

Sustainability: Energy

Curriculum: Sustainability KA4a - Definitions

Key terms

The enhancement of the natural greenhouse effect through man-made emissions of greenhouse gases, trapping increasing quantities of heat.

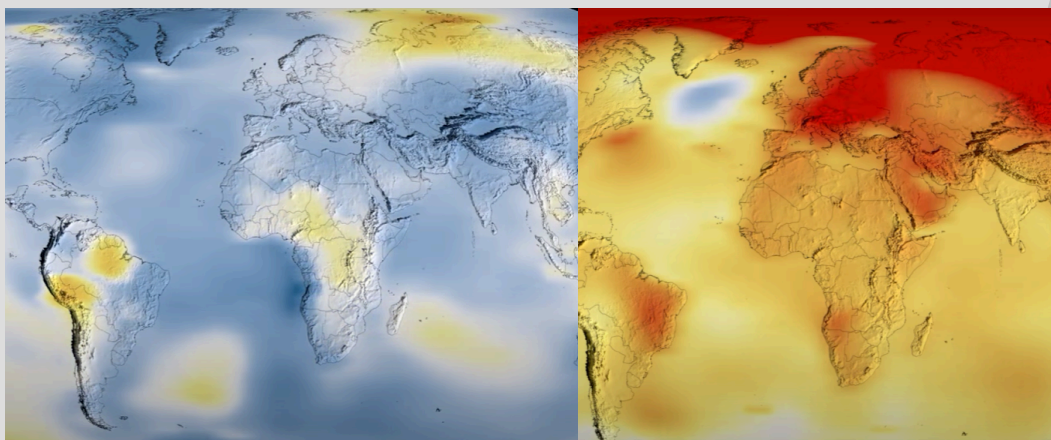
Enhanced greenhouse effect

Climate change

A large-scale, long-term shift in Earth's weather patterns or average temperatures.



What is the difference between global warming and climate change? Watch this [video](#) to observe "global warming" between 1880 and 2021. Why does this **not** show "climate change"? Use this [website](#) to learn more.



1903 - 1907

2015 - 2019

The images (left) show global warming at different time points. Above average temperatures (red) and below average temperatures (blue) are shown.

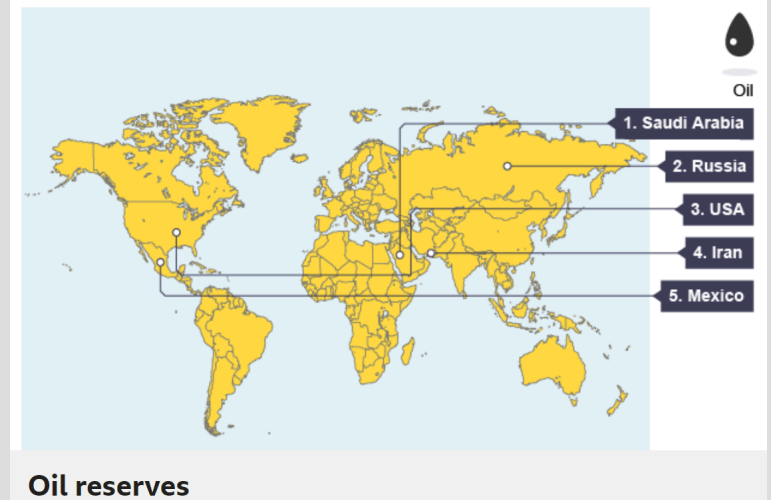
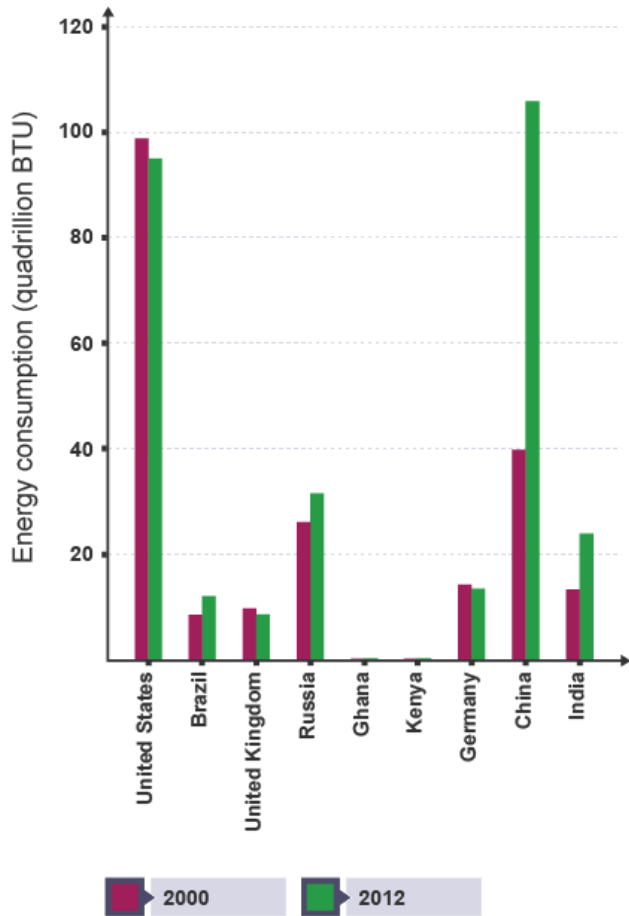
Image: NASA Goddard Space Flight Center/NASA Scientific Visualization Studio/NASA Goddard Institute for Space Studies

