

BIO FUELS FACTS

1 What is biomass, what are bio fuels?

Biomass is the total dry organic matter or stored energy content of living or recently living organisms. Biomass can be used for fuel directly by burning it, indirectly by fermentation to an alcohol, or extraction of combustible oils. Biomass also includes biodegradable wastes that can be burnt as fuel.

Bio fuel is a fuel that is derived from biomass. It is a renewable energy source; the CO₂ released when it is burnt was absorbed from the atmosphere during plant growth.

Bio fuels include:- Bio ethanol, Bio butanol, Bio diesel, Biogas

2 The driving factors behind bio fuels

2.1 **Global warming and climate change**

The Stern Report has focused interest on greenhouse gas emissions and global warming. The concentration of Greenhouse gases in the atmosphere has reached 430ppm. Pre industrial revolution levels were 280ppm. As a result world surface temperatures have risen by 1°C. Unabated a level of 550ppm could be reached by 2035 which will result in a 77% chance of a 2°C rise in temperature. According to analysis in 2000 agriculture is estimated to be responsible for 14% of green house gas emissions, with land based activities the source of a further 18%.

2.2 **Fossil fuel reserves and prices**

Many geologists predict that peak oil production has been reached. Latest estimates indicate 33 years of oil at current rates of use of 29 Billion barrels per annum. There is varying opinion on the reserves of fossils fuels, and their accessibility. One certainty, in the face of increasing demand particularly for oil, prices will increase, and the threat of high prices fuels a race for alternatives. *China's consumption will double from 7M barrels per day in 2006 by 2025. India's requirements are set to increase fivefold to 5M barrels per day by 2020*

2.3 **Energy security**

World daily consumption of oil is estimated at 80.1M barrels, of which the US consumes 25%. OPEC countries control over 75% of global oil reserves. Political regimes and instability of countries that have the greatest reserves give cause for concern. Iran has 9.82% of the worlds proven oil reserves, Iraq 8.5% and Saudi Arabia 19.5%. The US has a meagre 2.17%. Russia and Iran between them have over 45% worlds proven gas reserves. In 1990 65% of Europe's and 45% of America's oil was imported. In 2005 this had risen to 85% and 65% respectively.

2.4 Legislation

A global framework for climate change was set in place on the signing of the United Nations Framework on Climate Change (UNFCCC) in 1994.

The Kyoto Protocol followed in 1997, setting mandatory targets for GHG emissions for 2012. The aims are to reduce global emissions by at least 5% below 1990 levels in the period 2008-2012.

Trading of carbon emissions is fundamental in the protocols effort to reduce greenhouse gas emissions

In Europe the emissions trading Scheme (EU ETS) was introduced in 2005. Permits are issued to companies allowing them to produce a certain level of pollution.

Trading occurs at company level enabling a company that has reduced its emissions below its target level to trade its surplus allowance.

2.4.1 EU legislation

The EU has introduced a number of directives that relate to renewable energy and biofuels.

2001/77/EC – Set a target of 12% of total energy use and 22% of total electricity consumption from renewable sources by 2010.

2003/30/EC - promotion of the use of bio fuels or other renewable fuels for transport

Set targets of 5.75 % by energy content, of all petrol and diesel for transport purposes for member countries by 31 December 2010.

A recent EU proposal to reinforce the legislative framework will set a binding minimum target of 10% for 2020.

2.4.2 UK legislation

UK Implementation of the EU directives have created a range of legislation that applies to energy and biofuels

Climate Change Levy (CCL) - an energy tax applied to electricity, gas, coal and Liquid Petroleum Gas that typically adds 15% to energy bills of UK businesses.

Renewables Obligation Order – (ROO) Covers the electricity market. Electricity supply companies are required to source a percentage of their electricity sales from renewable sources. The obligation for 2006/7 is 6.7% rising to 15.4% by 2015/6

Renewable Transport Fuel Obligation – (RTFO) a requirement for road transport fuel suppliers in the UK to ensure that by 2010 5% by volume of all road vehicle fuel is supplied from sustainable sources.

Land fill tax – a tax of £24/tonne for 2007/8 paid for disposal of waste in a landfill site, rising by £3/year

3 Road transport Bio Fuels

3.1 Bio ethanol

Bio ethanol is increasingly used as an oxygen additive in petrol. Inclusion levels can be increased to 10%, but beyond that level specially designed engines, as fitted to the Ford Focus and Saab E85 flex cars that can use 85% ethanol are required.

