

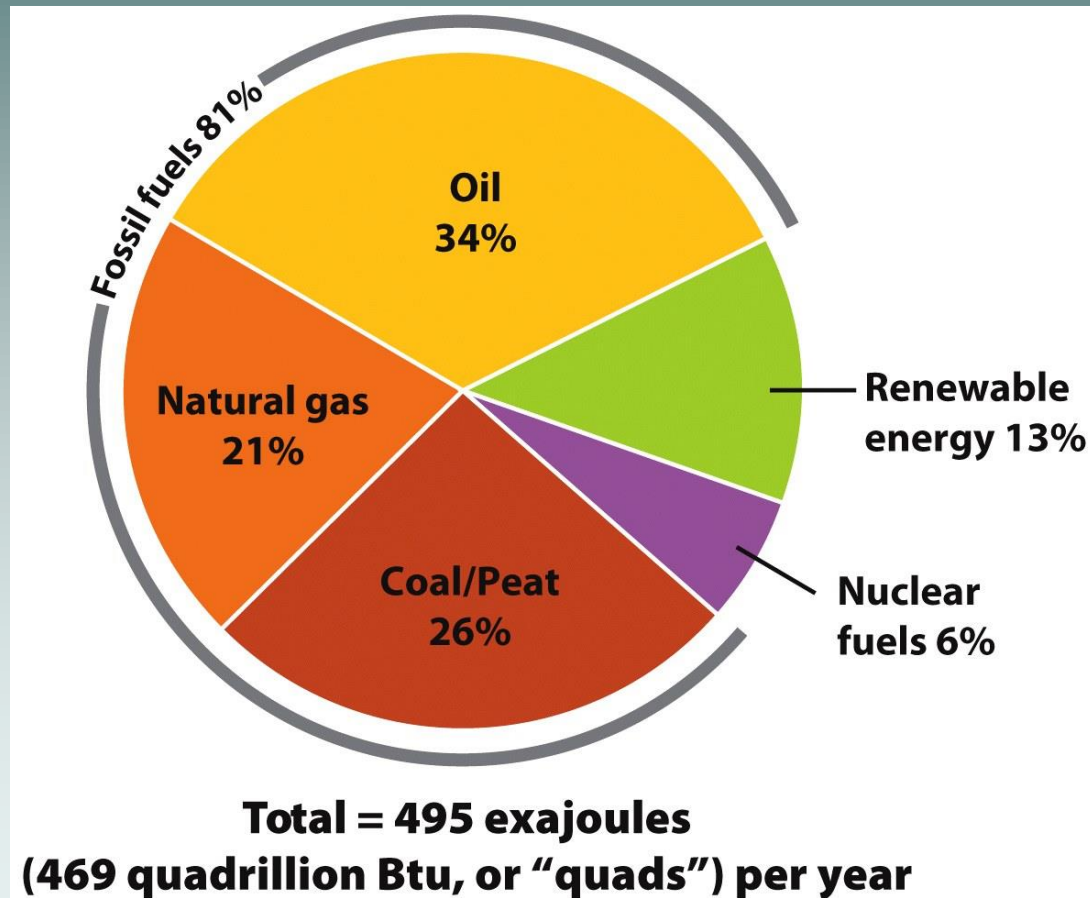


Chapter 12

Nonrenewable Energy Resources

Nonrenewable Energy

- Nonrenewable energy resources- fossil fuels (coal, oil, natural gas) and nuclear fuels.



Energy Use

- ▣ Commercial energy sources- those that are bought and sold, such as coal, oil and natural gas.
- ▣ Subsistence energy sources- those gathered by individuals for their own use such as wood, charcoal and animal waste.

