Quick Guide to Biofuels

Definition

Biofuels are fuels made from biomass. Biomass is organic matter or recently living organisms and their by-products. Therefore, in theory at least, biofuels can be made from all sorts of plants and animals, and different parts of those plants and animals – the parts we use for food, the parts we plough back in to the ground to nourish it, the parts we use to make other products and even the parts we throw away.

Why the rush for biofuels?

Biofuels are nothing new. People have burned wood, charcoal and dried animal dung for heat for millennia. However, over the last hundred years, we have turned from the surface to underneath the earth – to fossil fuels such as coal, oil and natural gas. These are essentially densely packed biomass, conveniently separated into solid, liquid or gas forms. The industrialised world has built its heat, electricity and transport systems around them, not least because they have been relatively inexpensive. Oil has been key for transport fuel because it is a liquid and packed with energy and, today, cars and trucks consume almost half of the world's crude oil production. There is interest in biofuel as an alternative transport fuel because, in the long term, accessible oil will be in shrinking supply. Biofuels can decrease dependency on oil and can be grown or sourced at home.

Climate change

Perhaps more importantly, biofuels also offer the potential to slow the rate of growth in the world's CO_2 production. Burning fossil fuels is a big contributor to increasing levels of CO_2 in the atmosphere, which is having an impact on our environment. Transport accounts for about a quarter of our energy-related CO_2 emissions (cars and trucks about 10%) – and demand is rising fast. As the global population grows and becomes more prosperous, the 900 million vehicles in the world today could increase to two billion by the middle of the century.

Conventional or first generation biofuels

When choosing organic raw material (or feedstock) for biofuels, people have first looked to plants that have high energy and can be grown regularly in large quantities. Today's most widespread biofuel, ethanol, is commonly made from sugar cane, corn or wheat. These starchy or sugary plants are converted into ethanol via basic fermentation. The second most widespread biofuel, FAME (Fatty Acid Methyl Esters), is often made from rapeseed, palm oil or soya bean. The oils from these plants are converted into a diesel type fuel via a basic process called transesterification.

Blending with gasoline and diesel

In theory, ethanol and FAME can be used in pure form for transport fuel. However, the reality is that most of today's engines are not designed to use them. Also, they have some shortcomings as a fuel (e.g. ethanol absorbs water, which can cause engine corrosion, and FAME has a tendency to freeze in harsh conditions). However, ethanol can be blended at low concentrations with gasoline and FAME with diesel – and standard engines can accommodate a blend of 5%-10% (B5 or E10) with no problem. Behind-the-scenes, fuel suppliers need specialised infrastructure to blend the fuel and get it to the pump safely (special trains, tanks, blending facilities, trucks) but the consumer does not see a difference.

Advanced vehicles

Many vehicle manufacturers are increasing their production of modified vehicles, which run on much higher biofuel blend rates. However, at high concentrations, biofuels, particularly ethanol, have a lower energy content. This means noticeably less driving distance per litre or tank. Still, sales of these modified vehicles are rising and fuel companies are installing dedicated E85 or B100 pumps, with parallel storage and distribution systems behind them.

Carbon neutral?

Biofuels and fossil fuels emit about the same amount of CO_2 when used in vehicle engines. The difference is that the organic raw material used in biofuels recently absorbed the same amount of CO_2 from the air during its growth – through photosynthesis in the case of plants. In theory, this leaves the balance neutral. (Fossil fuels were originally made from organic matter too, but they absorbed their CO_2 too long ago to balance out emission today.)

Well-to-wheel CO_2

The actual CO_2 reduction of a biofuel entirely depends on the journey the organic raw material has taken before combustion. Factors to consider in measuring the actual life-cycle or 'well-to-wheel' CO_2 emissions include: nitrogen fertiliser; power for drying or seed grinding; fuel for agricultural vehicles; power for the conversion process itself; and fuel for transport of the biofuel. Every journey is different.

CO_2 profiles today

Although no one methodology has been agreed, effort is being made to calculate the CO_2 production on a well-to-wheel basis. Some say a typical US ethanol variety from corn produces only 10% - 30% less CO_2 than gasoline; a UK variety from wheat is more like 50% less and an efficient Brazilian variety from sugarcane 90% less. Some varieties of ethanol and of FAME are more contentious, with some estimating that production actually contributes more CO_2 rather than less (owing to energy intensive processing or rainforest clearance, draining of peat or ploughing of fallow fields.)

Collective effort

If the biofuel is blended with gasoline at 10%, the CO_2 saving of using the combined fuel (using the above figures) in your vehicle becomes 3% - 8%. With a modified vehicle the saving is higher, notwithstanding the fuel economy shortcoming of E85 (lower energy content of ethanol). This reminds us that reducing CO_2 in transport is not just a matter of fuel. It is also a question of vehicle technology and consumer behaviour. To really tackle CO_2 emissions from transport, fuel suppliers need to be encouraged to develop low-carbon fuels, vehicle manufacturers to make cars and trucks more efficient and consumers to take fewer and more efficient journeys (better driving, public transport, car pools).

Standards in practice

A number of issues are linked to the production of ethanol and FAME, particularly in developing countries and in tropical climates. Safeguards are needed in areas including migrant and child labour, the protection of human rights and local community land rights. In addition to the importance of the biofuel's CO_2 profile, environmental safeguards are needed in areas including rare habitats and species (biodiversity), soil and water.

Competition with food

The overarching issue with today's biofuels is availability of the agricultural raw materials being used. Production of sugar cane, corn, wheat, rapeseed, palm oil and soya bean cannot easily scale up to meet the level of global demand for transport fuels that is predicted. At least not without new planting on a massive scale and diverting crops away from food production at a time when demand for food, too, is growing rapidly.

Second generation or next generation biofuels

On the horizon are new biofuels that use non-food organic raw materials, have potential to be provided in high volumes and avoid competition for agricultural land. As well as the technical challenge of converting these tougher materials, the task is also to ensure that life-cycle CO_2 production is low, performance of the fuel is high and manufacture can be commercially viable. These next generation biofuels are expensive to produce and it may be difficult to convince people to pay for their key environmental benefit – CO_2 reduction. However, they show real promise as an alternative to conventional biofuels.

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