CARBON APP

ESSAY – FOR19

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1 INTRODUCTION

In recent years, carbon emissions have received significant attention due to their harmful impact on the environment, including global warming, climate change, and irreversible damage. It is therefore crucial to measure carbon emissions as it helps individuals and businesses to understand their environmental impact and make informed decisions to reduce it. To facilitate this, we have developed an app that calculates carbon emissions, with a particular focus on the transport sector. Transportation is one of the largest sources of carbon emissions worldwide, making it a critical area for effective change and improvement (Environmental Protection Agency, 2023b).

In this essay, we will discuss the methodology used for our app, our business model, and the policy implications we have learned. Our methodology involves gathering relevant data, applying emission factors, and developing a carbon emission calculator. The policy implications of our findings highlight potential consequences of relevant policies. Our business model is centered around reducing the environmental impact of business travel. We believe that companies have a crucial role to play in mitigating carbon emissions, and that our innovative and user-friendly app is an essential tool for companies seeking to demonstrate their commitment to environmental responsibility. By providing data on emissions associated with travel, we make businesses aware of their carbon emissions, and how to effectively reduce these. Moreover, as we continue to develop our app, we plan to introduce additional features that will further enhance its capabilities and help business reduce their emission even more.

1.1 EMISSIONS IN THE TRANSPORT SECTOR

As mentioned in the introduction, carbon emissions have become a critical issue in today's society due to the harmful effects of global warming. However, despite the growing awareness of this issue, many individuals and businesses struggle to identify effective and affordable methods to reduce their carbon emissions.

The transport sector is a significant contributor to many greenhouse gases (GHGs) emissions, with emissions of carbon dioxide (CO_2), nitrogen oxides (N_2O), sulfur hexafluoride (SF_6), methane (CH_4) and other GHGs emissions (Office for National Statistics, 2022). CO_2 emissions accounts for 74,4% of the total global GHG emissions (Ritchie & Roser, 2020). Furthermore, transportation emissions account for approximately 17% of global CO_2 emissions (Statista Research Department, 2023). According to the Environmental Protection Agency's report from 2023, the transport sector in the United States accounts for 28% of the total CO_2 emissions in the US. Meanwhile in Europe, it is responsible for as much as 37% of the total CO_2 emissions, according to the International Energy Agency's report from 2023. With the ongoing global population growth and increasing urbanization, the demand for transportation is set to rise significantly, making it even more critical to reduce carbon emissions from the transport sector.

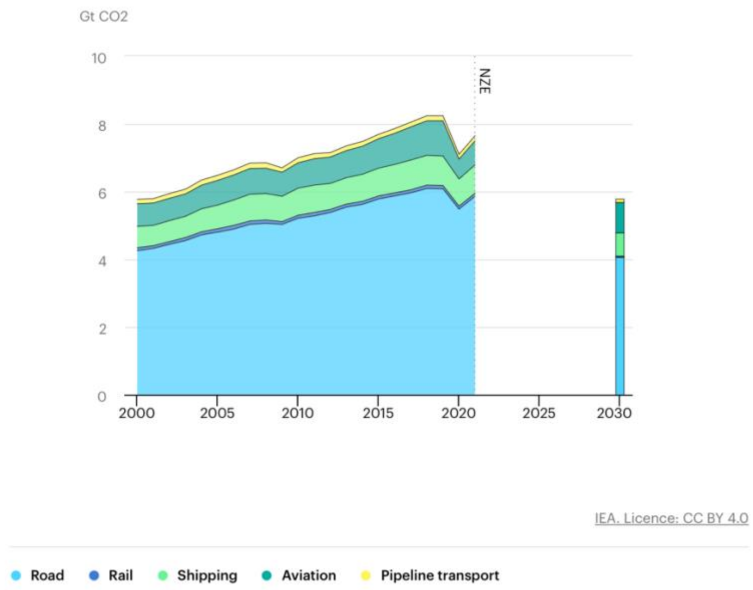

Chart 1 – Global CO_2 emissions from transport, 2000-2030 (International Energy Agency, n.d.).

The chart above is a visualization of the global carbon emissions from the transport sector between the years 2000 and 2022. The chart clearly displays an ongoing trend of annual increase in emissions from the transport sector, except for a dip in 2020 due to the COVID-19 pandemic. The single standing column for 2030 represents the maximum level of transport emissions that Europe can produce if we hope to achieve the goal of limiting global warming to 1,5 degrees Celsius (International Energy Agency, n.d.). For this to happen, significant reductions in emissions from the transport sector are necessary.