Process of Energy Use

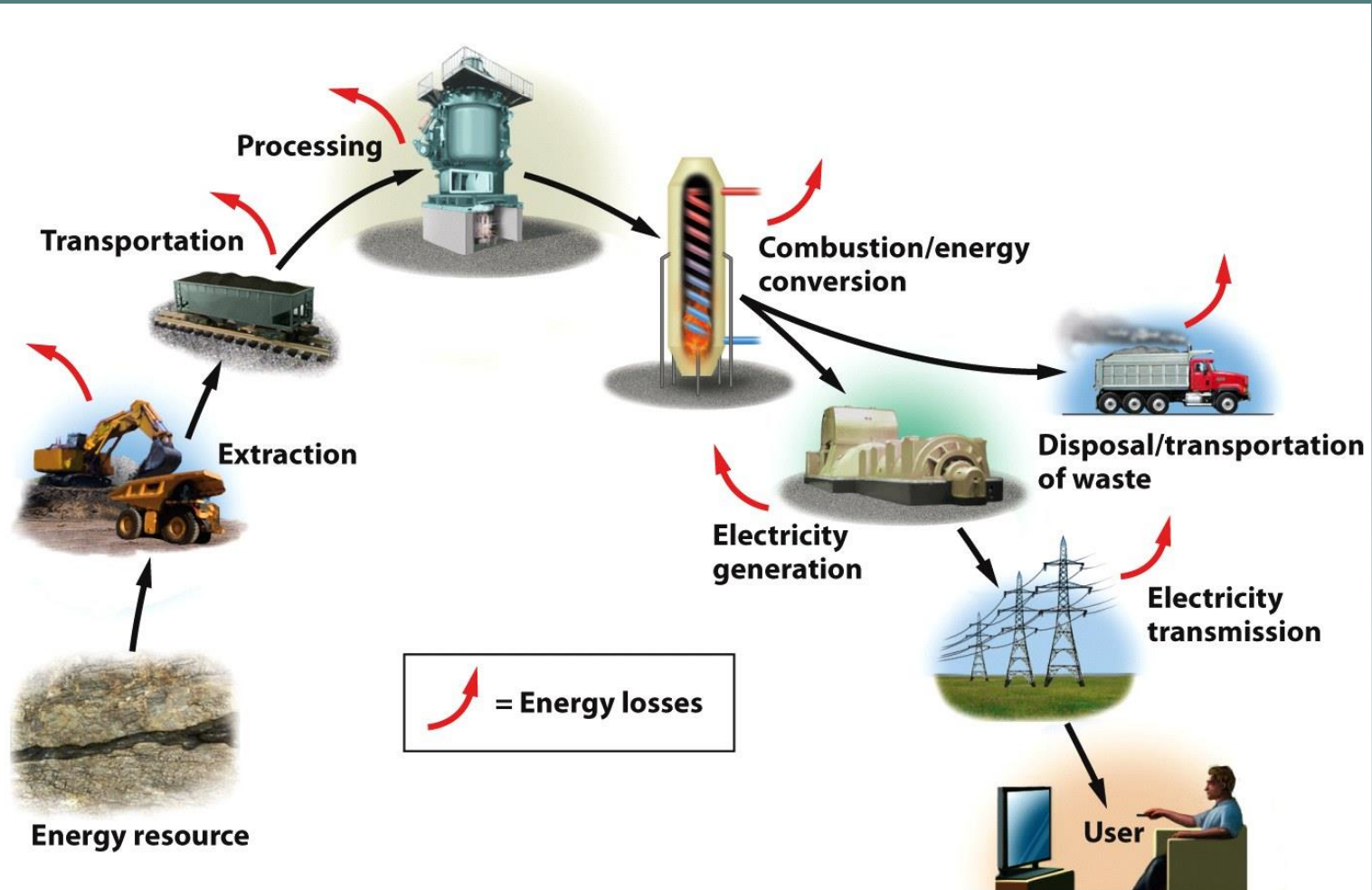


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Overall Fuel Efficiency of U.S. Automobiles

