Energy Resources and Environment

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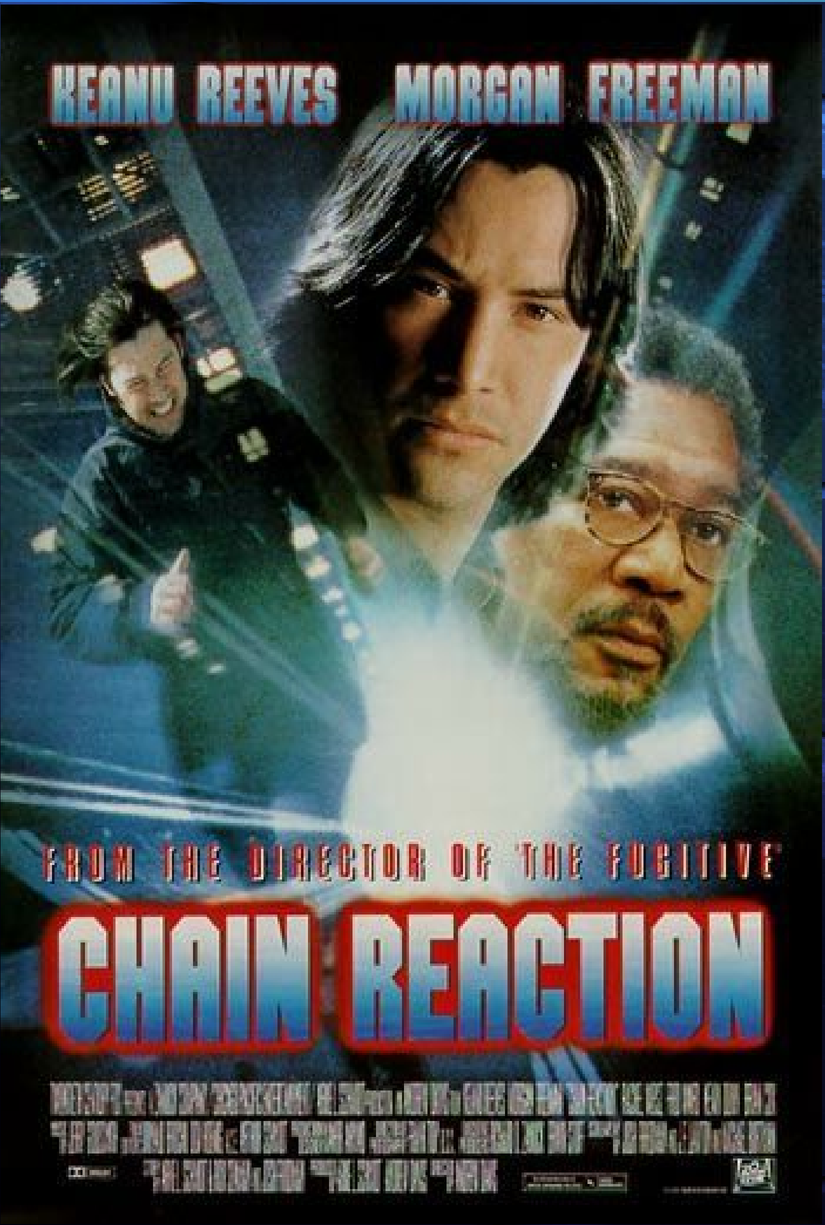
Why should We Save Energy?



We have a limited supply of fuel. At some point our current supplies will run out. Any conservation efforts now will extend this deadline further into the future.

Chain Reaction (1996)

-> Eddie Kasalivich, an undergraduate at the University of Chicago, works as a technician for a scientific team that discovers an alternative, low-cost, pollution-free fuel source. When one of the chief scientists is murdered and the invention stolen…

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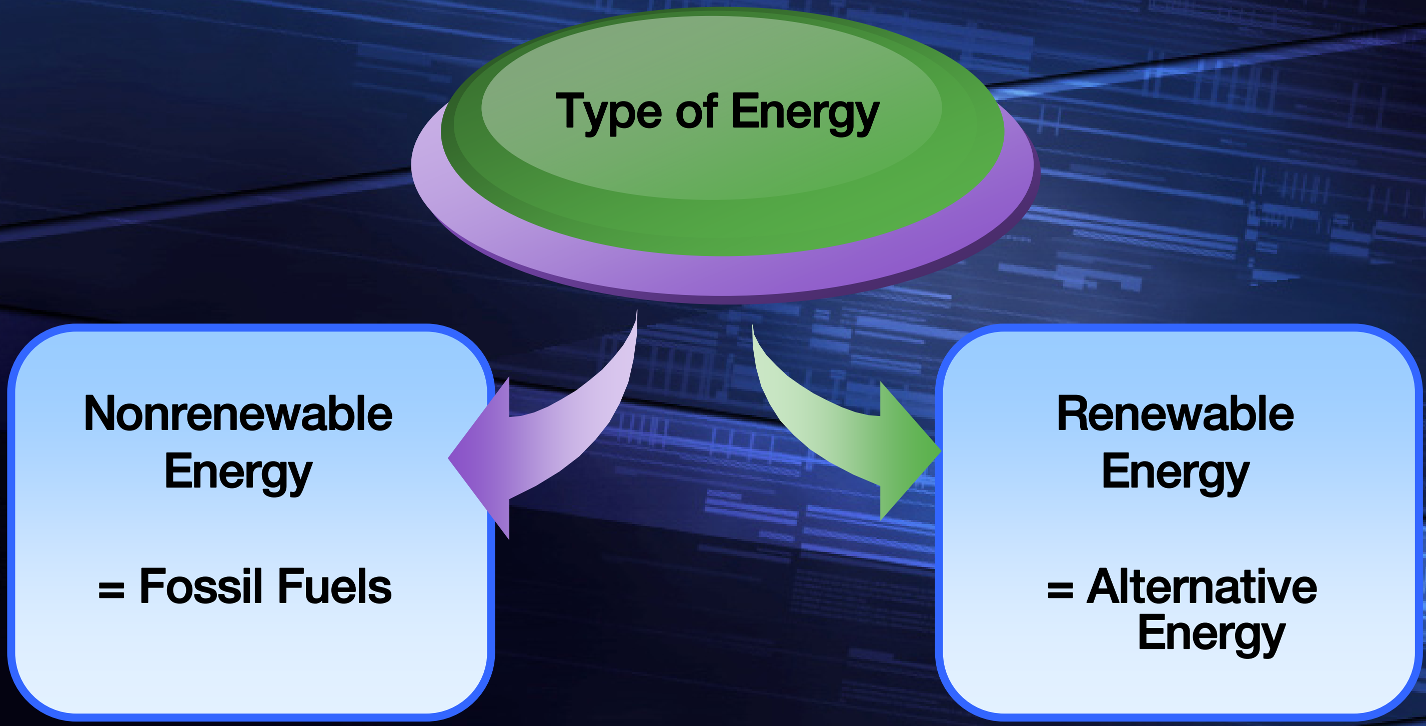
Energy

Capacity or Ability to do work.

A society's quality of life depends in large part on the availability of energy.



Energy Mix

Energy mix in developed countries and developing country

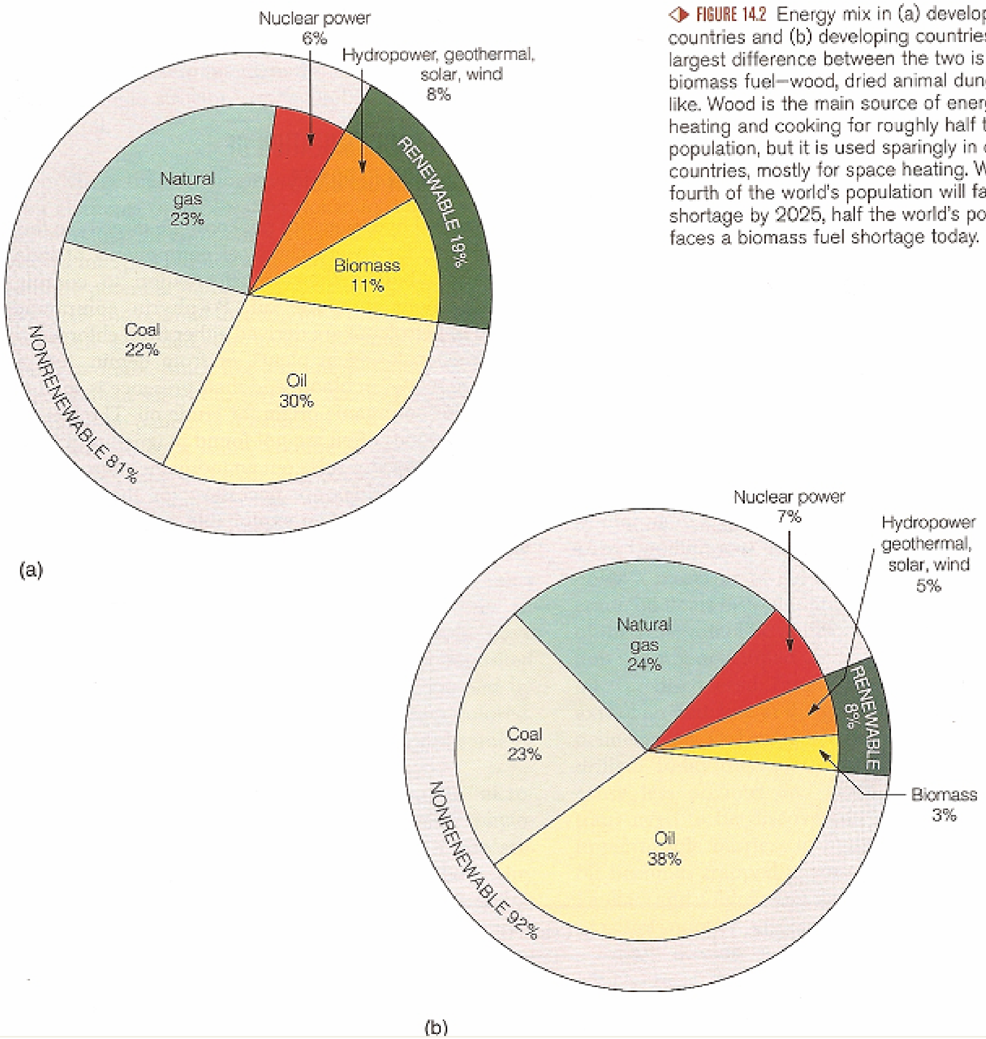


FIGURE 14.2 Energy mix in (a) developed countries and (b) developing countries. The largest difference between the two is the use of biomass fuel—wood, dried animal dung, and the like. Wood is the main source of energy for heating and cooking for roughly half the world's population, but it is used sparingly in developed countries, mostly for space heating. Whereas a fourth of the world's population will face an oil shortage by 2025, half the world's population faces a biomass fuel shortage today.

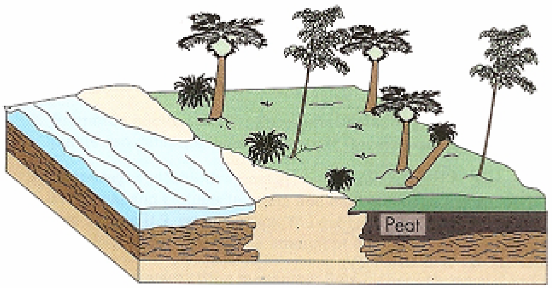
Fossil Fuels

Coal

Carbonaceous residue of plants that has been preserved and altered by heat and pressure

Figure 15.9 Mining coal Large backhoe at the Trapper Mine, Colorado, removing the coal and loading it into large trucks for delivery to a power plant just off the mining site. *(Edward A. Keller)*

Coal-forming Process



(a) Coal swamp forms.

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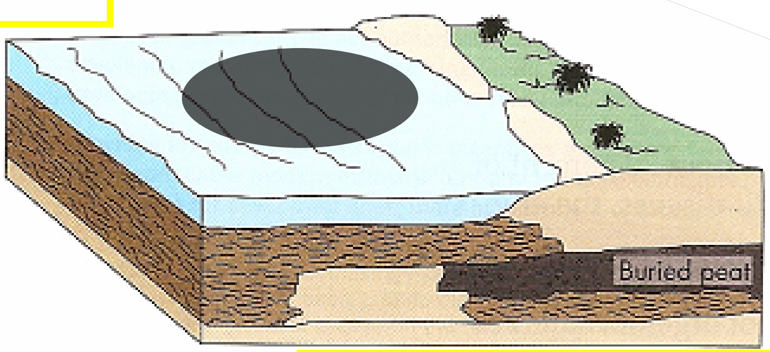

(b) Rise in sea le

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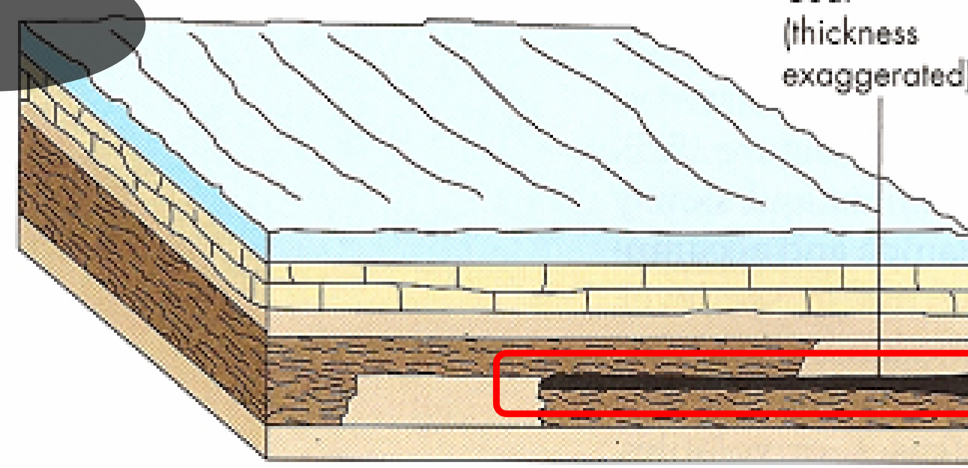


(c) Compression of peat forms coal.

