ANKARA UNIVERSITY
DEPARTMENT OF ENERGY ENGINEERING

FOSSİL FUELS

INSTRUCTOR

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- Introduction to Fossil Fuels
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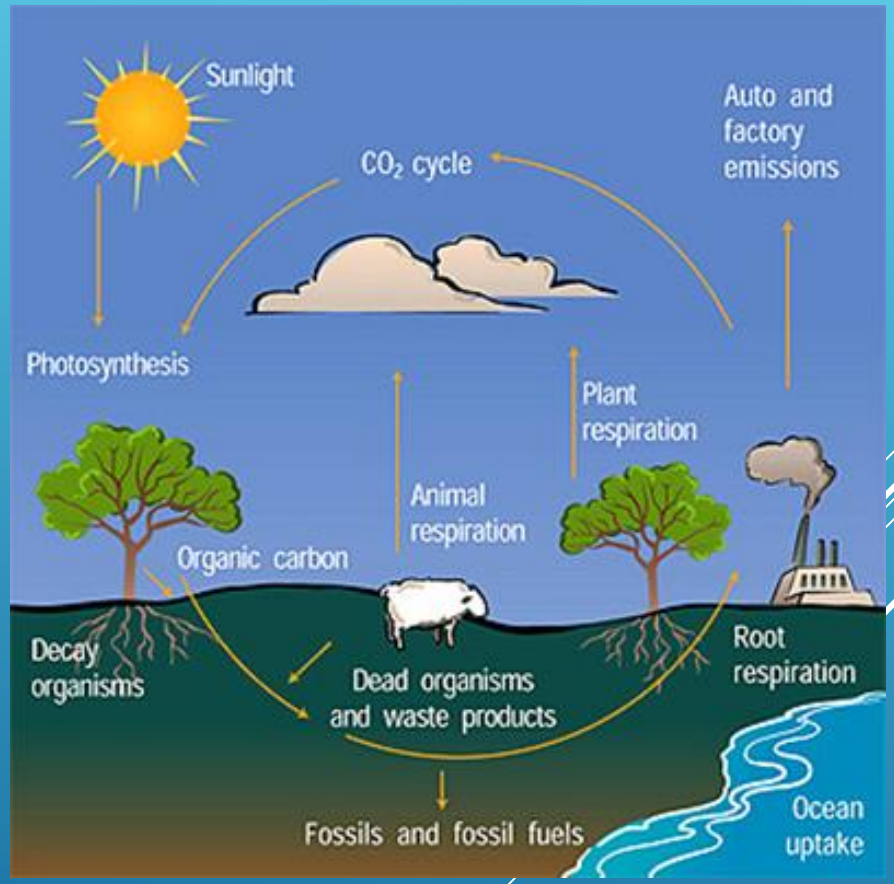
INTRODUCTİON TO FOSSİL FUELS

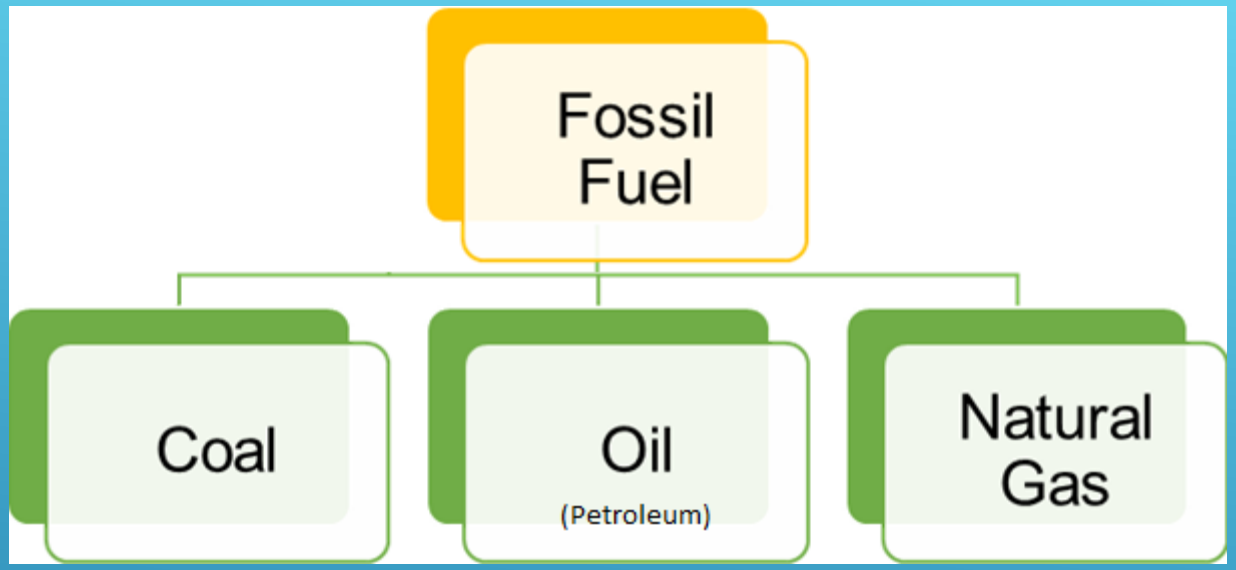
FOSSIL FUELS

Generally, energy is defined in science as the capability of matter to perform work. All available energy forms may be classified as either accumulated (stored) energy or transitional energy. Examples of stored energy are chemical energy of fossil fuels, internal energy of a substance, potential energy associated with position of a mass in a force field, such as the gravitational field of the earth or an electrostatic field. Transitional energy is the energy transferred between a system and its surroundings. In the case of heat-to-work conversion, heat and work are the transitional forms of energy.

Fossil fuels are the accumulated remains of living organisms that were buried millions of years ago. The term fossil fuel includes hydrocarbon-containing natural resources that are derived from animal or plant sources.

Energy can also be categorized as conventional energy, alternative energy, renewable energy, primary, secondary, end-use energy, and useful energy. Conventional energy sources are fossil fuels, including hard coal, lignite (brown coal), natural gas, coal-bed methane, pit, petroleum oil products (petrol, diesel, fuel oil), as well as artificially produced fuel types such as coal gas, liquefied gas, coke, char, as well as combustible waste materials.