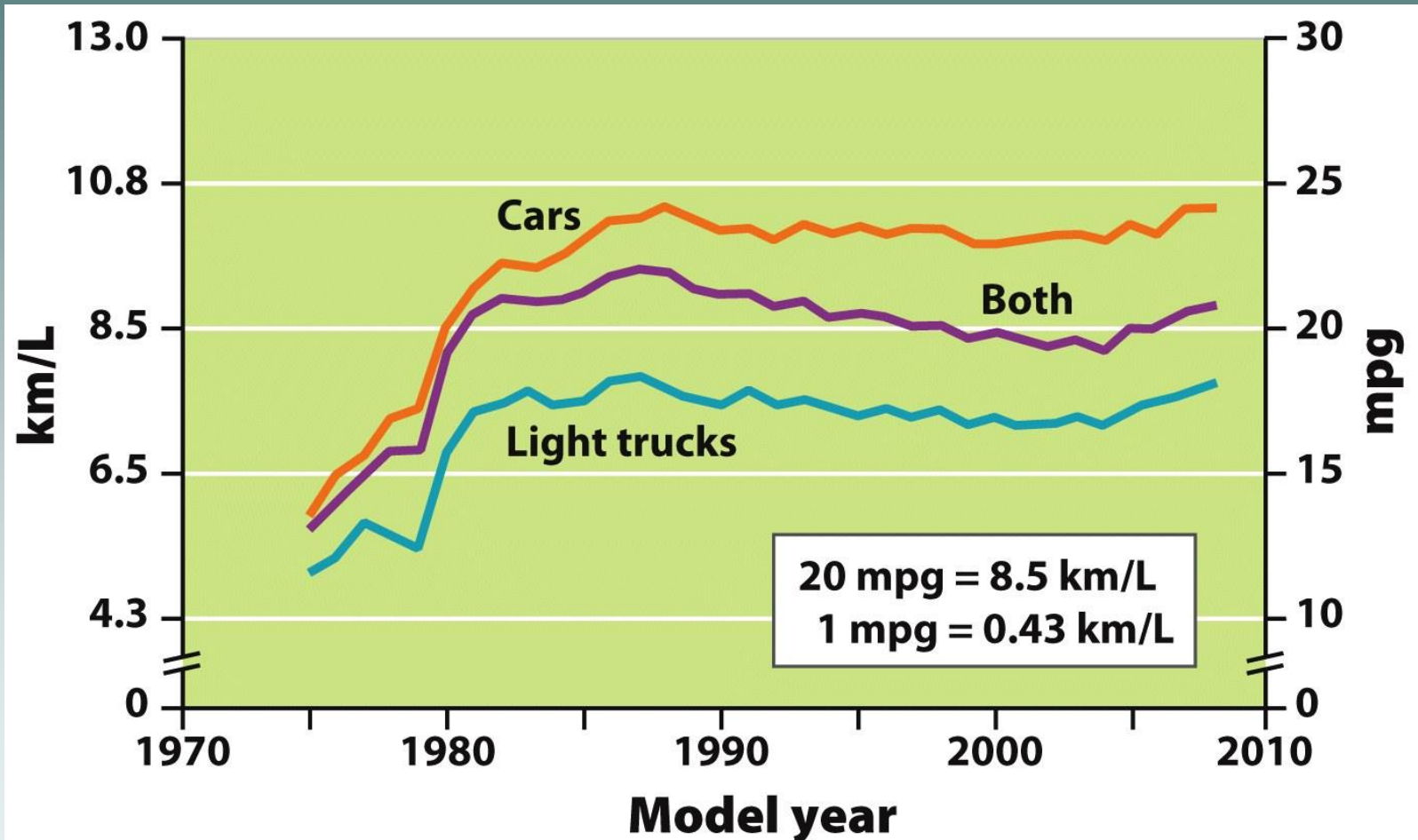


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Electricity Generation

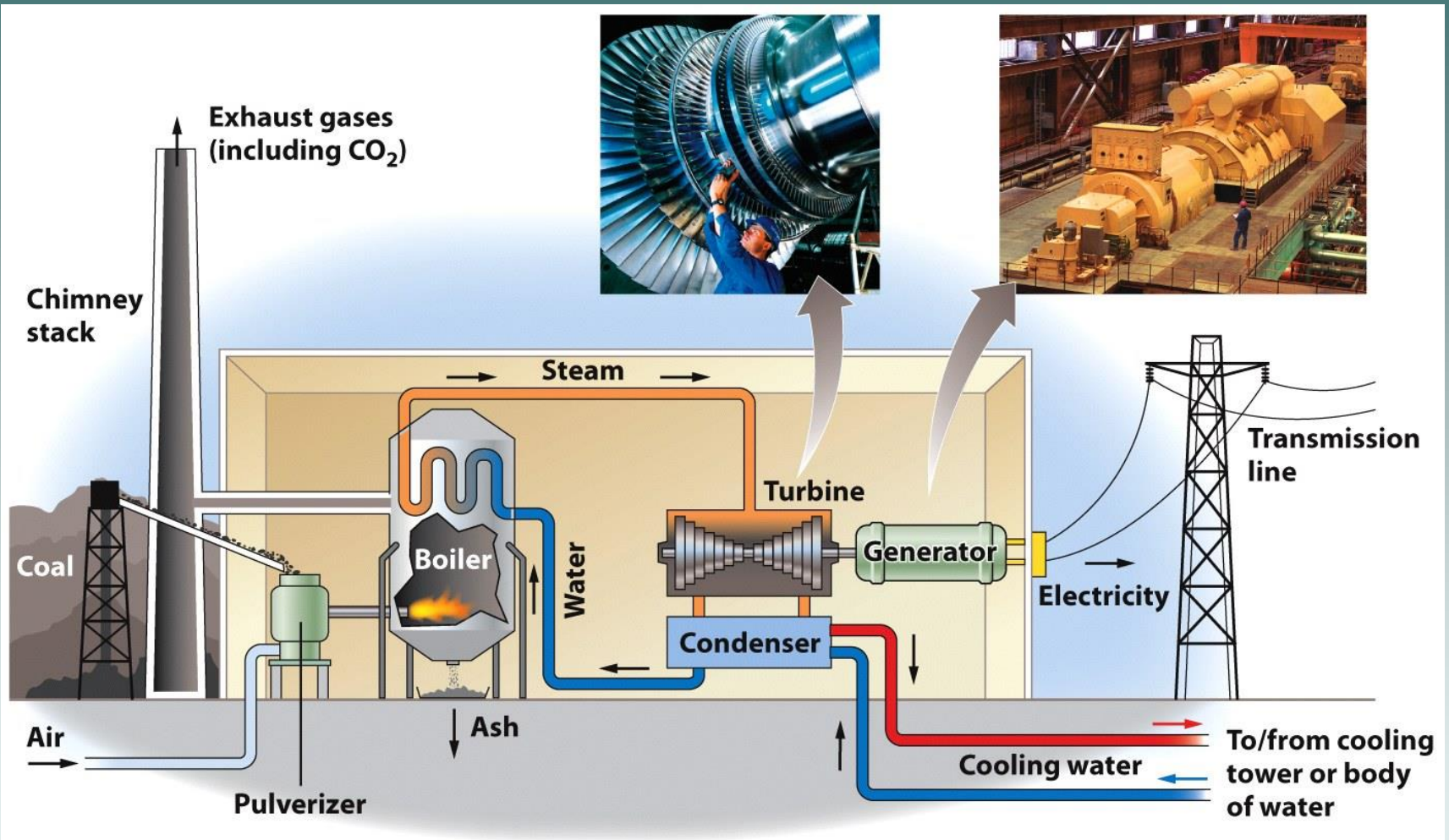


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Electricity Generation

- ▣ The burning fuel from coal transfers energy to water, which becomes steam.
- ▣ The kinetic energy contained within the steam is transferred to the blades of a turbine, a large device that resembles a fan.
- ▣ As the energy in the steam turns the turbine, the shaft in the center of the turbine turns the generator.
- ▣ This mechanical motion generates energy.

Energy Efficiency

- Most coal burning power plants are about 35% efficient.

