CarbonTrace

FOR19

GROUP 2

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1.0 INTRODUCTION

Over the past few decades, the issue of carbon emissions has been at the centre of environmental and political discussions. Greenhouse gases contribute to rising global temperatures, more frequent extreme weather events, ecosystem instability, and sea-level rise. Carbon dioxide (CO_2), primarily released from the burning of fossil fuels, is one of the main drivers of global warming (*Causes - NASA Science*, 2022).

The transport sector stands out as a major contributor, accounting for 23% of global CO_2 emissions in 2019, with road vehicles responsible for nearly 70% of that figure (IPCC, n.d.). In the United States, transportation alone made up 28% of national greenhouse gas emissions in 2021 (US EPA, 2025).

While emission reductions depend on strong policy and technological innovation, individual awareness and action are equally important. Yet, many people still struggle to understand how their daily travel choices affect the environment. As the European Environment Agency (EEA) notes, improving public awareness is essential for driving behavioural change (Andersson & Carlsson, 2023).

To contribute to creating public awareness, we developed CarbonTrace, a web-based carbon calculator that estimates the emissions associated with transportation. Users enter distance, mode of travel and fuel-type, and our application returns an estimate in CO_2- equivalents (CO_2e). The values are calculated using a simple but scientifically robust methodology, based on average emission factors per passenger-kilometre, retrieved from reliable sources relevant to Norway and the EU.

Our business model follows a freemium structure. This means that the core calculator remains free and open to all, while advanced features will soon be available through a low-cost premium version. In the longer term, we aim to offer a licensed version tailored for institutions who wishes to promote sustainability, with additional features.

This essay outlines the background for the calculator, presents our methodology and key assumptions, and explains the emission factors used. It also describes our business strategy, deployment plans, and future features aimed at making the tool both impactful and scalable.

2.0 METHODOLOGY

To provide users with accurate and understandable information about their emission, based on their means of transportation, it is important that the calculator is based on a simplified, but robust methodology for estimating emissions. Our goal is to balance scientific credibility with user friendliness, as well as ensuring the tool is accessible for individuals with no prior knowledge of carbon accounting.

The underlying logic of our methodology is based on the use of average emission factors per kilometre travelled for various transport modes. These emission factors are measured in grams of carbon dioxide equivalents (CO_2e) per passenger-kilometre. When multiplying this with the distance travelled (km), the calculator provides a reasonable estimate of the user's total emissions.

2.1 CALCULATING CARBON EMISSIONS

Although various greenhouse gases contribute to global warming, they differ significantly in their potency; carbon dioxide (CO_2) is used as the standard reference because it is the most common greenhouse gas, while other gases like methane (CH_4) and nitrous oxide (N_2O) are measured in CO_2-equivalents (CO_2e) to reflect their stronger climate impact and to have a standard output.

The general formula we use for calculating emissions is:

$$CO_2e = Distance * Emissionfactor_i$$

Distance refers to the user-inputted number of kilometres travelled using one kind of transportation. The $emissionfactor_i$ is amounts of CO_2e per kilometre and is determined by the mean of transportation and fuel-type. For instance, will 3 kilometres of walking equal to CO_2e=3km*0=0.

Each individual journey, calculated with the formula above, is then summed up to provide the user with a total:

$$Total\ emissions\ (CO_2e) = \sum_{i=1}^{n} (Distance * Emissionfactor_i)$$

2.3 CLARIFICATIONS AND UNCERTAINTIES

Finding specific emission factors for different modes of transportation, without any prior knowledge of the field, has been difficult. We are aware that an incorrect emission factor may provide the user with false information on their own emissions. However, we have focused on retrieving numbers from reliable sources and have strived to use newer and more accurate publications. It is also important to emphasize that the numbers are general averages. Real-world emissions can vary significantly from the averages based on fuel quality, driving behaviour, weather conditions and terrain. In addition, some transport modes are more problematic to use general averages for then others. For instance, emissions from electrical vehicles vary depending on the electricity mix. Electricity markets in the EU is composed, and the origin of the electricity is therefore hard to predict. The European Environment Agency (EEA) states that electric cars powered by energy grids provided by fossil fuels, may have significantly higher emissions compared to those charged with renewable electricity (EEA, 2021).

Furthermore, our model is mostly based on operational emissions, meaning the emissions that result from using a vehicle. It does not account for the full lifecycle emissions of vehicles, such as emissions from production, maintenance, or fuel extraction and refining. This is especially relevant for electric cars, where manufacturing an electric car battery can account for between 25 and 41% of the vehicles total lifecycle emissions (Bieker, 2021).

2.4 TRANSPORT MODES AND EMISSION FACTORS

Different types of transport have a predefined emission factor. However, in different parts of the world, the transportations emission factor may differ from the one we have in Norway. In our app, we will use emission factors primarily based on transportation modes in Norway and EU. The factors we are using, are retrieved from reliable sources, and referenced in the bibliography.

Table 1: CO_2e per passenger kilometer from different modes of transport.