Given the pressing need to reduce emissions from the transport sector, we believe that the creation of innovative solutions, such as our app, can play a crucial role in raising awareness and enabling people to gain better insight into their emissions. The vision for our app is to create a user-friendly and effective tool, that helps business reduce their carbon emissions related to travel. By providing information about the carbon emission associated with different means of transportation, we aim to encourage users to make more informed decisions about their travel choices and take actions to reduce their environmental impact. We will delve deeper into the data behind, and how our app works, below. Overall, we strongly believe that our app has the potential to contribute to a more sustainable future by promoting environmentally conscious behavior and thus reducing carbon emissions from transportation.

2 METHODOLOGY

In this part of the essay, we provide an explanation of the methodology behind our app.

2.1 CALCULATING AND COMPARING CARBON EMISSIONS

Before designing our calculator, it is important to understand the different methods used to compare modes of transport and measure their emissions. The most common approach is to calculate the amount of carbon dioxide equivalent (CO_2e) emissions for transporting a passenger by a defined mode of transport over one kilometer (passenger kilometer) (Eurostat, 2021). This metric allows for emissions data to be standardized per individual passenger, regardless of the transportation mode.

The CO_2e metric represents the amount of GHG emissions that have been converted into an equivalent amount of CO_2 (EPA, 2023a). The global warming potential (GWP) parameter is used to convert these emissions, such as N_2O, CH_4 and other GHG emissions, into a common unit of measurement (EPA, 2023b). By converting GHG emissions into CO_2 equivalents, it becomes easier to compare the environmental impact of different modes of transportation. Thus, CO_2e considers factors such as the type and amount of fuel used, making it a comprehensive and accurate measurement for assessing the environmental impact.

To show how CO_2e works, we will provide a simple example with methane (CH_4). Methane has a GWP of approximately 27, meaning that the emission of 1 kg of CH_4 equals the emission of 27 kg of CO_2 (EPA, 2023c). Which implies that the emission of 1 kg of CH_4 and 27 kg of CO_2 has the same adverse environmental impact. We can calculate the CO_2e using the following equation, where "a" is number of kg emitted and "c" is the GWP:

$$ac = CO_2e$$

Equation 1: Converting the emission of a GHG to CO_2e

If we emit 1 kg of CH_4, which has a GWP of 27 kg as previously stated, the equation will look as follows:

$$1\ kg\ (CH_4) * 27\ (GWP) = \ 27\ kg\ (CO_2e)$$

Equation 2: Converting the emission of a methane to CO_2e

When combusting fossil fuels, several GHGs are emitted. To calculate the CO_2e emission from the combustion, we must convert the emissions from each GHG to CO_2e. We can do this by multiplying the number of kilograms emitted of the given GHG (a), with the GWP of the GHG (c). Then we have to sum the CO_2e of all the GHGs. We can express this as in the equation below, where "i" is a given GHG and "n" is the number of GHGs.

$$CO_2e = \sum_{i=1}^{n} a_i c_i$$

Equation 3: Converting the emissions of GHGs to CO_2e

If we want to express the CO_2e per passenger kilometer traveled, we can modify the equation, where "d" is the number of passenger miles traveled.

$$\frac{CO_2e}{d} = \frac{1}{d}\sum_{i=1}^{n} a_i c_i$$

Equation 4: Converting the emissions of GHGs to $\frac{CO_2e}{d}$

To demonstrate the use of equation 4, we will provide a simple example as follows. Alice travels 100 passenger kilometers, which emits 2 kg CH_4 (i=1), 0,2 kg N_2O (i=2) and 10 kg CO_2 (i=3). $N_2O's$ GWP is 273 and $CO_2's$ GWP is 1 (EPA, 2023c). Given this information, we can calculate Alice's CO_2e emission per passenger kilometer traveled as follows:

$$\frac{CO_2e}{d} = \frac{(2\ kg * 27 + 0{,}2\ kg * 273 + 10\ kg * 1)}{100\ km}$$

