

FACT SHEET 8: BIOMASS

What is Biomass?

Biomass is the name given to any material which is recently derived from plants that use sunlight to grow. That is plant and animal material such as wood from forests, material left over from agricultural and forestry processes, and organic industrial, human and animal wastes. It is sometimes classified as 'combustible renewables and waste'.

IS BIOMASS RENEWABLE ENERGY?

The energy contained in biomass originally came from the sun. Through photosynthesis carbon dioxide in the air is transformed into other carbon containing molecules (e.g. sugars, starches and cellulose) in plants. The chemical energy that is stored in plants and animals (animals eat plants or other animals) or in their waste is called bio-energy.

When biomass is burned it releases its energy, generally in the form of heat. The biomass carbon reacts with oxygen in the air to form carbon dioxide. If fully combusted the amount of carbon dioxide produced is equal to the amount which was absorbed from the air while the plant was growing.

In nature, if biomass is left lying around on the ground it will break down over a long period of time, releasing carbon dioxide and its store of energy slowly. By burning biomass its store of energy is released quickly and often in a useful way. So converting biomass into useful energy imitates the natural processes but at a faster rate.

Provided biomass is not used faster than it can be produced, the energy obtained from biomass is considered a form of renewable energy. Using biomass energy means that the total amount of carbon dioxide in the environment stays reasonably constant, unlike burning fossil fuels which increases the amount of carbon dioxide in the air. Of all the existing renewable energy sources, biomass is the only one that stores solar energy as a convenient solid, liquid or gaseous fuel.

SOURCES OF BIOMASS

Biomass comes from a variety of sources which include:

- Wood from natural forests and woodlands;
- Forestry plantations;
- Forestry residues;
- Agricultural residues such as straw, bagasse, animal slurries and green agricultural wastes;
- Livestock residues;
- Black liquor from paper manufacturing;
- Sewage wastes;
- Sugar and grain grown to make alcohol for use as a fuel; and
- Grains and oil seeds grown for production of biodiesel.

About 11% of the world's energy comes from biomass (Figure 1). About half of this is wood. Biomass, mostly wood, is far more significant in developing countries. For approximately half the world's people wood or dung is the main source of energy.

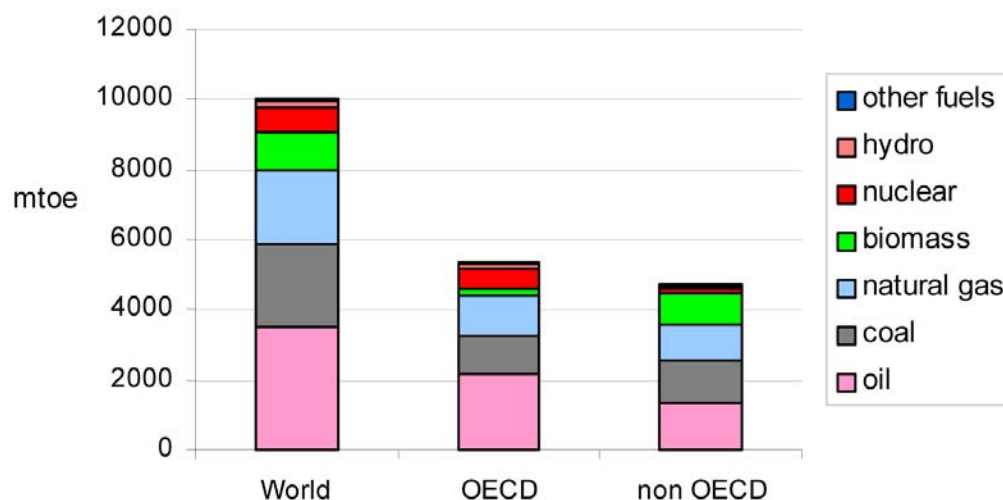


Figure 1.
Total Primary Energy Supply 2001 (source IEA, 2003)

The amount of biomass energy used is difficult to measure because much is gathered and used in a non commercial way.

Biomass Applications

Biomass can be used as it is (e.g. burning wood for heating and cooking). It can also be processed to produce liquid biofuels (biodiesel, alcohol) or a gas biofuel (biogas) which can be used instead of traditional fossil fuels (e.g. alcohol from sugar crops can replace petrol or biogas from animal waste can replace natural gas). The amount of energy available from a biofuel depends upon its type (Table 1). These values can be compared to coal (23 - 30MJ/kg) (Twidell 1998).

Type of biomass	Energy available (megajoules per kilogram)
green wood	8
oven dry plant matter	20
methane gas	55

Table 1.
Typical energy content of different types of biomass.



DIRECT BURNING

Most biomass is burnt directly for heating or cooking. Improved wood stove and kiln technologies could be usefully developed to increase efficiency and reduce air pollution from burning biomass.