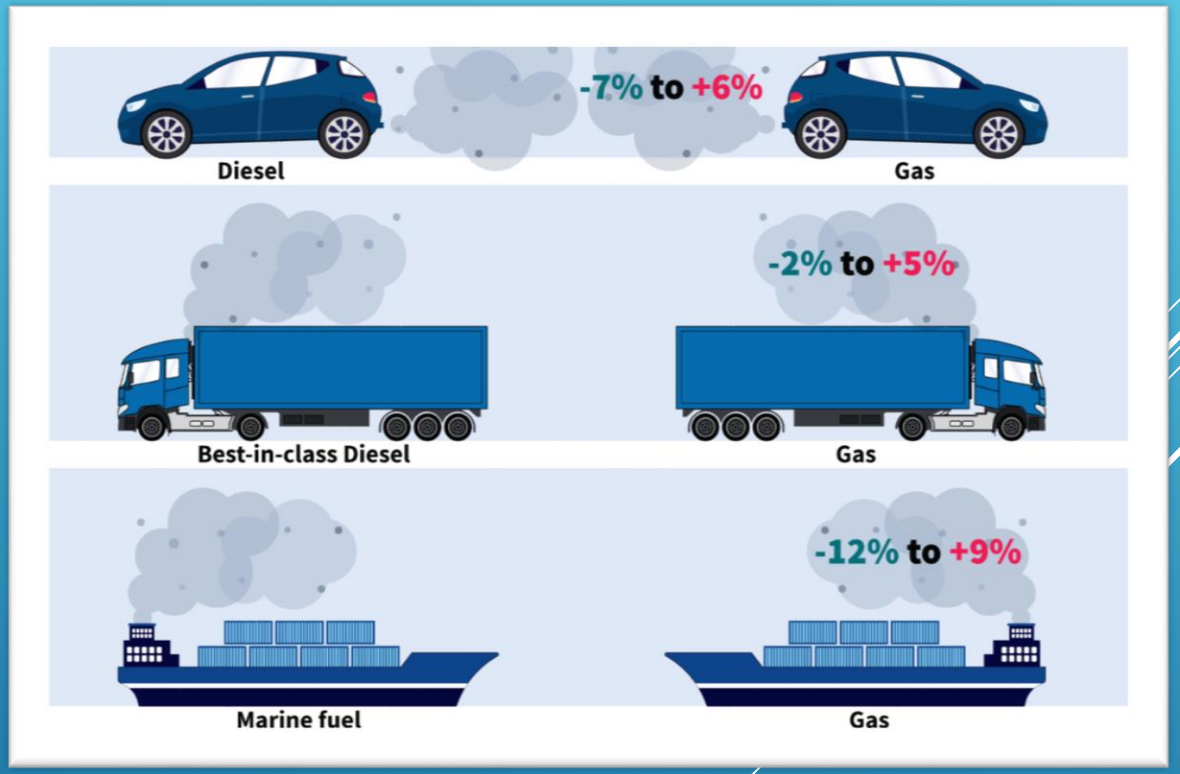

Fossil Fuel
Coal
Oil
(Petroleum)
Natural Gas

USING AREAS OF FOSSIL FUELS

Energy source (Fuels) of power plants

Melting metal ores (with burning processes)

Heating source of households



Power source of cars

Advanteges of fossil fuels

- Well- developed techniques

The technology we use to harness the energy in fossil fuels is well developed.

- Cheap and Reliable

Fossil fuels are cheap and reliable sources of energy. They are excellent types of fuel to use for the energy base-load, as opposed to some of the more unreliable energy sources such as wind and solar.

- Abundance

They also happen to be available pretty much anywhere in the world, it is believed there is a 300 year supply of coal.

- Transportation
- High calorific effect
- By products

Disadvantages of fossil fuels

Contribute to Global Warming

- Fossil fuels are not green sources of energy. In fact, they contain high amounts of carbon and have been blamed for being the main contributor to global warming.
- **Unsustainable (Non-Renewable)**
  - We are spending our fossil fuel reserves in a non-sustainable manner
- **Pollution**
  - When we burn fossil fuels a lots of chemical by products generates and these materials pollutes environment.
- **Environmental hazardous**
  - The mining of coal results in the destruction of wide areas of land. Mining this fossil fuel is also difficult and may endanger the lives of miners.
- **Non-Renewable**
  - Fossil fuels are non-renewable energy sources. This means that there is a finite amount of fossil fuels available and the reserves are not replenished naturally.

Why Are They Important To The Production Of Fossil Fuels?

An oil refinery or petroleum refinery is an industrial process plant where oil is processed and refined into more useful petroleum products, like gasoline, diesel fuel, asphalt base, heating oil, kerosene, and liquefied petroleum gas.

COAL

Coal is made up of carbon, hydrogen, oxygen, nitrogen and sulphur. The three main types of coal are anthracite, bituminous and lignite. Anthracite coal is the hardest and has more carbon. Lignite is the softest and is low in carbon but high in hydrogen and oxygen content. Bituminous is in between anthracite and lignite.

Stages of coal formation

1. Peat is a fibrous, soft, spongy substance in which plant remains are easily recognizable. It contains a large amount of water and must be dry before use.
2. Lignite is formed when peat is subjected to increased vertical pressure from accumulating sediments. It crumbles with no trouble and should not be shipped or handled before use.
3. Bituminous Coal is greatly used in industry as a source of heat energy.
4. Anthracite is also known as "hard coal" because it is hard and has a high lustre

COAL

- Hard
- Black
- Rock-like
- A nonrenewable energy source because it takes millions of years to create.
- Energy in coal comes from the energy stored by plants that lived hundreds of millions of years ago

