

Vehicle CO₂ Emissions - EDA

*Project 1 - Rice University Data Analytics and Visualization
Boot Camp*

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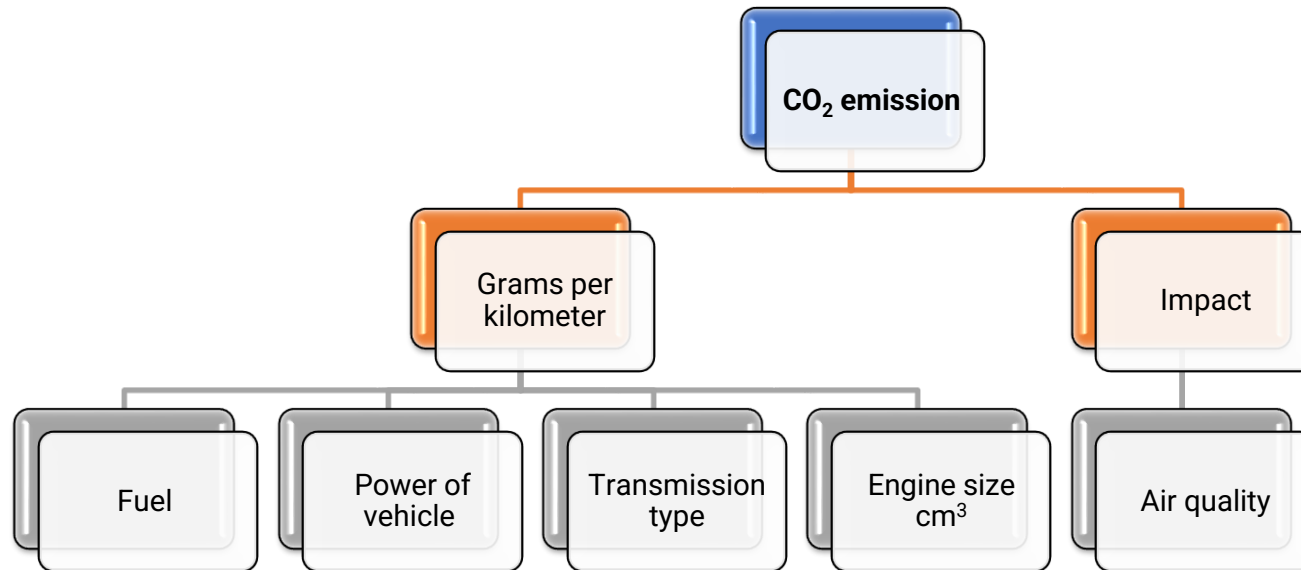
June 10th , 2024.



CO₂

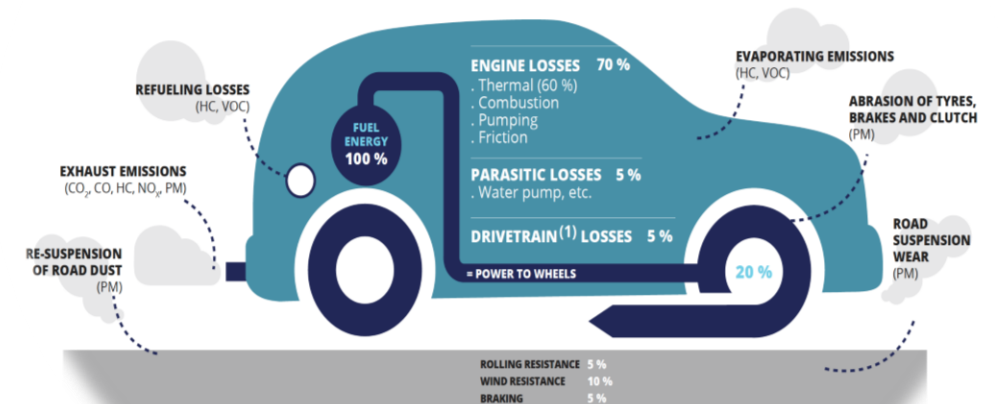


Introduction



Vehicle emissions and efficiency

Fossil fuel powered road transport represents the most significant source of transport related air pollution. Each vehicle releases pollutants from a number of sources.



⁽¹⁾ drivetrain of a motor vehicle is the group of components that deliver power to the driving wheels. It includes the transmission, the axles and the wheels.

HC - Hydrocarbons; VOC - Volatile Organic Compound; PM - Particulate Matter; CO - Carbon monoxide; CO₂ - Carbon dioxide; NO_x - Nitrogen oxides

Source: European Commission, Explaining road transport emissions — a non-technical guide (2016)

Approach



- Vehicle Emissions Data Set -**used secondary data**.
- The base data has information about 6,756 records.
- Programming language: Python
(*panda, numpy, matplotlib, plotly, seaborn, Scipy, sklearn*)

Data cleaning



Total records before cleaning = 6,756

Final cleaned dataset = 6,542

Data cleaned, with "Electric" filtered
out of "transmission_type" column

Fields list

Item	Field	Description	Type
1	car_id	Number - A unique identifier for each vehicle	String
2	manufacturer	Name of manufacturer e.g. "MERCEDES-BENZ", "RENAULT"	String
3	model	Type of model	String
4	description	Description of vehicle e.g. "595 1.4 145 BHP"	String
5	transmission	Gearbox identifier if applicable	String
6	transmission_type	"Manual", "Automatic", or "Electric - Not Applicable"	String
7	engine_size_cm3	Volume of gas displacement in cm ³	number
8	fuel	Fuel type e.g. "Petrol" "Diesel", etc.	String
9	powertrain	Vehicle's powertrain e.g. " Internal Combustion Engine (ICE)", "Hybrid Electric Vehicle (HEV)", "Mild Hybrid Electric Vehicle (MHEV)"	String
10	power_ps	Power of vehicle in PferdStarke (metric measure of horsepower, equivalent to 98.6% of one HP)	Number
11	co2_emissions_gPERkm	<ul style="list-style-type: none">CO₂ emissions (WLTP measurement) in g/km	Number

1

Research question

Does the fuel type have an effect on CO₂ emissions?