Transport mode	Fuel/type	CO_2e – g per passenger per kilometer	Source of emissions
Walking	Human powered	0g	No direct CO2e emissions.
Cycling	Human powered	0g	
Car	Petrol	160g	Emissions from burning gasoline in combustion engines.
	Diesel	170g	Burning diesel in combustion engines but also releases potent greenhouse particles.
	Electric (EU)	19,3g	Indirect emissions due to sources of electricity production.
	Hybrid	126,1	Direct emissions from combusting of fuels. Indirect emissions from electricity production.
Motorbike	Small	82,77g	Emissions from burning gasoline in combustion engines.
	Medium	100,86g	
	Large	132,37g	
Bus	Diesel	27g	Burning diesel in combustion engines but also releases potent greenhouse particles.
	Electric	13g	Indirect emissions due to sources of electricity production.
Train	Norway average	10g	Indirect emissions due to sources of electricity production.
Train	EU average	33g	Indirect emissions due to sources of electricity production.
Ferry	Diesel	377g	Burning diesel in combustion engines but also releases potent greenhouse particles.
Plane	Long haul	147g	Direct emissions from combustion of jetfuel.
	Short haul	246g	Direct emissions from combustion of jetfuel. Less energy-efficient due to frequent landing and take-off.

3.0 BUSINESS MODEL

3.1 OBJECTIVE AND VALUE PROPOSITION

Our primary objective is to increase awareness of individual emissions and empower users to make sustainable travel decisions. Offering a free, accessible and user-friendly application, we aim to create consumer-awareness and hopefully bridging the gap to everyday action. In contrast to many existing tools that either require technical knowledge or focus on national or corporate emissions, our solution is designed to speak directly to individuals. It simplifies the complex task of emissions accounting into a practical, visual, and personal experience.

Our core value proposition lies in enabling users to estimate, understand, and reflect on their own travel habits in terms of environmental impact. The calculator provides real-time feedback based on inputs such as travel distance and mode of transportation, using reliable emission factors. By presenting the result in terms of CO_2-equivalents (CO_2e) per passenger-kilometre, users receive a tangible measure of their carbon footprint.

Another key aspect of the value proposition is accessibility. The calculator is web-based, lightweight, and optimized for use across devices, including smartphones and tablets. The user interface is intentionally designed to be intuitive, so that users with no prior knowledge of climate science can still derive value from the tool. Our tone and visual design aim to be engaging and motivational, avoiding guilt-driven messaging in favour of positive encouragement.

The long-term vision is to offer both personal and public value: raising awareness at the individual level while supporting collective climate action through data-driven decision-making.

3.2 TARGET MARKETS AND USER SEGMENTS

While the carbon calculator is designed to be universally accessible, the platform is particularly tailored toward individuals and groups who are interested in gaining insight into their transportation-related emissions and who are motivated to reduce their climate impact. Our target market consists of the main segment: private individuals, especially in Norway and Europe, and our secondary segment: institutions, municipalities and companies with environmental focus.

The primary user group includes individuals who are climate-conscious or curious about their personal impact yet may lack the tools or knowledge to understand the scale of their emissions. This group include individuals from a broad range of ages and backgrounds. Many of these individuals are already familiar with the importance of climate action but may not know how to quantify or evaluate their choices. For this group, our calculator serves as a starting point for making more informed decisions. By offering simple inputs like mode of transport and distance, it removes the barriers often associated with complex climate data and allows users to engage with the topic in a personal and interactive way. Targeting this segment is supported by empirical research, such as a 2023 Swedish study which found that users of carbon calculators typically hold strong environmental values and are motivated to change their behaviour when given accessible tools to guide them (Andersson & Carlsson, 2023).

In addition to individual users, our secondary target segment includes organizations such as public institutions, municipalities and companies, specifically those actively seeking to promote sustainability and track emissions. These organizations often require accessible digital tools to support internal climate initiatives or engage external stakeholders. This segment benefits from features such as group-level reporting, custom interfaces, and aggregated data insights, making the tool actionable at an organization level. Private companies may use CarbonTrace to measure the impact on green choices and use their data insights to attract environmentally conscious consumers. Reaching this audience supports our long-term strategy of offering a licensed version of the calculator as outlined in our revenue models.

While the initial geographic focus is on Norway and the EU, due to available data and policy alignment, the platform is built in a way that allows for future expansion. Because emission factors vary by country (especially for electricity-driven transport), localization features could be implemented to adjust the calculator's accuracy in different regions. For now, the model is best suited for users in areas with similar transport infrastructure and climate targets, where data on emission factors is available and relevant public interest in climate issues is already high.

To address the needs of different user segments, the platform offers a flexible and engaging experience. Casual users can simply test the calculator once to satisfy curiosity, while others may track their emissions over time. Future versions could include user profiles, journey

histories, achievements for reduced emissions and the ability to compare with national or regional averages. By designing for varied use cases, the platform ensures relevance and appeal to a broad audience.

3.3 REVENUE MODELS

As this carbon calculator is currently being developed as a pilot project, the short-term focus is not on generating revenue but on building a fully functional tool. The primary goal at this stage is to demonstrate the technical usability, and environmental relevance of the platform.

