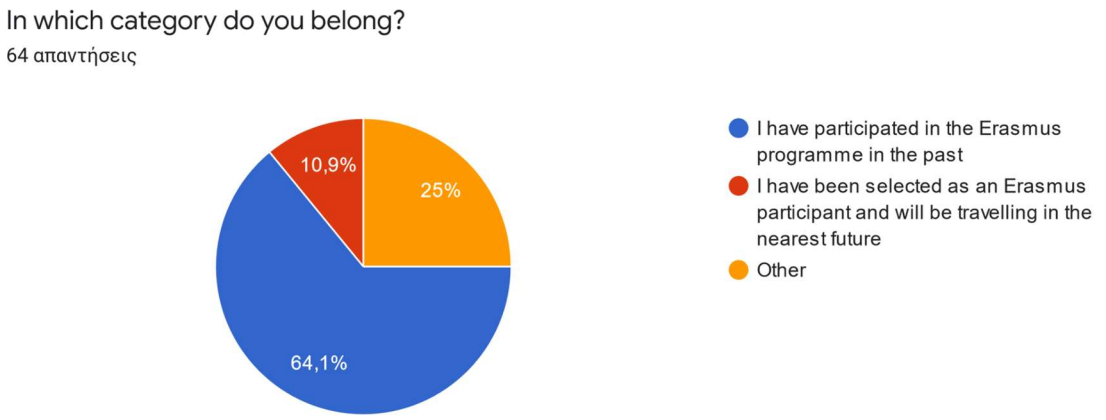
Maybe not mix colors (green and yellow don't really go well)
I liked very much the part about the ideas on how to offset the carbon footprint
TEST
Its really good to know because i have learned it before
Could not submit the amount of CO_2. "there was an error trying to send you message. PLease try again." Carbon offset options already proposed by Carbon Footprint calculator. amount of C02 not on the same page to compare (it's on different tabs)
This tool would be good if the person traveling is conscious about his/her carbon footprint. However, some adjustments have to be made in order to convince others to use this tool. An example would be to add options or a range of values so people can just select.
It needs some updates, especially travel tool. Also, it would be great to have some suggestions on how to calculate some parts of the carbon footprint.
The platform is easy to use and the experience made me for confident about the environmental issues linked to travelling
Its really useful . I hadnt recognize my footprint before
More visual and fewer information no interactive
The idea of the tool is very good but it needs more technical work, more clarity how to use it, why, what for (for instance why do you ask me to send you my carbon footprint) and better language. If it worked fine I would use it for my travel but the way it is now is not that appalling.
I think to add a section where you stated your core values.
It was interesting to see how big is carbon footprint for flights.
I like the map you offer when choosing the driving option. But There are other calculators like from Atmosfair or EcoPassenger, which are more simple to use, in my opinion.
I think the design have to be changed
It is good , and gives me more knoweldge
-
I would suggest checking other calculators. Also, I do compensate my CO_2's and that was not possible to choose. I also understand that compensating CO_2's is not the answer, it just gives us a bit more time to prepare.



3.2.2 Testing Phase – Form collected answers

During the trial period of the calculator, several registrations were made in the database of tool (available at: egg.civil.auth.gr). These records are available for export to a .csv file and after filtering are presented in the following Table:

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ID	Submission Date	Academic degree	Departure city	Destination city	Traveling By	Carbon Footprint
1	10/3/2022 14:00	Postgraduate Student	Paris	Paris	bus	0.06
2	15/3/2022 10:22	Administrative Staff	Paris	Munich	flight	0.19
3	28/3/2022 16:23	Postgraduate Student	Valencia	Porto	flight	0.2
4	29/10/2021 12:08	Administrative Staff	Helsinki	Rovaniemi	flight	0.2
5	30/3/2022 9:30	Administrative Staff	Munich	Barcelona	flight	0.24
6	14/2/2022 14:10	Administrative Staff	Paris	Berlin	flight	0.24
7	10/3/2022 13:58	Undergraduate Student	Paris	Thessaloniki	rail	0.26
8	17/3/2022 12:20	Academic Staff	Thessaloniki	Vienna	flight	0.28
9	28/3/2022 16:34	Postgraduate Student	Poznan	Urbino	flight, bus, rail	0.29
10	18/3/2022 8:29	Postgraduate Student	Thessaloniki	Krakow	flight	0.31
11	28/3/2022 16:25	Undergraduate Student	Salamanca	London	flight	0.38
12	18/3/2022 8:30	Undergraduate Student	Thessaloniki	Madrid	flight	0.38
13	28/3/2022 16:28	Undergraduate Student	Pisa	Nottingham	flight	0.4
14	22/3/2022 9:41	Academic Staff	Thessaloniki	Berlin	flight	0.42
15	18/3/2022 8:31	Academic Staff	Thessaloniki	Dijon	flight, bus, rail	0.42
16	18/3/2022 8:30	Academic Staff	Thessaloniki	Lyon	flight, car, rail	0.44
17	17/3/2022 8:43	Undergraduate Student	Thessaloniki	Freiburg im Breisgau	flight, rail	0.44
18	30/3/2022 8:39	Administrative Staff	Catania	Milan	flight	0.49
19	19/10/2021 16:12	graduate student	Brussels	Adrano	flight, car	0.49
20	18/3/2022 8:29	Undergraduate Student	Thessaloniki	Brussels	flight	0.51
21	18/3/2022 8:25	Undergraduate Student	Barcelona	Thessaloniki	flight	0.52
22	18/3/2022 8:26	Undergraduate Student	Thessaloniki	Lund	flight	0.53
23	27/4/2022 10:27	Administrative Staff	Dublin	Budapest	flight	0.54
24	18/3/2022 8:29	Undergraduate Student	Thessaloniki	Strasbourg	flight, rail	0.54
25	18/3/2022 8:27	Undergraduate Student	Thessaloniki	Paris, Strasbourg	flight, rail	0.54
26	18/3/2022 8:30	Postgraduate Student	Thessaloniki	Valencia	flight, bus, rail	0.59
27	28/3/2022 16:34	Postgraduate Student	Covilha	Prague	flight, bus, rail	0.67