LIQUID BIOFUELS

Liquid biofuels such as ethanol (alcohol) and biodiesel have the potential to replace fossil fuels in many transport applications and have advantages as additives. However, they are more costly to produce than petrol and diesel. In Australia only 10% ethanol is permitted in petrol. Vehicle fuel systems and engine components need special modifications to avoid potential damage to paintwork and plastic and non-ferrous components from higher concentrations of ethanol. Biodiesel can be used in regular diesel engines without any need for modification either straight or as a blend.

A number of countries encourage the use of liquid biofuels through tax incentives or subsidies. These countries include the USA, Germany and other European nations. There are two reasons given for subsidies.

The first reason is to support a local industry and thus avoid the cost of importing oil, particularly if there is a world wide shortage. Brazil set up a Fuel Alcohol Program in 1975 to avoid the cost of importing petrol and to support its sugar growing industry. By 1987 consumption of petrol had halved. However, when the price of sugar rose there was less incentive to produce alcohol. Over the next ten years the consumption of petrol more than doubled while alcohol stayed much the same. Energy crops have to be able to compete with food crops for land and other resources.

The second reason given for subsidising biofuels is to reduce greenhouse gas emissions. Fossil fuels are often consumed in the production and processing of biofuels, especially if significant amounts of nitrogenous fertiliser are required. Biofuels will reduce greenhouse emissions but only to the extent that there is a net energy gain.

ELECTRICITY GENERATION

Electricity can be generated from a number of biomass sources and therefore can be marketed as "Green Power". This is a particularly useful renewable source of electricity as, unlike solar or wind, it can be generated on demand. However, in nature biomass has a low bulk density (large volumes are needed when compared to fossil fuels to produce the same amount of energy), which makes transportation and handling difficult and costly. This cost can be reduced by locating the generator near a concentrated source of biomass, such as a sawmill, sugar mill or pulp mill.

COMBUSTIBLE GAS

Biogas is produced when organic matter rots without oxygen, an anaerobic process. It can be collected from sewage treatment plants, wet animal and agricultural wastes (e.g. piggeries, fruit canneries) and from landfill sites. It is mostly methane and like natural gas has a number of uses. It can be used to make electricity and to produce heat for businesses and homes.



On a small scale, anaerobic digesters are commonly used in Asia. There are an estimated 5 million digesters in use in rural China (World Energy Council 1994). Each digester provides sufficient biogas for a family unit, or several families together (see Figure 2). In addition, the residue from the digesters is a very rich fertiliser. On a larger scale, anaerobic digesters are utilised in Korea to dispose of municipal food waste, one digester processing up to 15 tonnes of waste per day. There are around 10,000 medium to large-sized digesters operating on factories and large livestock farms in China.

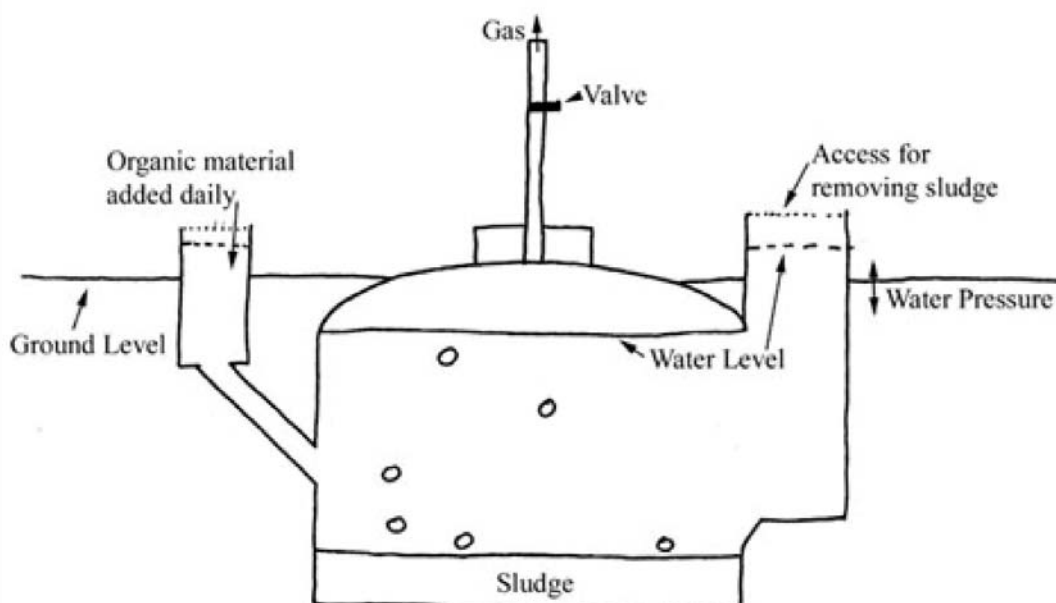


Figure 2.
Diagram of a Chinese water pressure anaerobic digester.
(Source: J. Todd, University of Tasmania)

Biomass in Australia

In Australia less than 5% of energy is generated using biomass fuels. Wood represents 2.4% of Australia's total primary energy consumption (Bush, Harris & Ho Trieu 1997). About three quarters of the heat energy produced from this wood is used in the residential sector. The remaining heat energy is used in making wood products, paper and in food industries. About 22% of Australian homes use wood for heating (DPIE 1997). However, the use of wood for home heating is being discouraged in cities because of concern about smog.

