



FACTORS AFFECTING THE RATE OF CO₂ EMISSIONS FROM VEHICLES OF DIFFERENT ENGINE TYPES

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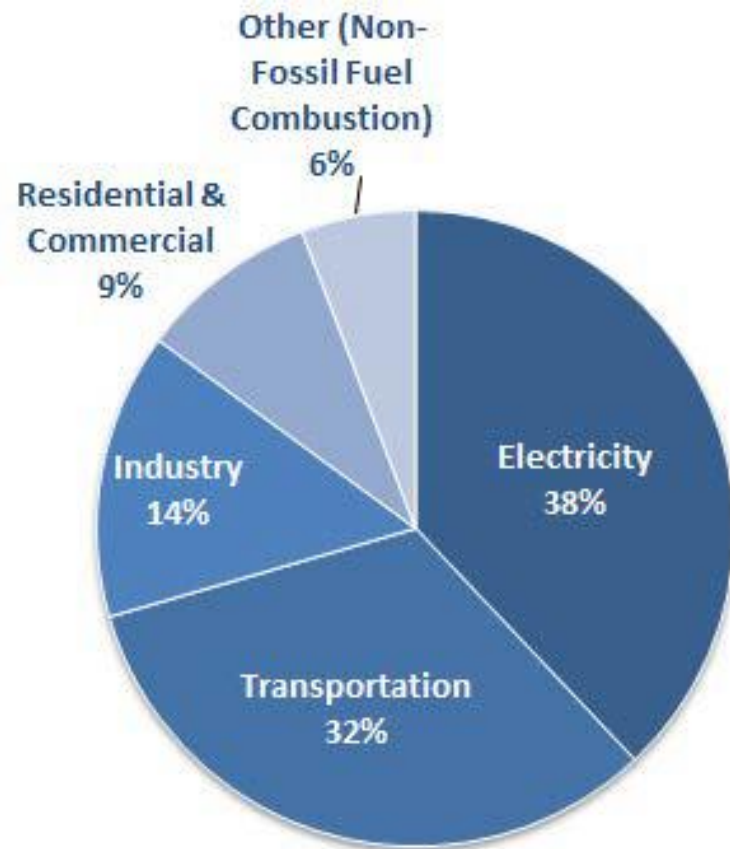
PROBLEM STATEMENT

- Which factor or factors show significant effect on the rate of carbon dioxide emissions from vehicles with various engine sizes?



BACKGROUND RESEARCH

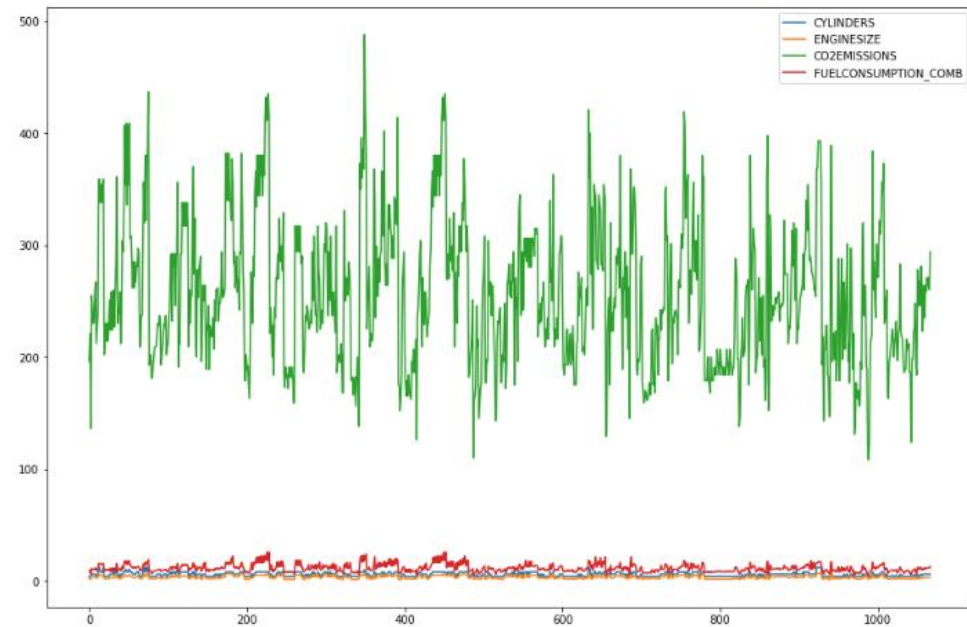
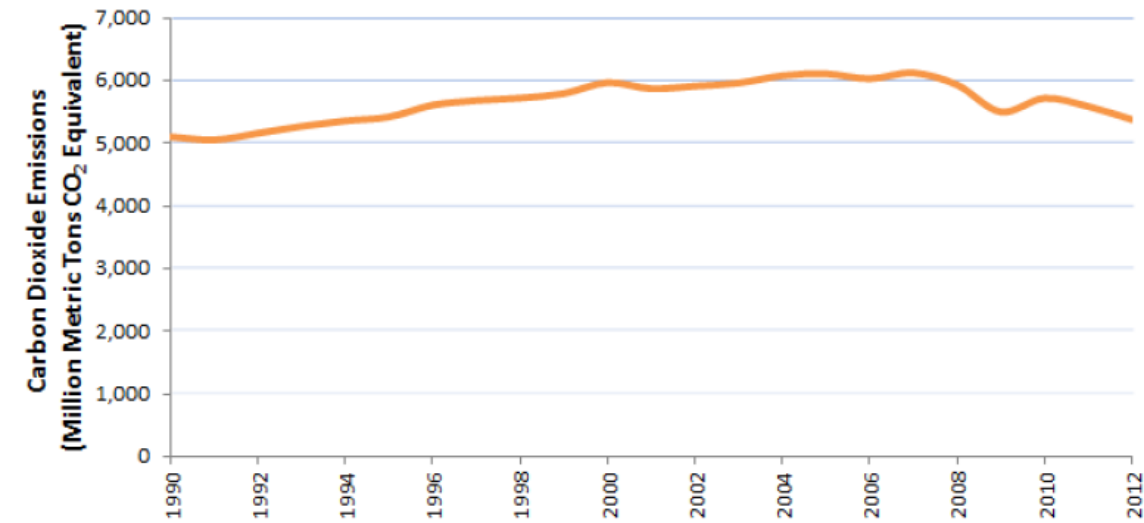
- In 2012, about 38% of the total U.S. carbon dioxide emissions came from the combustion of fossil fuels, specifically coal, to generate electricity; this is the largest source of carbon dioxide emissions in the nation.