Composition of Coal

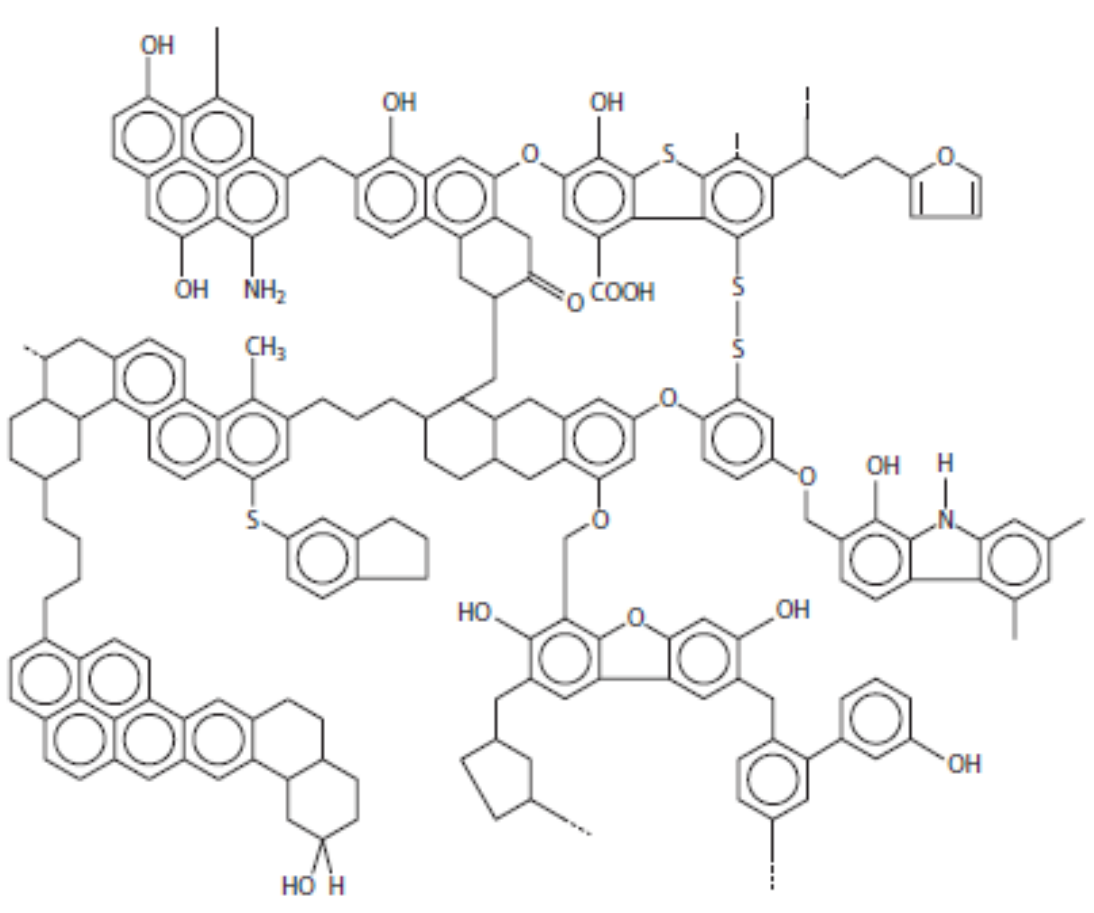


Table 2.1 Four Basic Ranks of Coal Based on the American Standards Association

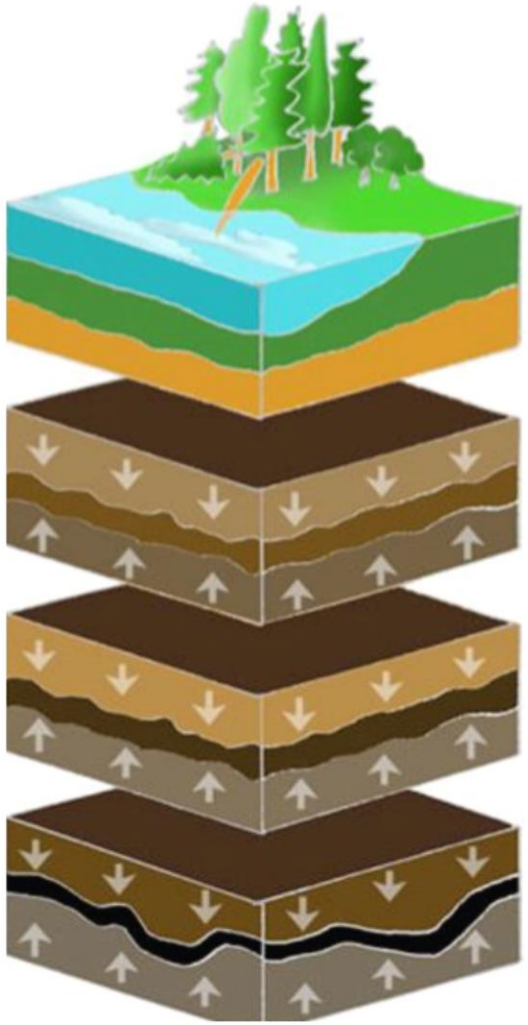
Rank	Carbon Content (%)	Energy Content (BTU/lb)
Lignite	<46	5,500–8,300
Subbituminous	46–60	8,300–11,000
Bituminous	46–86	11,000–13,500
Anthracite	86–98	13,500–15,600

An empirically determined formula for the energy content of coal based on the elemental abundances of carbon, hydrogen, oxygen, and sulfur is

$$E = 337\mathrm{C} + 1442(\mathrm{H} - \mathrm{O}/8) + 93\mathrm{S}$$

where E is in units of kilojoules per kilogram, and the symbols stand for the mass percentages of the elements C, H, O, and S.

