Taking the heat

Lessons learned from using biomass heating in low carbon buildings
# Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is biomass heating?</td>
<td>2</td>
</tr>
<tr>
<td>How the technology has changed since the open fire</td>
<td></td>
</tr>
<tr>
<td>Why choose biomass?</td>
<td>4</td>
</tr>
<tr>
<td>Reducing carbon can also cut your costs</td>
<td></td>
</tr>
<tr>
<td>Assessing feasibility</td>
<td>7</td>
</tr>
<tr>
<td>How to estimate your heat demand and supply</td>
<td></td>
</tr>
<tr>
<td>Design, procurement and installation</td>
<td>10</td>
</tr>
<tr>
<td>Tackling installation and choosing contractors for your biomass system</td>
<td></td>
</tr>
<tr>
<td>Ensuring best performance</td>
<td>16</td>
</tr>
<tr>
<td>Key staff can help you get the most out of your heating system</td>
<td></td>
</tr>
<tr>
<td>Project summaries</td>
<td>22</td>
</tr>
<tr>
<td>Further information</td>
<td>23</td>
</tr>
<tr>
<td>Further information</td>
<td></td>
</tr>
</tbody>
</table>
Taking the heat is part of the ‘Sharing our experience’ series. These booklets provide advice and tips to help you plan, build and manage cost-effective low carbon buildings that really work to save you money and carbon.

The insights are based on real data from 28 case studies from the Department of Energy and Climate Change’s Low Carbon Buildings Programme and our work on refurbishments. The projects cover many sectors including retail, education, offices and mixed use residential buildings.
What is biomass heating?

Biomass systems generate heat from the combustion of organic materials, most commonly wood or wood-based materials.

Biomass and the carbon cycle

Biomass is organic matter such as wood, straw, energy crops, sewage sludge, waste organic materials and animal litter.

It is often viewed as a form of stored solar energy, captured by the plants as they grow. Of course the plants also absorb CO$_2$ as they grow, so using biomass fuels completes the carbon cycle. This is low carbon compared to traditional fuels which release CO$_2$, but do not absorb it in their production.

The basic concept behind what we now call biomass heating is nothing new, but technology has changed a lot since the open fire.

Figure 1 The carbon cycle

- Atmospheric carbon dioxide, water and sunlight
- Harvested and burnt
- Converted into new plant material through photosynthesis
- Carbon released back into atmosphere
Biomass boilers

Biomass boilers (the most common means of generating heat from biomass) can burn a variety of fuels. Some are limited to wood pellets or chips; others can be used to burn multiple types of fuel. Whatever the fuel is, biomass systems are most commonly used for space heating and domestic hot water. In some cases, systems also raise steam for industrial process uses.

Biomass technology can vary in size greatly, from the small wood burning stove for space heating in a home, to the boiler used to power a community heating scheme that can heat hundreds of homes.

Most biomass boilers now have the option of automatic fuel feed and handling that can reduce the number of times they have to be refuelled when used in combination with adequate storage. While other biomass fuels can be used, all the case studies in this document used wood as a fuel source in either pellet or chip form.
Why choose biomass?

Biomass heating can offer material carbon savings over traditional heating fuels and can, in some cases, reduce the cost of heating.

Motivations

The main motivation for using biomass in the case study projects was to reduce the carbon emissions of the buildings. Using solid biomass for heating typically gives reductions in net carbon emissions of around 90% relative to using fossil fuel heating systems.

At Woodbrook Ecovillage, the biomass boilers are fuelled with chips from willow coppiced trees, supplied from a local supplier less than 20 miles away, reducing the CO₂ emissions from transportation. The installation of the district heating system, including the four 500 kilowatt (kW) biomass boilers, cost £2.6 million. This equalled about £7,500 per property. The developer was confident that this increase in cost would not cause a problem if the development was marketed as an eco-village. They appear to have been correct as the take-up has been good.

The operational carbon savings were 61% below the 2006 Building Regulations compliance level.