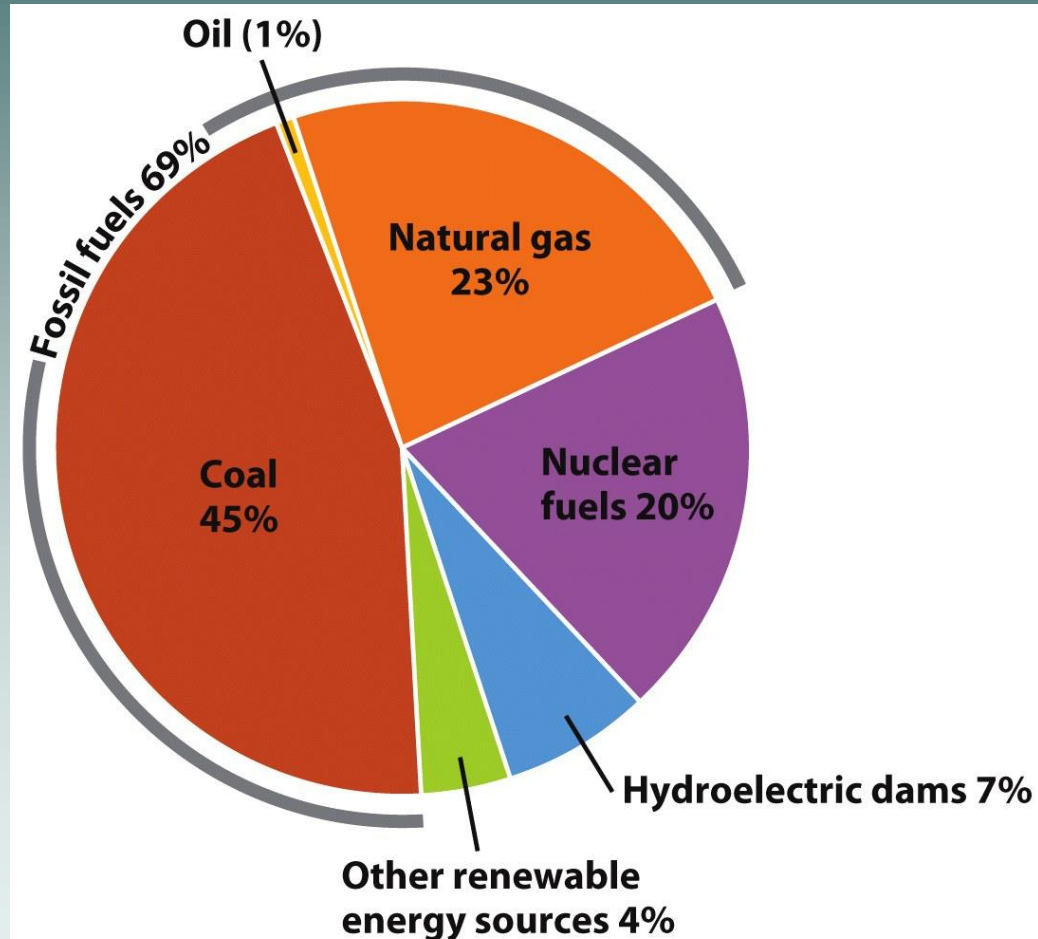


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Cogeneration

- ▣ Cogeneration- using a fuel to generate electricity and to produce heat.
- ▣ Example- If steam is used for industrial purposes or to heat buildings it is diverted to turn a turbine first.
- ▣ This improves the efficiency to as high as 90%.

Coal

- ▣ Coal- a solid fuel formed primarily from the remains of trees, ferns, and other plant materials that were preserved 280-360 million years ago.
- ▣ Four types of coal ranked from lesser to greater age, exposure to pressure, and energy content.
- ▣ These four types are: lignite, sub-bituminous, bituminous, and anthracite.
- ▣ The largest coal reserves are in the United States, Russia, China, and India.

Coal

Ancient forests cover much of Earth's surface.

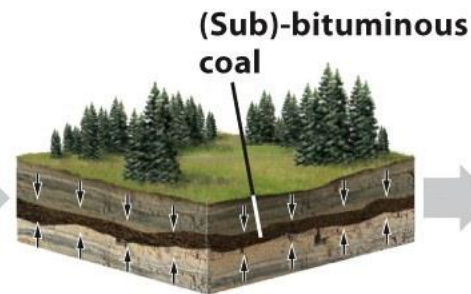
Time and pressure



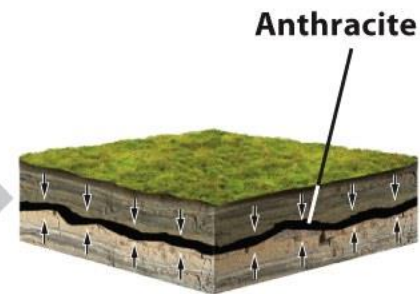
The vegetation dies and is buried under anaerobic conditions, forming peat (partially decomposed organic matter).



The peat is compressed between sediment layers to form lignite.



Further compression yields sub-bituminous and bituminous coal.



After yet more pressure and time, anthracite forms.

