CENTRE FOR SUSTAINABLE ENERGY

Bristol City Council Biomass Study

Final Draft Report – for consultation

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EXECUTIVE SUMMARY

This report presents the results of a detailed feasibility study into the scope and options for utilising local biomass as a source of renewable energy to meet heat needs at appropriate Bristol City Council owned or controlled sites. CSE was commissioned to carry out the study by the Bristol Council Sustainable City Team, with additional financial support coming from the SWEB Green Fund.

The study considered in detail the feasibility of installing biomass boilers at two sites, namely: Social Housing Tower Block in South Bristol, a multi-storey social housing block in the Hartcliffe and Withywood area of Bristol, and Blaise plant nursery, based within the Blaise Castle Estate.

During a preliminary assessment, possible sites at Blaise museum, and Ashton Court Mansion were also considered, but found to be less viable.

As well as considering potential sites for biomass boilers, the study also assessed the quantities of biomass supply that might be available within the City from a variety of sources, namely: green wood residues – from tree work, and thinnings from Council controlled woodlands, and other woodlands; and recycled untreated waste wood – from joinery workshops, civic amenity sites, and waste management contractors

The key findings and recommendations are as follows:

Social Housing Tower Block in South Bristol

- Initial estimates suggest that a 700kW biomass boiler would be the optimum size for the site. This would supply baseload heating needs, and would meet about 70% of the annual heat load, running for about 1640 equivalent full load hours. By displacing the use of mains gas, this would save about 266 tonnes of CO_2 emissions per year.
- The economics appear favourable. Based on a grant level of 50%, (which is readily achievable given current levels of government support) and allowing for the avoided cost of installing a biomass boiler in place of a gas boiler, then the simple payback is 9 years, based on savings from reduced gas consumption. The total capital investment that would be required from the Council, or a third party, is estimated to be £95,000.
- It is recommended that the Council should submit a bid to the EST Community Energy Fund for a more detailed feasibility study for Social Housing Tower Block in South Bristol, as soon as possible.
- The gas boilers at Social Housing Tower Block in South Bristol are due to be replaced in 2004. There is a key window of opportunity to include installing of a biomass boiler as part of this replacement.

Blaise Nursery

- The economics of installing a biomass system at this site are more marginal, and depend on making use of cheaper arboricultural wood chip, and the use of the existing barn for use as the boiler house.

- If these are possible, then, with a level of grant support of 50%, the simple payback time will be 13 years, due to savings in LPG consumption. Assuming a 50% grant, it is estimated that a capital investment of about £85,000 would be required, either from the Council, or a third party.
- Initial modelling suggests that the optimum size of biomass boiler for Blaise nursery would be about 400kW maximum output, although more detailed modelling is required. Typically, this would run for the equivalent of about 900-1000 full load hours per year, and would save about 45,000 litres in LPG consumption per year. This would reduce CO_2 emissions from the site by about 70 tonnes per year.

Biomass Supply

- The quantity of green wood chip currently available at Ashton Court is roughly estimated to be 378 oven dry tonnes.
- Allowing for errors in this coarse estimate this is almost certainly enough supply a biomass boiler at Blaise nursery, which would require about 100 over dry tonnes (odt) per year. It may also be enough to supply a boiler at Social Housing Tower Block in South Bristol, which would require about 300 odt per year. However, based on the rough estimate provided, it would probably not be enough to supply boilers at both Social Housing Tower Block in South Bristol and Blaise nursery.
- The survey of tree surgeons suggests that in the region of approx. 482 odt additional supply of green wood chip could be available if tree surgeons were provided with a site where they could dispose of their wood chip for free.
- Before any of the arboricultural wood chip, either from Ashton Court, or from tree surgeons, could be used, it would need to be screened, to remove oversize slivers, foreign objects and green matter. Furthermore, it should also be kept in covered barn, to prevent it from getting any wetter, and to allow preliminary drying to take place.
- If the Council wish to proceed with installation of a biomass boiler, at either Social Housing Tower Block in South Bristol, or Blaise nursery, or both, then it should consider establishing a one or more wood fuel supply depots, to enable green wood chip to be used as the fuel. Potential sites for this could be either at Bower Ashton Estate Yard, or Blaise nursery. As a minimum, this should include a covered barn, for storing the wood chip, to protect it from rain, and to allow preliminary natural drying. It could also include a screener, although this function could also be carried out by a contractor. A ballpark cost for this facility is in the region of £20-30,000.

ABBREVIATIONS

EMU	Bristol City Council Energy management Unit
ET&L	Bristol City Council department for Environment, Transport, and Leisure
N&HS	Bristol City Council department for Neighbourhood and Housing Services
Odt	Oven dry tonnes – a term used to describe quantities of wood fuel
LPG	Liquid Petroleum Gas – also called Propane
CSS	Bristol City Council Central Support Services
LA21	Local Agenda 21
MC	Moisture content (of wood fuel) – usually expressed as a % of dry weight
BMS	Building management system
CCL	Climate Change Levy – a levy on charged on fossil fuels used by non-domestic customers; introduced as part of UK government Climate Change Strategy
M&E	Mechanical & Electrical
LPHW	Low pressure hot water

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1 INTRODUCTION

1.1 Scope and objectives of study

This report presents the results of a detailed feasibility study into the scope and options for utilising local biomass as a source of renewable energy to meet heat and/or power needs at an appropriate Bristol City Council owned or controlled site.

From the outset, the study was to consider the Heritage Estates of Blaise and Ashton Court as potential sites, and also to assess the potential for application in a social housing context.

The original study was commissioned from CSE by the Bristol City Council Sustainability Team, and had as a primary output a detailed feasibility study for one site. However, additional funding was obtained from SWEB's Green Energy Fund, to focus specifically on the Heritage Estates. This enabled the study to be broadened to produce detailed feasibility studies for 2 sites. The study was steered by Bristol City Council's LA21 Energy Group.

As well as considering potential sites for biomass boilers, the study also assessed the quantities of biomass supply that might be available within the City from a variety of sources, namely: untreated waste wood, arboricultural thinnings, thinnings from Council controlled woodlands, and other woodlands.

This report covers the following:

- Results of a preliminary assessment of potential sites
- Detailed feasibility study for Blaise nursery
- Detailed feasibility study for Social Housing Tower Block in South Bristol
- Assessment of sources of biomass supply within Bristol City

1.2 Context

Bristol City Council is committed to expanding the use of renewable and sustainable energy supply, as part of its climate protection and Local Agenda 21 work. The Council's draft Sustainable Energy Supply Strategy identifies (amongst other technologies) the opportunity to increase the use of local biomass (e.g. wood chips, wood pellets) for heating and/or power production as a sustainable source of energy for the city.

Existing local biomass resources could be developed as a sustainable energy resource more extensively within the city. Biomass could be used solely as a heating fuel (as an alternative to coal, oil or gas, feeding a boiler in a central heating system) or to provide heat and power (if used as an energy source for a combined heat and power unit). As an energy resource, local biomass is an extremely 'low carbon' emitting source of energy, absorbing an equal amount of CO_2 whilst growing, as is eventually released through combustion.

The existing woodland resource within Bristol (e.g. Ashton Court Estate, other council woodlands, street tree management, local agricultural and Forest of Avon resources) are thought to be able to provide sufficient existing biomass resource for heat and power supply to a limited number of suitable projects. The council is also restoring the mansions at Ashton Court and Blaise heritage estates in the city. At the start of the study, it was felt that this could be a window of opportunity to introduce local biomass as a renewable energy fuel as part of boiler replacement work at these sites.

2 METHODOLOGY

2.1 Potential sites for biomass boilers

2.1.1 Heritage Estates

Telephone discussions were held with: Andrew Searle, ET&L Technical Services Manager; Peter Wilkinson, ET&L Head of Development; Chris Wood, Ashton Court Mansion manager; Martin Miller, Manager of Blaise Castle Museum; Brian Treanor, CSS Senior Building Services Engineer (responsible for maintaining boilers at Blaise Museum).

Initial site visits were carried out to Ashton Court Estate and to Blaise Castle estate, at the end of July, and early August 2002. Following this initial screening, Blaise nursery was selected for more detailed study, and re-visited with two separate biomass boiler suppliers, namely Econergy, and Wood Energy Ltd.

2.1.2 Social Housing

An initial screening of potential social housing sites was carried out with Don Wainwright, from the Council's Energy Management Unit (EMU). Key criteria that were used for selecting potential sites were: size of annual heat energy demand (with a minimum cut-off point of about 300,000kWh), scheduling of boiler replacement, whether or not the site was on the gas network, and suitability of the site for fuel storage and access for fuel deliveries.

During this initial meeting, it was established that:

- there were no social housing properties within Bristol that were not connected to the gas network
- the study should focus on multi-storey social housing, rather than EPDs (elderly person's housing)

A second meeting was then held with EMU and Norman Jennings, Maintenance Services Officer from the NH&S M&E team, to identify a specific social housing multi-storey block. This meeting identified Social Housing Tower Block in South Bristol, in Hartcliffe and Withywood, as being suitable, as it is due for a boiler replacement, and has space for fuel storage and good access.

A site visit was then carried out to Social Housing Tower Block in South Bristol in October, 2002, together with Norman Jennings, and Jim Birse, from Econergy, a biomass boiler supplier.