$$\frac{CO_2e}{d} = 1{,}186 \frac{kg}{km}$$

As evidenced by this example, we need detailed information about how many kilograms of GHGs that is emitted, as well as the corresponding GWP, to calculate the CO_2e emission per passenger kilometer traveled. To simplify the process and make our app more user-friendly, we have decided to use average of CO_2e emitted per passenger kilometer for each mode of transport, rather than requiring exact emission factors for each individual vehicle. For example, instead of using different emission factors for cars made by different manufacturers, we will use a single average emission factor for cars using a given power source (electric, hybrid, diesel, and gasoline). This factor represents the average grams of CO_2e emitted per passenger kilometer for a particular mode of transport, for example 192 grams of CO_2e per passenger kilometer for gasoline cars. While we acknowledge that this approach may result in some imprecision, we believe it is a reasonable trade-off to make the user interface cleaner and more intuitive. It is also very important to note that we are relying on experts and data collected from the entire world, to provide us with accurate emission factors and calculations for CO_2e. We will provide more details on this in section 2.2.

Another argument against using a very advanced equation to calculate CO_2e is that it would require us to have access to, or create, a database containing emissions data for all vehicle types worldwide. This would be a highly resource intensive project that is beyond our current capabilities. However, we recognize the potential value of such a database as a future extension of our app. Another option to address this issue could be to allow users to input their own emission standards. However, this is likely not a viable solution, as it would require users to have knowledge of emissions, which they may not possess. Furthermore, if users did have access to this information, they would likely not need our app in the first place. Despite these limitations, providing a rough estimation of carbon emissions is still beneficial, as it raises awareness and motivates users to consider their environmental impact, which is better than having no estimation at all.

2.2 DATA FOUNDATION

In this section of the essay, we will present the data foundation for our carbon emission calculator, including the numbers and assumptions used in our calculations. As we have already discussed, we will be using $\frac{CO_2e}{d}$ to calculate and compare carbon emissions from different modes of transport. The data is presented in Table 1 in the appendix. In the first column we have the different modes of transport, where we have identified the most common means of transport. The second column consists of emitted grams of CO_2e per passenger kilometer traveled, which corresponds to equation 4. In the third column we list the energy source of the given mode of transportation. In the fourth column, there is a brief explanation of what the sources of CO_2e emissions are, where direct emissions are the emissions that occur during the combustion of fuel, and indirect emissions are emissions that occurs in the extraction, production, and transportation of fuel.

Without prior knowledge or education in the relevant topic, it is an extremely challenging and technical process to calculate CO_2e emissions. Furthermore, incorrect estimations of emissions have several negative consequences, such as underestimating the environmental impact and reducing the reliability of our app. Therefore, it is essential to seek data from experts who possess the necessary expertise and experience to calculate CO_2e. To obtain reliable data for our carbon emission calculator, we conducted a search on the internet and found various sites and sources providing information about the environmental impact of the different modes of transport. However, we had to exercise caution as not all sources are credible. After thorough research, we decided to use data from the UK Governments' methodology paper for greenhouse gas reporting, which is widely used by companies to quantify their emissions (GOV.UK, 2019) (Ritchie, 2020).

It is crucial to note that Table 1 focuses primarily on the direct and indirect CO_2e emissions from the use, transportation, and production of the energy source. However, it does not take in to account the lifecycle emission of the transportation vehicle. For example, there are substantial CO_2e emissions related to the production and transportation of a car before it even reaches the end costumer. In addition, there will be CO_2e emissions related to the production of the parts needed to maintain the car. Incorporating all these aspects into our app would be difficult because it requires that the user provides a lot of information, which they might not know. Additionally, including these aspects would significantly expand the scope of the essay and app, and potentially create confusion. Thus, while these aspects have been considered, we have chosen to focus on direct and indirect CO_2e emissions for clarity and simplicity.

According to Table 1, electric cars produce 53 g CO_2e per passenger kilometer. This stems from the indirect emissions related to the production of the energy that charges the vehicle. Our data is primarily from the UK, where over 40% of the electricity was generated from fossil fuel in 2022 (Department for Business, Energy & Industrial Strategy, 2022). Thus, if you charge in a country with a higher proportion of renewable energy production, the indirect emissions from electric cars will be lower, and vice versa.

The effect of the changes in the renewable share of the electricity production will apply for all forms of electric transport. However, we limited our app to only electric cars since they are currently the most commonly used form of electric transportation. We didn't introduce for example electric planes and ferries because they aren't as widespread as the equivalent fossil fuel options yet, and the statistics lack reliability. However, we anticipate a significant increase in electric alternatives for different modes in the future. This shift towards electrification has the potential to significantly reduce CO_2e emissions and contribute to a more sustainable transportation infrastructure.