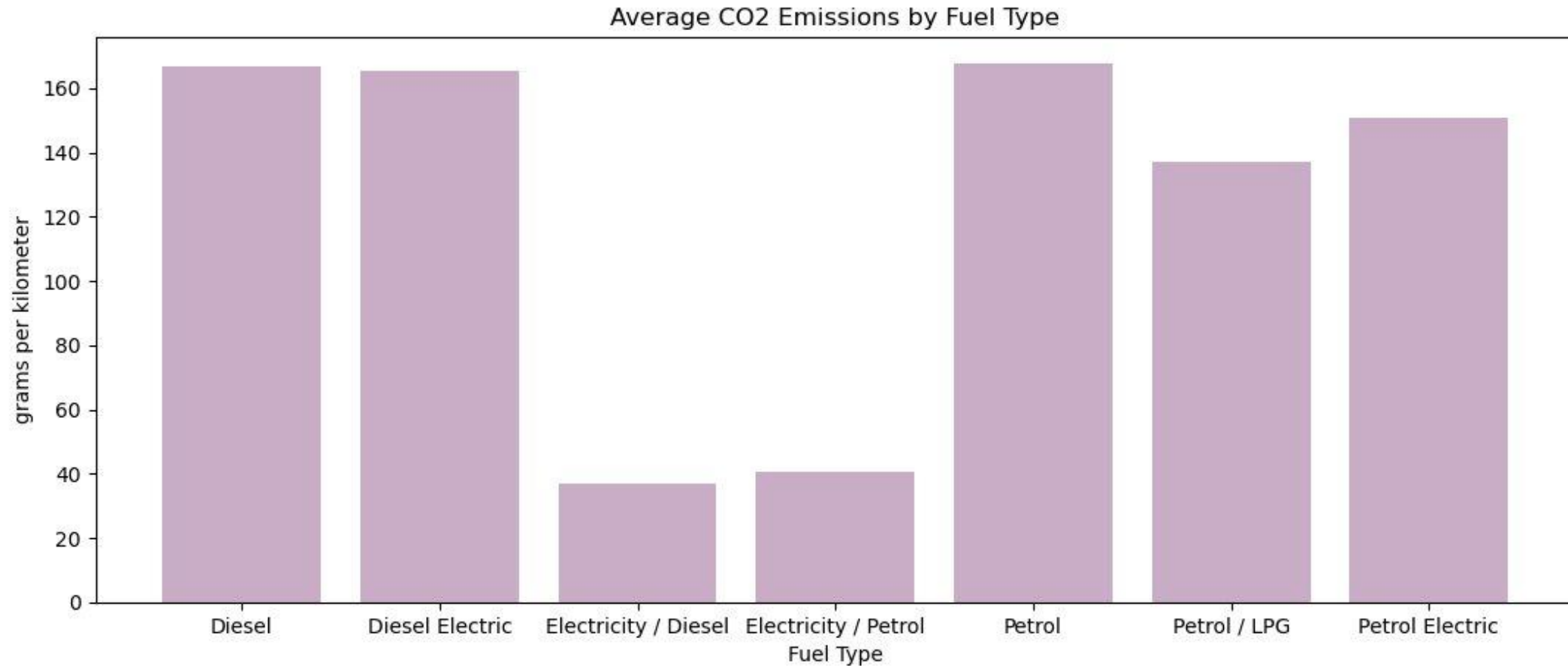


Hypothesis:

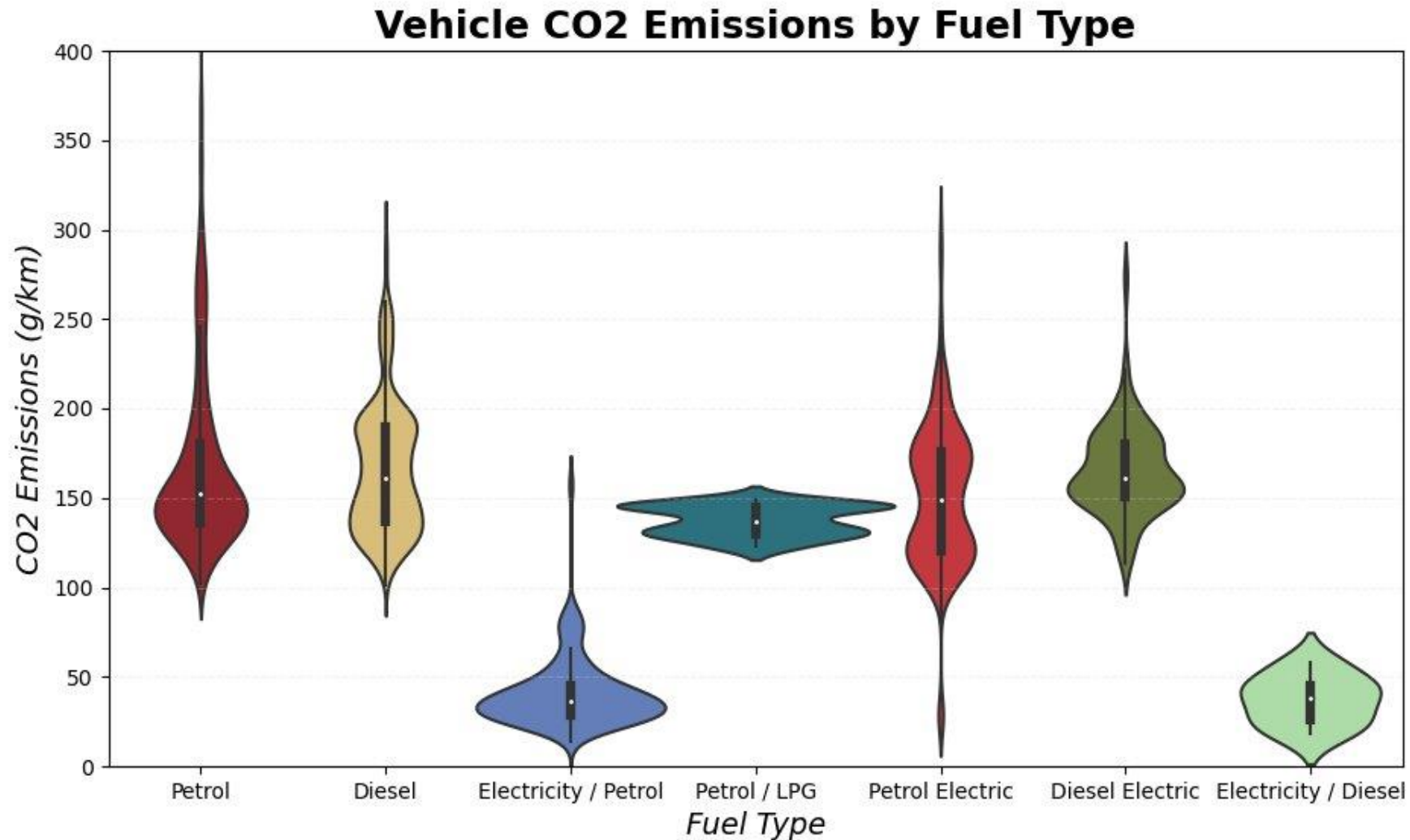
H_0 = CO₂ emissions are not affected by fuel type.