CO2 EMISSION BY CARS

- There are four major pollutants that come from cars:
- 1. A car emits carbon monoxide when the carbon in fuel doesn't burn completely.
- 2. A car's exhaust emits hydrocarbons, a toxic compound of hydrogen and carbon.
- 3. When fuel burns, nitrogen and oxygen react with each other and form nitrogen oxides (NO_x).
- 4. Particulate matter -- small particles of foreign substances -- in the air contribute to atmospheric haze and can damage people's lungs.

CARBON DIOXIDE EMISSIONS



MATHEMATICAL COMPUTATION

- **4-cylinder vehicle:**

$$\begin{array}{ccccccc} \text{CO}_2 \text{ emissions/mile} & = & \text{CO}_2 \text{ per gallon} & = & 8,887 \text{ grams} & = & 266.08 \text{ grams/gallon} \\ & & \text{MPG} & & 33.4 & & \text{l mile} \end{array}$$

- **V-6 vehicle:**

$$\begin{array}{ccccccc} \text{CO}_2 \text{ emissions/mile} & = & \text{CO}_2 \text{ per gallon} & = & 8,887 \text{ grams} & = & 423.19 \text{ grams/gallon} \\ & & \text{MPG} & & 21.0 & & \text{l mile} \end{array}$$

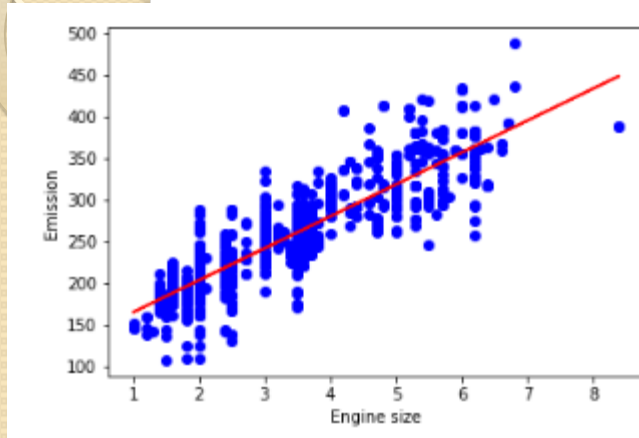
- **V-8 vehicle:**

$$\begin{array}{ccccccc} \text{CO}_2 \text{ emissions/mile} & = & \text{CO}_2 \text{ per gallon} & = & 8,887 \text{ grams} & = & 444.35 \text{ grams/gallon} \\ & & \text{MPG} & & 20.0 & & \text{l mile} \end{array}$$

- **Diesel Engine:**

$$\begin{array}{ccccccc} \text{CO}_2 \text{ emissions/mile} & = & \text{CO}_2 \text{ per gallon} & = & 10,220.05 \text{ grams} & = & 730.00 \text{ grams} \\ & & \text{MPG} & & 14.0 & & \text{l mile} \end{array}$$

