



System	Closed system	<b>No change in total energy in system</b>
	Open system	<b>Energy can dissipate (can enter or leave)</b>

**Dissipate**  
**To scatter in all directions or to use wastefully**  
When energy is 'wasted', it dissipates into the surroundings as thermal energy and the temperature rises.

Useful energy	<b>Energy transferred and used</b>
Wasted energy	<b>Dissipated energy, stored less usefully</b>

Conduction transfers thermal energy through solid objects.

**Thermal conductivity**  
**How well a material conducts energy**  
Metals have high thermal conductivity.

Kinetic	<b>Anything moving has energy in its kinetic energy store.</b>
Thermal	<b>Any object – the hotter it is the more energy is in its thermal energy store</b>
Chemical	<b>Anything that can release energy by a chemical reaction e.g. food, fuels</b>
GPE	<b>Anything that can fall / in a gravitational field</b>
EPE	<b>Anything stretched e.g. springs, rubber bands</b>
Electrostatic	<b>Two charges that attract or repel each other</b>
Magnetic	<b>Two magnets that attract or repel each other</b>
Nuclear	<b>Atomic nuclei release energy from this store in nuclear reactions</b>

Total energy input = useful energy output + wasted energy

**Principle of conservation of energy**  
**The amount of energy always stays the same.**  
Energy cannot be created or destroyed, only changed from one store to another.

Energy is only useful when it is transferred from one store to another useful store

Cavity walls	<b>An air gap reduces the amount of energy transfer by conduction</b>
Thick walls	<b>Thick walls have a slow rate of energy transfer</b>

In buildings the lower the thermal conductivity the slower the rate of energy transfer

**Energy transfers**

**Conservation of energy**

**Physics SP3 Conservation of Energy**

**Efficiency**  
**How much energy is usefully transferred**

Efficiency =  $\frac{\text{Useful output energy transfer}}{\text{Total input energy transfer}}$

Efficiency =  $\frac{\text{Useful power output}}{\text{Total power input}}$

**HIGHER ONLY**

Efficiency can be increased by reducing the thermal energy transferred due to friction by lubricating and the energy transferred by heating by insulation.

Gravitational Potential energy (GPE)	<b>Energy gained by an object raised above the ground</b>
Kinetic energy (KE)	<b>Energy stored by a moving object</b>

Change in GPE = Mass X gravitational field strength X change in vertical height  
 $\Delta GPE = m \times g \times \Delta h$

$KE = \frac{1}{2} \times \text{mass} \times (\text{speed})^2$   
 $KE = \frac{1}{2} \times m \times v^2$

**Energy transfer diagrams**  
**An easy way to show what happens to the energy**  
Boxes = energy stores and arrows = energy transfers

Transfers between stores	
<b>Mechanical</b>	A force acts on an object (doing work e.g. push, squash, stretch)
<b>Electrically</b>	A charge doing work against resistance e.g. charges moving round a circuit
<b>By heating</b>	Energy transfers from a hot object to a cooler object e.g. hot drink
<b>By radiation</b>	Energy transfers by waves e.g. sunlight reaching the Earth

**Unit**  
**Joules (J)**  
Thermal energy store of hot drink

**By heating Thermal energy transfers from hot liquid to cooler air and cup**  
Thermal energy store of cup and surrounding s

<b>Important energy Transfers between stores</b>	An object projected upwards or up a slope	The object does work against gravity so energy is transferred mechanically from the object's KE store to the GPE store.
	A moving object hitting an obstacle	The moving object has energy in it's KE store. Some of this is mechanically transferred to the obstacle's KE store. Some energy is mechanically transferred to the thermal energy store of the object and obstacle, to the thermal energy store of the surroundings by heat and the rest of the energy is 'carried' away by sound
	An object being accelerated by a constant force	Assuming there is no air resistance, gravity does work on the object. The object accelerates constantly towards the ground. Energy is transferred mechanically from the GPE store to the object's KE store.
	A vehicle slowing down	Energy in the vehicle's KE store is transferred mechanically due to friction between the road and tyres, and then by heating to the thermal energy store of the vehicle and road.
	Boiling water in an electric kettle	Energy is transferred electrically from the mains to the element in the kettle. The energy is then transferred by heating to the thermal energy store of the water.