Coal Formation



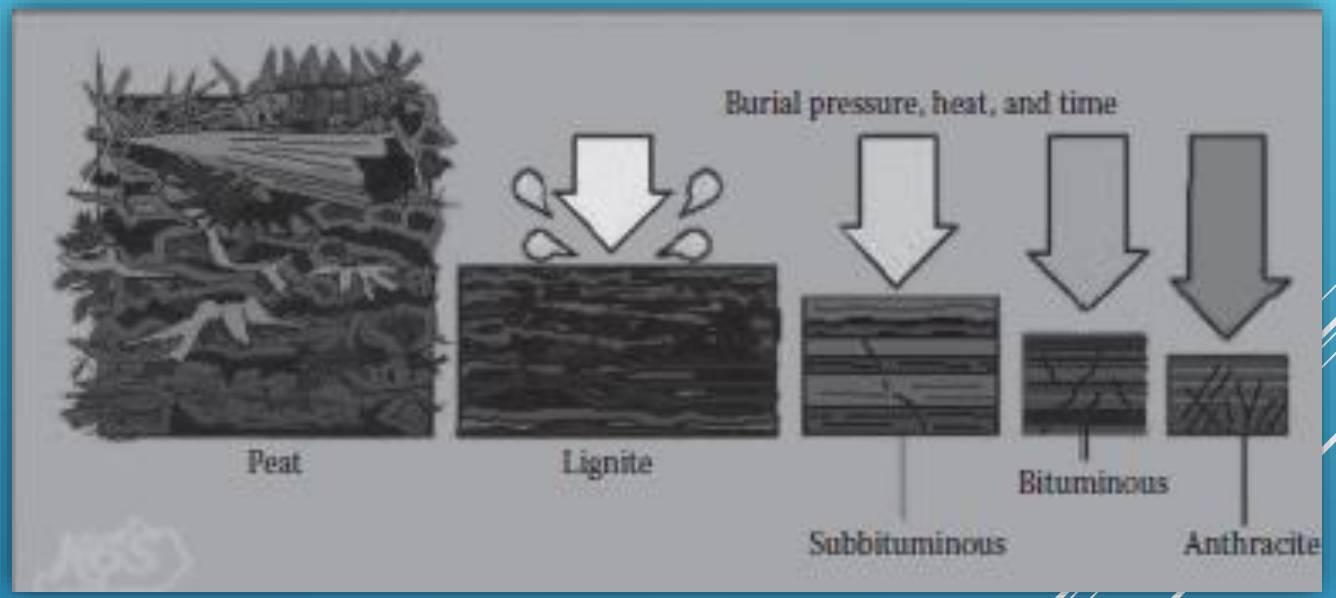
HUGE FORESTS GREW AROUND 300 MILLION YEARS AGO COVERING MOST OF THE EARTH

THE VEGETATION DIES AND FORMS PEAT

THE PEAT IS COMPRESED BETWEEN SEDIMENT LAYERS TO FORM LIGNITE

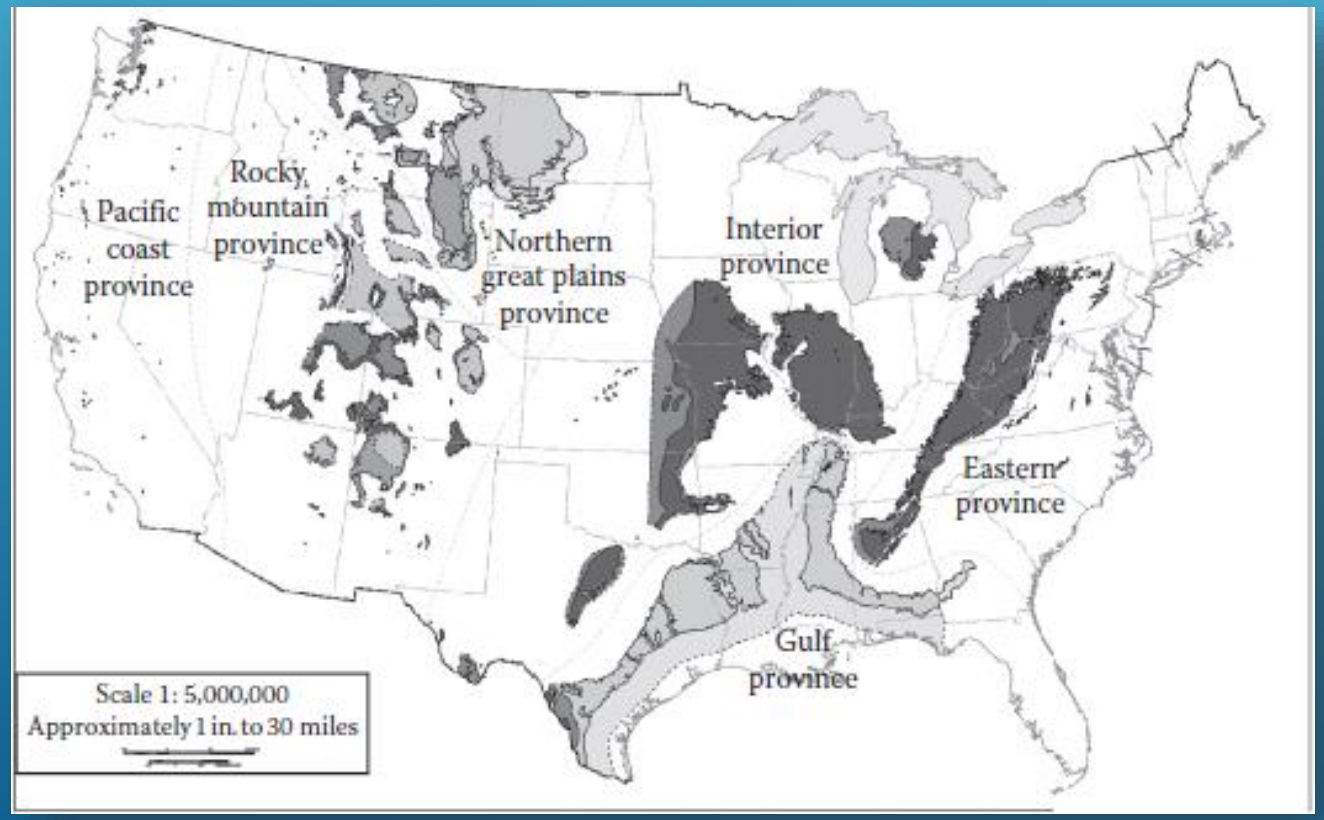
FURTHER COMPRESSION FORMS BITUMINOUS AND SUBITTUMINOUS COAL

EVENTUALLY ANTHRACITE FORMS

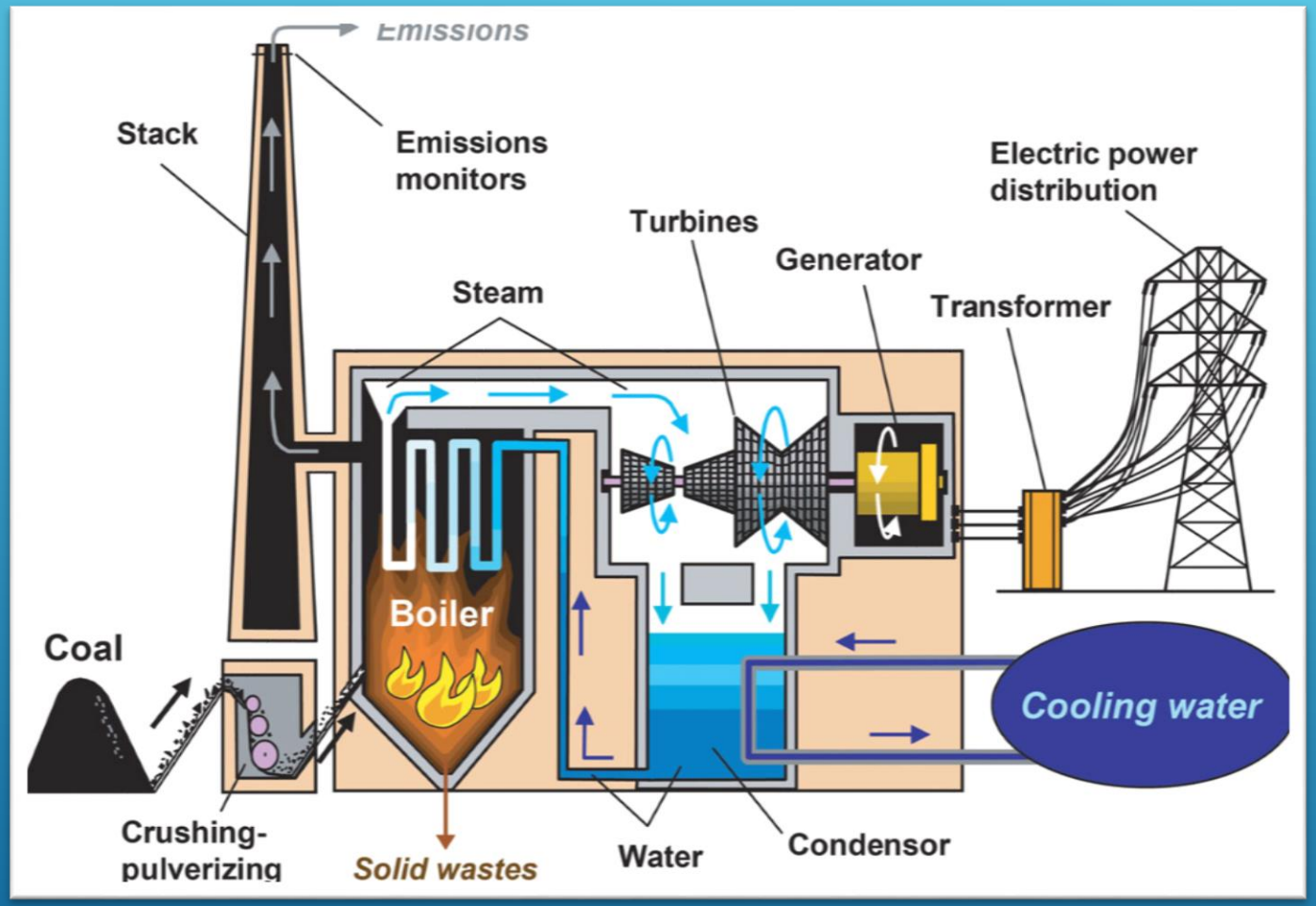


Resource Base

Coal is the most abundant of the fossil fuels, and around 50 nations have commercially operating mines. Nevertheless, about 85% of the recoverable reserves of coal in the world can be found in these nine nations: the United States (22.6%), Russia (14.4%), China (12.6%), Australia (8.9%), India (7.0%), Germany (4.7%), Ukraine (3.9%), Kazhakstan (3.9%), and South Africa (3.5%).



Electricity Generation From Coal



Basic components of a coal-fired power plant

Conversion of Coal to a Transportation Fuel

