Høgskulen
på Vestlandet

Green Digitalization and App Development

Group 3

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1. Introduction

In this essay, we aim to provide an in-depth explanation of our application, its significance, and the sources of data used in the carbon calculator. Additionally, we will discuss our business model and share insights gained from this project.

Enter our carbon emission calculator app - an innovative tool that allows you to calculate your transport carbon emissions in a quick and easy way. By simply inputting data about your daily travels, you can get a comprehensive breakdown of your carbon emissions, as well as recommendations for reducing them. With this app, businesses can take control of their carbon footprint and make informed decisions about the employees lifestyle and habits, helping to reduce the impact on the environment.

1.1 Our Application

Transport carbon emissions are a major contributor to climate change. A study from the US shows that the transportation sector is responsible for the largest proportion of greenhouse gas emissions, primarily resulting from the combustion of fossil fuels used in vehicles such as cars, ships, trains, and planes. These emissions account for 28% of the total greenhouse gas emissions in 2021 (EPA, 2021). Petroleum-based fuels, including gasoline and diesel, make up more than 94% of the fuel consumed in transportation (EPA, 2021).

In an effort to address this issue, we have developed an app that can measure a company's carbon emissions related to transportation. By providing a realistic number, companies are able to assess the scale of their impact and take effective steps to reduce their emissions.

1.2 Carbon Emission

Carbon emissions, also known as greenhouse gas emissions, refer to the release of carbon dioxide and other gasses into the atmosphere, primarily as a result of human activities such as burning fossil fuels for energy, deforestation, and industrial processes (Osmanski, 2020). These emissions are a significant contributor to global climate change, which has far-reaching impacts on our planet, including rising sea levels, more frequent and severe weather events, and changes in ecosystems and agriculture. As the world becomes more industrialized and populations continue to grow, the need to address carbon emissions and mitigate their impact becomes increasingly urgent (NOAA, 2021). Governments, businesses, and individuals around the world must be working to reduce emissions through a variety of strategies, including increasing the use of renewable energy, improving energy efficiency, and adopting low-carbon lifestyles.

The United Nations General Assembly developed 17 global goals called Sustainable Development Goals (SDGs) in 2015. These goals aim to end poverty, protect the planet and ensure that all people are treated right. The UN's Sustainable Development Goal 13, *Climate*

Action, specifically highlights the need to make an urgent action to combat climate change and its impacts (United Nations, n.d.).

Reducing carbon emissions is vital to reduce these impacts and ensure a sustainable future. The United Nations suggests that this can be achieved through various measures, including transitioning to renewable energy sources, improving energy efficiency, and adopting sustainable practices in transportation (United Nations, n.d.). Our app is working alongside these goals, and will help businesses to mitigate their pollution.

2. The Methodology

Methodology refers to a systematic approach of principles, practices, and procedures used to conduct research or achieve a goal, involving various methods and techniques to collect and analyze data. It ensures reliability, validity, and ethicality of research.Our carbon calculator uses mathematical formulas from different reliable sources. An excel sheet with the formulas used in the calculator are located in the attachment, as well as the sources are located at the end of the essay.

2.1 Standardizing of the Calculations

Calculating CO2 emissions from different types of vehicles can be a complex and a challenging task due to the wide variety of factors that can impact emissions, such as the type of fuel used, vehicle size, weight and driving conditions. In addition, there are often different methods for measuring and reporting emissions, which can make it difficult to compare data across different regions or vehicle types.

Since our objective is to bring light to this situation it is important to provide consumers with accurate and comparable emissions data to help them to make better and more educated choices with regards to co2 emissions. For simplicity reasons both for the customers and on our end we have decided to standardize the source information to fit in a formula with a coefficient that is multiplied with the number of kilometers commuted, as well as in some instances, the number of passengers in the vehicle. The coefficient is a calculated number that is set to represent the emissions of each mode of transportation and will make it easier to calculate your emissions. Here is our basic formula:

$$kgco^2 = km \cdot X$$

Where X is the coefficient, kgco2 is the number of kilos co2 you will emit, and km being the number of kilometers you travel.