2.2 Energy data

Fuel consumption, as far as possible, was obtained from the EMU. Where this was not possible (at Blaise nursery), data was obtained from fuel bills provided by site staff.

2.3 Biomass Supply

In order to assess the potential for biomass supply within the city, the following activities were carried out:

- Telephone and e-mail discussions with: Richard Ennion, Bristol City Council Urban Forestry manager; Roger Young, Waste Management Administrator; staff at Bristol Civic Amenity sites; Bryn Williams, Recycling and Waste Minimisation Officer
- Meetings with: Jim O'Shaughnessy, Forest of Avon Co-op; Paul Cox, Contract Services
- A telephone survey was carried out with tree surgeons and wood processing firms (sawmills and joinery workshops) in the Bristol area, to identify the quantities of waste wood being produced, and current methods of disposal

3 PRELIMINARY ASSESSMENT OF POTENTIAL SITES

A preliminary assessment of 4 sites was carried out. These sites were:

- Blaise museum
- Ashton Court Mansion & Bower Ashton
- Blaise nursery
- Social Housing Tower Block in South Bristol

The sites were assessed against the following criteria, namely:

1. Environmental benefits
2. Economics
3. Social benefits
4. Suitability of load profile
5. Legal and planning issues
6. Plans for boiler replacement/refurbishment
7. Stakeholder attitudes
8. Demonstration potential/ publicity and potential for replication
9. Storage space
10. Operation and maintenance
11. Possibilities for grant funding/ support for capital costs

On the basis of these criteria, and following discussion with the steering group, Social Housing Tower Block in South Bristol and Blaise nursery were chosen for more detailed investigation.

3.1 Ashton Court mansion

The situation at Ashton Court mansion is complex. The site runs on mains gas. There is no access for wood fuel supply down to the existing boiler room. Therefore, a biomass system would require the construction of a new boiler room, outside of the building, which would substantially add to the capital costs – a potential site for this has been identified. There are merits in this, in that the manager would be keen to see the removal of the current boiler flues from within the building.

However, the running of the functions and catering is about to be contracted out for 5 years – and the likelihood of any major new investments taking place within this new arrangement is, according the manager, very low. There is the potential, as identified by ESD[1], for supplying more than just the mansion building – e.g. to include Ashton Park school. This would involve laying a heat main from the boiler house to the school.

A condition survey of the mansion's heating system was recently carried out, by Babcock SGI, in preparation for the new contract arrangements. This concluded that both boilers were nearing the end of their economical life, and they recommend that they should be replaced. However, a decision on whether to carry out this replacement has yet to be taken. From discussion with Andrew Sirle, there are no plans to refurbish the boilers, and they plan to nurse them along for the next 5 years.

Conclusion

If a decision is taken to replace the existing boilers, then this would be the opportunity to take a more detailed look at the cost of installing a biomass boiler, and construction of a new external boiler house, with a heat main to connect up to existing internal distribution system.

3.2 Blaise Museum

Blaise Castle mansion also runs on mains gas. As with Ashton Court, access to the boiler room is not suitable for biomass supply. More importantly, the existing gas boiler flues are at ground level. The biomass boiler flues will need to be above roof level, for reasons of dispersal. As the building is listed it would not be possible, from a planning point of view, to install new flues up to roof level, as they would be too unsightly.

Therefore, as with Ashton Court, a new, external boiler house would need to be built. A possible site has been identified in the stable block. However, the capital cost involved with constructing a new boiler house, for what is a relatively small load at the museum, is likely to be prohibitive. There is the potential for also supplying heat to Cannington College, which is adjacent to the stable block, and also possibly to the nearby church and school. However, this would require further research.

According to Martin Miller, the caretaker for the museum, there are no plans to refurbish the boilers – although they are almost 20 years old, and so near the end of their life.

Conclusion

if a biomass boiler were to be installed, a new boiler house would need to be built, in order to provide fuel access. The current heat load at Blaise museum is probably too

[1] Proposal for a City Wide Sustainable Energy Supply Strategy for Bristol, March 2001

small to justify this cost, particularly as the site currently runs on relatively cheap mains gas. However, there is the potential to install a larger boiler in the existing stable block, and supply heat to Cannington College, and possibly other nearby buildings, as well as Blaise museum. This would require further work to assess the heat loads, and capital costs.

4 FEASIBILITY STUDY FOR BLAISE NURSERY

4.1 General Site Description

Blaise plant nursery is situated at the western end of the Blaise Castle Estate off Kings Weston road, in Lawrence Weston (see annex B4 for location map).

The nursery consists of approx. 10,000m^2 of covered area – about 2500m^2 of glass, and approx. 7500m^2 of polythene greenhouses. As well as the green houses, there are two office buildings, which are temporary, pre-fab buildings, and a barn for storing Contract Services' equipment such as mowers.

The site is managed by Bristol City Council Contract Services, who lease it from BCC Leisure Services.

Also, part of the site is used as a "recycling" area for Contract Services – large quantities of wood chip, and logs from street tree trimmings and forestry operations on the Blaise estate are stored here. (see section 6, sources of supply for more information).

The nursery is a commercial operation, and has a number of long-term contracts (5 years) with other local authorities to supply bedding plants.

Throughout this section, the term "greenhouse" will be used to mean both the glasshouses and the polytunnels.

4.2 Existing Heating Plant and Infrastructure

Currently, the greenhouses are heated primarily using stand-alone, propane (LPG) fired air heating units (see annex B3 for photos). A couple of the polytunnels are also heated using oil fired air heating units. There is no heat main around the site, and there is no heat storage. In total, there are about 14 propane heaters in active use, and two oil heaters. The heaters are supplied by "RiteAir". The distribution, and capacities of the air heaters are given in the figure below. The site plan to which the table refers is given in annex B1.

Fig 1. capacities and location of Blaise nursery air heating units

Site Plan Ref	**Description**	**Rating**
A	Propane heaters	Unknown (assume 200,000 Btu/hr / 59kW)
B,E,F,G	Propane heaters	300,000 Btus/hr / 88kW
C	Oil cabinet heater	300,000 Btus/hr / 88kW
D	Oil cabinet heater	200,000 Btus/hr / 59kW
H	Propane heater	Unknown (small 'easi-heat' yellow heater) – not used
I,J,K,L,M,N,O,P,Q	Propane heaters	300,000 Btus/hr / 88kW

The total installed capacity is about 1.35MW. However, heater B, in greenhouse 16, is hardly ever used – only in an emergency.

Operation of the greenhouse heaters is controlled using digital thermostats ("digistats"). The thermostats are calibrated annually. The operation of the heaters is a simple on or off, there is no part load operation.

The fuel for the heaters is supplied from a total of 7 LPG tanks, and one oil tank. The location of these tanks is shown on the site plans. Greenhouses 1-8 are supplied by one group of tanks, and 11-15 and 18 and 19 are supplied by another group. The office buildings and the propagator, greenhouse 17, are supplied by a single LPG tank. The oil tank supplies oil heaters in greenhouses 9 and 10. Greenhouse 16 has its own LPG heater and tank, but this is rarely used.

The current LPG supplier is Calor. Due to high levels of consumption, the nursery currently has a contract whereby they do not pay a standing charge for the LPG tanks. The current oil supplier is Ticknells.

The burners on the site are a variety of ages, with the oldest being about 6 years old. There are no plans to replace or refurbish them over the next few years.

4.3 Heat Demand

The main heat demand for the greenhouses comes during the 3 months March to May, inclusive. This is the growing season for the bedding plants. The growing temperature required in the greenhouses is 15^{o}C – and this is the temperature at which the digistats are set. However, the demand temperature profile for the various greenhouses is actually fairly complex – and varies depending on the month and the particular greenhouse, as certain greenhouses are used for different plants.

As well as providing heat during the growing season, the heating system also provides frost protection during the winter months, using the same air heaters, for greenhouses 9, 10 and 17, and provides heat for the office block.

According to the nursery manager, the heating is generally turned off during the day – between about 9a.m. to 3p.m., to save fuel, as the greenhouse doors are being continually opened, but also because solar gain during the day means that it is generally warm enough in the greenhouses at this time.

Furthermore, the nursery manager has stated that it is acceptable for the demand temperature of 15^{o}C not to be reached for about 25% of the time. In practice, this is already the situation, as the heating system in greenhouse block 1-5 is known to be underpowered. Furthermore, the nursery manager has said that the demand temperature for May is only 12^{o}C – however, this currently tends to be achieved more by turning off the heating system manually, rather than adjusting the digistats. This heat demand information is summarised in the table below:

Fig 2. temperature demand profiles for different greenhouses at Blaise nursery

Month	No. of Greenhouse	Plants	Demand Temp (^{o}C)
oct	9-10, 17		5 (frost protection)
nov	9-10, 17		5 (frost protection)
dec	9-10, 17		5 (frost protection)
jan	9-10, 17		5 (frost protection)
feb	9-10, 17		5 (frost protection)
mar	1-5, 6-8, 9-10,17, 19	geraniums (at 15), frost protection for dot plants	15 for 1-5, 9-10 and 19, 12 for 17, 5 for 6-8
apr	1-5, 6-8, 9-10, 11-15, 17, 19	various	15 for all
may	all - including 18	various	12

4.3.1 Fuel Consumption

Despite repeated attempts, copies of fuel bills could not be obtained from the Council accounts section. The fuel use is not recorded by the Council's Energy Management Unit. Therefore, data on fuel consumption is based on that obtained from the nursery manager. The fuel consumption data for 2001, January to December inclusive, is presented in the figure below.