“The biomass boiler was the most cost effective way of providing a high-quality environment/high-quality heating system”

Chris Carvill, Director Carvill Group

Other motivations were security of fuel supply, price stability and lower cost when compared to fossil fuels.

Biomass fuel should be sourced locally to reduce the transport costs and associated carbon emissions.
Taking the heat

The biomass boiler at the One Brighton development was initially fuelled with wood pellets from Scotland. The developers believed that these would offer a more reliable and predictable source of fuel than more locally sourced wood chip. However, they paid extra for the transportation costs, so once the boiler had been commissioned and was working reliably, the developers switched to locally sourced wood chip at a lower price.

Costs of biomass fuel vary considerably across the UK, depending on the type of fuel, the location of the supplier, the delivery/handling arrangements and other factors.

**The bigger design picture**

Good building design can improve the feasibility of biomass in two ways:

- Minimising the heat and hot water loads will reduce the size (and cost) of the system required.

- Housing the biomass boiler, ancillaries and fuel in a way that allows straightforward and safe access for cleaning, maintenance and fuel deliveries will minimise fuel costs and reduce system breakdowns.

However, as the cost of biomass plant increases considerably per kW installed at smaller scales, minimising heat loads will mean that at a certain point the technology stops being a cost-effective option for decarbonising a building.

Biomass boilers cannot respond rapidly to changes in demand for heat as oil or gas boilers can. They operate much more effectively if run at continuous output for longer periods. In fact, constantly requiring biomass boilers to modulate output from very low to very high levels of heat output (known as ‘cycling’) can affect performance. Biomass is much more effective as a base load technology, ie it is used to fulfil the base heating/hot water load of an individual building or community heating scheme. It is usually best practice to use a biomass boiler as part of a system which combines a large thermal store (essentially a hot water tank acting as a form of rechargeable battery to help manage the peaks and troughs of a building’s heat loads) and a fossil fuel boiler to provide additional heat required during peak demand periods.

Sites such as Riverside Dene and Bideford College included a large heat store as part of the system.

However, the biomass boiler installed at another site has suffered from emissions problems due to ‘cycling’ in response to widely and rapidly varying loads. The boiler size was based on a larger community heating scheme, so is currently oversized.
Community heating schemes

Biomass is an ideal heat source for community heating schemes due to its ability to produce large amounts of heat and the fact that it is well suited to being a base load heat technology.

Community heating schemes are local heat networks, where hot water is supplied to multiple buildings or dwellings from central heat generating plant.

One Brighton and Riverside Dene provide hot water to apartments within blocks of flats, where individuals are charged for the heat they use, measured by a heat meter at the heat exchanger in each apartment.

Ceredigion County Council building is connected to a community heating scheme that only supplies public buildings. At present it supplies two office buildings, but with the intention of connection to a leisure centre (with two swimming pools – ideal loads for a biomass system) and a school.

Lessons learned

- Biomass can provide significant carbon savings (up to around 60%) over traditional heat sources.
- Biomass boilers are better suited to higher constant loads.
- A thermal store helps keep the biomass from cycling, which improves efficiency and increases use.
- Biomass boilers are well suited to community heating schemes where there are base heat loads.
Assessing feasibility

The success of a biomass installation depends on reviewing key factors of the design at an early stage. Ensuring that the boiler is correctly sized and can be maintained is vital. We will look at the issues to consider when determining feasibility.

Biomass can be more flexible than other renewable heat sources in terms of site requirements, as it can be fired up when needed and can be configured physically to fit most sites’ circumstances.

Biomass has most often been selected for non-economic benefits, i.e., the huge potential savings in carbon emissions over fossil fuels. In some cases the client specifically requested a biomass boiler to enhance the ‘green’ image of the building.

Predicting heat load

Predicting the heat demand of a project can be difficult as shown by several of the case study sites. As discussed earlier, the heat demand from One Brighton is much reduced from the predicted level, leading to overcapacity in the system.