BBC
Bitesize



Task: Global patterns of energy supply

Global energy supply and consumption are unequal and, as the global human population continues to grow, energy sustainability is a concern for all. It is estimated that energy demands will be 56% higher in 2040 compared to 2010. Watch the video on this [webpage](#) and read the accompanying information to suggest three reasons, other than increasing population, for this increased energy demand.



About two thirds of global oil supplies are from the Middle East. Coal, natural gas and uranium reserves are expected to last from 50-112 years.

Images from [BBC Bitesize](#).



Earth at Night

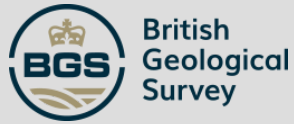
When the sun goes down and the lights turn on, there's still a lot to explore. Learn about NASA's Black Marble project and see some of the brightest places on the globe.

Images courtesy of NASA Earth Science

EXPLORE

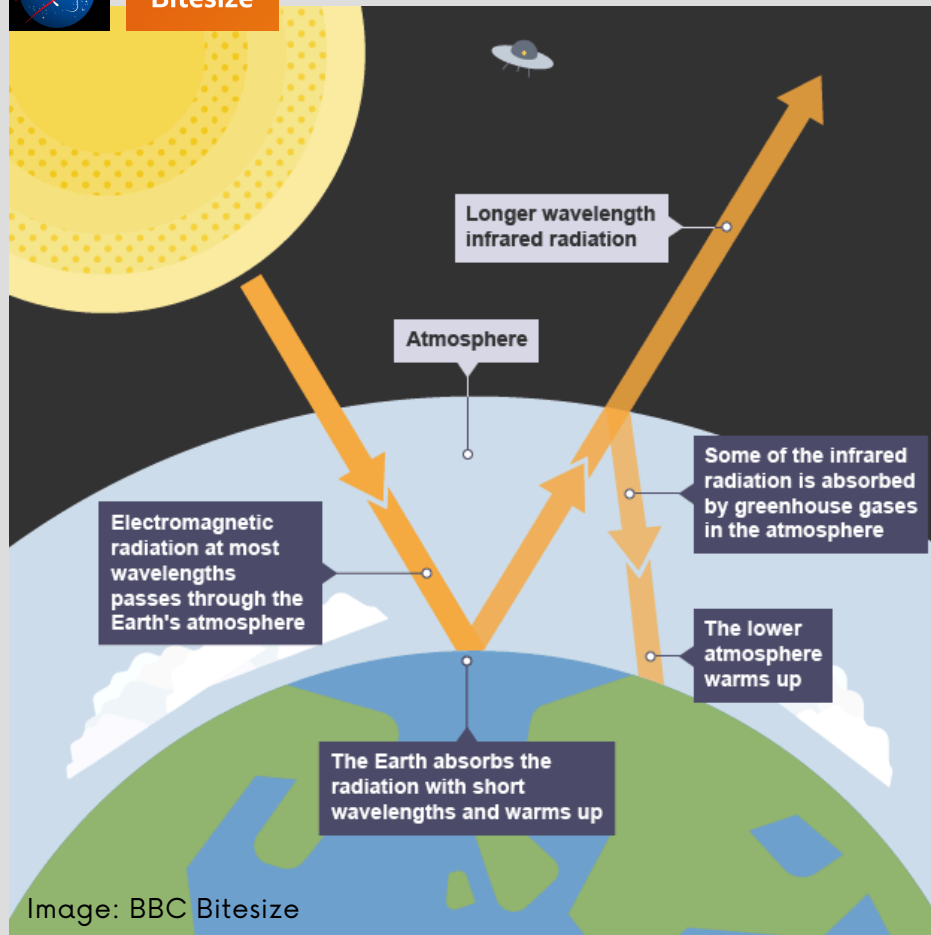
Task: Satellite images of Earth at night