2.2 Car

There are several ways to calculate carbon emissions per person for a car trip. It can be on a vehicle´s fuel and distance, if it's an electric, diesel or gasoline vehicle. A typical passenger vehicle emits about 4.6 metric tons of carbon dioxide per year (EPA, 2022). One liter of diesel emissions 2,731 Co2. One liter of gasoline emits 2,401 Co2. Hybrid electric vehicles (PHEV) will emit only water vapor. Electric vehicles (EV) do not generate any tailpipe emissions (EPA, 2022) Here is a breakdown of the approximate CO2 emissions per kilometer per person for different types of cars:

Gasoline-powered cars:
0.18 kilogram of CO2 per passenger kilometer (EEA,2019).

$$kgco^2 = km \cdot 0,18$$

Diesel-powered cars:
0.16 kilogram of CO2 per passenger kilometer (EEA,2019).

$$kgco^2 = km \cdot 0,16$$

Electric cars:
The average CO2 emissions for electric cars in the United States is around 0.12 kilograms of CO2 per passenger kilometer, assuming an average mix of energy sources (EEA,2019).

$$kgco^2 = km \cdot 0,12$$

As we can tell from the formula and carbon stamp per passenger, the usage of electric cars contributes to reducing the carbon emissions in the world. This is significantly relevant, especially in Norway, where 1 out of 5 car owners drives an electric car.

2.3 Ferry

Ferries play an important role in transportation and commerce on a worldwide and European scale.They are used to transport people, vehicles, and goods across rivers, lakes, and seas, connecting islands and coastal areas with mainland regions. Ferries are a popular mode of transport for both commuters and tourists, providing a cost-effective and convenient way to travel across waterways. In Europe, ferries are particularly important for connecting islands to the mainland, such as in the Mediterranean, the Baltic Sea, and the North Sea. (European Travel Commission, 2018)

Based on data provided by Klimasmartsemester, a Swedish website that promotes sustainable travel options, foot passenger ferries emit approximately 0.018 kg of CO2 per passenger kilometer (Larsson & Kamb, 2021). This highlights the relatively lower environmental impact of foot passenger ferries compared to other modes of transportation.

$$kgco^2 = km \cdot 0,01874$$

According to FerryGoGo, a website that provides information on ferry transportation, it has been found that ferry transportation for cars is a significantly more CO2-intensive endeavor as compared to foot passenger ferries (Van der Bij, 2022). The source highlights the carbon

emissions produced by ferries transporting cars, further emphasizing the importance of considering the environmental impact when choosing the car.

$$kgco^2 = km \cdot 0,12952$$

2.4 Bus

There are 3 million city buses in operation worldwide! (Review of Energy Challenges and Horizons of Hydrogen City Buses, 2022) Currently, a majority of buses run on diesel fuel. However, the trend is likely to shift towards more sustainable alternatives, like CNG powered buses (Editorial, 2023). The average bus in Europe is a CNG powered bus - 0.11 kg per passenger per km. On average, a diesel-powered bus in the UK emits around 0.09 kilograms of CO2 per passenger kilometer (DEFRA, 2007), while a compressed natural gas (CNG) bus emits around 0.11 kilograms of CO2 per passenger kilometer (Giechaskiel, B., 2022, p. 651).

A passenger that travels with a diesel powered bus emits an estimate of 0,09 kg per km:

$$kgco^2 = km \cdot 0,09$$

A passenger that travels with a CNG powered bus emits an estimate of 0,11 kg per km:

$$kgco^2 = km \cdot 0,11$$

2.5 Tram

Data for electric trams is sometimes hard to acquire due to the amount of variables in the calculations, trams get most of their passengers in highly urban areas, as well as the distance commuted varies highly depending on the person. Our data is borrowed from the UK, where we averaged the carbon emissions of two different teams; the Manchester Metrolink and the Croydon Tramlink. This is done so that we have a larger amount of variables accounted for and therefore better accuracy. We can see the data in the table below gathered from the UK Department of environment, food and rural affairs. We can disregard the top two due to them being light rails and not trams.

	Type	**gCO_2 per pkm**	**Line km**
Tyne & Wear Metro	Light Rail	120.7	59
DLR (Docklands Light Rail)	Light Rail	74.0	27
Croydon Tramlink	Tram	42.0	28
Manchester Metrolink	Tram	42.1	39
Average*		**78.0**	

(Department of environment, food and rural affairs [DEFRA], 2008, page 24)

Here we can get an average of the two trams' grams of carbon dioxide emission per person and per kilometer, which we will use as our emission factor. 42.0 + 42.1 / 2 = 42.05 which we

round up to 42.1. After converting the gram to kilos this leaves us with 0,0421 kg co2 per kilometer per person:

$$kgco^2 = km * 0,042$$

2.6 Flights

Flying is a highly controversial topic in climate debates all over the world. This type of carbon emission dominates a frequent traveler's individual contribution to climate change, even though it only contributes approximately around 3,8% of the total CO2 emissions in Europe (European Commission, 2020). The aviation sector represents 13,9% of all transport emissions, which makes it the second biggest source of transport GHG emissions, just beaten by road transport (European Commission, 2020). For instance, flying from Lisbon to New York and back generates roughly the same level of emissions as the average person in the EU does by heating their home for a whole year (European Commission, 2020). To calculate our carbon emission traveling with aviation throughout the EU we have used Defra's conversion factors from their methodology paper (Department of Environment, 2008).