Fig 3. fuel consumption data for Blaise nursery 2001, January to December inclusive

Buildings	Fuel Type	Litres	kWh	Cost	Comments
Office block and GH17	LPG	13,244	92,708	£2,450	
Greenhouses 9 and 10	Oil	14,706	159,560	£2,500	
All other greenhouses	LPG	56,191	393,337	£10,395	heat only required mar-may
		Totals	**645,605**	**£15,345**	

Notes and assumptions for table:

- energy content of LPG 7kWh/litre
- energy content of oil 10.85kWh/litre
- cost of oil 17p/litre
- cost of LPG 18.5p/litre
- oil consumption is a rough estimate, from nursery manager

As a non-domestic user, the site does pay Climate Change Levy (CCL) on LPG (oil is exempt from CCL), which is charged at 0.48p per litre. However, as a horticultural application the site gets a 50% CCL rebate. Therefore, the effect of the levy is to increase LPG fuel costs by only 1.3%.

4.3.2 Demand Profile

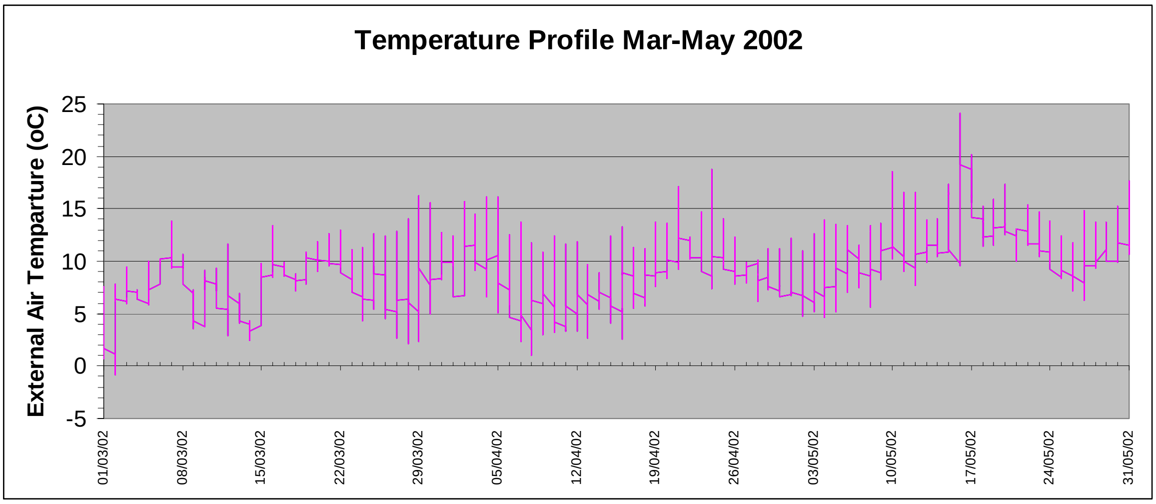
As mentioned above, the site has a complex heat demand profile. The current installed system has a low load factor. Excluding the oil units, the heater in GH16, which is hardly ever used, and GH17 and the office buildings, then the installed capacity of LPG heaters for the greenhouses is about 1.06 MW. Based on the data in fig. 3, which shows an energy consumption of 393,337 kWh for March to May, then this equates to only 371 full load hours, or 17% load factor[2].

This is not an unusual situation for a fossil fuel system, where the capital costs tend to be relatively low, and the running/ fuel costs relatively high. However, the reverse is true for biomass systems, where capital cost is very sensitive to size. The challenge for this site, then, is not to oversize the biomass boiler, but to achieve an optimum balance between the capital cost of the boiler, and the cost of burning oil in the back-up boiler. Therefore, a more accurate picture of the actual heat demand for the greenhouses was required.

Fortunately, it was possible to obtain 5 years of hourly temperature data for the site from Bristol City Council's Environmental Quality Team. This data comes from a sensor mounted on top of Blaise Castle museum, and therefore will be a close match to actual temperatures at Blaise nursery. An example of this temperature profile is shown in the figure below:

[2] in the 3 months of March to May, there are 2208 hours. 371 hours is 17% of this.

Fig 4. example of ambient air temperature profile for Blaise nursery



For the months of March to May, the data for 2001 had a lot of missing data (recordings were taken for only 61% of hours) so the data for this year could not be used. However, the data for the years 2000, and 2002 was very good, with data points for over 98% of hours in the period, so the data for these 2 years was used for the model.

Using this data, in combination with the information on demand temperatures in fig. 3 above, and by estimating the heat loss from each greenhouse (the U values) it was possible to construct a basic heating demand model for the greenhouses. More information on this model is given in Annex B2. The most useful expression of this heat demand is in the form of a heat duration curve – this is a frequency distribution, which shows how many hours in a period a particular heat input is required.

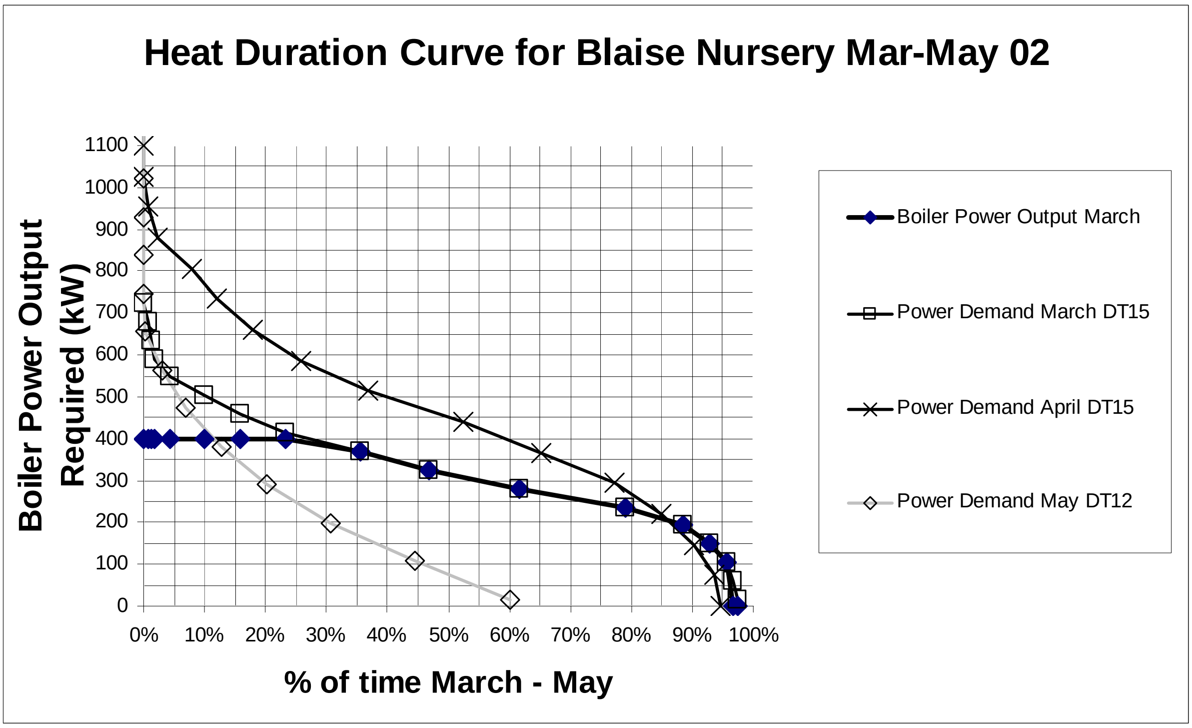
Validation of Model

The output from the model was validated by comparing the estimated energy demand for March to May 2002, with actual data on fuel bills. The actual fuel consumption was about 5,870 litres of oil and 45,217 litres of LPG, giving a total energy consumption of 380,213 kWh. The figure estimated by the model is 393,413 kWh, which is within 3.5%.

The heat loss model also predicted that greenhouses 1-5 are currently underpowered. With the current installed heating capacity in these greenhouses of 166kW, the model predicts that it will only deliver a temperature rise of 8^{o}C above ambient air temperature. For March, 2002, this would have meant that for 20-30% of the heating hours in March, the greenhouse would not reach the demand temperature of 15^{o}C. This was confirmed by the nursery manager, who mentioned that often the heaters are running continuously all night during March, which means that the demand temperature is not reached.

An example of the resulting heat demand duration curve is shown in the figure below, for March to May, 2002:

Fig 5. estimated heat duration curve for Blaise nursery, March to May 2002



Notes:

- This curve excludes the hours 9.00 a.m. to 3.00 p.m. where it is assumed that either the heating is turned off, or the solar gain is sufficient such that heating is not required.
- DT stands for demand temperature

From this curve, several things are apparent:

- The greatest heat demand is in April, which is when greenhouses 11-15 are brought into service.
- In May, when the demand temperature is reduced to 12°C, heating is required for only about 60% of the month
- Although the peak heat input requirement goes up to 1000kW, the graph shows that in April, the heat demand 650kW or less for 80% of the time, and for March and May, the demand is less than 450kW for 80% of the time.

