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Technical Matters

1. What is a biomass boiler?

Answer A biomass boiler is a boiler designed to burn solid fuels classed as biomass. Such boilers can be supplied to burn every form of biomass from woodchips, wood pellets or logs to waste agricultural materials such as straw and grain husks, olive kernels, rice and the dust from any of these including sawdust. Boilers need to be designed to burn specific materials, with any given boiler able to burn a limited range of biomass.

2. Can a biomass boiler be connected to my existing heating system?

Answer Yes, in much the same manner as any other boiler. However, as many biomass boilers operate at a higher temperature, and hence pressure, than fossil fuelled boilers, with some operating at above 100C, it may be necessary to interpose a plate heat exchanger between the biomass boiler and the existing heating system.

3. How is a biomass boiler controlled?

Answer In many respects biomass boilers can be controlled based on heat demand just as with fossil fuelled boilers. However, the much slower response of biomass boilers to changes in load mean that up to three control loops are used to control the fuel feed rate, the primary and secondary air fans, and the delivery of energy to the load including the charging/discharging of the buffer vessel. The minimisation of emissions requires carefully controlled combustion for which a Lambda sensor in the flue monitors the excess oxygen level to enable combustion to be optimised.

4. Do I need another boiler as a back-up?

Answer Many situations require one or more back-up boilers, especially those involving residential accommodation. A properly designed and installed biomass boiler will be as reliable as a fossil fuelled boiler, and in this respect the usual rules for specifying back-up boilers should be applied. However, as a biomass boiler is rarely sized to meet the peak load, the back-up boiler usually acts as a peak-lopping boiler as well. Hence, it is usual for back-up boilers to be sized to meet the peak load.

5. What are the best applications for a biomass boiler?

Answer Biomass boilers operate at their highest efficiency, and are most reliable, when operating continuously. Biomass boilers cannot be switched on and off like fossil fuelled boilers and need to operate in conjunction with a buffer tank if the boiler is to be able to handle modulating loads, particularly loads less than the minimum boiler output, whilst continuing to operate efficiently. Biomass boilers are ideally suited to meet the continuous heat loads of buildings such as swimming pools, hospitals and nursing homes, and industrial processes with a constant heat demand. Other buildings with long periods of daily heat demand like schools and hotels are also a good match to a biomass boiler when a buffer tank is used in conjunction with the boiler.

6. What maintenance does a biomass boiler require?

Answer While fossil fuelled boilers usually require an annual maintenance visit only, biomass boilers require more attention. Biomass boilers burning even the most difficult of materials can operate unattended, but weekly inspection visits are required to carry out a visual inspection of the boiler and fuel feed system, to check the lubrication of bearings and to empty the ashbin. If the boiler is not fitted with automatic flue cleaning, regular cleaning of the flue tubes is required using a flue brush.

7. Can a biomass boiler supply hot water in summer as well as heating in winter?

Answer Summer hot water loads are usually very small in relation to the size of the boiler, typically 5% - 10% of the boiler rating and, as such, are always less than the minimum output of the boiler. The use of a correctly sized buffer vessel allows the boiler to be operated for short periods once or twice a week to charge the vessel. Hot water is then drawn from the buffer vessel as required to meet the load.

8. What are the main components of a biomass system?

Answer In addition to the boiler itself, a biomass system will require a fuel store (silo) and a mechanism to extract fuel from the store and to feed it into the boiler. The flue gases may require treatment and a cyclone grit arrestor is the most common flue gas cleaning device. Where a cyclone or other flue filtration system is fitted, an induced draught fan will be required on the flue. Finally, a buffer vessel will be required for the majority of boilers in the majority of circumstances.

