Entry Carbon Accounting Project: GHG Protocol Report of a Car Rental Company

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Contents

1. Project Description

This paper serves to detail an introductory 2-week carbon accounting project based on a fabricated car rental business, using Greenhouse Gas Protocol reporting. It will utilize application of fundamental carbon accounting techniques and will be primarily done in the software **PowerBI**, a business tool meant to preprocess and analyze datasets and aid comprehension of various projects between businesses and shareholders, via Data visualization in dashboards.

1.1. Motivation

The project aims to tackle the problem of increasing transport emissions in Poland. Between 1990 and 2016, emissions from transport increased by a factor of 2.5 from 22.4 Mt CO2eq to 56.0 Mt CO2eq. As such, Poland is experiencing amplified climate change compared to the rest of Europe. As part of the European Union, Poland is signatory to the 2015 Paris Agreement - requiring the full decarbonization of the economy by early 2030 to limit warming by 1.5C and 2.0C by 2050 compared to pre-industrilization level [1].

Largely due to the growing economy in Poland, vehicles have become increasingly more prominent among new buyers, while the average age of vehicles on the road remains 15 years. If Poland takes no action, it will fall short of the 2030 reduction goal by 47.2 Mt Emissions. Assuming all other sectors meet their targets, this could cost €30 Billion in allowances, assuming €100/tonne and 297 million allowances.

As such, businesses with personal vehicle fleets face the challenge of measuring their effect on climate change. Clients, investors and regulators have set a standard in companies to provide transparency, emission reduction strategies, and high quality reports. Large companies are required by EU's Corporate Sustainability Reporting Directive to showcase their climate impact, and this will soon affect smaller businesses too.

1.2. Greenhouse Gas Protocol

Greenhouse Gas Protocol (GHGP) provides the foundation for more sustainable climate strategies and more efficient, resilient and profitable organizations. GHGP standards are the most widely used accounting tools to measure and report on gas emissions. As such, GHGP standards shall be used in order to form the general structure of this report.

EU Member countries are required to report their Greenhouse emissions annually as per the Paris Agreement and the UNFCCC. As such, reports must be **Relevant, Complete, Consistent, Transparent** and **Accurate**. GHGP standards will be applied as much as possible in the scenario of a car rental business, unless a lack of accessible data prevents it.

A GHGP report requires the following:

- Company description
- Organizational boundary; Consolidation approach
- Operational boundary
- Reporting period

- Total scope 1 and scope 2 emissions
- Emissions of all 7GHGs separately
- Base year and emissions profile over time
- Calculation methodologies
- Any exclusion of sources

1.3. Dataset Limitations

As this is a personal project meant to showcase the application of carbon accounting techniques, access to real data of a particular company is greatly restricted. Instead, the project will utilize free-access data from industry-standards and the European Environment Agency (EEA). EEA Provides a dataset detailing the monitoring of CO2 emissions from passenger vehicles [2].

This is an incredibly large dataset consisting of all vehicles in the EU, as per year of registration. The data contains information on vehicle model, fuel type, lab-tested CO2 emissions via. Worldwide Harmonized Light Vehicles Test Procedure (WLTP), engine capacity, and more. In order to create a meaningful dataset for this project, non-electric vehicles in Poland were randomly selected in order to generate a fleet of 250 vehicles. This was done with Power Query in PowerBI.

This method has limitations in that all vehicles of a particular fleet were registered in 2023, hence all models are relatively new. Thus, the generated dataset does not represent the average age of vehicles in Poland. Furthermore, emission trends may not be analysed as in typical GHGP reports, with a baseline year and emission changes over time - this limits the data visualization possible. It can be assumed that for a corporate fleet, vehicles may be newer in order to reduce maintenance costs. The resultant estimations are incredibly likely an **underestimation** of average non-EV fleet emissions, due to the various assumptions made during the exercise. These will be detailed in a later section, following the methodology.

Please keep in mind while reading this report, company details and emissions are all fabricated for the sake of the exercise - without breaching data protection laws. Nevertheless, it will attempt to recreate a realistic carbon accounting scenario as possible with the data that was easily-accessible within the 2-week period.

2. Company Description

CarRentals4U is a car rental company based in Warsaw, Poland. It specializes in providing short and long-term vehicle rentals for individual and corporate clients throughout Poland. The primary operations include vehicle rentals, maintenance services, and administrative functions, all based out of the Warsaw headquarters located at [address].

