



# Energy

## What is energy?

It is quite difficult to define what energy is.

One way to describe it is power derived from physical or chemical resources.

## What types of energy are there?

There are many different forms of energy including:

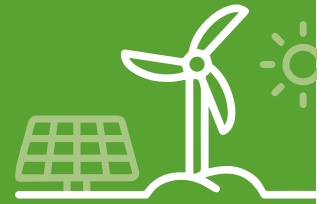
- **Nuclear energy** – energy released from the nucleus (core) of an atom creating electricity. For example, the sun uses nuclear energy to produce light and heat.
- **Chemical energy** – energy released from molecules stored in chemical compounds, reacting with other molecules. For example, releasing energy from nutrients in the food that we digest, accessing glucose that our cells use to produce energy that we need to move our bodies, and burning fuel to release thermal energy.
- **Kinetic energy** – energy of objects in motion. Through the application of force on an object to make it move, energy is transferred, and the object moves with a new constant speed. The energy that is transferred depends on the mass of the object and the speed achieved. Any object in motion is using kinetic energy. For example, when we walk, run or play, a ball being thrown and a flowing river.
- **Sound energy** – energy produced by the vibration of an object. For example, our voices, musical instruments, aeroplanes and engines.
- **Electrical energy** – energy obtained from the free electrons that have a positive or negative charge. For example, lighting, batteries when being used, powering our mobile devices, cars and hospital equipment.
- **Gravitational energy** – energy stored in an object due to its height above the Earth. For example, water behind a dam, riding a bike downhill being faster than going uphill or falling out of a tree.
- **Radiant energy** – energy that travels by waves or particles. For example, radiant energy sources include the entire electromagnetic radiation spectrum, including gamma rays, x-rays, radio frequencies, microwaves, light and heat.
- **Thermal energy** – also known as heat energy, generated by the motion of atoms when they collide with each other, for example, the sun, radiators, lightbulbs and fires.
- **Elastic energy** – energy is stored when materials stretch or compress. For example, pulling back or stretching a band of elastic, springs and slingshots.

## Why do we need energy?

Energy cannot be seen but is all around us, in our own bodies and throughout the universe. It is something we use every day. Access to energy is fundamental for modern societies. It supports much of our daily lives, from the buildings we live in, the products and services that support our economy, the transport we rely on and the leisure activities we enjoy. Without energy, we simply do not exist.

## Energy transference

Energy cannot be created or destroyed but only changed from one form to another. This principle is known as the first law of thermodynamics. For example, when you eat food you give your body chemical energy. Your body changes this into sound energy when you speak. When we walk or run, we are using chemical energy to move by converting it to kinetic energy. In turn this changes to thermal energy as the movement heats our bodies.



## Why do we need sustainable energy?

There is a growing awareness that our existing energy sources will run out as we are using non-renewable sources. Most of our energy needs are met using fossil fuels, such as coal, oil and gas, which are found in the ground. These resources have been produced over millions of years. For example, peat is still used for energy, with peat-cutting still visible in our landscapes, but it is less prevalent as awareness is raised as to the negative environmental impacts.

### Non-renewable

energy comes from carbon-based materials that have taken millions of years to become fossil fuels such as coal, oil and natural gas. This material is limited and will eventually run out.

While alive, the trees breathed in carbon dioxide from the air and stored the carbon in their woody parts. Trees fell or sank into mud and swamps. The carbon in the wood slowly turned into coal as the soil layers above applied weight and pressure to them. Humans have been digging up coal to use as a fuel for a very long time as it burns easily.

Oil and gas formed in the same way, except that carbon was stored in the bodies and shells of tiny sea creatures who died and were buried over time.

Today, we still burn fossil fuels to make a lot of the energy we use in our day-to-day lives but using them for energy has a negative impact on our climate. Climate change is caused by the build-up of so-called 'greenhouse gases' in the earth's atmosphere. These include carbon dioxide, methane and nitrous oxide. Carbon dioxide is the main greenhouse gas and is formed as a result of burning fossil fuels. When we burn fossil fuels, we release the carbon that was locked up in fossil fuels, back into the atmosphere where it contributes to the greenhouse effect.

Greenhouse gases, such as carbon dioxide, add to the invisible blanket that surrounds our planet, trapping more of the sun's heat. This makes the temperature of the Earth rise. We call this global warming which is causing the world's long-term weather patterns to change. These emissions prevent energy received from the sun from being reflected back into space. The earth's temperature rises, and this leads to a wide range of overwhelmingly damaging consequences.

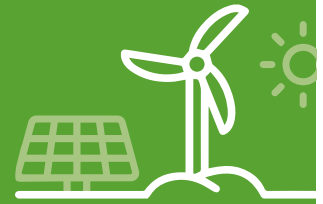
Climate change, global warming and the greenhouse effect have slightly different meanings. However, they all describe how energy from the sun warms our planet; how the earth's atmosphere (the layers of gases surrounding Earth, composed approximately of 78% nitrogen, 21% oxygen, and one percent other gases) traps some of that warmth and stops it escaping into space; and how humans have added gases to the atmosphere to make it hold more of the heat than it used to.