Explore the growing human population by scanning satellite images of Earth at night. Click on [Explore](#) and let Google take you on a tour.



Task: Natural and Enhanced Greenhouse Effect

While some of the electromagnetic radiation from the Sun passes through Earth's atmosphere, the majority is absorbed.



The Earth radiates this energy as infrared radiation, some of which is absorbed by greenhouse gases. This energy is released in all directions resulting in the lower atmosphere and Earth's surface warming up. This "natural greenhouse effect" is crucial to sustain life on Earth. But how is it different to the "enhanced greenhouse effect"? Read this [webpage](#) from the British Geological Survey to answer this question.



The gases above are called "greenhouse gases". What are their full names, what is the source of each of them and what is the relative contribution of each to the "enhanced greenhouse effect".

These two webpages will support your research:

- [British Geological Survey](#)
- [NASA](#)

The Causes of Climate Change

Human activities are driving the global warming trend observed since the mid-20th century.

Task: "U Gotta Switch"

This is a collaborative discussion activity with practical work embedded. In teams, learners will be assigned an island with unique characteristics. Decide the most appropriate renewable energy strategy, from both an environmental and economic perspective. Click [here](#) to access and download these resources.



Welcome to the communities of

Cloudy Island

Skisdale

Surfsville

Sun City



Fact Sheet – Hydro Power

The world's leading form of renewable energy!

Small scale hydro power can be done with a water height of just a few metres; but the best drop from top to bottom is around 120m. They only need small reservoirs compared with large projects, and often can be completed much more quickly.

Micro hydro plants just use the water flowing in a stream or river.

Making your Wave Turbine

The following diagrams show the construction of the turbine. It uses 5 litre bottles.

1. What you need



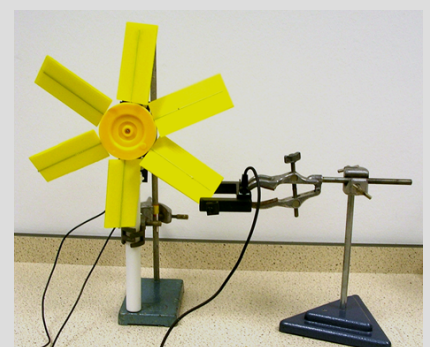
Task: Dye-sensitised solar cells

Build your own dye-sensitised solar cells using the instructions in this [resource](#). These solar cells are likely to play an important role in energy production of the future. With the possibility of cheap, flexible and durable solar cells, this technology is surely going to become ubiquitous for small scale electricity generation.



