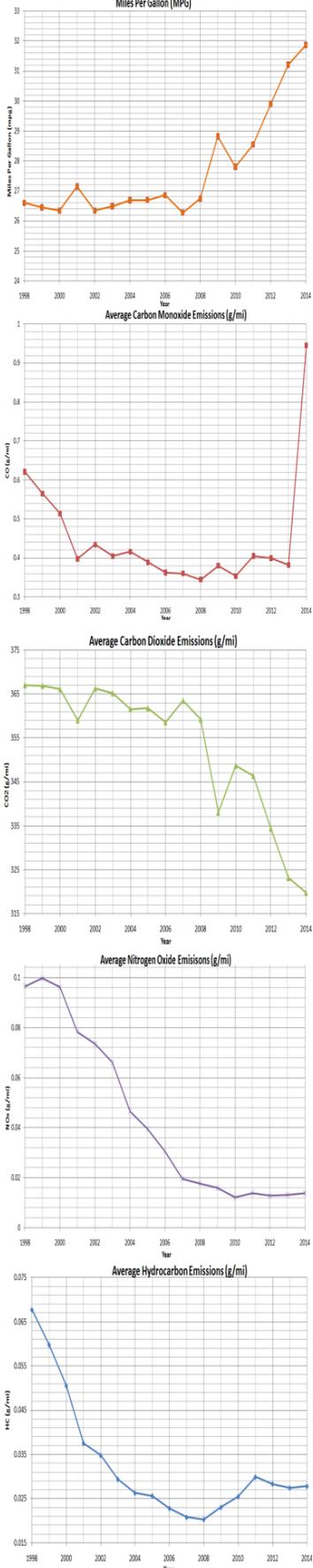


**MPG and Emissions Trends for Past 16 Years**



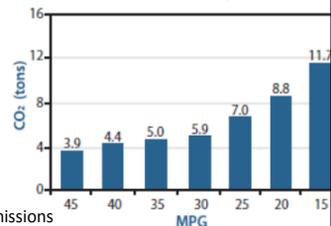
**Why Consider Fuel Economy?**

- Save Money**  
Choosing the most fuel-efficient vehicle in a particular class can save you as much as \$1,700 a year in fuel costs.
- Reduce Oil Dependence Costs**  
Nearly 40% of the oil used to produce the gasoline used in the U.S. is imported. About 19 million barrels of oil are used per day in the U.S., two thirds of which are used for transportation. Oil dependence cost the U.S. economy around \$500 billion in 2012 alone. A more fuel efficient vehicle will result in a smaller oil dependence.

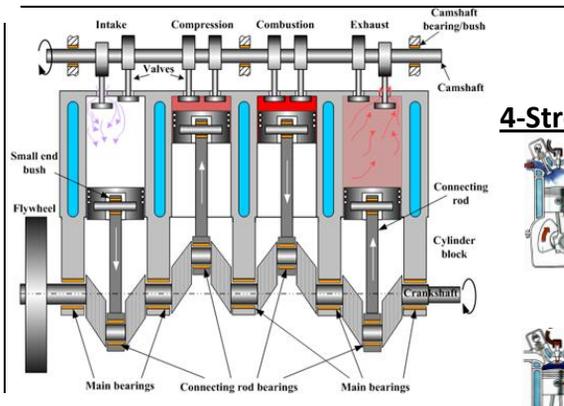
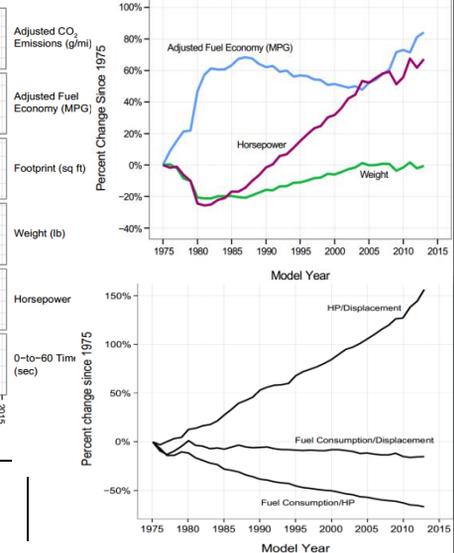
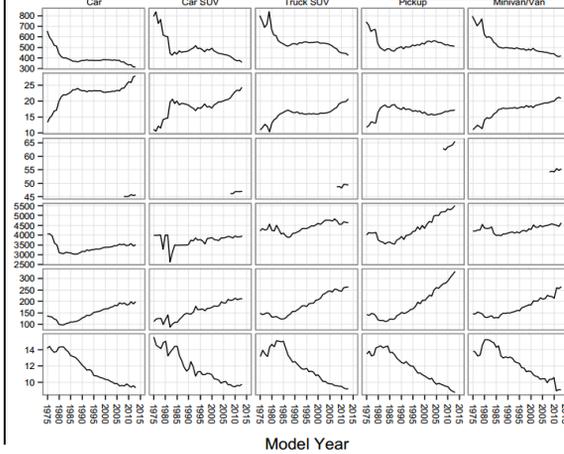
**Reduce Climate Change**

