

INTRODUCTION

Biomass, as a fuel, is plant material that can be burnt to produce renewable heat or electricity, it utilises the sun's energy stored during plant growth which is then released when it is burnt. Traditionally, wood logs have been the most widely used of the biomass fuels, but other forms of wood have now increased in popularity such as pellets, chips and briquettes. In addition, there is increasing interest in energy crops such as Miscanthus and short rotation coppice (SRC), alongside the utilisation of residues from the crop sector such as straw.



Fig 1 Biomass Boiler

CALORIFIC OUTPUT VALUE OF FUELS

The calorific output value (Gigajoules, GJ) is a measure of how much energy is contained in the different fuels, while the energy content (kilowatts per hour, kWh) is a measure of the rate at which energy is produced. Because plant biomass naturally contains water this reduces the outputs compared to fossil fuels such as oil and coal. The amount of water that is in the biomass is critical to the energy output of the fuel: water content must be minimised by proper drying and storage and maintained at a constant level to avoid fluctuations in energy output when burnt.

Table 1 shows how a tonne of biomass compares on an energy basis at typical moisture contents supplied. Heating oil is very energy dense, and a smaller mass of oil is required to give the same energy output as biomass.

Table 1: Typical energy outputs from a mass of 1 tonne

	Water content %	Calorific value (GJ)	Energy content (kWh)	Heating oil equivalent (kg)
Hardwood, Beech (naturally dried)	35	11.1	3085	259
Softwood, Spruce(naturally dried)	35	11.3	3139	264
Wood pellets (kiln dried)	<10	17.0	4725	396
Wheat straw (naturally dried)	15	14.4	4032	339
Wheat grain (naturally dried)	15	14.2	3976	334
Meadow hay (naturally dried)	15	14.3	4004	336
Miscanthus (naturally dried)	15	14.9	4172	350
Fuel oil	Negligible	42.7	11860	1000
Coal	Negligible	26.7	7417	625

STORAGE AND SUPPLY

A vital part of the viability of biomass as a fuel is its density. Table 2 compares densities of a variety of fuels. Where possible, systems should aim to maximise density by compression and proper drying so the weight per volume is as high as possible.

Transport of the fuel can contribute a large part of the cost, so the higher the density the greater the weight and the less number of loads are required. This links in importantly with the moisture content which ideally will be as low as possible so that each delivery contains the maximum amount of combustible fuel.



Fig 2 Harvesting Miscanthus

Table 2: Comparison of biomass densities

	Typical moisture content %	Typical mass per unit volume (kg/m ³)
Stacked logs	50 (green wood) – 20 (air dried)	450-700
Loose packed logs	50 (green wood) – 20 (air dried)	200-500
Wood chips	50 (green wood) – 20 (air dried)	175-350
Wood pellets	ca. 10	600
Wheat straw (baled)	ca. 15	135
Wheat grain	ca. 15	760
Meadow hay (baled)	ca. 15	133
Miscanthus (baled)	ca. 15	140
Fuel oil	Negligible	840
Coal (loose)	Negligible	800-1100

RESIDUES

Biomass also includes mineral nutrients, which are incorporated into the plant during growth, when they are burnt some are lost as volatiles into the atmosphere while others are collected as ash. This presents additional handling requirements compared to fossil fuels such as oil and gas, and in some cases where there is a high silica content, such as Miscanthus, periodic cleaning of the boiler is required to reduce the build up of 'clinker'. However, ash can often be returned to the soil as fertiliser for future growth.

Table 3: Ash content comparison

	Ash content %
Hardwood (naturally dried)	0.3
Softwood (naturally dried)	0.4
Wood pellets (kiln dried)	0.5
Wheat straw	5.7
Wheat grain	3.9
Meadow hay	7.1
Miscanthus	3.9

**Fig 3 Biomass crop**

BIOMASS EMISSIONS

When fossil fuels are burnt in air they release the carbon they stored underground into the atmosphere as carbon dioxide (CO₂). When biomass fuels are burnt they release the carbon stored during growth, but reincorporate that carbon into the plant during the next growth cycle. The result is less additional carbon dioxide in the atmosphere with biomass fuels.

Table 4: Green house gas emissions from biomass

	CO ₂ equivalent emissions (kg/oven dried tonne)
Wood chips	33
Straw	171
Short rotation coppice	35
Miscanthus	40
Fossil fuels (Coal, Oil & Gas)	750-1000

**Fig 4 Emissions**