4.3.3 Peak Demand

The worst case scenario would be for a cold snap to occur during April, which is when the greatest number of greenhouses are in use. The system needs to be sized such that it can keep the crop at a minimum temperature of 5°C during this cold spell.

From studying the temperature data for the last 5 years, the minimum temperature recorded was -3.3°C at the beginning of March, 2001. From discussion with the nursery manager, it would appear to be appropriate to design the system for a -5°C cold snap in April. This means it must provide a temperature lift of 10°C. From the heat model, the heat demand in this scenario would be 733kW for the greenhouses, excluding the office blocks and the propagator. Allowing for heat main losses, this would require a total boiler output capacity of approximately 750kW. This size of boiler would be able to cope with a -11^{O}C cold snap in March, due to there being fewer greenhouses in use.

4.3.4 Projected Demand

The nursery manager, Rod Pooley, has stated that he feels that there will be no expansion of the number of greenhouses, and hence the heating requirement over the next few years. Therefore, the biomass heating system can be sized to meet the current heat requirement.

4.4 Outline Design of Biomass System and Technical Options

4.4.1 Sizing

The sizing of the biomass boiler is a balance between capital cost, and wanting to minimise the cost of using back-up oil. The heating model shows the optimum size of biomass boiler is about 400kW. This would meet about 90% of heat demand in the greenhouses from March to May, and, using the temperature data for 2002, would run for the equivalent of 928 full load hours.

4.4.2 Distribution

The proposal is that the current system of stand-alone air heating units be replaced by a centralised boiler unit. This would distribute heat around the site using low pressure hot water (LPHW) heat main. Each of the current air heaters would be replaced by an air heater fitted with a water-to-air heat exchanger. The optimum layout of the heat main would be determined at the detailed design stage, but one option is to have two ring circuits – one serving the greenhouses 1-10, and the other serving greenhouses 11-19.

More sophisticated distribution systems within each greenhouse could be considered at a detailed design stage, and would depend on the degree of portability and flexibility required for the positioning of heaters.

One side effect of this arrangement is that the CO_2 enrichment to the plants that burning LPG and oil directly in the greenhouses currently provides will be lost. However, the nursery manager does not feel that this would be a problem.

4.4.3 Proposed back up system

For economic reasons, the biomass boiler is sized to meet the baseload for the site, but not peak heating loads. In order to meet peak loads, a back up oil fired boiler is proposed. An oil boiler is suggested because, with current fuel prices, this would be a cheaper fuel than LPG.

The oil boiler would be as cheap as possible, as it will only provide 5-10% of the heat load. This means that it operate simply in an on and off fashion. The seasonal efficiency of such a boiler would be in the range of 60-70%. If a 400kW biomass boiler is used, then, based on section 4.3.3, the minimum size of back-up boiler required would be 350kW. For additional security, in the capital costs, a back-up oil boiler size of 500kW has been used.

It is also possible to use some thermal storage, in combination with an oil fired back-up boiler, to reduce the amount of oil used. This would take the form of a hot water storage tank. The optimum sizing of this – in terms of balancing savings in running costs with additional capital cost, would be decided at a detailed design stage.

Ultimately, the installation of the centralised boiler system would mean that the LPG air heating units could be removed. However, to provide additional security, the LPG units could be left in place to provide additional security, until confidence in the new system is established. After their removal, the LPG units may have some second hand value, which could help to defray some of the costs of the new system.

4.4.4 Heating of existing office block and frost protection

It does not appear to be viable, or desirable, to heat the office block from the centralised boiler for two reasons:

- The current office block is only temporary, and may be removed or re-built in the near future
- The heating demand for the block would fall well below the minimum operating capacity of a 400kW boiler, which is about 100kW

Therefore, it the best option is probably for the office block, and the propagator to continue to be heated using the existing LPG tank.

As explained above, frost protection is provided during the winter months by oil fired heaters in greenhouses 9 and 10. As with the office block, the heating demand for frost protection during the winter months would fall well below the minimum output of the proposed boiler. Therefore, the best option would probably be to retain the use of these existing oil heaters for frost protection during the winter months.

4.4.5 Description of proposed boiler

The major factor affecting the choice of boiler technology is the fuel moisture content. If the fuel moisture content is likely to be above 35%, then a moving grate type of boiler will be required, to allow combustion of the wetter fuel. If moisture content is below 35%, then a fixed hearth system can be used. For a 400kW boiler, the difference in cost between the two is in the region of £3-5,000, the moving grate boiler being the more expensive.

If the boiler is to use arboricultural residues, with no additional drying, then a moving grate type of boiler will be required.

The Compte boiler can modulate from 100% of maximum combustion rate (MCR) down to about 25% of full load e.g. from 400kW down to about 100kW, without a major loss in efficiency. A typical average efficiency, for burning fairly green wood chip, will be about 78%, with a full load efficiency of about 85%, or better.

4.4.6 Control

The biomass boiler would be fully modulating down to about 20-25% of full load, using a computerised controller. This would include the following:

- Variable fuel feed rate of stoker auger
- Variable speed control of primary, and secondary fan air
- Monitoring exhaust gas oxygen level to maintain optimum fuel to air ratio

Below this level of load, the boiler would fall into set back where all the fans are off and it would pulse in some fuel every few hours to maintain sufficient "glow" to go back to load from.

To deal with more prolonged no-load periods, as could occur in May, for example, an occasional pulse of heat round the system could be programmed in to let the boiler go onto 25% for 15 minutes every 6 to 12 hrs or to retain the fire.

Within the greenhouses, temperature control would be achieved using temperature sensors, to turn the fan heaters on or off, and to control the flow within the LPHW coils.

4.4.7 Technical Options

The following are technical options that would be considered in more detail when preparing a detailed specification, and in discussion with tendered suppliers.

- Choice of boiler make
- Thermal storage – explore optimum cost-effective sizing
- Automatic ash handling
- Sizing and nature of back-up/ peak load supply
- Detailed options for distribution

4.4.8 Access

Access to the site is very good, with main road access off Kings Weston Road. Heavy plant already visits the site, for delivering wood chip, machinery and burnt out cars, for example!

4.5 Legal and Planning Issues

Bristol has been declared a smoke control area by virtue of a number of smoke control orders originally under the Clean Air Acts of 1956 and 1968 (now consolidated into the Clean Air Act 1993). This, however, applies mainly to small-scale domestic installations and has resulted in a list of ‘Exempted Fireplace Orders’ being issued by DEFRA. Boilers of the size proposed for Blaise nursery do not fall into this category. Installations of this type (<3 MW) fall under Schedule B of the Environmental Protection Act 1990 and therefore are not regulated by Integrated Pollution Control (IPC). They are instead regulated by the Local Authority Environmental Health Office.

The type of wood fuel used may also dictate which regulations are relevant. The use of clean virgin wood may relate only to aspects of the Clean Air Act. For boilers using forestry / energy crop / sawmill / arboricultural type woodchip (i.e. "raw" clean chip) developers are simply required to notify the local EHO of the planned installation and provide details of the boiler to be installed, including flue gas clean-up, the fuel to be used, etc. Boilers above 400 kW net rated thermal input burning "clean wood waste" - furniture factory waste, pallets etc - are part B processes under the EPA and are regulated under Local Air Pollution Prevention and Control (LAPPC) as detailed in guidance PG1/12. These boilers need an authorisation from the EHO and usually an annual emissions test to check the boiler emissions are within limits set out in PG1/12. The Compte boiler is warranted by the manufacturer to meet these limits.

In any case, it is the Local Authority EHO who will regulate an installation of this type. Initial discussions with the relevant EHO have indicated that visible smoke is likely to be the principal issue. This should not be a problem as the Compte boiler considered is designed to emit no visible smoke under normal operation. On occasions, there may be instances of white smoke during start-up with ‘wet’ fuel, which is allowable under the Clean-Air Act legislation.

If a separate boiler house needs to be constructed, then this may require planning permission.

4.6 Operation and Maintenance Requirements

4.6.1 Ash handling

De-ashing of the biomass boiler will be required, and this can be carried out either manually or automatically. If manual, then the ash pans will need to be emptied about once every two weeks. Then, about twice during the heating season, the boiler will need to be completely shutdown for cleaning of the fire tubes, as well as de-ashing. This would take about 4 hours each time, allowing for the boiler to cool down, and could be carried out during daytime, when the heating is turned off anyway. All of these de-ashing operations could be carried out by a suitably trained member of the nursery team, or Contract Services, or an external contractor.

The ash has considerable potential value as a low nitrate fertiliser, and so could be used as such within the nursery. However, the wood being burnt may contain small quantities of heavy metals, either naturally occurring or from some types of fertiliser used to grow the fuel crop. Any use or disposal of the ash as a by-product will have to take full consideration of this. It is good practice for a full assessment of the contents of the ash to be undertaken before any use is determined. If there is no use identified, the ash will need to be disposed of in a landfill.

A 700 kW wood-fuelled boiler installation at Worcestershire County Hall currently utilises its ash as compost or fertiliser, as a result of using clean virgin wood fuel.

4.6.2 Greasing and lubrication

The augers and transmission chains in the fuel handling system will need to be greased/ oiled about twice every heating season (about every 400 hours). The oil in the fuel feed gearboxes will also need to be changed every 2-3 years. Again, all of these operations could be carried out by a suitably trained member of the nursery team, or Contract Services.