Burning fossil fuels such as gasoline releases carbon dioxide (CO<sub>2</sub>) and other harmful greenhouse gases(GHG) into the atmosphere, contributing to global climate change. Highway vehicles in the U.S. account for almost a quarter (1.7 billion tons) of CO<sub>2</sub> emissions each year (60% of all transportation emissions). About 20 pounds of CO<sub>2</sub> is emitted into the atmosphere per gallon of gasoline burned. The average vehicle emits around 5 to 8 tons of CO<sub>2</sub> each year.

Annual CO<sub>2</sub> Emissions by Vehicle MPG



**Motor Vehicle Trends**



**4-Stroke Internal Combustion Engine**



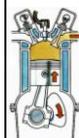
**Intake stroke**  
Piston descends to the bottom of the cylinder, increasing the volume inside the cylinder. The presence of an adverse pressure gradient between the intake manifold and the engine cylinder forces the air-fuel mixture through the intake valve filling the cylinder.



**Compression Stroke**  
The intake valve closes and the piston compresses the air-fuel mixture into the cylinder head by returning to the top of the cylinder.



**Power Stroke**  
When the piston reaches a designated position at the top of the cylinder, the air-fuel mixture is ignited by a spark plug. The pressure created from the combustion of the air-fuel mixture forces the piston back down the cylinder, ultimately turning the crankshaft and creating power.

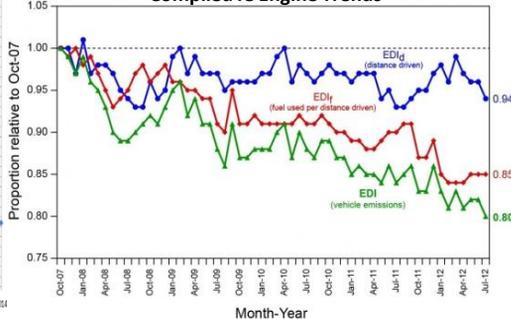


**Exhaust Stroke**  
The exhaust gases are forced through the exhaust valve as the piston travels back up to the top of the cylinder.

**Personal IC Engine Usage**

- 70% of all oil consumed in the U.S. is used for transportation
- 250 million personal vehicles registered which is 25% of all vehicles in the world
- U.S. transportation fuel consumption accounts for over 70% of total U.S. oil consumption, and more than 65% of that is for personal vehicles.
- American drivers consume 9 million barrels (378 gallons) of gasoline per day, for personal transportation

**Compiled IC Engine Trends**



**Stoichiometric Combustion**

- 1 gallon of gas → yields 18.07 lb CO<sub>2</sub>
- 1 gallon of gas → yields 9.32 lb H<sub>2</sub>O
- 1 gallon of gas requires 20.53 lb O<sub>2</sub> to burn completely

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Image

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Images

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Assumptions: Stoichiometric reaction for combustion of 100% octane fuel