$H_{(a)}$ = CO₂ emissions are affected by fuel type.

Question 1 - Does the fuel type have an effect on CO₂ emissions?

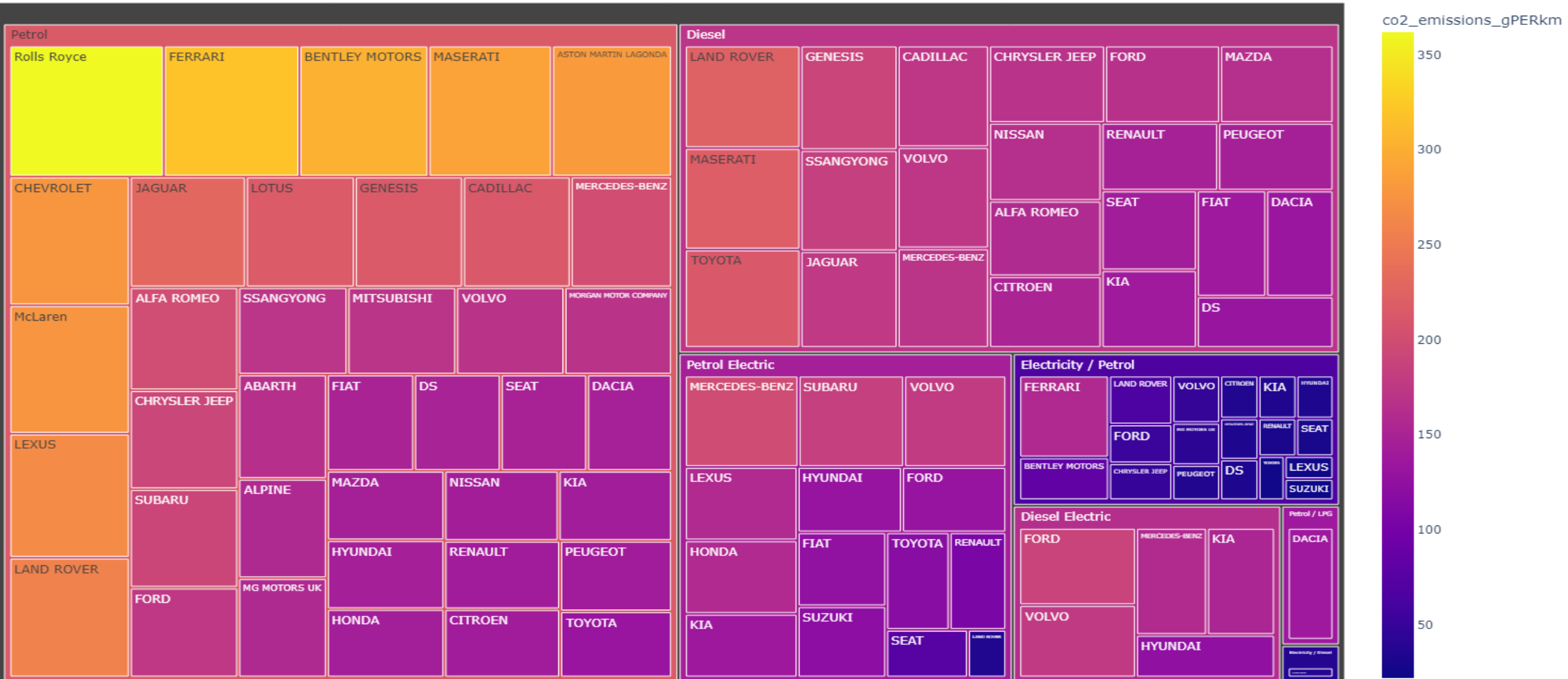


Question 1 - Does the fuel type have an effect on CO₂ emissions?



Question 1 - Does the fuel type have an effect on CO₂ emissions?

CO₂ Emissions grouped by Fuel Type and Manufacturer



2

Research question

What is the effect of engine power (PS) on CO₂ emissions (g/km)?

