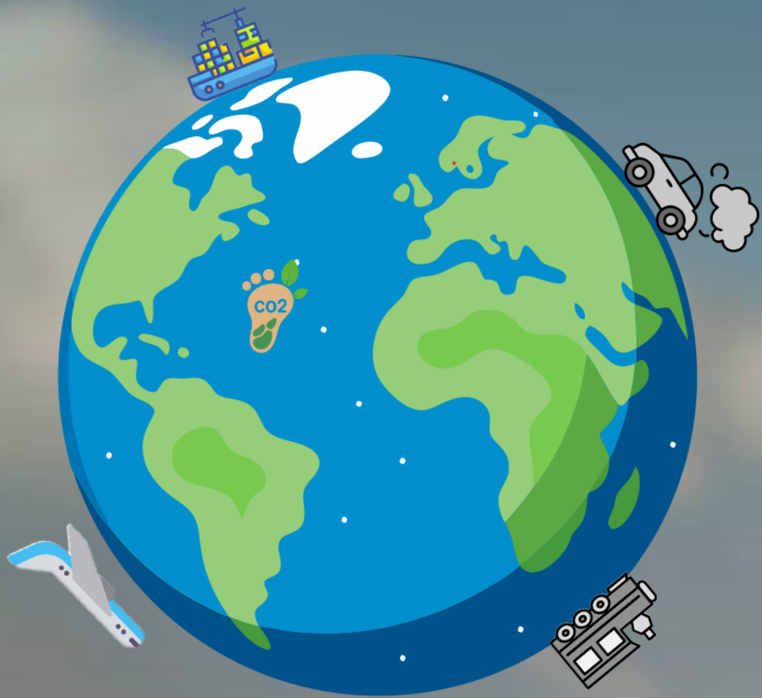
CarbonTrack
Methodology



«Every trip matters»

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Table of Content

1.0 Introduction

Climate change remains one of the most pressing challenges of our time. The transport sector is responsible for approximately 20% of total CO_2, emissions (Ritchie, 2020). Despite growing environmental awareness, there is still a gap between people's intentions to act sustainably and their actual behavior (Borges-Tiago et al., 2024). This gap may partly be due to limited access to clear information about emissions from everyday transport.

To address this challenge, CarbonTrack was developed as a digital platform designed to estimate, compare, and track transport-related emissions. The application is based on a standardized emission model, which enables consistent comparison across multiple transport choices. Unlike traditional emission calculators that provide one-time estimates, CarbonTrack is designed to support continuous user engagement. CarbonTrack allows users to track emissions over time and compare alternative travel options. Therefore, the platform encourages behavioral change and increases awareness of environmental impact.

1.1 Team and Development approach

CarbonTrack is developed by a team of six students with diverse academic and cultural backgrounds. This diversity has allowed the team to approach the project from multiple perspectives, which has strengthened collaboration throughout the development process. Different areas of knowledge and experience have led to a broader understanding of both the economic and technical aspects of building a digital emission calculator.

Instead of dividing the project into strictly separated roles, a collaborative approach was adopted. All team members are involved in both the technical development and the business aspects of the project. This ensures that the entire team gains an understanding of both the technical development behind CarbonTrack and the underlying business idea.

Throughout the project, the team has collaborated closely through regular meetings. Weekly Zoom meetings have been used to discuss progress, coordinate tasks, and make decisions related to the development of CarbonTrack. Version control and collaboration are managed through GitHub, which allows the team to work on the same codebase, review each other's contributions, and continuously improve the application throughout the development process.

By combining economic modelling with application development, the team developed a better understanding of how CarbonTrack functions as a solution.

2.0 Methodology

The methodology behind CarbonTrack creates the foundation of the application. As mentioned in the introduction, CarbonTrack's main purpose is to estimate and compare carbon emissions from different types of transport methods. The model focuses on commonly used transport types in Europe, such as cars, buses, trains, ferries, motorbikes and airplanes. These types of transport were selected because of the high availability of data and their relevance as realistic options within a European context.

The methodology is based on standardized carbon emission factors from institutions such as the European Environment Agency (EEA) and the UK Department for Energy Security and Net Zero (DESNZ). These sources provide data on how much CO_2 different transport types emit per kilometer, which is used to estimate emissions for a given trip. Using these established sources ensures that the model is based on reliable and widely used data.

In CarbonTrack, different emission factors are applied depending on transport type, fuel type, and regional energy systems (Europe and Nordic). This captures structural differences between transport options without complicating the model. For example, the model distinguishes between petrol, diesel, CNG and electricity and between different seating classes in air travel.

Rather than aiming for maximum precision, the methodology uses a simplified and standardized structure. This reflects a deliberate trade-off. More advanced models could include variables such as specific vehicle models, traffic conditions, route choice, or real-time occupancy rates. However, this would make the model more complex, less transparent, and harder to use in a digital application. The chosen approach therefore prioritizes usability while still capturing the most important driver of transport emissions.

2.1 Assumptions and Limitations

To ensure usability while still providing meaningful results, the emissions model is based on a set of simplifying assumptions. These help balance methodological accuracy with practical applicability and allow the model to function effectively in a digital application. The following section discusses the assumptions and limitations.