However, long-term sustainability of the platform also requires viable revenue models. Therefore, we have considered a variety of strategies that align with the calculator's climate-focused mission, while ensuring accessibility for the public. Importantly, these models are designed to balance open access with the potential to generate revenue from specific use cases or target groups that benefit from more advanced features.

The model we want to explore as part of our long-term strategy, is the "freemium model". This model is aligned with our mission, by allowing the core calculator to remain free and open to all users, ensuring low barriers to entry. However, users who want to unlock additional features such as tracking their emissions over time, saving past journeys, setting personal CO_2 reduction goals, or accessing visualizations could subscribe to a low-cost premium version. The freemium model is particularly effective for tools that serve both casual and repeat users and aligns with the habits of younger users who are used to app-based subscriptions.

Beyond the freemium model, we explore the option of offering a licensed version of the calculator tailored for public institutions, municipalities and companies that want to promote sustainability to their customers or employees. This version could include custom branding and reporting dashboards and may be extremely useful for institutions or companies to use in internal or external reporting.

We also have taken a decision to deliberately exclude advertising or data monetization from the business model, to maintain user trust, avoid greenwashing, and ensure privacy. All user data will be stored securely and, if used for research or reporting, will be fully anonymized and aggregated. By prioritizing transparency and ethical use of data, the platform can

establish itself as a credible and trustworthy tool in the increasingly crowded landscape of climate apps.

4.0 DEPLOYMENT AND FUTURE PLANS

The initial deployment of our app will be limited and primarily serve as a demonstration of the core functionality. The calculator will be hosted using Amazon Web Services (AWS) which offers robust and scalable cloud infrastructure suitable for small-scale web application.

In the short term, our focus is to ensure that the core functionality of the calculator is fully operational: users should be able to enter travel data, select transport modes, and receive accurate feedback based on the latest emission factors. The user interface will be designed to be mobile-friendly and intuitive, allowing for seamless interaction across different devices.

4.1 FUTURE PLANS

Looking ahead, the medium-term goal is to enhance the calculator's capabilities by adding features that improve engagement and support long-term use. This includes implementing optional user accounts, emissions tracking over time, goal setting, and personalized tips for reducing one's footprint. These additions would strengthen the case for adopting a freemium model in the future, while maintaining free access to the basic calculator.

A continuous development of the application is essential to ensure its credibility and long-term relevance. This includes regularly updating the underlying emission factor database to reflect the latest scientific research and policy developments. To improve accuracy, we also plan to introduce more nuanced distinctions between transportation types. For example, a potential partnership with the Norwegian Public Roads Administration (*Statens vegvesen*) could enable the calculator to automatically distinguish between routes served by electric or diesel-powered ferries. Such improvements will help ensure that the tool remains precise, trustworthy, and adaptable to emerging low-emission technologies.

In the long term, we aim to scale the platform into a broader tool for behavioural change. Moreover, localization features could be added to ensure emission factors are region-specific, particularly as the application reaches users in countries with different energy mixes or transport infrastructures. As the platform evolves, it may also be released as a mobile application through AWS-backed services, improving accessibility and attracting younger

tech users. With increasing public interest in sustainability and digital tools, this project has the potential to serve as both a personal motivator and an institutional resource in the transition to a low-carbon society.

4.2 EXPANDING INTO CLIMATE ECONOMICS

Governments and trade organizations are increasingly implementing policy tools that incentivize emission reductions, particularly through carbon pricing. One of the most relevant examples is the EU Emissions Trading System (EU ETS), which assigns a financial cost to every tonne of CO_2 emitted. Businesses subject to carbon pricing, will the next few years see an increasing cost of operating, and insights on emissions is therefore increasingly relevant. our calculator could be expanded to reflect these market dynamics by providing users with an estimated cost of their emissions based on the prevailing carbon price. With recent EU ETS prices between €80 and €100 per tonne of CO_2 (EU, n.d.), such a feature would offer an additional layer of insight, highlighting not only the environmental impact of travel but also its economic implications**.** This extension could take CarbonTrace to a new segment, while keeping our core functions and mission.

5.0 SUMMARY

We developed CarbonTrace, with the aim not only to provide accurate data but also to make emissions visible, relatable, and easy to understand. Especially for individuals who may not have prior knowledge of climate science or carbon accounting.

At the heart of the project is a strong mission: to turn abstract environmental data into meaningful personal insight. By presenting emissions in a user-friendly and engaging format, CarbonTrace empowers users to reflect on their behaviour and to explore lower-emission alternatives. The calculator uses a robust yet accessible methodology, backed by sources such as Statista, SSB, and VY, and emphasizes clarity without compromising scientific integrity. The prototype, deployed via Amazon Web Services (AWS), focuses on usability, accessibility, and technical functionality as a foundation for future growth.

Looking ahead, the project sees potential for broader societal impact through features like emissions tracking, goal setting, and even cost estimates linked to carbon pricing mechanisms such as the EU Emissions Trading System. The business model prioritizes long-term

sustainability through freemium features and potentially partnerships. While the current focus is on the successful completion and testing of the prototype, the overarching goal remains unchanged: to contribute to climate awareness, empower action, and support a low-carbon future, one informed decision at a time.

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