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28	22/3/2022 9:46	Postgraduate Student	Thessaloniki	Louvain la Neuve	flight, bus	0.7
29	22/3/2022 9:47	Academic Staff	Thessaloniki	Lisboa	flight	0.77
30	25/4/2022 16:50	Undergraduate Student	Thessaloniki	Porto	flight	0.78
31	28/3/2022 16:34	Undergraduate Student	Pisa	Nottingham	flight	0.8
32	28/3/2022 16:31	Undergraduate Student	Pisa	London	flight, car	0.8
33	28/3/2022 16:31	Undergraduate Student	Pisa	Nottingham	flight	0.8
35	28/3/2022 16:35	Undergraduate Student	Pisa	Nottingham	flight	0.81
36	17/3/2022 8:38	Academic Staff	Thessaloniki	Lisbon	flight, car	0.83
37	10/3/2022 13:58	Undergraduate Student	Paris	Stockholm	flight	0.87
38	17/3/2022 8:41	Administrative Staff	Thessaloniki	Essen	flight	0.97
39	17/3/2022 8:34	Academic Staff	Thessaloniki	Wroclaw	flight	0.97
40	18/3/2022 8:30	Undergraduate Student	Thessaloniki	GiebŸen	flight, rail	0.99
41	28/3/2022 16:33	Undergraduate Student	Milan	Delhi	flight	1
42	18/3/2022 8:25	Undergraduate Student	Thessaloniki	Brussels	flight	1.02
43	28/3/2022 16:33	Undergraduate Student	Pozna	Lisbon	flight, car, rail	1.48
44	25/4/2022 16:52	Postgraduate Student	Madrid	Cranfield	flight	1.69
46	10/3/2022 13:58	Undergraduate Student	Paris	Tokyo	flight	2.73
47	28/3/2022 16:36	Postgraduate Student	Cebu	Novara	flight, car, rail	3.43
48	10/3/2022 13:57	Administrative Staff	Paris	Seoul	flight	5.5

The following figures show data diagrams for the trial period, while the last figure shows the flight map of the test data.

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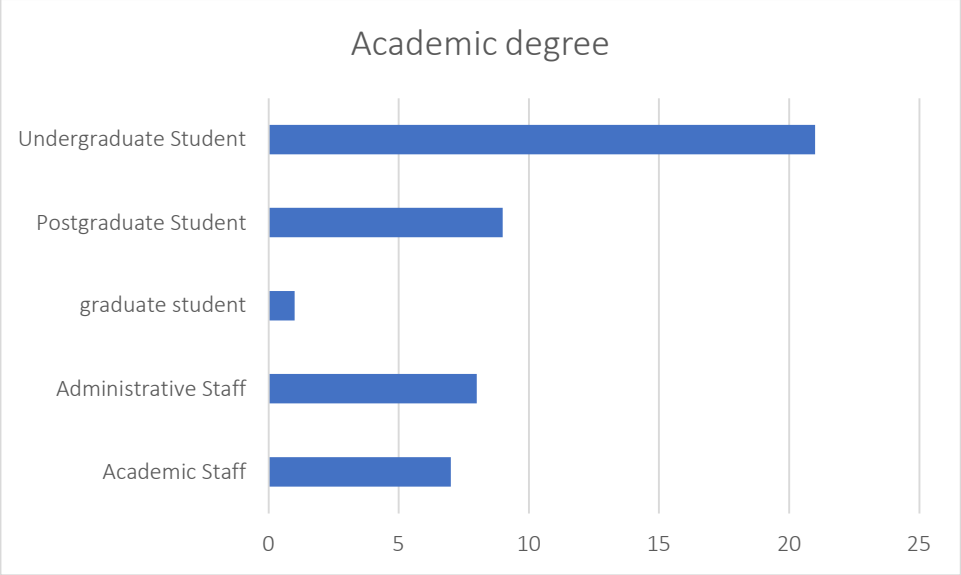

Figure 1.14: Bar chart of academic degree

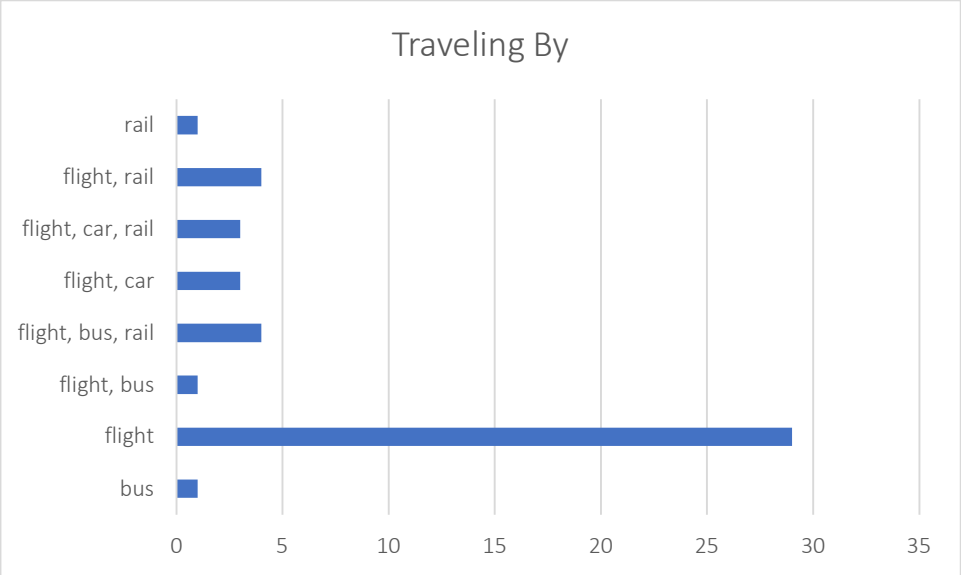

Figure 1.15: Bar chart of traveling way

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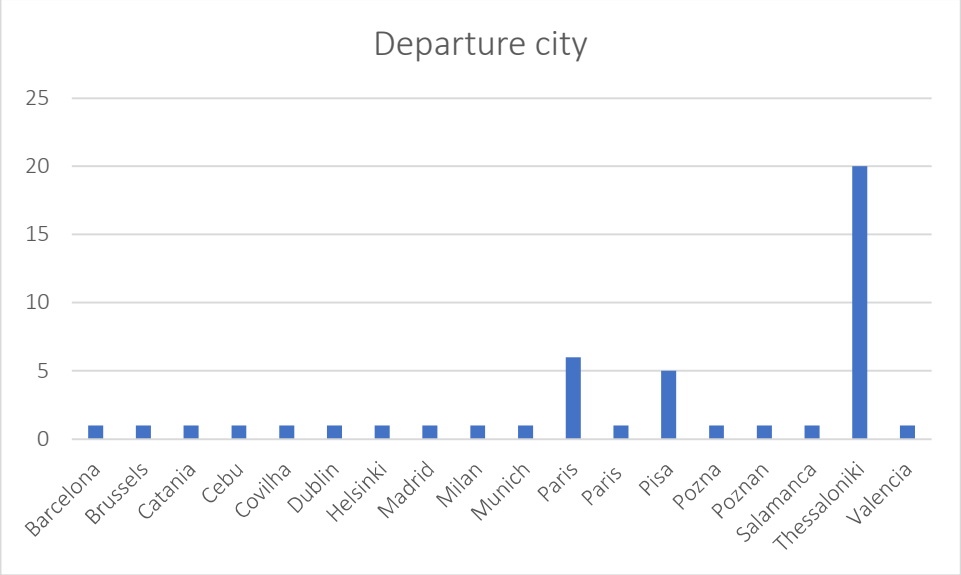