In this case, a smaller boiler could have been specified and installed, reducing capital cost. The heat demand doesn’t just affect the size of the boiler, it also affects the size of the space needed to store fuel.

“The first thing to consider with any biomass boiler is what fuel to put in it. Is the fuel itself sustainable? Is my fuel source safe? Sound? Reliable?”

Howard Little, Project Manager, Renewable Energy, Vital Energi

Fuel sources

Fuel is one of the most important considerations when looking into using biomass. The different types of fuel have issues that can change the storage and delivery strategies, as well as more common issues such as security of supply and stability of price.

The main fuel types used in the buildings in this study were either wood chip or pellets.

The Forestry Commission carries out regular woodland surveys and now has dedicated units looking at biomass fuel supply issues.

The type of fuel used will also dictate fuel delivery, storage and feed strategies. The common fuels are looked at below with the factors involved for each one.
Taking the heat

Wood chip fuel is the most common fuel used in the case study buildings. Chips can be made very easily, and can be made from the waste produced from forestry operations.

Wood pellets are smaller and more even in size, making them easier to handle. Pellets are often delivered in a tanker like vehicle and then blown into the storage vessel. Pellets are often transferred to the boiler by an auger system, although gravity feed systems are also available.

Always monitor the moisture content of fuels, as it can lower their calorific value and therefore the useful output of the biomass boiler. Several sites have had issues with high moisture content of the fuel supplied. This means that more fuel is burned to drive the moisture out of the fuel before it combusts.

Biomass is often bought by weight, and so when moisture content is higher the fuel is heavier for the same heat content or calorific value.

**Integrating with other technologies**

As well as the biomass boiler itself, consider any other heating technologies on-site. Many sites have installed gas boiler auxiliary systems for peak demand or for when the biomass boiler is undergoing maintenance. This is simple to integrate, but take care to ensure there isn’t a tendency to default to gas and bypass the biomass boiler.

One site had a combined heat and power (CHP) unit installed alongside the biomass boiler at the request of the client. This has caused problems and resulted in higher CO₂ emissions than expected.

Both biomass and CHP are technologies that require a constant heat demand to allow them to perform to their maximum efficiency. This is often done by sizing them to fulfil the base heating load of the building. The boiler or CHP will then act as the lead boiler, which means that it is the first heat source available to meet the heat demand, with more flexible technologies, such as gas or oil boilers, used to provide any top up heat. Having two technologies that require the same operating conditions will mean that either one or both of the systems will be running in an undesirable way.

**Spatial constraints**

In addition to the boiler itself, the biggest spatial considerations are the fuel store and access to it. At Pembrokeshire College an external silo store was used (pictured below), with the pellet fuel being pumped in. Removal of ash should be considered. One site only had stepped access to the plant room, which made ash removal less convenient.
Ash

The amount of ash produced by biomass systems is not as great as many people expect. Modern biomass boilers burn so efficiently that relatively little ash is actually produced. That which is produced is deposited into specially designed containers to allow for ease of removal. At Ceredigion County Council the ash is being put to good use in a sustainable way as a fertilizer on plants in the local area.

Lessons learned

- It is easy to overestimate the heat demand, which can lead to oversized systems that increase capital cost and reduce carbon savings.
- Finding a consistent quality fuel supply is a key factor to success and should be assessed at the feasibility stage.
- Space and access requirements on-site should be assessed at the feasibility stage to make it easier to maintain the system.
- Biomass boilers work best as the lead boiler in the heating system. To maximise efficiency, don’t mix base load technologies on the same system.
Design, procurement and installation

Find an experienced team to design, install and be involved in the operation of the system to ensure effective low carbon operation.

Building successful teams

An experienced lead contractor is essential with any low carbon technology, and biomass is no different.