3

Figure 15.5 **How coal forms** The processes that convert buried plant debris, or peat, into coal. Considerable lengths of geologic time must elapse before the transformation is complete.

Classification and Distribution of Coal

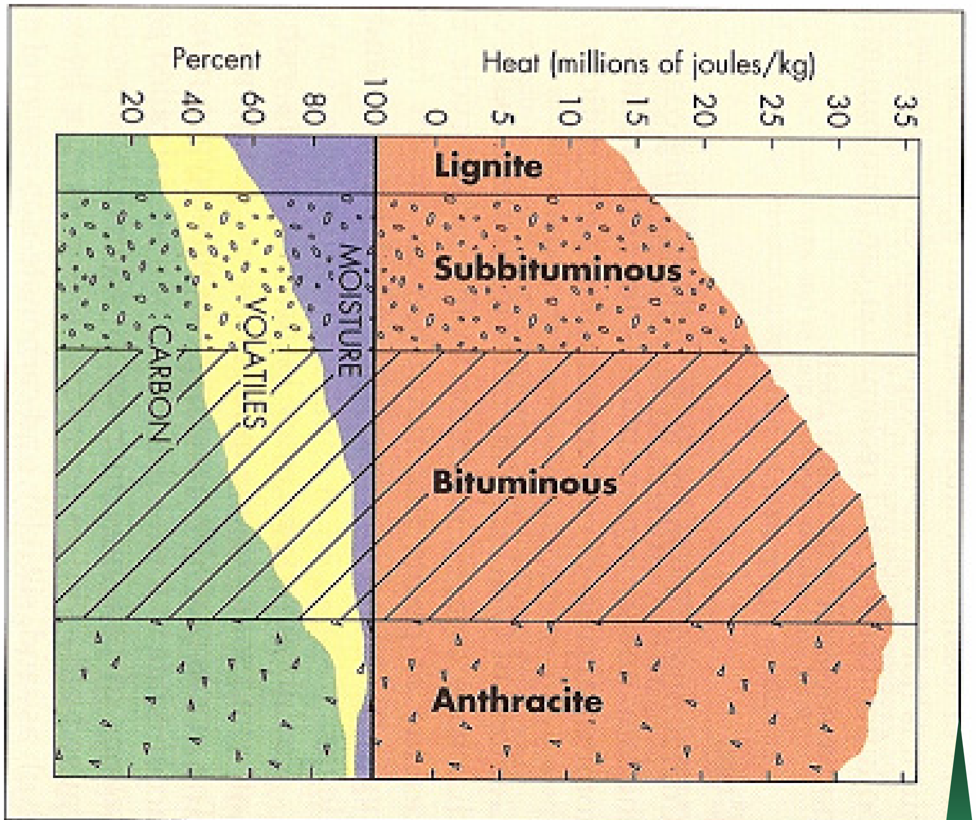


Figure 15.6 Types of coal Generalized classification of types of coal based on their relative percent content of moisture, volatiles, and carbon. The heat values of the different types of coal are also shown. *(After Brobst, D. A., and Pratt, W. P., eds. 1973. U.S. Geological Survey Professional Paper 820)*

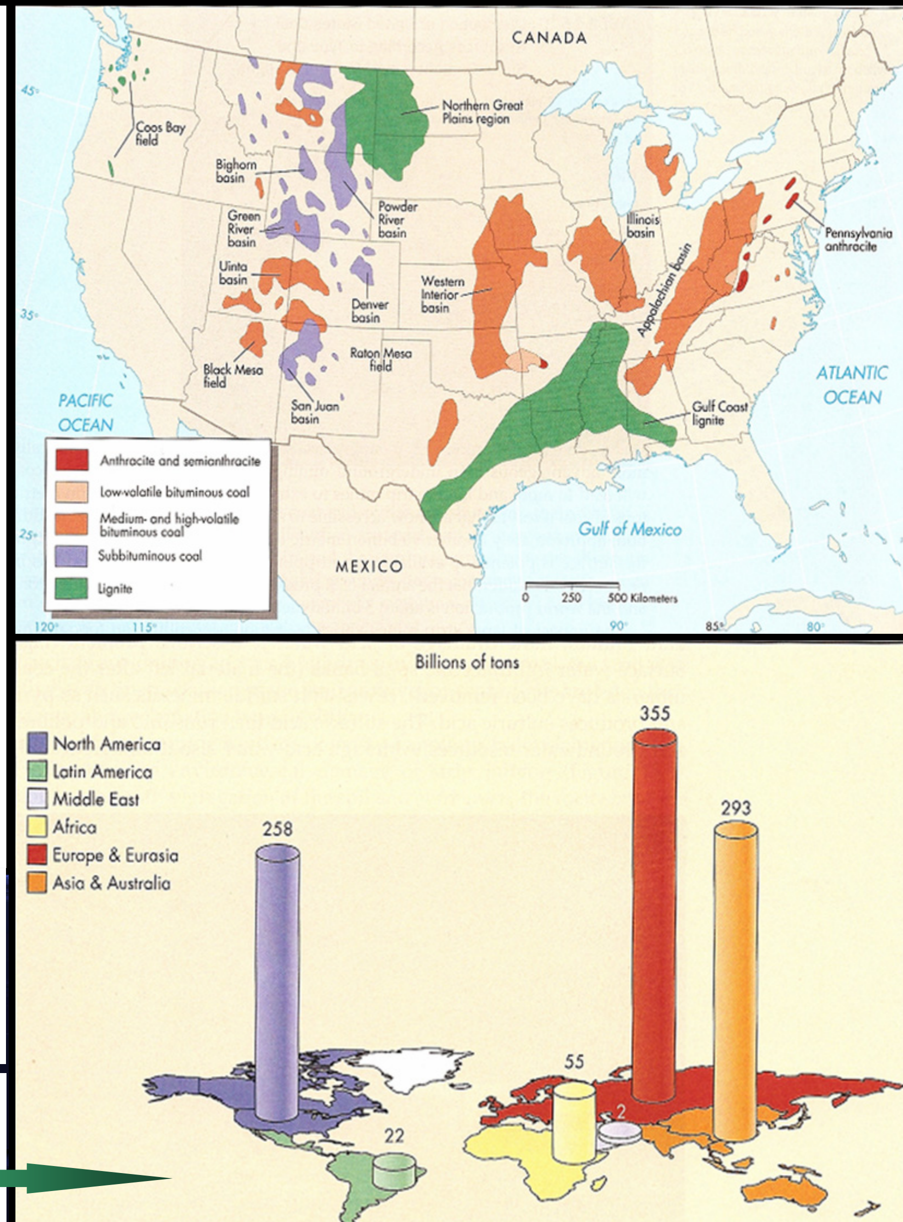
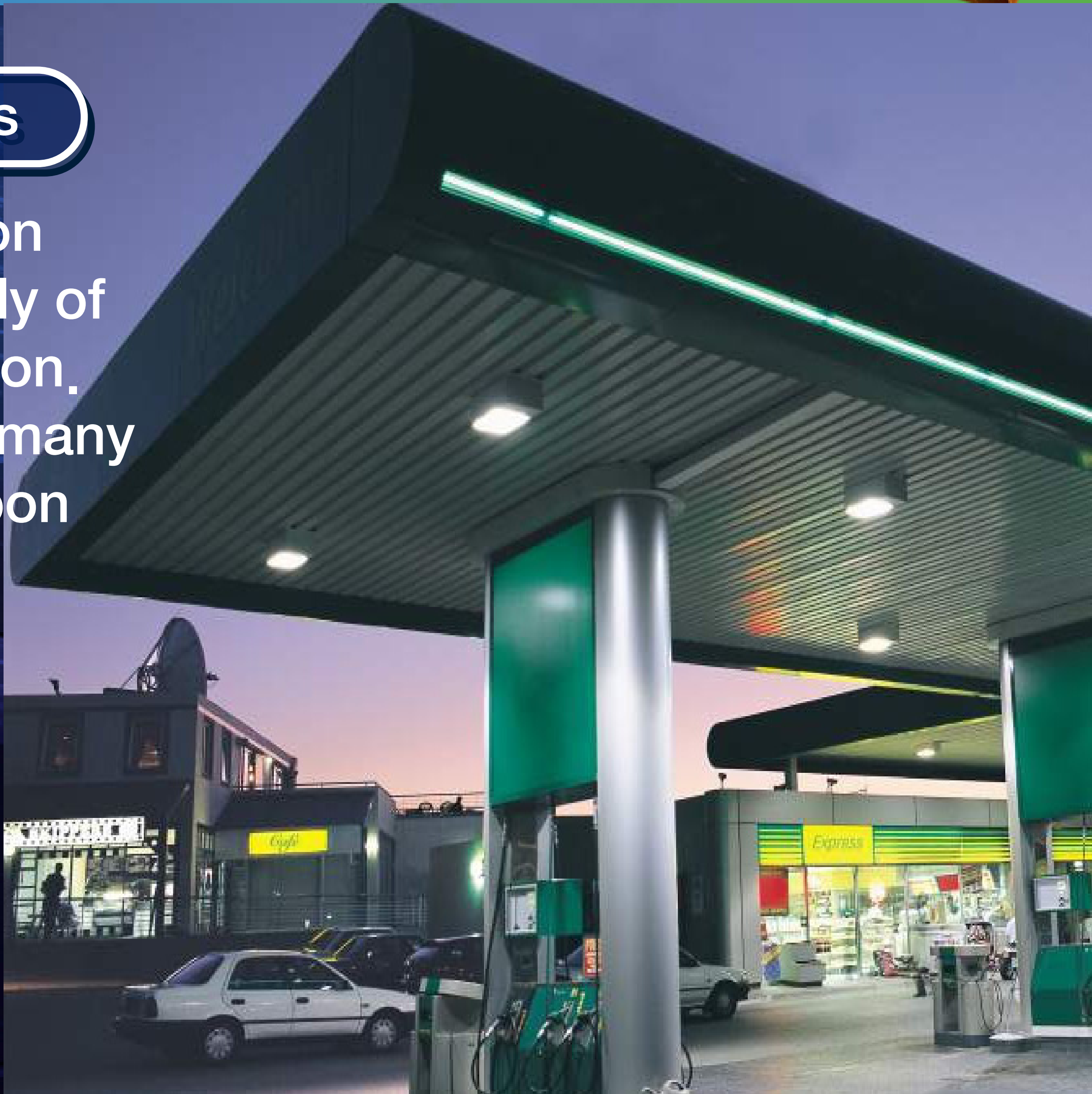


Figure 15.7 World coal reserves (a) Coal areas of the contiguous United States. *(Carbini, S., and Schweinfurth, S. P. 1986. U.S. Geological Survey Circular 979)* (b) World coal reserves (billions of metric tons) in 2002. The United States has about 25 percent of the total reserves. Unlike oil, coal reserves are more evenly distributed around the world. *(British Petroleum Company. 2003. BP statistical review of world energy)*

Fossil Fuels

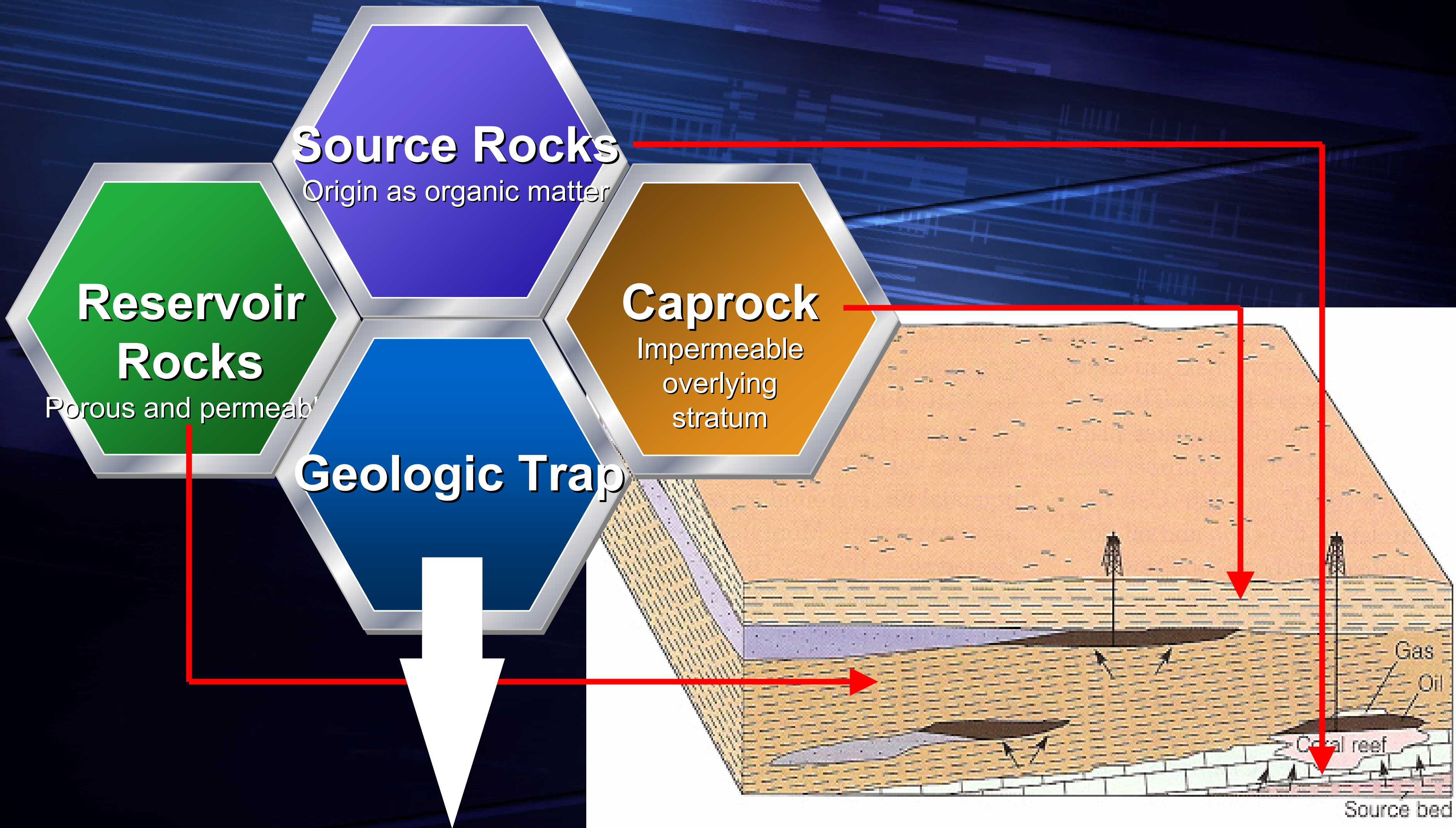
Oil and Natural Gas

Volatile hydrocarbon composed of mostly of hydrogen and carbon. Crude oil contains many different hydrocarbon compounds.