Figure 1.16: Bar chart of Departure city

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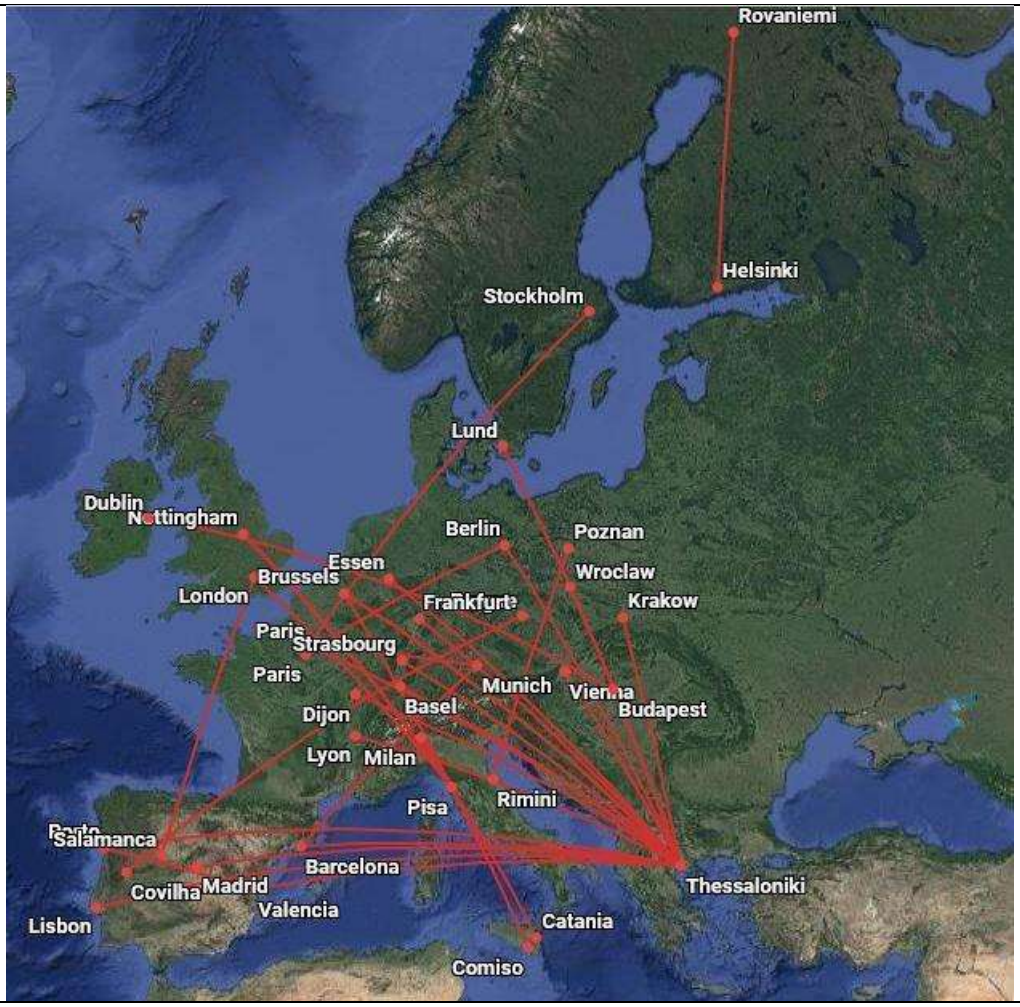

Figure 1.17: Flight map of trial period database

3.3 Conclusion

In overall, the developed platform performed well. Most users were happy with having a tool ready to use to calculate their footprint and expressed their positive views through the form and/or orally to the facilitators after their testing group had finished. The negative reviews and comments focus on the appearance of the calculator, which cannot be altered and on a false response appearing after clicking “submit” in the form, which was due to a server lag but was later fixed. It has to be noted, that their answer was eventually submitted and registered through the form. Next steps include the isolation of the tool and its connection to the project’s website.

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4. User Handbook

4.1 User Handbook

The process of calculating the carbon dioxide footprint is organized on the website: https://egg.civil.auth.gr and includes three independent steps.

- The use of Carbon Footprint Calculator tool
- The auxiliary use of the route map and computer for road transport
- The submission of results by the user

Upon entering the main page of the site, the user sees the following Fig. 4.1:

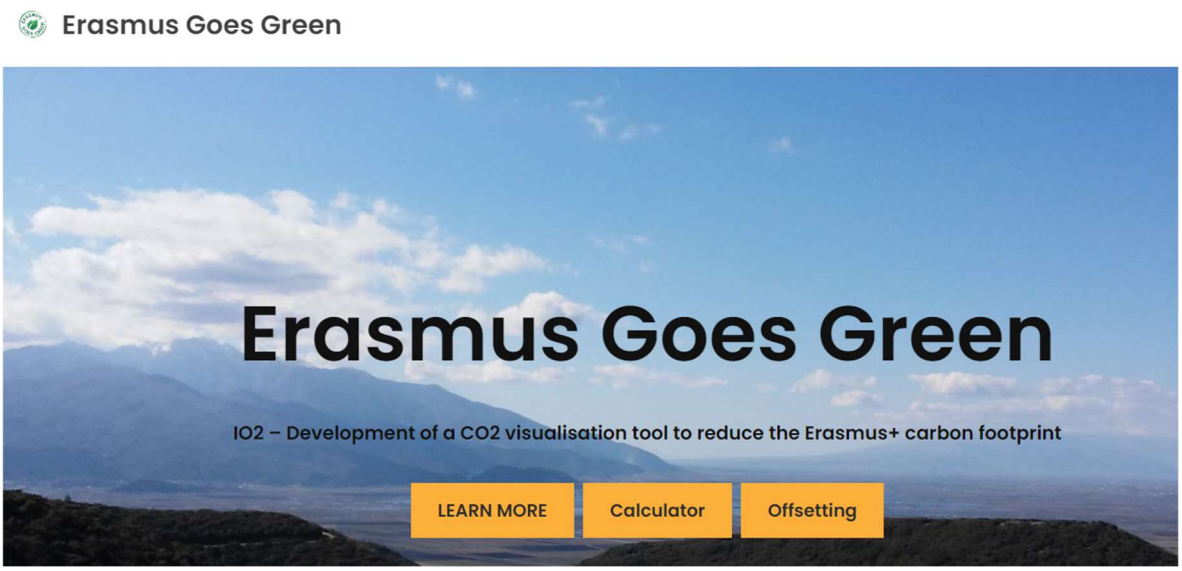

Figure 4.1: The main page of website

There are three buttons on the main page: the "LEARN MORE" button, which takes the user to the #learnmore tag, the "Calculator" button, which takes the user to the calculation tool, and the “Offsetting” which takes the user to the end of the site where the measures to reduce the transport-related carbon footprint are included (identified by IO3). In the learn more section there are three reports from which the user can be further informed. These reports are:

