Data Visualization for Fuel Consumption Rating Canada 2012-2023

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1. Overview

The Government of Canada provide essential information about the fuel consumption rating in light duty vehicles. The data is collected by Environment and Climate Change Canada from the vehicles manufactures. Natural Resources Canada (NRCan) then published the Fuel Consumption Rating to help consumers compare vehicles and choose the most fuel-efficient option that meets their daily needs. We obtained a database from Natural Resources Canada's Open Government Licence - Canada[[1]](#footnote-1) providing a comparison of various manufacturers and vehicle types based on fuel economy and CO2 emissions from 2012 to 2023.

* *Flaming the problem*

In Canada, 27 percent of greenhouse gas (GHG) emissions come from the transportation sector. Nearly half of this is from light-duty vehicles - the cars, vans and light trucks we drive. Although car manufacturers have managed to reduce emissions of criteria air pollutants (CACs) from cars and light trucks, fuel consumption and carbon dioxide (CO2) emissions have steadily increased over the past two decades. That is because CO2 is an unavoidable by-product of burning fossil fuels. CO2 is the primary greenhouse gas linked to climate change. Although light-duty vehicles are more fuel efficient than they were in the 1970s, there are many more vehicles on the road today, and we're driving them farther than before, using more fuel. While much of the energy used in Canada is necessary, there are times when we could use energy more wisely (Government of Canada, 2010).

In light of these facts, people must make conscientious decisions about which vehicle should be more convenient both in terms of fuel economy as well as environmental friendliness. In this context, it is essential to address the following questions in our analysis:

* *Questions*
* What types of vehicles are there in Canada and how do they relate to fuel consumption and CO2 emissions?
* What is the relationship between driving mode (city/highway) and CO2 emissions?
* What is the relationship between engine type and combined (city/highway) fuel consumption per 100km?
* What are the changes that have occurred in the levels of CO2 emissions, and what do we anticipate for the upcoming years?
* What is the current trajectory of fuel consumption, and what are the projected alternatives that are expected to emerge in the near future?
* How can the reputation of a vehicle be understood in terms of the CO2 emissions it produces?
* What is the most fuel-efficient and environmentally friendly vehicle segment in terms of CO2 emissions and fuel consumption?

1. Methodology

We obtained a database from Natural Resources Canada's Open Government Licence - Canada[[2]](#footnote-2) providing a comparison of various manufacturers and vehicle types based on fuel economy and CO2 emissions. To guarantee accuracy and consistency, we took considerable care to clean and integrate these datasets using Python. We were able to acquire trustworthy data using this rigorous process, which served as the foundation for our following data visualization analysis.

1. Goal

What are the vehicles with superior fuel efficiency and commendable CO2 emission rating within the period of 2012 to 2023 in Canada?

1. Dataset

Datasets provide information on model-specific fuel consumption ratings and estimated carbon dioxide emissions for new light-duty cars available for purchase in Canada. Fuel consumption figures for vehicles made between 2012 and 2023 have been changed to reflect more realistic testing procedures that better match normal driving situations, allowing for easier comparisons between model years. It is crucial to note that these are merely estimates based on the original ratings, not actual vehicle testing (Open Data Canada, 2023)

The data set contains information about fuel consumption rating in vehicles such as electric, hybrid and gasoline information as shown in **Table 1**. The objective of this data set is to explore how three different vehicles segments are being rating according to CO2 emissions.