For GHG emissions reporting, CarRentals4U uses the operational control approach, encompassing **100%** emissions from all company-owned 250 non-electric rental vehicles, maintenance facilities and corporate offices. CarRentals4U is fully self-owned and

managed, allowing it to maintain complete control over its fleet, facilities and all operational aspects.

The value chain of the business can be summarised:

- **Upstream emissions**s – OEM production, transport & distribution, maintenance/repair, IT services, purchased goods
- **Core operations** – Fleet emissions, energy consumption in offices
- **Downstream emissions** – Client fuel use, waste disposal, end-of-life emissions

Following on, scope emissions are detailed:

Scope	**Definition**
Scope 1 – Direct Emissions	Emissions directly generated from operations controlled by CarRentals4U. Significant emission sources include: • Fuel combustion from transportation equipment and goods to/from clients • Natural gas consumption in heating offices
Scope 2 – Indirect Emissions	Emissions from the production of purchased electricity, heating or cooling. Most significant emission sources include: • Energy consumption (electricity and heat) from operating assets
Scope 3 – Upstream Emissions	Emissions generated by activities occurring before company provides service. Significant sources include: • Extraction, production and transportation of fuel and electricity • Purchased goods: paper, pens, etc
Scope 3 – Downstream Emissions	Emissions generated after service is provided. Significant emission sources include: • Client use of rental vehicles • Waste disposal

Table I: Scope Emissions

This report covers the period from **January 1, 2023, to January 1, 2024**. Emissions data are presented on Scope 1 and Scope 2, and Scope 3 reporting to capture upstream and downstream impacts linked to vehicle operation and fleet management. Most of the emissions will occur in Scope 3, due to the nature of a car rental value chain.

3. Emissions Data

3.1. Data Collection Process

As already mentioned in the Data Limitations section of this report, the fleet information was generated via randomly sampling non-EV vehicles registered in Poland from an EEA Monitoring of CO2 emissions from passenger cars dataset, Regulation (EU) 2019/631, through PowerBI PowerQuery.

As such, 250 rows of data detailing vehicles, their emissions and other characteristics were obtained.

Along with fleet data, more information is required to perform a complete report of Scope emissions. Moreover, missing data regarding the scope emissions of the business as listed in Table I was obtained from secondary sources appropriate for the scenario. These sources, along with the emission factor database, can be found in the references of this report.

All data was loaded and prepared into PowerBI for emission estimation; as described in the following section.

3.2. Methodology

3.2.1. Mobile Emissions

In a car rental business, most significant emissions are produced via. the customer use of rental vehicles [3]. This falls under Scope 3 downstream emissions and must be estimated accurately as possible.

The average rental car mileage annually falls between 20-25k miles/year [4]. Furthermore car rental businesses have an average fleet utilization rate of 80% [5]. Therefore 200 vehicles were further randomly sampled from the 250 fleet dataset.

Due to varying efficiencies, emission factors (EFs) take fuel type as an additional parameter. The count of fuel types in the resultant dataset is shown:

Fuel Type	Vehicle Count
petrol	156
lpg	1
diesel	43
Total	**200**

Table II: Count of Fuel Types of RentalCars4U Fleet

The average distance of 20k miles was multiplied by respective fuel type efficiencies (litres/mile), in order to compute vehicle fuel consumption:

$$\text{Vehicle Fuel Consumption} = \text{Distance Traveled} \times \text{Vehicle Fuel Efficiency}$$

The EFs for each fuel type are then multiplied by the fuel consumption value to yield mobile emissions:

$$\text{Mobile Emissions} = \text{Vehicle fuel consumption} \times \text{Fuel EF } (\text{kg}CO_2\text{e/litre})$$

Further Scope 1 mobile emissions occur from the transportation of equipment and goods to/from clients. The exact consumption-based method would be re-utilized in order to compute further emissions from fuel combustion, however, a lack of data prevents this step.