Woodbrook and Riverside Dene both used an energy company to design, install and operate the biomass boiler. The companies then had a contractual requirement to provide heat to the two developments, as well as operating and maintaining the systems. This has the benefit of ensuring that experienced people are involved in designing and operating the system, and ensures continuity from construction through to operation. Most importantly for you, it passes the risk of issues such as poor fuel quality and system maintenance onto the operating company, who are then incentivised to ensure good, efficient performance of the system.

Early involvement in any project of the biomass system supplier is vital in order to influence the architect’s design in and around the plant room. Always consider delivery during the design to allow for ease of access.

Close integration and cooperation between the biomass system installers and the M&E engineers is extremely beneficial for a project. Think about any maintenance and operational issues during the design stage. This should include issues not normally considered with traditional fuels, such as ash removal.

Sizing the boiler

When sizing the boiler, estimate the heat demand for the building or community heating scheme. For community heating schemes this should include the heat distribution losses from the distribution pipework.

Several of the case study sites have experienced significant distribution losses (heat lost from the distribution pipework).

Ideally, the biomass boiler should be as close to the systems that it serves as possible to reduce the heat distribution losses. Other methods of reducing heat loss are available. At One Brighton they were advised to reduce the flow temperature to reduce losses, as well as improve the insulation of the pipework. At Riverside Dene they have reduced the
Taking the heat – in this case from around 120°C to 80°C. Here they have also used a ‘pipe in pipe’ system to retain more heat.

The heat demand calculation should also look at how the heat demand varies throughout the year, when sizing the boiler. There are several strategies in linking heat demand patterns to boiler size. One is to size the biomass boiler to meet the base load, another sizing on the peak load and a third which sits somewhere in between, often called ‘optimum’ sizing. See Figure 2 on page 12 for the advantages and disadvantages of these strategies.

Woodbrook used a peak load sizing strategy with four 500kW boilers installed, and no gas or oil back-up. Three boilers are run at any one time, with the fourth as a back-up, to allow time for maintenance.

Riverside Dene employed one 700kW biomass boiler with three 1.2MW gas boilers to provide the heat for the community heat scheme. This was chosen as there were concerns about fuel supply. The biomass is designed to run 24 hours a day and provide 50% of the heat demand.
### Figure 2 Comparison of biomass boiler sizing strategies

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Base load sizing</th>
<th>Peak load sizing</th>
<th>Optimum sizing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advantages</strong></td>
<td>• Plant operates almost continuously – good for biomass</td>
<td>• Ability to provide all of the heat demand from biomass</td>
<td>• Maintains relatively high capacity factor</td>
</tr>
<tr>
<td></td>
<td>• Lower cost of CO₂ saved (£/tonne) than other options</td>
<td>• Maximises the amount of CO₂ savings, and potentially eliminates fossil fuel systems</td>
<td>• Avoids potential maintenance issues associated with low load conditions</td>
</tr>
<tr>
<td></td>
<td>• Lower capital costs as system is a smaller size</td>
<td>• Lower cost per kW provided due to economies of scale</td>
<td>• Maintains a reasonable cost-per-tonne of CO₂ saved</td>
</tr>
<tr>
<td><strong>Disadvantages</strong></td>
<td>• Some sites have very low summer loads, so boiler would be very small</td>
<td>• Higher capital costs</td>
<td>• Medium capital costs</td>
</tr>
<tr>
<td></td>
<td>• Lower CO₂ savings due to limited heat provided by biomass</td>
<td>• Higher cost of CO₂ saved (£/tonne) than other options</td>
<td>• Allows larger plant to be installed where there is a small base load</td>
</tr>
<tr>
<td></td>
<td>• Requires back-up plant for peak demand, which is usually gas or oil boilers</td>
<td>• Potentially higher maintenance costs if needed to run at low load conditions for extended periods</td>
<td>• Does not completely displace fossil fuels</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Higher capital costs than base load sizing</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Requires conventional back-up plant</td>
</tr>
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### Controlling costs

Biomass boilers can cost around £300/kW (though costs varied widely for the case study projects) but the actual boiler often makes up less than half the cost of the whole system. Due to size, fuel storage and access issues for fuel deliveries, the boilers are often installed in a dedicated boiler house, which can add significant additional build costs to the system.

