Fact sheet
Energy 03
V1 2020
03

BIOMASS FOR ENERGY

Introduction

Chipped wood storage.

Biomass can be defined as any material which is, or is derived directly or indirectly from, plant matter, animal matter, fungi or algae. This includes wood, straw, energy crops, sewage sludge, waste organic materials and animal litter.

Wood fuels can take the form of logs, chipped wood, shredded wood or pellets. Logs are commonly used in small-scale systems (less than 50kW thermal output), which are manually loaded on a daily basis. Chipped or shredded wood is generally used for automated systems from 50kW up to 1MW and beyond. Pellets have a much higher energy density than other wood fuels, and are commonly used in smaller automated systems or where space is restricted.

Energy crops can be divided into several categories: short-rotation energy crops; grass-energy crops; and, other agricultural energy crops (which may be grown for biogas production or to make transport fuels, and are not discussed further in this guide).

Short-rotation energy crops include short-rotation coppice and short-rotation forestry. Short-rotation coppice uses fast-growing trees, such as poplar and willow. The trees are cut back every two to four years to encourage the production of several new stems in the following growing season. Short-rotation forestry consists of felling a plantation after a period of eight to 20 years, when the trees are still relatively immature. Grass-energy crops, which include miscanthus, reed canary grass and hemp, provide an alternative fuel supply and diversification option for many farmers. These crops typically have higher ash content than wood fuels and this must be considered in the design of the biomass installation.

Sewage sludge, waste organic materials and animal litter usually require specific energy conversion and fuel-handling equipment. The type of equipment will be determined predominantly by whether the fuel is wet or dry. Wet fuels are usually unsuited to combustion or gasification as it takes energy to dry the fuel before these processes can take place. It must be noted that there are environmental and regulatory constraints associated with the use of waste as a biomass fuel. These constraints may significantly increase the costs associated with the installation and maintenance of a waste-fuelled biomass plant.

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A biomass boiler.

Biomass heating

Biomass has been successfully used for heating for many decades and is a proven technology. Biomass heating systems can be used for space heating, hot water production, steam production, or a combination of these uses.

While there are a number of different types of biomass boilers, the key elements of biomass systems are the same. Fuel is fed to the grate mechanically, where it undergoes combustion to produce energy. Biomass combustion takes place in the following four stages, which can occur simultaneously:

warming and drying ▸ pyrolysis ▸ gasification ▸ combustion of gases.

The main components of a biomass boiler are:

- fuel transfer system – to move fuel from the storage area to the boiler;
- fuel feed system – to move fuel into the boiler;
- ignition system – used to start the combustion process;
- combustion grate – the type of grate will vary according to the fuel type;
- refractory material – used to reflect heat back to the grate to help dry the fuel and retain heat;
- air feed/control system – to enable even and thorough combustion;
- heat exchangers – to transfer the heat generated to water;
- ash extraction – to clear the combustion chamber and exhaust gas treatment system;
- control system – overarching system that controls variables such as fuel intake and air feed;
- exhaust gas treatment system – used to minimise emissions of particulate matter and fly ash;
- flue gas fan – used in certain circumstances to draw flue gases through the plant;
- flue – chimney stack to draw gases through the plant and disperse them at a safe distance;
- expansion tank – allows the expansion of water in sealed systems; and,
- fire protection system – most modern plants include water dousing systems and automatic shut-off gates to prevent burn back and reduce fire risk.

One of the most important factors to consider when thinking about a biomass heating installation is the type of fuel you will be using. This will be determined by several factors, including the availability of the fuel, the fuel storage capacity, and the level of automation required. For example, a pellet boiler is generally smaller than a wood chip boiler, as the fuel handling system is more compact. In addition, the space required to store pellets is less than that of a woodchip or a log store. Likewise, the fuel for a log boiler will be cheaper per tonne than wood pellets, but most log systems are not automated and will need to be fed manually.

The key elements of biomass systems are the same – fuel is fed to the grate mechanically, where it undergoes combustion to produce energy.

It is also important to consider the physical size of the plant required and any access restrictions for fuel delivery vehicles. If space is limited, a pellet system may be more suitable than a large batch bale system. The cost of the installation may also influence the type of boiler chosen. In most circumstances, the more automated a system is, the more expensive it will be to purchase and maintain.

The Irish Bioenergy Association has developed a biomass and wood fuel quality assurance scheme.

Feedstock

All fuel supply and specification is vitally important to the effective operation and success of a biomass installation. Certain biomass boilers are designed to operate on a range of fuel types and specifications, but the most efficient systems require a particular grade of fuel.

Biomass fuels are made up of a number of different characteristics but the most important variables to consider are the following:

Moisture content as a percentage of the weight – the moisture content of the fuel directly relates to its net calorific value and the energy obtainable from it. Put simply, if the fuel has to be dried before it is burnt, the energy benefit obtained from the fuel is decreased. Most biomass boilers are designed to burn specific moisture content and if the fuel exceeds the moisture tolerance, the boiler may cease to operate.

Particle size or dimensions – the size and shape, or grade of fuel will normally be dictated by the boiler type and fuel feed system. The most common reason for boilers to break down is blockages in the fuel feed system, caused by use of an incorrect fuel grade.

Contaminants – contaminants in biomass fuels can cause a number of problems if the biomass installation is not designed to deal with them. Contaminants such as metal can create blockages or damage the biomass installation. In addition, contaminants such as sand can inhibit the combustion of the fuel and cause bridging in the combustion chamber. Contaminants also lead to combustion emissions like nitrogen oxides (NO_x), sulphur dioxide (SO_2), and particulates.

