

Fuels, nuclear power, renewables and the climate

Grade 8 science (Year 9 · Class 8) · Lesson

Quick answer: Energy resources are non-renewable (coal, oil, natural gas, uranium) or renewable (solar, wind, hydro, tidal, geothermal, biomass). Most power stations heat water to steam to spin a turbine and generator. Burning fossil fuels releases CO₂, which strengthens the greenhouse effect and warms the climate.

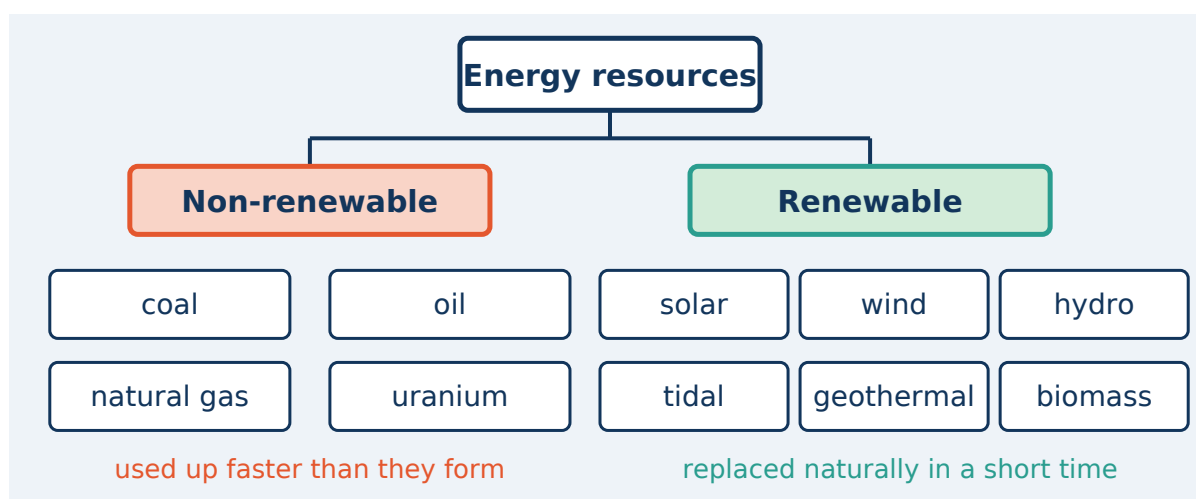
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What are energy resources and how are they grouped?

Every light, bus and phone charger needs energy from somewhere. We call the places we get it from energy resources. Some resources are used up faster than nature can replace them, while others are replaced all the time.

Definition

A non-renewable resource is used up much faster than it forms: coal, oil, natural gas and uranium. A renewable resource is replaced naturally in a short time: solar, wind, hydroelectric, tidal, geothermal and biomass energy. Coal, oil and natural gas are called fossil fuels because they formed from ancient plants and animals buried for millions of years.



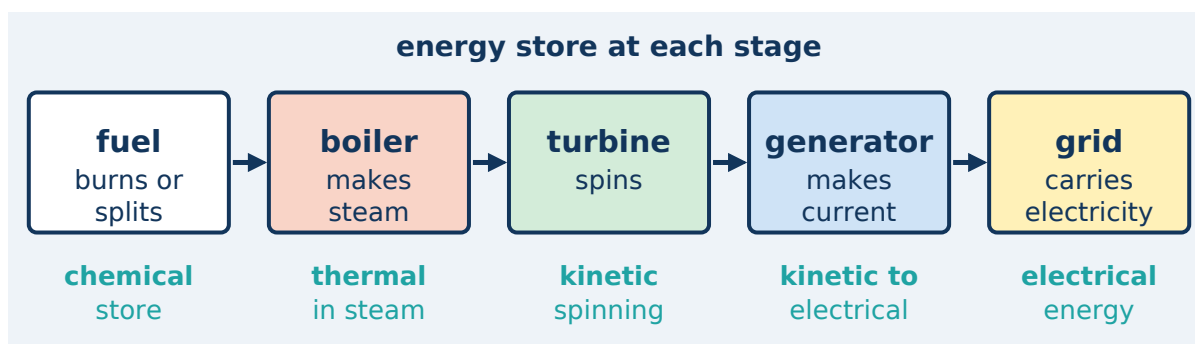
Fossil fuels and uranium will run out. Renewable resources will not, but many depend on the weather.