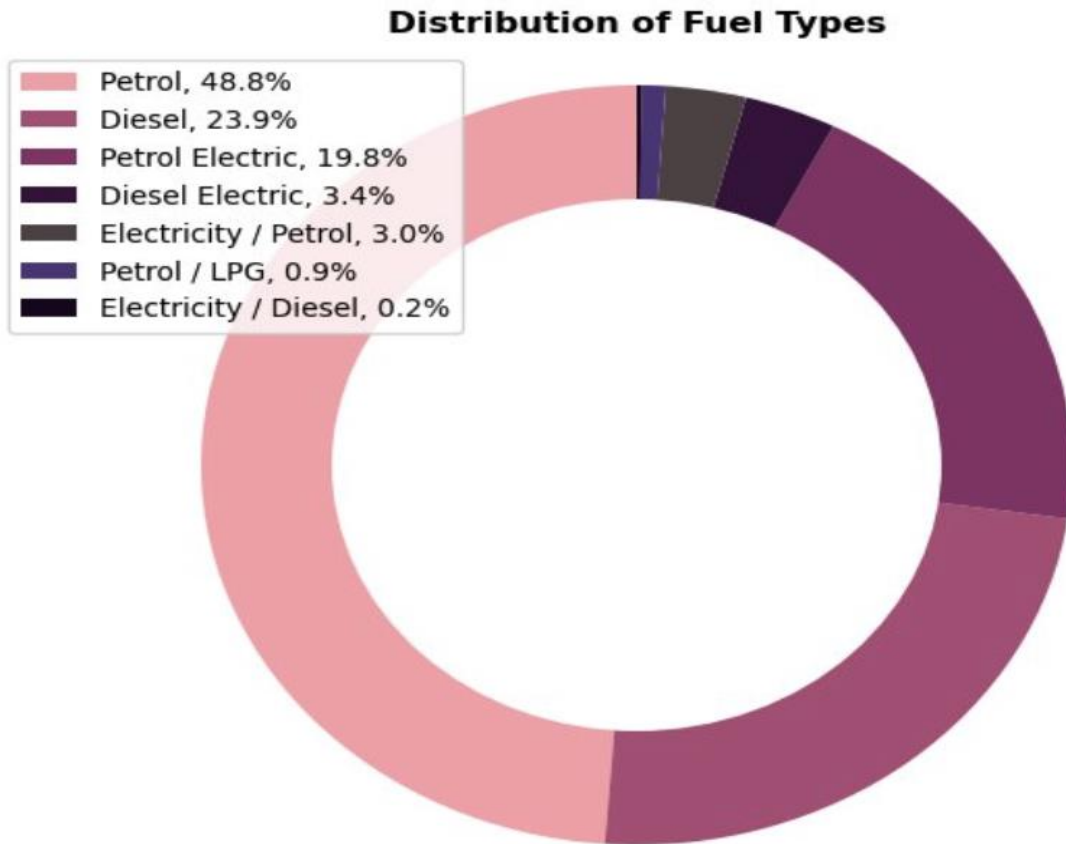


Hypothesis:

H_0 = CO₂ emissions are not affected by engine power.

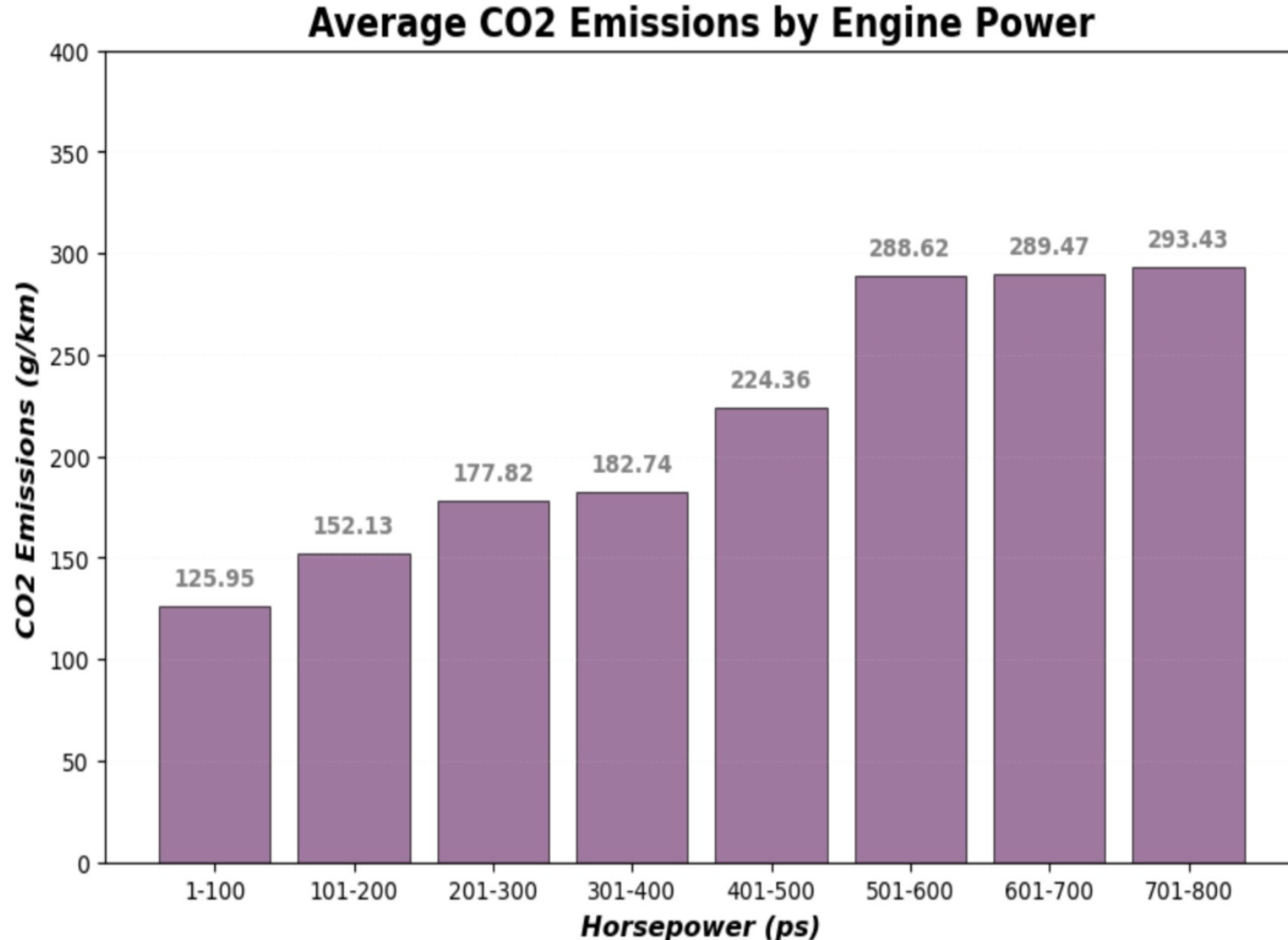
$H_{(a)}$ = CO₂ emissions are affected by engine power.

Question 2



The chart highlights the diverse range of fuel types and combinations used in vehicles, with petrol being the most prevalent fuel type followed by diesel and various hybrid options.

