



# **Renewable Energy Sources**

(Types, Advantages and Limitations)

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# Background

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- In 1831, Michael Faraday's many years of efforts rewarded when he discovered electromagnetic induction
  - Later, he invented the first generator
  - Today, electric energy technologies have a central role in social and economic development at all scales
  - Energy is closely linked to environmental pollution and degradation, to economic development and quality of life
  - Today, we are mostly dependent on nonrenewable fossil fuels that have been and will continue to be a major cause of pollution and climate change
  - Finding sustainable alternatives is becoming increasingly urgent
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# Renewable Energy

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- Renewable energy is energy from sources that are constantly being formed
  - Types of renewable energy includes:
    - solar energy
    - wind energy
    - the power from living things: biomass
    - the power from moving water: hydro/micro-hydro and tidal waves
    - Earth's heat
  - Remember, all sources of energy, including renewable sources, affect the environment
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# Why renewable energy?

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- There are many energy sources today that are extremely limited in supply. Some of these sources include oil, natural gas, and coal. It is a matter of time before they will be exhausted.
  - Estimates are that they can only meet our energy demands for another fifty to seventy years. So in an effort to find alternative forms of energy, the world has turned to renewable energy sources as the solution. There are many advantages and disadvantages to this.
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# Renewable energy: advantages

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- One major advantage with the use of renewable energy is that as it is renewable **it is therefore sustainable and so will never run out.**
  - Even more importantly, renewable energy produces little or **no waste products** such as carbon dioxide or other chemical pollutants, so has minimal impact on the environment.
  - Renewable energy facilities generally **require less maintenance** than traditional generators. Their fuel being derived from natural and available resources reduces the costs of operation.
  - Renewable energy projects can also **bring economic benefits** to many regional areas, as most projects are located away from large urban centers and suburbs of the capital cities. These economic benefits may be from the increased use of local services as well as tourism.
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# Renewable energy: disadvantages

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- One disadvantage with renewable energy is that **it is difficult to generate the quantities of electricity** that are as large as those produced by traditional fossil fuel generators.
  - Another disadvantage of renewable energy sources is **the low reliability of supply**. Renewable energy often relies on the weather for its source of power. Hydro generators need rain to fill dams to supply flowing water. Wind turbines need wind to turn the blades, and solar collectors need clear skies and sunshine to collect heat and make electricity. When these resources are unavailable so is the capacity to make energy from them. This can be unpredictable and inconsistent.
  - The current **cost of renewable energy technology is also far in excess of traditional fossil fuel generation**. This is because it is a new technology and as such has extremely large capital cost (especially R & D costs).
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# Solar Energy - Power from the Sun