Ethanol can be produced from Maize and sugar beet. Production from wheat will dominate domestic production. Three tonnes of wheat are required to produce one tonne of ethanol. Total UK petrol consumption in 2005 was 18.54Mt. To meet the RTFO obligation for 2010 0.927M tonnes ethanol will potentially be required. If this is all produced domestically from wheat a new market for 2.8M tonnes will exist.

There are currently plans for the construction of nine plants in the UK to produce 1.175M tonnes. Only two are under construction. US production of ethanol topped 20B litres in 2006, with Brazil producing 16.5B litres. Europe produced 3.4B litres, the UK none.

3.2 Biobutanol

Similar to ethanol in characteristics and the biofuel produced from sugar beet by British Sugar at Wisington plant under construction. Butanol has advantages in that it is less evaporative than ethanol and petrol and is more resistant to absorption of water, enabling it to be transferred in existing pipelines.

3.3 Biodiesel

A substitute fuel for compression-ignition (diesel) internal combustion engines, produced by the transesterification of waste or vegetable oils and animal oils or fats to form methyl esters, rape methyl ester (RME) Soya methyl ester (SME).

At 100% inclusion 5-6% more fuel is required to maintain the same level of power and performance in an engine as fossil fuel. EN14214 is the European standard for bio diesel. The standard limits the percentage of soya oil used to 20%. Fuel additives are necessary to prevent the waxing of bio diesel in lower temperatures.

To qualify for the 20p/l fuel duty in the UK Customs and revenue must have proof that the fuel has 96.5% ester content.

There are currently plans for the construction of four further large scale plants in the UK to produce 1315M tonnes. Four plants are operational.

Total UK diesel consumption in 2005 was 19.33 M tonnes. To achieve the RTFO obligation target for 2010 would require 0.927M tonnes biodiesel which, if produced domestically from rape oil, would require 2.9M tonnes of oilseed rape.

3.4 Biogas

Biogas can be cleaned to remove hydrogen sulphide and compressed and used as a vehicle fuel as Compressed Natural Gas, CNG. This carries a duty concession in the UK of 40 ppl, but unlike Sweden where it is used as a fuel, particularly in captive vehicle fleets, its use as a vehicle fuel is limited.

3.5 Second generation biofuels

Terminology used to describe:-

3.5.1 Bio ethanol produced from cellulose, hemicellulose and ligno cellulose, (straw, wood, biomass crops, paper, grass etc) by enzyme breakdown, acid hydrolysis or thermophilic conversion of the cellulose after the lignin has been separated into sugars that are fermented to ethanol.

3.5.2 Synthetic biodiesel produced by gasification of cellulose, hemicellulose and ligno cellulose, (straw, wood, biomass crops) and conversion of the "syn gas" into biodiesel through the Fischer Tropsch

Second generation technology is in its infancy so production costs are high. Future biofuel production will move towards second generation as too much land would be necessary to satisfy higher levels of biofuel substitution for fossil fuels relative to food production. Companies developing the technology are Iogen, Abengoa, TMO and Choren industries. In early 2007 Abengoa will have a straw to bioethanol plant running in Spain, and Choren Industries will have a wood chip to synthetic biodiesel plant running in Germany.

3.6 Energy and greenhouse gas reduction

Analysis is complex, and depends on crop yield, cultivation system, fuel production method, fertiliser manufacture method. Standardisation is based on "field to wheel" compared to "well to wheel" – includes all carbon and energy costs from planting to use of the fuel.

3.6.1 Energy output v energy input

	Energy output vs energy input	Reduction in CO2 equivalent GHG/km compared to petrol/diesel
Ethanol from wheat	1.2	20-45%
Ethanol from maize	1.3-1.8	20-45%
Ethanol from sugar beet	1.9	30-50%

Ethanol from sugar cane	8.3	85-90%
Ethanol from Lignocellulose		60-100%
Bio diesel from rape oil	3	45-65%
Synthetic bio diesel from biomass	2.2	80-90%

Sugar cane benefits from the higher physiological efficiency of a tropical crop and is the crop with the most efficient conversion into ethanol. Second generation technology offers the greatest reduction in green house gas emissions.

3.7 Impact on commodity prices

The production of road transport bio fuels from cereal grains and oilseeds has created a new market for these commodities that did not previously exist. The US has been swept by a bio fuels revolution, with over 20% of the US maize crop now used in the production of bio ethanol. This is set to increase to over 80M tonnes by 2012 to satisfy the Renewable Fuel Standard target.

