SDG335 – Group 5

VestTrack

Carl August Lygre-Wiencke

Quan Cao Nguyen

Olai Frøyen

Sander Mogen Alexandersen

Josef Leininger

Leevi Pihlaja

Philip van Bommel

1.1 Background and motivation

As time progresses, it becomes increasingly clear that the environmental challenges we face are intensifying, bringing us dangerously close to a point of no return, if we have not already reached it. The urgency of the climate crisis leaves no time to lose. Humanity's influence on the physical environment is undeniable and it shows in multiple ways, for example through energy production, transportation, and industrial activity.

As global energy demand continues to grow, it is important to explore alternatives and more sustainable solutions for energy production that can guide us away from heavy reliance on fossil fuels. Norway has set an ambitious national goal of becoming a *"low-emission society"* by 2050. However, according to the Norwegian National Human Rights Institution (2023), the largest sources of emissions in Norway remain oil and gas extraction (24.5%), other industries (23%), road traffic (17%), and other forms of transport (15%). Norway's geographical landscape is characterized by long distances, deep fjords, and high mountains. It is understandable that transport constitutes a significant share of the country's emissions.

According to the International Energy Agency (2025), global energy-related CO_2 emissions increased by 0.8% in 2024, reaching an all-time high. In response to this alarming development, our team has developed an application designed to track emissions from transport. The purpose of this app is to inspire individuals to become more conscious of their carbon emissions and gain a better understanding of their personal carbon footprint.

Our application contributes to addressing this issue by allowing users to track their CO_2 emissions from various modes of transport. By calculating and visualizing each user's carbon footprint, the app provides meaningful insights that encourage behavioural change and promote more sustainable travel habits. Our app aims to be an extension of the current public transport app Skyss in Bergen, and our goal is to make the people of Vestland more aware of their CO_2 emissions. This will be done through data transparency, where users can make informed decisions that collectively support the transition towards a low-emission future.

1.2 Target Group

We aim to reach the broadest audience possible by targeting all individuals who rely on public transport in Vestland, especially in the area around Bergen. We want to encourage the travellers to make more responsible and environmentally friendly choices.
People living in the urban areas often have access to several modes of transport. This gives them flexibility in their travel choices. By focusing on Vestland as a target group we can increase awareness of sustainable alternatives and then inspire them to live more climate friendly. This will contribute to a greener and more responsible future for Vestland.
Even though our target group is all of Vestland, we still think it is important to recognize that the younger generation often show a strong ethical responsibility towards the climate action (Wiig, 2021). We in VestTrack are a part of this generation, and we believe it's important for young people to start early, so sustainable choices become a natural habit. The residents of Vestland today play a key role in shaping tomorrow's travel habits. By giving them the right knowledge and information, we believe we can help to guide Vestland toward a greener future. A future where sustainable transport play a very central role.

1.3 App concept

Our app concept is based on the normal transportation patterns of Western Norway, and the county Vestland. This is a place where public transportation, private cars, ferries and planes play a central role in the daily commute. Vestland is known for its long distances, numerous fjords, and larger cities, where the biggest one is Bergen. All this indicates that transport is a very significant source for the regional carbon emissions.

Our goal with this app is to give users in Vestland specific and personalized insights into how much CO_2 they emit through their everyday travel, with the hope of making it easier for our users to make sustainable choices. We have a vision for the app where it can be an extension of the already existing "Skyss Reise" app. The "Skyss Reise" app is an app where inhabitants in Vestland can plan their public transportation and features vehicles like bus, light rail/trains, boats, ferries and electrical scooters (Skyss, n.d.).

By collecting data and information about different transportation vehicles, travel routes and distances the app can calculate the carbon emissions per km. The users will get information about their CO_2 for each individual journey, compare different transport options for the same route and see how small changes can affect their overall personal climate footprint over time.

1.4 Our team

Our team consists of seven students from *Western Norway University of Applied Sciences*, four of whom are local Norwegian students, while the remaining three are international exchange students from Finland, Germany, and the Netherlands. This makes us a diverse group of young people of different ages, cultures, and native languages, something we see as a great advantage.

Our differences make us more diverse and adaptable, giving us a variety of perspectives on how to solve the challenges we face along the way. With different levels of experience in Python and coding, we divided the work to build on our individual strengths, while also ensuring that we could learn from and benefit from each other's knowledge.