Figure 12.9

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Advantages and Disadvantages of Coal

Advantages	Disadvantages
Energy-dense	Contains impurities
Plentiful	Release impurities into air when burned
Easy to exploit by surface mining	Trace metals like mercury, lead, and arsenic are found in coal
Technological demands are small	Combustion leads to increased levels of sulfur dioxide and other air pollutants into the atmosphere.
Economic costs are low	Ash is left behind
Easy to handle and transport	Carbon is released into the atmosphere which contributes to climate change
Needs little refining	

Petroleum

- ▣ Petroleum- a mixture of hydrocarbons, water, and sulfur that occurs in underground deposits.
- ▣ Oil and gasoline make this ideal for mobile combustion, such as vehicles.
- ▣ Formed from the remains of ocean-dwelling phytoplankton that died 50-150 million years ago.
- ▣ Countries with the most petroleum are Saudi Arabia, Russia, the United States, Iran, China, Canada, and Mexico.

Petroleum

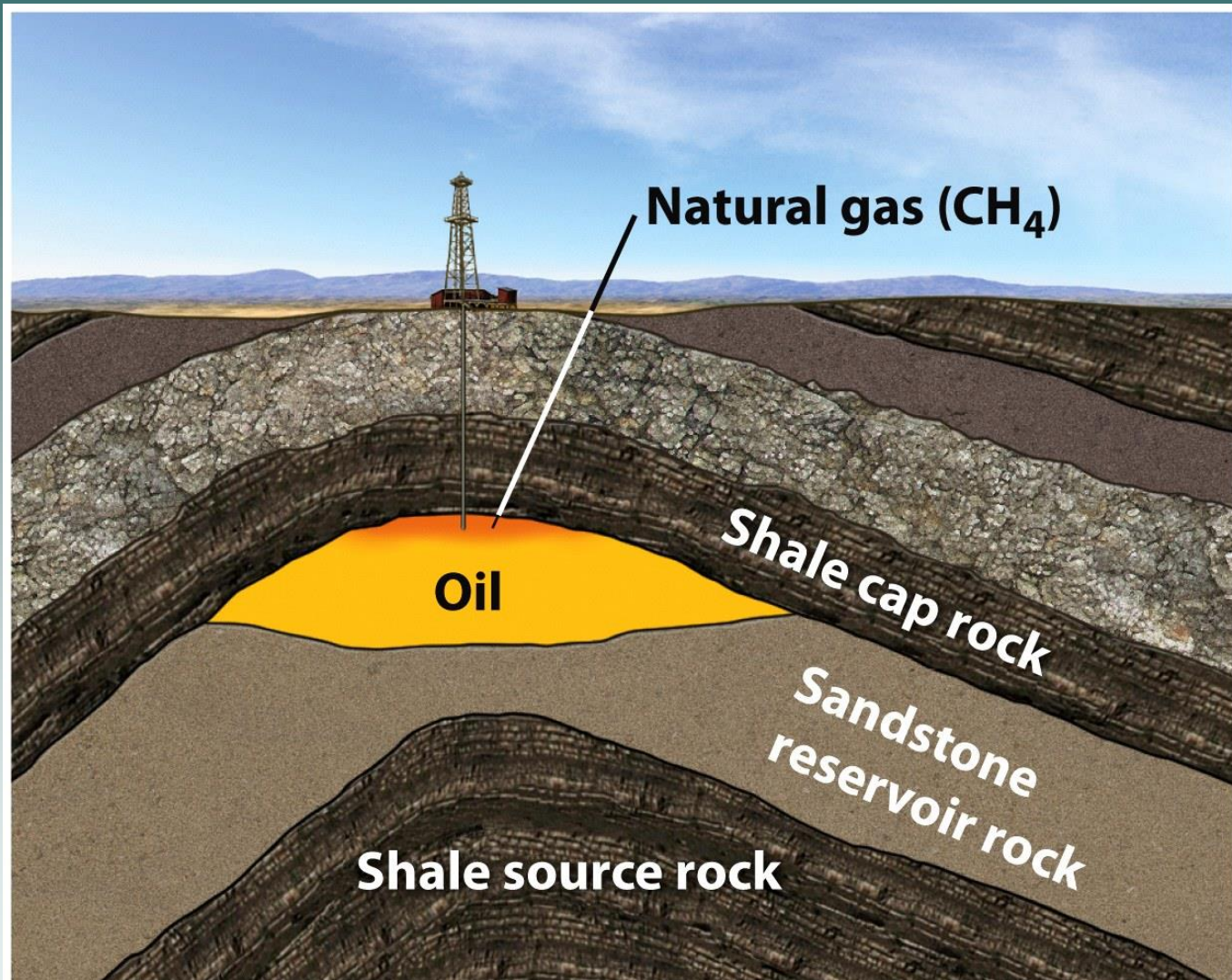


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Advantages and Disadvantages of Petroleum

Advantages	Disadvantages
Convenient to transport and use	Releases carbon dioxide into atmosphere
Relatively energy-dense	Possibility of leaks when extracted and transported
Cleaner-burning than coal	
Releases sulfur, mercury, lead, and arsenic into the atmosphere when burned	

Natural Gas

- ▣ Natural gas- exists as a component of petroleum in the ground as well as in gaseous deposits separate from petroleum.
- ▣ Contains 80 to 95 percent methane and 5 to 20 percent ethane, propane, and butane.

Advantages and Disadvantages Natural Gas

Advantages	Disadvantages
Contains fewer impurities and therefore emits almost no sulfur dioxide or particulates	When unburned, methane escapes into the atmosphere
Emits only 60% as much carbon dioxide as coal	Exploration of natural gas has the potential of contaminating groundwater

Other Fossil Fuels

- ▣ Oil sands- slow-flowing, viscous deposits of bitumen mixed with sand, water, and clay.
- ▣ Bitumen (tar or pitch)- a degraded type of petroleum that forms when a petroleum migrates close to the surface, where bacteria metabolize some of the light hydrocarbons and others evaporate.