3.2.2. Gas & Electricity Emissions

Stationary emissions fall under Scope 1 and come from fixed sources such as gas boilers, which are used in heating of office spaces. Emissions can be calculated via. the consumption-based method similarly to mobile emissions above. Secondary data shows that for small-sized businesses, gas consumption averages at 25,000 kWh [6]. Therefore, emissions are computed as follows:

$$\text{Stationary Emissions} = \text{Natural gas consumed} \times \text{Natural gas EF (kg}CO_2\text{e/kWh)}$$

Electricity consumption falls under Scope 2. To estimate, the location-based method was utilized. This calculates carbon emission by reflecting the average emission intensity of the grids where the energy consumption takes place. For small-sized businesses, electricity consumption averages at 20,000 kWh[6]. Therefore, emissions are computed as follows:

$$\text{Electricity Emissions} = \text{Electricity consumed} \times \text{Location-based Poland EF (kg}CO_2\text{e/kWh)}$$

3.2.3. Remaining Scope 3 Emissions

The extraction, production and transportation of fuel and electricity for the business falls under upstream emissions. This computation accounts for upstream processes associated with the fuel and electricity consumed by the company:

$$\begin{aligned}\text{Emissions from upstream fuel consumption (kg}CO_2\text{e)} = \\ \text{Scope 1 \& 2 energy consumption (litres, kWh)} \\ \times \text{Upstream EF for fuel/electricity(kg}CO_2\text{e/litre, kWh)}\end{aligned}$$

The EFs for this calculation differed per energy consumption type (e.g. natural gas, petrol, electricity).

Further upstream emissions come in the form of purchased goods, such as paper and pens for office use. A small company of 40 employees tends to spend $45 per employee [7], monthly, on office supplies. Annually, that comes out to $21600. This allows for a spend-based emission estimation.

$$\text{Emissions from office supplies} = \text{Cost (USD)} \times \text{EF for Office Supplies (kg}CO_2\text{e/USD)}$$

Finally, downstream emissions come in the form of waste disposal. This estimation will prove to be difficult without knowledge of real data regarding the usage of goods. However, a very rough calculation is possible based on averages. Paper makes up around 50% of a business' waste [8]. This would amount to $10800, and therefore assuming an

$0.08/sheet cost, this is approximately 135000 sheets of paper. Each A4 sheet of paper weighs approximately 5g, resulting in 675kg of paper wastage.

$$\text{Emissions from recycled paper} = \text{Paper Waste (tons)} \times \text{EF Paper Recycling (kg}CO_2\text{e/tons)}$$

Assuming that the rest of company wastage is in the form of plastic, and each employee produces 0.5kg of plastic waste per day, this would produce around 5200kg of wastage for all 40 employees. The recycling rate in Poland is 27% on average [9]. This results in 1404kg of plastic recycled, and 3796kg of plastic landfilled.

$$\text{Emissions from recycled plastic} = \text{Plastic Waste (tons)} \times \text{EF PET Recycling (kg}CO_2\text{e/tons)}$$

$$\text{Emissions from landfilled plastic} = \text{Plastic Waste (tons)} \times \text{EF Plastic Landfilling (kg}CO_2\text{e/tons)}$$

3.3. Data Presentation

All emission factors have been applied on the available data and this section serves to discuss the resultant scope emissions.

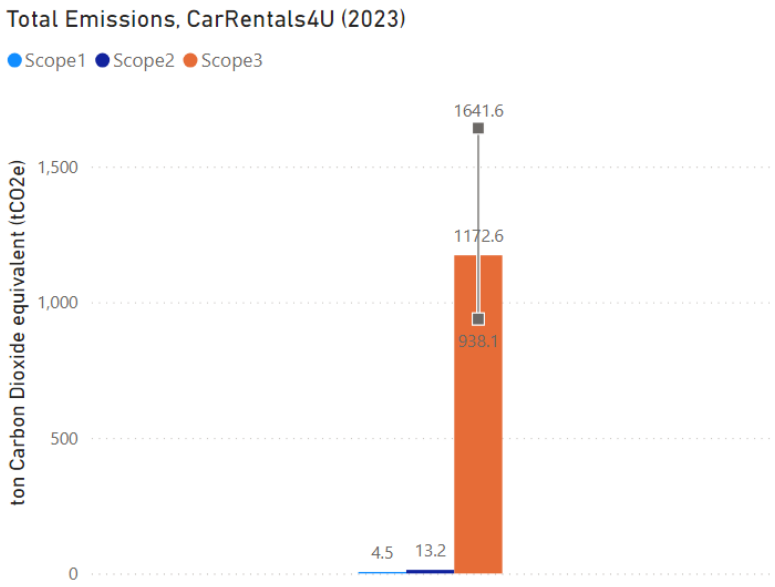

Figure 1: Scope 3 operations of CarRentals4U contribute 98% of the total business emissions. Error bar represents a 40% upper bound to account for assumptions made.