Resource	Advantage	Disadvantage
Coal	cheap and reliable	releases a lot of CO ₂ and sulfur dioxide
Natural gas	cleaner than coal, quick to start	releases CO ₂ , leaks of methane

Resource	Advantage	Disadvantage
Nuclear (uranium)	no CO ₂ while running, huge energy from little fuel	radioactive waste, expensive to build
Solar	no fuel and no emissions when running	no output at night, less in cloud
Wind	no fuel and no emissions when running	output changes with wind speed
Hydroelectric	reliable, water can be stored	dams flood land and affect wildlife
Biomass	can use farm waste	burning releases CO ₂ and needs land

How does a power station make electricity?

Most electricity comes from thermal power stations. The fuel is burned in coal and gas stations, or split in a nuclear reactor, to heat water into high-pressure steam. The steam spins a turbine and the turbine turns a generator.



Each stage transfers energy to the next. Wind and hydroelectric stations skip the boiler and turn the turbine directly.

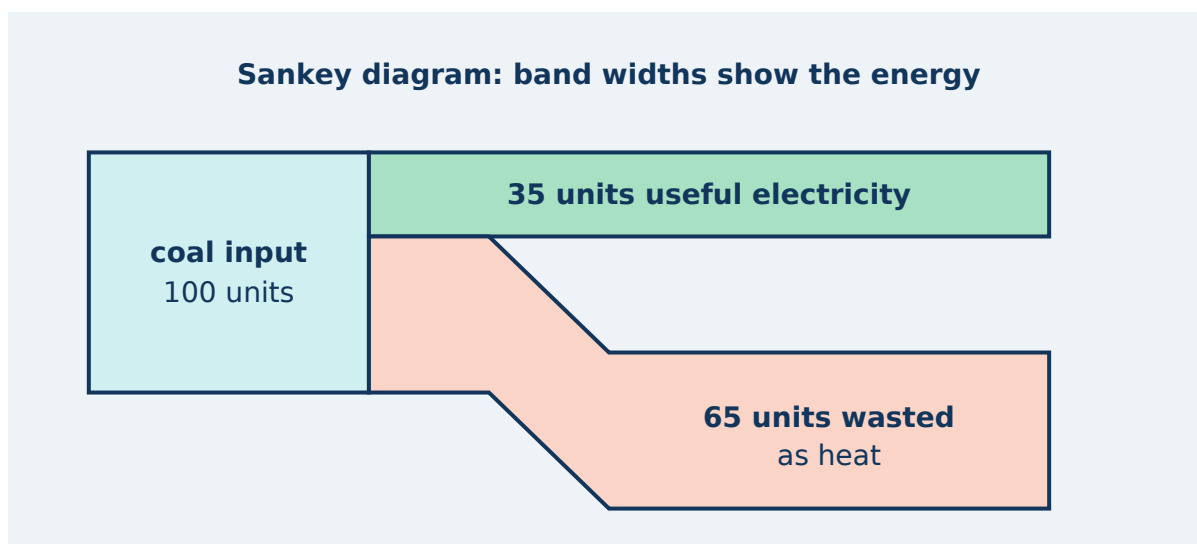
Solar panels are different: they change light directly into electricity with no moving parts. In every power station some energy is wasted as heat, so only part of the input becomes useful electricity.

Formula

efficiency (%) = useful energy output ÷ total energy input × 100. Both energies are in joules (J) or megajoules (MJ). Efficiency has no unit.

Worked example

A coal station in Uttar Pradesh takes in 3000 MJ of chemical energy and delivers 1050 MJ of electricity. **Method:** efficiency = $1050 \div 3000 \times 100$. **Answer:** efficiency = **35 %**, so 1950 MJ is wasted as heat.



In a Sankey diagram the width of each band is proportional to the energy it carries.

How do fossil fuels and nuclear power compare for the climate?