The European exportable grain surplus of 20M tonnes will not be sufficient to satisfy the bio fuels industry and EU targets.

Commodity prices are likely to strengthen further in the short term. Commercialisation of second generation technology is essential to enable the world to produce sufficient food and energy will enable waste and the by products of crops to be used in the production process, but in doing so end the increase in commodity prices.

4 Biofuels for heat and electricity

4.1 Biofuels for electricity

Biomass for the energy market can be broken down as follow:-

- Dedicated energy crops
 - Miscanthus and short rotation coppice
 - Maize, grass, whole crop wheat grown and ensiled for energy
- Agricultural crops residues
- Forestry residues
- Wood waste
- Animal wastes and slurries
- The organic fraction of municipal waste

Biomass has a major advantage over wind and photovoltaic in that energy can be produced on demand. There are three routes for biomass to be converted into electricity

4.1.1 Combustion

- Burning to produce heat and power through heating water to produce steam and drive a steam turbine.
- Co firing with coal

4.1.2 Gasification

- Biomass is heated not burned at very high temperatures, producing hydrogen, methane and carbon monoxide.
- The gases produced can be converted into synthetic bio fuels, or used to fuel a gas engine to generate electricity.

4.1.3 Anaerobic digestion - Biogas

- Biomass (usually animal slurries, food/vegetable waste organic waste) is digested anaerobically by bacteria to produce methane which is used to fuel a gas engine to generate electricity and heat.

4.1.4 Straight vegetable oil and bio diesel

- Can be used as a replacement for fossil fuel diesel in a generator set.

With the generation of electricity the following levels of efficiency apply:-

Generation of electricity only	-	20-30% efficient
Biomass for heating	-	85-95% efficient
Generation of electricity and heat together (<i>Combined heat and power</i>)	-	75-90% efficient

In the UK we waste more heat energy from central generation of electricity than would be needed to satisfy the heat requirements of the country.

Combined heat and power offers an efficient use for biomass, particularly if a "year round" use of heat can be found. Medium scale CHP technology is more efficient than small scale CHP, so successful projects must be linked to significant heat usage such as a district heating network.

4.2 Heat from biomass

Heat only systems on a medium scale offer the most efficient and cost effective use of biomass.

Fuels for biomass heating systems include:-

- Wood chips
- Wood pellets (for confined areas - pellets can be blown into a gravity feed hopper)
- Miscanthus
- Cereal grains (wheat, oats)
- Rape meal (by-product after oil extraction)

There are specifications for wood chips and wood pellets, and boilers are sold to a fuel specification. Wood chip specifications include G30, G50, G100 and G150, for chips with sizes increasing from 3 cm² to 15 cm².

Key differences in boiler design are the feeding system:-

- Underfed hearths are only suitable for fuels with a moisture content of up to 35%
- Step grate systems can cope with moisture contents up to 50% , and high ash fuels.

Good fuel quality for smaller boilers is essential with large boilers being better placed to cope with variation in quality

Due to high chlorine contents burning wheat results in the formation of "clinker", which can be overcome by adding lime.

More sophisticated boilers have remote monitoring, and the use of accumulator tanks to store hot water can make the boiler more independent of the heating system.

Fuel costs for heating

Fuel	p/kw hr
Heating oil @ 30 p/l	3.25
Gas @ 2.8	3.2
Wood pellets @ £120/tonne	3.1
Wheat @ £100/tonne	3.0
Rape meal @ £100/tonne	2.2
Wood chip 30% Moisture @ £50/tonne	1.7

5.0 Grants and funding available

There are currently a range of grants and funding streams available for bio fuel investments

5.1 Bio energy Capital Grants Scheme (phase 3)

<http://www.defra.gov.uk/farm/crops/industrial/energy/capital-grants.htm>

A five year scheme worth £10-15m in England over the two financial years to 31 March 2008. supporting the installation of biomass-fuelled heat and combined heat and power projects in the industrial, commercial and community sectors.