CarRentals4U has majority of emissions in Scope 3, coming to 1172.6tonsCO_2. This is explained by the main business model being focused on downstream leased assets (rental vehicles). Scope 3 emissions may be further drilled down in order to find the most significant sources.

In total, CarRentals4U, emitted an estimated 955.8 to 1659.3 tons of CO_2eq into the atmosphere in the year 2023. Assuming an allowance cost of €100/tonne, this will cost the business €95,580 to €165,930. With a fleet of 200 vehicles, there is an intensity ratio of 4 ton CO_2eq / car. Each vehicle costs €400 per ton CO_2 emitted in terms of allowances.

Could electrification of the fleet reduce emissions in the following year? While the average gasoline car emits near 410gCO_2/mile over its lifetime, an electric vehicle emits

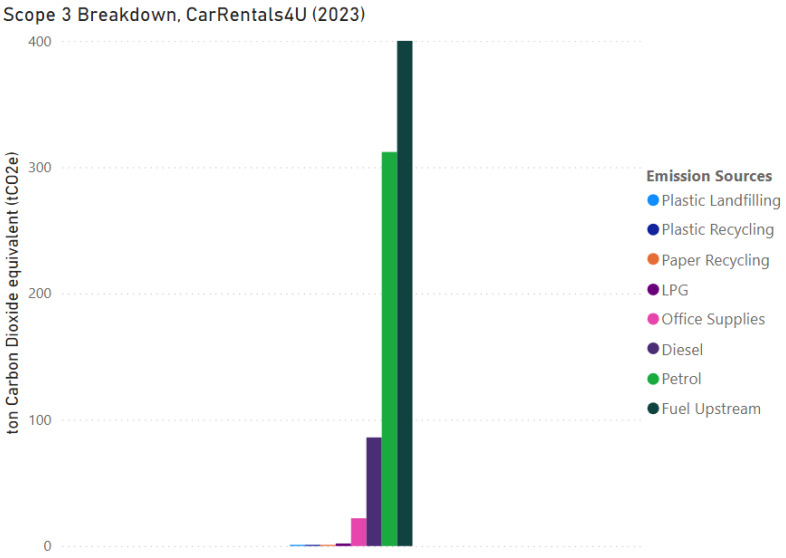

Figure 2: Fuel consumption and its upstream operations are biggest contributors to Scope 3 emissions.

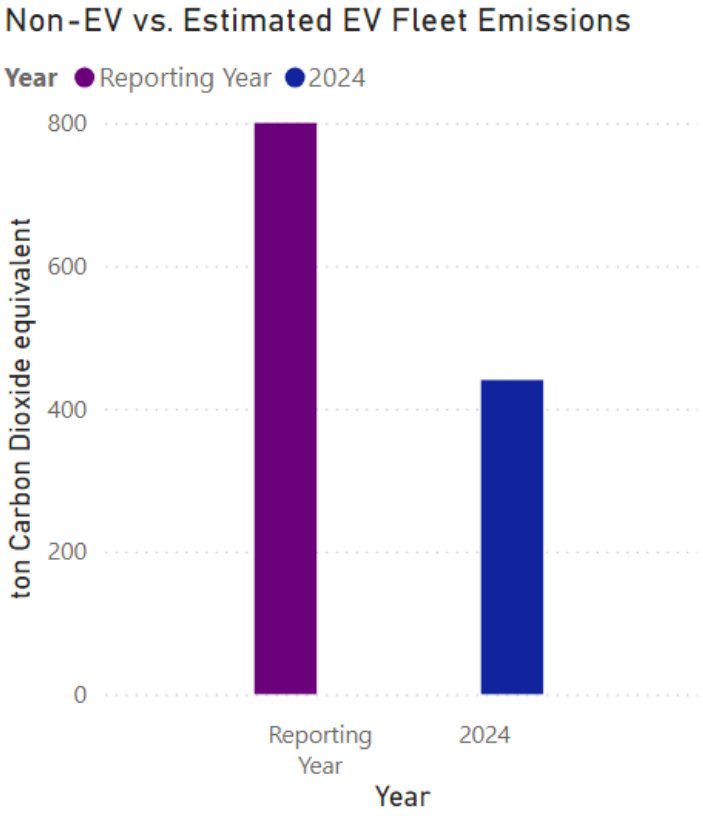

Figure 3: Fleet emissions are reduced by 45% in 2024.