#### Figure 3 Example capital costs breakdown for a 500kW biomass system

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boiler</td>
<td>39%</td>
</tr>
<tr>
<td>Fuel feeding system</td>
<td>27%</td>
</tr>
<tr>
<td>Fuel storage</td>
<td>12%</td>
</tr>
<tr>
<td>Boiler house</td>
<td>5%</td>
</tr>
<tr>
<td>Accumulator</td>
<td>4%</td>
</tr>
<tr>
<td>Flue system</td>
<td>2%</td>
</tr>
<tr>
<td>Design, PM, commissioning</td>
<td>2%</td>
</tr>
<tr>
<td>Transport/delivery</td>
<td>2%</td>
</tr>
<tr>
<td>Pipes and fittings</td>
<td>1%</td>
</tr>
<tr>
<td>Wiring and control</td>
<td>1%</td>
</tr>
</tbody>
</table>
Taking the heat

Design responsibilities

With biomass systems there are additional areas that need looking at, which would not necessarily be included in projects with traditional heating systems.

Ceredigion County Council benefited hugely from having a well-informed in-house facilities team. This meant that expectations were reasonable and they were aware of the common issues that can occur before they arose.

Figure 4 Additional responsibilities for project team members

<table>
<thead>
<tr>
<th>Role</th>
<th>Areas that need their attention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Architect</td>
<td>The architect must consider access to the fuel store in the masterplan for the development. They must also consider the fuel store itself and how it integrates with the building, ie silo, below ground container, etc.</td>
</tr>
<tr>
<td>M&amp;E engineer</td>
<td>The M&amp;E engineer must consider the integration of the biomass into the control system for the building. They will also have to consider the integration of the biomass boiler with the heat distribution network.</td>
</tr>
<tr>
<td>Structural engineers</td>
<td>The structural engineer may be involved in the design of the fuel store, depending on the type chosen. There may be a significant weight of wood fuel to be supported, as well as ensuring that delivery areas are capable of supporting truck movement.</td>
</tr>
<tr>
<td>Biomass expert</td>
<td>A biomass expert should be employed to advise on the design of the system as well as space and maintenance requirements. They are also likely to be subcontracted to install and commission the boiler and so should have a close relationship with the M&amp;E engineers. And they be very helpful in sourcing and checking fuel.</td>
</tr>
</tbody>
</table>
Lessons learned

• The architect, services and structural engineers all have to be involved in the design of the biomass system to ensure full integration.

• Use an energy supply company (ESCO) to design, install and operate the biomass boiler, or involve the supplier of the system early in the design process.

• Consider how the system is going to be operated and maintained – and by whom – during the design stage, so that these activities are as straightforward as possible.

• Correct sizing of the boiler is key to reducing costs, both initial capital costs and running costs.

• Biomass boilers are less than half the cost of the whole system, which may have to be accommodated in separate boiler houses. Costs of the whole system should be considered during the design.

• Engaging a biomass specialist early, and as a member of the project team, benefits the project by allowing prior experience of this technology to be brought to bear at design stage, without the need for costly alterations during construction.
Ensuring best performance

Effective metering and monitoring of a biomass system can lead to greater efficiencies in operation and reduced reliance on traditional fossil fuels.

Metering

It is more difficult to meter the consumption of biomass, like all solid fuels, in comparison to gas and oil. While it’s possible to meter the incoming biomass fuel supply as it is consumed by the boiler, it is more straightforward to measure deliveries by volume or weight or even by the heat content of the fuel (kWh).

Bideford College has set up a fuel contract that is based on the energy supplied rather than the fuel supplied. This is based on the measured output from the boiler’s heat meter, and has the benefit of passing the risk of any fuel quality issues from the client to the fuel supplier. Of course the supplier may be penalised if the client has a poorly performing boiler, so there should be a fair contract in place to ensure the boiler is well maintained.