9. Where can I find a list of biomass boiler suppliers and installers?

Answer A number of organisations list biomass boiler manufacturers, suppliers and installers. These include:

- The Renewable Energy Association:
  http://www.r-e-a.net/MembersTab/registry
- The Carbon Trust:
  http://www.carbontrust.co.uk/technology/technologyaccelerator/biomass-online-resources.htm
- The National Energy Foundation:
  http://www.nef.org.uk/logpile/fuelsuppliers/index.htm

10. Where can I find somebody to design by biomass system?

Answer Currently, most of the biomass system design experience resides with biomass boiler installation companies, but an increasing number of building services consultancies are gaining experience in biomass system design. When engaging an installation company or building services engineer it is important to establish their experience of designing systems of the size required and for the particular application. At present there is no database of individuals or companies specialising in biomass system design, neither is there an accreditation scheme for commercial heating although the Centre for Alternative Technology (CAT) and HETAS offer training courses for domestic biomass heating:

http://www2.cat.org.uk/shortcourses/index.php?cPath=1&osCsid=ae88561c1fee47d62ed2a216286ad585

and

http://www.hetas.co.uk/installer/biomass-training.html

11. Can a biomass boiler work fully automatically?

Answer All but the smallest of biomass systems can be configured to work fully automatically. Typical automated features include time switch or optimum start/stop, fuel feed, de-ashing and flue cleaning. The majority of boilers can operate for up to 1 week at a time without manual intervention.

12. Do I need a tall chimney?

Answer The height of flue required depends on many factors including the boiler rating, whether an induced draught fan is installed and whether the boiler is to be installed in a Smoke Control Area. The Biomass System Feasibility Guide, also available on the BEC website, contains a Flue Selection Flowchart which leads the user through the regulations relating to flue height. This chart should be referred to for a definitive answer.

13. How many biomass boilers are currently installed in the UK?

Answer Currently several hundred systems, larger than domestic systems, are installed in the UK ranging in size from 50kW to the 220MW system installed at a power station. However, the number of installations is increasing rapidly as is the associated design and installation, and operating experience.

Fuel

14. What sort of fuel can be burned in a biomass boiler?

Answer Almost all biomass materials can be burned in biomass boilers, but the majority of systems operate on woodchips or wood pellets. On a small scale almost any biomass material can be burned in a batch fed boiler including straw, wood offcuts, waste wood, and logs. It should be noted that the burning of waste wood and offcuts may be subject to the Waste Incineration Directive which prohibits the burning of materials contaminated by heavy metals (eg lead based paint) and halogenated organic compounds (eg some pesticides, sheep dip and similar materials). On a very large scale, as found in district heating systems, fully automatic boilers can burn straw, sawdust, nut husks, olive kernels, and oat, wheat and barley husks. Some of these latter materials are not recommended for burning on any but the largest scale because of the potential problems of slag formation, combustion control and emissions.

15. Who can supply wood fuel?

Answer Lists of wood fuel suppliers can be found on the following websites:

- The Renewable Energy Association:
  http://www.r-e-a.net/MembersTab/registry
- The Biomass Energy Centre (BEC):
  http://www.biomassenergycentre.org.uk/portal/page?_pageid=77,225275&_dad=portal&_schema=PORTAL
- The National Energy Foundation:
  http://www.nef.org.uk/logpile/fuelsuppliers/index.htm

16. How much fuel will I need?

Answer As with any heating system the amount of fuel required will depend on the size of boiler and the period for which it is operated. The amount of fuel required also depends on the calorific value of the fuel and its density. For example, a 100kW boiler operating at 85% efficiency for 10 hours a day for 7 days would require:

- Using wood pellets: 1.7 tonnes requiring 2.6m^3 of storage
- Using woodchips @ 30% moisture content: 2.4 tonnes requiring 11.2m^3 of storage
- Using woodchips @ 50% moisture content: 3.7 tonnes requiring 12.2m^3 of storage

17. How will my fuel be delivered?

Answer On a domestic scale fuel can be supplied as logs or as bags of pellets; above this size fuel has to be delivered by lorry. Woodchips are best delivered by tipping into a silo although they can be tipped into a trough from which they are blown into a silo. Wood pellets can be tipped or blown from the delivery vehicle, with specialist pellet delivery vehicles equipped with fans for this purpose. While other delivery methods are possible they are either slow or have health and safety implications, and are not recommended.