- Transportation fuels are generally either liquids or gases. A gaseous fuel *syngas* (short for synthetic gas, which is a mixture of carbon monoxide and hydrogen) can be produced from coal by heating it under high pressure in the presence of water vapor. The syngas reaction known as coal gasification is

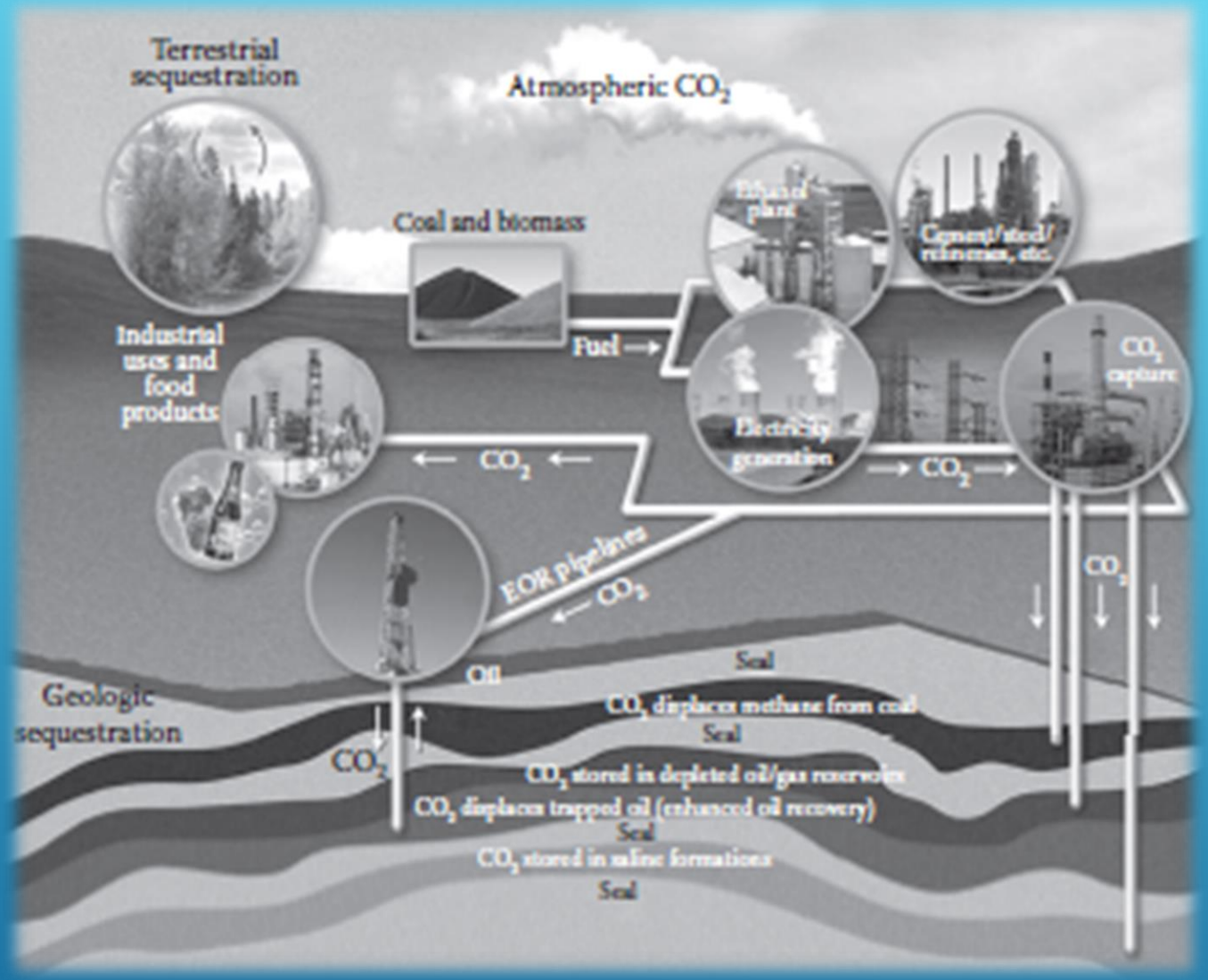
$$\text{Coal} + O_2 + H_2O \longrightarrow H_2 + CO$$

Environmental Impacts of Coal

Waterborne pollution and acid rain

Table 2.2 Emissions from Power Plants Using Various Fuels in Kilograms/Gigajoule for Actual Power Plants, as Reported by the European Environmental Agency

Pollutant	Hard Coal	Brown Coal	Fuel Oil	Gas
CO_2	94.6	101.0	77.4	56.1
SO_2	0.765	1.36	0.228	0.00068
NO*x*	0.292	0.183	0.195	0.093
CO	0.0891	0.0891	0.0157	0.0145
Particulates	1.203	3.254	0.016	0.0001



Carbon Sequestration

PETROLEUM

As diatoms died they fell to the sea floor. They were buried under sediment and other rock. The rock squeezed diatoms and the energy in their bodies could not escape. Carbon eventually turned into oil under pressure and heat.

PETROLEUM

Formed more than 300 million years ago.