Table 1. Details of the Fuel Consumption Rating Data Set

## Fuel Vehicles

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| --- | --- |
| Year | 2012-2023 |
| Make | List of automobile manufacturers |
| Model | 4WD/4X4 = Four-wheel drive  AWD = All-wheel drive  FFV = Flexible-fuel vehicle  SWB = Short wheelbase  LWB = Long wheelbase  EWB = Extended wheelbase |
| Transmission | A = automatic  AM = automated manual  AS = automatic with select shift  AV = continuously variable  M = manual  3 – 10 = Number of gears |
| Type Vehicle | EV=Electric Vehicle, Hybrid, Fuel |
| Class Vehicle | series of ratings assigned to different segments of automotive vehicles for the purposes of vehicle emissions control and fuel economy calculation. |
| Motor kW | kiloWatts/hour |
| Engine Size | Litres |
| Cylinders | Number of Cylinders inside engine |
| Fuel Type | X = regular gasoline  Z = premium gasoline  D = Diesel  E = etanol (E85)  N = natural gas |
| Fuel Consumption | City and highway fuel consumption ratings are shown in litres per 100 kilometres (L/100 km) - the combined rating (55% City, 45% Hwy) is shown in L/100 km.  City L 100km  Hwy L 100 km  Comb L 100 km |
| Electric Consumption | The combined fuel consumption rating reflects 55% city and 45% highway driving.  Le is gasoline litre equivalent. One litre of gasoline contains the energy equivalent to 8.9 kWh of electricity.  City kWh 100km  Hwy kWh 100 km  Comb kWh 100 km |
| CO2 emissions | the tailpipe emissions of carbon dioxide (in grams per kilometre) for combined city and highway driving |
| CO2 Rating | the tailpipe emissions of carbon dioxide rated on a scale from 1 (worst) to 10 (best) |
| Smog Rating | the tailpipe emissions of smog-forming pollutants rated on a scale from 1 (worst) to 10 (best) |

**Part A – Tableau workbook solution**

**Storytelling**

When it comes to storytelling, we take a certain approach. We focused on answering the story's "who," "what," and "how."

We research fuel consumption ratings to offer to our audience, which primarily consists of international students in Canada. Our goal is to educate them about fuel use and CO2 emissions. This is a particularly pertinent subject because car use is crucial in Canada. We utilize Tableau software to analyse and illustrate data to assist our audience to comprehend it.

* The context

The first of two slides are oriented to contextualize our audience. Initially, we want to offer in the story telling about a significant dilemma to use a efficient vehicle. Then, we are talking about our data resource to explain fuel consumption rating using several automobile variables.

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**What types of vehicles are there in Canada and how do they relate to fuel consumption and CO2 emissions?**

To answer this question, we created the following story

**Story : Driving Towards Sustainability: A Comparative Analysis of Vehicle Types and CO2 Emissions Over Time by Fuel Type**

In this story, we provide the reader with an overview of the share of CO2 emissions produced by vehicles using a particular fuel type and how it has changed over the past decade. Global data is also provided in the text box.

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Description automatically generated with medium confidenceDashboard**

We selected three types of graphs for the dashboard. A bar chart to show the quantities corresponding to the vehicle inventory of the data set, a pie chart to show the proportions of CO2 emitted by each fuel type, and a combined graph between the CO2 emissions quantity and the trend over a 10-year time window.

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**Sheetworks**

In general, the question "What types of vehicles are there in Canada and how do they relate to fuel consumption and CO2 emissions? "could be answered as follows:

Three types of vehicles have been registered in Canada over the past ten years: electric vehicles, hybrid vehicles (Chart 1), and vehicles that use some form of fossil fuel. Furthermore, four types of fossil fuels have been identified: regular gasoline, gasoline, premium gasoline, diesel, and E85 ethanol (chart 2). Each type of fossil fuel has a share of CO2 emissions depending on the type of vehicle. Finally, the trend of the type of vehicle with the amount of CO2 emissions over the last 10 years can be observed (chart 3). That is, while the amount of fossil fuel vehicles remains constant over time, there is an increasing trend in the production of hybrid vehicles and CO2 emissions.

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| **A screenshot of a computer  Description automatically generated with medium confidence**Chart1 |
| **A screenshot of a computer  Description automatically generated with medium confidence**Chart1 |
| **A screenshot of a computer  Description automatically generated with medium confidence**Chart3 |

**What is the relationship between driving mode (city/highway) and CO2 emissions?**

**Story: Fueling Our Drive to a Greener Future: Linear Regression Analysis of Fuel Consumption and CO2 Emissions in City, Highway, and Combined Driving Scenarios**

In this story, we show the existence of a relationship between the CO2 emissions of each type of vehicle and highlight an example vehicle for each type. In this way, the audience can get an idea of the comparison. In addition, an average difference will be shown for each driving scenario. In the end, we want to show the impact that each type of vehicle has on the CO2 emissions.