Origin and Accumulation

The necessary conditions for an oil field



Origin and Accumulation

- Type of petroleum geologic trap

Geologic Trap

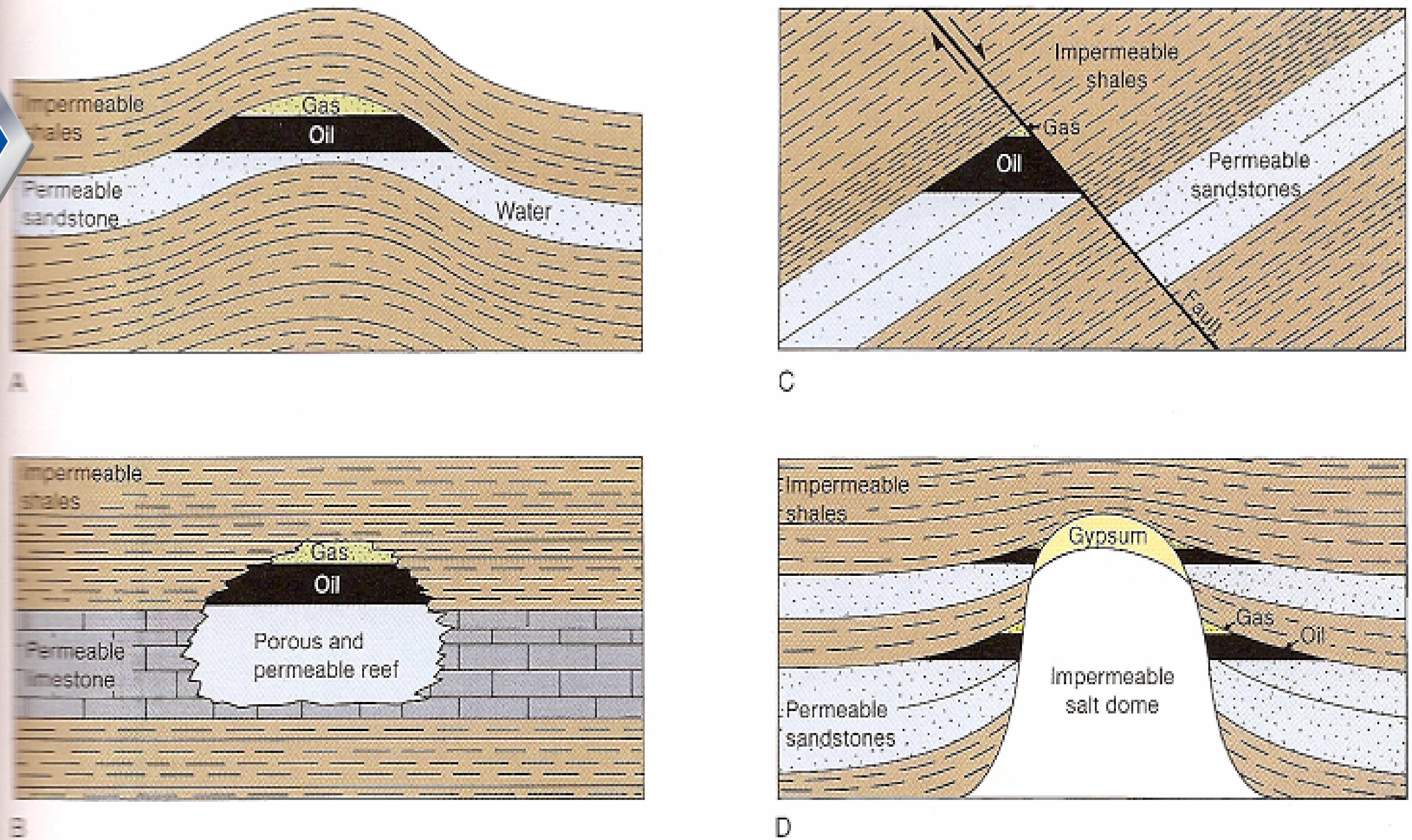


FIGURE 13.4 Types of petroleum traps. (*A*) A simple fold trap. (*B*) Petroleum accumulated in a fossilized ancient coral reef. (*C*) A fault trap. (*D*) Petroleum trapped against an impermeable salt dome, which has risen up from a buried evaporite deposit.

Reserves

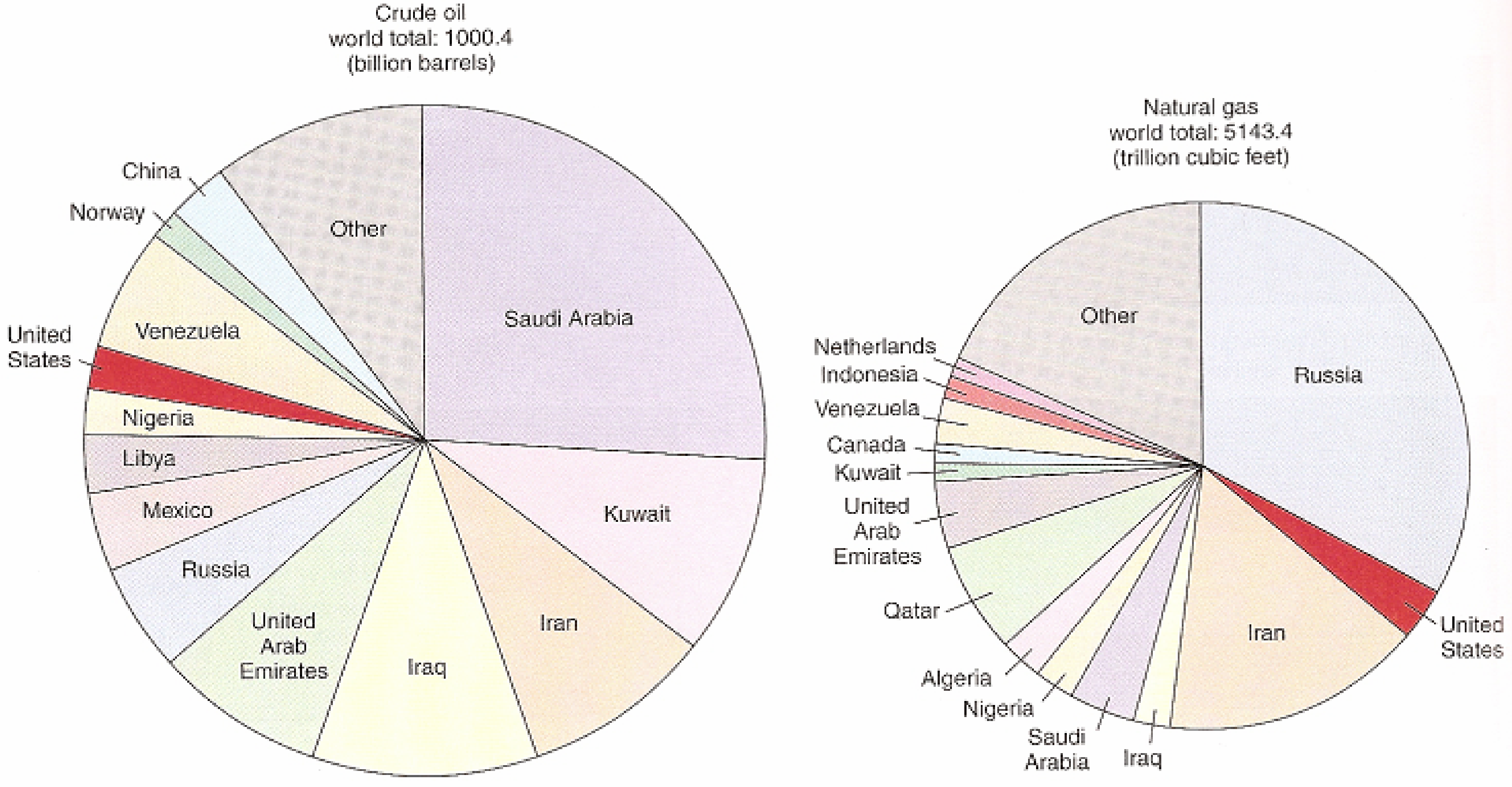


FIGURE 13.5 Estimated proven world reserves of crude oil and natural gas, January 1999. *Averages of estimates in* Oil and Gas Journal *and* World Oil, *as summarized in* International Energy Annual 1999, *U.S. Energy Information Administration.*

Reserves – Future of Oil and Natural Gas

The latest forecast is that world oil reserves will last until 2100.

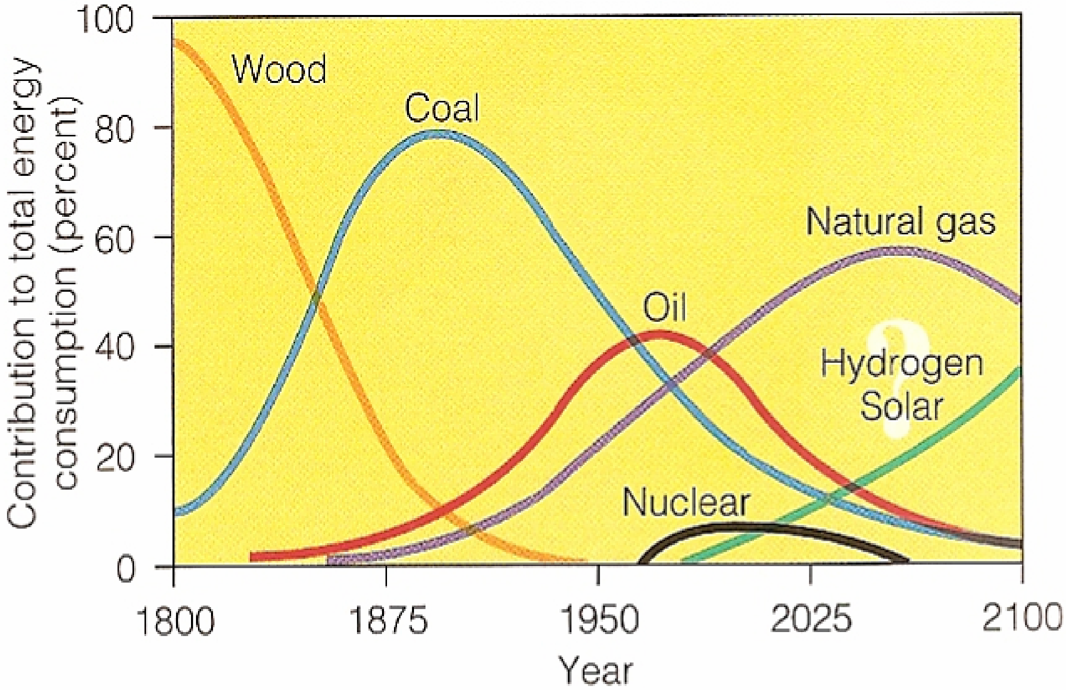


FIGURE 14.11 Use of energy resources in the United States since 1800, with projections to 2100. The shifts from wood to coal and then from coal to oil and natural gas each took about 50 years. Many analysts believe a new shift, to increased use of solar energy and hydrogen gas, will occur over the next 50 years.