Domestic flights from 0-785 KM (Climate Impact Partners, 2023) emit a total of 0,157 kg/CO2 per passenger per km (Department of Environment, 2008).

$$kgco^2 = km * 0,157$$

Short hauls from 785-3699 KM (Climate Impact Partners, 2023) emit a total of 0,130 kg/CO2 per passenger per km (Department of Environment, 2008).

$$kgco^2 = km * 0,130$$

Long hauls greater than 3699 KM (Climate Impact Partners, 2023) emit a total of 0,105 kg/CO2 per passenger per km (Department of Environment, 2008).

$$kgco^2 = km * 0,105$$

It's worth noting that this methodology only provides an estimate, and actual emissions can vary depending on factors such as the type of aircraft, load factor and routing.

2.7 Motorcycle

Motorbikes are less used than cars in the world, there are 600 million motorbikes and 1.4 billion cars. However, this does not change the fact that motorbikes increase CO2 emissions. (Riders Share, 2023). Motorbikes use two types of fuel, gasoline and diesel, but in the last few years almost all diesel motorcycles have disappeared. At the same time the electric motorbikes came to the world, but not on a large scale. We have decided to only include gasoline driven motorcycles (Brennan, 2021).

Co2 emissions (Gasoline- Average size):

$$kgco^2 = km * 0,11$$

2.8 Train

In 2019, there were approximately 31.5 billion passenger journeys by rail worldwide.The formula to calculate carbon emissions per person by train involves several variables, including the distance traveled, the type of train, and the energy source used to power the train. However, we have decided to use our standardized formula as an approximate amount of emission:

The distance traveled is measured in kilometers, while the emissions factor represents the amount of carbon dioxide (CO2) emitted per kilometer of travel (European Environment Agency, 2021, p.37-38). The emissions factor can vary depending on factors such as the type of train and the energy source used.The average emissions factor for passenger trains is 0.11 kilograms of CO2 per passenger-kilometer (kg CO2/pass-km) (International Energy Agency, 2019, p.56-58).

$$kgco^2 = km \cdot 0,11$$

2.9 Walking and biking

A reference point to the other sources of transportation.

Walking and biking are the most environmentally friendly modes of transportation as they do not produce any direct emissions of greenhouse gases, such as carbon dioxide (CO2) (United Nations Environment Programme, 2020). However, the production and disposal of the equipment used for walking and biking, such as shoes and bicycles, can generate some emissions (Stevenson, 2018). The carbon footprint of walking and biking equipment is much smaller than that of motorized transport (Environmental Defense Fund, n.d.). While motorized transport uses some type of fuel the only fuel needed for biking or walking is food. The emission for bikes is conservatively estimated to be:

$$km \cdot 0.02\ kg = kgco^2$$

As the carbon emissions produced by biking vary greatly depending on the frequency of use (with less usage resulting in a lower carbon footprint), we have made the decision to establish a standardized value of 0.0kg CO2 per kilometer for all biking activities.

2.10 Future extensions of our methodology

Electric cars do tailpipe emissions during the production process. Show to analysis done by Daimler AG for Mercedes-Benz. One car of B-class (electric), emits 10,1 tons of Co2. While one car is a gasoline car like B 180 (Gasoline), emissions 5,5 tons Co2. An electric car that is charged on what is called the European power mix, emits 11,9 tons Co2. However, an electric car that is charged on waterpower, emissions 0,2 tons Co2. (Mathisen, 2021).

Gasoline car: 5,5 tons Co2 (production) + 11,9 tons Co2 (by using) = 29,5 tons Co2. Electric car with European power mix: 10,1 tons Co2 (production) + 11,9 tons Co2 (by charging) = 22 tons Co2. Electric car with waterpower: 10,1 tons Co2 (production) + 0,2 tons Co2 (by charging) = 10,3 tons Co2. (Mathisen, 2021).
That means even when an electric car emits more Co2 during production than a gasoline car, it could be more sustainable than a gasoline car in the long term.

Our priority is to find out what is the difference between these options when it comes to Co2 emissions. This applies not only when these options are in use, but also through the production process. In this way, we can illustrate the entire process to businesses and give others who want to continue with this research a starting point.