Task: Investigating wind energy

[Use this resource to investigate the effect of wind speed on the output from a wind turbine. Access the resources via this webpage.](#)

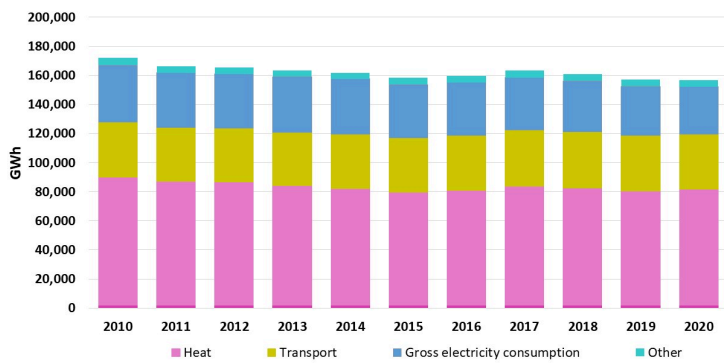




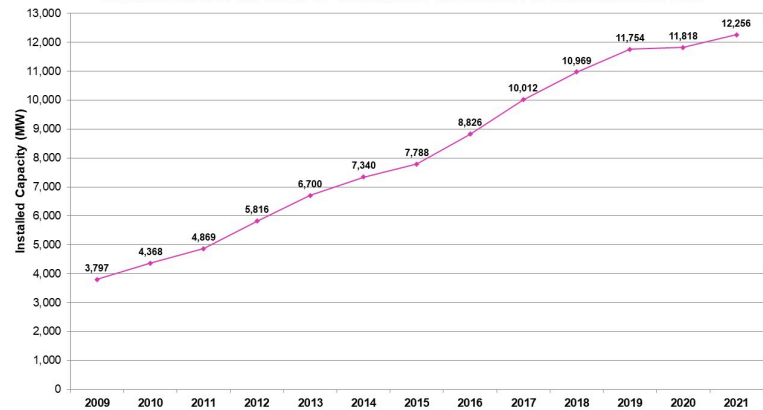
Task: Renewables in Scotland

Over the past 10 years, overall energy consumption in Scotland has slightly decreased from 170,000GWh (2010) to 155,000GWh (2020); 51.5% of Scottish energy consumption is from the heat sector, 24.5% from transport sector, 21% electricity sector (left graph). Data from [here](#).

ENERGY CONSUMPTION BY SECTOR 2010-2020 (GWh)

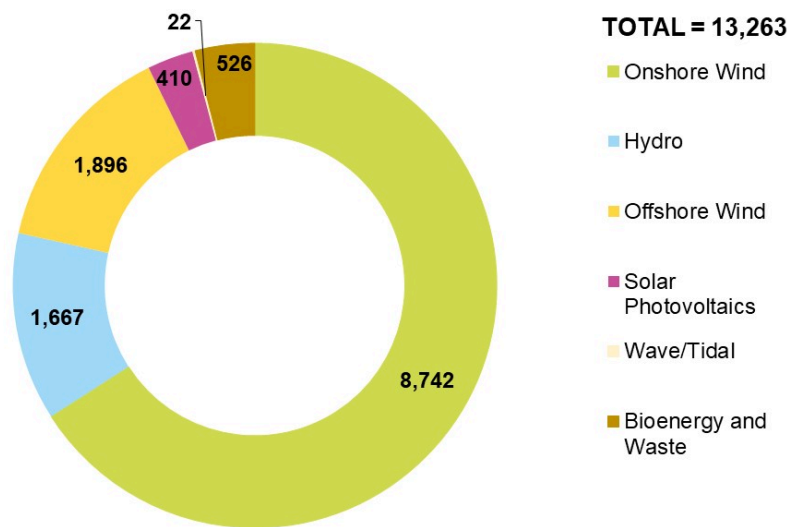


TOTAL INSTALLED CAPACITY OF RENEWABLE ELECTRICITY IN SCOTLAND 2009-2021



Over the past decade, Scotland has increased its renewable electricity capacity (above, right: source [here](#)) - the sector is 3x bigger than it was 10 years ago. The pie chart (right) shows the technology used for renewable electricity generation in Scotland, the largest contributor being onshore wind (66% of installed capacity).

CURRENT INSTALLED CAPACITY BY TECHNOLOGY Q1 2022 (MW)



What impact has this had on greenhouse gas emissions? Visit the [Scottish Renewables website](#) and look at Chart 8 and 9. What do these show?

This data accounts for renewable electricity generation but what about the heat sector? Currently, this sector is the largest energy consumer. How can fossil fuels be replaced by renewable energy sources in this sector?