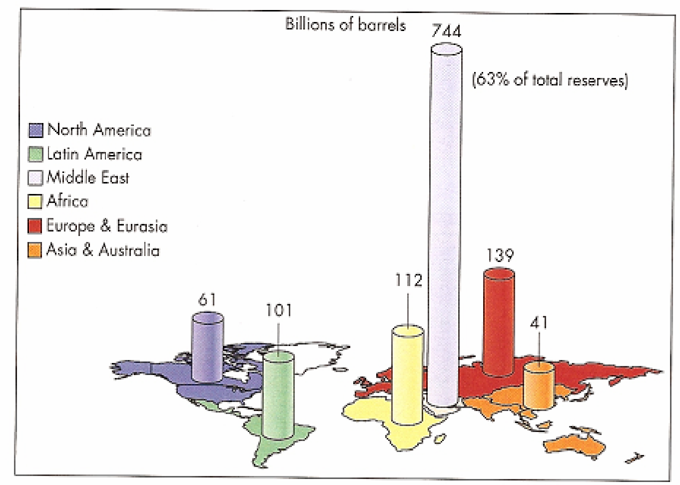


Figure 15.13 Oil reserves Proven world oil reserves (billions of barrels) in 2004. The Middle East dominates with about two-thirds of total reserves. *(British Petroleum Company, 2005. BP statistical review of world energy)*

Other Fossil Fuels

Tar Sands

Sands containing oil that is too thick to flow and that can be surfaced-mined. Oil is then washed from the sand.

One place the sands are mined is the Athabasca Field in Alberta, Canada.

(b)

(a)

FIGURE 14.14 (a) Locations of Alberta's tar sands—Athabasca, Cold Lake, and Peace River. (b) After extraction by huge machinery, the sands are washed with hot water to extract the oil adhering to the grains. Cleaned sand is then returned to the open pit, and the land is restored to its original contours.

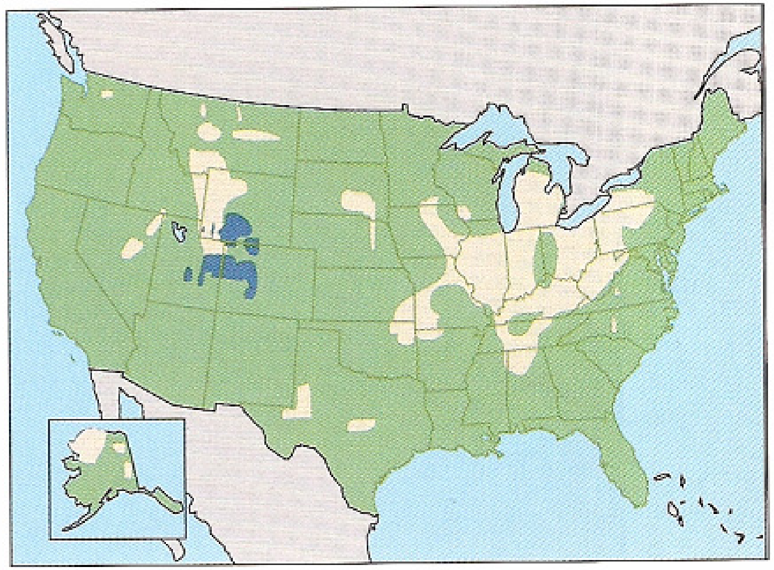
Other Fossil Fuels

Oil Shale

Eocene lake deposits containing light kerogen oil that can be removed by heating.

(a)

Distribution of U.S. oil shale deposits.



● FIGURE 13.22 Distribution of U.S. oil shale deposits. The richest of these deposits is the Green River formation (blue). *Data from J.W. Smith, "Synfuels: Oil Shale and Tar Sands," in* Perspectives on Energy, *3d ed., ed. by Lon C. Ruedisili and Morris W. Firebaugh, 1982, Oxford University Press, NY.*

Other Fossil Fuels

Oil Shale

Recovery of ‘Shale oil’

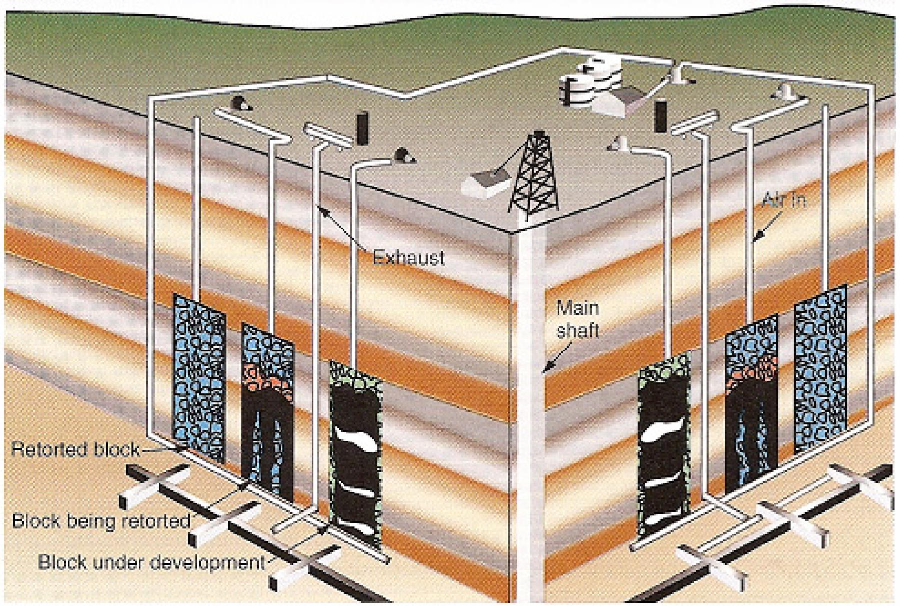
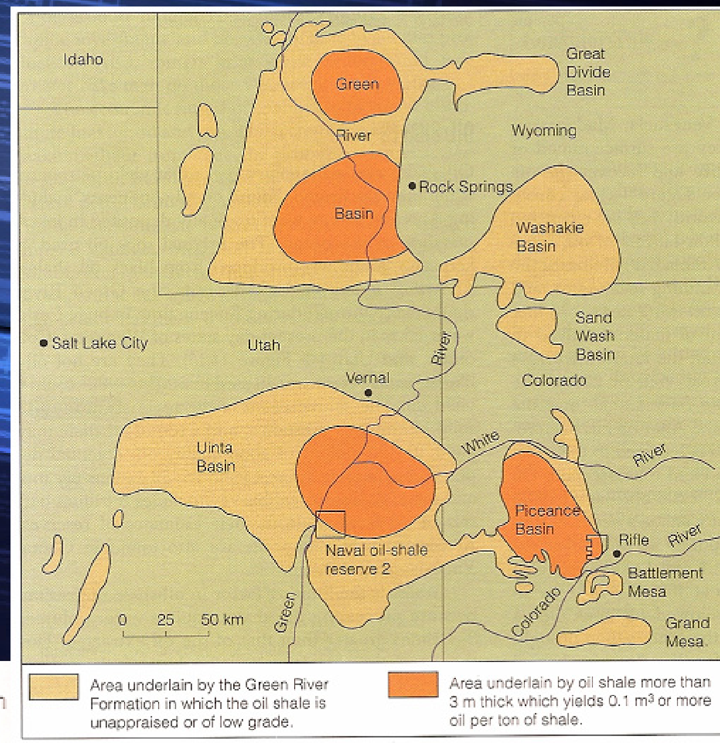


FIGURE 13.24 Schematic diagram of *in situ* recovery of “shale oil.” “Retorting” is the process by which shale oil is distilled out of the rock by the application of heat. *After R.L. Elderkin, Jr., U.S. Geological Survey.*

Deposits are found in Wyoming, Utha, and Colorado.



(b)

FIGURE 14.15 (a) Oil shale and the heavy oil that it produces when heated. (b) Distribution of oil shales in the Green River Formation of Wyoming, Colorado, and Utah.

Fossil Fuels and Acid Rain

Acid Rain is thought to be a regional to global environmental problem related to burning of fossil fuels

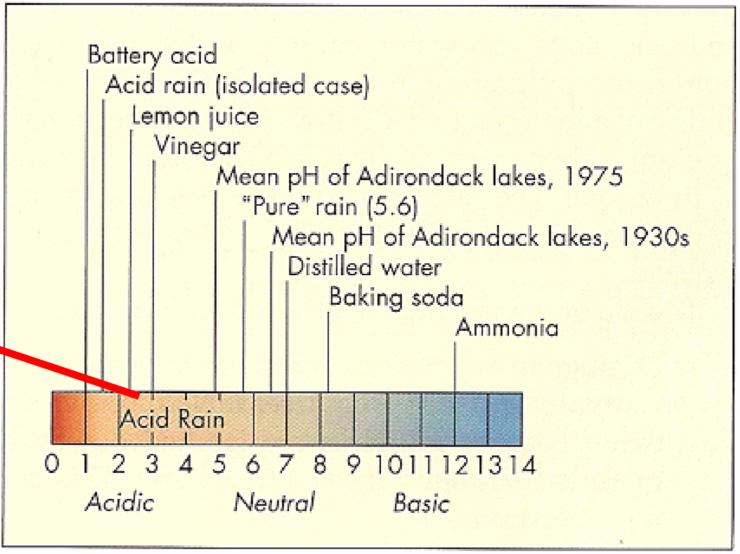


Figure 15.16 **The pH scale** Values for a variety of materials are shown. *(Modified after U.S. Environmental Protection Agency, 1980)*

How acid Rain Forms

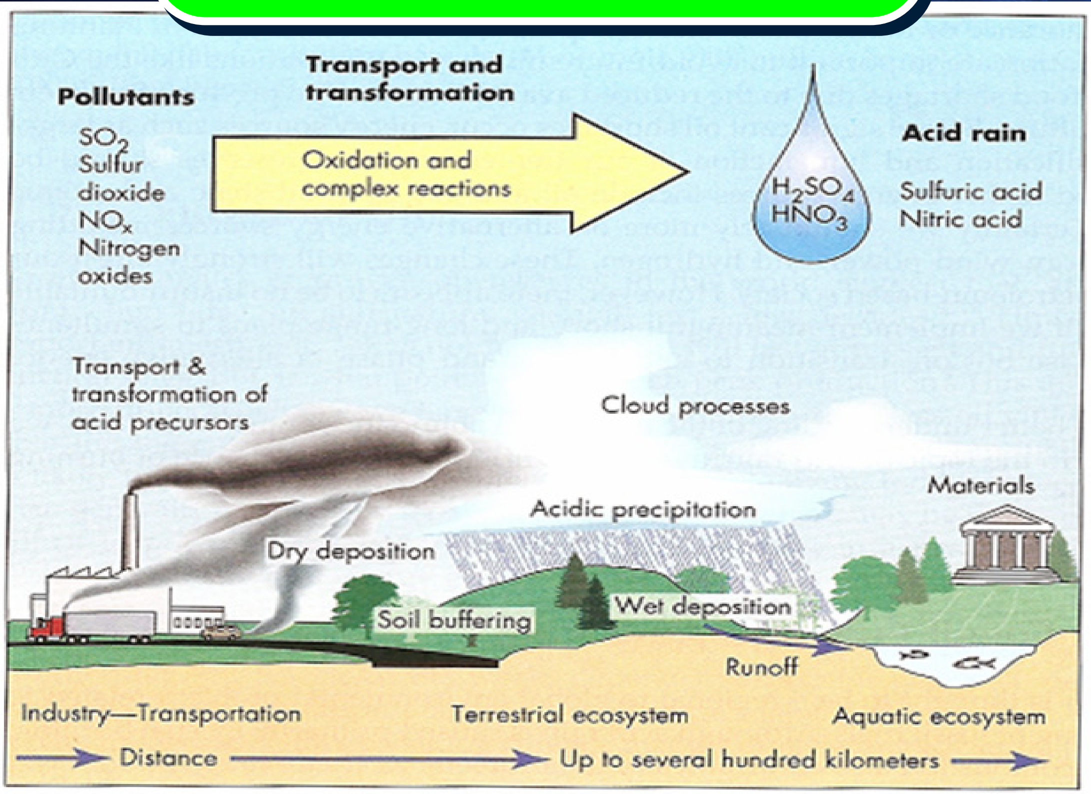


Figure 15.17 **How acid rain forms** Paths and processes associated with acid rain. *(Modified after Albritton, D. L., as presented in Miller, J. M.)*

Environmental Effect of Acid Rain

Damage to Vegetation

Damage to Lake Ecosystem

Damage to Human structures

Acidic rain kills or damages trees and other vegetation by lowering the pH of soil.