CLASSIFICATION MODEL



- Mean absolute error: 23.58
- Residual sum of squares (MSE): 894.22
 - R2-score: 0.67

STATISTICAL MODEL

Fig. 1: EU Toxic Emissions limits - cars

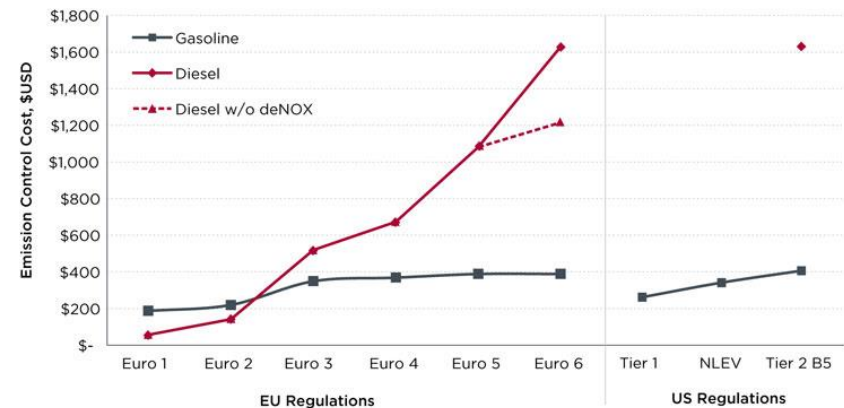
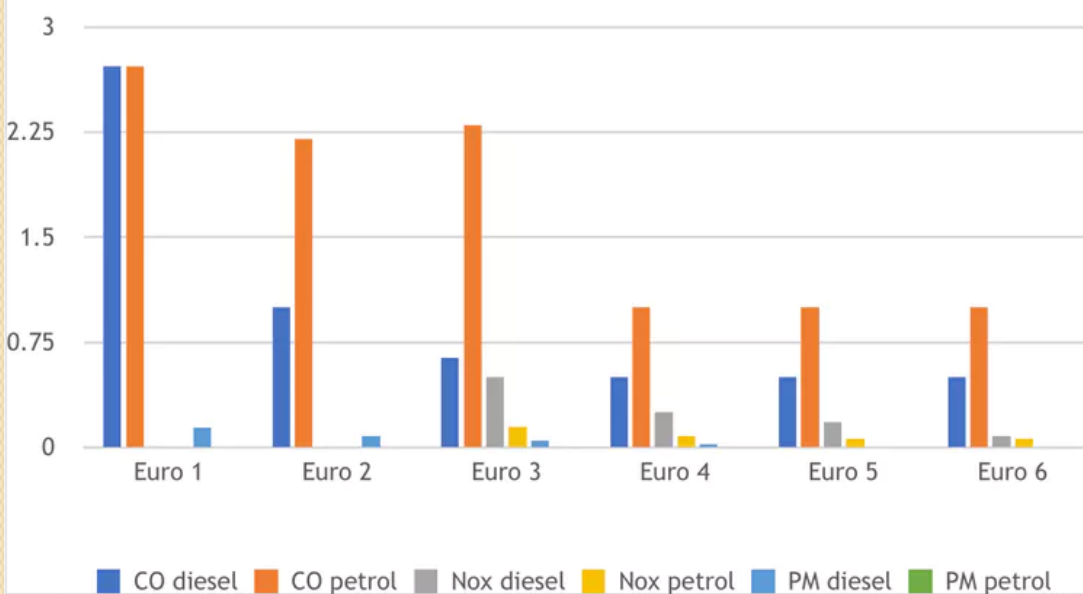


Figure ES-2 Estimated cumulative emission control technology cost for gasoline and diesel light-duty vehicles assuming a 2.0 L engine

CONCLUSION

Green credentials

Average lifecycle for car in US midwest

**Tesla Model S
P100D**
(battery-electric vehicle)

**BMW 7 Series
750i xDrive**
(internal combustion engine)

Mitsubishi Mirage
(internal combustion engine)



Production emissions (kg CO₂ equivalent)

12,204

8,190

4,752

Use emissions - 270,000km (kg CO₂ eq)

48,600

95,310

46,980

End of life emissions (excluding battery, kg CO₂ eq)

311

351

159

Lifecycle emissions total - 270,000km (kg CO₂ eq)

61,115

103,851

51,891

Lifecycle emissions per km - intensity (g CO₂ eq/km)

226

385

192

All data are based on vehicles driven in the US midwest
Source: Trancik Lab, MIT
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According to research, transportation accounts for about 32% of the total carbon dioxide emissions in the United States. The combustion of gasoline in many vehicles increases the amount of carbon dioxide gas in the atmosphere. We have identified three factors that significantly increase the rate of CO₂ emissions from vehicles of differing engine sizes (4-cylinder, V-6, V-8, and diesel).