First, the model uses average emission factors per kilometer or per passenger-kilometer depending on the transport mode. This provides a consistent basis for comparison across transport types. For public transport types such as buses, trains, and ferries, average occupancy rates are assumed. Emissions are therefore distributed across a typical number of passengers rather than based on real-time data. This simplifies the calculation and makes the model easier to apply, but actual emissions per passenger may vary depending on how full the vehicle is.

Second, the model does not account for differences between individual vehicles. Instead, it applies to average emission factors for each transport type. This means that the model does not consider variations such as the efficiency of a specific car, train, or aircraft. This simplifies the model and reduces user input, but the results reflect typical conditions rather than exact emissions.

Third, the model includes emissions from electricity production for electric transport types. Although electric vehicles do not produce carbon emissions directly, their electricity consumption is associated with emissions from electricity generation. The model therefore distinguishes between Nordic electricity, which is mostly based on hydropower, and the European average, where fossil fuels are often used to produce electricity. As a result, electric transport is assigned some emissions in the model, reflecting the indirect emissions from electricity generation.

Fourth, emissions are calculated based on the distance entered by the user, assuming a direct route between the starting point and the destination. The model does not include detours, traffic, weather, or differences between routes. Therefore, the results should be seen as estimates rather than exact values.

Fifth, airplane emissions include climate effects beyond direct CO_2 emissions. At high altitudes, aircraft can create effects such as condensation trails and changes in atmospheric gases, which can increase global warming (Wang et al., 2025). However, they are not included in this model because they are difficult to measure for individual flights. As a result, the actual climate impact of air travel may be higher than the estimates shown in the CarbonTrack app.

Finally, methane (CH_4) emissions from the transport sector are not included in CarbonTrack. Although CH_4 is a more potent greenhouse gas than CO_2, its emissions from passenger transport are relatively small compared to CO_2 emissions (U.S. Environmental Protection Agency, 2025). In addition, CH_4 emissions from the transport sector have dropped 76% since 1990 (EEA, 2025). Its exclusion is therefore considered a reasonable simplification.

Overall, these assumptions introduce certain limitations, but they are necessary to ensure that the model remains transparent and user-friendly. The methodology therefore reflects a deliberate trade-off, where some precision is sacrificed in exchange for consistency, usability, and comparability across different transport types.

2.2 Formula and Calculations

The calculation of carbon emissions in CarbonTrack is based on a standardized approach where emissions are estimated as a function of distance traveled and a belonging emission factor.

Carbon dioxide emissions can be calculated by the following formula:

$$\mathrm{CO}^2 = d \times ef$$

Where:

- *d* represents the distance travelled (in kilometers)
- *ef* denotes the emission factor (kilograms of CO_2 per kilometer), which varies depending on the mode of transport

This approach allows for a simple and consistent comparison between different types of transport. It makes it easier for users to understand how their travel choices affect emissions.

2.2.1 Cars

Cars are the most used type of transport in Europe and account for a large share of total passenger travel (EEA, 2024). This makes them a central part of the emissions model. The model includes different types of vehicles, such as petrol, diesel, and electric vehicles. Instead of modeling each car model, average emissions factors are used. This ensures consistency and allows for easier comparison between users.

The emission factors applied in the model are presented below:

Fuel type	Emissions (kg CO_2/km)
Petrol	0,167
Diesel	0,137
Electric (Nordic)	0,014
Electric (Europe)	0,045

These emissions applied in the model are based on numbers from Carbonlabel (CarbonLabel, 2024).

2.2.2 Buses

Bus transport is modeled using emissions per passenger-kilometer, since emissions are shared between passengers. The model includes different fuel types such as diesel and biodiesel. Emissions for buses depend strongly on occupancy, meaning that higher passenger numbers reduce emissions per person.

The emission factors applied in the model are presented below:

Bus type	Emissions (kg CO_2/km per passenger)
Diesel	0,025

Biodiesel	0,007

These emissions applied in the model are based on numbers from Carbonlabel (CarbonLabel, 2024).

2.2.3 Motorbike

Motorbikes are included as a form of personal transport. The model distinguishes between petrol and electric motorbikes.

The emission factors applied in the model are presented below:

Motorbike type	**Emissions (kg CO_2/km)**
Petrol	0,052
Non-fossil fuel (Average electric)	0,017

These values are based on European emission ranges for motorbikes (Ossby, 2024).

2.2.4 Train

Train transport is represented by using emission factors per passenger-kilometer. It is generally one of the most efficient types of transport.

The emission factors applied in the model are presented below:

Train type	**Emissions (kg CO_2/km per passenger)**
Diesel	0,091
Electric (Europe)	0,024

Electric (Nordic)	0,007

These values are based on numbers from CarbonLabel (CarbonLabel, 2024). Electric trains have low emissions, especially in regions with clean electricity, which explains why rail is often considered a sustainable transport option.

2.2.5 Ferry

Ferry transport is associated with relatively high emissions compared to other forms of public transport. In addition, emissions per passenger vary significantly depending on occupancy levels and whether passengers travel with vehicles.