- Scientists say that tiny diatoms (diatoms- sea creatures the size of a pin head and can convert sunlight directly into stored energy) are the source of oil.
- Oil has been used for more than 5,000-6,000 years.
- Is produced in; Russia, Saudi Arabia, United States, Iran, and China

NATURAL GAS

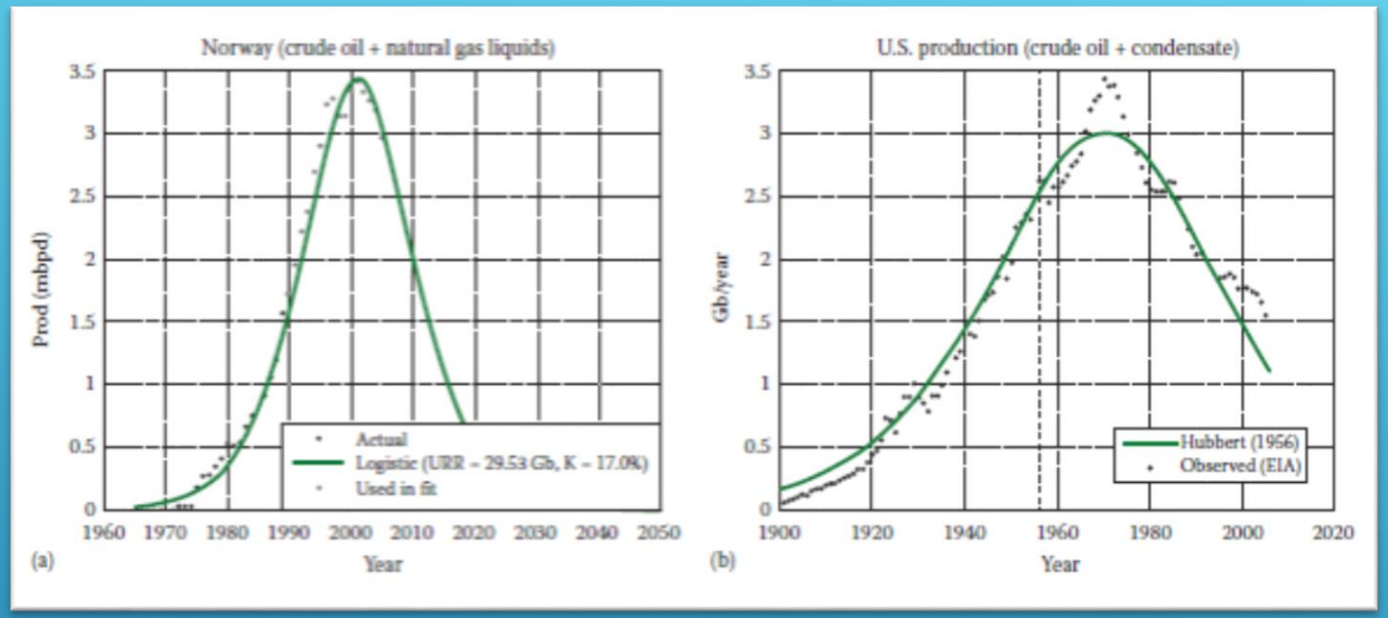
- Lighter than air
- Natural gas is mostly made up of methane.
- First discoveries of natural gas seeps were made in Iran.
- Mostly made up of a gas called methane.(methane-simple chemical compound that is made up of carbon and hydrogen atoms.)
- Usually found near petroleum underground.
- Pumped from below ground and travels in pipelines to storage areas.

RESOURCE BASE OF OIL AND GAS

Table 2.3 Percentage of the Proven Reserves of Natural Gas in the World, as of 2015

Country	World Gas Reserves (%)
Russia	24.2
Iran	17.2
Qatar	12.5
Turkmenistan	3.8
Saudi Arabia	4.2
United States	4.9

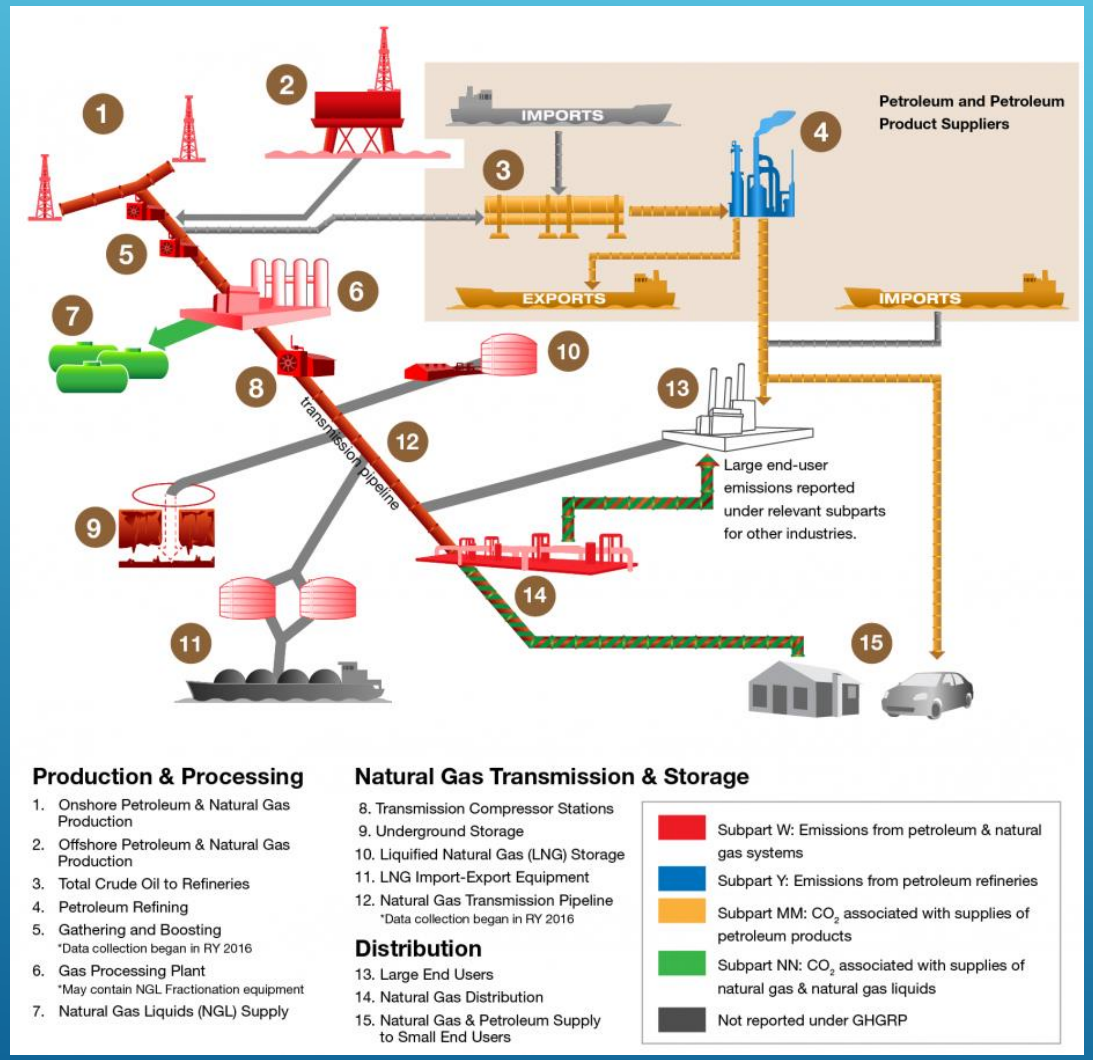
The world's petroleum reserves are quite unevenly distributed around the globe. While the nations of the Middle East have a majority of the proven reserves (56%), as seen in Figure 2.12, there are also very significant deposits in North America (16%), Africa (9%), South America (mainly Venezuela, 8%), and Eurasia (7%).

