Allison Zeoli
Class of 2014

Internal Combustion Engine Cars

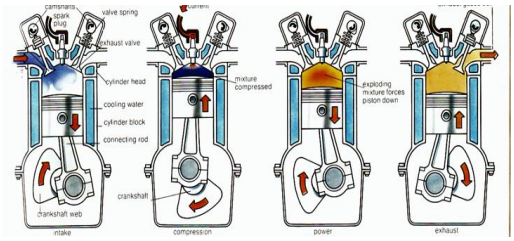
Classification

- Reciprocating , Spark Ignition, 4-Stroke
- In-line or V-line Cylinder Arrangement
- Water and Air Cooling Systems
- 0.75-37.5 kW Average Power Output

Parts Common to both Petrol and Diesel Engines	
Cylinder	Cylinder Head
Piston	Piston rings
Gudgeon pin	Connecting rod
Cranksaft	Crank
Engine bearing	Crancase
Flywheel	Governor
Valves	
Parts for petrol engines only	
Spark plugs	
Carburettor	
Fuel pump	
Parts for diesel Engine	
Fuel Pump	

Average Power Output and Speed	
Gas Engine	**Diesel Engine**
30 to 60 kW	1 to 3000 kW
4500 rpm	100 to 400 rpm

How It Works



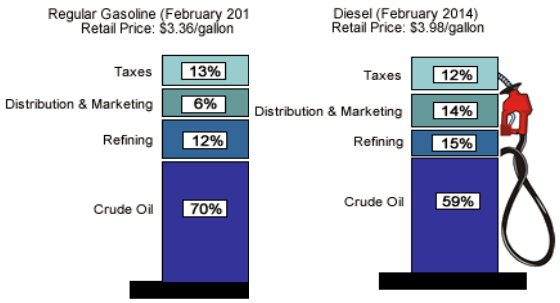
Intake Stroke –The fuel/air mixture is drawn in as the piston travels down

Compression Stroke - The piston travels back up the cylinder compressing the fuel/air mixture. A spark plug emits a spark to combust the fuel/air mixture.

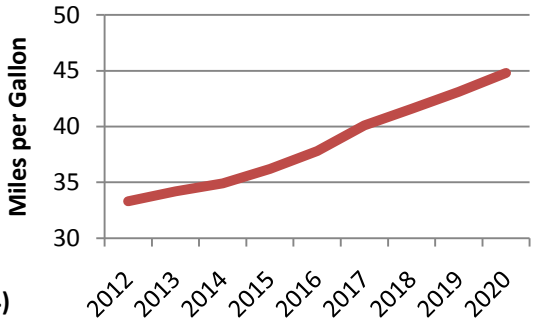
Combustion Stroke - The piston is now forced down by the pressure wave of the combustion of the fuel air mixture

Exhaust Stroke- The piston travels back up expelling the exhaust gases through the exhaust valve. This process is then repeated.

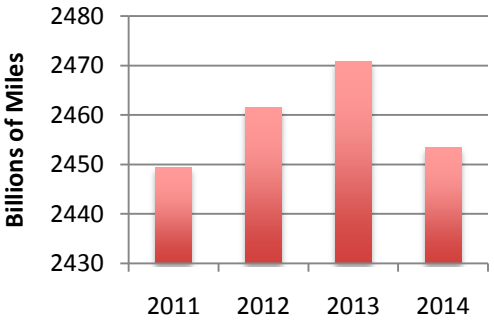
Fuel Prices



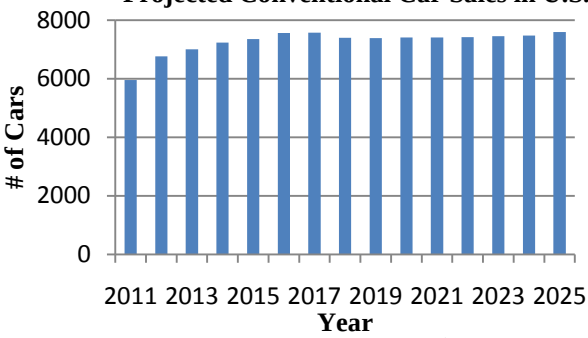
Projected Fuel Economy of ICE Cars in U.S.