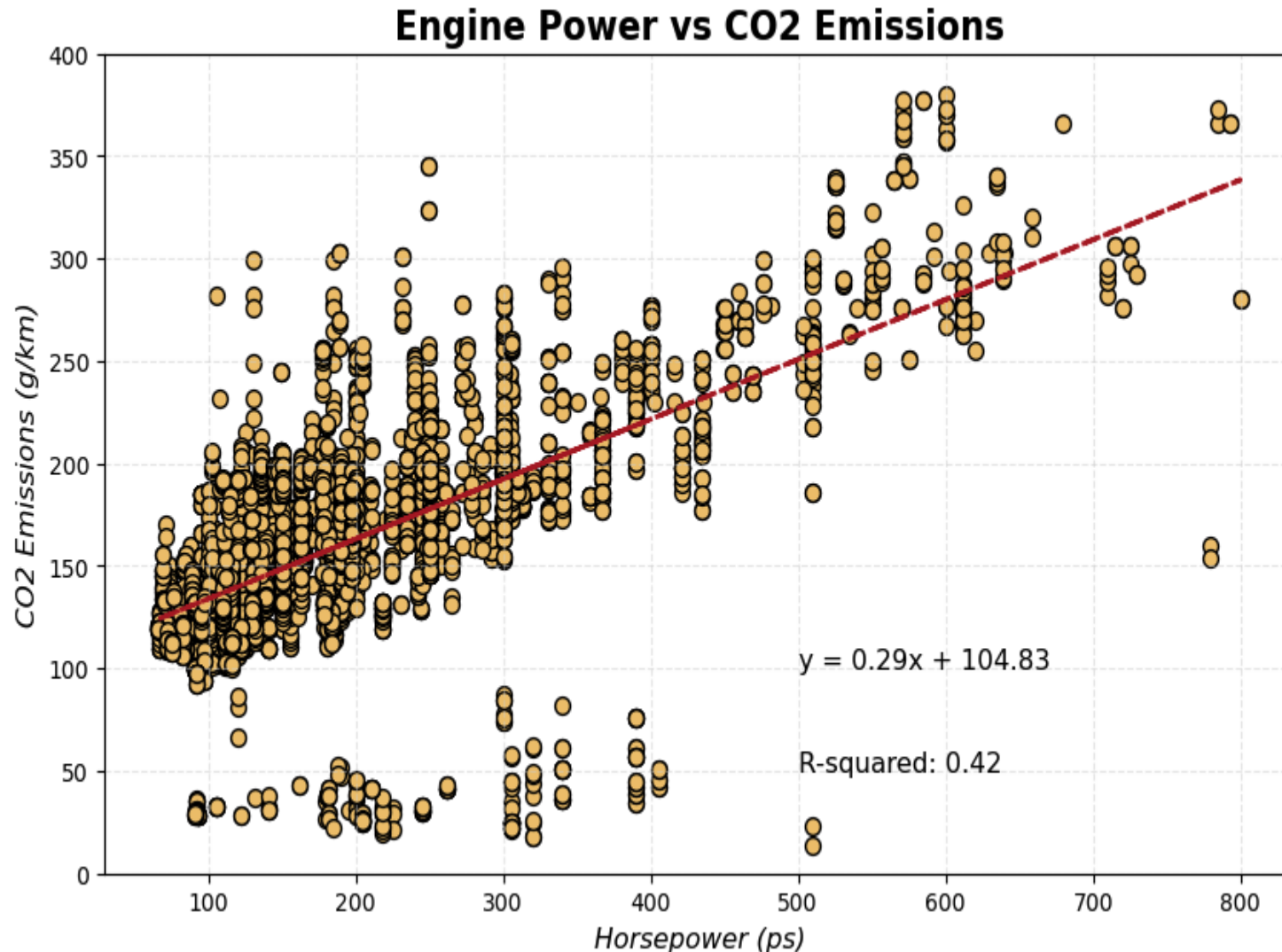
Question 2



The data illustrates a correlation between horsepower and CO2 emissions, with higher horsepower vehicles generally exhibiting increased CO2 emissions. Understanding these trends can inform decisions related to vehicle efficiency and environmental impact.

The highest average CO2 emission of 293.43 g/km is recorded for vehicles with horsepower in the 701-800 ps range.

Question 2



There is a correlation between power output and CO2 emissions in vehicles, but it is not a direct one. Other factors also play a crucial role in determining the overall emissions of a vehicle. Manufacturers are continuously working on improving engine efficiency, reducing vehicle weight, and developing alternative powertrains to minimize the environmental impact of their vehicles.

3

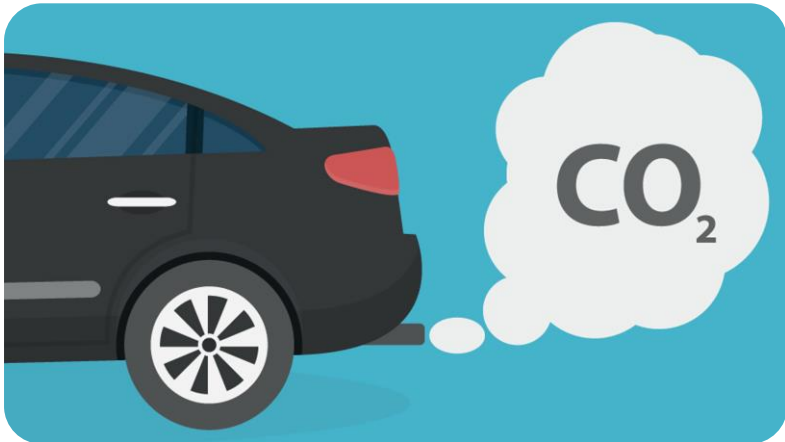
Research question

Does the type of vehicle transmission have effect on CO₂ emissions?

Hypothesis:

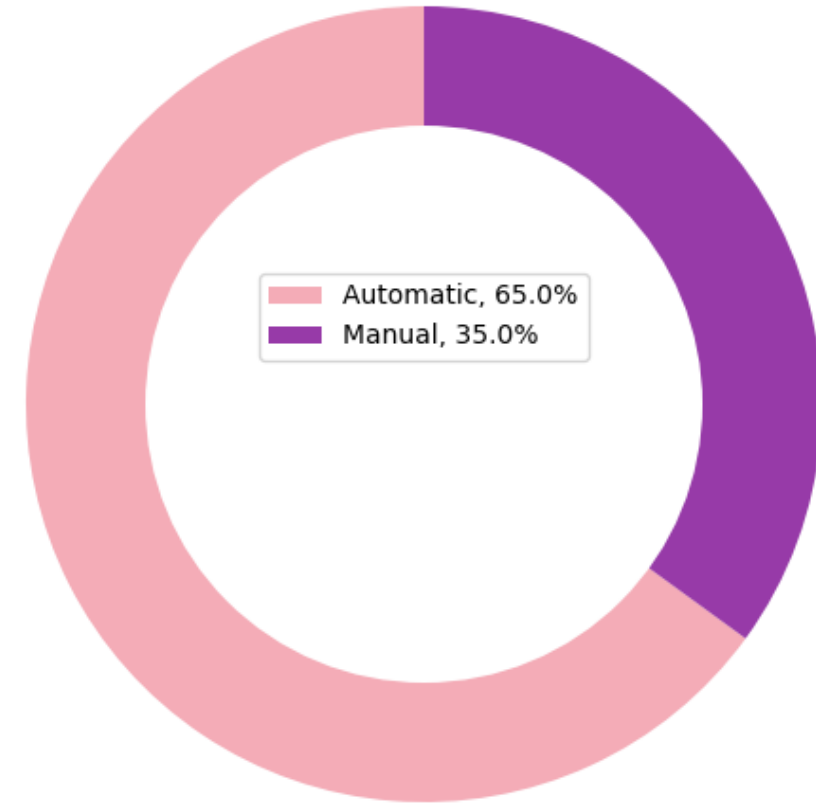
H_0 = CO₂ emissions are not different depending on the type of vehicle transmission.

