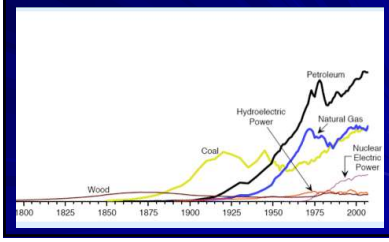
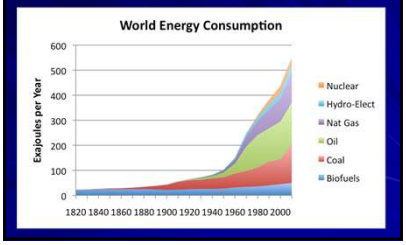
Energy Sources

Energy Sources used in the US



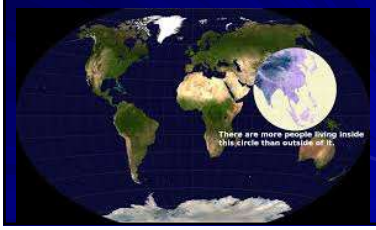
Past to present

- Interesting to note, the TOTAL energy used is an exponential graph.
- Not only is the population increasing, but the amount of energy each person needs is increasing at an exponential rate.
- Pre-industrial revolution, the main source of energy was wood.
- After that, we start into the fossil fuels. First with coal, then petroleum and natural gas.



World population

- https://www.census.gov/popclock/



Fossil Fuels

- Fossils fuels are a very convenient form of concentrated energy.
- Major fossil fuels used today are coal, petroleum, and natural gas.
- They are all ancient organic material, just as a solid, liquid or gas

Petroleum

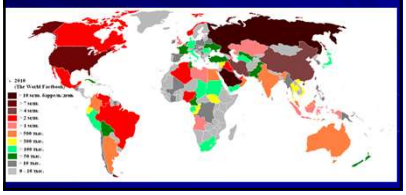
- Petroleum can be separated into gasoline, kerosene, and diesel fuel.
- The current deposits were formed when plants and animals were buried about 500 million years ago.
- Petroleum generally forms at the bottom of the ocean after kerogen (a build up of organic material) sinks and gets buried.
- These plants and animals took CO_2 from the atmosphere and energy from the sun 500 million years ago and stored it.

Petroleum

- Plants and animals are made of high energy compounds.
- Normally this energy is released when it decomposes, digests or is burned, but these were shut off from the world when they were buried. So it sat there stored from millions of years.
- The pressure over time concentrated the energy source.
- People have discovered several uses for these concentrated stored energy sources.

Oil Producing Countries

- US produces the third most oil behind Russia and Saudi Arabia.



Oil Reserves

- Although the US produces a lot of oil, it also uses more than it makes.
- The United States also imports oil to meet its demand.
- At some point, the reserves in the world will run out.

Drilling

- Oil used to be easier to get to.
- Now the only reserves left are deep in the Earth and require drilling. This takes a lot of energy.
- It used to take 1 barrel of oil's worth of energy to produce 100 barrels of oil.
- It currently takes 1 barrel of oil's worth of energy to produce 4 barrels of oil.
- Before we run out of reserves we may reach a point where there is no net gain in energy from drilling for oil.

Coal

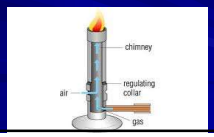
- Coal is still plentiful in the United States. Purdue University calculated we have enough to last 2000 years
- However, it is the most polluting to burn as it releases sulfur and nitrogen compounds which create acid rain, mercury and carbon dioxide.
- Mining of coal has many negative environmental impacts.
- Much of the coal was formed from plant life during the carboniferous period, 350 million years ago.

Natural Gas

- Natural gas forms underground when organic compounds decompose.
- It is commonly found with oil and coal.
- It is primarily used to heating and electricity generation.
- Natural gas is the cleanest burning of the fossil fuels as there are not many impurities possible to stay with a gas.
- Bunsen burner technology makes it safe to use indoors provided a complete combustion occurs.