We hold group meetings every Monday before lectures to make sure everyone is prepared for the upcoming weekly challenges. These meetings also give us the opportunity to discuss our strategies and overall game plan for the project.

Methodology

This section presents the methodology used to calculate and analyse CO_2 emissions from different modes of transport. It shows how the data is collected and explains the formulas applied, providing a clearer understanding of how travel behaviour is translated into a measurable environmental impact.

2.1 Data sources

Our data is collected from real-world travel data, official statistics, official reports and direct communication with transport providers such as Skyss and Fjord1. This is used to estimate the carbon footprint associated with various transportation methods. It is important to acknowledge that certain limitations and assumptions may affect the precision of the results. The objective of this application is therefore not to provide an exact measurement of individual carbon footprints, but rather to offer a reasonably accurate model that illustrates the environmental impact of everyday transport choices. It is also important to point out that carbon emission figures vary significantly from source to source. We have chosen to focus on the figures that are most relevant to our business model, and therefore numbers that are more relevant to Norwegians and especially the areas in and around Bergen.

2.2 Formulas and Calculations

To estimate the carbon emissions from different modes of transportation, our application uses a simplified and consistent calculation model. This ensures that the results are comparable across transport types while maintaining a practical level of accuracy.

Emissions depend on factors such as vehicle type, fuel source, weight, and number of passengers. To capture these elements in a structured way, our model applies one general formula for all transportation categories:

$CO_2 = d * ef / p$

Where:

- CO_2 = carbon emissions (grams)
- d = distance traveled (km)
- ef = emission factor (grams of CO_2 per km)
- p = number of passengers

For our calculations, we have generalized each mode of transport to represent a realistic average of its carbon footprint. This approach simplifies the model while still reflecting essential parameters such as distance, fuel type, vehicle weight, and passenger capacity.

We have reviewed multiple sources to determine the most accurate emission factors and generalizations possible. This ensures that the model provides credible and comparable results while remaining simple enough for practical use within the app.

2.3 Transportation modes

2.3.1 Car

Out of all land-based vehicles in Norway, passenger cars account for approximately 78% of the total distance travelled. The average distance covered by a passenger car in Norway is 11,215 kilometres per year, amounting to a total of 35.44 billion kilometres nationally. This means that by reducing national fuel-based passenger car travel by just 1%, Norwegians would drive approximately 354 million kilometres less (SSB, 2025).

Using an average emission factor of 140 grams of CO_2 per kilometre (Miljødirektoratet, 2019), this reduction would equal around 50,000 tonnes of CO_2 saved annually. This is roughly equal to removing 30,000 petrol cars from the road for an entire year, based on an average emission of 1.6 tonnes of CO_2 per car annually (SSB, 2023).

Our calculations in the application are based on data provided by (*Framtiden i våre hender*, 2025). For cars, emissions were calculated per vehicle per kilometre rather than per passenger, as this method was considered to provide a more accurate representation of the total CO_2 emissions. To get better results, we further differentiated between large, medium and small vehicles and by fuel type, including diesel, petrol, and electric cars.

Emission per car-per km (g)	**Small**	**Medium**	**Big**
Petrol	150	198	261

Diesel	174	229	302
Electric Nordics	45	59	78

2.3.2 Bus

In 2024, buses accounted for 60,6% of all the collective transports in Norway (SSB, 2024). Since buses make such a large share of collective transport, it is important to get accurate data for them. Therefore, we decided to contact Skyss by mail to get more data about emissions from their buses.

In their response the data they gave us were not so easy to interpret. Firstly, the CO_2 emissions from bus travels vary significantly based on whether the bus is electric, or diesel powered. Secondly, it also varies depending on the season, where the emissions are higher in the winter than in the summer. They also mentioned that the buses use diesel for heating the electrical buses in the winter, which makes it difficult to calculate an exact emission value.

We decided to separate between electrical and diesel-powered buses in our calculation and we will be using data from “fremtiden i våre hender” and skyss to get the best possible estimate.

Diesel-buses: Framtiden i våre hender have calculated that buses running on diesel emit 30 g CO_2/passenger-kilometer here in Norway (Framtiden i våre hender, 2025). This is the number we will be using in our calculation.