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- Most renewable energy comes either directly or indirectly from the sun.
  - Direct solar energy is used every day, like when the sun shines on a window and heats the room.
  - Solar energy can also be used indirectly to generate electricity in solar cells.
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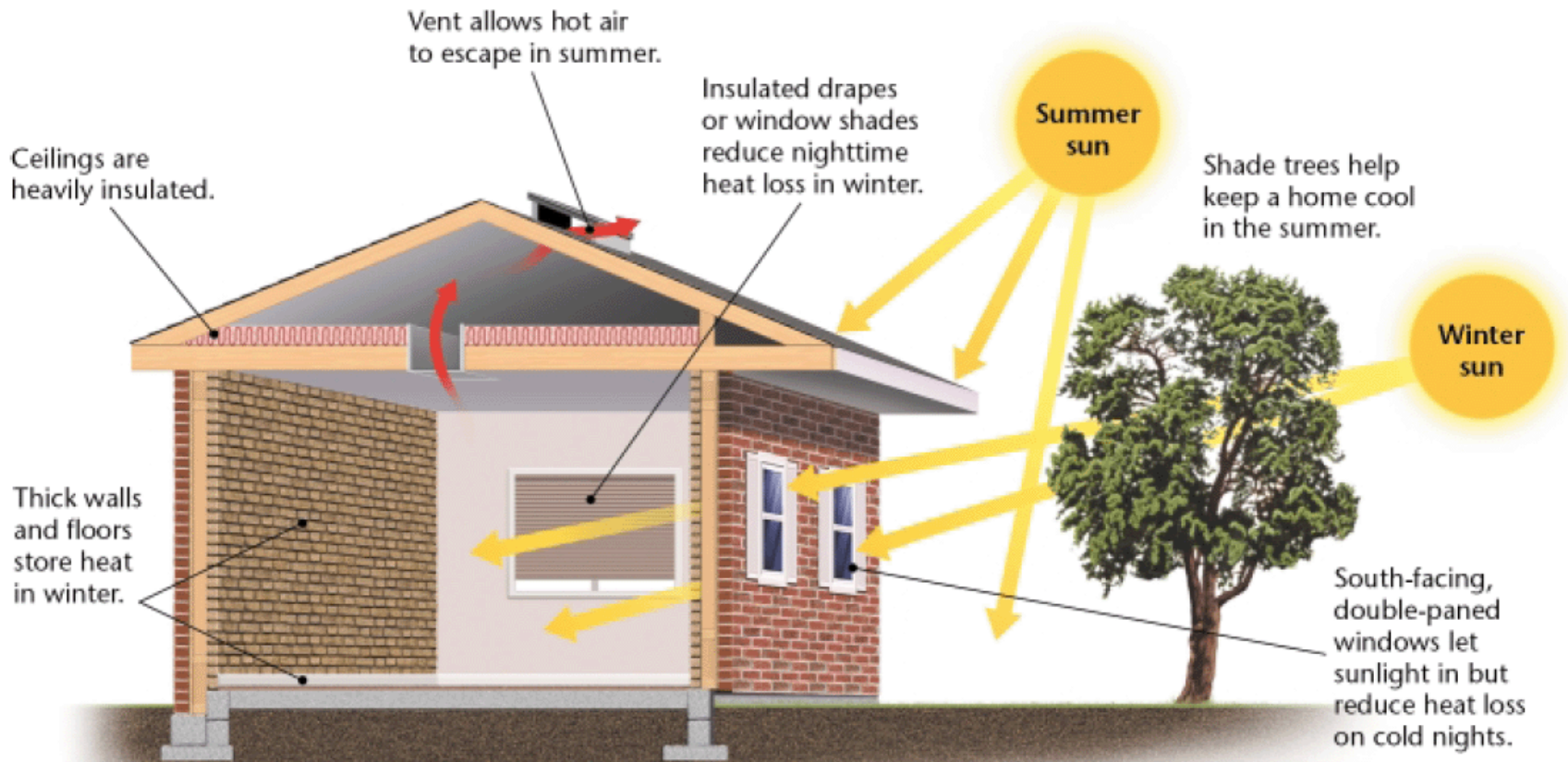
# Passive solar heating/cooling

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- Passive solar heating is the use of sunlight to heat buildings directly.
  - In the Northern Hemisphere, south facing windows receive the most solar energy. Therefore, passive solar buildings have large windows that face south.
  - Trees – A house shaded by trees is a much cooler house during the summer. Also, keep in mind that during the winter, the leaves are gone off the deciduous trees, so the winter sun can still shine into the home.
  - Natural ventilation – Natural ventilation requires pressure differences to move fresh air through a building.
  - An average household could reduce its energy bills by using any of the passive solar features
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# Passive solar heating/cooling house design