Vehicle Miles Travelled in U.S. (2011-2014)



Projected Conventional Car Sales in U.S.



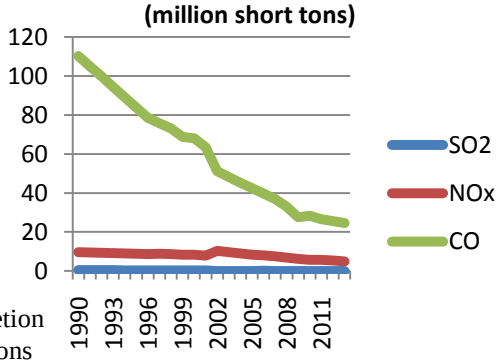
EPA GHG Compliance Standards

1. National Emission Standard for Hazardous Air Pollutants
2. New Source Performance Standards
3. Standards of Performance for Stationary Compression Ignition Internal Combustion Engine

EPA Exhaust Emissions Compliance Standards

1. Tier 2 Exhaust Emissions Standards
2. Tier 3 – 2017 Implementation

Total National GHG Emissions in U.S. (million short tons)



Recent Innovations

- Improved fuel efficiency
- 10% increase in patents received by auto companies
- Spending more than $18 billion annually on research and development in the U.S.
- Incorporating Driver Assist Systems to improve safety
  - Ultrasonic Sensors, Radar Application, Lidar Detection
- Connected Cars with factory installed telematics
  - Vehicle-to-Vehicle, Vehicle-to-Infrastructure
- Advanced Materials
  - Graphene, Aerogel. Smartphone Gass

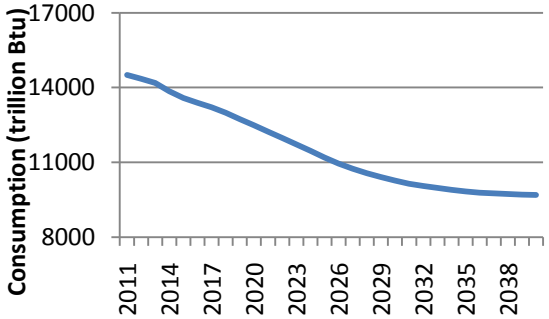
Environmental Impacts

- Air Quality
- Water Quality
- Use of Finite Resources
- Noise Pollution
- Ozone Depletion
- GHG Emissions
- CFC Emissions
- Lead Emissions

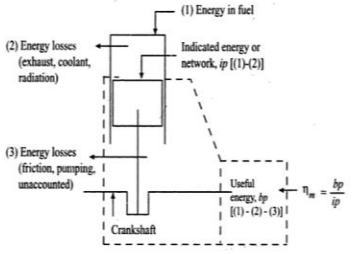
Solid Waste Estimations

Year	Direct Waste	Recycled Material
2013	7.61E+08	1.45E+10
2012	7.19E+08	1.37E+10
2011	5.21E+08	9.90E+09
2010	4.78E+08	9.08E+09
Year	**Recovered Material**	**Shredded Material**
2013	1.08E+10	2.20E+08
2012	1.02E+10	5.03E+02
2011	7.42E+09	5.03E+02
2010	6.81E+09	5.03E+02

Projected Energy Consumption of ICE Cars in U.S.



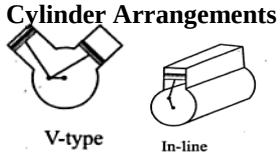
Energy Flow



Energy Losses

Engine Losses	68%-72%
Parasitic Losses	4%-6%
Drivetrain Losses	5%-6%
Idle Losses	3%

Cylinder Arrangements



Internal Combustion Engine Cars

Allison Zeoli
Class of 2014

Classification

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Solid Waste Predictions

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Estimated national emissions of carbon monoxide . (2013, January). Retrieved from http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_statistics/index.html

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Estimated national emissions of Nitrogen Oxides . (2013, January). Retrieved from http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_statistics/index.html

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Energy Losses

Where the energy goes: Gasoline vehicles. (2014, April 11). Retrieved from www.fueleconomy.gov/feg/atv.shtml