

Wood is a renewable source of energy. Could we use wood to generate electricity in the UK, and what are the advantages and disadvantages?

Tree power

• A useful website is: <http://www.woodfuelresource.org.uk>

Humans have been using the warmth and light from wood fires for hundreds of thousands of years. Even now up to half the people in the world cook their food on open fires. Wood fuel is news again now because it is a renewable source of energy. At present almost all our energy comes from fossil fuels and in the long term these will run out. Burning fossil fuels also releases carbon dioxide and contributes to global climate change. We need to replace them with renewable and more sustainable sources of power.

The government has set a target for 10% of our electricity to be generated from renewable sources by 2010. At present, renewables supply only 1.5% of UK electricity.

• A tree weighs several tonnes. About half this mass is carbon. Where have the carbon atoms come from?

Biomass

Trees are made of **biomass**. This term covers material from both plants and animals. Wood, straw, animal dung and domestic refuse are all biomass fuels.

Biomass stores energy from the Sun. Chemical reactions harness the energy in sunlight to synthesise



energy-rich compounds. This is the process of **photosynthesis**. Carbon dioxide from the air and water from the ground are combined in this process to make the carbohydrates that are the main building blocks of biomass. When biomass is burnt the carbohydrates react with oxygen from the air to make

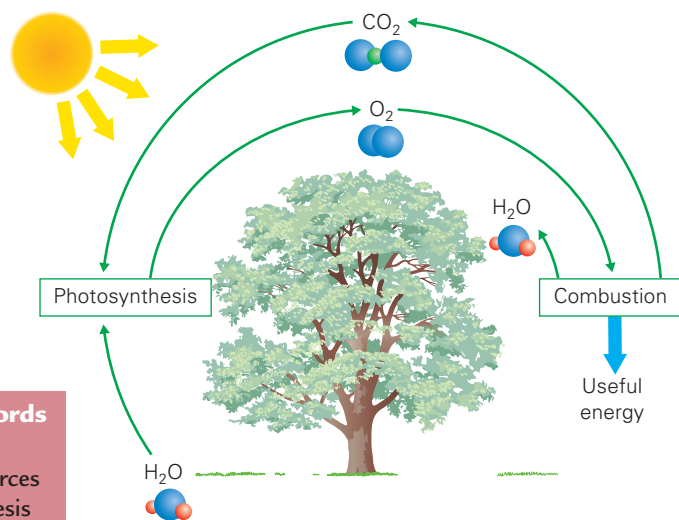


Figure 1 When it burns, wood fuel gives off only the carbon dioxide it took from the atmosphere when it grew

Box 1 Renewable and sustainable energy sources

Wind, wave, tidal, solar voltaics (PV), hydro, geothermal and biomass are all renewable energy sources. They are called **renewable** because they do not get used up. However they have another very important advantage over fossil fuels. They do not increase the amount of the greenhouse gas, carbon dioxide, in the atmosphere.

Nowadays the word **sustainable** is often used in connection with renewable energy sources. To be sustainable, an energy source must not run out, damage the environment, create health hazards or cause wars or social injustice. A sustainable energy source is one whose use now will not make it more difficult for future generations to meet their needs.

GCSE key words

Biomass
Energy resources
Photosynthesis
Renewables
Sustainability



Sean Sprague/Still Pictures

Wood is a source of energy for many people around the world, including this family in Guatemala

carbon dioxide and water again. The biomass gives off *only* the carbon dioxide it took from the atmosphere when it was growing (Figure 1). If the forests that supply the fuel wood are replanted at the same rate they are cut down then the wood is a renewable energy source.

Have we got wood to burn?

About 9% of the total land area of Great Britain is woodland. This could give a sustainable yield of nearly 700 000 tonnes of air-dried wood per year. In the past, wood was harvested as the raw material for making paper but the paper industry has shifted overseas. We also import timber for the building

Table 1 Energy content of fuels

Fuel	Energy content (kJ/g)
Wood (air-dried)	15
Paper (stacked newspapers)	17
Dung (dried)	16
Straw	14
Domestic refuse	9
Oil	42
Coal	28
Natural gas	55



Chris Knapton/SPL

Box 2 Growing energy

The best energy crop for northern European conditions is coppiced willow. Saplings are planted and, after 1 year, cut back close to the ground. This is called **coppicing**, and it stimulates several new woody stems to grow. The crop is allowed to grow for 2–4 years and then the stems are cut. The plant will grow more stems so the cycle is repeated. One hectare of land can produce 10 tonnes of air-dried wood per year.

Above: Coppice plantations like this can provide new habitats and encourage biodiversity. They need smaller amounts of agricultural chemicals than arable crops

industry, so today we only harvest half the yearly growth of wood from our forests.

Table 1 shows that wood is a less concentrated store of energy than any of the fossil fuels. Because it is bulky the use of wood increases lorry traffic. However, a wood-fuel industry could help to create jobs in the countryside.

Converting wood energy into heat and electricity

Domestic and community heating projects are already using the thinnings and trimmings from existing woods and forests. Landowners and farmers are increasing the supply of wood fuel by growing ‘energy crops’ like willow or poplar. The wood-fired heating system at Weobley School in Herefordshire uses 150–300 tonnes of wood chips every year.