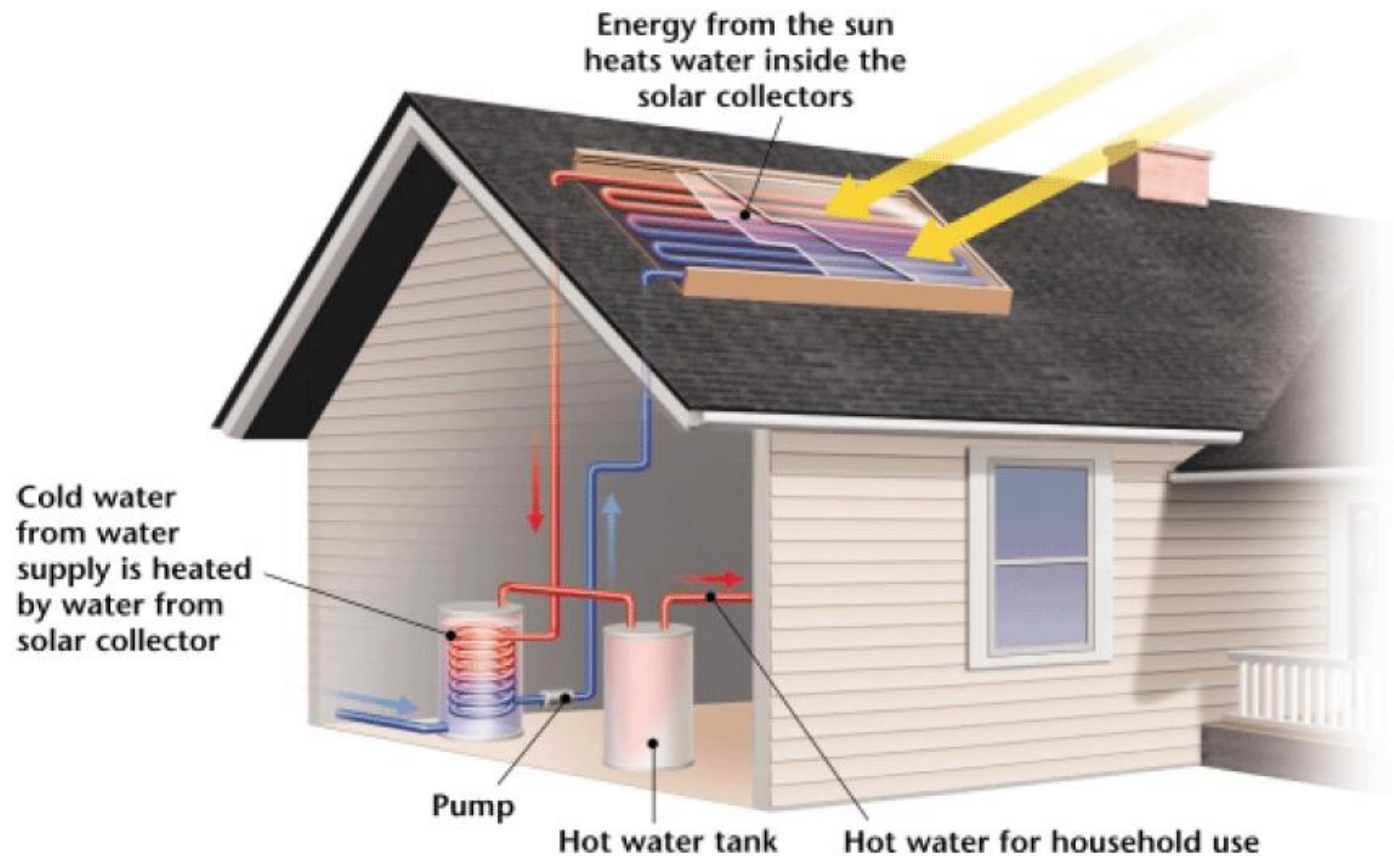
# Active solar heating

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- Active solar heating is the gathering of solar energy by collectors that are used to heat water or heat a building
  - Solar collectors, usually mounted on a roof, capture the sun's energy
  - A liquid is heated by the sun as it flows through solar collectors
  - The hot liquid is then pumped through heat exchangers, which heats water for the building.
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# Active solar heating

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# Photovoltaic cells

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- Photovoltaic cells are solar cells that convert the sun's energy into electricity.
  - Solar cells have no moving parts, and they run on nonpolluting power from the sun.
  - However, they produce a very small electrical current. Meeting the electricity needs of a small city would require covering hundreds of acres with solar panels.
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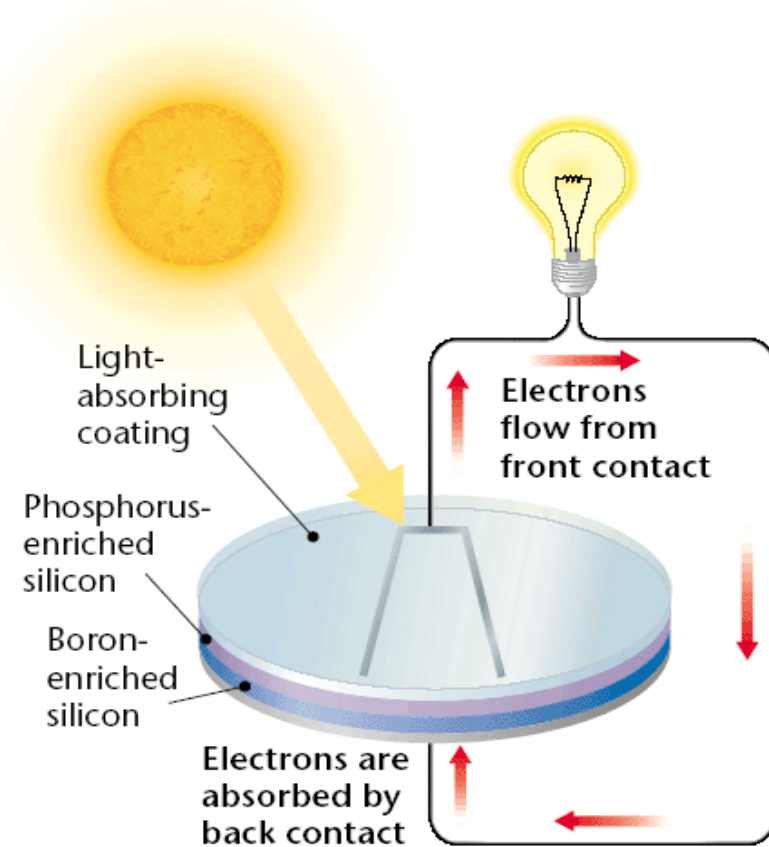
# Photovoltaic cells