18. Where do I store wood fuel?

Answer Fuel on a domestic scale, which is manually handled into a boiler feed hopper, can be stored in any dry shed or building. Most automatically fed boilers require a fuel silo attached to the boiler house, this silo requiring access for a delivery vehicle. Depending on the manner of delivery, discussed in the answer above, the vehicle will need to tip into the silo or fuel will need to be blown into the silo. In the case of blown fuel the silo does not necessarily need to be on the outside of the building and, in the case of pellets, fuel can be blown up to 20m from the delivery vehicle. On the smallest automatic pellet boilers, fuel be stored some distance from the boiler and extracted from the silo and delivered to the boiler by a vacuum conveying system. Finally, containerised silos are available where fuel is delivered in the container which forms the fuel store and is coupled up to the fuel extract mechanism on delivery.

19. How does the fuel get into the boiler?

Answer On automatically fed boilers a fuel extract and fed mechanism is employed to move fuel from the silo to the boiler. The Automatically Fed Systems Guide, available from the BEC website, details the fuel storage, extraction and feed systems possible together with photographs of the systems. In summary the fuel extract options are walking floors, sweeping mechanisms and hopper bottoms, while fuel feed is by auger or ram stoker.

20. How much space is needed for the fuel delivery vehicle?

Answer The space required for a fuel delivery vehicle depends on the type and quantity of fuel being delivered, and the nature of delivery. If a vehicle has to reverse around corners or turn at the end of a road the space required will be determined by the type and size of delivery vehicle. The IVECO website has specification sheets for many types of vehicle which give a guide to the turning circles required for delivery vehicles: www.iveco.com/Uk/Products/Pages/Trakker_Specification_Sheets.aspx. Where pellets are to be delivered by blowing the vehicle can often remain at the roadside akin to an oil delivery vehicle. The smaller specialist pellet delivery vehicles are of a similar size to oil tankers for domestic fuel deliveries.

Regulations, Planning, Building Warrants and Emissions

21. Do I need Planning Permission and/or a Building Warrant to install a biomass system?

Answer While Planning Permission is not required for a boiler, it may be required for a boiler house, fuel silo and flue (chimney). It may also be required for any aspect of an installation where historic buildings are involved or in sensitive locations. If there is likely to be an increase in the number of large vehicle movements for fuel delivery, or fuel delivery is likely to be noisy, eg when blowing woodchips, Planning Permission may be required. However, all installations will require a building warrant.

22. Do I need a licence to operate a biomass boiler?

Answer A licence is not normally required to operate a biomass boiler, but there are exceptions to this. Any biomass boiler with a rated input greater than 20MW requires a licence from the relevant environmental agency under the Pollution Prevention & Control (PPC) Regulations. Boilers burning waste wood as a fuel may also require a licence depending the particular circumstances. Boilers to be operated in Smoke Control Areas must be listed on the Exempt Appliances List, otherwise permission will be required from the Local Authority. The Biomass System Feasibility Guide, available on the BEC website, contains a flowchart leading the user through a series of questions to establish what permissions are likely to be required.

23. Can I install a biomass boiler in an Air Quality Control Area?

Answer Yes. Normally, the boiler should be on the Exempt Appliances List but a Local Authority may be persuaded that a non-exempt appliance can be used providing they have been satisfied that the emissions will not be prejudicial to health or a nuisance.

24. Are there any regulations about burning waste wood in my boiler?

Answer The burning of waste wood is governed by the Directive on Waste Incineration, commonly known as WID. The Directive permits the thermal recycling of waste wood where the heat is used beneficially providing the wood is not contaminated by heavy metals (eg lead based paint from demolition waste), or halogenated organic compounds (eg some pesticides, sheep dip and similar materials containing fluorides, chlorides, bromides or iodides) which result in the formation of dioxins. The relevant environmental agency may take an interest in the material being burned and may require evidence that the wood has not come into contact with any prohibited material.