For ferry transport, the model applies a single category with average emission factors. This is because ferry emissions can vary widely depending on factors such as vessel type, fuel use, size, and route conditions. Using standardized average values therefore provides a simplified representation of typical ferry emissions.

The emission factor applied in the model is presented below:

Ferry type	**Emissions (g CO_2/km per passenger)**
Average ferry	0,226

These values are based on numbers from CarbonLabel (CarbonLabel, 2024). The model uses average values to represent typical ferry operations.

2.2.6 Airplanes

Air transport is modeled using emissions per passenger-kilometer. Emissions vary depending on ticket class because different seating classes use different amounts of space per passenger.

This reflects differences in space allocation per passenger, where higher-class seating results in higher emissions per passenger.

The emission factors applied in the model are presented below:

Ticket class	Emissions (g CO_2/km per passenger)
Business	0,298
Economy	0,118

These values are based on numbers from CarbonLabel (CarbonLabel, 2024).

3.0 Business Model

CarbonTrack requires a business model that supports the long-term development of the platform. The business model describes how the platform creates value for users and how this value can be translated into a sustainable business over time. By combining direct user engagement with potential partnerships with companies, CarbonTrack can reach different user groups while creating opportunities for future revenue streams. The following sections present the main elements of the business model, including value creation, target users, revenue opportunities, and cost structure.

3.1 How CarbonTrack Creates Value

CarbonTrack creates value by bridging the gap between complex emission data and everyday transport choices. Through a web-based platform accessible across devices, users can calculate and compare emissions across multiple transport types. Instead of providing only a single emission estimate, the platform allows users to track their emissions over time, giving them a clearer basis for evaluating their travel options and the relative emission impact of different transport methods.

People often choose transport based on convenience, cost, and environmental impact (Kelela et al., 2025). However, comparing emissions between transport modes can be difficult because the information is often unclear or not easily accessible. By standardizing and visualizing emissions across transport types, CarbonTrack makes this information easier to find and understand. This supports more informed travel decisions and can nudge users toward more sustainable transport choices. In this way, CarbonTrack creates value not only for users by improving transparency and decision-making, but also for the environment by encouraging more sustainable behavior over time.

3.2 Customer Segments and Channels

The primary target group consists of individuals interested in sustainability, particularly students and young adults who are both digitally active and more responsive to environmental information. This target group is well-suited for a digital, self-service platform that provides immediate feedback. To acquire new users CarbonTrack plans to be visible on social media, such as LinkedIn, Facebook and Instagram. Establishment on social media enables cost-efficient outreach and scalability.

CarbonTrack also plans to target potential business customers, including mobility providers, travel platforms, and companies seeking to monitor employee-related emissions. This expands the application beyond personal use and increases its commercial potential.

3.3 Revenue Model and Scalability

At its current stage, CarbonTrack is offered as a free platform to build a user base and increase engagement. This approach supports the growth of a large and active user community by lowering the barrier to entry.

As the platform develops, a freemium model can be introduced. Basic functionalities, such as emission calculations and basic tracking can remain free, while advanced features are offered through a subscription. These may include detailed analytics, long-term tracking and personalized recommendations.

A key scalability driver is the potential for API integration, allowing third-party platforms to incorporate emission calculations directly into their services. For example, travel booking platforms could track transport-related emissions internally with help from CarbonTrack. This creates opportunities for business-to-business revenue streams.

3.4 Cost Structure and Scalability

The primary costs of CarbonTrack are related to infrastructure, development, and platform maintenance. At the current stage, infrastructure costs are mainly driven by using cloud services, such as Amazon Web Services (AWS). Amazon Web Services supports data processing, storage, and application hosting.

In addition to technical infrastructure, development and coordination represent key cost factors. This includes time invested in coding, improving the calculation model, and maintaining the platform. As the application evolves, costs will arise from marketing activities, user acquisition, and further platform optimization. At a later stage, personnel costs will become increasingly relevant, particularly as the platform scales and requires dedicated development and management resources.

If the user base grows significantly, personnel costs will not increase at the same rate, which supports the scalability of the platform. Infrastructure costs, such as cloud services like AWS, will increase as more users access the platform, but these costs scale with usage and remain predictable (Voicu, 2025).

4.0 Summary

Climate change remains one of the most pressing challenges of our time. The transport sector accounts for a significant share of global emissions. Despite increasing environmental awareness, many individuals still lack simple and accessible tools to understand the environmental impact of their everyday travel choices. CarbonTrack was developed to help address this challenge.

The platform provides a user-friendly way to estimate, compare, and track transport-related emissions. It translates complex emission data into clear and comparable information. This makes it easier for users to understand the environmental consequences of different transport options. The application is particularly relevant for young and digitally active individuals.

Overall, the project illustrates how digital tools operationalize emissions data and support more sustainable behavior. By making emissions visible, comparable, and relevant in everyday life, CarbonTrack contributes to bridging the gap between environmental awareness and practical action. In this context, the platform is guided by the principle that *every trip matters*, emphasizing that even small, everyday decisions have an impact on overall emissions.

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