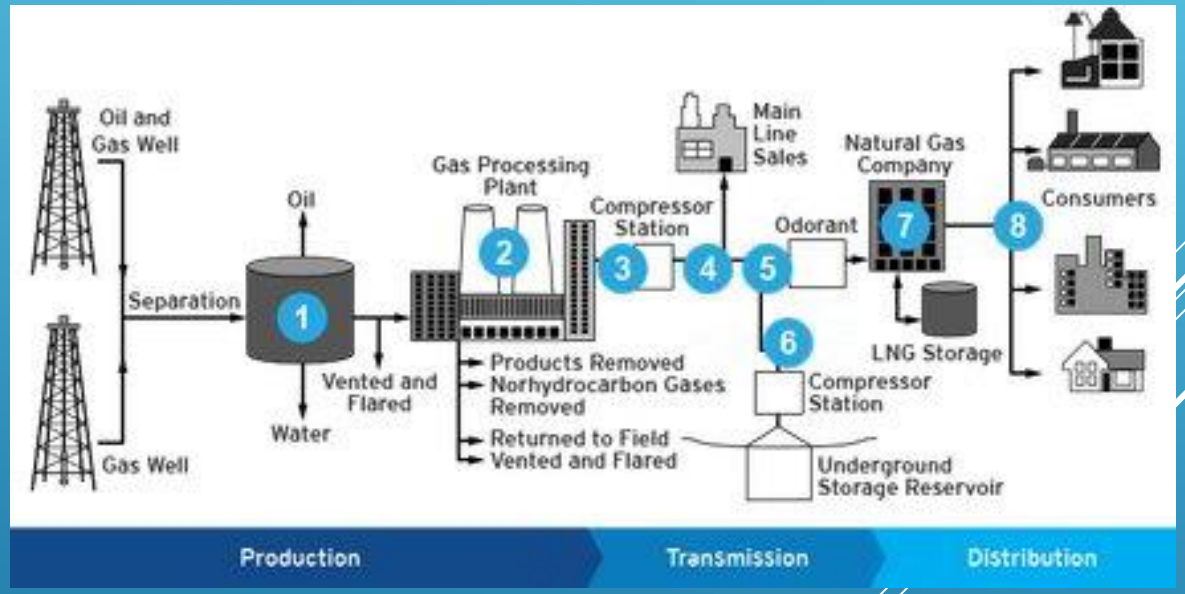


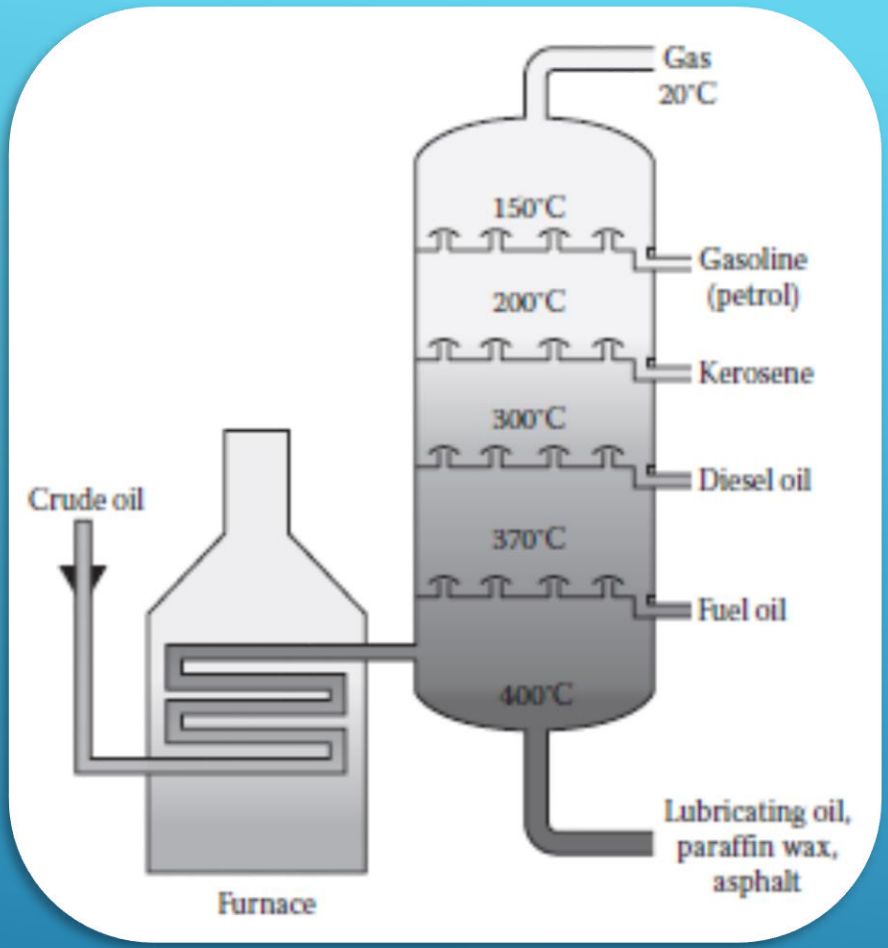
Hubbert's theory of peak oil was made at a time when the climb up the bell curve in many nations was in its early stages, well before the peak. moreover, hubbert applied his theory to the world as a whole for which he predicted a maximum oil production around the year 2000.

Example: Show that if the present world consumption of a resource is now at its absolute peak and consumption follows a Gaussian curve, then T defined as the number of years left at the present rate of consumption R_0 is roughly equal to half of the full width of the Gaussian at half max (FWHM). Note that it can easily be shown that the FWHM and standard deviation are related by FWHM = 2.35σ.