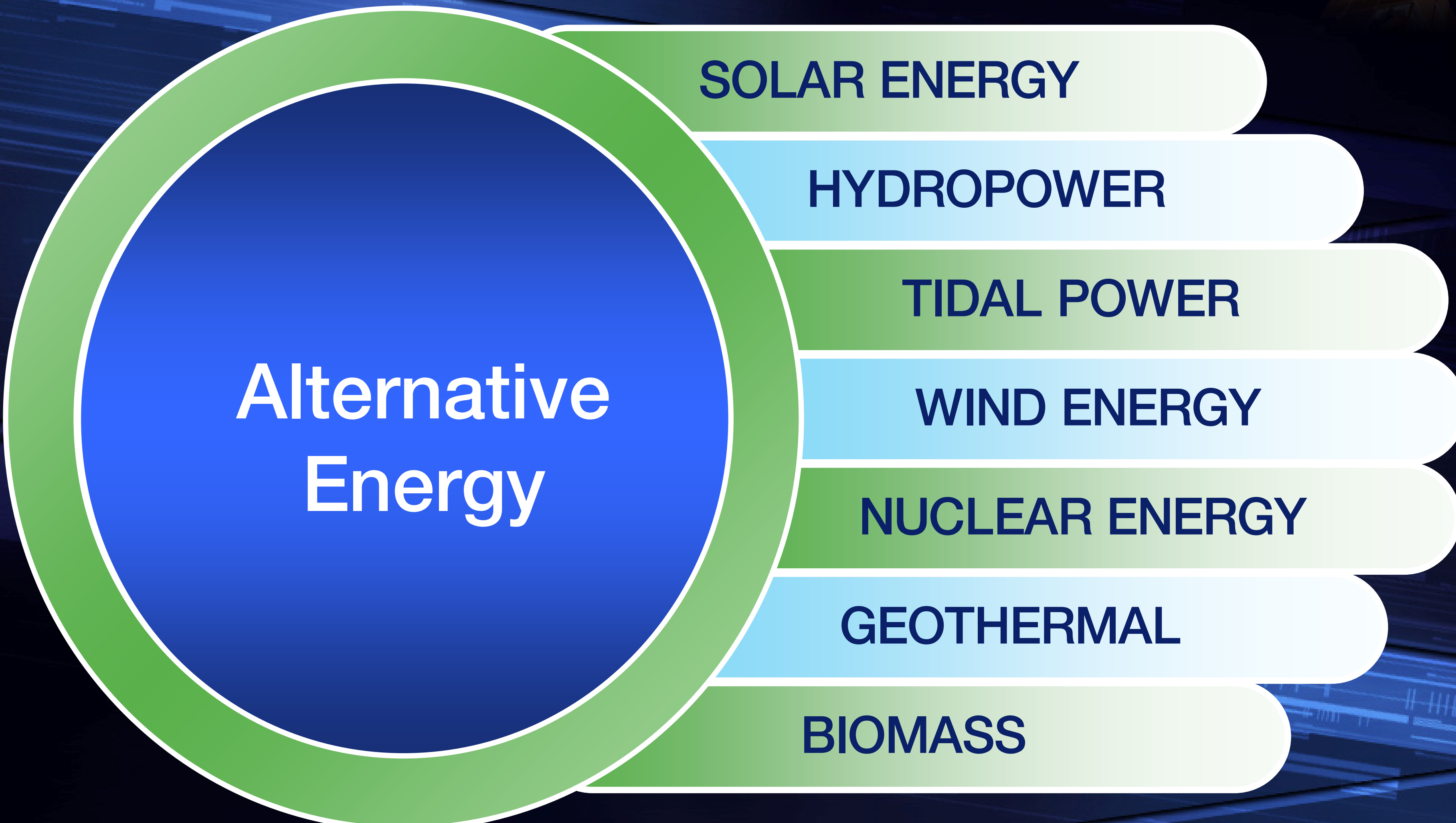
ure 15.19 **Acid rain dam-**
stone Air pollution and acid
are damaging buildings and
es in many urban regions.
vn here is the Acropolis in
ns, Greece. Statues here have
damaged to such an extent that
nals have been placed inside
ings in specially constructed
containers. *(Peter Christopher/*
erfile Corporation)

Mine Collapse

Areas underlain by shallow lignite are vulnerable to subsidence

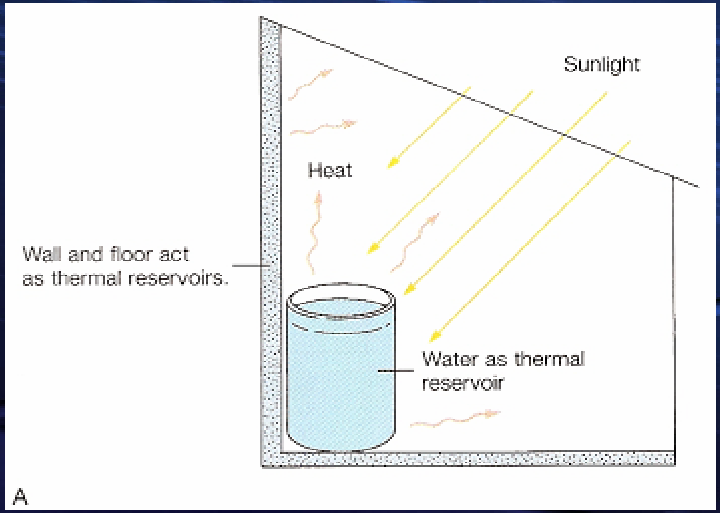
FIGURE 14.20 Surface effects of underground mining along the Tongue River in Wyoming. The pits, troughs, depressions, and cracks have formed since the mine was abandoned in 1914.

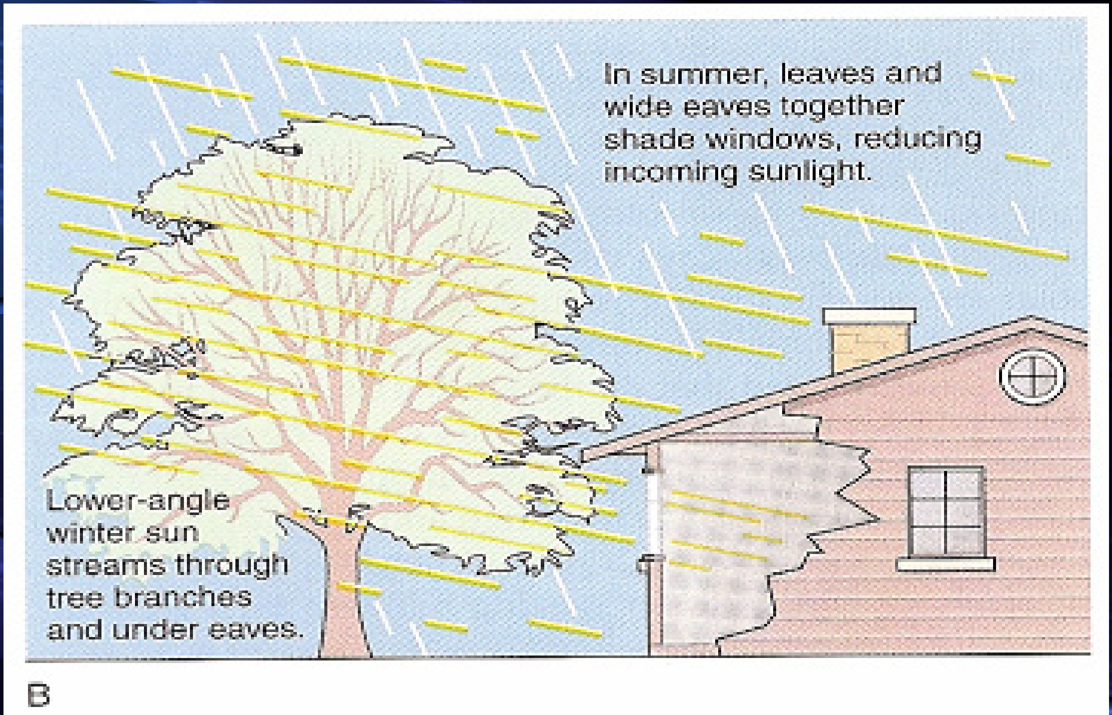
Alternative Energy



Solar Energy

Solar Heating Solar heat collectors warm a fluid, which is then put to work.





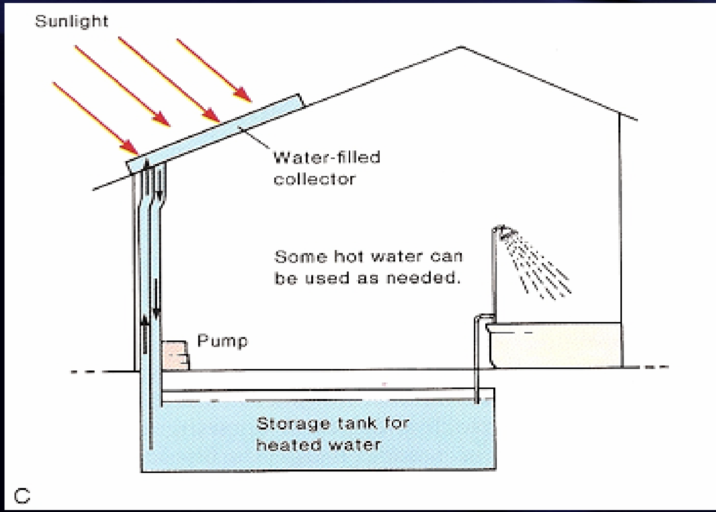


FIGURE 14.16 (*A*) Basics of passive-solar heating with water or structural materials as thermal reservoir: Sunlight streams into greenhouse with glass roof and walls, heat is stored for nights and cloudy days. (*B*) Design features of home and landscaping can optimize use of sun in colder weather, provide protection from it in summer. (*C*) A common type of active-solar heating system with a pump to circulate the water between the collector and the heat exchanger/storage tank.

Solar Energy

Solar Electricity

Photovoltaic cells convert light directly into electricity.

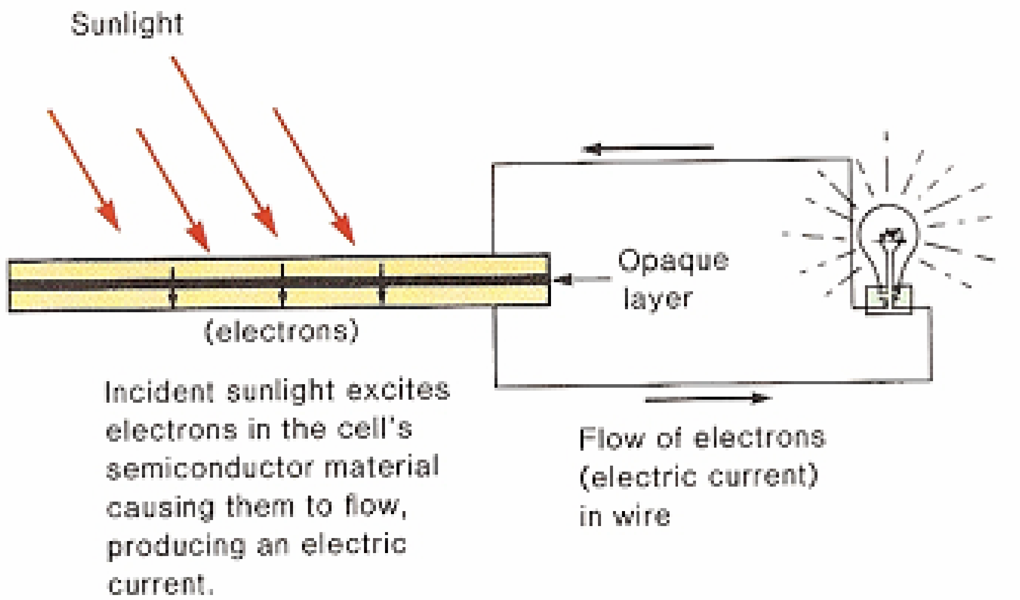


FIGURE 14.17 Schematic diagram of a photovoltaic (solar) cell for the generation of electricity.

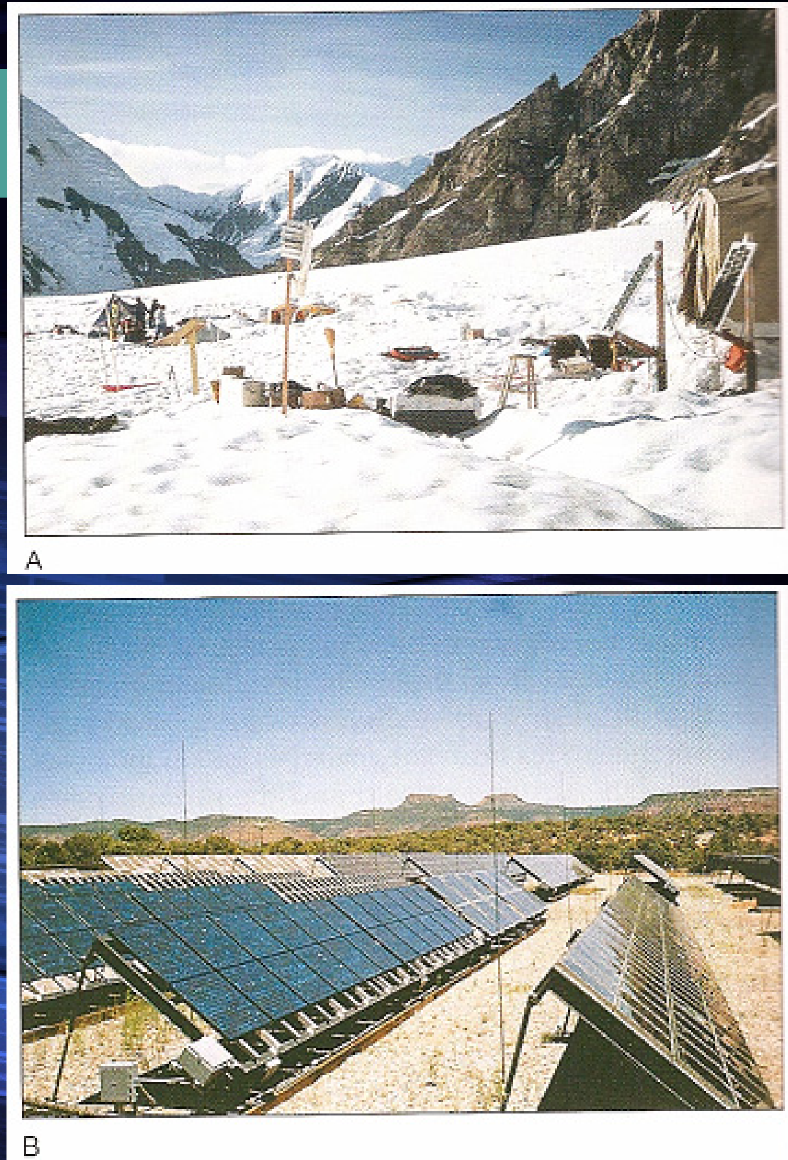


FIGURE 14.18 Solar electricity is very useful in remote areas. (*A*) High in the mountains of Denali National Park, at the base camp that is the takeoff point for expeditions to climb Denali (Mount McKinley), solar cells (right) power vital communications equipment. (*B*) Near the visitors' center at Natural Bridges National Monument is a solar-cell array used to power the center.