The data provided in Table 1 will be incorporated into our app, allowing users to access it while using the app. To calculate the CO_2e emission from a specific trip, users simply need to select the appropriate mode of transportation and the corresponding fuel type, and then enter the distance traveled in kilometers. The app will use the corresponding average $\frac{CO_2e}{d}$ and multiply it with the distance traveled. If the user has traveled using multiple modes of transport, the app will calculate the CO_2e emissions for each mode and sum up the total emissions for the entire journey. The results will then be presented to the user both visually and numerically in a clear and concise manner.

3 BUSINESS MODEL

The business model we have developed for our app is specifically tailored to meet the growing demand for sustainable solutions in the business world. As more and more companies recognize the importance of reducing their carbon footprint, our app offers a valuable solution to help them achieve their sustainability goals.

We have decided to target businesses that are interested in monitoring and managing their emissions, and our app will be sold as a service in the business-to-business segment. Our aim is to make the app an essential tool for businesses that are committed to reducing their environmental impact, and we believe it can contribute to creating a more sustainable future.

To demonstrate the accessibility and user-friendliness of our app, we will market it as an easy-to-use app that incentives users to reduce their carbon emissions. Its intuitive design will enable companies to track their emissions more effectively, giving them a better understanding of their impact on the environment.

We also want to allow companies to set targets for emission cuts and follow up on the progress towards their goals. This can be a useful tool for executives responsible for cutting emissions, providing a way to track and monitor their progress over time.

Additionally, we are also planning to introduce features that allows users to share their emission stats and help other business to cut their emissions. This will create a valuable network for businesses that want to cut emissions. As well as it introduces an element of friendly competition and encouraging more businesses to adopt a climate-friendly practice. By adding these features, our app will have a certain degree of network effects, where more users on the platform will make it more attractive for non-users to sign up to the platform.

Our target customers will mainly be companies that want to monitor and manage their carbon emissions. As sustainability continues to become a more pressing issue, we believe that this market will continue to grow, making our app a valuable tool for business in various industries. Moreover, with investors and stakeholders setting higher standards for climate reporting, our app can help companies meet these expectations and demonstrate their commitment to sustainability.

To generate revenue, we will use a subscription-based model where companies will pay a quarterly fee to gain access to our software. We will use differential pricing to maximize our revenue, with larger companies with more employees paying a higher subscription fee than smaller companies. Our value proposition to customers is to streamline the climate accounting process, starting with business travel. We offer an overview of a company's total emissions related to business travels and metrics like emissions per employee, per department and per kilometer traveled. These metrics will be presented graphically for the user, which makes it easy for the user to understand the information. This will enable companies to identify areas for improvement and set targets for emission cuts.

In the next stage of the app, we are planning to add a database of cars, so the user can select the car that she is driving. This will make the emissions calculations even more accurate. We have also looked into incorporating other sources of emissions from businesses, such as energy consumption, waste disposal and from the food served in the workplace canteen. By providing a comprehensive overview of a company's carbon emissions, our app can help identify several areas of improvement and enable companies to take specific action to reduce their emissions from a wide range of sources.

To achieve this, we will need to collect additional data from businesses on their energy usage and other sources of emissions and develop new methodologies for calculating carbon emissions from these sources. It could be very useful to add features that assist businesses and provide recommendations for reducing energy consumption or display different travel options based on travel time and CO_2e emission. Overall, by expanding the functionality, we add more value for the users, and our app becomes more unique.

4 POLICY IMPLICATIONS AND DISCUSSION

Given the pressing need to reduce carbon emissions from the transport sector, our app has the potential to make a significant contribution to the overall goal of reducing emissions and mitigating the effects of global warming.

In terms of policy implications, there has been a growing trend of policies and regulations aimed at reducing carbon emissions in businesses. We will highlight some that we found particularly relevant.

4.1 INCENTIVIZING THE USE OF ENVIRONMENTALLY FRIENDLY TRANSPORTATION

Governments are implementing policies to incentivize businesses to adopt environmentally friendly transportation. For instance, tax credits and subsidies are being offered to make electric vehicles more affordable, and thus decreasing the average CO_2e emissions per passenger kilometer. Additionally, investments are being made in public transit infrastructure, and incentives are being provided to encourage employees to use public transportation. Such policies have a direct impact on our business model, as our app can help companies track their emission and take advantage of these incentives.

