

Session 5: Teachers Notes

Renewable energy

This session looks at how various technologies can be used to harness natural, renewable energy. The session looks at all the major types of renewable energy, and there are practical demonstrations of solar PV, solar hot water and wind power.

1. Renewable energy - definition

Renewable energy is obtained from sources that are essentially inexhaustible, unlike fossil fuels, of which there is a finite supply. The main sources of renewable energy are sunlight, wind, water and biomass.

Renewable energy does not emit CO₂ at the point of electricity generation.

At the moment it's NOT as simple as 'renewables are good, fossil fuels are bad'. All energy sources have their pros and cons. You need to weigh up their convenience and availability as well as the full financial cost and environmental impact of getting energy from where it's produced to where it's needed. Some renewable energy schemes have sparked international controversy, for example the Three Gorges dam project in China. These issues can be an interesting area for discussion, but they are outside the scope of the Climate Action Programme.

The following notes outline some of the renewable technologies that are available and which feature in this session.

2. Solar photovoltaic panels

Solar photovoltaic panels use cells to convert solar radiation into electricity. "Photovoltaic" come from the words photo pertaining to light and voltaic pertaining to electricity. They are usually known as PV Panels.

PV cells are made up of layers of silicon, which is a semi conducting material. This means when light shines on the cell it produces an electrical field across the layers. The more intense the light the greater the amount of electricity created. In basic terms, light excites electrons in the silicon that creates a flow of electricity.

PV panels can be built at many scales, from very small panels in calculators to roof-mounted panels on homes and huge arrays generating significant amounts of energy.



Domestic Solar PV system



Solar PV array, Las Vegas

To work best, solar PV panels need to be south facing (SE or SW will do) with minimal shading from trees, chimneys and other buildings. The panels work most efficiently when angled at 35-40 degrees (the normal angle of a roof).

Roof-mounted solar panels can be added to an existing roof or be integrated as part of the tiles. A reasonable system would cost approx. £7,000.

3. Solar hot water panels

The other sort of solar panels provide hot water, so are called hot water or thermal panels. The simple principal is that the sun heats up a fluid as it passes through the panel, which then passes through a heat exchanger, to heat water.

There are many designs some of which are more efficient than others at heating the fluid. Common elements of the designs are that they are dark coloured, to absorb heat, and usually covered with clear glass to allow sunlight to enter.

In the UK hot water panels generally work well in summer and can provide up to 100% of hot water needs. In the winter this can vary between 10-50%.

As with PV panels, they work best when angled at 35-40 degrees and out of the shade.

4. Wind turbines

The force of the wind is used to turn aerodynamic blades that drive a generator to produce electricity.

Wind turbines are made in various sizes, from relatively small roof-mounted turbines, to medium-sized turbines used to provide power for individual buildings, to the familiar large white turbines, found in wind farms.

Wind farms:

Wind farms are sites where several wind turbines are located together. The construction of wind farms is arguably the most controversial aspects of

renewable energy sources mainly because of their visual impact. High wind speeds are usually found in upland areas, which are often seen as the most “untouched” and beautiful parts of the landscape. This aspect of wind power often divides opinion, because other people may find wind farms attractive and like to see that electricity is being generated in a sustainable way. This can be an interesting topic for discussion in this session.

Wind farms can be built on-shore (on land) or offshore (out at sea). On-shore wind farms have traditionally been favoured because the required engineering and infrastructure is more straightforward. Offshore wind farms are now being developed, and in 2006, the government gave planning consent for the world's largest offshore wind farm that will be built 12 miles off the Kent coast and will include 341 turbines.

The UK has the best “wind resource” in Europe, which means that there are good, reliable wind speeds in many parts of the country. This makes the UK an attractive option for wind farm developers.

5. Biomass

Logs, wood chips or pellets are used in a modern efficient burner to provide heat. The fuel can be grown specifically or produced using waste products from other activities like forest management.

A smaller system could simply be a wood-burning stove fuelled by logs used to heat a specific room. Larger boilers can be automated and connected to the central heating and hot water system; these would use wood chips or pellets.

Burning wood fuel is carbon neutral; the carbon dioxide released during burning is equal to the amount absorbed during growth.

Wooden waste products can be saved from going to landfill. Buying wood fuel can contribute to local employment.

6. Ground Source Heat Pumps

Solar heat stored in the ground is drawn up, concentrated and transferred to the building.

If you put your hand round the back of a fridge or freezer, it is warm because the heat has been drawn out of the appliance. The same principle lies behind a heat pump.

Below about 6 feet, the ground is at a constant temperature.

The process requires electricity to run a compressor but it is so efficient that for each unit of electricity used, 3 - 4 units of heat are produced.

7. Hydro-electricity

Hydro-electric power uses flowing water to turn turbines that power generators to generate electricity.

By building a dam across a large river it is possible to create a huge store of potential energy, which can be tapped when needed by allowing the water to fall through the dam. Falling water has energy that can be harnessed using a hydroelectric power plant.

As with wind power, hydro electricity systems can come at a range of scales from small domestic installations to massive dams and power stations.

Domestic installations are not common, as the property must be suitable. Old watermills are ideal, as there is likely to be a good supply of water available to turn the turbine, and some form of infrastructure that could be adapted for the new use. In the UK, large-scale schemes are only common in upland areas, where dams can be constructed and there is a lot of water, for example in the Scottish Highlands.

Some of the largest engineering projects in the world are hydro-electricity dams, for example the Hoover dam in the US.



The Hoover Dam, Colorado River, Nevada

Like wind power, some large hydro-electric schemes can be controversial, because of their ecological impact.

8. Wave power

Wave power uses the flow of waves to turn turbines directly, or to force air through a shaft that turns the turbine.

Wave power plants can either be built out at sea or on the shore.

A good example of a land based wave power plant is the “Limpet” on the Scottish island Islay



The “Limpet 500”, Islay

9. Tidal power

Tidal power is a form of hydroelectricity that uses the movement of the tide to turn the turbines.

There are two systems in use. The first uses a barrage that traps in or out-flowing water, creating a difference in water height that can be exploited to turn turbines.

The other uses the actual flow of the tide to directly turn turbines like an underwater wind turbine.

An example of the barrage type is on the Rance River, France. A barrage is proposed for the Severn Estuary.



Rance tidal barrage, France

10. Large scale renewable energy in the UK

The United Kingdom government, has a target for 10% of domestic energy to be generated from renewable sources by the year 2010.

In 2005, renewable energy accounted for 4.2% of all electricity generated in the UK. Wind power accounted for 17% of this total, and hydropower 28%.

11. Solar Car Kits

The PV panel used in the car is a lightweight flexible panel that is an advance in technology that has allowed them to be used in outdoor adventure and survival equipment.

The car kits are worth £32 each please make sure they are treated with respect by the students. The charity that makes the solar cars has more information on their website www.pluggingintothesun.org.uk.