Always monitor the biomass system’s electrical supply as well, as the consumption of items such as pumps, fans and pre-heat systems can be significant. At Woodbrook Ecovillage the electrical power consumption for each of the 500kW boilers is in the region of 1,500kWh per month. The split of electrical loads is shown in Figure 5.

Like many installations, the biomass boiler feeding the community heat network at Ceredigion County Council was backed up with traditional gas boilers. In addition, the biomass boiler had an integrated gas burner for pre-heating the boiler, providing an additional back-up heat source. The gas supply to this burner was not installed with a meter, so the gas used here could not be separated from the main gas boilers. This means the facilities team

Figure 5 Estimated split in electrical consumption in the boiler house at Woodbrook

- Boiler aux: 66%
- Fuel feed: 22%
- Lighting: 3%
- DH pumps?: 4%
- Ventilation?: 5%
Taking the heat

commissioning company to commission multiple systems within the building. The college is performing as a low carbon building, better than the industry benchmarks, although there have been some commissioning problems with heat meters and the BMS.

From the project performance data, using a biomass specialist or commissioning specialist to commission the biomass boiler appear to be equally beneficial. Commissioning management and good design are more influential factors. However, using the manufacturer or partner installation company does have the benefit of having engineers on-site who are familiar with all aspects of the plant.

Often the biomass boiler is required to generate heat for part of the development, while other parts of the development are still being constructed. This can cause problems when trying to test and commission the system.

**Handover and fine tuning**

Handing over the system from the construction team to the facilities management team is a pivotal part of a building’s life.

Several sites employed a company to design, install and operate the biomass system. This has the benefit of having very knowledgeable people on hand to monitor the system and fix any faults. They can also pass on lessons learned from other sites they are operating.

At Riverside Dene, Vital Energy are running the boiler system and are regularly monitoring the system and adjusting it to optimise performance. This is especially important in the first few years on this site as more and more buildings are being added to the community heating network. It is most important for those buildings completed in the summer months when the heat load is

Specialist commissioning

Specialists were used to commission the biomass boilers in all projects. These were either the manufacturer or its UK partner installation company, except for Pembrokeshire College who used a specialist

A heat meter installed to measure the heat output from a biomass boiler

couldn’t accurately monitor their energy usage and so were unable to determine whether the gas burner in the biomass boiler was running excessively.

It is important to monitor the output of the boiler using a heat meter. With community heating schemes, there should also be heat meters installed in the individual properties, in order to bill them for the heat they have used.

At the One Brighton development, the developer found that the actual heat usage was very low, causing them to question the accuracy of the heat meters at low load conditions. In such circumstances, given the cost of accurate heat metering and billing, the developer has indicated that in future developments they may instead just include a standard element in the service charge for heat and hot water.

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likely to be at its lowest, making it impossible for full load commissioning to take place.

Training of the key facilities management personnel is key to effective operation. At Pembrokeshire College the requirement for training was put into the contract, with the contractor required to submit a detailed programme of training to the client. The training was given to four key personnel by the main contractor and specialist installers over two days, with special sessions on the biomass boiler and BMS.

Documents were provided in most projects, in addition to the training. These were in the form of O&M manuals as well as building user guides.

Training on fuel acceptance is an important aspect of the handover period as poor fuel can have a dramatic affect on the performance of the boiler. Having someone on-site during the delivery to check for the correct level of moisture content or physical contamination can mitigate this risk as they can reject the delivery before the fuel is added to the store.

At the Woodbrook residential development, four biomass boilers supply heat to a community heating scheme burning locally produced willow chip. The fuel is delivered in bulk based on weight, with agreed moisture content (typically about 18%). While there is no formal testing of the fuel for moisture content, it is assessed by visual inspection – something that requires an expert eye. Early in 2010 there was a period where the moisture content was higher than agreed, around 50%. This was missed at the delivery stage and only picked up when smoke was noticed from the boiler house chimney and the volume of fuel consumed increased beyond expected limits.