4.2 PROMOTING TRANSPARENCY, ACCOUNTABILITY, AND IMPORTANCE OF SUSTAINABILITY FOR INVESTORS

Policies requiring companies to report their carbon emissions are becoming increasingly common, and this helps to create transparency and accountability in the business world. The EU Taxonomy, a sustainability classification system for business and projects, is a prime example of such a policy (European Commission, 2023). This system has made climate accounting almost a requirement in the EU. This is because financial institutions and other investors prioritize sustainability in their investments on a much larger scale than before. To be able to get a good rating from the Taxonomy, and secure financing, companies must keep track of their emissions and demonstrate a commitment to improving their sustainability.

Our app helps companies meet these new requirements by providing the tools to track and report their carbon emissions. By doing so, companies can demonstrate their commitment to improving their sustainability and secure financing from investors who prioritize environmentally friendly businesses.

5 SUMMARY

In summary, carbon dioxide (CO_2) contributes to 74,4% of the world's total greenhouse gas emissions, and within Europe, the transport sector is responsible for 37% of the region's total CO_2 emissions. This makes the transport sector one of the biggest sources of emissions. If we aim to limit global warming to 1,5°C, it is imperative that we significantly reduce emissions from the transport sector.

We can use CO_2 equivalent (CO_2e) and global warming potential (GWP) to compare the emission of different GHGs. We can calculate the CO_2e by multiplying the number of kilograms emitted of the given GHG, with the GWP of the GHG. By dividing the CO_2e emission from your journey by the kilometers traveled, we get the CO_2e per kilometer traveled.

Our business model targets the growing demand for sustainability solutions in the corporate sector. By offering our app as a subscription-based service, we aim to help businesses of different sizes effectively track their carbon emissions and set targets for emission reduction. Our plans to expand the app's functionality to include other sources of emissions, such as energy consumption and waste disposal, will further enhance its value for our users.

The policy implications discussed in this essay emphasizes the importance of our app in the current policy environment. As governments around the world implement policies to promote environmentally friendly business and increase transparency and accountability, our app is well positioned to meet the evolving needs of businesses.

Overall, we strongly believe that our app helps business to cut emissions, which supports the development of a greener and better future. The app is an excellent tool for businesses that wants to track and reduce their emissions. In the future, we can expand the functionally of our app, which will increase its value for businesses, while also supporting the reduction of emissions.

6 REFERENCES

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7 APPENDIX

Mode of transport	Grams of CO_2e per passenger kilometer ($\frac{CO_2e}{d}$)	Energy source	CO_2e source
Walking	0 g	Human power	No direct CO_2e emission. Indirect emissions from the production and transportation of food (energy) that is needed for walking.
Bicycle	0 g	Human power	No direct CO_2e emission. Indirect emissions from the production and transportation of food (energy) that is needed for cycling.
Ferry	19 g	Diesel	Direct emission from the combustion of fuel. Indirect emission from extraction, production, and transportation of fuel.
Train	41 g	Diesel	Direct emission from combustion of diesel. Indirect emission from extraction, production, and transportation of fuel.
Car (Electric)	53 g	Electric	No direct emission from driving. Indirect emission from charging when the electricity is generated by fossil fuel power plants (in this case from the UK electricity grid).
Motorbike	103 g	Gasoline	Direct emissions from combustion of fuel. Indirect emission from extraction, production, and transportation of fuel.
Bus	105 g	Diesel	Direct emission from combustion of fossil fuel. Indirect emission from extraction, production, and transportation of fuel.

Car (Hybrid)	109 g	Gasoline and electric	Direct emission from combustion of fuel. Indirect emission from extraction, production, and transportation of fuel, and from charging when the electricity is generated by fossil fuel power stations.
Long distance flight	150 g	Jet fuel	Direct emission from combustion of jet fuel. Indirect from production and transportation of fuel, as well as contrails and other aviation related factors.
Car (Diesel)	171 g	Diesel	Direct emissions from combustion of fuel. Indirect emission from extraction, production, and transportation of fuel.
Car (Gasoline)	192 g	Gasoline	Direct emissions from combustion of fuel. Indirect emission from extraction, production, and transportation of fuel.
Domestic flight	255 g	Jet fuel	Same as for long distance flight. Domestic flights typically have a higher emission per km due to the energy intensive takeoff and landing phases.

Table 1 - CO_2e per passenger kilometer from different modes of transport (GOV.UK, 2019) (Ritchie, 2020).