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Sunlight falls on a semiconductor, causing it to release electrons.

The electrons flow through a circuit that is complete when another semiconductor in the solar cell absorbs electrons and passes them on to the first semiconductor.

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# Photovoltaic cells

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- Solar cells require extended periods of sunshine to produce electricity. This energy is stored in batteries, which supplies electricity when the sun is not shining.
  - Currently, solar cells provide energy for more than 1 million households in developing countries, where energy consumption is minimal and electricity distribution networks are limited.
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# Wind power

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- Energy from the sun warms the Earth's surface unevenly, which causes air masses to flow in the atmosphere.
  - We experience the movement of these air masses as wind.
  - Wind power, which converts the movement of wind into electric energy, is the fastest growing energy source in the world.
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# Wind farms

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- Wind turbines are used to capture the energy from the wind.
  - Large arrays of wind turbines are called wind farms. Large wind farms supply electricity to thousands of homes.
  - In windy rural areas, small wind farms with 20 or fewer turbines are also becoming common.
  - Because wind turbines take up little space, some farmers can add wind turbines to their land and still use the land for other purposes.
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# Wind: an underdeveloped resource

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- Scientists estimate that the windiest spots on Earth could generate more than ten times the energy used worldwide.
  - In the future, the electricity may be used on the wind farm to produce hydrogen from water.
  - Today, most of the large energy companies are developing plans to use more wind power.
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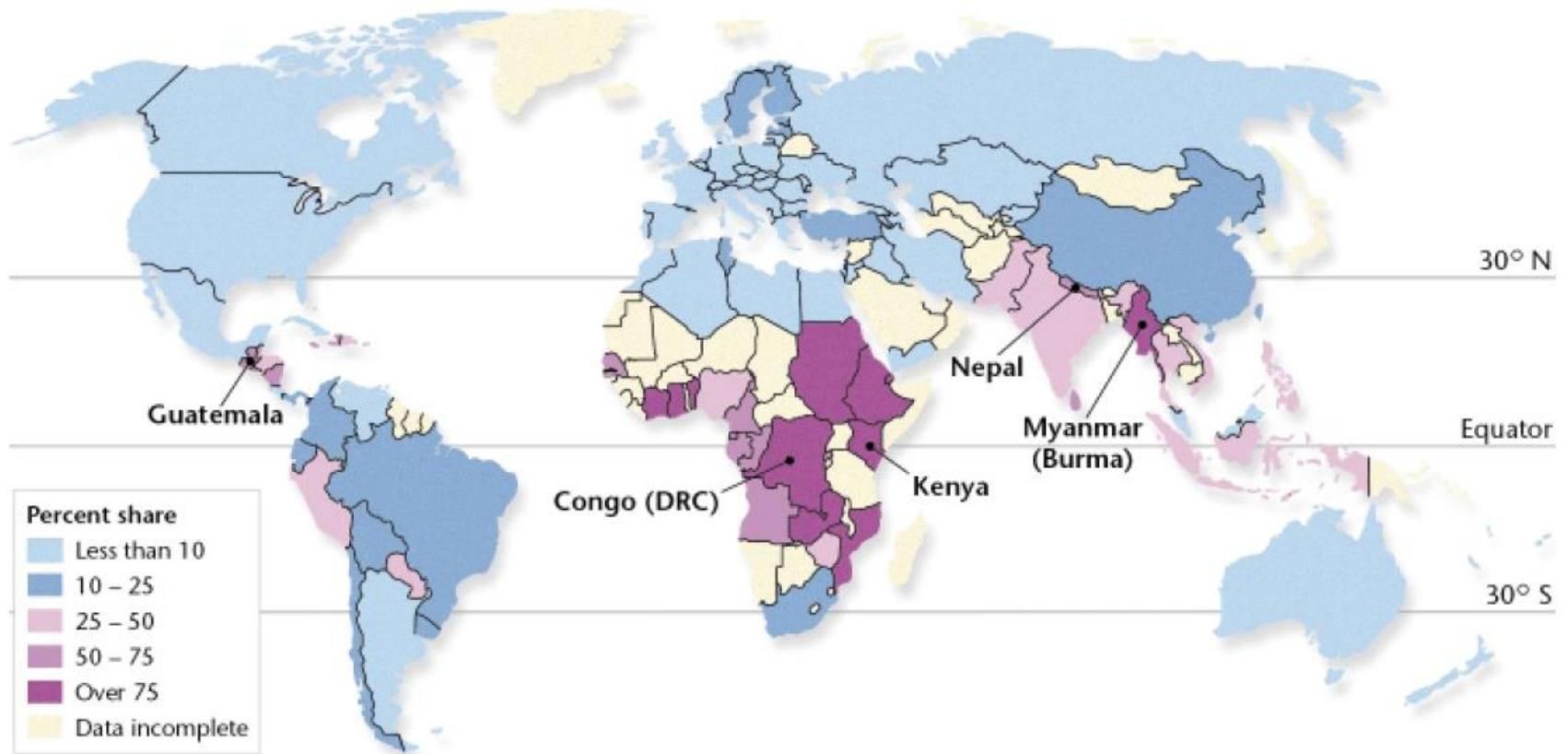
# Biomass: power from living things