- Carbon Footprint from transportation
- Methodology for the estimation of Carbon Footprint
- Other Carbon Footprint Calculators

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In the first section there is an extensive and comprehensive review carbon emissions. This includes a first part that discusses the effects of climate change on the environment and human societies, a second part on methodologies for carbon footprint assessment and a third part on the goals of low greenhouse gas emissions in the European Union. The following is a report that includes methodologies for carbon footprints with a focus on transport-related emissions in Europe. In the last session, there is an inventory of visualization tools which describes the calculator used on this page (Carbon Footprint Network) and in addition are described several alternative calculators in case the user wants to experiment further. The links to the three reports are presented in Figure 4.2.

Figure 4.2: Learn more reports

If the user presses the "calculator" button or if he scrolls down the page on the left side there is the calculator form. First of all, it should be clear that this application has been developed by RADsite Web Development for Carbon Footprint Ltd which encapsulates the home page. Thus, there is no possibility of modifying or extending the calculation form. For this reason, the calculation process involves three independent steps.

Beneath the “Learn more” section, four (4) buttons were added to further help the users understand what the carbon footprint is, how it is calculated, and what are the differences between each Means of Transport.

Figure 4.3: The Find out more section regarding the carbon footprint for each Means of Transport

By clicking each button, a pop-up window appears containing easy-to-understand information about what factors contribute in GHG emission production for each transportation (aviation, means with combustion engine, rail).

At the end of the site, there is a section dedicated to the measures identified by IO3 regarding the reduction of the transport-related carbon footprint.

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4.1.1 STEP 1- Use the Calculator

The calculator consists of 8 tabs.

- Welcome
- House
- Flights
- Car
- Motorbike
- Bus & Rail
- Secondary
- Results

In the welcome tab you choose where you live. Something like this allows you to compare your carbon footprint with the average person in your country, and also sets up the units used in the calculator. For some countries, there are more accurate information for electricity generation emissions, and gas & electricity prices, depending whereabouts you live. Then select the calculation period. Calculations are usually based on average annual values. In this case the calendar boxes are not filled out.If you would like to calculate your carbon footprint for a different period set values to calendar boxes below. The “welcome” tab is shown in the Figure 4.4

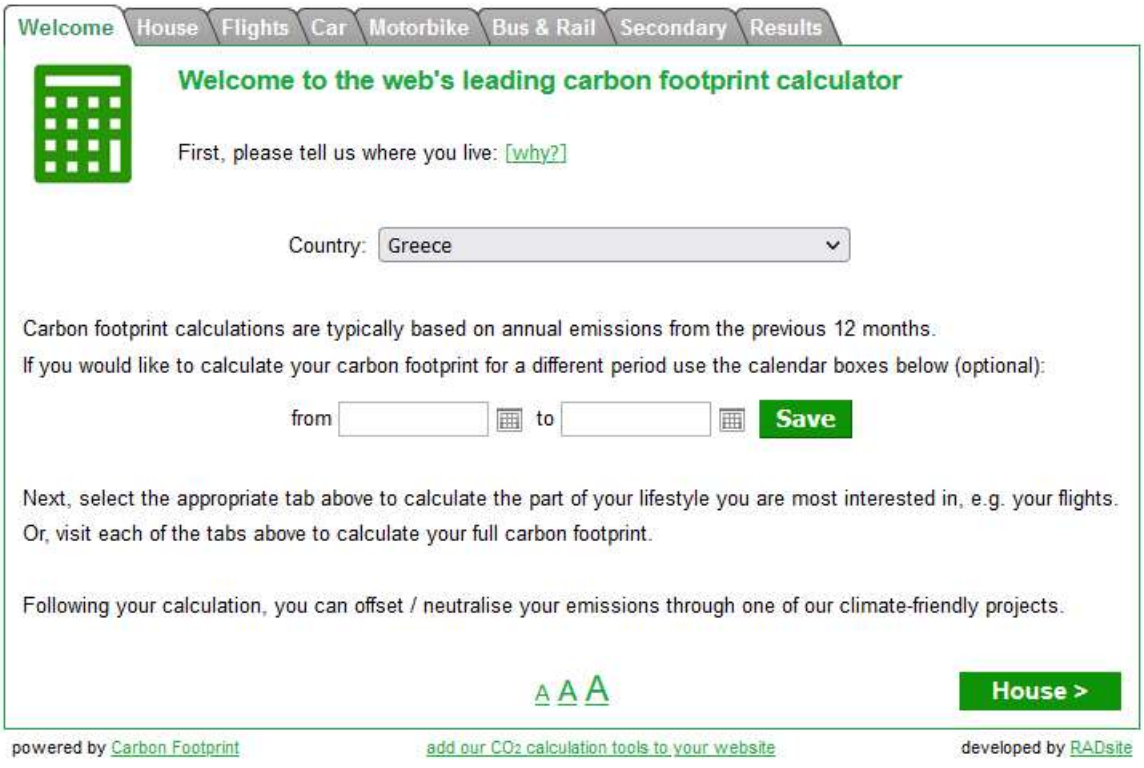

Figure 4.4: Welcome Tab in Calculator

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The next tab is a Household carbon footprint calculator. In this tab you can calculate the carbon footprint when staying in a house and based on energy consumption. This tab can be ignored as long as it does not involve travel. You can use it as an aid in case, in addition to the carbon footprint of the trip, you also want to calculate the footprint of your stay. The third tab calculates the Flight carbon footprint. You can enter details for up to 3 flight itineraries. In this tab there are 2 radio buttons for One-way flight or Return Trip Then fill in the text boxes, the departure airport, the destination airport and optional the intermediate airport. Then select the airplane seat class as well as the number of times you made this trip. Radiative forcing may also be considered. Carbon emissions from planes at high altitude have an increased effect on global warming. Tick the box if you would like to multiply aviation emissions by DEFRA's recommended Radiative Forcing factor of 1.891. Then click "calculate and add to footprint" and the application calculates and adds the carbon footprint to the final result. You can repeat the process a total of three times and each time the result is added to the final joint. You can also remove some of the 3 routes. The tab with the calculation of the human footprint is presented in figure 4.4.