4.6.3 Air handling units and digistats

The nursery currently has a maintenance arrangement with RiteAir to service the air heaters and calibrate the digistats. The current cost of this is estimated to be £1275/ year. This cost is likely to be similar with a biomass system installed.

4.6.4 Wood fuel supply and consumption

There are two options for the supply of biomass fuel to the site:

- Make use of untreated recycled wood waste, e.g. from pallets – to be purchased from a waste management company
- Make use of wood residues from Council forestry operations – e.g. from street tree trimmings, and thinnings from Council woodlands

(see section 6 for a more detailed discussion of sources of supply).

A 400kW biomass boiler at the site, running for 900-1000 equivalent full load hours, would consume about 100 odt of wood chip during the 3 months of March to May. This would be equivalent to about 220 wet tonnes of arboricultural residues, or 115 tonnes of drier, recycled wood waste[3].

If arboricultural residues are going to be used, then they will need to be kept somewhere under a covered store, and also screened, to remove over size pieces, before being fed into the boiler (this is dealt with in more detail in section 6).

At its time of maximum demand, during April, then a 400kW boiler will run for the equivalent of about 400 full load hours. This would consume about 200m^3 of arboricultural chip (MC 45%) over the month, which is equivalent to about 70 wet tonnes[4]. Therefore, on a daily basis, about 7m^3 of wood chip, or 2.45 tonnes, would need to be moved from the wood chip storage and screening area, into the fuel delivery system for the boiler. This could either be carried out on a daily basis, or a weekly basis. If weekly, then this would require moving about 49m^3 of wood chip, or 17 tonnes.

The wood chip could be moved using a front loader.

However, these figures assume that the wood chip will not have lost any of its energy content through composting. If this has occurred, then more wood chip would be required to meet the same energy demand (see section 6 for more information about fuel storage).

4.7 Economics

[3] Based on MC 50% for wet arboricultural residues, and MC 15% for recycled wood waste
[4] Based on 80% boiler efficiency, wood chip packing density of 0.35, typical hardwood basic density of 1 green tonne/ m^3, and 0.54 odt/m^3, and energy content of 5167kWh/odt

To complete this section, ballpark costings were obtained from two reputable biomass suppliers – namely, Econergy Ltd, in Bristol, and Wood Energy Ltd, in Devon. Both of these companies have recently successfully secured DTI Bioenergy capital grants (see section on funding).

4.7.1 Capital Costs

The table below shows ballpark capital costs for a 400kW biomass heating system.

Fig 6. *table showing estimated capital costs for Blaise nursery biomass system*

Item	**Estimated Budget Cost**
Boiler	
400kW Compte biomass boiler - fully modulating, installed and commissioned with flue, fuel handling, basic civils	£86,400
500kW backup oil boiler, including tank, chimney and installation	£15,000
Distribution	
Heat main - below ground, pre-insulated plastic pipe, and installation, Low Pressure Hot Water (LPHW)	£40,000
Circulation pumps and valves	£10,000
15 air heaters with water (LPHW) to air heat exchangers, installation	£18,000
Subtotal	**£169,400**

Notes and assumptions

- This assumes that the existing barn can be used as the boiler house. If a new boiler house of similar dimensions needs to be built, then this would add approximately £30-50,000 to the capital cost.
- This costing assumes no thermal storage.
- This cost does not include any allowance for a drying store for storing wood chip (see below).
- De-ashing carried out manually

It can be seen that the installation of the heat main, and new air heaters, forms a major component of the capital cost.

Cost of wood fuel store

As mentioned in section 4.6.4 above, if arboricultural wood chip is to be used, then it will need to be stored somewhere under cover and screened. The cost of a drying barn, screener, and tidying up a corner of the site and laying hardcore would be in the region of £20-30,000. The details of a possible fuel store are explained in more detail in section 6.

The cost of the fuel store is treated here as a separate item because:

- It is likely that such a store could be funded separately, as part of establishing a wood fuel depot (see section 6)
- Such a store could provide fuel for more than one site – e.g. for both Social Housing Tower Block in South Bristol and Blaise nursery, therefore the cost could not be all attributed to one boiler installation

4.7.2 Running Costs

- **Operation and maintenance** – based on the maintenance requirements outlined in section 4.7, the labour requirement would be about 2 man-days per heating season. Allowing for consumables, the annual additional maintenance cost is estimated to be about £1,000 per year. The cost to maintain the air heaters and digistats is not included here, as this is likely to be comparable to the existing cost and is therefore not additional.

  There will also be the additional running cost of moving the woodchip from its store into the fuel delivery system for the boiler – as described in section 4.6.4. This cost is proportional to the quantity of fuel used, and is therefore best considered as part of the cost of the wood fuel, and is therefore considered below.

- **Cost of back-up oil** – the quantity of back-up oil actually required will, of course, vary from year to year, based on the temperature profile. It will also depend on how much thermal storage, if any, were to be used as part of the system. Using the model, and based on temperature data for 2002, then for a 400kW biomass boiler, with no thermal storage, 57,588kWh of oil would be required. The cost of this would be about £900.

- **Cost of Wood fuel** – the cost of the fresh, unscreened wood chip, delivered to the site, would be virtually zero. This is because the chipping cost, and transport to the site is being borne already by Contract Services, and forestry contractors and tree surgeons. However, some allowance needs to be made for labour time for screening the wood chip, and moving it from the wood chip storage area to the boiler fuel handling system - as mentioned in section 4.6.4 above, when running at full power, the boiler will burn about 2.5 wet tonnes of wood chip per day.

  It is difficult, at this stage to quantify this cost. However, a rough estimate of £7 per wet tonne has been used. This assumes a cost of £5 per tonne for moving woodchip from the storage area into the boiler fuel handling system, and an additional £2/tonne which would be the revenue lost from using the wood chip stored at Ashton Court in the boiler, rather then selling to Fountain Bark Products.

Fig 7. *summary of typical estimated annual running costs for Blaise nursery biomass heating system (based on 2002 temperature profile)*

Running Costs		
Estimated amount of back-up oil required	57,588	kWh
Cost of back-up oil	£904	
Annual quantity of green wood chip required (MC 50%) for 400kW boiler, running for 928 equivalent full load hours	204	Wet tonnes
Annual cost of wood chip	£1,427	@ £7/wet tonne
Additional annual O&M cost	£1,000	
Total estimated Annual running costs	**£3,331**	

4.7.3 Avoided Costs

Based on the fuel data, and temperature profile for 2002, the avoided fuel costs would be 45,217 litres of LPG and 5,882 litres of 35 sec oil, with a saving of £8,591, and £1,000 respectively. This gives a total annual fuel saving of £9,500.

However, this will need to be offset by the quantity of back-up oil required to meet peak demands, as described in section 4.8.2.

These savings are based on the biomass boiler only displacing LPG and oil use during the heating season of March to May. It also assumes that the office block, and the propagator will continue to be heated by LPG, and that frost protection in greenhouses 9 and 10 over winter will continue to be met by oil.

As the current system of air stand-alone heaters is only 5-6 years old, it is not due for refurbishment; therefore there is no possibility to offset this against the capital cost of a new biomass heating system. However, the current air heaters may have some re-sale value, and one of them could be used in the propagator, in place of the current tube heater.

4.7.4 Payback

The simple payback, in years, based on the above costs, is shown below, for 3 different levels of grant support.

Fig 8. typical payback times for Blaise nursery biomass system

Capital Cost	**£169,400**
Value of annual fuel saving	£9,569
Annual cost of wood fuel	£1,427
Annual O&M costs	£1,000
Annual cost of back-up oil	£904
Net annual saving	**£6,238**
Grant level	**Payback Time (years)**
0%	27
30%	19
50%	14

These payback times compare with a typical life of a biomass boiler of 15-20 years.

A grant level of 30%, based on this capital cost, is very achievable. A subsidy of £20,000 would be almost automatic, if the system is installed by one of the suppliers successful in securing a Bio-energy Capital grant. A further £30,000 could come from the SWEB Green Fund.

Additional grant funding could be sought from the funding sources listed in section 7 – in particular, the community stream of the Clear Skies programme, which would grant fund 50% of the cost of an installation.

Sensitivity analysis

If an allowance of £20,000 is added to the capital cost, to cover the cost of building a fuel store, then with a 50% grant this would increase the payback time to 15 years.

If the cost of arboricultural wood chip was regarded to be zero, i.e. if the labour time for handling it were treated as part of daily activities on the site, then the payback time would reduce to 11 years, based on a 50% grant.

If the cost of the back-up oil were to double, to £1,800, this would increase the payback time to about 16 years, based on a 50% grant.

4.8 Stakeholder Analysis

Rod Pooley, who is the nursery manager, is keen on the idea of a biomass boiler, and has been very supportive in providing information as part of the study. He has seen the biomass heating system at the Welsh Botanical Gardens, and therefore has some familiarity with the technology.

It would seem that a decision on whether to make the capital expenditure would need to come from Roy Fox, head of Contract Services. His attitude to the project is not known, at this stage.

4.9 Social and Environmental issues

4.9.1 CO_2 savings

Based on the 'carbon neutrality' concept of sustainable wood fuel, the saving in CO_2 emissions, based on a saving of 45,000 litres of LPG per year, will be about 68 tonnes per year[5]. However, other factors do need to be considered, such as CO_2 emissions from fuel transport, etc.