5.2 Bio energy Infrastructure Scheme (phase 2)

<http://www.defra.gov.uk/farm/crops/industrial/energy/infrastructure.htm>

Grants to farmers and foresters to help develop the supply chain required to harvest, store, process and supply energy crops and woodfuel to energy end-users. Funding for the purchase of specialist equipment for

harvesting, pre-use processing (e.g. dryers, chippers etc), quality assurance and handling. Purchase of storage and hard-standing, training of members of a producer group or business

5.3 Low carbon building program
www.lowcarbonbuildings.org.uk

Scottish Community and Householder Renewables Initiative
Managed by the energy savings trust, funding for installation of microgeneration renewable energy projects

Stream 1 - grants for householders and community organisations
Stream 2 - grants for medium and large projects by public sector buildings, not for profit and commercial organisations

6.0 Incentives for adoption of bio fuels and biomass technology

- 6.1 First and second generation biofuels for road fuel use carry a concession on fuel duty of 20p/l. (Duty on fossil fuel derived petrol and diesel is 48.25p/l, biofuel 28.25p/l)
- 6.2 Under the Renewable Transport Fuels Obligation fuel suppliers who fall short of the inclusion targets set for 2010 have to "buy out" the volume of fuel they fall short on at 15p/l. The buy out is returned to producers of biofuels.
- 6.3 Renewable obligation certificates are issued to generators of renewable electricity, these are tradable and worth at a base value £32/Mwh. Electricity suppliers who fall short on their obligation to supply a percentage of renewable electricity buy out the shortfall, and the buy out is recycled to producers of renewable electricity.
- 6.4 Energy crop payments, a payment of approximately €45/ha depending on the total area grown is made for crops destined for energy and bio fuel.
- 6.5 Renewable electricity is exempt from the climate change levy.
- 6.6 Renewable energy investments benefit from 100% tax allowance in the first year.
- 6.7 Carbon neutral houses are exempt from Stamp Duty.
- 6.8 Renewable energy features and biomass heating incorporated into a build can help satisfy Building Regulations Part L.
- 6.9 Local planning requirements, some local authorities require new build to have 10% renewable energy.

Terminology

Biobutanol

An alcohol made from sugar or starch crops, which can be used as a petrol substitute. Has a lower vapour pressure, a more similar energy value to petrol, can be blended at higher levels without engine modifications than bio ethanol.

Biodiesel

A methyl ester diesel substitute made from vegetable oil, recycled cooking oil or tallow.

Bioethanol

An alcohol made from sugar and starch crops, which can be used as a petrol substitute.

Biogas

Combustible hydrocarbon gases, mainly methane, carbon dioxide and hydrogen sulphide produced by the anaerobic digestion of any organic material; animal slurries, food waste, vegetable, green waste, crops and sewage.

Carbon abatement

Reduction or elimination of CO₂ pollution

Carbon sequestration

The uptake and long term storage of carbon or carbon dioxide in forests, soils, or underground depleted oil and gas reservoirs, coal seams and saline aquifers

CHP or Cogeneration

Combined heat and power, simultaneous generation of electrical and heat energy from the same source of fuel.

Emissions trading

Under the Kyoto Protocol allows countries to participate in trading of their allocated amounts of emissions enabling emission commitments to be met

Field to wheel

Lifecycle GHG emissions including carbon storage of different land – use types, emissions from energy generation needed for irrigation, use of fertilisers and insecticides, planting and harvesting of crops, transportation to the biofuel

Fischer Tropsch Process

A reaction catalysed with iron and cobalt in which carbon monoxide and hydrogen are converted into synthetic fuels

Gasification

A process that converts carbonaceous materials, such as coal, petroleum, petroleum coke or biomass, into carbon monoxide and hydrogen

Global warming

Increase in the earth's surface temperature

Greenhouse gases GHG

Gases in the earth's atmosphere that absorb and re emit infra red radiation, these gases occur naturally and through human influenced processes, Water vapour is the main GHG, and others include Carbon Dioxide, Methane, Nitrous Oxide, ozone and CFC

Greenhouse gas effect

Increased concentrations of greenhouse gases reducing outgoing solar radiation and increasing the temperature of the atmosphere

Life cycle analysis

The environmental impact of a product during the entirety of its life cycle

LEC Levy Exemption Certificates

Evidence of Climate Change levy exempt electricity supply generated from qualifying renewable sources.

ROC

Renewable obligation certificate

Synthetic Biodiesel

Diesel produced by the Fischer Tropsch process from gases produced by gasification of any cellulosic material

Syn gas

Gas containing hydrogen and carbon monoxide produced by the gasification process

Well to wheel

Total GHG emissions of oil well during exploration, production, transportation, refining, storage, distribution, retailing fuelling and tailpipe emissions from the vehicle.