



## Are Biofuels Carbon Neutral?

To succeed in this topic you need to understand:

- why plants use carbon dioxide in photosynthesis
- why we need to find alternatives to fossil fuels
- what global warming is and the effect it may have on the Earth's climate

After working through this Factsheet you will be able to:

- state the meaning of the term biofuel
- explain the environmental impact of biofuels
- explain the phrase 'carbon neutral'
- assess the claim that biofuels are carbon neutral

### What are biofuels?

Biofuels are fuels made from biological matter. Some biofuels, like wood and charcoal, have been used for thousands of years. Biofuels can be produced from animal products, but are most often made from plants such as sugar cane, wheat, maize and palm oil. They can also be produced from waste matter such as wood, manure, cooking oil and other food waste.

The two biofuels commonly used in cars and lorries are biodiesel and bioethanol (Table 1). Both are normally sold as a mixture with conventional diesel or petrol and can be used in engines without any modification.

Table 1. Comparison of bioethanol and biodiesel

	Bioethanol	Biodiesel
Raw materials	Sugar cane, sugar beet.	Vegetable oil.
How is it made?	Fermentation.	Reaction with an alcohol (e.g. methanol) and hydrochloric acid.
Where is it used?	In cars, as a mixture with petrol. Bioethanol has been widely used in Brazil for over 20 years.	In cars, buses and vans, as a mixture with diesel.
How widely available is it?	Increasingly available in the UK.	Can be home-made. Is available from some petrol stations.

### Why are scientists investigating biofuels?

There are a number of reasons why scientists are investigating the use of biofuels. Firstly, because plant crops are used to make biofuels, they are renewable. In theory, therefore, we have an unlimited supply of biofuels. This is advantageous because conventional fuels are, of course, fossil fuels and have a limited supply. Indeed, it is predicted that shortages of fossil fuels will be apparent before the end of the century.

Next, fossil fuels are also subject to political issues over their control and distribution. In contrast, the production and supply of biofuels are not restricted to just a few countries, since many different crops can be grown worldwide to supply the raw materials.

Finally, as the crops used to make biofuels grow, they absorb carbon dioxide for photosynthesis from the atmosphere. This is a major advantage compared to fossil fuels. Don't forget, though, that both types of fuel still release carbon dioxide when burned. Biofuels have the potential to make a significant contribution to limiting climate change and our dependence on fossil fuels. The European Union has set a target that, by 2020, 10% of all fuel used in transport will be biofuel.

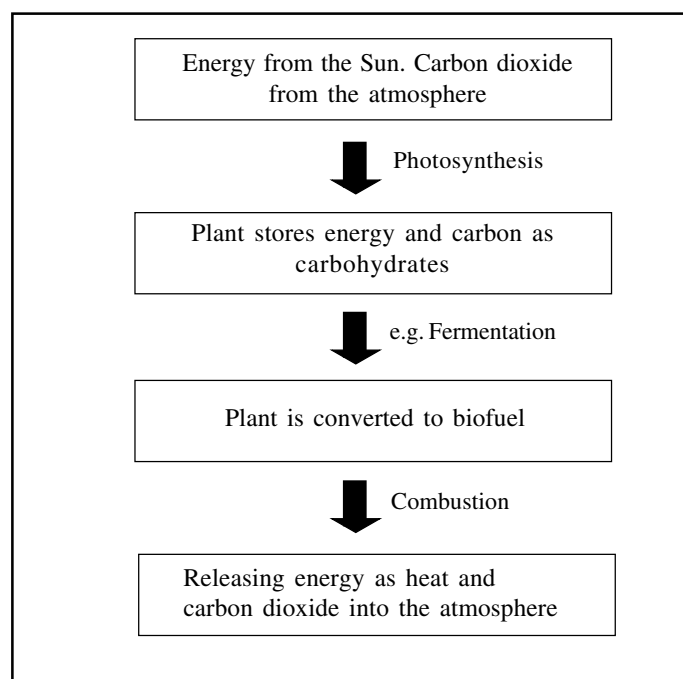
### What is carbon neutral?