Electrical buses: We contacted Skyss directly, to hopefully get more information. They did not have data about CO_2/km, however they did provide us that their consumption is between 0,9 kwh/km and 2,5 kwh/km. Since this is quite a big gap, we decided to take the average, which is 1,7 kwh/km as a baseline. To calculate CO_2 emissions per person-kilometer we first need to find the CO_2 emissions per kilometer for electric buses. For this, we use the following formula: g CO_2/km = (kWh/km × g CO_2/kWh). We already know that energy use is 1,7 kWh per kilometer, and according to NVE (2021), the CO_2 emissions from Norwegian electricity production is 18,9 g/ kWh. If we solve the equation, we find that g CO_2 km = 1,7 * 18,9 = 32.13.

To find per passenger-kilometer we divide with the average number of people per bus which is 28 (Klimatsmartsemester, 2024). And get that the emissions per person-kilometer for electrical buses is (32,13 / 28) = 1,15.

2.3.3 Train

In Norway, trains are important for transporting both people and goods, especially in major cities such as Oslo and Bergen. We have used data from *Klimatsmartsemester*, where we differentiated between nordic and international trains. The results show that trains in Norway, Sweden, and Finland emit approximately 7 g CO_2 per passenger-km, while the European average is around 26 g CO_2 per km. Since the intention of this app is to serve as an extension of Skyss, we apply the Norwegian emission rate of 7 g CO_2 per km in our calculations for electric trains. For diesel trains we have used a general emission factor of 91 grams of CO_2 per km.

2.3.4 Ferry

To estimate emissions from ferries, we based our calculations on data provided by Fjord1, one of Norway's largest ferry companies. By contacting them via e-mail, we got personal information and access to specific information about what the ferries emit. The illustration under shows the numbers provided. This allows us to further calculate the emissions more precisely and give a greater view of how the ferries polute. (J. H. Eide, personal communication, 7. november 2025)

Type of route	**Energy consumption (kWh)**	**Share of electric operation**	**Distance (km)**	**kg CO2 e / km**
Short – electric	80	100%	1.85	1.2
Medium – electric	200	100%	3.5	3
Medium hybrid	240	90%	2.8	19.5
Long – electric	640	100%	14.25	9.68
Long hybrid	660	85%	12.5	76.0

	kWh	kWh / l	CO2E	Unit
Electricity	1	-	0.015	CO2E/kWh
Diesel	-	10.02	2.71	CO2E/kWh

These emission factors are shown as kilograms of CO_2 equivalents per kilometre, representing the total emission factor from each ferry route. Since our goal is to estimate the emissions per passenger, we have to distribute the total emission from the ferries across the number of passengers on board. Since this number can vary a lot, we estimated the average passenger count on each ferry all year round.

According to Fjord1's 2024 sustainability report, the company transported 18.4 million passengers across 743,000 journeys, resulting in an average of approximately 25 passengers per trip. With the provided information that most of the routes drive short to medium distances, we base our emission calculations on that. This means that we have a generalized emission of 84 grams CO_2 per kilometre per person on average with electric ferries.

For diesel ferries we use the emission factor provided by *Fremtiden i våre hender.* Here the average emission per person is 186 grams of CO_2 per kilometre.

2.3.5 Airplane

Flight per person- per km (g)	
Economy	127
Economy premium	155
Business	285

Most commercial aircraft use the same type of fuel, called kerosene. Therefor we made it possible for the consumers to choose between different travel classes. This helps raise awareness of how small choices can contribute to reducing CO_2 emissions. We have used data from (*framtiden I våre hender,* 2025) and the emission factors are listed as above.

2.3.6 Motorbike

The motorbike is another way of getting around and can be a good alternative if you are traveling light and the weather is nice. The way of traveling is more environmentally friendly and emits less CO_2 than, for example, a car. Our motorbike calculations are based on data from SSB and show that the average motorbike emits approximately 81,5g of CO_2 per km (SSB, 2016).

2.3.7 Electrical scooter

The electric scooter is a very popular means of transport when traveling short distances. It's easy to unlock, relatively cheap, and it goes much faster than walking. Because it's so flexible, especially young people use it a lot in big cities in both Norway and the rest of the world. They are often promoted as "green", but studies show that they emit approximately 35 g CO_2 per person per km, which is more than diesel buses (Tiltak.no, n.d.). These calculations include many factors, and production and lifespan are some of the reasons why electric scooters are not as environmentally friendly as many people think.