110gCO_2/mile. Using a consumption-based method of 20000 miles per vehicle, it is possible to compare future emissions in the 200EV fleet. Although initial investment may be higher, lowering transport emissions will become increasingly crucial for growing businesses as time nears the Paris Agreement deadlines. Therefore it is advised to begin early, not only to reduce cost of allowances, but also to network and form strong relations with manufacturers.

The European Commission 'Greening corporate fleets' initiative presents a vital

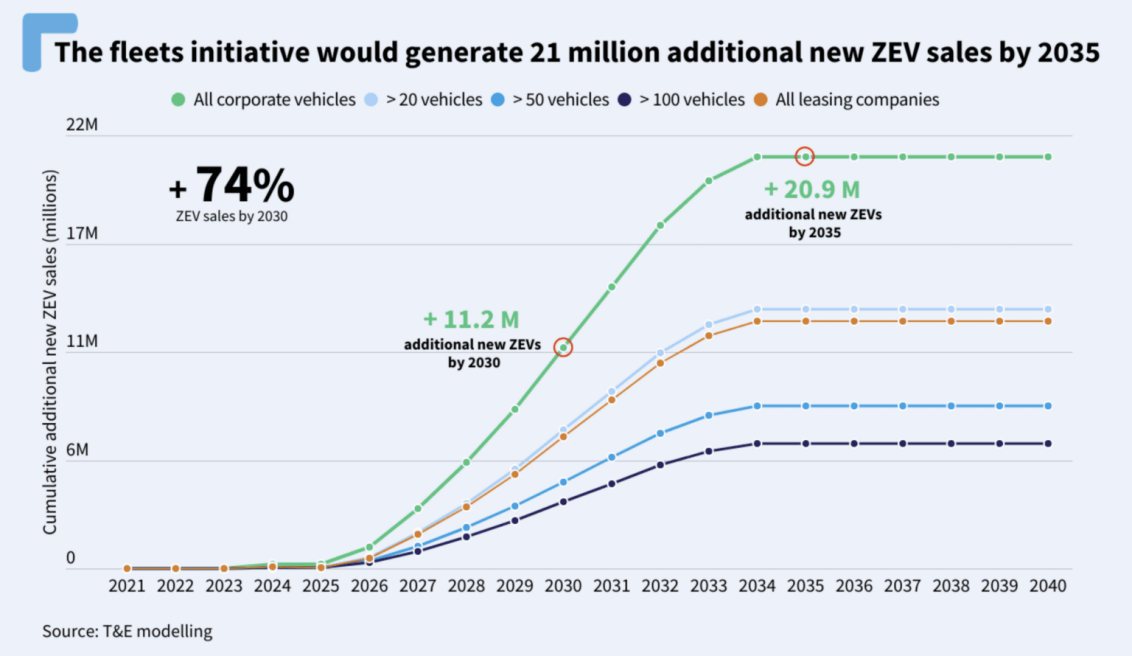

Figure 4: Source: The corporate cars problem and what the EU can do about it — The ICCT

opportunity to electrify corporate fleets and reduce car emissions by 30 $MtCO_2eq$ by 2030, by increasing availability of affordable EVs. Furthermore, the all industries are urged to promote a transition to sustainable transportation. The trend of corporate vehicles investing in electric vehicles is shown in Figure 3.

3.4. Limitations and Assumptions

Due to the nature of this fabricated exercise, the limitations and assumptions are extensive and must be described in great detail. This section will attempt to discuss the reasons for the steps taken in the report chronologically, and provide a better solution in the scenario of having access to better data.

Sample Limitations:
A random sample takes into account the distribution of the many EU registered vehicles, though it may not represent:

- The distribution of real fuel type usage – Only 1 vehicle utilizing lpg fuel.
- The vehicles that a car rental business may invest in – There was no account for model cost.