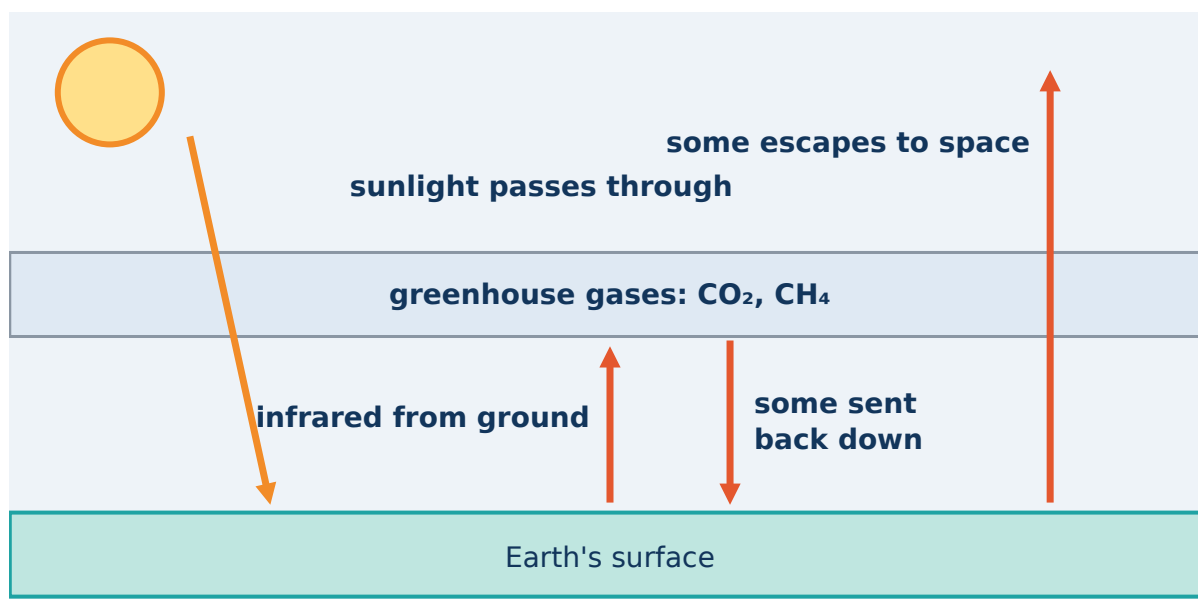
Burning a fossil fuel releases carbon dioxide (CO₂) into the air. A nuclear station releases no CO₂ while it runs, but it produces radioactive waste that must be stored safely for thousands of years. Renewable stations release almost no CO₂ while running, although building them does cause some emissions.

Worked example

A school in Leeds uses 2500 kWh of electricity a year. **Data:** coal electricity causes about 0.90 kg of CO₂ per kWh, and wind electricity about 0.012 kg per kWh (typical full-life values). **Method:** coal $2500 \times 0.90 = 2250$ kg; wind $2500 \times 0.012 = 30$ kg. **Answer:** switching to wind saves $2250 - 30 = 2220$ kg of CO₂.

How do energy resources change the climate?

The Sun warms the ground, and the warm ground gives out infrared radiation. Greenhouse gases such as carbon dioxide and methane absorb some of this infrared and send part of it back down, which keeps the Earth warm enough for life. This is the greenhouse effect.



More greenhouse gas sends more infrared back to the ground, so the average temperature rises.

Key law

Burning fossil fuels adds extra CO₂ to the atmosphere. More CO₂ strengthens the greenhouse effect, which causes global warming, rising sea levels and more extreme weather.

Common mistake

Global warming is not caused by the hole in the ozone layer. The ozone layer blocks ultraviolet, while the warming is caused by extra greenhouse gases that trap infrared.

Countries cut emissions by using renewable resources, by improving efficiency so that less fuel is needed, and by planting trees that absorb CO₂ as they grow. Energy and power are linked by $E = P \times t$, so a 5.0 kW solar array that delivers full power for 6.0 h gives $5.0 \times 6.0 = 30$ kWh.

Lina's tip

For any energy resource question, ask three things: is it renewable, does it release CO₂, and is it reliable day and night? Your answer usually follows from those three.

Key points to remember

- Non-renewable: coal, oil, natural gas, uranium. Renewable: solar, wind, hydro, tidal, geothermal, biomass.
- Thermal station chain: fuel, boiler, steam, turbine, generator.
- Efficiency (%) = useful energy output ÷ total energy input × 100.
- Energy $E = P \times t$, with kWh = kW × h.
- Burning fossil fuels releases CO₂ and strengthens the greenhouse effect.

Fuels, nuclear power, renewables and the climate: frequently asked questions

What is the difference between renewable and non-renewable resources?

A renewable resource, such as wind or sunlight, is replaced naturally in a short time. A non-renewable resource, such as coal or uranium, is used up much faster than it forms, so it will run out.

How does a fossil fuel power station work?

The burning fuel heats water to make steam. The steam spins a turbine, and the turbine turns a generator that produces electricity for the grid.

Why is nuclear power low carbon but controversial?

A nuclear reactor splits uranium atoms and releases no CO₂ while it runs. However, it creates radioactive waste that must be stored for a very long time, and an accident could be serious.

Why can wind and solar not supply all the electricity alone?

Their output depends on the weather and the time of day. A grid also needs storage or backup stations for calm and dark periods.

How do fossil fuels cause global warming?

Burning them releases CO₂, a greenhouse gas that traps infrared radiation near the surface. More CO₂ means more energy is kept in the atmosphere and the average temperature rises.