We wanted to raise awareness about this, as many people don't know the real extent of CO_2 emissions from electric scooters. However, in our app we have set the emissions to 0 in order to match the other modes of transport, which do not include factors such as production, transportation, or lifespan.

3.0 Our Business Model

To generally outline our business model, we used the Business Model Canvas as a starting point but decided to use a "building stairs" design to make it more appealing. For the purpose of giving more insight into our value proposition, we decided to draw up a flow diagram, to make it easier to understand our business from a user perspective. Our app distinguishes itself from other similar applications by not being a standalone product but by being integrated into the ecosystem of Skyss. This key collaboration gives us some great advantages and selling points. First of all, user acquisition is much more streamlined, as the existing Skyss products already have a lot of users. This also influenced our design choices, with the goal in mind that a user who is familiar with Skyss would have a pleasant user experience. Furthermore we can integrate data from Skyss and benefit from the expertise and knowledge, that this organization has. On top of that, we want to ensure that our idea and work continue to improve. That's why we decided to put a lot of effort into designing our business model using a circular feedback loop, while not losing the starting goal of reducing emissions.

3.1 Value Proposition

By using our app, the people of Vestland have the opportunity to track and reduce their travel-related emissions. The app allows users to track different modes of transport, from cars, trains and buses to ferries and flights. We make this possible by giving personalized insight into one's transport footprint and an integration with the existing Skyss app and travel ecosystem. This is made possible by using actual travel data, and the inputs of the user.

3.2 Customer Segments

The app is primarily aimed at local Vestland commuters and residents who are between 16 and 65 years old, while the focus of marketing should be aimed at younger people under the age of 35, since this group is generally more focused on sustainability. A second segment is tourists travelling in Vestland, who have an interest in keeping their travel emissions low. The app can also be used by businesses and institutions to improve their travel reporting.

3.3 Channels

The main channel remains the app itself, either standalone or integrated into already existing products by Skyss. We also reach out to our customers by advertising and notifications within the partner apps.

3.4 Customer relationship

We strengthen our relationship with our customers by regular personalized reports showing monthly emissions. We also encourage engagement through transparent communication and open feedback channels in the app.

3.5 Revenue Streams

The app mainly finances itself through partnership agreements with the local transport providers and government. The app also offers a Freemium model, where users can pay to receive advanced analytics. Furthermore, some anonymous travel data insights can be sold to municipalities to improve the sustainability reporting.

3.6 Key resources

Our main resource is our development team, who use technical resources such as AWS cloud infrastructure, GitHub, Python and Code Editors to develop and deploy our application. The travel data, either provided by the users or through access to Skyss infrastructure is also key to ensuring a functional and useful application.

3.7 Key activities

The key activities include developing and deploying the app, while also providing the necessary methodology explaining the inner workings in a paper. In addition, the outlining and implementation of our business model is necessary.

3.8 Key partners

Our key partners include the local public transport authority Skyss as well as local governments and the Vestland region, for strategic and financial support. Since the development is done by students at HVL, they can also be seen as a key partner.

3.9 Cost structure

The costs of the app are relatively low compared to competitors, because the development is done as a part of a student project. Other relevant factors include the cost of server hosting through AWS, potential fees for access to APIs as well as costs for marketing and promotional activities. A key target is to manage financial resources responsibly.

3.10 Flow diagram

The flow diagram visualizes the value creation process of our app. It illustrates how every step of reducing emissions is realized in our concept, from tracking to insight, from integration to reporting and from feedback to action.