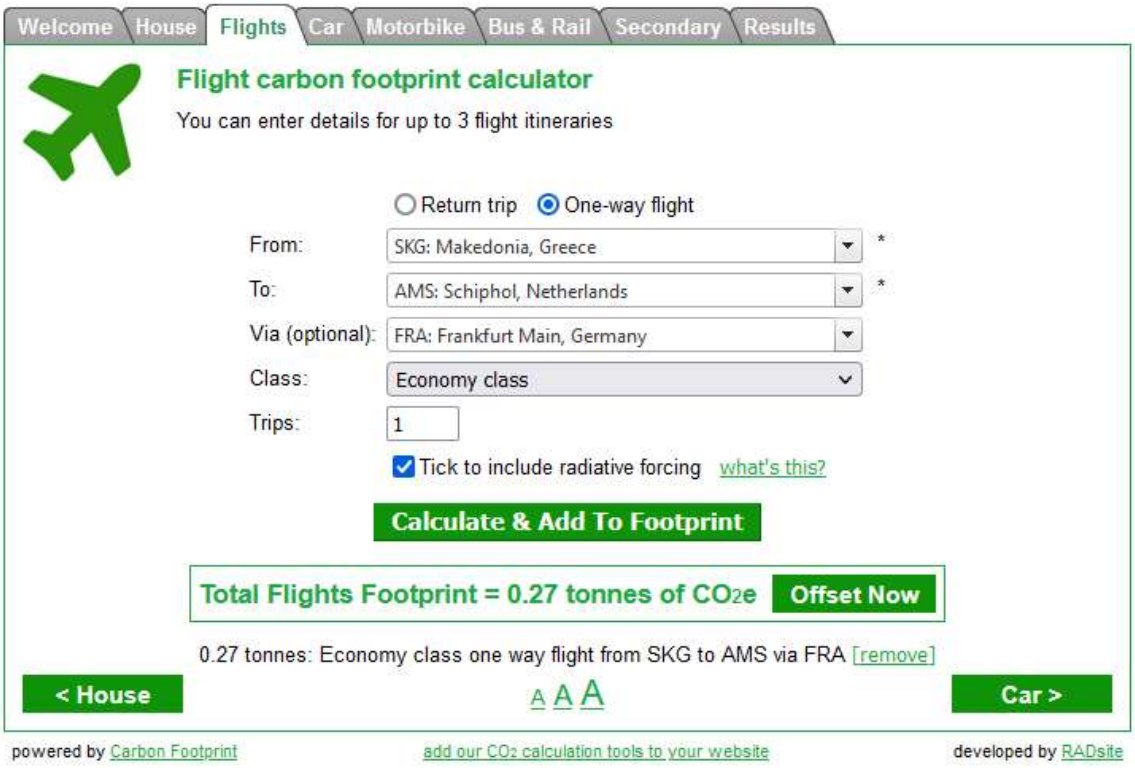

Figure 4.5: Flight carbon footprint Calculator

In the fourth tab you calculate the carbon footprint from the road movements by using a car, in the fifth by using a motorbike and in the sixth by using a train and a bus. Unlike the car-

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Motorbike-Bus-Rail tab, we need to know the distance between departure and destination to use the calculator. For this reason, we have developed a calculate driving route which is described in step 2. It should be emphasized that at this point there must be an interactive relationship between step 1 and step 2 in order for the former to work properly. Step 2 will be described in detail in the next chapter. The relationship between the steps to complete the calculation is described in Figure 4.6.

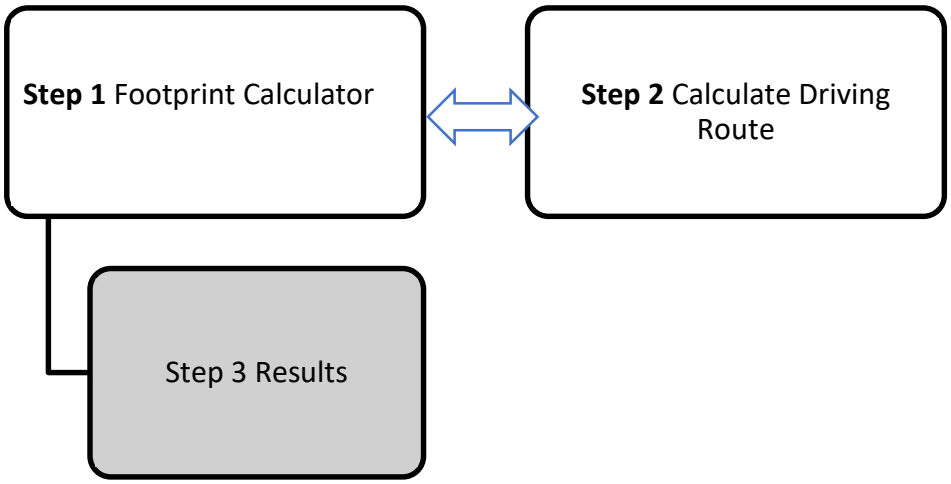

Figure 4.6: Flight carbon footprint Calculator

In the tab with the car fill in the distance (in km or in miles), choose the vehicle from a pop up list or enter manually the fuel consumption. You can choose between 4 types of fuel. The car tab is shown in Figure 4.7. On the Motorcycle tab, set the distance, select a motorcycle type, or adjust the fuel consumption manually. In the Bus & Rail tab you can calculate the carbon footprint by setting the distances for the following public transport: Bus:

- Coach
- National rail
- International rail
- Tram
- Tube / Subway
- Taxi

The tab for the car and public transport is shown in Figures 4.8 and 4.9 respectively. In the Secondary carbon footprint calculator tab you can calculate the carbon footprint for various products and services. This tab, like the house tab, is optional and does not involve the production of greenhouse gases from travel.

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Finally, the results tab shows the total carbon footprint in tons of CO_2e as well as the individual ones. Also inform you about the average of your country, the European Union and the planet. The result tab is shown in Figure 4.10.