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**Dashboard and worksheet**

For the dashboard, a linear regression chart was used to compare three types of vehicle their relationship to CO2 emissions. Additionally, an average of CO2 emissions line was added altogether with a trend line. In the future dashboard, we will investigate the relationship between CO2 emissions and fuel use in various scenarios such as cities, highways, and combined driving. Fuel consumption is measured in litres per 100 kilometres for three types of vehicles: hybrid, electric, and gasoline. When we look at fuel consumption statistics, we can see that driving in the city uses around 12 litres per 100 kilometres, which is over two litres higher than travelling on the highway, where the average is 8.66 litres. Yet, when cars are driven in a 45% city/55% highway combined, the average fuel usage is roughly 10.50 litres. In terms of the linear model, we discovered that gasoline-powered cars emit more CO2 into the environment than hybrids. Electric cars, on the other hand, emit relatively little CO2 (less than 2 grammes per kilometre). Finally, the Bugatti Chiron Super Sport model was chosen as the most polluting car, with almost 500 (g/km) and a fuel usage of 26 litres per 100 km.

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Dashboard

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Worksheet

**What is the relationship between engine type and combined (city/highway) fuel consumption per 100km?**

**Story: Driving the Future: Comparing Vehicle Performance Across Engine Size and Motor Power with Linear Regression Models for Electric, Hybrid, and Gasoline Cars in Terms of Fuel Efficiency per 100km**

In this story, we show the differences between a gasoline engine and an electric engine in terms of fuel/energy consumed per 100km driven. We note the equivalence of one liter of fuel and kilowatts of energy consumed.

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**Story**

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**Dashboard**

**Worksheets**

In both worksheets, the variables were evaluated to determine how they relate to each other. For engine size, there is a positive relationship with fuel consumption. Therefore, storing more energy/fuel means increasing engine size, directly with positive increase.

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**What are the changes that have occurred in the levels of CO2 emissions, and what do we anticipate for the upcoming years?**

Story In this story, we show the past and future CO2 emissions by fuel type over the last decade. In addition, we forecast the behavior of CO2 emissions for the years 2024 to 2026.

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**Story**

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**Dashboard**

**Worksheet**

For the dashboard, two different charts were used. The first one corresponds to a table that shows the different behavior of each year in comparison to the previous year. The red arrows indicate a negative increase, and the green arrows indicate a positive decrease of the CO2 emissions over a period of 10 years. This allows you to quickly see which type of fuel and in which year there has been an increase in CO2 emissions. For example, 2017 saw a significant decrease in CO2 emissions compared to the previous year, which was a good year for Canada. However, in the years 2015 and 2022, respectively, there was a significant increase in CO2 levels in comparison to the previous year.

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In terms of forecasting, the trend and upward behavior of CO2 emissions can be quickly distinguished from the line graph with a dotted line showing the average CO2 emissions. Furthermore, a slight increase of CO2 emissions of 8 points is forecast for the next three years.

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**What is the current trajectory of fuel consumption, and what are the projected alternatives that are expected to emerge in the near future?**

In this story, we show the audience a perspective and future analysis of using different fossil fuels. Thus, the audience gets a historical context and a prognosis on the use of fossil fuel. In particular, those that exceed the average annual CO2 emissions.

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**Story**

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| **A picture containing text, screenshot, plot, diagram  Description automatically generated**  **Dashboard** | The dashboard is based on a single worksheet that displays a predictive line chart that shows different types of fuels compared to the average annual CO2 emissions over time, shown by a dotted line. As a result, premium gasoline and ethanol show steady growth without much fluctuation. This contrasts with diesel. Regular gasoline, on the other hand, has remained constant over time without any significant fluctuations. |
| **A screenshot of a graph  Description automatically generated with low confidence**  **worksheet** |

**How can the reputation of a vehicle be understood in terms of the CO2 emissions it produces?**

With this story, we want to show the audience how important CO2 emissions are and how they can determine a vehicle's reputation for environmental sustainability. Therefore, there are two key points that are explained in this story. The first one is about the CO2 rating, i.e. how good or bad a vehicle is. The second is the degree of efficiency of a vehicle regarding CO2 emissions.

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**Story**

The dashboard explores the possibility of comparing a clustering analysis for environmental sustainability on the basis of CO2 emissions and engine size.

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**Dashboard**

**Worksheets**

The first worksheet used clustering analysis on CO2 emission data and CO2 rating. This analysis allowed us to separate the vehicles into 4 main groups, which we then ranked as bad, fair, good, and excellent in terms of their CO2 emissions. Then the vehicles that emit the highest quantity of CO2 are classified as bad in place 1. On the other hand, the vehicles with the lowest CO2 emissions are ranked as excellent in the 10th position.