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- Biomass fuel consists of plant material, manure, or any other organic matter that is used as an energy source.
  - Fossil fuels can be thought of as biomass energy sources, although they are nonrenewable.
  - Renewable biomass fuels, such as wood and dung, are major sources of energy in developing countries.
  - More than half of all wood cut in the world is used as fuel for heating and cooking.
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# Biomass: power from living things

Share of Woodfuels in Energy Consumption



## **Biomass: power from living things**

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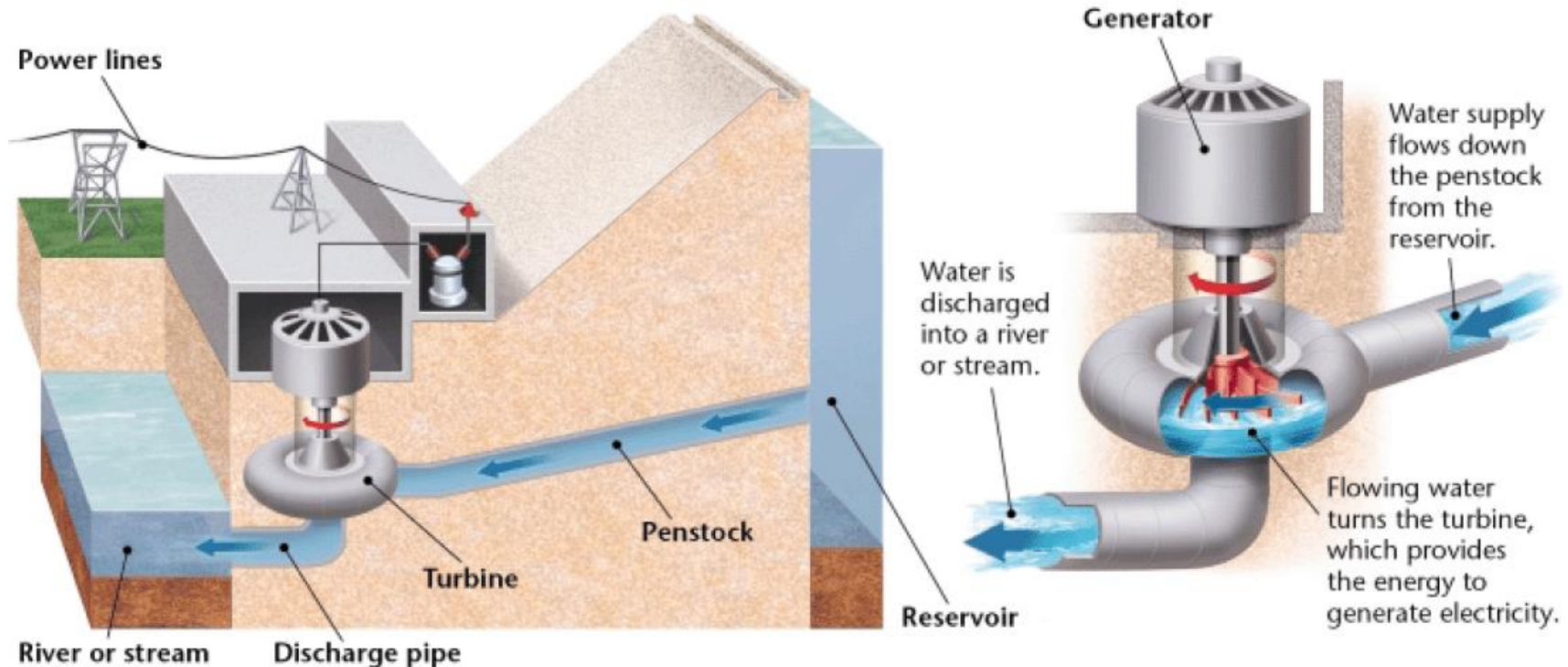
- Although materials like wood are a renewable resource, if trees are cut down faster than they grow, the resulting habitat loss, deforestation, and soil erosion can be severe.
  - In addition, harmful air pollution may result from burning wood and dung.
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# Methane