4.9.2 Savings in Nox and Sox

NOx, SOx, particulates and VOC emissions from a wood-fuelled boiler will generally be slightly higher than those from a gas-fuelled installation[6]. NOx emissions, for example, are around 30% higher than from oil, LPG and mains gas, although figures will vary depending on which technologies are compared.

4.9.3 Social benefits

Given its location within the Blaise Castle Estate, there is considerable potential for linking a boiler installation with environmental education and interpretation activities for schools and the general public, and for the Council to be seen to be playing a key role in promoting low carbon technologies. It would be an important exemplar project within the area, and would play a key role in demonstrating biomass energy technology.

4.10 Project Management and Realisation Considerations

If the project went to tender, in order to ensure the best price, there would be sense in splitting the contract into 2 parts, namely:

1. Installation of biomass boiler, fuel handling equipment, and back-up oil boiler
2. Installation of heat main, and air heaters

Although this would increase project management time, to manage the interface between two contractors, there are likely to be considerable cost savings, as the biomass supplier would in all likelihood subcontract the heat main element anyway. There is also the potential for the installation of the heat main to be carried out using existing Council staff/ contractors.

If a choice were made to progress the project, then the next step would be to make a choice about some of the technical options available, and prepare a more detailed specification, as the basis for a tender document.

[5] based on emissions of 1.51 kg CO2 per litre, or 0.21kg per kWh.
[6] Source: Econergy Ltd.

4.11 Conclusions and Recommendations

1. The economics of installing a biomass system at this site are marginal, and depend on:

   - making use of arboricultural wood chip, sourced from council operations and, potentially, tree surgeons – this is cheaper than buying in recycled wood waste from a waste management contractor
   - a level of grant support of 50%
   - the use of the existing barn for use as the boiler house

   If these are possible, then, with a level of grant support of 50%, the simple payback time will be 14 years, due to savings in LPG consumption. Assuming a 50% grant, it is estimated that a capital investment of about £85,000 would be required, either from the Council, or a third party.

2. The economics of any boiler installation, as given above, will be sensitive to the quantity of back-up oil required. The cost of back-up oil has been estimated on the basis (from discussion with the nursery manager) that it is acceptable for the demand temperature not to be reached for about 25% of the time. However, more detailed work would be needed to identify a control strategy to achieve this, in discussion with the nursery manager and a heating engineer.

3. Discussions need to be held with Contract Services staff to ascertain the length of payback time required in order to make a positive investment decision. This would determine the actual level of grant that would be required to make the project work economically.

4. If these payback times are likely to be acceptable, then it should be established as soon as possible whether or not the existing barn could be used as the boiler house, when Contract Services move to Muller Rd. If it cannot, then this will have a significant impact on the capital cost.

5. If the barn can be used, then the Council should consider more detailed investigations for the site, with a view to submitting a bid for capital funding to the Clear Skies funding programme, and other sources.

6. If arboricultural chip, from Council sites, is to be used to run the boiler, then the wood chip that is currently being delivered and stored at Ashton Court will need to be diverted to Blaise nursery, or supply established from another source – e.g. tree surgeons. This fuel will need to be kept in a covered fuel store, preferably with a drying floor, and screened. The wood chip that is currently stored at Blaise is all re-used by Contract Services staff, for paths and mulching (see section 6 for more information on biomass supply).

7. The annual quantities of wood chip delivered to Ashton Court are estimated to be about 278 oven dry tonnes (odt) per year. The consumption of wood chip at Blaise would be in region of about 100 odt per year. Therefore, even allowing for losses due to screening, margins of error in estimates, and loss of energy content due to composting during storage, there should enough wood chip available from current supplies to Ashton Court to meet the need of a biomass boiler at Blaise

nursery (see section 6 for more information on biomass supply).

8. Initial modelling suggests that the optimum size of biomass boiler for Blaise nursery would be about 400kW maximum output. Typically, this would run for the equivalent of about 900-1000 full load hours per year, and would save about 45,000 litres in LPG consumption per year. This would reduce CO_2 emissions from the site by about 70 tonnes per year.

9. In addition to the economic and environmental benefits, a biomass boiler at Blaise would have the following potential benefits and advantages:

   - Nursery staff are present almost every day, so would be able to carry out routine maintenance, and fuelling of the boiler
   - Wood chip is already being stored on the site, so there is existing experience with storing and handling this resource
   - Given its location within the Blaise Castle Estate, there is considerable potential for linking a boiler installation with environmental education and interpretation activities for schools and the general public, and for the Council to be seen to be playing a key role in promoting low carbon technologies
   - Given the above, such a project is likely to be attractive to funders – this opens up the possibility of securing perhaps more than 50% grant funding for the project
   - A biomass boiler at Blaise would fit well with the idea of establishing a possible wood fuel supply depot at Blaise nursery
   - The site is unlikely to run into any major problems with planning permission, and has very good access for fuel/ wood chip deliveries, and space for wood chip storage
   - The use of a wood chip boiler on the site would fit well with the “green” nature of a plant nursery
   - It would be an important exemplar project within the area, and would play a key role in demonstrating biomass energy technology

10. Potentially, recycled wood waste could be used as an alternative fuel source (e.g. from Churngold). However, this fuel would be 1.5 to 2 times as expensive, which would increase the payback times.

    However, this would open up the possibility of possibly selling Packaging Recycling Notes (PRNs), which would reduce the effective fuel cost (see section 6 for a more detailed discussion)

    One option is to use recycled wood waste in the short term, to establish the biomass plant, before switching to the use of arboricultural chip. This would allow more time to establish a supply chain for the arboricultural chip, and fuel storage, screening and drying facilities. However, this would depend on being able to secure a short term fuel supply contract with a waste management contractor at a reasonable price.

11. There are a number of technical options and choices that are still to be made – as detailed in section 4.4.6 – that would also have an impact on capital costs and hence payback times.

12. It would be worth, at an early stage, discussing with Council staff the likely costs of installing the heat main at Blaise nursery, using in-house expertise. This could lead to a considerable cost saving, as the cost of the heat main is a major part of the capital cost.

13. If a biomass boiler were installed at Blaise nursery, this would open up the potential for growing other crops at Blaise outside of the current heating season (March to May), with minimal energy costs. This might be an option worthy of discussion with the nursery manager and Contract Services. This would increase the number of running hours of the biomass boiler, and hence improve the payback time.

14. Currently there is some uncertainty over the length of the lease between Contract Services and Leisure Services. This would need to be clarified before any investment decision could be made.

5 FEASIBILITY STUDY FOR SOCIAL HOUSING TOWER BLOCK IN SOUTH BRISTOL, HARTCLIFFE AND WITHYWOOD

5.1 General Site Description

Social Housing Tower Block in South Bristol is a council-owned social housing block located off Silcox Road in the Hartcliffe & Withywood area of Bristol. The building, built in the mid-1960s, contains 62 flats over 10 storeys. Photos of the site and a map showing the location are given in annexes C1 and C2.

5.2 Existing Heating Plant and Infrastructure

Currently, 2 gas-fired boilers (model SR1300 Plus, from Hoval of Sweden) are used to heat the building. These are nominally rated at 1.3 MW each and are also used to heat two similar buildings, Millmead House and Hayleigh House, via a heat main. A schematic of the heat main is shown in Annex C4. The boilers are nearing the end of their working life and are due to be replaced within the next 2 years. At the beginning of 2002, the heating controls were replaced with a modern Building Management System (BMS).

The building was originally heated using oil as a fuel, with two unused oil storage tanks remaining in-situ within a separate fuel storage room. The layout of the boiler room, and adjacent areas containing the calorifiers and oil tanks is shown in Annex C3.

5.3 Heat Demand

The combined capacity of both existing boilers is currently sufficient to supply approximately 1.5 times a peak load of 1.7 MW. The boilers operate continuously and fire up sequentially in four stages, with the minimum turn-down being 25% i.e. one boiler operating at 50%. Radiators within each dwelling are supplied with hot water directly from the boiler, as controlled by the BMS, and have no individual controls. Heat supplied is measured using heat meters in each flat.

5.4 Fuel Consumption

Fuel consumption and costs are shown for the period March 2001 to Feb 2003 in Annex C5. Gas consumption for this period was 2,055 MWh (March 2001 to Feb 2002) and 2,054 MWh (March 2002 to Feb 2003). An annual fuel consumption of 2,000 MWh is assumed in the following relevant sections. Based on a seasonal efficiency of 82% for the boilers currently in place, this represents an annual heat demand of 1,640 MWh.

The Council currently purchases gas from Northern Electric & Gas at a cost of 1.113p/kWh. As the energy is supplied to domestic users, this is not subject to the Climate Change Levy.

5.5 Outline Design of Biomass System and Technical Options

Discussions have led to the idea of replacing both existing boilers with one fuelled by wood and the other by gas as before. One of the old boilers would, however, remain in place as a back-up for a short period.

Two options have been discussed for the new boiler arrangement:

(a) The wood-fuelled boiler will be located in the room adjacent to that of the existing boiler room. Although this room currently houses the two calorifiers, sufficient space may be available for the new boiler. The oil tank storage room is adjacent to this and removal of these tanks would create a suitable storage space for the wood fuel. Access would then be required through the wall separating the fuel store from the wood-fuelled boiler in order to facilitate automatic transfer of fuel.