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The second worksheet shows another clustering analysis that allowed us to determine the fuel efficiency of a vehicle and its corresponding CO2 emissions. For example, low CO2 vehicles are classified as high efficiency because they travel the same distance (100km) as high CO2 vehicles, which are classified as low efficiency.

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**worksheet**

**What is the most fuel-efficient and environmentally friendly vehicle segment in terms of CO2 emissions and fuel consumption?**

In this story, the audience is shown what would be the best cars that would be available on the market by 2023. This is the most special part because the audience can become familiar with different classes, models and brands of vehicles that excel in being the most efficient and environmentally friendly.

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**Story**

This dashboard displays an assortment of 2023 electric, hybrid, and gasoline vehicles. It shows the different classes of vehicles, as well as some of the well-known brands.

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**Dashboard**

**Worksheet**

The spreadsheet was created by selecting the cluster of the best vehicles in terms of fuel efficiency and low CO2 emissions in the different vehicle classes that were under study. It was then filtered to show only 2023 as the most recent information.

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* 1. **The Dashboards**
* *The big picture*

In the next slide, we will give data on the types of cars, fuels, and CO2 emissions related with automobiles over the last decade. This will provide us a more comprehensive perspective of the data landscape and a better grasp of the general patterns.

Chart

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* The relationships

By examining the connection between different variables, we can determine whether they are working together in a synergistic manner. This means that multiple factors may be involved in fuel consumption and the release of CO2 emissions into the atmosphere.

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* The trending

In this section, we examine both the past and future to gain insight into how various types of fuel have behaved over time. Anticipating what may happen next is essential for individuals or businesses to make informed strategic decisions.

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* *Finding insights and making recommendations*

The last section of the story explains how we categorize and select vehicles that are both environmentally friendly and have high energy efficiency. Ultimately, our viewers gain valuable knowledge that they can apply in the future.

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**Part B – Microsoft Power BI solution**

• Connect to data source(s) in Power BI

• Load and transform data as necessary to prepare for analysis

We connected the same file (fuel\_consumption\_rating.csv) that was employed in Tableau to data visualization. In this part, we only transform a column as date format (Year) the rest of the columns kept the format.

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• Create at least two (2) types of visuals

In power BI we created three different charts to find some insights.

* **We created a scatter plot to investigate the correlation** between CO2 emissions (in grams per kilometer) and combined fuel consumption (in both city and highway settings) for different types of vehicles. Our analysis revealed that gasoline-powered vehicles emit a significantly larger amount of CO2 into the atmosphere compared to hybrid vehicles, which demonstrated a marked reduction in CO2 emissions. Lastly, electric vehicles produced the lowest CO2 emissions, with some vehicles registering as close to zero emissions. Overall, our scatter plot clearly highlights the relationship between vehicle type, fuel consumption, and CO2 emissions.
* **We utilized a bar chart to present the distribution** of vehicles across different classes. Our analysis revealed that there are four dominant lines of vehicles in the marketplace, including Small SUVs, Mid-Size SUVs, Compacts, and Standard SUVs. We also incorporated a categorical variable to determine the frequency of each vehicle type. Our findings indicate that fuel-gasoline vehicles are the most prevalent in the dataset, while hybrid and electric cars are fewer in number. This observation aligns with the fact that hybrid and electric cars are relatively recent introductions to the market.
* **To track the changes in CO2 emissions and fuel usage trends over time**, an area graph was employed. The graph reveals that the vast majority of vehicles in Canada rely on gasoline, including both regular (X) and premium (Z) types, and this trend has remained steady over the past decade. Nonetheless, diesel (D) and E85 ethanol (E) have been gaining a larger market share despite not being as commonly used as gasoline. From these observations, it can be concluded that regular and premium gasoline are the primary sources of CO2 emissions in Canada over the past decade.

Dashboard

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Worksheet

Graphical user interface, chart

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REFERENCES

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1. <https://open.canada.ca/data/en/dataset/98f1a129-f628-4ce4-b24d-6f16bf24dd64> [↑](#footnote-ref-1)
2. <https://open.canada.ca/data/en/dataset/98f1a129-f628-4ce4-b24d-6f16bf24dd64> [↑](#footnote-ref-2)