$H_{(a)}$ = CO₂ emissions are different depending on the type of vehicle transmission.



Descriptive

Distribution of Transmission Types



Results and Interpretation

①

CO₂ emissions for manual and automatic transmission type **are not normally distributed.**

②

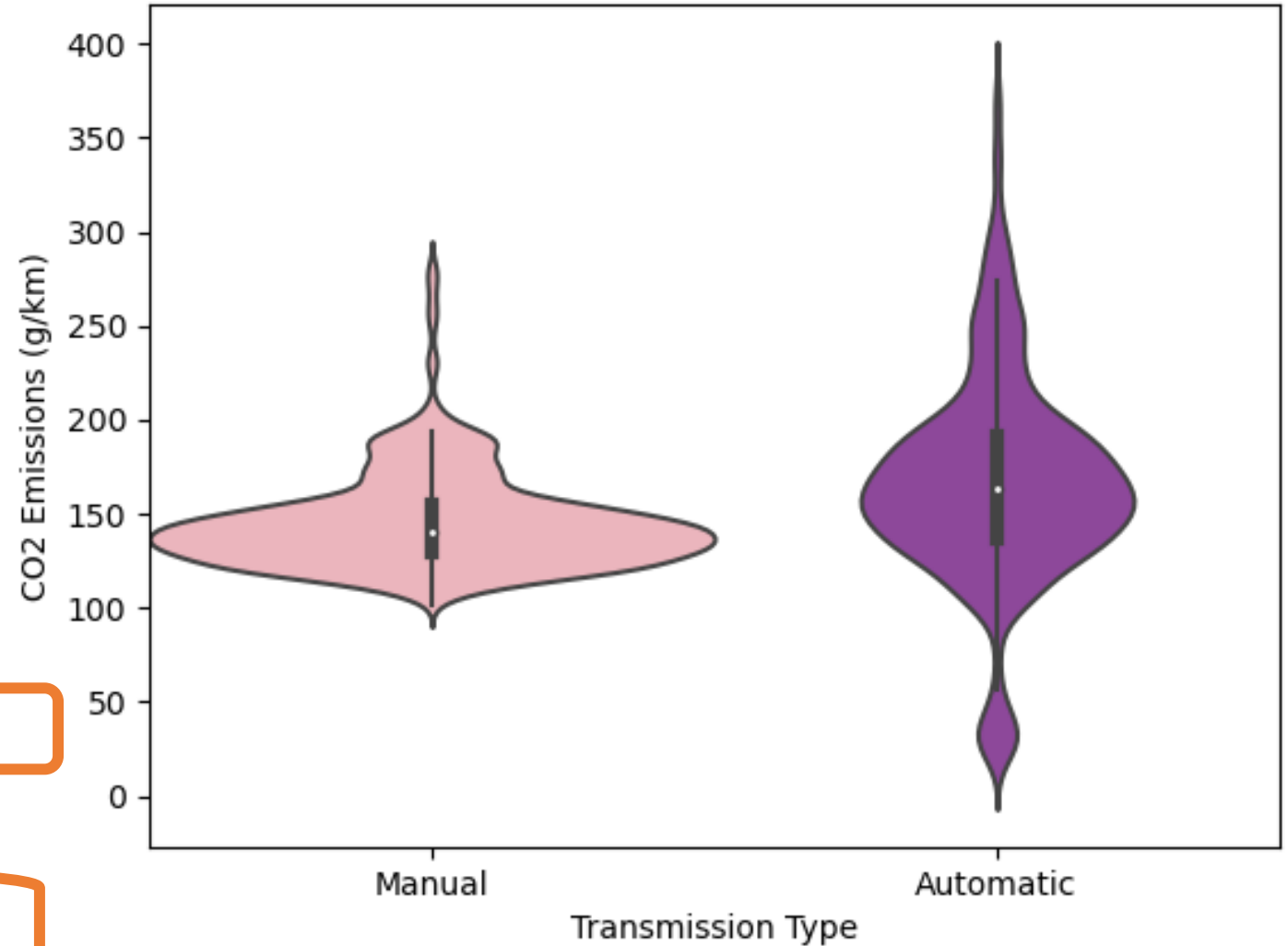
Mann-Whitney U test:

U statistic=759.0

p-value=0.0064

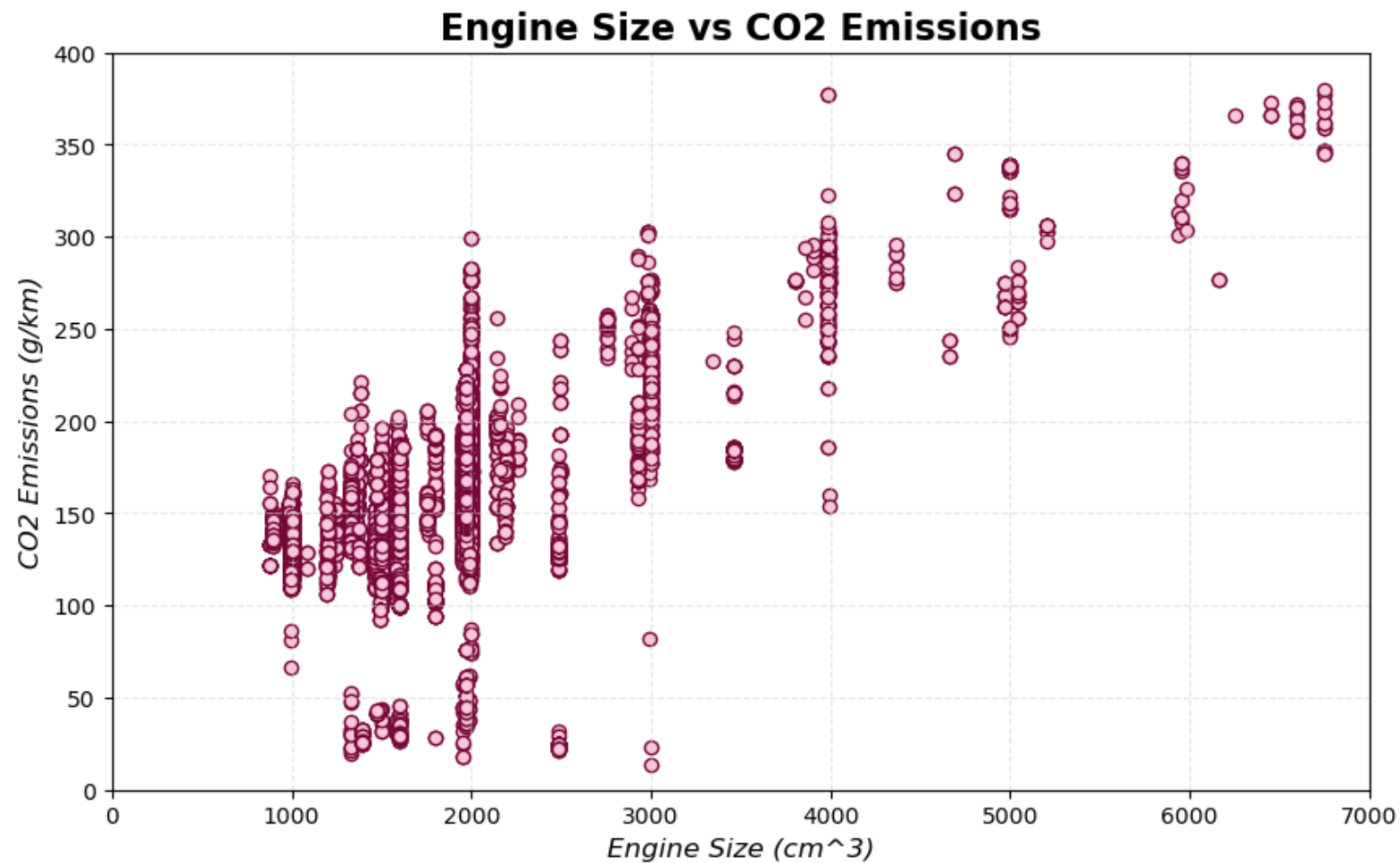
A highly significant difference in CO₂ emissions between manual and automatic transmissions.

CO₂ Emissions by Transmission Type



4

Additional Analysis

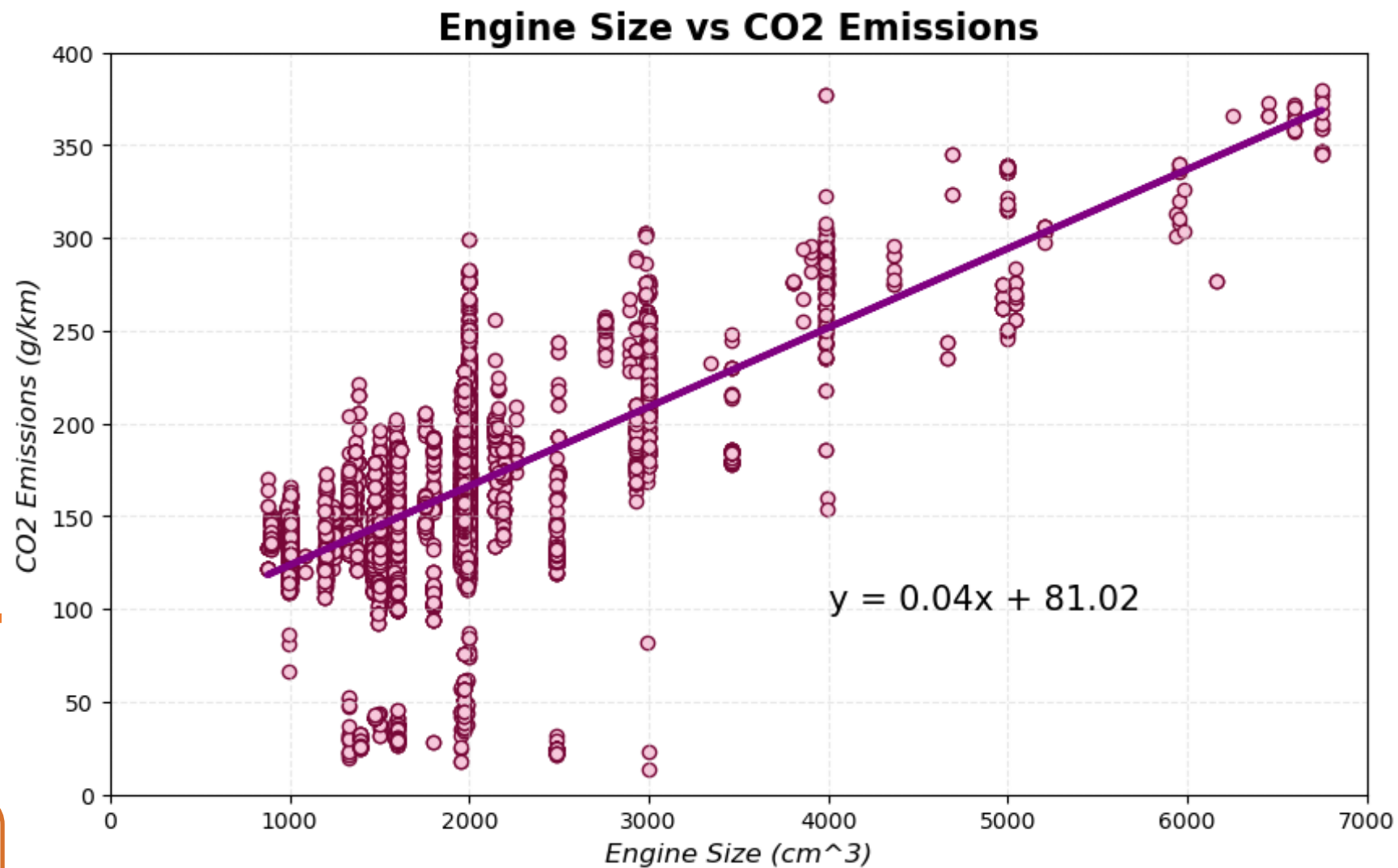


Prediction time...