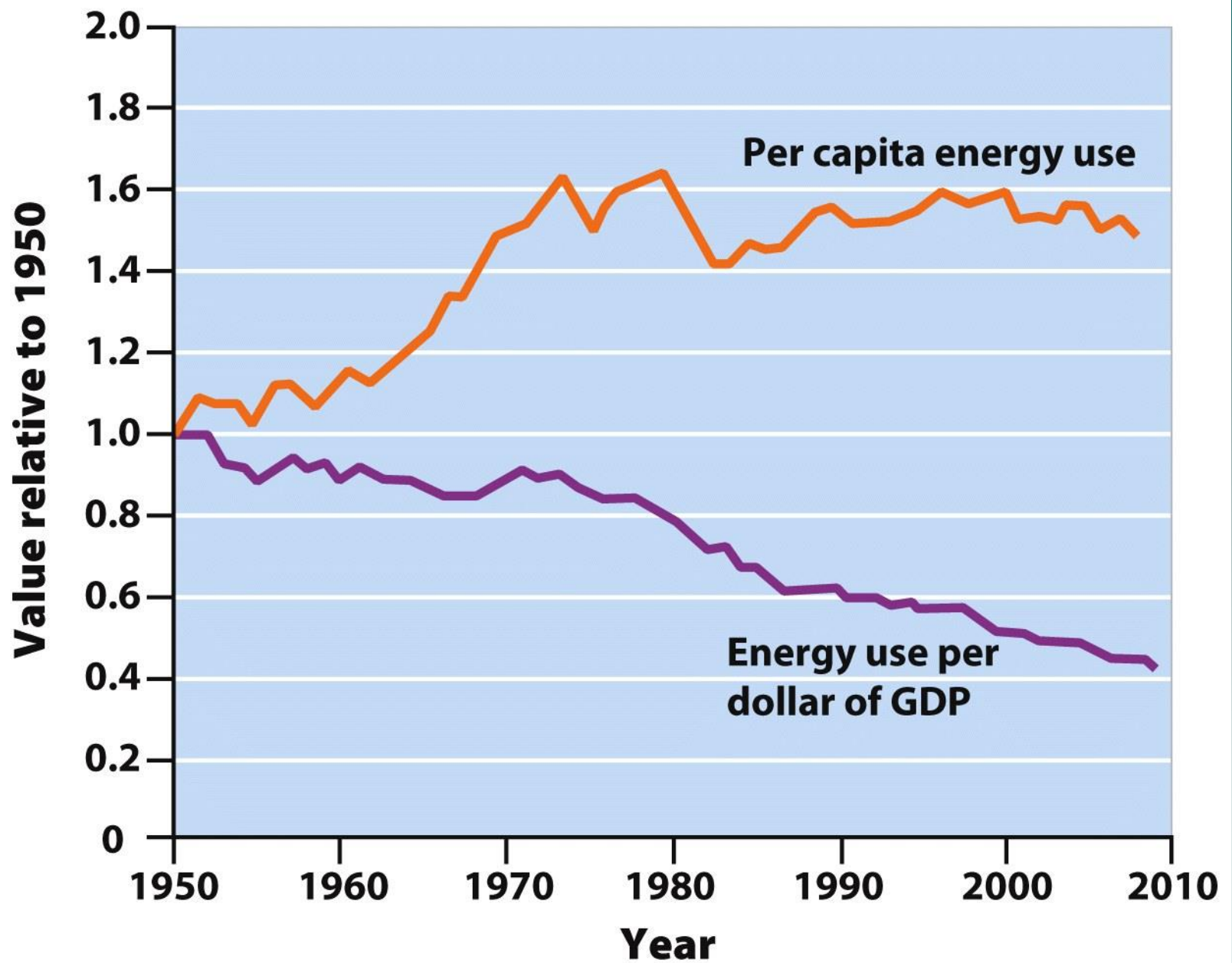


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The Hubbert Curve

- Hubbert curve- a graph that shows the point at which world oil production would reach a maximum and the point at which we would run out of oil.