Hydropower

Hydroelectric dams harness the power of water distributed over the earth by the hydrologic cycle.

FIGURE 14.26 Glen Canyon Dam hydroelectric project. In dry surroundings such as these, evaporation losses from reservoirs are high and can exacerbate regional water-supply problems.

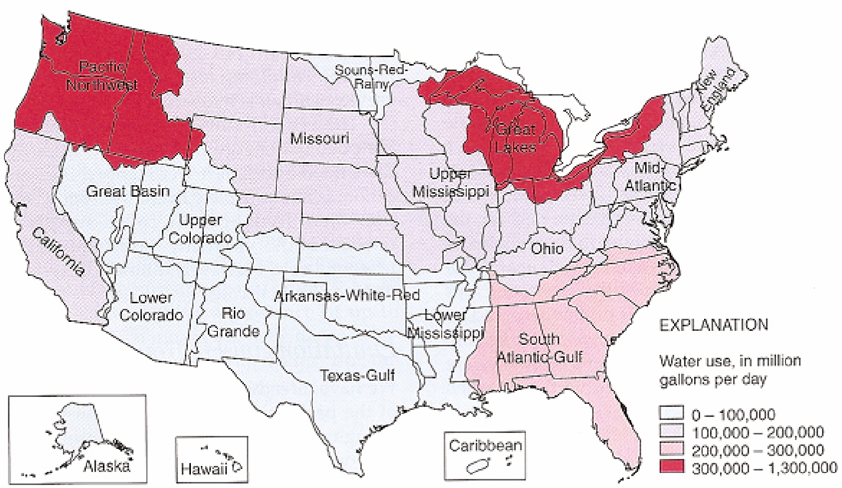
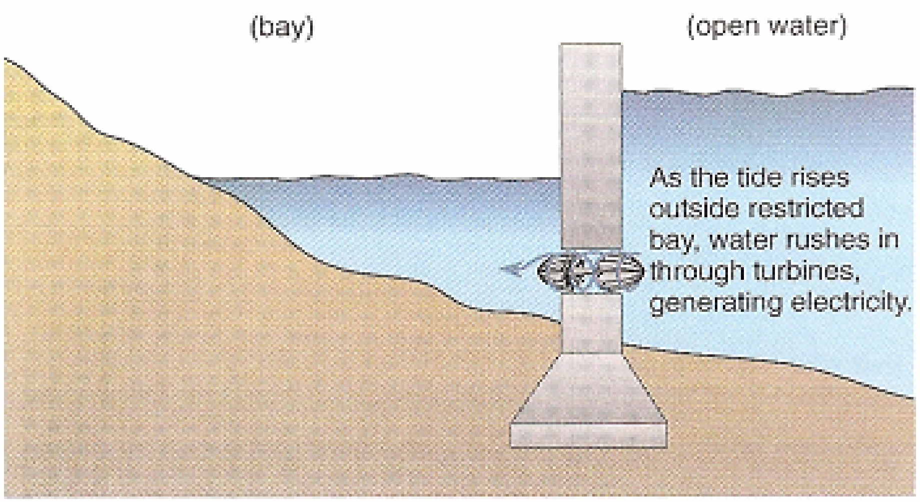


FIGURE 14.27 Water use for hydropower generation in the United States is concentrated where streamflow is plentiful. 1995 Estimated Water Use in the United States, *U.S. Geological Survey*.

Tidal Power

The sources of Blue Energy's tidal power production are fast flowing tidal currents.

The gravitational pull of the moon causes water to flow in from the ocean twice a day on the flood tides, and outward during ebb tides.



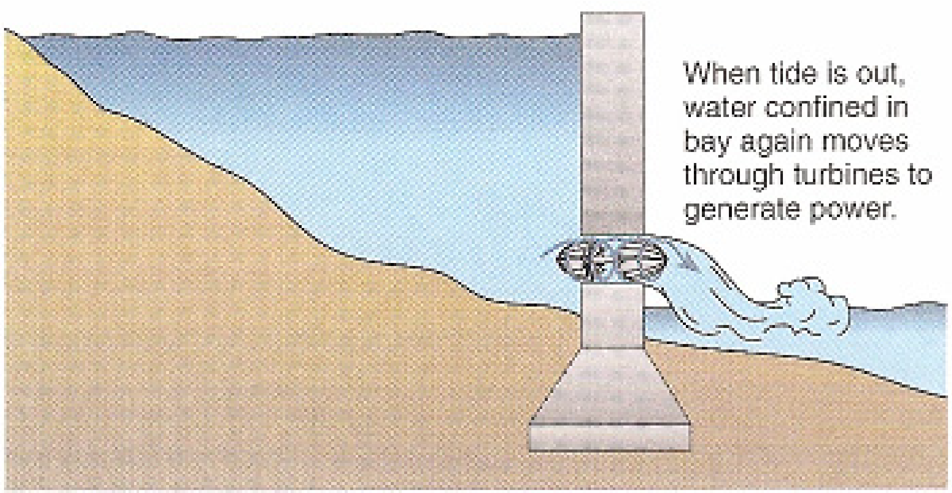


FIGURE 14.29 Tidal-power generation uses flowing water to generate electricity, as with conventional hydropower.

Wind Energy

The most common style, large or small, is the "horizontal axis design" (with the axis of the blades horizontal to the ground). On this turbine, two or three blades spin upwind of the tower that it sits on.

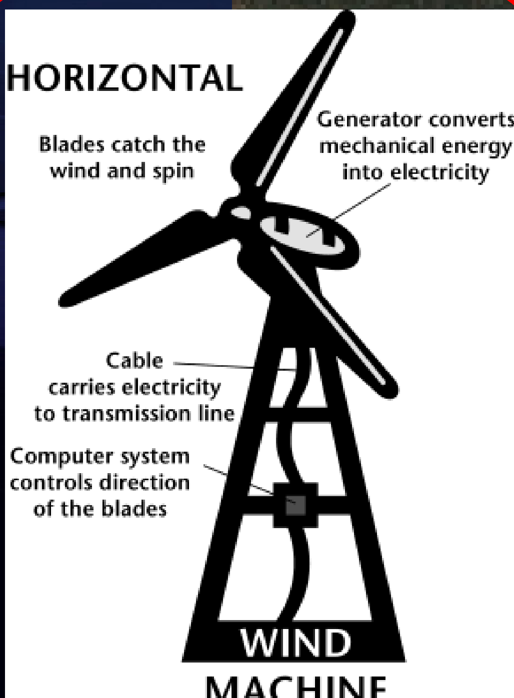


FIGURE 14.31 Wind-turbine array near Palm Springs, California. Different elements of the array can take advantage of various velocities of wind. Some of the smaller turbines are turning even in light wind, while the larger turbines require stronger winds to drive them.

Nuclear Energy

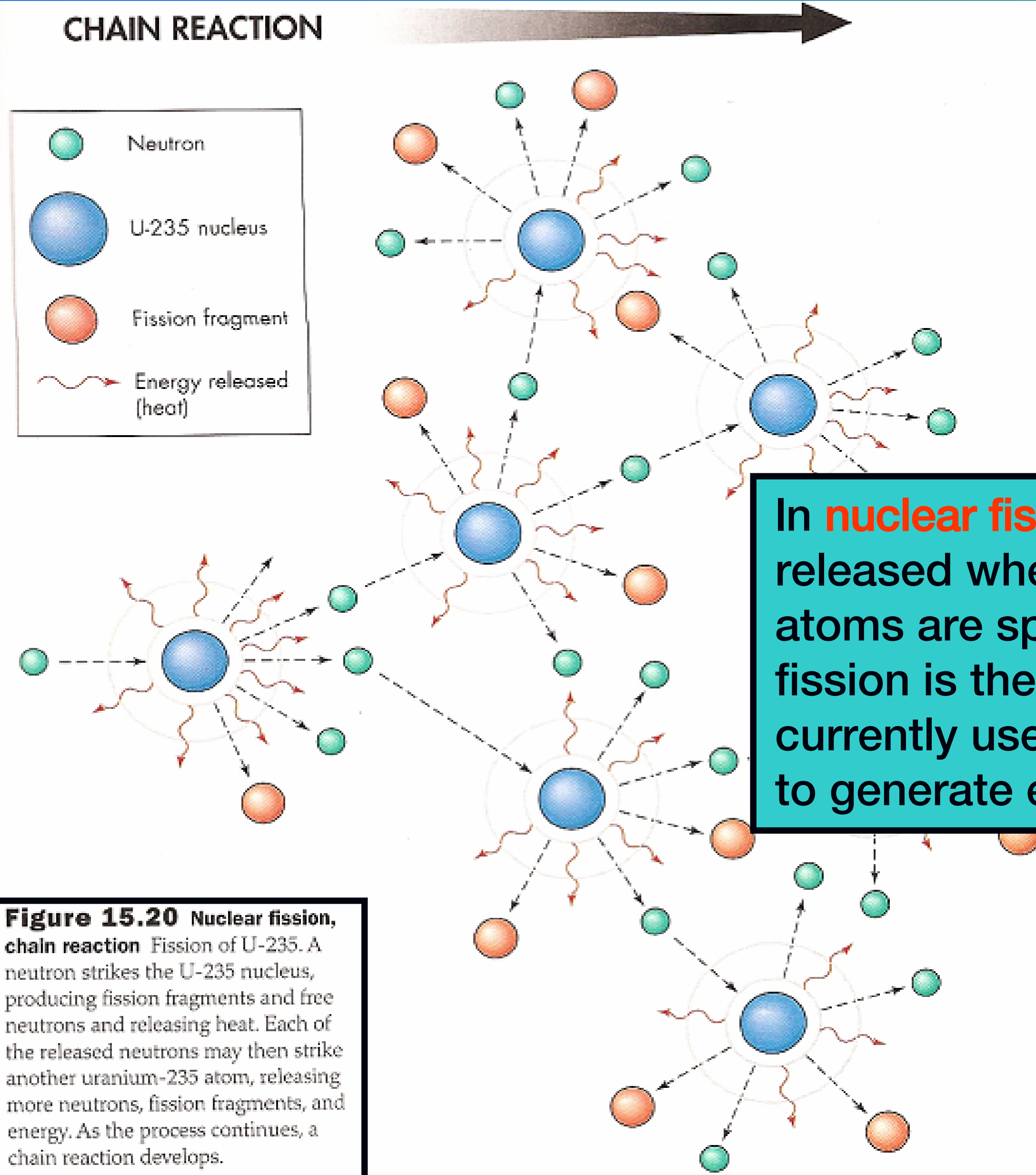
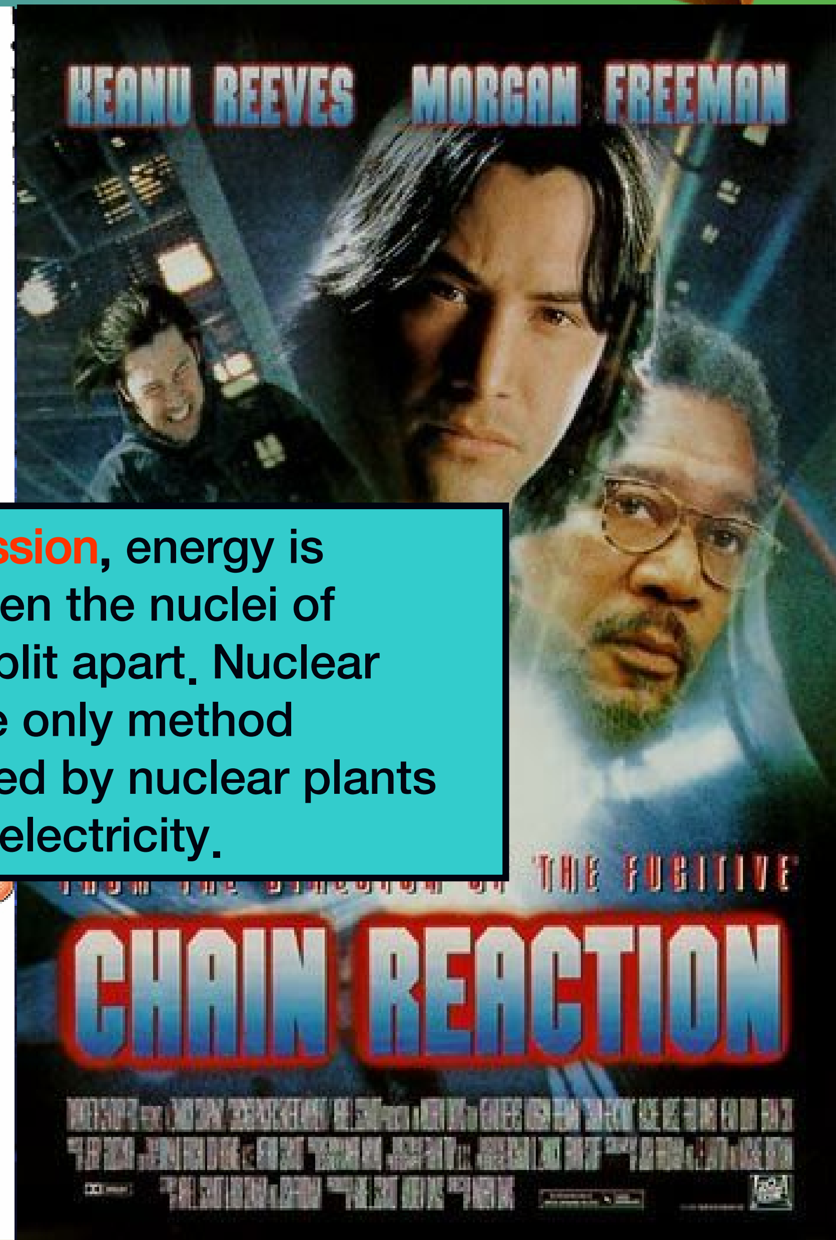
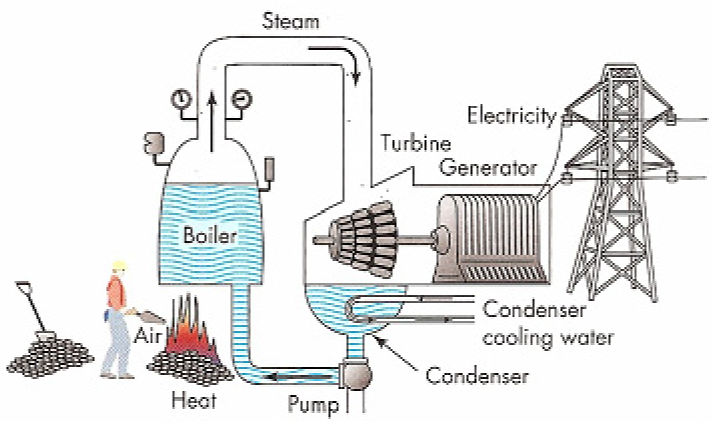