However, upon further analysis, the complete dataset shows that LPG fuel is used in only 3% of registered vehicles. This fits well with our random sample. LPG is considered to be a cost-effective and environmentally friendly fuel, producing less emissions than diesel and petrol on average, and hence a representative sample is essential. Moreover, there was no attention given to the hypothetical investments a car rental may make based on cost. In reality, a carbon data analyst would have access to detailed fleet data.

Scope Emission Exclusions:
Many aspects of the value chain of a typical car rental business were not included in the definition section of Table I. As per following the guidelines of European Rental

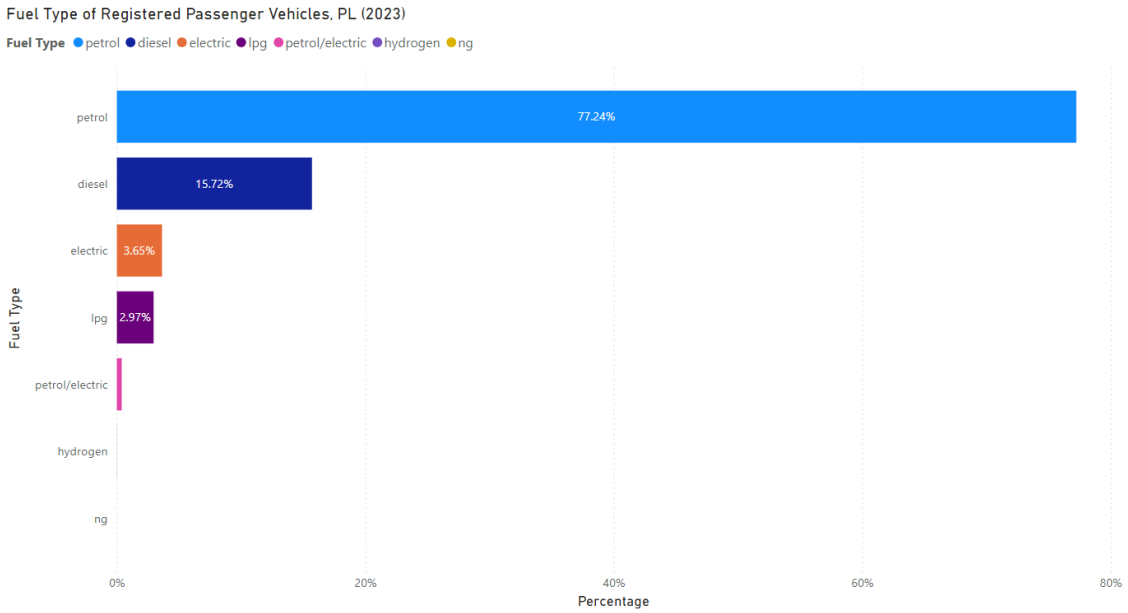

Figure 5: Distribution of fuel types in registered passenger vehicles in Poland.

Association, many aspects of a car rental business were assumed to have negligible impact:

- **Fugitive emissions** (Scope 1) – intentional/unintentional GHG gas releases from leaks
- **Processing of sold products** (Scope 3, downstream) – Emissions from processing of sold products by third parties (e.g. manufacturers)
- **Franchises** (Scope 3, downstream) – Emissions from operation of franchises
- **Investments** (Scope 3, downstream) – Emissions associated with a company's investments in the reporting year

Further aspects of the value chain were excluded in order to simplify the accounting required for this project. This can be explained by the restricted access to data as well as the 2-week constraint to have it completed. Omitted Scope 3 emission sources include:

- **Capital goods** (upstream) – Emissions from acquired assets such as equipment from OEMs, real estate, vehicles
- **Transport and distribution losses** (upstream) – Losses on transported/distributed fuel after extraction
- **Waste in operations** (upstream) – Emissions from disposal of waste in company's upstream operations, e.g. maintenance/repair
- **Business travel** (upstream) – Emissions in transportation of employees for business activities
- **Employee commuting** (upstream) – Emissions in transportation of employees from home to workplace

- **Leased assets** (upstream) – Emissions from operation of leased assets e.g. leased real estate, equipment, vehicles
- **Transportation & distribution** (downstream) – Emissions from T&D of sold products by vehicles not owned by the company
- **End of life treatment of sold products** (downstream) – Emissions from waste disposal of products sold (e.g. vehicles).