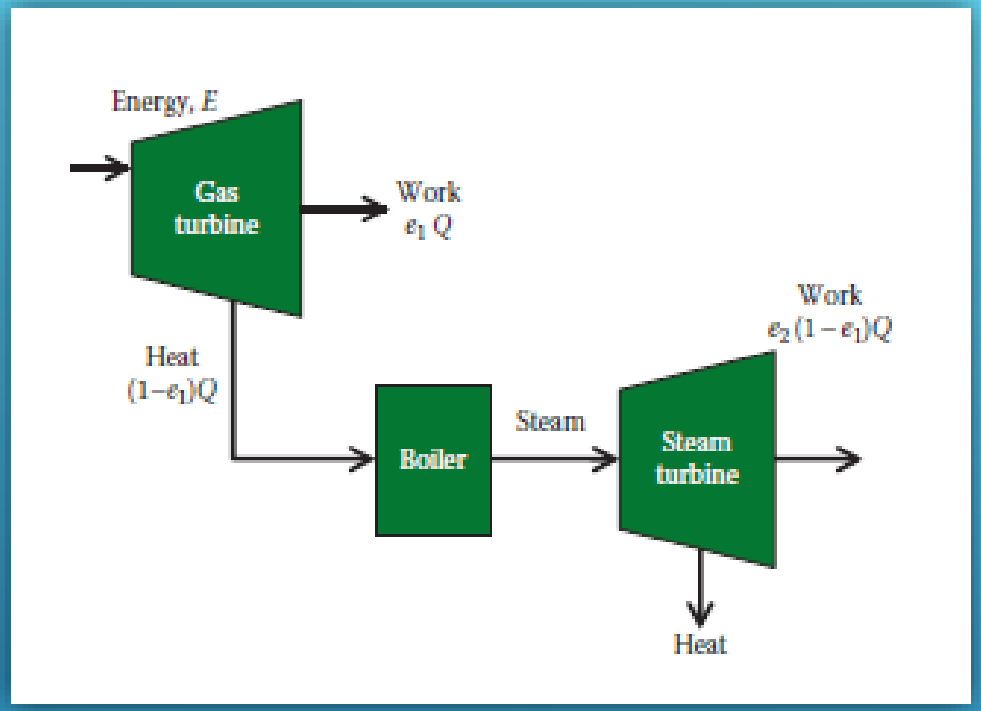
Petroleum and Natural Gas Processing







Fractional distillationprocess in an oil refinery in the case of straight run refining. Most gasoline today is made by catalytic cracking of large molecules to small molecules and then reforming them into gasoline.

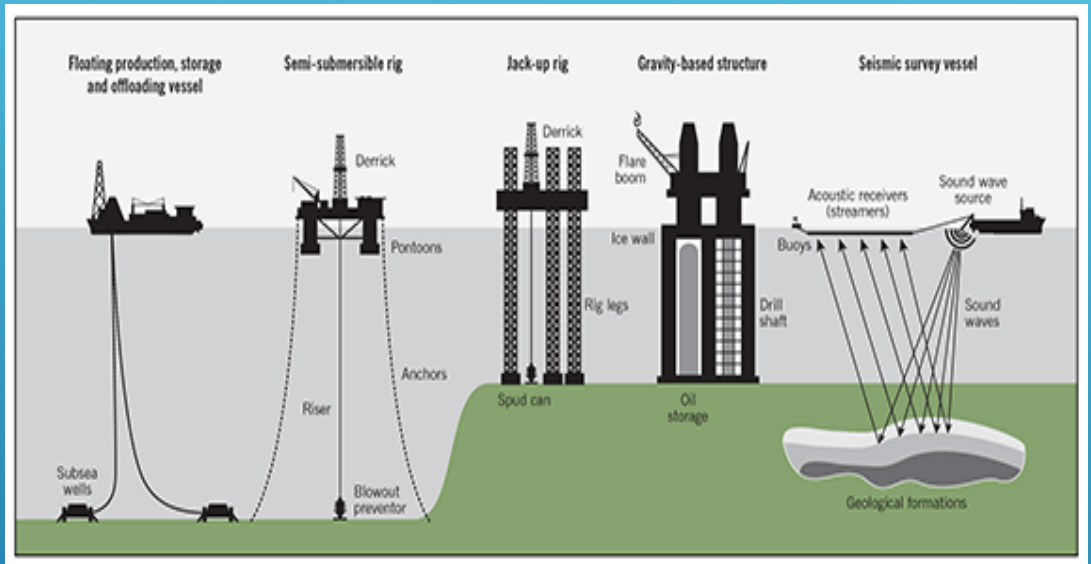


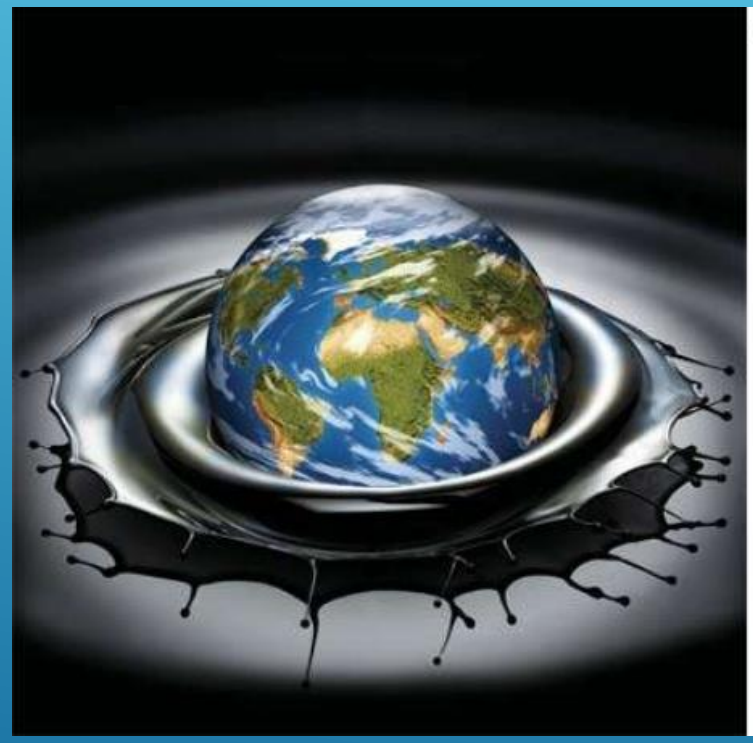
The efficiency of a binary cycle plant can be expressed in terms of the efficiencies for each cycle as

$$e_{CC} = \frac{\text{Work}}{\text{Heat}_{in}} = \frac{e_1 Q + e_2(1-e_1)Q}{Q} = e_1 + e_2 - e_1 e_2.$$

2.3.7.1 Example 5: a binary cycle plant suppose that the first stage of a binary cycle power plant has an efficiency of 35%. what is the maximum possible overall efficiency if the second stage operates at a temperature of 227°c = 500 k and expels heat to the environment at 27°c = 300 K ?

Environmental Impacts of Oil and Gas





- The environmental impacts on the air of the oil and gas industry split into two types :
  - Risk of explosions and fires
  - Emissions

Emissions had a much greater impact and had been the focus of public and political attention such as through the Kyoto Protocol.

Environmental Impacts of Oil and Gas

SUMMARY

This chapter considers the three fossil fuels, coal, oil, and gas, and their formation, uses, and especially their environmental consequences, which can be very detrimental—especially in the case of coal. It also considers a variety of controversial questions including whether coal, oil, and gas are really fossil fuels at all, whether there can be such a thing as clean coal, and whether natural gas, which may be cleaner than coal or oil, can really serve as a bridge fuel while we move toward renewable energy sources.

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