There are a number of fuel specification standards used to describe the parameters of wood fuel. The overarching biomass fuel specification standard is the European Standard EN 335. The two primary technical specifications of EN 335 are the classification and specification standard (EN 14961) and quality assurance for biofuel standard (EN 15234).

The classification and specification standard (EN 14961) includes parameters for particle size (P16/P31.5/P45/P63/P100), moisture content (M20/M25/M30/M40/M55/M65), and ash content. In addition to the EN standard, the biomass industry also uses the Austrian Standard ÖNORM M7 133. The Austrian Standard also includes parameters for particle size (G30/G50/G100/G120/G150), moisture content (W20/W30/W35/W40/W50), and ash content.

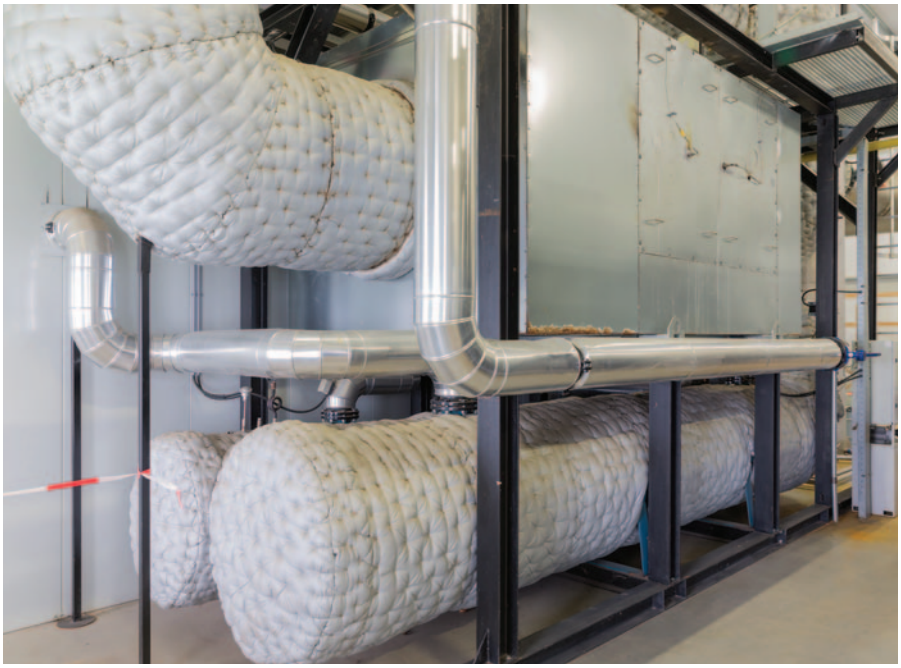
The Irish Bioenergy Association has developed a biomass and wood fuel quality assurance scheme based on EN 335, called the Wood Fuel Quality Assurance (WFQA). The scheme covers firewood, briquettes, pellets and woodchip, and provides a WFQA seal of quality assurance confirming that the fuel is safe, efficient and reliable. The WFQA assures that the fuel conforms to a certain standard, that the producer knows how to produce fuel that is the correct size and moisture content for the appliance, and that the supplier understands how to deliver fuel without compromising the standard.

Financial incentives

The production of heat by a biomass installation is now supported by the Support Scheme for Renewable Heat (SSRH). The SSRH provides a subsidy payment based on the amount of heat produced by the boiler that goes in to the process or building being served.

Biomass combined heat and power

Combined heat and power (CHP) is the simultaneous generation of usable heat and power in a single process. CHP units recover the steam and hot water produced in generating electricity for further use in industrial processes or community and space heating. Large scale (>1MW) biomass CHP units typically use conventional, super-heated steam turbines to generate electricity. Alternatively, a gas turbine can be used with a biomass gasification plant. At a smaller scale, CHP technology based on renewable fuels is still being developed and is not wholly proven in Ireland.



A combined heat and power biomass system.

Installation considerations

In addition to the considerations regarding fuel type, availability and site restrictions, a CHP plant must have access to a grid connection and a constant heat demand. The efficiency and economic performance of a CHP plant will be affected by fluctuations in the heat demand; therefore, a reliable heat demand is preferable. In addition, if the electricity generated by the plant is to be exported, the plant must be located in relatively close proximity to a suitable grid connection. The cost of transporting the heat or electricity off site will have a substantial impact on the financial performance of the installation.

Emissions standards and sustainability

For details about limits on biomass emissions contact the Sustainable Energy Authority of Ireland (SEAI) on 01-248 4982 or ssrh@seai.ie. The UK's Renewable Heat Incentive (RHI) scheme ensures that emission limits are observed. Flue gas emission standards were introduced for the UK's RHI eligibility from September 23, 2013, and proof of compliance is now required on application to the RHI. The UK standards are:

- NO_x limits of 150g/GJ energy; and,
- particulates less than 30g/GJ.

While challenging at first for some biomass systems, especially those operating on straw or miscanthus fuel, it appears that most models of boiler can meet regulatory limits. Check carefully with your supplier that emissions compliance has been met for your intended fuel.

Check that emissions compliance has been met for your fuel.

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Further information

For further information please contact Barry Caslin, Teagasc, Rural Economy Development Programme at:
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The following resources are also helpful:

- www.wfqa.org
- www.irbea.org
- https://www.seai.ie/business-and-public-sector/business-grants-and-supports/support-scheme-renewable-heat/

www.teagasc.ie/ruraldev

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This fact sheet was produced by Barry Caslin, Teagasc, Rural Economy Development Programme.