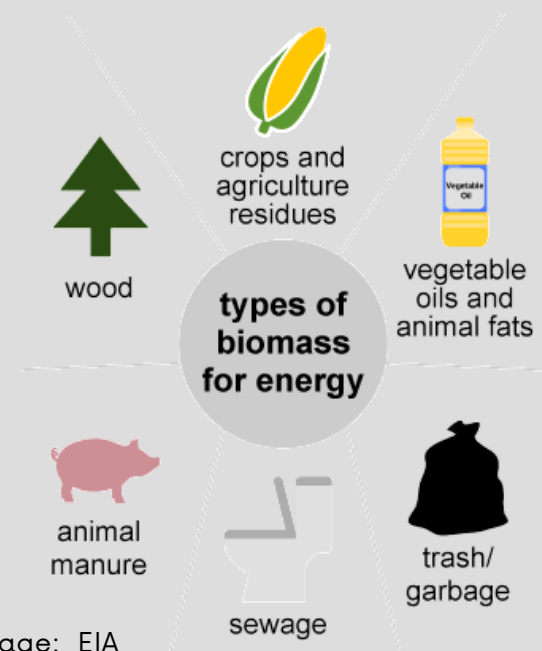


Image: [EIA](#)



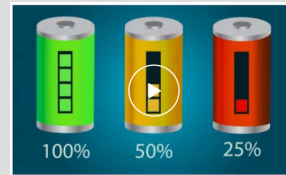
Task: Renewables energy sources across the UK

The electricity sector is in a period of profound change. The rapid expansion of low-cost renewables has created massive opportunities for decarbonising the sector. We need to meet a huge increase in the demand for electricity, reach ambitious energy security and climate change targets.

Deputy Director, Energy UK



The Naked Scientists podcast put together four episodes on renewable energy: wind, solar, hydro and storing energy. The full transcripts for the episodes are available [here](#), with a breakdown of episode content to listen to discrete parts more conveniently.



Storing Energy: What does the Future Hold?

14 June 2022

Renewable energy is part of the solution, but efficiently storing and distributing electricity are priorities too...

▶ PLAY Ⓞ DOWNLOAD



Winding up Wind Power

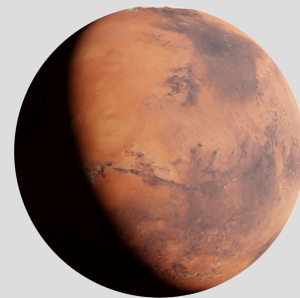
07 June 2022

Is breeze energy blowing us all away? Or are we throwing caution to the wind?

▶ PLAY Ⓞ DOWNLOAD

e.on Task: Power on Mars

The Mars One Project and NASA are looking to set up a human settlement on Mars in the next 10-20 years. But how would they generate power on Mars? Use this resource to develop your own ideas to solve this challenge. Click on the files icon to download the resource.



Renewable energy source

Wind power

Solar power

Hydroelectric power

Wave power

Tidal power

Geothermal

Biomass

Task: Renewable energy sources

This resource from BP Educational Service includes an up-to-date knowledge organiser comparing non-renewable and renewable energy. There is also a [career section](#) on their website with videos about different roles.