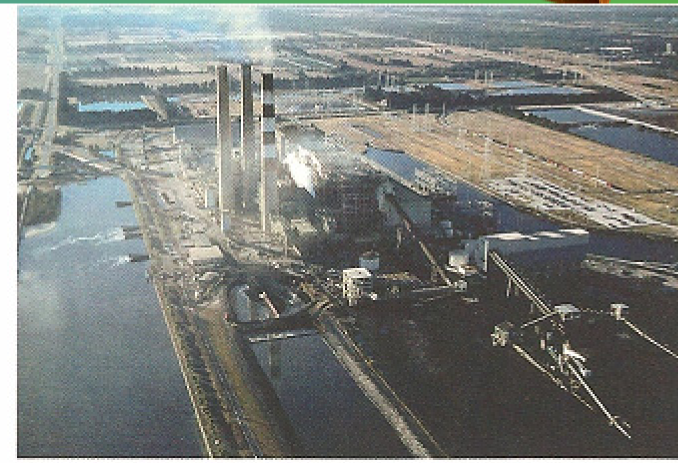
Figure 15.20 Nuclear fission, chain reaction Fission of U-235. A neutron strikes the U-235 nucleus, producing fission fragments and free neutrons and releasing heat. Each of the released neutrons may then strike another uranium-235 atom, releasing more neutrons, fission fragments, and energy. As the process continues, a chain reaction develops.



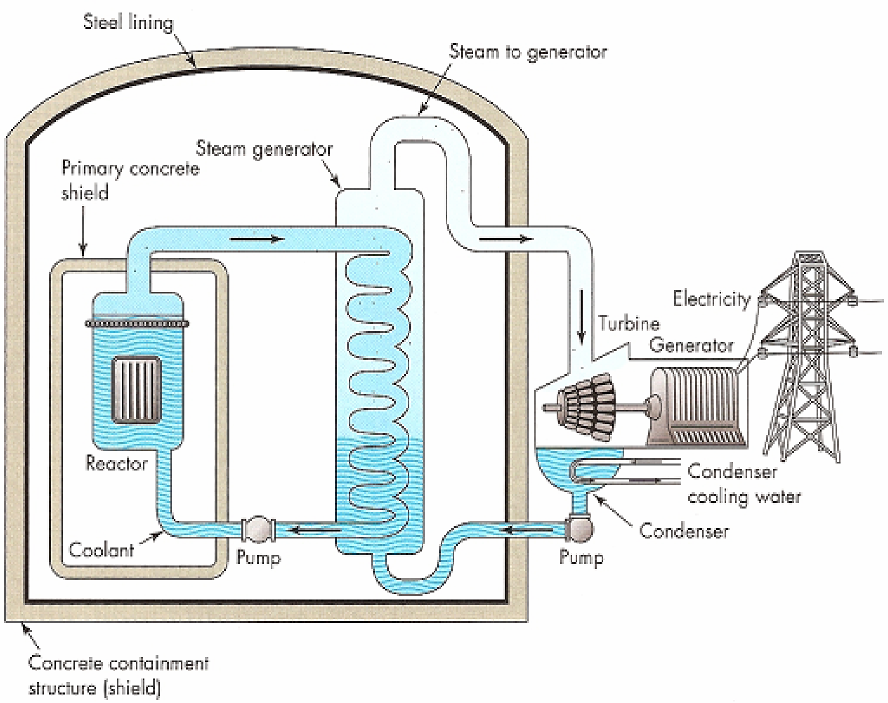
In **nuclear fission**, energy is released when the nuclei of atoms are split apart. Nuclear fission is the only method currently used by nuclear plants to generate electricity.

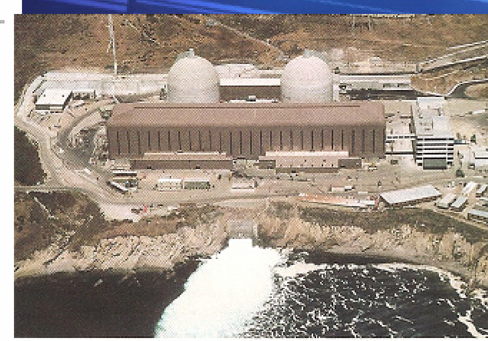
Nuclear Energy





(a)





(b)

Figure 15.21 **Comparing fossil fuel and nuclear power plants** (a) Fossil fuel power plant and (b) nuclear power plant with a boiling-water reactor. Notice that the nuclear reactor has exactly the same function as the boiler in the fossil fuel power plant. *(Reprinted, by permission, from Nuclear power and the environment, American Nuclear Society, 1973)* Photographs: (a) This fossil fuel power plant, Skytell Bridge in Tampa Bay, Florida, burns coal. Components include the storage of coal in the lower right-hand corner, the power plant itself in the center, cooling water leaving the power plant on the left, and the series of electric power lines leading away from the power plant. *(Wingstock/ Comstock Images)* (b) Diablo Canyon Nuclear Power Plant near San Luis Obispo, California. Reactors are in the dome-shaped buildings, and cooling water is escaping to the ocean. The siting of this power plant has been and remains very controversial because of its proximity to faults capable of producing earthquakes that might damage the facility. *(Comstock Images)*

Geothermal Energy

Geothermal energy is heat from within the earth. We can use the steam and hot water produced inside the earth to heat buildings or generate electricity. Geothermal energy is a renewable energy source because the water is replenished by rainfall and the heat is continuously produced inside the earth.

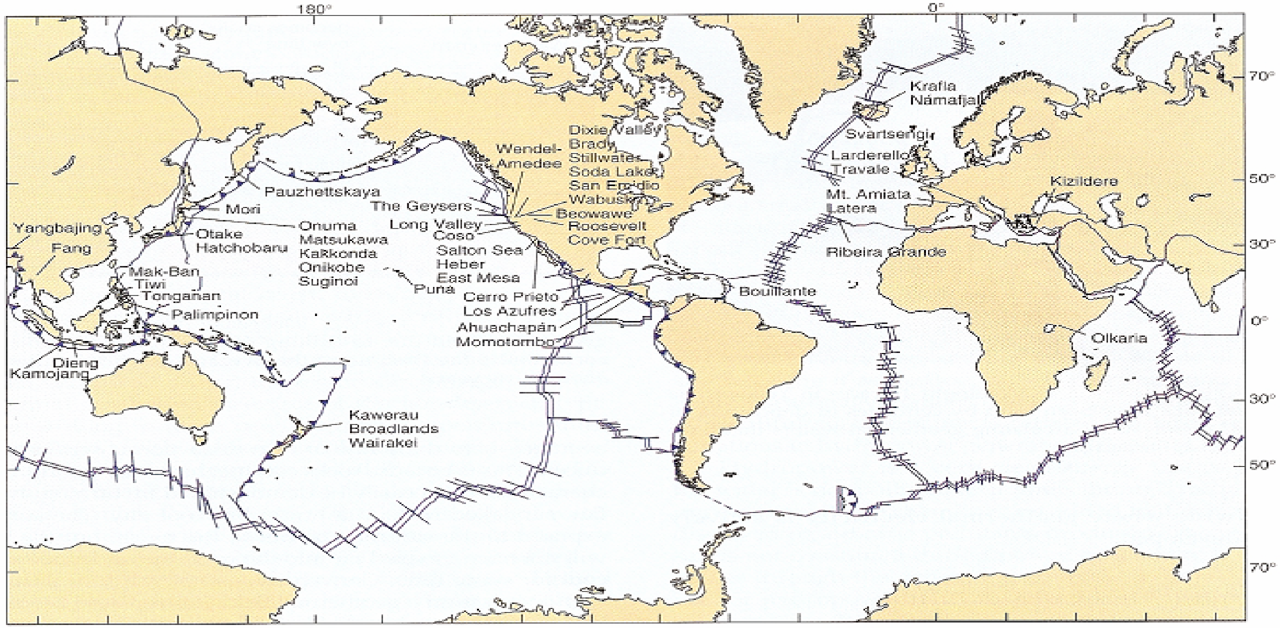
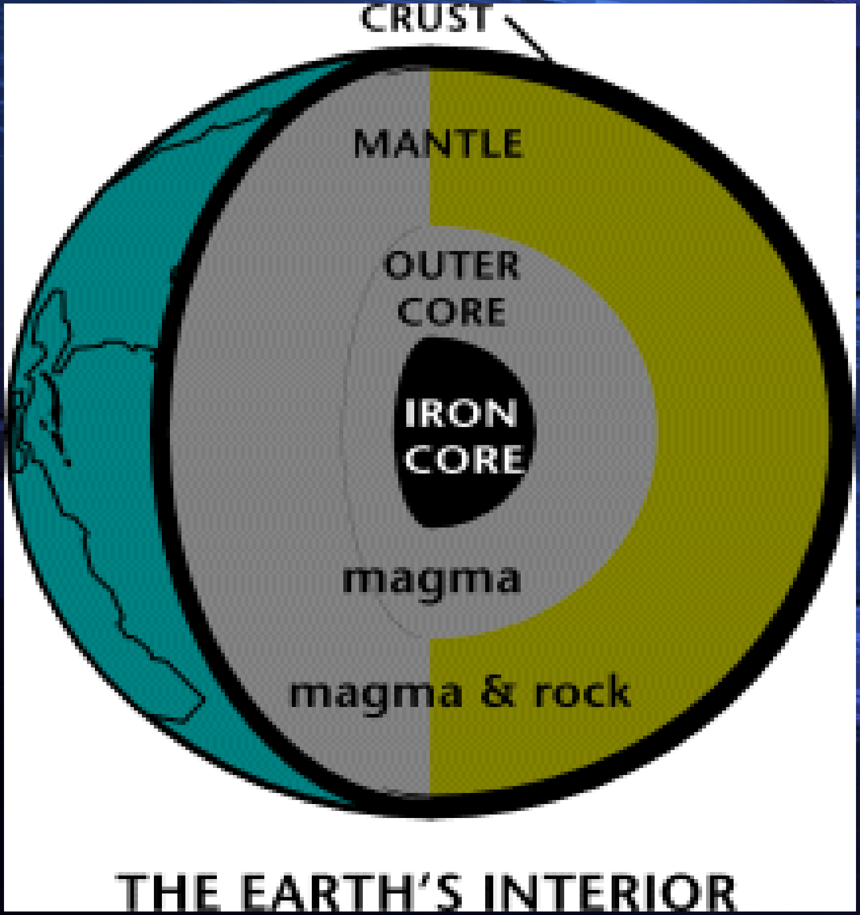


FIGURE 14.22 Geothermal power plants worldwide. *Figure prepared by L. J. Patrick Muffler and Ellen Lougee, U.S. Geological Survey; plate-tectonic boundaries supplied by Charles DeMets, University of Wisconsin at Madison.*

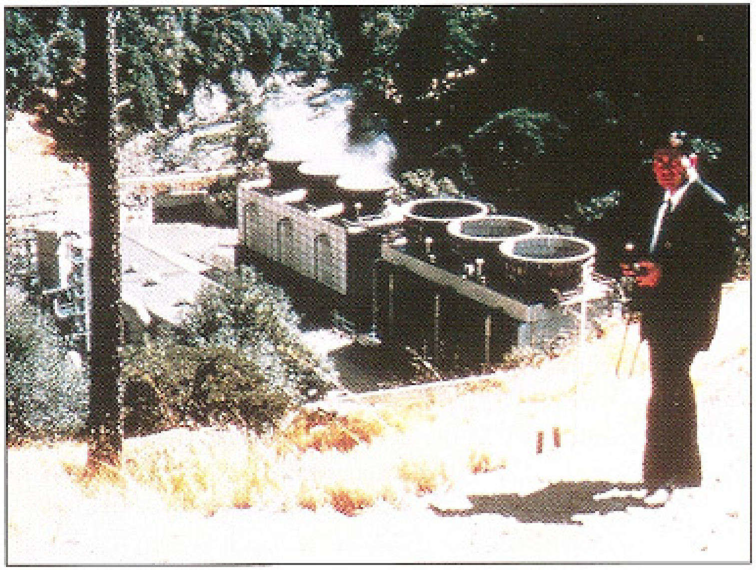
Geothermal Energy

- Energy inside the Eaeth



The earth's crust is broken into pieces called plates.
Magma comes close to the earth's surface near the edges of these plates.
This is where volcanoes occur.
The lava that erupts from volcanoes is partly magma.
Deep underground, the rocks and water absorb the heat from this magma.
The temperature of the rocks and water get hotter and hotter as you go deeper underground.