Something that is carbon neutral leads to no net increase in atmospheric carbon dioxide. For example, a manufacturing company might calculate its carbon dioxide emissions from energy use and transport. It could then plant trees around its site, ensuring that the number of trees planted will absorb an equivalent amount of carbon dioxide. Overall, the company would not (in theory) make any *net* carbon dioxide emissions, since the growing trees effectively absorb any carbon dioxide emitted by burning fossil fuels.

### Why are biofuels said to be carbon neutral?

Biofuels are said to be carbon neutral because, although they release carbon dioxide when burned, they also absorb carbon dioxide as they grow. If the plant matter was entirely converted to fuel, and then completely combusted, it would release the same amount of carbon dioxide as it had absorbed, leading to no net increase in atmospheric carbon dioxide. This is summarised in Fig 1.

Fig 1. Absorption and release of carbon dioxide by biofuels



**Are biofuels really carbon neutral?**

Although biofuel crops absorb carbon dioxide as they grow, they cannot be truly carbon neutral. Fossil fuels are still used at every stage of their production, including planting seeds, harvesting crops, refining and transporting the fuel. Each time a fossil fuel is used, some carbon dioxide is released which is not offset by the growth of the biofuel crop.

One of the major contributors to fossil fuel use is in the synthesis of fertilisers for growing the crops. It is estimated, for example, that the production of bioethanol from maize uses about 30% more energy than the finished fuel contains, because it requires large amounts of fertiliser. Bioethanol from sugar cane is much closer to carbon neutral, but still requires more energy for its production than is contained in the fuel.

Another problem with biofuels is the land needed to grow the crops. In some tropical countries, rainforest has been cleared for biofuel crop growth. In other countries, crops which were previously grown for food, such as wheat, are now grown for biofuel.

**Summary**

Table 2 summarises the major advantages and disadvantages of biofuels.

**Table 2: Advantages and disadvantages of biofuels**

Advantages	Disadvantages
<ul style="list-style-type: none"> <li>• Renewable</li> <li>• Can be made from food and plant waste</li> <li>• Less subject to political controls</li> <li>• Plants providing biofuels absorb carbon dioxide as they grow</li> <li>• Engines can burn biofuels without adaptation</li> </ul>	<ul style="list-style-type: none"> <li>• Fossil fuels are used to plant, harvest, refine and transport the fuel</li> <li>• Need space to grow, leading to habitat destruction and loss of food crops</li> <li>• Use fertilisers when growing</li> <li>• Currently must be mixed with fossil fuels when used</li> </ul>

Although there is some controversy about the increasing use of biofuels, mainly due to the space needed for their growth, on balance they are environmentally preferable to fossil fuels. This is because they are renewable and have lower net carbon dioxide emissions than fossil fuels, especially as the processes used to convert plant matter into fuels continue to develop and become more energy efficient.

**Practice Questions**

1. Define these terms: (a) fuel; (b) biofuel; (c) carbon neutral.
2. State the names of three biofuels.
3. What are the raw materials for: (a) biodiesel; (b) bioethanol?
4. What is the name of the process by which bioethanol is produced from its raw material?
5. State three advantages of biofuels over fossil fuels.
6. Why do some people say that biofuels are carbon neutral?
7. In what way are biofuels not carbon neutral?

**Answers**

1. (a) A fuel is a substance that is burned to provide useful heat energy; (b) A biofuel is a fuel which is derived from plant or animal matter; (c) Carbon neutral is any process or product which contributes no net gain in carbon dioxide to the atmosphere.
2. The most common biofuels are wood, charcoal, bioethanol and biodiesel.
3. (a) Biodiesel is made from vegetable oils; (b) bioethanol is made from sugar.
4. Fermentation.
5. Biofuels are renewable, they are not subject to political controls, they can be made from a variety of crops and waste materials, and the crops they are made from absorb carbon dioxide as they grow.
6. Biofuels might be said to be carbon neutral because, although they release carbon dioxide on burning, the plants producing the fuel absorb it as they grow.
7. Biofuels are not carbon neutral because fossil fuels are required to plant and harvest the crops, to make fertilisers, and to process, refine and transport the fuel.