- Global warming refers only to the Earth's rising surface temperature.
- Climate change is the weather of an area averaged over long timescales, while weather refers to short term atmospheric conditions. Climate change is increasing the likelihood of extreme weather events so there are both chronic and acute changes.
- The greenhouse effect is a natural process, where the atmosphere and the surface of the Earth are warmed by gases in the air that capture solar energy (light energy from the sun). Some of this energy is reflected back into space, while the rest is absorbed by the land and the sea, which heats the Earth. Heat then radiates from Earth towards space. Greenhouse gases absorb the heat, trapping it in the atmosphere, keeping the Earth warm. Without greenhouse gases, this heat would escape back into space. However, human activity, such as burning fossil fuels, is increasing the amount of greenhouse gases in the atmosphere, trapping extra heat and causing the Earth's temperature to rise.

The energy supply sector is the largest contributor to global greenhouse gas emissions which cause climate change. The Welsh energy supply sector contributed 29% as the highest contributor of greenhouse gas emissions in 2018, followed by business, transport, agriculture and residential.

(Natural Resources Wales, 2020, [State of Natural Resources Report for Wales](#))

To reduce the amount of non-renewable energy we are using, the government, organisations and individuals all need to use more renewable energy and reduce our energy consumption.



### Renewable energy

is sustainable as it comes from sources that replenish themselves and can be used indefinitely. There are examples of slowly renewable energy sources, such as peat, despite it being classified as a fossil fuel in terms of its emissions. See our [Information note - Peat](#)

## What are the 5 main types of renewable energy?

This information is subject to change in line with developing technologies.

- **Wind energy** – electricity is generated by wind-powered turbines. The energy in the wind turns propeller-like blades around a rotor. The rotor is connected to a main shaft, which turns a generator to create electricity. Turbines can be placed on land or out at sea. Sea-based wind turbines tend to produce more electricity but are more expensive to build.
- **Solar energy** – we currently get about 13% of our electricity from solar energy, even though Britain is not known for its sun. Nearly half a million homes in Britain have solar panels. They work by using light energy to knock electrons free from atoms to create electricity.
- **Hydro energy** – water bodies such as rivers, lakes and the sea are used to power turbines such as Archimedes screws. These are machines made of a tube bent spirally around an axis which is used to move low lying water to generate electricity through the harnessing of water flow. Hydroelectric schemes can have a negative impact on the water system and the wider natural environment. For example, changes to water flow can cause deteriorating water quality, migration corridor barriers, sedimentation, and biodiversity loss.
- **Biomass energy** – the energy comes from burning organic matter to create electricity and gas. The most common fuels used for biomass energy production are wood, crops, waste from households, businesses and sewage. The burning of these fuels does release carbon dioxide and can have an environmental impact, but it is significantly less when compared to fossil fuels.
- **Tidal and wave energy** – tidal streams (water movements caused by forces of gravity), pass water through waterwheels which power turbines and generate electricity. Barrages (artificial barriers across a river or estuary to prevent flooding, aid irrigation or navigation, or to generate electricity by tidal power) can also be used to create tidal reservoirs, where water passes through underwater tunnels containing turbine generators. To convert wave energy into electricity the movement of the wave passes through the equipment that is situated at the sea's surface level. These systems are expensive to build and can have a positive and negative affect on the natural environment. For example, they can help reduce CO<sub>2</sub> emissions, but they can alter the movement of water which can disrupt the life cycles of certain marine life. Turbines can also kill wildlife that tries to swim through them.

## Energy and climate change

Climate change is the greatest environmental threat humanity has ever faced and the biggest challenge.

Trying to reduce the effect our energy use is having on climate change flags up three key issues. These are called the 'energy trilemma.'

1. Energy security - security of energy supply and reliability of infrastructure, uninterrupted availability of energy sources at an affordable price.
2. Energy equity - how accessible and affordable the energy supply is, affordable energy for all.
3. Environmental sustainability - moving towards renewable and low-carbon energy, avoiding depleting natural resources and compromising the future generation's ability to meet their daily needs.

To help address climate change, our energy systems need to transition from older forms of energy generation like coal stations, to emerging new technologies to achieve continuous energy productivity whilst reducing carbon usage.



Moving from one type of energy production to another (energy transition) can cause issues and can alter supply and demand (the amount of goods and services that are available, compared to the amount of goods and services that people want to buy), which can have an impact on energy reliability and costs.

The solution to this energy challenge requires us to:

- reduce energy consumption
- become more energy efficient
- invest in and increase the proportion of energy produced and used from renewables and low-carbon sources
- phase out fossil fuels

Doing this should enable us to satisfy future demand for energy without overheating the planet; energy supplies will be cleaner, and people's needs will be met more efficiently.

### Wales' energy targets

In September 2017, The Welsh Cabinet Secretary for Energy, Planning and Rural Affairs, Lesley Griffiths proposed the following targets for Wales:

- Wales to generate 70% of its electricity consumption from renewable energy by 2030
- 1GW of renewable electricity capacity in Wales to be locally owned by 2030
- By 2020 all new renewable energy projects to have at least an element of local ownership

Natural Resources Wales is working towards delivering these targets by regulating energy generation and supporting the development of renewable energy.

### For further information

- Visit Natural Resources Wales's website for more information on our [energy work](#).
- State of Natural Resources Report (SoNaRR2020) [Resource Efficiency Energy](#)
- [Wales' Global Footprint Register](#)

### Looking for more learning resources, information and data?

Please contact: [education@naturalresourceswales.gov.uk](mailto:education@naturalresourceswales.gov.uk) or go to <https://naturalresources.wales/learning>

Alternative format; large print or another language, please contact: [enquiries@naturalresourceswales.gov.uk](mailto:enquiries@naturalresourceswales.gov.uk) 0300 065 3000