3. Business Model

Our business idea is to make a calculator that can help our target group, businesses, to reduce their carbon footprint and become more eco friendly. The app is designed and made for companies, like Sparebanken Vest, who want to make a change and contribute to end the challenges we are approaching. This app is introducing a more user-friendly-interface, which looks good and is functional. Businesses can easily calculate their carbon footprint, avoiding heavy research and wrong information.The Carbon App's sources are easily found in our essay, making the calculator a trustworthy instrument.

The climate change is more important than ever, whereas we have to reduce our carbon emission drastically (NOAA, 2021). The idea for this app has its origin from a statement from the Bank Manager at Sparebanken Vest (Pettersen, 2023). In February 2023, Jan Erik Kjerpeseth, and a couple of his colleagues flew from Bergen - Oslo and spent a night at a hotel just to present a quarterly report. The local newspaper in Bergen (BA) commented on this and asked the bank manager what they would do to prevent climate change (Pettersen, 2023). As the bank has their core business in sustainability, they will from now on compensate for their carbon footprint by using trains instead of aircrafts as their mode of transportation.This is a real example from a corporation of decent size where accountability makes substantial differences on the mindset of travel policies while conducting business. This application is made for businesses like Sparebanken Vest, where the calculator will increase their awareness of carbon emission.

3.1 Business Model Canvas

The business model focuses on providing a carbon app and report, consulting services, promotions, and website maintenance to businesses that want to reduce their carbon emissions. Key resources include web developers, designers, marketing teams, and environmental consultants. Customer relationships are maintained through 24-hour customer service, email newsletters with sustainability tips and updates. The target customer segments are businesses who want to reduce their emission, like e-commerce and banks. The cost structure includes salaries and benefits for staff members, marketing, research and development costs. The business model aims to provide a comprehensive approach to help businesses reduce their carbon emissions. In this essay, we chose to focus on value propositions, key partners and revenue streams, however an overview of the Business Model Canvas can be found in the attachments.

3.2 Value Propositions

Businesses would be interested in the carbon calculator app because it provides an easy-to-use and accurate tool for measuring their carbon footprint, along with detailed recommendations for reducing carbon emissions. This can help businesses improve their sustainability practices, reduce costs, and enhance their reputation in the eyes of consumers and stakeholders.

3.3 Key Partners

The key partners for the carbon footprint calculator are a diverse group of organizations and people that provide valuable expertise and support to the application. Canva provides graphic design tools that we use to provide content to promote content on the different channels (Canva, n.d.). NGO's and sustainability influencers are important partners who help raise awareness on how businesses can become greener through our app. Forward Education and Høgskulen på Vestlandet are educational institutions that can provide expertise in environmental sustainability, development, coding and quality of the calculator. *Innovasjon Norge* and *Start Up Norge* are government-funded organizations that can provide financial and business support (Innovasjon Norge, n.d.; Start Up Norge, n.d.). Finally, Fiverr is an online marketplace for freelance services, which can provide valuable support for web development and marketing (Fiverr, n.d). These partnerships demonstrate the importance of collaboration in promoting sustainable business practices and highlight the diverse range of expertise and resources that are necessary to create an effective carbon footprint calculator.

3.4 Revenue Streams

To secure an income that can develop and improve the application we decided to make a premium membership and additional consumer-services. The premium membership will guarantee monthly revenue for the company. Additionally, the application will have income from an exclusive customer service phone line.The employees working here offer premium service, with a 100% satisfied guarantee.

4. Discussion

After analyzing the methodology and results presented in the text, it appears that determining the precise amount of CO2 emissions is a challenging task. However, there are other alternatives available that emit significantly less CO2. Through the research conducted, we were able to identify the better alternatives, even though we couldn't obtain exact figures. For instance, electric cars and collective transport produce lower CO2 emissions compared to gasoline or diesel cars.

The goal of the application is to assist businesses in reducing their carbon dioxide emissions and to promote the use of sustainable alternatives. For instance, companies can conduct meetings using virtual platforms like Zoom instead of traveling by airplane to destinations such as Oslo. This approach not only benefits the environment but can also prove to be economically advantageous for both the business and society as a whole.

We have accomplished building an app from scratch, and expanded our skills in coding and knowledge about carbon emission. In addition our group has become better in team work and communication, whereas an organized structure has been necessary. As a result of our participation in this project, we have been able to acquire and develop a diverse range of skills that will be valuable assets in our future careers. We hope that this project is contributing to a more sustainable world, as an increase of knowledge and consideration about the environment.

5. Attachments

Business_Model_Canvas
Excel_sheet_formulas

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