There is debate about whether we have enough land to grow sufficient energy crops.

Below: The 350 kW boiler at Weobley School in Herefordshire was installed in 1998 to heat the primary school, the adjacent secondary school and the schools’ swimming pool

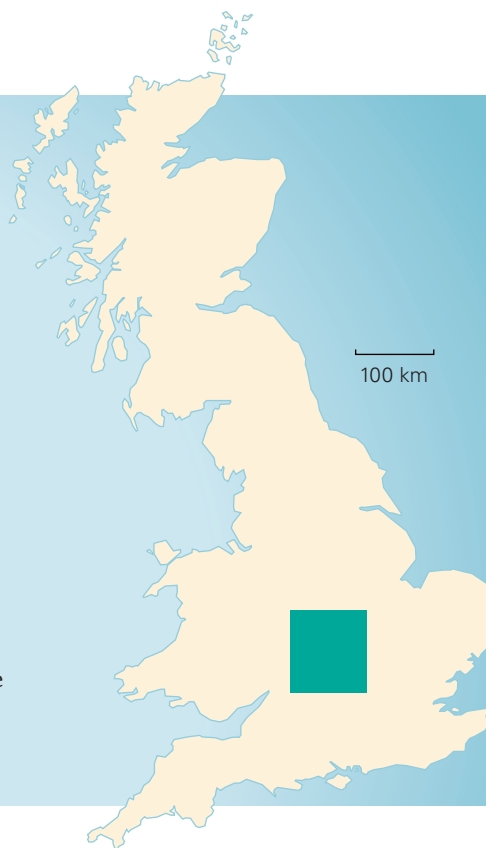


Weobley School

Box 3 How much electricity could energy crops produce?

Energy crops can be grown on farmland that is not needed for food. The area could be 1 million hectares by 2010. This is 10 000 km², about half the area of Wales (see map).

By 2010 energy crops *could* generate 1000–2000 MW. This is less than 2% of our electricity. In the long term, if 10% of the farmed area of the UK were to be planted with willows for coppicing, 9000 MW could be produced, enough for two large cities.



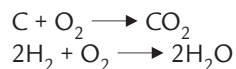
Purpose-built biomass power stations that generate electricity from wood burning are being planned and built. Wood can also be burnt in combination with coal (co-firing) in existing power stations.

Gasification and turbines

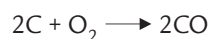
Today the furnaces that burn wood for space heating are clean and efficient. But when it comes to generating electricity the favoured method is more hi-tech. Biomass is converted to power in an IGCC (integrated gasification combined cycle) power plant.

Gasification is a combustion process in which the reaction is 'starved' of oxygen so that it is not completely oxidised. Wood is mainly composed of carbon, hydrogen and oxygen. If it is oxidised

completely the carbon and the hydrogen atoms form carbon dioxide and water:



During gasification wood fuel is heated with a mixture of gases and air in a sealed container. The mixture doesn't contain enough oxygen for all the carbon and hydrogen atoms to be completely oxidised. The overall reaction with the carbon atoms is:



The gas produced is mainly carbon monoxide with some hydrogen, hydrocarbon gases and nitrogen. Tar and ash, formed as by-products, are washed out of the mixture. The gas can still burn and is now the fuel for a combined cycle gas turbine (CCGT) plant.

In these power plants the hot gases produced by burning the carbon monoxide turn the first turbine. They then also heat a boiler to make steam, which drives a second turbine. Both turbines turn generators, which produce electricity. Combining them makes the system very energy efficient.

Carbon monoxide is a deadly poison but good engineering and good practice at the plant make the risks negligible. IGCC is a clean technology.

The ARBRE project

ARBRE stands for ARable Biomass Renewable Energy. The project was set up in Yorkshire. It was a prototype for a 10 MW IGCC plant, using forest residues and energy crops. The hope was that it would be the first of many for Britain.

The plan was to fuel the plant with forest residues at first and then switch to coppiced willow. By May 2000 some 500 hectares had been planted, with a further 625 hectares to be established within the year. There were many difficulties. Farmers were reluctant to grow willow, harvesting was difficult and expensive. At the end of May 2003, Yorkshire Water, the owners and instigators of the ARBRE project, sold the company, and it was shut down. The plant had produced electricity for just 8 days.

The future

Wind power provides the largest share of renewable electricity. But there are days when there is hardly any wind across the whole of the UK (this happened for a few days during the cold spell in January 2003). It is essential to have other types of power station to back up windfarms on windless days.

Power stations fuelled by wood and other types of biomass have the great advantage of being able to generate electricity on demand. The failure of the ARBRE project was a setback, but new projects must be encouraged. Energy crops are both green and flexible.

Janet Taylor is a science teacher and has contributed to many websites and textbooks.

Below: During the Second World War there was a shortage of petrol and 1 million vehicles ran on gas from wood or charcoal. Here mechanics are fitting a gas-producing unit to a car



Topfoto