This issue was instigated during the drying of the new harvest, which was done during a period of very high humidity, when there was very little natural drying. This resulted in a moisture content of around 50%, which meant that the boiler had to ‘dry’ its own fuel – leading to the increase in fuel consumption.

*Figure 6 on page 19* shows the energy from the deliveries. The peak in March 2010 corresponds to the period of high moisture content and a smoothed curve evens out the inconsistencies in reading periods.

**Maintenance**

The perceived difficulty and costs of maintaining biomass boilers have often put clients off installing them. However, the projects we studied show that some of these worries are unfounded. Maintenance of the boilers can be reduced by selecting the correct technology as well as through good design.

Fuel transfer systems need to be checked regularly to ensure that the motors do not burn out. This is especially important if the type of fuel has changed, eg from pellet to chip. The motor is a key component of auger systems. At Ceredigion County Council the motor for the auger has failed several times, possibly because it was undersized. Luckily, they have maintained a good relationship with the installer, which has proved invaluable, and they are now discussing this issue with them.
Availability of spares

As many boiler manufacturers are based in central Europe, and production is still relatively low, spare parts can take some time to arrive. This can have a significant impact on how much the biomass boiler is used.

At Pembrokeshire College, the boiler was offline for around eight weeks because of a temperature sensor repeatedly failing due to burn back. Burn back occurs when heat is transmitted back to the fuel transfer system. The impact of this issue could be reduced by purchasing a spares kit at the outset. Your boiler supplier should be able to identify the items most likely to fail. Retaining the installer to cover maintenance during the initial occupation can reduce problems. The sites with community heating have used the ESCO approach, where one company was appointed to design, install and operate the system.

Figure 6 Biomass fuel consumption at the Woodbrook residential development
Case study

Maintenance time

Bideford College

At Bideford College, the additional ongoing maintenance costs of the boiler for the facilities staff are minimal. The facilities team on-site say that they have not taken on any additional staff due to the wood chip boiler, they have just absorbed it into their regular duties. The current regular time consuming duties are:

- five minutes daily check in the morning
- vacuum clean out the ash bin every two weeks and store ash in sacks
- attend weekly fuel deliveries.

The maintenance input from the on-site staff has been minimised by specifying a wood chip boiler that has self-cleaning features. The Binder RRK model that is used has both automatic de-ashing, as well as HVA, which is a high-velocity cleaning system that uses exhaust air to automatically clean off any ash deposits in the burner tubes. This means that the only general maintenance tasks that need to be carried out manually are:

- greasing bearings (with grease gun) on the stoker, dosing and extract augers
- cleaning boiler flue annually
- checking dosing connection pipes and manifold.

The input from the facilities staff has also been minimised through good design of the fuel reception area and the fuel store. This means that staff do not need to cordon off the delivery area, nor do they need to carry out any double handling of the wood chip fuel as it is tipped straight into the underground fuel store.

The intention is that, in the future, the facilities staff will manage the day-to-day maintenance of the boiler with just a one-off annual service visit from a specialist. Currently there is a maintenance contract with the installation company.

The major annual service would:

- change oil on gearboxes
- check and replace any worn components
- thoroughly clean the whole boiler, including the step grate and heat exchanger.
Taking the heat

Lessons learned

• Fuel supply contracts based on the heat supplied, rather than the amount of fuel delivered, are beneficial for the client as they reduce the risk of the costs incurred by burning high moisture content fuel.

• Effective metering of all inputs is required to understand the performance of the biomass boiler, especially where there is a gas burner installed.

• An experienced or well-trained operative on hand during deliveries of fuel can usually spot quality issues with a simple visual inspection in the absence of a detailed fuel delivery monitoring regime.

