

BIODIESEL FROM 'OILY' PLANTS

*Current
biofuel*

What is biodiesel?



Biodiesel is a biofuel that can be blended with normal diesel.

Biodiesel can be made from oils which have been extracted from plants such as palm, soybean, oilseed rape, or sunflower.

What are the advantages of biodiesel and current biodiesel production?

Biodiesel has several advantages. Firstly, it is a renewable fuel. The plant material from which it is made can be replenished.

Running a vehicle on a mix of biodiesel and normal diesel (20% biodiesel and 80% normal diesel) gives off lower emissions of harmful pollutants, compared to using diesel alone. This could improve air quality and reduce health problems caused by pollution.

If biodiesel is of good enough quality it can be used in cars without the need to change the engine or car design.

Some vehicles can even run on pure vegetable oil so there is no need to blend it with normal diesel at all. The vegetable oil can be used for cooking first, and then be used as a biofuel as long as the water and wastes have been removed.

What are the disadvantages of biodiesel and current biodiesel production?

Biodiesel has a lower energy density than fossil fuel equivalents. This means motorists are able to drive fewer miles on a litre of biodiesel compared with a litre of normal car fuel.

Biodiesel is commonly derived from palm oil; in certain parts of the world, the use of oil palm plantations has been associated with deforestation, where many trees are cleared from forest land in order to plant the trees. The increase in greenhouse gases created by forest fires, or by cutting down trees can mean that more greenhouse gases are created as a result, not less!

The forests are home to many species of wildlife, including birds and butterflies, which may be lost when the forests are cleared. It is thought that deforestation in Malaysia, driven by oil palm plantation expansion, may lead to the extinction of rare species which live in the forests, such as the orang-utan of Borneo (the island split between Malaysia, Indonesia and Brunei).

Poor working conditions for farmers working on the oil palm plantations are another problem. There are also reports of palm oil producers taking over large parts of land where local people live and farm, thus depriving them of their homes and resources.

BIOETHANOL FROM FOOD CROPS

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What is bioethanol?



Bioethanol can be used to blend with petrol.

Bioethanol can be made from the sugary and starchy parts of crops such as sugar cane, corn or wheat.

What are the advantages of bioethanol and current bioethanol production?

Like biodiesel, bioethanol is a renewable fuel. The plant material from which it is made can be replenished.

Bioethanol is the most commonly produced biofuel in the world, and its largest producers are the US and Brazil from corn and sugar cane respectively. To be used as a fuel, bioethanol must be mixed with petrol, and typically a mixture will contain 10% bioethanol and 90% petrol.

Ethanol produced from sugar cane in Brazil has been found to produce at least 50 percent less greenhouse gas emissions compared with their fossil fuel equivalent, although the calculation of greenhouse gases is a controversial area of science.

What are the disadvantages of bioethanol and current bioethanol production?

Bioethanol cannot be used as a fuel on its own – it can only make up 10% of a fuel. If we wanted to use more bioethanol than that, we would have to change the design of car engines. Bioethanol absorbs water from the atmosphere and so cannot be used 'neat'.

Bioethanol has a lower energy density than fossil fuel equivalents, so motorists are able to drive fewer miles on a litre of bioethanol compared with a litre of normal car fuel.

Bioethanol made from corn in the US has been blamed for driving up the price of corn and other grains in developing countries, by diverting corn and land away from food production. In Brazil, many people are worried that people who work on the sugar cane plantations are forced to work in unhealthy conditions, and that employers may be using child labour.

BIOGAS*Current
biofuel***What is biogas?**

Biogas is a mixture of methane and carbon dioxide gases.

It is produced when microorganisms digest waste material from plants or animals in the absence of oxygen (anaerobic digestion). When biogas is burned, the energy released can be used to generate heat and power. Biogas can also be compressed from a gas to a liquid, and used as a transport fuel.

What are the advantages of biogas and its production?

There are many sources of biogas – for example, sewage, kitchen waste, animal manure – and these are readily available and renewable. You can even create biogas from landfill – i.e. rubbish dumps.

Anaerobic digestion is a naturally occurring process which requires less land than other types of composting. Production of biogas using this method reduces the amount of waste material that goes to landfill.

Biogas production is considered to be carbon neutral as when it is burnt the amount of carbon released is the same as that which was taken up by the plants, sewage etc which later formed the waste. Using biogas also directly reduces greenhouse gas emissions by preventing methane being released into the atmosphere (methane is 21x stronger as a greenhouse gas than carbon dioxide).

Biogas can be used in several ways - as a fuel for heating, electricity generation or to power vehicles (if compressed from gas to liquid). It is estimated that in 2010, 70,000 vehicles, mostly in Europe, were powered by biogas.

What are the disadvantages of biogas and its production?

Because the production of biogas involves a naturally-occurring process, it is not easy to control or manipulate. The rate of gas production is variable, e.g. production is slowed down in cool weather.