# Physics SP3 Conservation of Energy

## Trends in Energy resource use

Fossil fuels	<b>Produce most of our electricity</b>	The need for electricity increased greatly in the 20 <sup>th</sup> century
	<b>Devices are becoming more efficient</b>	Designers are trying to reduce the amount of wasted energy

Other uses of fossil fuels	<b>Oil (diesel and petrol) used to fuel cars</b>
	<b>Gas is used to heat homes and to cook food</b>

Energy resources are chosen for their effect upon the environment.

Fossil fuels have a negative effect upon the environment.

Targets have been introduced to reduce the use of fossil fuels.

Car companies are designing electric and hybrid cars.

Renewable fuels	<b>Limited by reliability</b>	Energy resources cannot quickly respond to demand like fossil fuels
	<b>Limited by cost</b>	Building new renewable power stations is expensive

Research into improving the reliability of renewable energy resources is expensive and takes time.

Hybrid cars and solar panels for houses are still very expensive

People object to wind farms (visual pollution).

## Energy resources

Negatives for using fossil fuels and nuclear fuel	<b>Create environmental problems</b>	Fossil fuels release carbon dioxide when burnt.
	<b>Non-renewable</b>	Will run out.
	<b>Nuclear power stations are expensive</b>	To build and to decommission safely.

Positives for using fossil fuels and nuclear fuel	<b>Reliable</b>	Provides lots of energy.
	<b>Plenty of fuel to meet current demand</b>	Respond quickly to electrical needs from National Grid.
	<b>Cost to extract is low</b>	Fossil fuel power plants relatively cheap to build and run.

Non-renewable energy resource	<b>These will run out. It is a finite reserve. It cannot be replenished.</b>	e.g. Fossil fuels (coal, oil and gas) and nuclear fuels.
Renewable energy resource	<b>These will never run out. It is an infinite reserve. It can be replenished.</b>	e.g. Solar, Tides, Waves, Wind, Geothermal, Biomass, Hydroelectric

Most do cause some damage to the environment but less than non-renewables

Do not provide a lot of energy and some are unreliable

Biofuels	<b>Made from plants and animal waste dung</b>	
	Positives.	Negatives.
	Renewable.	Cost to refine biofuels is very high.
	Can be solid, liquid or gas and can be burnt to produce electricity.	Growing biofuels takes space away from growing food.
	Reliable and take a short time to grow.	Natural habitats are destroyed to make room to grow biofuels.
	'Carbon neutral' theoretically plants take in the same amount of CO <sub>2</sub> as they release when burnt	Decay or burning of the cleared vegetation increases methane and CO <sub>2</sub> emissions.

Solar cells	<b>Made from materials that use energy transferred by light to create an electric current</b>	
	Positives.	Negatives.
	No damage to the environment	Expensive
	Used in remote places.	Weather dependant – cannot be used in cloudy countries.

Tidal barrages	<b>Big dams built across river estuaries with turbines in them. As the tide comes in, water fills up the estuary, then water is let out through the turbines to generate electricity</b>	
	Positives.	Negatives.
	No polluting gases	Visual pollution
	Reliable as tides occur twice a day	Prevent boat access Alter habitats for wading birds
	No fuel costs, minimal running costs	Initial costs high

Wind	<b>Each wind turbine has a generator inside it. As the wind rotates the blades, the generator turns and produces electricity</b>	
	Positives.	Negatives.
	No polluting gases.	Initial costs quite high Need lots to make enough electricity.
	Running costs minimal.	Visual and noise pollution. Weather dependant – only work when windy

Hydro-electric power	<b>Rainwater collects behind the dam and is allowed out through turbines.</b>	
	Positives.	Negatives.
	Can respond immediately to demand.	Building dams and flooding valleys Big impact upon environment. Loss of habitats. .
	No polluting gases.	Initial costs high but minimal running costs.