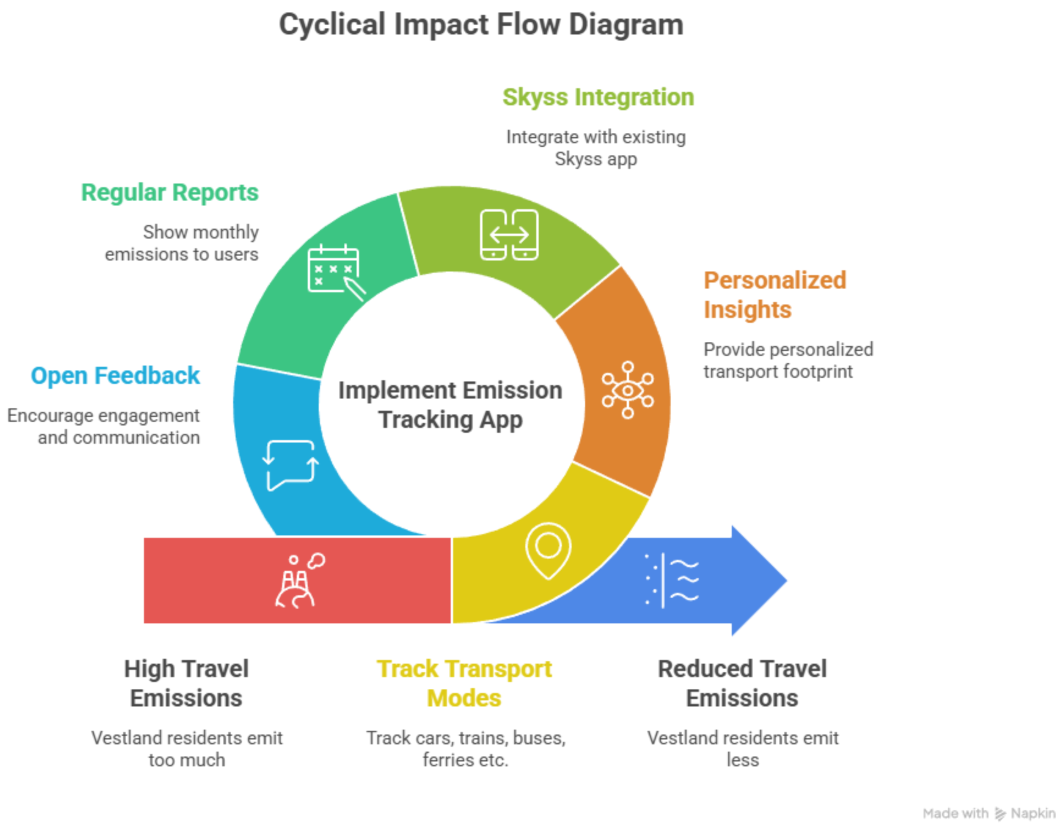
This diagram illustrates the step-by-step process of how the emission-tracking app contributes to reducing travel emissions in Vestland. The process follows a circular structure, but it has a clear starting point and an end goal.

The process starts with high travel emissions. At this stage, many residents in Vestland produce a lot of emissions through their daily travel. Clearly, there is a problem, but often people do not know just how high their emissions really are. The next step is tracking transport modes. In this step, the app starts collecting data about the way people travel, such as by car, bus, train, or ferry. This tracking happens in the background and creates a very thorough picture of everyday mobility patterns. It is not possible to measure or improve anything without such a step. By means of this information, the app generates Personalized Insights. Instead of general climate information, each user is provided with an overview of their individual emissions. Therefore they are able to see which modes of transport emit the most and where further change could be made. In this manner, the environmental impact is being made tangible and understandable.

After that, the diagram shows Skyss integration. The app is integrated into the existing Skyss system. The service is easier to use and much more reliable because of that. Users do not need to input all trips manually; the system may use Skyss data for accuracy and convenience.

The next is regular Reports. The individual users receive frequent summaries of their emissions over time, such as on a monthly basis. These reports show trends and progress, allowing users to stay informed about their behaviour and any improvements they have already made.

Then comes open Feedback. Here, users can share their experiences, problems, or suggestions. This two-way communication helps the developers improve the app while strengthening user engagement. The process leads finally to Reduced Travel Emissions. Through better data, clearer insights, strong integration, and continuous feedback, residents are encouraged toward more sustainable transport options. Over time, this leads to lower emissions for individuals and the region as a whole.



Conclusion

In this project we set out to create a smart and accessible way for the residents in Vestland to get a better understanding of their CO_2 emissions caused by their daily travels. By combining travel data from the real world and combining them with inputs from our users, our app provides personalized insights for each and every user. We made this so it becomes easier for each individual to act upon their habits and see where they can improve. Through the integration with already existing "Skyss reise" app, our solution becomes more accessible and convenient for the travellers in Vestland who already use their platform.