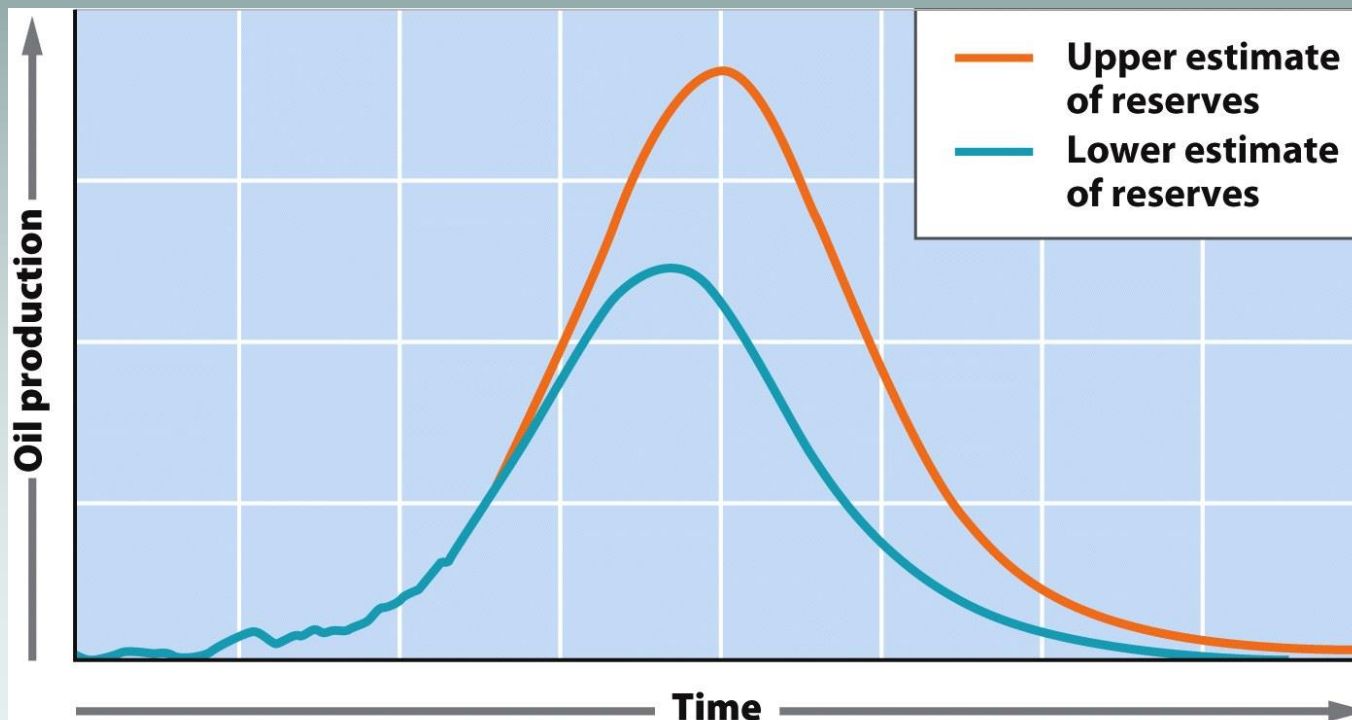


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The Future of Fossil Fuel Use

- ▣ If current global use continues, we will run out of conventional oil in less than 40 years.
- ▣ Coal supplies will last for at least 200 years, and probably much longer.

Nuclear Energy

- Fission- a nuclear reaction in which a neutron strikes a relatively large atomic nucleus, which then splits into two or more parts.