(b) The wood-fuelled boiler will be located in the oil tank storage room, once the tanks are removed, with the remaining area within this room being used as a wood fuel store. It is thought that the fuel store could extend outside the exterior wall, below ground level, enabling hatch access for fuel delivery. Several types of fuel-handling systems are available and typically incorporate a high-speed auger screw.

At this stage, option (b) looks more feasible, although a detailed engineering survey will be required to confirm this.

Based on a boiler plant annual fuel consumption of 2,000 MWh, it is estimated that installing a 700 kW wood-fuelled boiler in the above arrangement could provide a base heat load equal to approximately 1,640 full-load equivalent hours operation, sufficient to replace 70% of current gas consumption.

Annex C6 presents a specification of the boiler considered (Compte R Compact 700 kW). Fuel type, i.e. 'wet' arboricultural waste or 'dry' recycled wood waste, will dictate the boiler design, with the former requiring a more expensive option. However, the wet fuel boiler is considered the preferable option in this case as it can also switch to dry fuel, subject to modifying the control programme.

5.6 Fuel supply and storage

Using the assumptions above, and assuming 80% boiler efficiency, annual volume of wood required would be approximately 319 wet tonnes or 911 m^3. A suitable fuel store capacity would be 50-60 m^3. Peak fuel consumption periods may require twice-weekly fuel deliveries of 30 m^3 each. This should be adequate to ensure that the boiler always has 2-3 days supply on hand.

The fuel store, especially the access hatches, will need to be adequately secure to guard against vandalism. Precautionary measures may be required e.g. a fire-block ceiling or enclosure, to mitigate any fire hazard risk associated with the fuel store. Approval of the fuel store design by a fire-safety officer or other relevant authority may be required.

There are two options for the supply of biomass fuel to the site:

- Make use of untreated recycled wood waste, e.g. from pallets – to be purchased from a waste management company

- Make use of wood waste from Council forestry operations – e.g. from street tree trimmings, and thinnings from Council woodlands

The estimated size of the latter resource is presented in Section 6, along with issues relating to collection, processing and transport.

As mentioned above, the boiler specification, and hence cost, will be affected by fuel type.

5.7 Access

Access to the site and proposed fuel store is straightforward. Double doors currently allow direct access to the oil tanks from outside. As mentioned above, access hatches immediately outside the fuel storage room are proposed for fuel delivery. Currently this area is clear, thus enabling a delivery vehicle to offload directly into the fuel store. **There is, however, an area around the building that must be left clear for fire service vehicle access. Approval in this respect will be required from the relevant authorities.**

5.8 Legal and Planning Issues

<u>Emissions</u>

Bristol has been declared a smoke control area by virtue of a number of smoke control orders originally under the Clean Air Acts of 1956 and 1968 (now consolidated into the Clean Air Act 1993). This, however, applies mainly to small-scale domestic installations and has resulted in a list of 'Exempted Fireplace Orders' being issued by DEFRA. Boilers of the size proposed for Social Housing Tower Block in South Bristol (700 kW) do not fall into this category. Installations of this type (<3 MW) fall under Schedule B of the Environmental Protection Act 1990 and therefore are not regulated by Integrated Pollution Control (IPC). They are instead regulated by the Local Authority Environmental Health Office.

The type of wood fuel used may also dictate which regulations are relevant. The use of clean virgin wood may relate only to aspects of the Clean Air Act. For boilers using forestry / energy crop / sawmill / arboricultural type woodchip (i.e. "raw" clean chip) developers are simply required to notify the local EHO of the planned installation and provide details of the boiler to be installed, including flue gas clean-up, the fuel to be used, etc. Boilers above 400 kW net rated thermal input burning "clean wood waste" - furniture factory waste, pallets etc - are part B processes under the EPA and are regulated under Local Air Pollution Prevention and Control (LAPPC) as detailed in guidance PG1/12. These boilers need an authorisation from the EHO and usually an annual emissions test to check the boiler emissions are within limits set out in PG1/12. The Compte boiler is warranted by the manufacturer to meet these limits.

In any case, it is the Local Authority EHO who will regulate an installation of this type. Initial discussions with the relevant EHO have indicated that visible smoke is likely to be the principal issue. This should not be a problem as the Compte boiler considered is designed to emit no visible smoke under normal operation. On occasions, there may be instances of white smoke during start-up with ‘wet’ fuel, which is allowable under the Clean-Air Act legislation.

The existing flue arrangement runs up the interior of the building. It should be possible to either install an additional flue within this, or use an existing one, for the wood-fuelled boiler emissions. A separate flue is normally required due to possible differences in flue gas velocities for the two types of boiler.
There are two types of ash produced: ash collected in the combustion unit (the residue left in the primary chamber); and ash collected from the flue gases. There is, however, a closed circuit process for all ash since it is captured and can be safely contained prior to a decision on disposal or use. The amount of ash produced depends on the technology used; in gasification plants it is very small, only 1-2% of the original bulk. The following general points may apply:

- Ash can be a valuable by-product: it has considerable potential value as a low nitrate fertiliser, and may be used as a raw material in the brick and cement industries.
- The wood being burnt is likely to contain small quantities of heavy metals, either naturally occurring or from some types of fertiliser used to grow the fuel crop. Any use or disposal of the ash as a by-product will have to take full consideration of this. It is good practice for a full assessment of the contents of the ash to be undertaken before any use is determined.
- If there is no use identified, the ash will need to be disposed of in a landfill.

A 700 kW wood-fuelled boiler installation at Worcestershire County Hall currently utilises its ash as compost or fertiliser, as a result of using clean virgin wood fuel.

<u>Planning</u>

Any modifications to areas outside the existing boiler room would need approval by the Area Housing Office.

5.9 Operation and Maintenance Requirements

The council currently have a maintenance contract with INTEGRAL Ltd. who undertake all servicing and repairs. Should the wood-fuelled boiler be installed, the option preferred by Neighbourhood & Housing Services is to continue with this arrangement and organise training for staff to conduct maintenance work on the boiler plant. Alternatively, the boiler installers can offer a maintenance contract for around £3k / year.

Two general services per year are normally undertaken on boilers of this type, along with additional maintenance as required. Around twice during the heating season, the boiler will need to be completely shutdown for cleaning of the fire tubes, as well as de-ashing. This would take about 4 hours each time, allowing for the boiler to cool down. All of these de-ashing operations could be carried out by a suitably trained member of the existing maintenance contractors.

With an automated system, ash is collected by one of two 1,100 litre bins and will require emptying approximately once per month -an option may exist to combine fuel deliveries with light maintenance tasks such as these.

In the costing scenario that follows, an extra £1.5k per year on top of capital cost has been assumed for operation and maintenance over and above that which is currently required for the existing boilers. This figure will therefore largely depend on the extent to which additional work can be integrated with existing practices. Typically, apart from two annual general services, weekly on-site checks are currently undertaken with cleaning and repair as required.

5.10 Economics

Figure 9 below presents a costing scenario. This assumes that a 50% capital grant (up to £100k max) will be available from the Clear Skies Grant Scheme. An annual energy consumption of 2,000 MWh is assumed. A more detailed economic analysis incorporating annual heat load profiles, if available, will be the subject of an in-depth engineering survey as proposed in Section 5.14.

The potential economic value of CO_2 savings through emissions trading are not included in the table. However, based on the estimated saving in CO_2 of 266 tonnes (see section 5.12.1) and based on long term indicative prices for carbon trading of around £3-5 / tonne, this could provide a potential additional revenue of £800-£1330 per year.

Fig 9. costing scenario for biomass boiler at Social Housing Tower Block in South Bristol

Capital Costs	
Boiler max output	700 kW
Installed cost	£190,000[1]
Grant aid @ 50%	£95,000
Net Capital Cost	**£95,000**

Running Costs	
Woodfuel moisture content	15% (assuming use of recycled pallets)
Boiler annual efficiency	80%
Effective heat output	3,601 kWh / tonne
Rate of fuel use @ max boiler output	1.18 m^3 / hour
Fuel cost (assumes recycled wood waste)	£22 / tonne (£25.88 / dry tonne)
Effective cost of woodfuel / unit useful heat	0.61 p / kWh
Boiler full-load equivalent hours operation	1,640 hours
Biomass boiler energy output / year	1,148 MWh
Fuel used / year	319 tonnes (wet)
Annual cost of wood fuel	£7,018
Estimated annual O & M costs[2]	£1,500
Estimated Annual Running Costs	**£8,518**

Savings & Payback	
Assumed gas boiler annual efficiency	82%
Cost of gas	1.113p / kWh
Cost of gas / unit heat output	1.36p / kWh
Wood boiler energy produced / year	1,148 MWh (assuming meets 70% of annual heat load)
Quantity of gas currently used / year	2,000 MWh
Cost of gas / year	£22,260
Annual saving in gas	1400MWh
value	**£15,820**
Net annual saving	**£7,302**
Simple payback on capital	**13 years**
Payback (assuming £30k avoided capital cost)[3]	**9 years**

Notes:

[1] Capital cost quoted is supplied by Econergy Ltd. and allows for a more expensive boiler spec using wetter, arboricultural-derived wood. This gives the option of burning either “dry” recycled wood waste, or “wet” arboricultural chip. It also allows for automatic ash-handling, and includes building modifications for provide improved

fuel access. The existing oil tanks are due to be removed anyway, so this cost is excluded.