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- When bacteria decompose organic wastes, one byproduct is methane gas.
  - Methane can be burned to generate heat or electricity.
  - In China, more than 6 million households use biogas digesters to ferment manure and produce gas for heating and cooking.
  - Some landfills in the United States generate electricity by using the methane from the decomposition of trash.
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# Hydroelectricity: power of moving water



# Hydroelectricity: power of moving water

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- Hydroelectric energy is electrical energy produced by falling water.
  - Hydroelectric energy accounts for 20% of the world's electricity.
  - Large hydroelectric power plants have a dam that is built across a river to hold back a reservoir of water.
  - The water in the reservoir is released to turn a turbine, which generates electricity.
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# The benefits of hydroelectric energy

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- Hydroelectric dams are expensive to build, but relatively inexpensive to operate.
  - Unlike fossil fuel plants, hydroelectric dams do not release air pollutants that cause acid precipitation.
  - Hydroelectric dams also tend to last much longer than fossil fuel-powered plants.
  - Dams also provide other benefits such as flood control and water for drinking, agriculture, industry, and recreation.
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# The disadvantage of hydroelectric energy

- A dam changes a river's flow, which can have far-reaching consequences.
- A reservoir floods large areas of habitat above the dam. Water flow below the dam is reduced, which disrupts ecosystems downstream.
- When the land behind a dam is flooded, people are often displaced. If a dam bursts, people living in areas below the dam can be killed.
- River sediments build up behind the dam instead of enriching land farther down the river, making farmland below the dam less productive.
- Recent research has also shown that the decay of plant matter trapped in reservoirs can release large amounts of greenhouse gases-sometimes more than a fossil-fuel powered plant.

# Modern trends

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- In developing countries the construction of large dams continues
  - One modern trend is **micro-hydropower**, which is electricity produced in a small stream without having to build a big dam. The turbine may even float in the water, not blocking the river at all.
  - Micro-hydropower is much cheaper than large hydroelectric dam projects, and it permits energy to be generated from small streams in remote areas.
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# Geothermal energy: power from the earth

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- In some areas, deposits of water in the Earth's crust are heated by geothermal energy.
  - Geothermal energy is the energy produced by heat within the Earth.
  - The United States is the world's largest producer of geothermal energy.
  - Although geothermal energy is considered a renewable resource, the water that is used must be managed carefully so that it is not depleted.
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# Geothermal energy: power from the earth

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- Geothermal power plants generate electricity using the following steps  
Steam rises through a well Steam drives turbines, which generate electricity  
Leftover liquid is pumped back into the hot rock
- The leftover liquid, water, is returned to Earth's crust because it can be reheated by geothermal energy and used again.