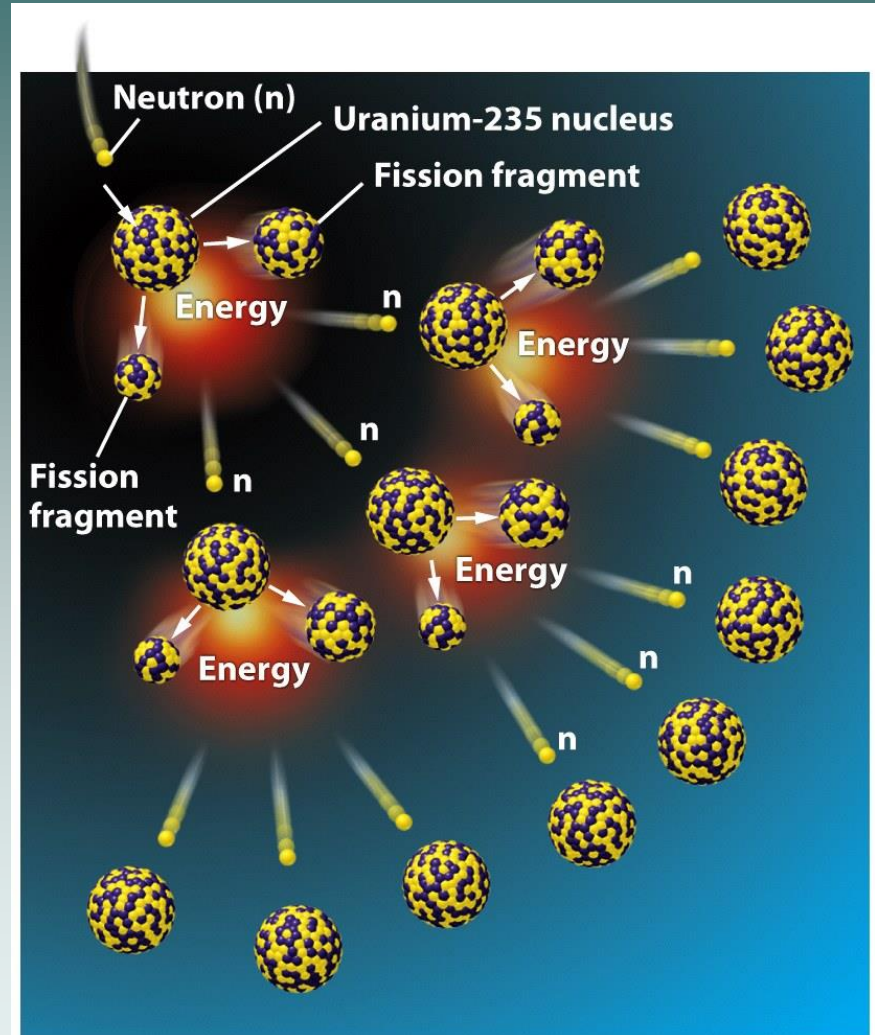


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Nuclear Reactors

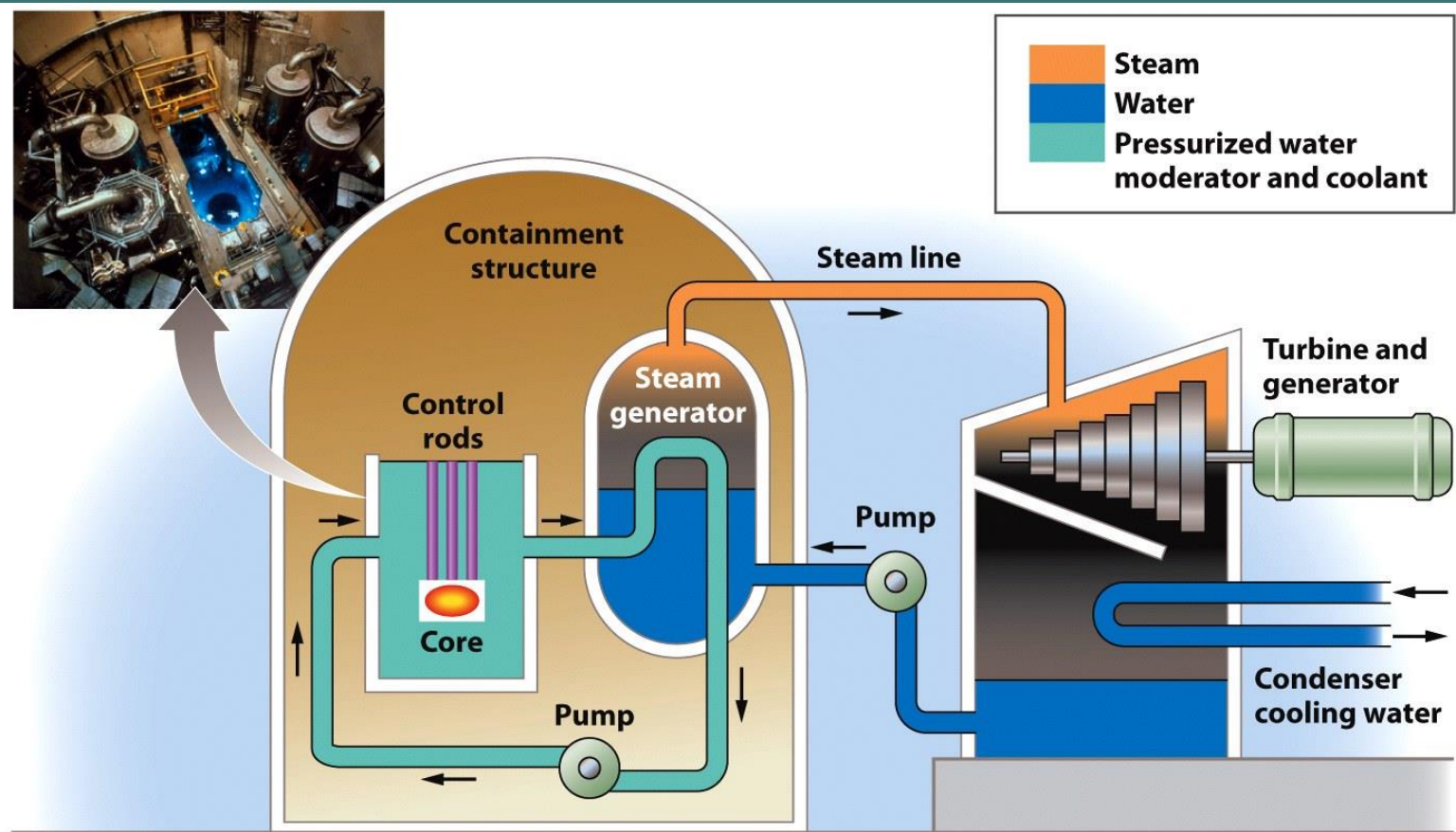


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Nuclear Reactors

- ▣ Fuel rods- the cylindrical tubes that house the nuclear fuel used in a nuclear power plant.
- ▣ Nuclear power plants work by using heat from nuclear fission to heat water. This water produces the steam to turn the turbine, which turns a generator.
- ▣ Control rods- cylindrical devices that can be inserted between the fuel rods to absorb excess neutrons, thus slowing or stopping the fission reaction.

Advantages and Disadvantages of Nuclear Energy

Advantages	Disadvantages
No air pollution is produced	Possibility of accidents
Countries can limit their need for imported oil	Disposal of the radioactive waste

Radioactive Waste

- ▣ Radioactive waste- once the nuclear fuel can not produce enough heat to be used in a power plant but it continues to emit radioactivity.
- ▣ This waste must be stored in special, highly secure locations because of the danger to living organisms.

Radioactive Waste

- ▣ High-level radioactive waste- the form used in fuel rods.
- ▣ Low-level radioactive waste- the protective clothing, tools, rags, and other items used in routine plant maintenance.

Fusion

- ▣ Nuclear fusion- the reaction that powers the Sun and other stars. This occurs when lighter nuclei are forced together to produce heavier nuclei and heat is released.
- ▣ Fusion is a promising, unlimited source of energy in the future, but so far scientists have had difficulty containing the heat that is produced.