Science at work

Physics knowledge organiser: Renewable energy sources Ages 14-16

Renewable energy source	How it works	Advantages	Disadvantages
Wind power	Wind turbines are exposed places on land and at sea generate to have wind electricity.	• Operates with fewer than any other renewable that can produce the set amount • No fuel costs and low running costs	• High manufacturing and implementation costs • Wind and noise pollution • Weather dependent - needs wind
Solar power	Water cells use energy from sunlight to generate electricity. Cells are grouped in solar farms.	• Operates with fewer than any other renewable that can produce the set amount • No fuel costs and low running costs • Relatively low manufacturing costs • Can give a single source of electricity locally • Cheap to produce and easy to install	• Solar panels have a life span of around 20 years • Solar cells produce a relatively small amount of electricity, solar farms can require a lot of space • Weather - some dependent - solar panels are more effective in areas with high rainfall
Hydroelectric power	Mass falling water reservoir that collects behind a dam causes through turbines to generate electricity.	• Operates with fewer than any other renewable that can produce the set amount • No fuel costs and low running costs • Can give a single source of electricity locally • Cheap to produce and easy to install	• High manufacturing and implementation costs • High environmental impact due to flooding of the valley and habitat loss • Only works in hilly areas with high rainfall
Wave power	As waves come to shore, they form an area of small turbines to generate electricity.	• Operates with fewer than any other renewable that can produce the set amount • No fuel costs and low running costs • Can give a single source of electricity locally • Cheap to produce and easy to install	• High manufacturing and implementation costs • High environmental impact due to flooding of the valley and habitat loss • Only works in hilly areas with high rainfall
Tidal power	A tidal barrage to dam with turbines in it to generate a power station. As the tide comes in, the water flows through the turbines and generates electricity.	• Operates with fewer than any other renewable that can produce the set amount • No fuel costs and low running costs • Can give a single source of electricity locally • Cheap to produce and easy to install	• High manufacturing and implementation costs • High environmental impact due to flooding of the valley and habitat loss • Only works in hilly areas with high rainfall
Geothermal			

How to use this knowledge organiser

1. What are non-renewable and renewable energy sources?

2. How are the energy sources we use changing?

3. What's the Paris Agreement?

4. How will the rise of renewables affect future jobs?

Go further

Page 2/2 | bp.com/one

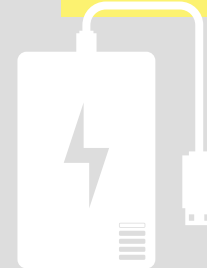


e-on Task: Energy Wasters

This resource from E-on encourages learners to think about energy waste in their own lives. Learners will design "energy hacks" that reduce energy use and save money, with prompts to post their hacks on social media. Click on the files icon for the resource.

Interested in this? You could be...

- A mechanical engineer - develop products (of all sizes) around the world to solve problems
- An electrical engineer - design and develop new electrical equipment, solve problems and test equipment
- A materials scientist - study and analyse chemical properties of different man-made and natural materials.



Did you know?

Energy cannot be created or destroyed, only transferred from one form to another. When we talk about wasting energy, we mean the energy is being transferred to our surroundings - which makes it difficult to do anything useful with it, and we still pay for this energy, both in terms of money and in carbon emissions.



Task: Greenest Church in Scotland

With a Climate Challenge Fund grant, Gate Church in Dundee launched their Carbon Saving Project. Watch the [video](#) and visit this [webpage](#) of their site to list all the energy efficiency improvements the church has made. Who did these changes benefit?

GATE CHURCH CARBON SAVING PROJECT



Task: Climate Heroes

Click on the file icon above to learn about Scotland's Climate Heroes - volunteers who have supported their communities to grow local food, tackle waste, support sustainable travel and help others develop new skills. From pages 6-17, chose one climate hero and explain how their work promotes a sustainable use of energy.

A sustainable approach to getting from A to B. How do we do that?

- Encourage more people to walk or cycle
- Use public transport
- Avoid using private cars
- Transfer freight using rail or sea, rather than road

Transform Scotland state that these measures will "benefit the economy, improve the nation's health, reduce emissions, and be accessible and affordable for all". In groups, put together an action plan for how this could be achieved? What would persuade your family to walk/cycle more, rather than use the car?

Click [here](#) to access some ideas to guide you.



In 2019, the UK Government committed to the Net Zero Greenhouse Gas (GHG) emissions target that was recommended by the Climate Change Committee. But this requires significant change.



What changes are needed?

Image: Climate Change Committee

- resource and energy efficiency, that reduce demand for energy across the economy
- societal choices that lead to a lower demand for carbon-intensive activities
- extensive electrification, particularly of transport and heating, supported by a major expansion of renewable and other low-carbon power generation
- development of a hydrogen economy to service demands for some industrial processes, for energy-dense applications in long-distance HGVs and ships, and for electricity and heating in peak periods
- carbon capture and storage (CCS) in industry, with bioenergy (for GHG removal from the atmosphere), and very likely for hydrogen and electricity production.

What sustainable approaches can individuals take to support these changes?
Click [here](#) to start your research.