Bunsen burner

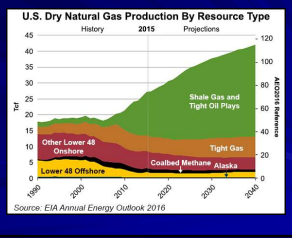
- Developed in 1885 by Robert Bunsen, this allows the gas to mix with oxygen before ignition.
- When scaled up this becomes a furnace or water heater



Natural gas reserves

- Around the year 2000, natural gas reserves were running low in this country, prices started to go up as supply was low
- Grants were made to determine how to better get shale gas.
- This is gas is the pores of organic rich shale rock.
- Directional drilling and fracking were developed and greatly increased production.

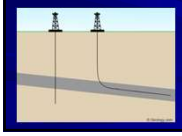
More than half of our gas comes from Shale Gas



Source: EIA Annual Energy Outlook 2016

Directional Drilling

- Instead of drilling straight down. The shale bed with the gas is located. The drill head is then turned to drill a hole straight along the shale bed.



Hydraulic fracturing or fracking

- A pipe with holes in it is inserted into the well.
- A high pressure liquid, usually water is forced through and it sprays out at all of the holes. This causes tiny fractures in the shale rock.
- A proppant such as sand is added to hold the holes open and allow the gas to flow more freely.

Concerns with fracking

- It may cause Earthquakes if there is a fault line, and not all fault lines are known.
- Ground water can become contaminated as we are shooting a high pressure water through the ground into areas containing organic material.
- Although this has greatly increased production for the time being, we will run out again.
- Current estimates state shale gas will last for 100 years at our current pace

Green production of natural gas

- Natural gas can be created from any rotting organic compound.
- This includes food waste, and feces.
- It is a natural byproduct of digestion.
- 10 cows produce enough natural gas to heat an average US home just by existing.
- There are several bio processer devices that create natural gas from these types of waste being used in third world countries an developed for future use elsewhere.
- This can decrease the rise in greenhouse gases

Biomass Fuel

- Ethanol is one fuel with potential to supplement or even replace gasoline
- Ethanol can be mixed with gasoline, or used to run a car by itself.
- Current gasoline has 10% ethanol in it, E85 is a fuel that is 85% ethanol and 15% gasoline.

Combustion of ethanol

- $C_2H_5OH + 3\ O_2 \rightarrow 3\ H_2O + 2\ CO_2\ \Delta H^o = -1367$ kJ

The energy from this combustion is about half the energy **per gram** as gasoline.

Fuel	kJ/g
Hydrogen	141.9
Gasoline	47.0
Diesel	45.0
Ethanol	29.7

- You would need a bigger tank, but it can work.
- They have been running cars off of "moonshine" (ethanol) for years.

To make ethanol

- You need a source of sugar.
- Corn, sugar cane, or any plant that produces sugar works.
- Then allow yeast to ferment the sugar.
- This is a spontaneous natural process.
- It won't take energy from humans to happen.
- It is actually capturing the Sun's energy.

Greenhouse gas…

- Carbon dioxide is produced from the combustion. However, the carbon dioxide was pulled out of the atmosphere in the production of sugar by the plant.
- The carbon dioxide concentration cannot increase in our atmosphere.
- There is not new carbon.

Methanol

- Methanol, an alcohol similar to ethanol, has been used in race cars for many years.
- It also has a possibility of powering cars and motors of all types.

Problems

- Growing enough sugar to make this feasible on global scale isn't possible currently.
- Plus, you are reducing your food supplies to make fuel.
- Better methods for growing and breaking down cellulose to sugars could change that in the future.

Biodiesel

- Biodiesel is a fuel made by esterifying the fatty acids found in vegetable oil.
- Biodiesel works very similarly to regular diesel.
- Small modifications need to be made to an engine to run off pure biodiesel.
- It is also runs in blends, like ethanol.

Production

- This can be produced from used vegetable oil from restaurants.
- It is cheaper using this method because the oil is “free”.
- It is still expensive to produce.
- At the moment there is plenty of unused oil.
- However, there is not enough used to satisfy a larger demand.
- It becomes significantly more expensive if the oil is produced and purchased.