Our methodology shows that different transport modes contribute very differently to total CO_2 emissions. It also shows that even small changes can make a significant difference. By presenting these insights in a clear way, our app encourages users to choose better and prioritize more sustainable alternatives when it's possible. Our business model canvas shows that our app can easily be integrated into the already existing “Skyss reise” app with a feedback loop supported by our value flow diagram. This ensures improvement and more accurate emission insight. Our business model differentiate us from standalone apps because our model allows us to use data, user feedback and system integration work to together with Skyss to deliver a smoother and better costumer experience.

Ultimately, our project demonstrates how modern technology, data gathering, and local partnerships can encourage individuals to take a part in the worldwide transition towards a greener future. If this was implemented on a larger scale, this solution could help both Vestland and maybe even the whole of Norway to support their climate goals. As this is important for our future generations.

References

Business Model Canvas. (n.d.). *The business model canvas*. Strategyzer. Retrieved from https://www.strategyzer.com/library/the-business-model-canvas

European Environment Agency. (n.d.). *CO_2 performance of new passenger cars*. European Environment Agency. Retrieved from https://www.eea.europa.eu/en/analysis/indicators/co2-performance-of-new-passenger

Fjord1. (2024). *Bærekraftsrapport 2024*. Fjord1 ASA. Retrieved from https://www.fjord1.no/

Framtiden i våre hender. (n.d.). *Klimagassutslippet fra ulike reisemåter*. Retrieved from https://www.framtiden.no/tips/klimagassutslippet-fra-ulike-reisemaater

International Energy Agency. (2025). *Global energy review 2025: CO_2 emissions*. Retrieved from https://www.iea.org/reports/global-energy-review-2025/co2-emissions

Larsson, J., Kamb, A., & Månsson, E. (2024). *Method report – "Så har vi räknat"* [Version 4.1]. Klimatsmart Semester. Retrieved from: https://klimatsmartsemester.se/sa-har-vi-raknat

Miljødirektoratet. (n.d.). *Tabeller for omregning fra energivarer til kWh*. Retrieved from https://www.miljodirektoratet.no/ansvarsomrader/klima/for-myndigheter/kutte-utslipp-av-klimagasser/klima-og-energiplanlegging/tabeller-for-omregning-fra-energivarer-til-kwh/

Norwegian National Human Rights Institution. (2023). *Canary in the coal mine: Norway's GHG emissions and climate policies*. Retrieved from https://www.nhri.no/en/report/canary-in-the-coal-mine/5-norways-ghg-emissions-and-climate-policies/

Skyss. (n.d.). *Nyttig reiseinformasjon*. Skyss.no. Retrieved from https://www.skyss.no/reise/nyttig-reiseinformasjon/

Statistisk sentralbyrå. (2016, December 7). *Drivstofforbruk og utslipp per kjørte kilometer for et utvalg av trafikksituasjoner og kjøretøygrupper*. Statistisk sentralbyrå. Retrieved from https://www.ssb.no/318322/drivstofforbruk-og-utslipp-per-kjorte-kilometer-for-et-utvalg-.øav-trafikksituasjoner-og-kjoretoygrupper.2016.g-km

Stensvold, M. (2019, August 26). *Studie: Elsparkesykkel er mindre miljøvennlig enn buss*. NRK. Retrieved from https://www.nrk.no/urix/studie_-elsparkesykkel-er-mindre-miljovennlig-enn-buss-1.14650738

The Norwegian Water Resources and Energy Regulatory Authority. (2021, August 27). *Electricity disclosure 2018*. Retrieved from https://www.nve.no/norwegian-energy-regulatory-authority/retail-market/electricity-disclosure-2018/

Tiltak.no. (n.d.). *Delte elsparkesykler*. Retrieved from https://www.tiltak.no/c-miljoeteknologi/c1-drivstoff-og-effektivisering/delte-elsparkesykler

Wiig, Å. (2021). *Climate activism amongst young Norwegians and their motivations* [Master's thesis, Norwegian University of Life Sciences]. NMBU Brage. Retrieved from https://nmbu.brage.unit.no/nmbu-xmlui/bitstream/handle/11250/2837013/wiig2021.pdf