In 1997 bagasse represented about 2% of Australia's total primary energy consumption (Bush, Harris & Ho Trieu 1997). The energy produced by burning it is used to power the sugar cane mills and the excess is sold to the local electricity company. The sugar mills in Queensland, NSW and WA had a combined maximum output of about 300 MW in 1997 (DPIE).

In 1997 the total capacity of power plants using landfill gas in Australia was about 72MW (DPIE). Landfill gas projects are a recent development in Australia, with the number growing from only 15 projects in 1998 ([Australian Greenhouse Office](#)) to 29 at the beginning of 2004.





Figure 3.
Sludge digesters at Woodmans Point sewage treatment plant, Western Australia.
(Photo: Sustainable Energy Development Office Western Australia).

The use of sewage gas for electricity production is also increasing in Australia. In 1997 the installed sewage gas electricity generation capacity was about 7MW, which represented a 59% recovery of methane gas from wastewater treatment plants ([Australian Greenhouse Office 1998](#)). This output is expected to treble by the year 2010.

While there is increasing interest in generating electricity from biomass sources, there is opposition to using biomass from native forests as a fuel.

Biomass and the Environment

ENVIRONMENTAL BENEFITS OF BIOMASS

- Biomass is a renewable source of energy and its use does not contribute to global warming.
- Biomass fuels have almost no sulphur content and therefore produce very little sulphur dioxide, which causes acid rain.
- Burning biomass generally produces less ash than burning coal. In addition, the ash produced can be used as a soil additive on farm land to recycle elements such as phosphorus and potassium.
- The use of agricultural residues, forestry residues and municipal solid waste for energy production is an effective use of waste products. It also reduces the problem of waste disposal.
- Perennial energy crops, like Mallee trees, can be used to lower the water table and reduce salinity as well as sequester carbon in their roots.

ENVIRONMENTAL CONSTRAINTS ON BIOMASS USE

- If wood is not fully burnt small particles of soot-like material (which can cause smog on a large scale), carbon monoxide (deadly in confined spaces) and other organic gases are produced. If wood is burnt at high temperatures oxides of nitrogen will be produced which can cause photochemical smog. In developing countries people have health problems from the air pollution inside houses where wood is burnt inefficiently in open fires for domestic cooking and space heating.



- If there is widespread use of natural forests as a source of wood for fuel this could cause deforestation, with serious ecological and social results. This is currently occurring in Nepal, parts of India, South America and in sub-Saharan Africa. In many Asian countries much of the wood used for energy purposes comes from natural forest areas, which could become deforested if overused.
- There is a potential conflict over the use of land and water resources between biomass for energy production and other uses, such as food and fibre production.
- The production and processing of biomass may require a significant amount of energy input, such as fuel for agricultural vehicles and fertilisers. The amount of energy produced minus the amount of energy used in its production has to be worked out. To get the most out of the biomass-to-energy conversion process it is necessary to:
 - i) minimise the use of energy-intensive fossil fuel based inputs,
 - ii) maximise the biomass and other renewable energy sources input and
 - iii) maximise the energy recovered.

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Further Information

For further information on “Biomass Resources” and “Biomass Conversion Technologies” visit the

[RE-Files](#)

[British Association for Biofuels and Oils](#)

[Prospect of greenhouse gas reduction drives biofuels market](#)

[IEA Bioenergy](#)

<http://wwwphys.murdoch.edu.au/acre/refiles/biomass/index.html>

[US Bioenergy Information Network](#)

[Biomass Research Information Clearinghouse](#)

[U.S. Department of Energy's Biomass Power Program](#)

[Centre for Biomass Technology](#)

[National BioEnergy Industries Association](#)

[Bioenergy Australia](#)

[SEDA Biomass Information](#)

[CADDET Technical Brochures](#) (Search for the area of biomass/waste you are interested in)

[Australian Biomass](#)

Asia (Some of these links require Acrobat reader with is available free [here](#))

[Regional Wood Energy Development Programme](#) in Asia

[Biomass Energy in ASEAN Member Countries](#)

[Turning sawdust into charcoal in Malaysia](#)

[Food Waste Disposal Using Anaerobic Digestion](#), Korea

[Biomass Energy Development](#) in Yunnan Province, China

[Biomass cogeneration in Indonesia](#)

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