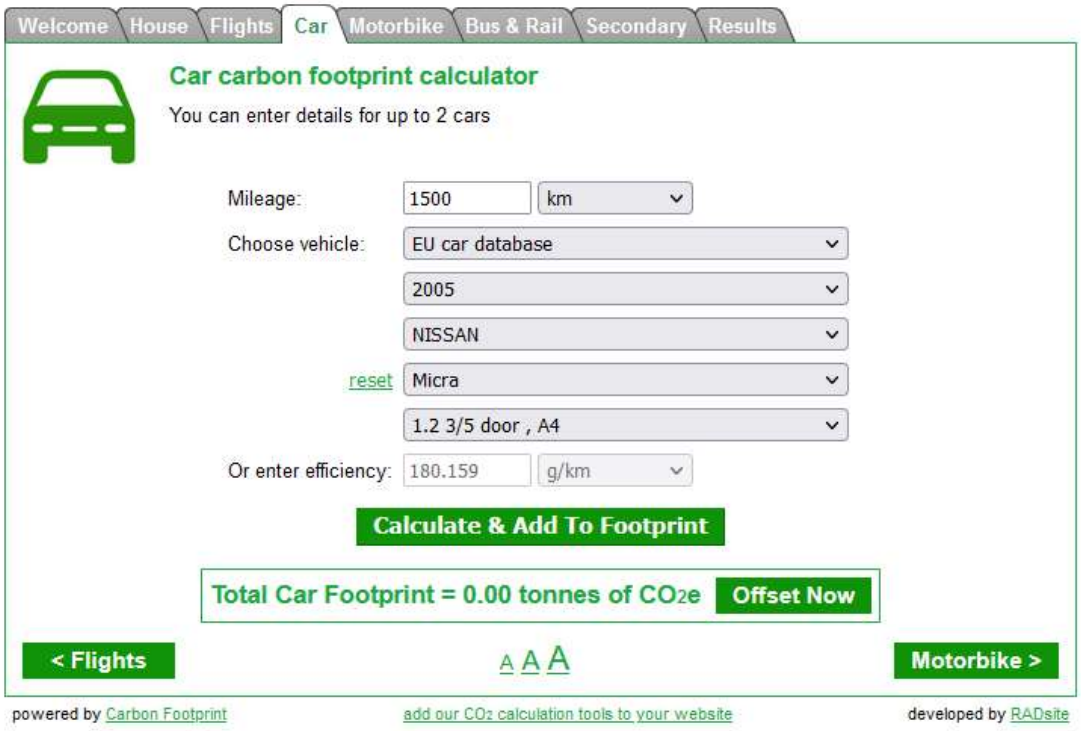

Figure 4.7: Car carbon footprint Calculator

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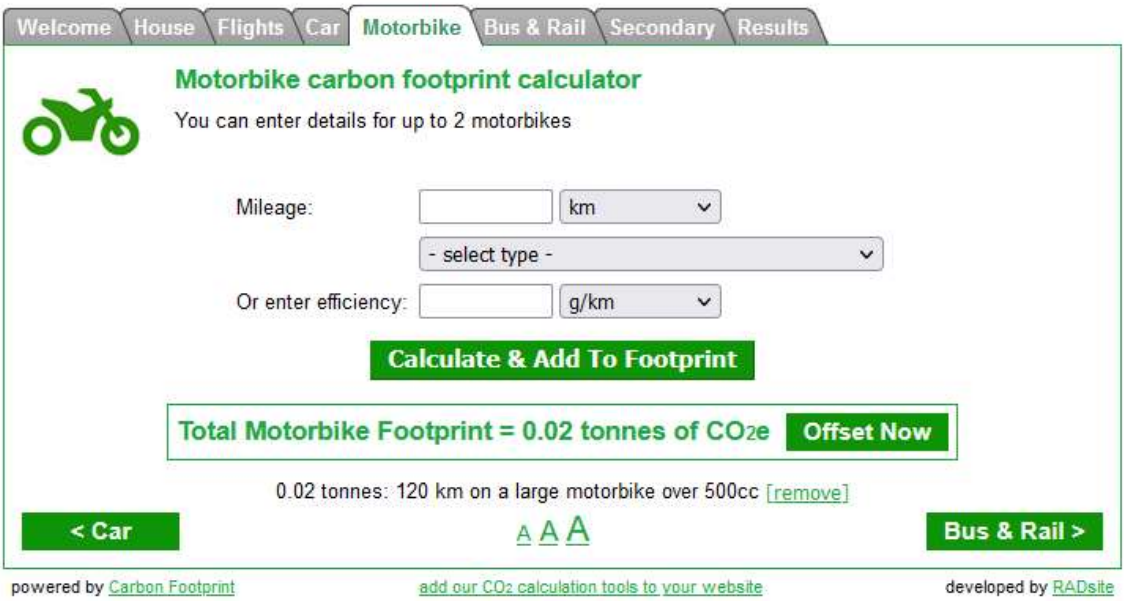