25. Do biomass boilers produce any smoke or other emissions?

Answer A well designed and operated biomass boiler burning fuel within the specification of the boiler should not produce any smoke, but black smoke may be produced if the fuel is too wet for the boiler. All biomass boilers produce some oxides of nitrogen (NO_x), particularly nitrogen dioxide (NO_2). While NO_x emissions from gas boilers have been reduced significantly in recent years through the use of low NO_x burners which burn at a temperature slightly below that at which NO_x forms, the nature of biomass combustion, and the need to ensure the complete combustion of wood gases, means that combustion takes place at a temperature where atmospheric oxygen and nitrogen can chemically combine. The better the quality of the combustion control system on a biomass boiler, the lower the NO_x emissions will be. In general, biomass boilers produce less NO_x than oil boilers. Biomass boilers do not produce any oxides of sulphur (SO_x).

26. How do I dispose of the ash which is produced?

Answer The ash produced from biomass boilers is high is potash which makes the ash valuable as a top dressing by farmers or as a component of composts by horticulturalists. If ash cannot be disposed of in this way, or if the quantities are small, it can be disposed of to landfill with other wastes. On large boilers fitted with flue gas cleaning equipment, and where the fly ash is collected separately, it may need to be treated as special waste if the concentration of any heavy metal in the fly ash exceeds a threshold value. Currently, there is no regulatory requirement to segregate bottom ash from fly ash in the UK.

Finance, Grants & Incentives

27. How much do biomass systems cost?

Answer Biomass systems are very expensive when compared to gas or oil fired boilers. Additional costs can arise from the civil engineering works associated with the construction of silos and much larger boiler houses, and the boilers and fuel feed systems themselves are much more expensive. The requirement for a buffer vessel also adds cost. Typically, a complete biomass system will cost up to ten times that of a gas or oil fired boiler system.

28. Are there any Grants available?

Answer Many grants have been available over the years, with separate systems operating in England & Wales, Scotland, and Northern Ireland. There is no one location where information on the availability of grants can be found. Biomass boiler installers are usually aware of all the grant schemes available in there are of operation, and other organisations such as the Renewable Energy Association, the BEC and local enterprise companies can provide advice.

29. Are there any Government incentives for installing biomass systems?

Answer The Carbon Trust operates an interest free loan scheme to businesses repayable over 5 years. Information, and an on-line loan calculator, can be found on the Carbon Trust website: http://www.carbontrust.co.uk/energy/takingaction/about-loans.htm.
Another planned programme which is unlikely to be implemented before 2012 is the Renewable Heat Initiative. Under this scheme it is proposed that, like Renewable Obligation Certificates (ROCs) for renewable electricity generation, a payment will be made per kilowatt hour (kWh) of heat produced.

30. Do I need special insurance for my biomass system?

Answer Whilst special insurance is unlikely to be required, because biomass boilers present a greater fire risk than fossil fuel boilers it is likely that an insurance company will impose a higher premium commensurate with the greater fire risk.

31. Do I pay climate change levy on biomass fuel?

Answer Currently Climate Change Levy is not applied to any biomass fuel.

32. What payback period can I expect on my biomass system?

Answer The much greater capital cost of biomass systems means that the payback period will, inevitably, be longer than for a fossil fuelled boiler system. Set against the greater capital cost is the usually lower price of biomass fuels. The majority of biomass systems to date have been installed in areas where mains gas is not available and where, in comparison to the price of fuel oils, biomass fuels are relatively cheap. Taking into account these two factors a typical payback period for a biomass boiler is about 8 years, but this figure can vary considerably. If fuel oil prices continue to increase steadily over the coming years payback periods will fall as wood prices are not anticipated to increase at the same rate as fossil fuel prices. Finally, where grants or other incentives are available a typical payback period is about 5 years.