Geothermal Energy



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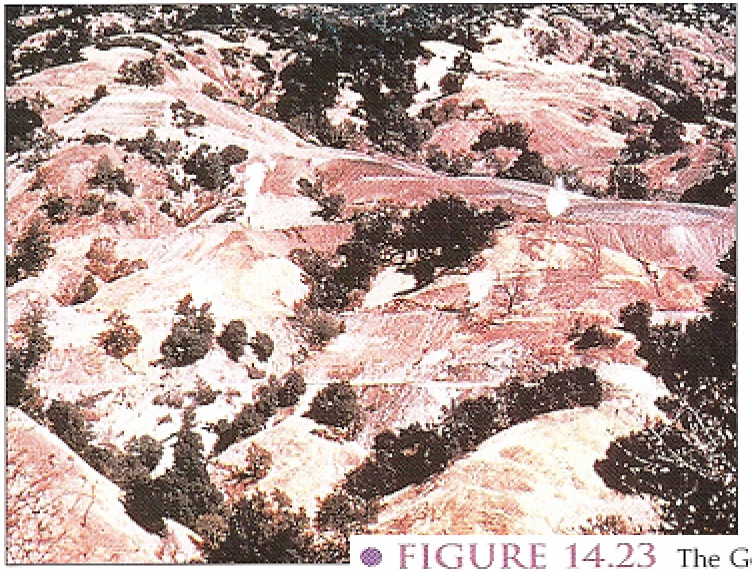


B

FIGURE 14.23 The Geysers, California. (A) Close-up of power plant. (B) Aerial view of The Geysers geothermal area.
Photographs by R. E. Wallace, USGS Photo Library, Denver, CO.

FIGURE 14.21 One of the many thermal features in Yellowstone National Park: Lone Star Geyser. Structure is built by deposition of dissolved minerals.

Geothermal Energy

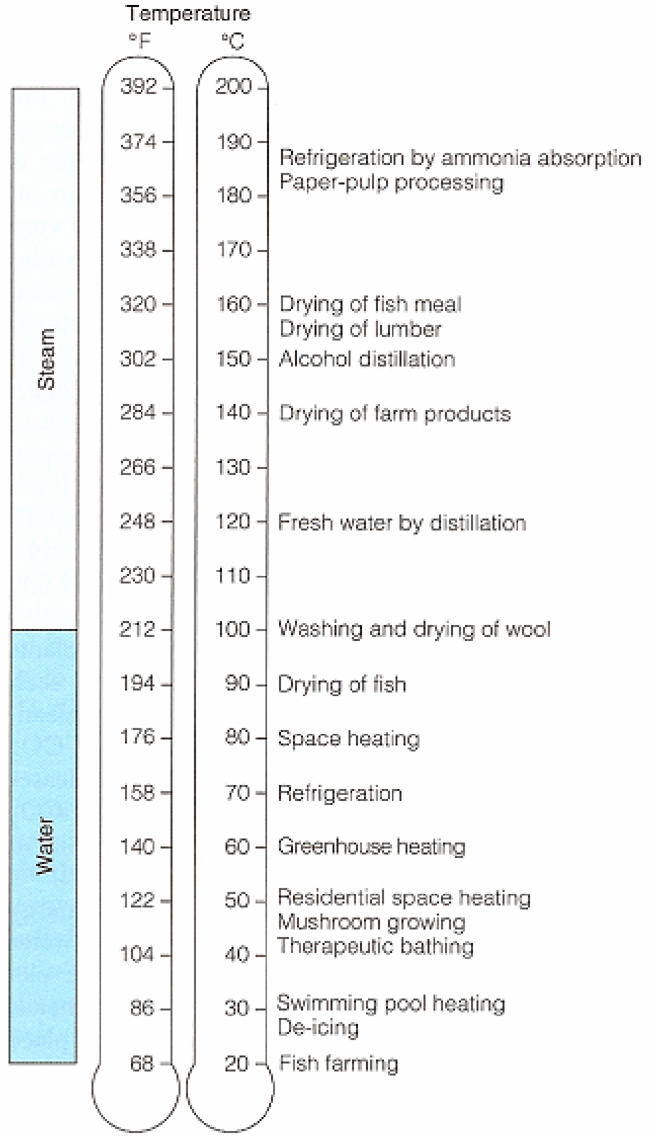
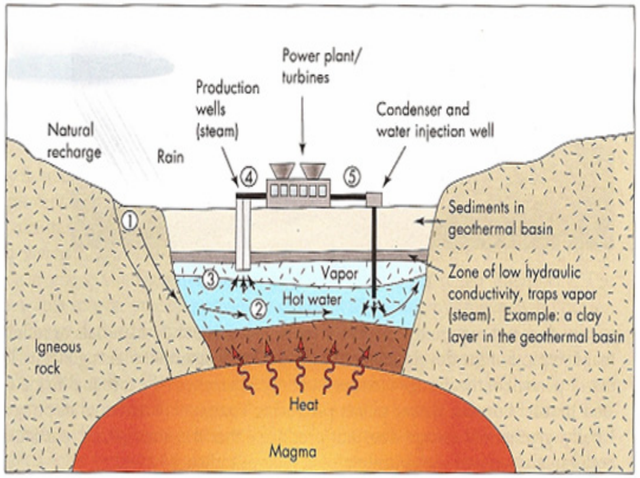


FIGURE 14.25 Some established commercial uses of geothermal energy.

People around the world use geothermal energy to heat their homes and to produce electricity by digging deep wells and pumping the heated underground water or steam to the surface.

Figure 15.26 Geothermal power plant Aerial view of the Geysers Power Plant north of San Francisco, California. The facility is the world's largest geothermal electricity development. *(Courtesy of Pacific Gas and Electricity)*

Geothermal Energy and Environment

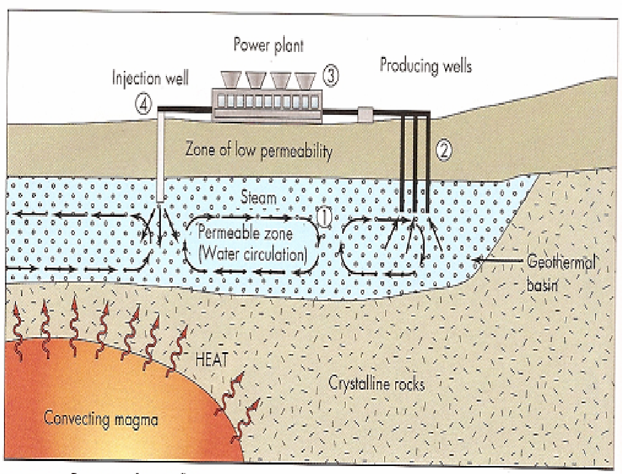


Direction of water flow

1. Natural recharge of water from rain
2. Hot water produced by Earth processes
3. Steam to production well
4. Steam to turbines to produce electricity
5. Water is injected back into ground

Figure 15.27 Vapor-dominated geothermal system and powerplat Idealized diagram of a vapor-dominated geothermal system. Wells produce steam that runs turbines to make electricity.

Figure 15.28 A hot-water geothermal system (a) At the power plant, the steam is separated from the water and used to generate electrical power. The water is injected back into the geothermal system through a disposal well. *(Courtesy of Pacific Gas and Electricity [PG&E])* (b) Mammoth Lakes, California, hot-water geothermal power plant. The plant uses 12 production wells and 6 injection wells to producing 40 MW, enough to provide power for about 40,000 homes.



Direction of water flow

1. Water circulating in geothermal basin
2. Wells pump out water and steam
3. Turbines in plant produce electricity
4. Water is injected back into basin

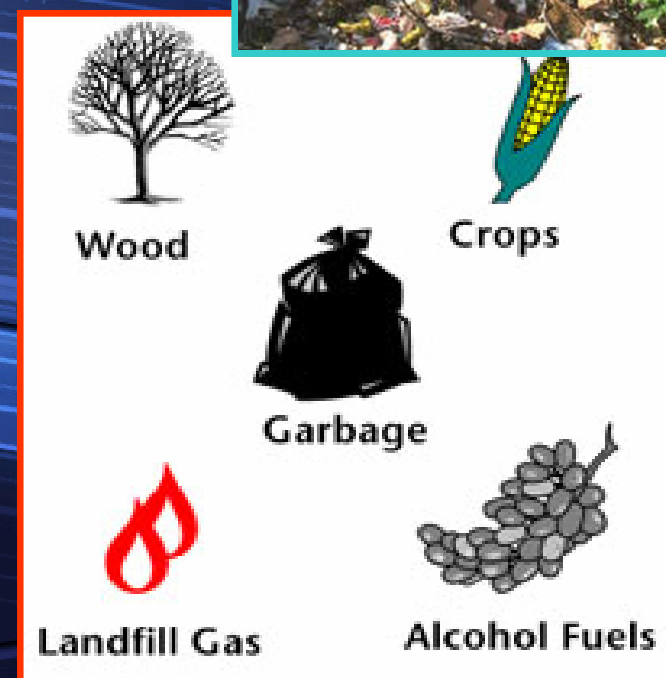
The environmental impact of geothermal energy depends on **how it is being used**.

1. Direct use and heating applications have almost no negative impact on the environment.

2. Geothermal power plants do not burn fuel to generate electricity, so their emission levels are very low.

Biomass

Biomass refers to living and recently dead biological material that can be used as fuel or for industrial production.



Types of Biomass

In general there are two approaches:

- growing plants specifically for energy use

- Trees
- Grasses
- Other crops
- Oil plants

- using the residues from plants that are used for other things

1. Forestry wastes
2. crop residues
3. urban wood waste

http://www.darvill.clara.net/altenerg/biomass.htm

Biomass

Converting Biomass to Energy

Thermochemical

When plant matter is heated but not burned,
it breaks down into various gases, liquids, and solids.

Biochemical

Bacteria, yeasts, and enzymes also break down carbohydrates.

Chemical

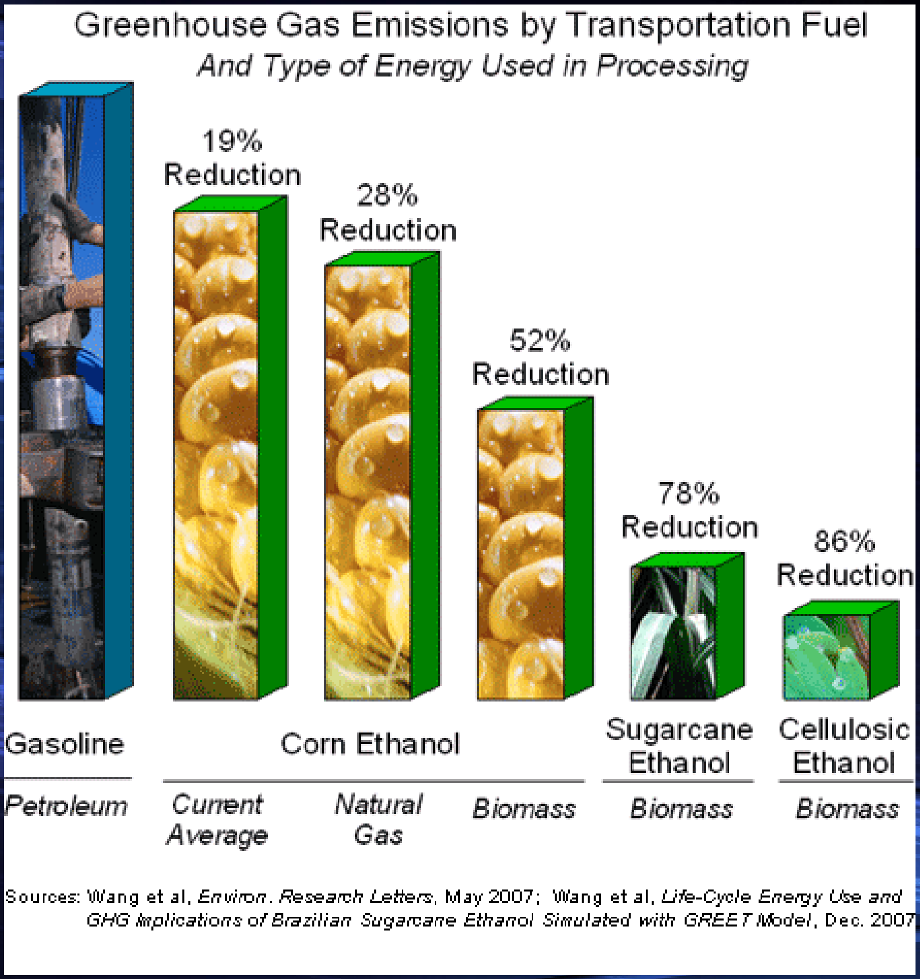
Biomass oils, like soybean and canola oil,
can be chemically converted into a liquid fuel similar to diesel fuel,
and into gasoline additives.

Biomass and Environment

1. Biomass reduces air pollution by being a part of the carbon cycle (see the box below), reducing carbon dioxide emissions by 90 percent compared with fossil fuels.

2. Biomass crops can create better wildlife habitat than food crops.

3. By growing our fuels at home, we reduce the need to import oil and reduce our exposure to disruptions in that supply.



Conclusion

Existing technologies for new energy sources, such as new renewable energy technologies, nuclear fission and fusion are promising, but need sustained research and development, including consideration of possible harmful side effects.

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Thank You !