Figure 4.8: Motorbike carbon footprint Calculator

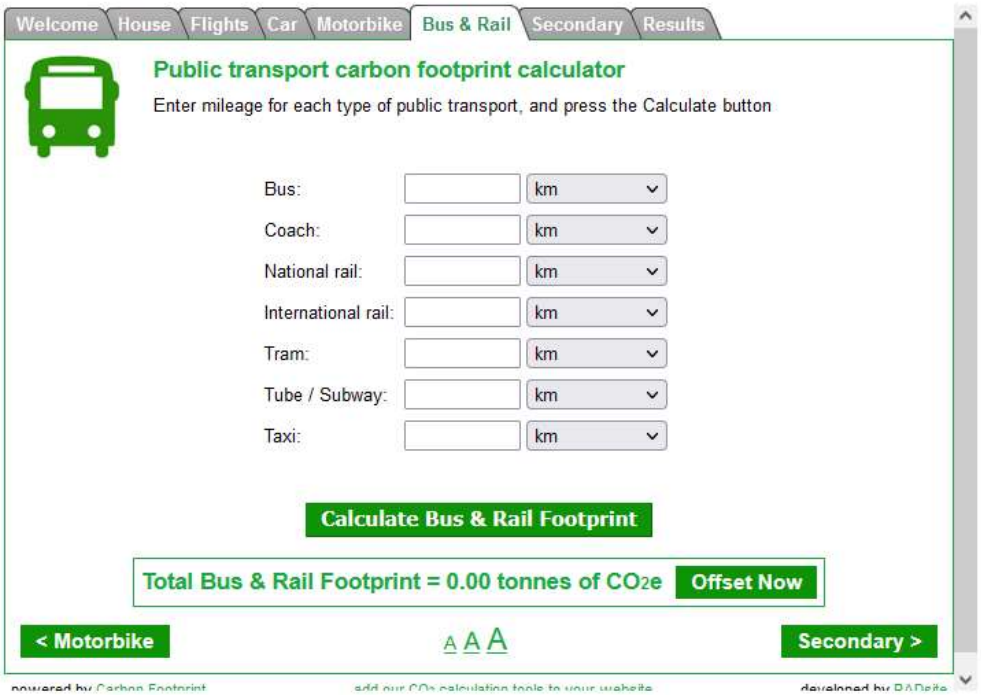

Figure 4.9: Public transport carbon footprint Calculator

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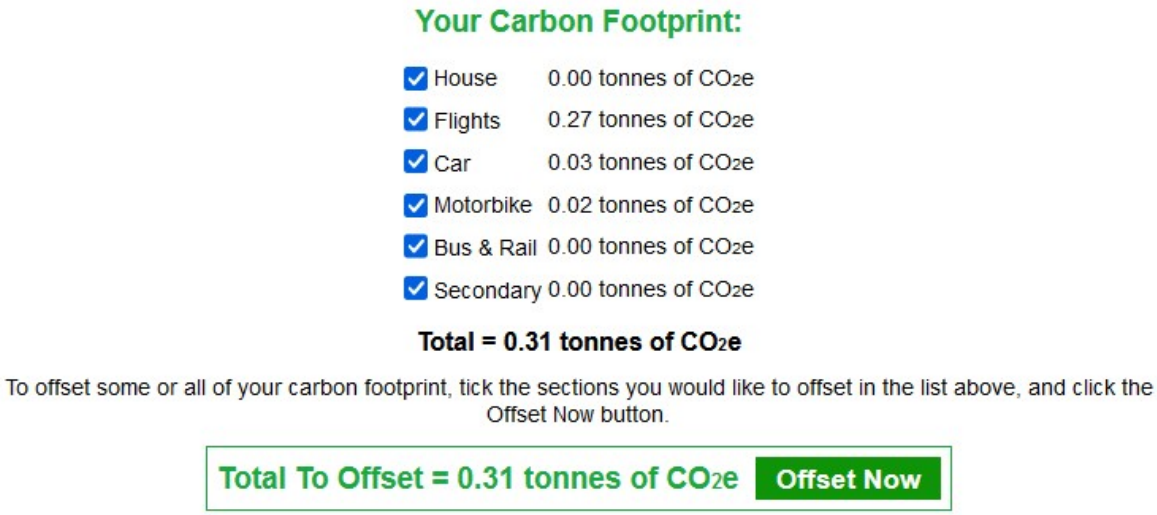

Figure 4.10: Results Tab

4.1.2 STEP 2- Calculate the distance

Step two is used interactively with step one in case road distances need to be calculated. The distance calculation form is located below the calculator and is shown in Figure 4.11

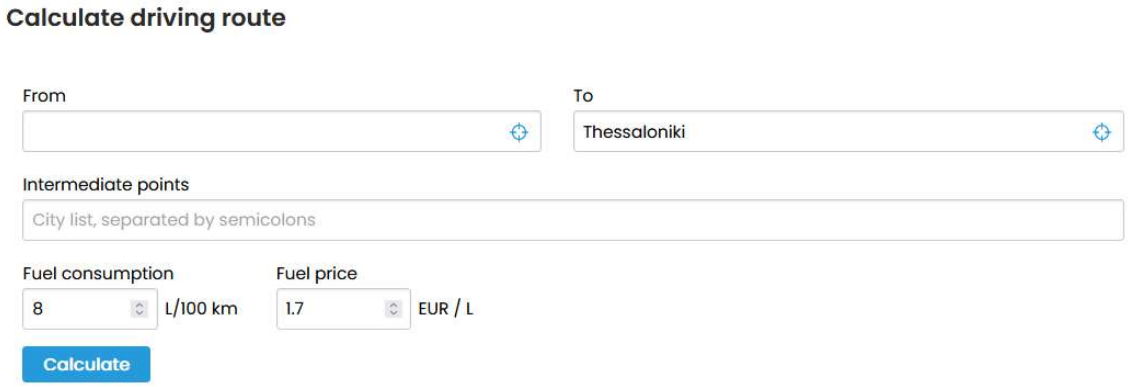

Figure 4.11: Calculate driving route form

In the form you set the starting point, the destination, any intermediate stations and indicatively the consumption and the price of fuel. Then pressing the calculate button displays an OpenStreetMap with the path and three label boxes with the Route length, Driving time and Driving time. The starting point, destination and intermediate points can be modified by

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drag and dop with the computer mouse. For example, we can calculate the route from Paris to Thessaloniki with a stopover in Belgrade by filling in the form as in Figure 4.12.

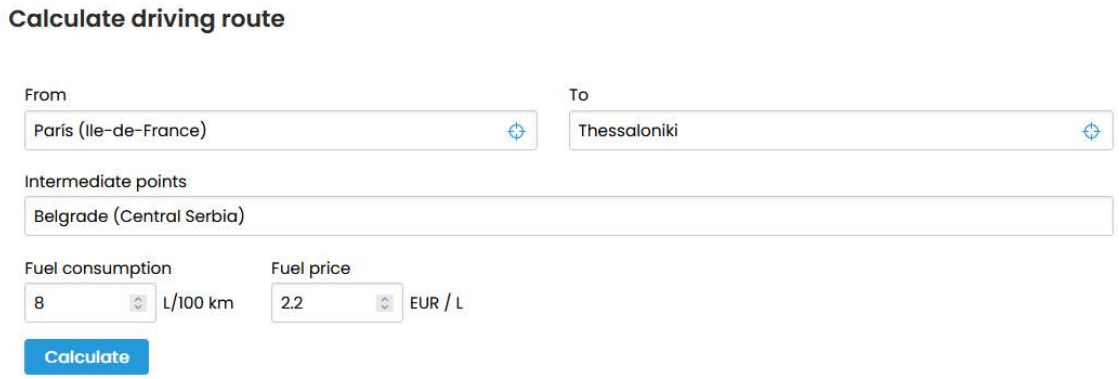

Figure 4.12: example of filling out the form

Thus, by clicking "calculate", the map and the route information are displayed as in Figure 4.13.