33. What are the costs of biomass fuels?

Answer Biomass fuels, including wood pellet, cost consistently less than fuel oils although at 2009 prices they are only marginally cheaper than mains gas. While woodchips are always cheaper than wood pellets on a per kWh basis variable fuel quality, in particular high moisture content can erode the margin significantly. Other factors in woodchip price are the number of times timber is handled between standing as a tree and being delivered into a silo, and the distance woodchips are transported. A crude rule of thumb is that it costs up to £10 every time a tonne of wood is handled. In respect of wood pellets this amounts to 0.2 pence per kWh whereas for woodchip the cost is 0.29 pence per kWh at 30% moisture content and 0.44 pence at 50% moisture content. Another rule of thumb applied across Europe is that it is uneconomic to transport woodchips more than about 30 miles because the fuel cost per kWh increases disproportionately above that distance.

Risks Associated with Biomass Systems

34. What systems are used to prevent the fire travelling back to the fuel store?

Answer All biomass boiler systems are supplied with a minimum of two systems to provide burn-back protection. Typically, these are a physical barrier and a water dousing system, although a number of other protection systems can be installed in addition to these two. Full details of burn-back protection systems can be found in the Automatically Fed Systems Guide available from the BEC website.

35. Are there any explosion risks associated with operating a biomass system?

Answer As with any system burning a fuel an explosion risk of some nature exists. In the case of biomass boilers, depending on how gas tight the boiler combustion chamber is, a small explosion risk may exist. The wood gases given off by gasification for burning in the boiler are a mixture of hydrogen, carbon monoxide and carbon dioxide, and if they leak from the combustion chamber an explosive mixture with air could result. The design of flue systems must take into account the need to keep the combustion chamber at negative pressure under all circumstances including a sudden electrical failure to the boiler house. If the flue is not correctly sized for a particular boiler, and that boiler is not of a gas tight design, a problem could result. Another slight risk associated with boilers is flash-back. Great care should always be taken when opening combustion chamber doors as partly burnt gases very occasionally flare out into the boiler room. While this risk is low, boiler operators must be aware of the risk of flash-back from the combustion chamber.

The other explosion risk associated with biomass is when delivering wood pellet fuel by blowing. When pellets are blown into a silo a proportion break up producing the sawdust from which they were manufactured. If the dust concentration is not controlled an explosive mixture of dust in air can be created which will explode in the presence of an ignition source. To prevent an explosive concentration of dust arising, a pressure relief and dust recovery fan is required, and this is usually to be found on the pellet delivery vehicle. To minimise further the risk of explosion the metal pellet delivery and dust extract ductwork in the silo must be of smooth bore construction and the bends must be of large radius (to prevent pellets breaking up), and metal ductwork must be fully bonded to earth.

36. How do I ensure consistent fuel quality?

Answer Operators of wood pellet boilers rarely need to concern themselves with fuel quality as pellets are manufactured to a consistent size, moisture content and calorific value. Operators of woodchip boilers, however, need to be aware of the many fuel quality issues which can arise with the use of woodchips. Standards have been prepared for the manufacture of woodchips which include specifications for chip size, moisture content, the percentage of fines or dust and the ash production percentage. Operators must ensure that the fuel suppliers' specification matches the capability of the boiler, and may need to carry out fuel sampling to ensure the fuel supplied meets the fuel specification. One way to avoid the need to check fuel is for the fuel supplier to supply on a kWh basis where the quantity of fuel used is matched to the heat output from the boiler by metering, but this brings other issues into play. Finally, operators of woodchip boilers must be aware of potential contaminants in fuel particularly sand, which causes slag to form, and foreign objects, such as stones and lumps of metal, which can jam or break auger feed mechanisms.

37. How reliable are biomass systems?

Answer The reliability of a biomass system is closely allied to the quality of fuel being burned. Hence, wood pellet systems tend to be inherently more reliable and less prone to breakdown than woodchip systems for the reasons given in the answer above. Another reliability issue relates to the type of fuel extract and feed mechanism used. On larger boilers hydraulic ram-stokers are preferred to auger mechanism because of their robustness and ability to handle large and oversized fuel. Finally, the quality of the boiler influences the overall system reliability with the more robust systems, which cost up to four times more than other systems of the same size, producing greater annual availabilities than their cheaper counterparts.