• Moisture content of the fuel can be affected by the prevailing climatic conditions. High humidity levels in the atmosphere can reduce the effectiveness of the drying process. Extra attention should be paid to fuel deliveries during wet times of year.

• To help ensure maximum availability of the boiler, a full set of spares of the most important items should be kept on hand or express delivery agreements made with the manufacturers.

• Auger technologies are simple, but need attention to keep them operating and avoiding motor burn out.

• A good ongoing relationship with the installer is invaluable in fixing problems that arise during initial occupation and use.
## Project summaries

<table>
<thead>
<tr>
<th>Description of project</th>
<th>Bideford College</th>
<th>Woodbrook Ecovillage</th>
<th>Ceredigion County Council</th>
<th>Riverside Dene</th>
<th>Pembroke College</th>
<th>One Brighton</th>
</tr>
</thead>
<tbody>
<tr>
<td>A new school building</td>
<td>241 houses, 111 flats, six retail outlets and a crèche</td>
<td>Two open plan office buildings</td>
<td>10-15 tower blocks (flats)</td>
<td>Construction technology centre in a college of higher education</td>
<td>160 apartments</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Floor area</th>
<th>15,700m²</th>
<th>34,200 m²</th>
<th>7,200m²</th>
<th>43,000m²</th>
<th>1,566m²</th>
<th>11,352m²</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Biomass boiler output rating</th>
<th>500kW</th>
<th>4 x 500kW</th>
<th>12,00kW</th>
<th>700kW</th>
<th>300kW</th>
<th>500kW</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Total capital cost for boilers only</th>
<th>£300,000</th>
<th>£606,700</th>
<th>£310,596</th>
<th>£730,250</th>
<th>£88,400</th>
<th>£165,000</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Fuel type</th>
<th>Chip/pellet</th>
<th>Woodchip</th>
<th>Woodchip</th>
<th>Woodchip</th>
<th>Pellet</th>
<th>Woodchip</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Community heating</th>
<th>No</th>
<th>Yes</th>
<th>Yes</th>
<th>Yes</th>
<th>No</th>
<th>Yes</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>System features</th>
<th>Gas auxiliary boilers and thermal store</th>
<th>No traditional fuel auxiliary boilers</th>
<th>Gas auxiliary boilers and thermal store</th>
<th>Gas auxiliary boilers and thermal store</th>
<th>Gas auxiliary boilers</th>
<th>Gas auxiliary boilers</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Other LZC technologies</th>
<th>Wind turbine</th>
<th>Photovoltaic panels on two houses</th>
<th>Wind turbine and solar hot water</th>
<th>None</th>
<th>Solar hot water</th>
<th>Photovoltaic panels</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>% carbon reduction from 2006 building regs</th>
<th>55%</th>
<th>61%</th>
<th>49%</th>
<th>64%</th>
<th>45%</th>
<th>62%</th>
</tr>
</thead>
</table>
Further information

✉️ The Carbon Trust
CTG 012 – Biomass Heating
A practical guide for potential users.

✉️ Forestry Commission
www.forestry.gov.uk
The Forestry commission provides information on biomass fuels.

✉️ Biomass Energy Centre
www.biomassenergycentre.org.uk
A site provided by the Forest Commission giving general information on biomass systems and fuels.
The Carbon Trust is a not-for-profit company with the mission to accelerate the move to a low carbon economy. We provide specialist support to business and the public sector to help cut carbon emissions, save energy and commercialise low carbon technologies. By stimulating low carbon action we contribute to key UK goals of lower carbon emissions, the development of low carbon businesses, increased energy security and associated jobs.

**We help to cut carbon emissions now by:**
- providing specialist advice and finance to help organisations cut carbon
- setting standards for carbon reduction.

**We reduce potential future carbon emissions by:**
- opening markets for low carbon technologies
- leading industry collaborations to commercialise technologies
- investing in early-stage low carbon companies.

[www.carbontrust.co.uk](http://www.carbontrust.co.uk)  
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