Using animal manure or other wastes to make biogas means the same waste can't be used for fertiliser or compost.

Biogas production tends to be small scale and will only produce a limited quantity of energy. At the moment it is not produced on a large enough scale to meet energy demands.

Source: US Department of Energy Alternative and Advanced Fuels Data Center:
http://www.afdc.energy.gov/afdc/fuels/emerging_biogas.html

BIOETHANOL FROM TREES, GRASSES, AND WASTE

*Future
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What are biofuels from trees, grasses and waste?



Scientists are developing technologies that enable all parts of the plant to be used in biofuel production, instead of just the sugary, starchy or oily parts. For example, trees, grasses, forestry waste and wood chippings could be used.

Trees like willow and poplar, and grasses such as miscanthus and switchgrass are amongst the most promising crops that can be grown specifically to make bioethanol, using these new technologies.

What are the advantages of these biofuels?

Crops like willow, poplar, switchgrass and miscanthus can grow relatively quickly and successfully without much fertiliser. This minimises soil and water pollution, and increases the greenhouse gas emissions savings associated with their use.

Land that is unsuitable for growing food crops could be used to grow these trees and grasses, meaning that food production would usually not be threatened by the biofuel crops.

As well as having potentially high energy outputs, trees and grasses can be selectively bred to use less water and to maximise the amount of bioethanol that can be made from one plant. Switchgrass and willow have high genetic diversity which can be maximised to further improve yield.

Growth of willow can even help to address other environmental problems such as removing harmful chemicals from the soil. Switchgrass can be used for grazing as well as for biofuels. In addition, the processing of these plants would not require new machinery.

What are the disadvantages of these biofuels?

The processing of these plants into biofuel is more complex and involves more stages than when converting edible parts of plants into biofuels. The technology is still being perfected. It could take anything up to 10 years before these fuels are ready to use on the market.

If forestry waste is used to make biofuels, it cannot be used as a natural fertiliser to help provide soil with important minerals.

Whilst miscanthus and switchgrass use water very efficiently, a disadvantage of willow is that it requires a certain amount of water and therefore cannot be grown in dry areas.

Poplar is an alternative to willow as it shares several characteristics. However, it has less genetic diversity which makes it harder to produce the perfect plant for producing biofuel and it can also be very susceptible to 'rust' diseases caused by fungi.

BIOETHANOL FROM DUAL-USE CROPS

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What are biofuels from dual-use crops?



Residue products from food agriculture, such as straw, could be used for making bioethanol.

If the waste parts are used for fuel, food crop plants could become effectively dual-use, producing both food and fuel.

What are the advantages of these biofuels?

There is a good supply of agricultural residues that could be processed to produce bioethanol, including straw – the dried stalks of food crops such as wheat, barley and oats. In 2006, an estimated 2.9 million tonnes of straw was available to the UK after traditional uses had been taken into account.

This represents a potential source for fuel production which does not threaten food as no additional land to the land already in use is necessary.

The fuels can be produced without harming the environment or local populations, and they can be processed efficiently to yield high-quality liquid biofuels in large quantities.

What are the disadvantages of these biofuels?

The technology needed to process dual-use crops efficiently is the same technology used to produce biofuels from trees, grasses and forestry wastes, and the processes have not yet been perfected. It could take anything up to 10 years before these fuels are ready to use on the market.

Some people think that limits should be placed on the amount of straw used for biofuel, as it can also be used for other purposes, such as improving soil condition. Some suggest that a maximum of only 40% of straw should be used in bioethanol production or other industrial purposes.

Farmers require compensation for parting with their straw, as it is not a cheap waste product but can be worth around £32 per tonne if sold, for example to make fertiliser or as bedding for large farm animals.

ALGAL BIOFUELS

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What are algal biofuels?



Algal biofuels are made from harvested algae.

Biofuels produced from algae are usually in the form of biodiesel, which can be blended with normal diesel.

What are the advantages of algal biofuels?

Algae can produce biodiesel more directly than oily plants, so the processing stages would be less complicated.

Algae can be grown in places where other crops cannot be grown, such as in the sea or in tanks in the desert, so they don't need to compete with other crops that need to be grown on land, such as food crops.

Algae can use waste water and waste gas as a source of nutrients.

The production of algae is continuous unlike crops which have a limited number of harvests per year.

What are the disadvantages of algal biofuels?

Algae need warmth and sunlight to photosynthesise and grow. In the UK if we rely upon natural sunlight we may be limited in how much algae we can grow. Open ponds are a cheap method of production but it means you don't have a controlled environment that provides optimum growing conditions.

If large sealed tanks are used instead to create a controlled environment these are expensive. Harvesting the algae is also expensive in general.

The production of algal biofuels is mostly at the experimental stage and it is likely to take 5-10 years to scale up production and lower costs.