From this list, the most significant omitted source of emissions would come from end of life treatment of sold products. It is common among car rental businesses, that once a vehicle completes a total mileage of 30k miles, it is then sold off.

A carbon data accountant would have access to all relevant data required to produce a complete analysis of the value chain. Car rental businesses on average produce 95% of their emissions within Scope 3, and should do their best to avoid omitting emission sources as in this project.

Emission Estimation Limitations:
There are two assumptions made for the estimation of mobile emissions. It was assumed that only 200 out of 250 was driven an average distance of 20k miles, while the remaining 50 vehicles were sampled out. Realistically, every vehicle at a car rental is likely to be utilized and driven some mileage annually. This means certain fuel types would be utilized more than others. Additionally, fuel consumption tends to vary between city/rural/highway driving. Furthermore, it is assumed that transportation of goods to/from clients is negligible.

For gas and electricity estimations, secondary data is utilized to perform an average calculation. CarRentals4U is assumed to be a small-sized business, with industry-standard energy consumption values. This leaves out a lot of nuance that would realistically be taken into account, such as: fuel types, efficiency of office space, etc. Moreover, utilizing a country location-based emission factor approach in this project may be accurate enough, although estimation improvements could be seen with a market-based method.

Further nuance is lost on assumptions made on purchased goods emissions. An attempt was made to produce a rough estimation based on industry averages. However, the majority of the information is based on US-markets, not Poland. It can be assumed that the emission factors account for cost differences. Realistically, a business may invest more or less in certain goods based on national costs.

4. Project Challenges & Reflection

This two-week project was set in order to become familiar with GHG Protocol reporting, carbon-accounting terminology and the fundamental data analysis process within PowerBI in a very short period. All goals were achieved and the project pushed me beyond to identify problems in my methodology, the need for well-collected data, as well as the pros and cons of different estimation approaches.

The greatest challenge of this project was to work with fabricated data and averages, as

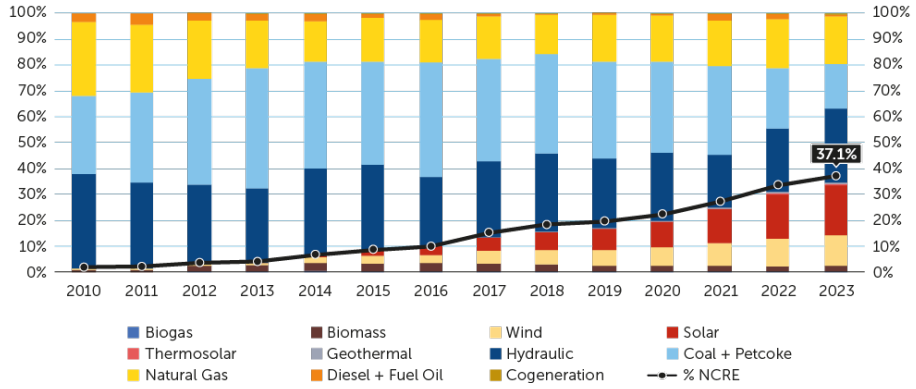

Figure 6: Example graph evolution of GHG KPIs. Source: hacienda.cl

well as a lack of data. As a result, many assumptions had to be made in various parts of the value chain (e.g. transport & distribution). In many cases, without direct knowledge of the car rental industry, emissions felt impossible to estimate. Literature reports a 40% error rate in Scope 3 emissions in professional carbon accounts, which signifies the importance of having access to data with a high-quality collection process. Unfortunately, a lack of access to data further limited the level of data visualization possible, there was not a simple method to show trends as in a typical GHG report, nor completely report Scope 1 and 2 emissions, which are typically required to have a great accuracy.

As for GHGP standards, relevancy, consistency and transparency was applied. Completeness and accuracy was not achieved. In terms of report requirements, only two points were not achieved: emission trends over time, emissions of all 7GHGs over time. This is quite impressive considering the challenges presented.

In a future report, I would dedicate a greater time to the project. This will allow acquiring data to fill more missing spots of the value chain. I would ensure that emission factors are applied with greater nuance to improve the accuracy of my estimations. If company data would be available, I would additionally employ a supplier method in quantifying emissions from purchased goods rather than the spend-based method in this paper. Finally, I would analyse the two KPI's in this report (ton CO_2eq / car, and € / ton CO_2eq) over time with a combination line and bar chart as in Figure 6.

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