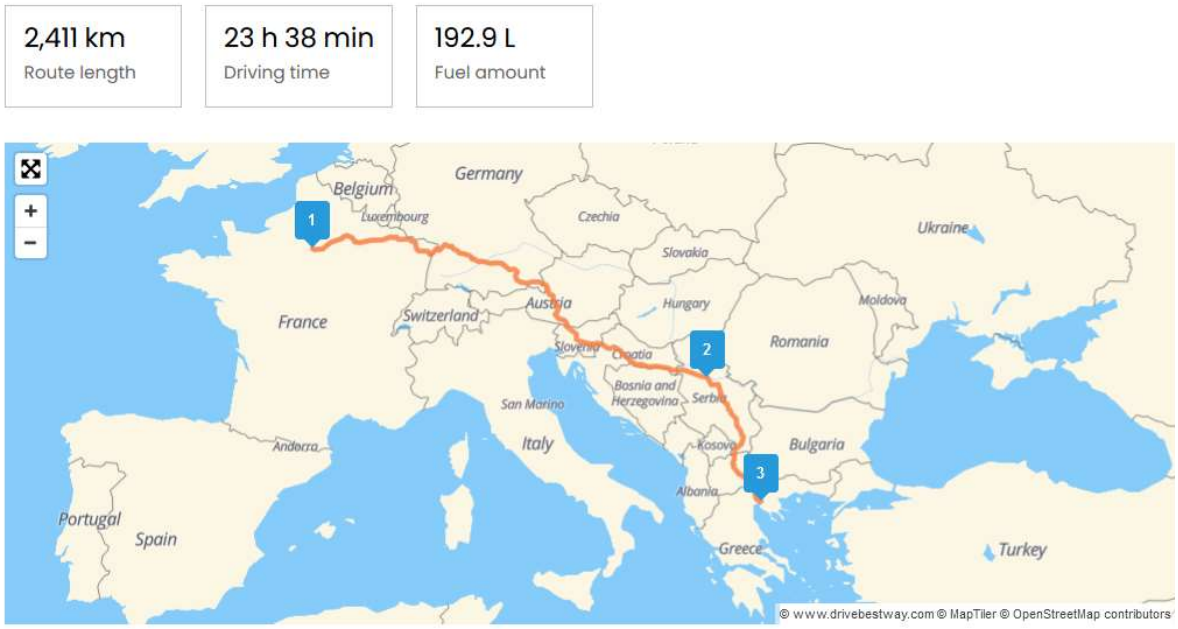

Figure 4.13: Route map and information

4.1.3 STEP 3- Send us your carbon footprint

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In the final step there is a form for submitting the results. The user selects Academic degree from a pop up menu, sets Departure city, Destination city, the travel way and the Carbon Footprint. Optionally the user can send a message or comments about the whole process. The submission form is shown in Figure 4.14. Then the user presses the submit button and the submitted data are sent to the server of egg.civil.auth.gr where they can then be exported in csv format. If the submission is successful, the message "Thank you for your message. It has been sent" is displayed. Otherwise, an error code is displayed.

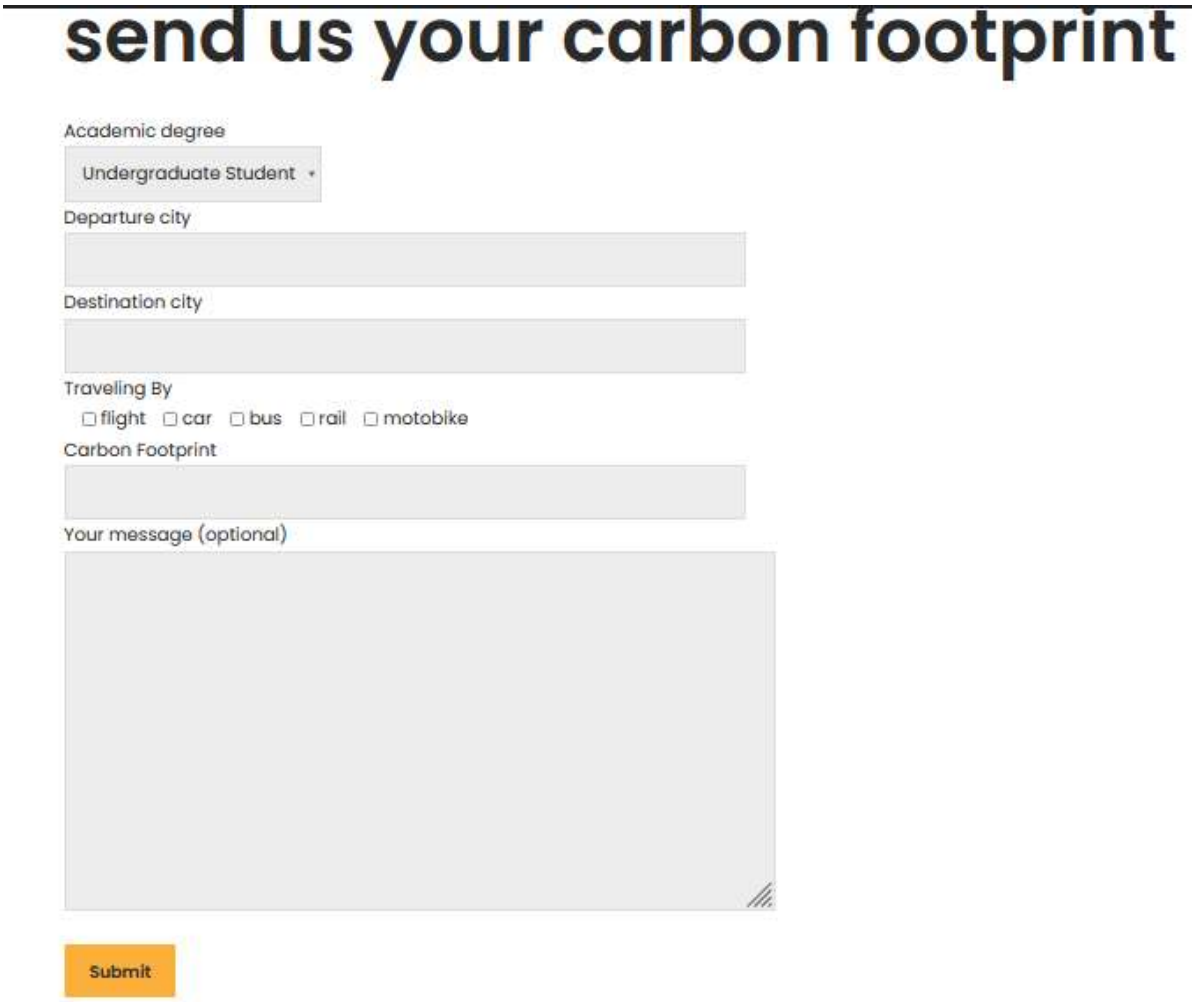

Figure 4.14: The Submission form

By sending us your carbon footprint, you contribute in the monitoring and understanding on how much Greenhouse Gases are emitted due to the Erasmus+ Programme. Your answers may provide further insights on how Erasmus+ beneficiaries move around Europe and which

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Means of Transport (MoT) they choose to travel. This may eventually lead to the development of alternative routes or enhance less famous MoT, such as the railway.

5. Conditions for further scalability

Scalability as a term entails the possibility of a project idea to be adapted to a bigger scale than just the local context and the utilization of the developed platform in other concepts. Since the developed platform used open-source software as well as an up-to-date footprint calculator, several add-ons can be used to ensure a user-friendlier experience. Furthermore, the included tools (map & form) are designed as minimalistic, to exclude any possible fuss and user-haste. Of course, several actions can be taken in order to grow the project more:

- Development of an open-source carbon footprint calculator that draws data from the Erasmus Offices, as well as from the users, combines them and suggests the most environmental friendly route. To do so, Machine Learning and Optimization Techniques can be utilized. This calculator can include means that are not seen in most footprint calculators, such as ferry/ship emissions
- Development of a central user-profiling database that allows the active Erasmus students keep track of their transportation and calculate their total carbon footprint during their stay abroad

During the testing phase of the tool, participants were excited that their institution has given them a chance to understand what carbon footprint is and how their choice affects the environment through measurable data. The interest shown and their enthusiastic approach can only be deciphered as a need for more thoughtful choices with the support of the local Erasmus offices, a need that can be partially covered by the EGG developed tool.

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