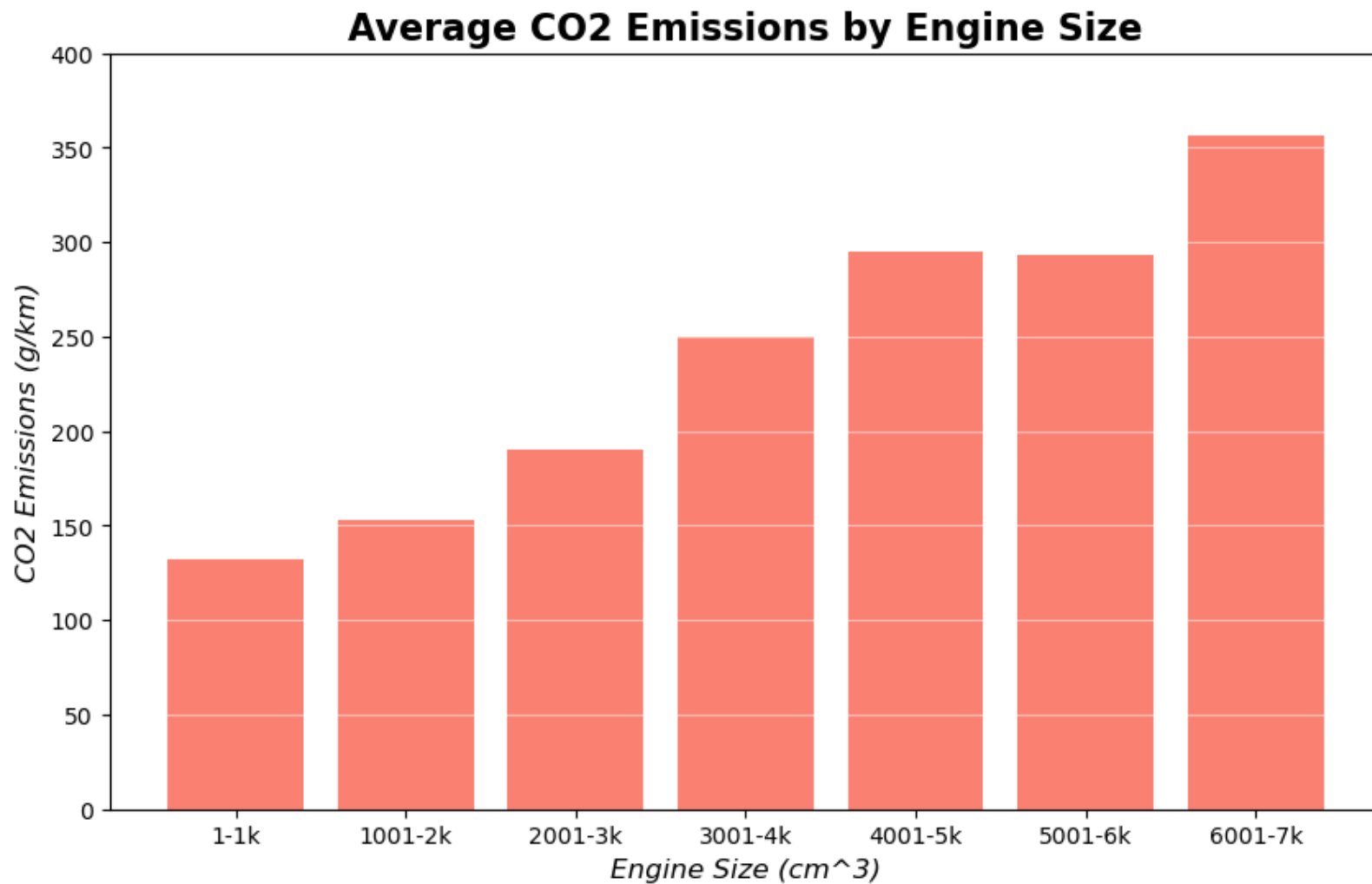
4

Linear Regression

R2: 0.472



4



Note: Engine sizes are grouped in ranges of 1,000 cm³

Conclusion

The following factors have a large impact on CO₂ emissions:

- Fuel Type
- Engine Power
- Transmission Type
- Engine Size



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Recommendations



Government

Increase effort and set targets to implement from collaborators to community about impact of CO₂ emissions.

Tax incentives for less CO₂ emissions.

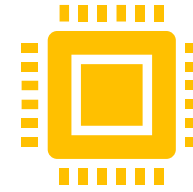
More options for public transportation.



Community

Should receive more education about factors that impact on CO₂ emissions.

Should have more accessibility to efficient transportation according to goals of greenhouse gas emissions.

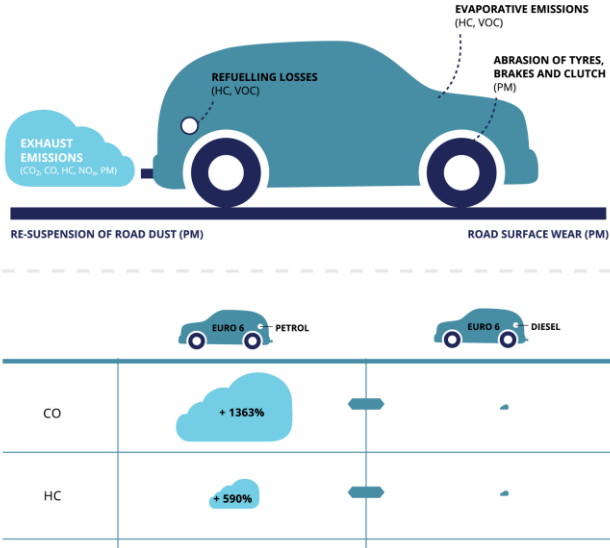


Further Development

Automatic car computers to mimic results of manual transmission possibly with the help of artificial intelligence or machine learning.



The different types of emissions from vehicles, and a comparison of the relative amounts of selected pollutants released by the latest Euro 6 petrol and diesel vehicles



Thank you !

Q&A



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