[2] Operation and maintenance is currently undertaken by INTEGRAL Ltd. And typically involves two annual general services, as well as brief weekly visits

[3] Replacement of the existing plant with two conventional gas boilers will cost approximately £100k, the avoided cost of replacing only one, therefore, may be in the order of £30k.

5.11 Stakeholder Analysis

Norman Jennings, Maintenance Services Officer from the Council's Neighbourhood and Housing Services M&E team, has expressed interest in the project and offered much information.

John Long, Technical Investments Manager, Hartcliffe (Housing Dept), has yet to be consulted on the study. This consultation will take place following circulation of this report.

5.12 Social and Environmental issues

5.12.1 CO_2 Savings and other Emissions

Based on the 'carbon neutrality' concept of sustainable wood fuel, it is estimated that a wood-fuelled boiler installation as described above would save around 266 tonnes per year of CO_2 emissions[7]. However, other factors do need to be considered, such as CO_2 emissions from fuel transport, etc.

NOx, SOx, particulates and VOC emissions from a wood-fuelled boiler will generally be slightly higher than those from a gas-fuelled installation[8]. NOx emissions, for example, are around 30% higher than from oil, LPG and mains gas, although figures will vary depending on which technologies are compared.

5.12.2 Social benefits

A wood-fuelled boiler installation at Social Housing Tower Block in South Bristol would be the first of its kind in the area and could be viewed as an exemplar project in progressing the Council's environmental policy. Such a project will help to kick-start a local market in sustainable wood fuel supply, possibly creating local employment opportunities and local supply chains for other biomass heating projects. The installation could also be used for educational purposes with regard to use of renewable energy.

[7] based on 0.19kg of CO2 per kWh for mains gas, and a saving in gas of 1400MWh per year
[8] Source: Econergy Ltd.

5.13 Project Management and Realisation Considerations

- The Clear Skies Grant Scheme is now in place and can offer up to 50% of capital costs or £100k, whichever is lower.

- There will be an option to apply for funding to undertake a more detailed feasibility study under the Community Energy Programme. Calls for bids are on a rolling basis and funding allows up to £10k, with 50% match funding. The main purpose of this would be to undertake an engineering survey in order to produce a detailed specification and is expected to cost £2-3k.

- Currently, the existing boilers are set to be replaced in 2004.

- Development of an area adjacent to Social Housing Tower Block in South Bristol is currently being planned under the SRB budget. This could possibly include CHP as an option for district heating and so should be investigated as soon as information is available.

5.14 Conclusions and recommendations

1. The gas boilers at Social Housing Tower Block in South Bristol are due to be replaced in 2004. There is a key window of opportunity to include installing of a biomass boiler as part of this replacement.

2. Initial estimates suggest that a 700kW biomass boiler would be the optimum size for the site. This would supply baseload heating needs, and would meet about 70% of the annual heat load, running for about 1640 equivalent full load hours. By displacing the use of mains gas, this would save about 266 tonnes of CO_2 emissions per year.

3. The economics appear favourable. Based on a grant level of 50%, (which is readily achievable given current levels of government support) and allowing for the avoided cost of installing a biomass boiler in place of a gas boiler, then the simple payback is 9 years, based on savings from reduced gas consumption. The total capital investment that would be required from the Council, or a third party, is estimated to be £95,000.

4. This payback is based on the use of relatively expensive (£22/wet tonne) recycled untreated wood waste, bought in from a waste management contractor. The use of green wood chip sourced from Ashton Court, for example, would significantly improve the payback time, as this is a much cheaper source of fuel. However, due to its lower energy content, more frequent fuel deliveries would be required. The wood chip would also need to be kept in a covered store, and screened before it could be used (see section 6 for a more detailed discussion about a wood fuel depot).

5. It is recommended that the Council should submit a bid to the EST Community Energy Fund for a more detailed feasibility study for Middelford House, as soon as possible. This should cover the following aspects:

   - Consultation with tenants and key stakeholders in NH&S about the proposals
   - More detailed engineering survey, to look at modifications to the existing boiler plant room
   - More detailed economic analysis, based on discussion with key Council staff, to provide information to make investment decision, and meet Best Value requirements
   - Preparation of tender documentation

6. This size of biomass boiler would burn about 278 odt wood chip per heating season – this equates to about 319 wet tonnes of recycled wood waste, or about 615 wet tonnes of green wood chip. This compares with the estimated wood chip resource at Ashton Court of 700 wet tonnes. There would appear to be a sufficient wood fuel resource, of both arboricultural and recycled wood waste, to supply the proposed installation. However, choice of fuel type may affect eligibility for some types of grant funding (see Section 6).

7. Use of arboricultural-derived wood chip would require a more expensive boiler specification. However, subject to boiler control adjustments, this type may also

accommodate untreated recycled wood waste. The costings have assumed the use of a boiler that can handle the wetter arboricultural wood chip.

6 ASSESSMENT OF SOURCES OF BIOMASS SUPPLY

6.1 Overview

The scope of the study was to assess the types and quantities of wood residues generated within the city of Bristol that could be potentially used to fuel biomass energy installations at Council controlled sites within the city.

Nature of this resource in fairly complex in terms of the differing sources, quality and forms that these residues take. Broadly, the residues can be split into two categories, namely:

1. Green wood residues
2. Recycled untreated wood waste

These are explained in more detail below.

Green wood residues

There are two major sources of this:

- Arboricultural residues – tree trimmings carried out by BCC Contract Services on street trees, park trees, and smaller woodland areas; private tree work carried out by tree surgeons

- Woodland thinnings – generated from the management of BCC woodlands, under the control of the Urban Forestry team, including Ashton and Blaise woodlands. This work is carried out under contract by Fountain Forestry.

This type of resource comes as either wood chip, or larger logs. It is the former which can be used as fuel for the boilers described in sections 4 and 5 – they are "wood chip" boilers. The latter can be used as fuel in smaller log burning boilers which would be suitable for individual household use – but that is not part of this study.

Recycled untreated wood waste

Sources for this are as follows:

- Joinery and furniture workshops in the City – generating both timber offcuts and sawdust
- Waste management contractors (e.g Churngold) – this collect wood waste from a variety of, generally, commercial clients, and sort it into treated and can sort it into treated and untreated wood waste – good sources for the latter are pallets.

Pallets and wood offcuts can be chipped and then burnt in the wood chip boilers described in sections 4 and 5.

Sawdust can be converted into pellets, which can then be burnt in pellet boilers, suitable for use in individual households, or small scale non-domestic applications, such as a school. Rather than converting them to woodchip, pallets and woodcuts can also be macerated to convert them to sawdust, and then turned into pellets.

The term "untreated" is a key one. There are large quantities of treated wood waste that end up, for example, at civic amenity sites in the city, or go to a WMC. But this sort of wood waste would not be suitable for burning in the type of boilers described in sections 4 and 5, as it is regarded as an environmentally hazardous waste, and falls under different regulations with regard to the control of emissions – e.g. the EC Waste Incineration Directive.

6.1.1 Moisture content and oven dry tonnes

A key variable for describing the quality of different forms of potential wood fuel is the level of moisture content (MC). This is commonly expressed as a % of the dry weight. The MC of a quantity of wood chip affects its useful energy content, per unit weight. This is because a proportion of the weight is water, rather than wood, and because when the wood is burnt, a certain proportion of energy is used to evaporate the water rather than providing useful heat.

For this reason, the phrase oven dry tonnes (odt) is commonly used to describe the quantity of wood resource. All forms of wood have roughly the same energy content per tonne when oven dry, (i.e. 0% moisture content), about 5167kWh/ odt. Green wood chip has a moisture content of about 50% by weight, and has an energy content of about 2333kWh/tonne.

6.2 Forest Residues/ Woodland Thinnings

6.2.1 Bristol City Council controlled woodlands

There is about 320ha of woodland in Bristol. With the main concentrations in the west, around Ashton Court estate (80ha), and Blaise castle and Kings Weston estates (71ha) (see annex C xxx for map of woodland distribution). It would seem that any thinnings that come from the woodlands already end up as chip at Blaise, Ashton, or Aldbury.

Potentially, greater volumes of thinnings could be available for chipping from these woodlands, through more active management. However, the Urban Forestry Manager stressed that these woodlands are managed primarily for amenity and biodiversity, rather than yield.

As part of a Heritage Lottery Fund application, a 10 year woodland work programme has been prepared for Ashton Court, which gives a forecast of thinnings volumes. This suggests that the likely economical thinning yield would be about 1155m^3. This equates to an average of about 115m^3 per year, which is roughly the same in green tonnes. However, these thinnings forecasts are only very rough estimates, and the actual volumes extracted are likely to be less than this.

6.2.2 Forest of Avon Co-op

Initial discussions were held with the Forest of Avon Co-op, and they were in principle interested in the idea of selling woodland thinnings to any biomass plant operating in Bristol. They have a database of landowners who belong to the Co-op, who are outside of the Bristol boundary, but would be in close enough proximity to make supply potentially economically viable. This database contains information that would give a rough indication as to the volumes of thinnings that might be available from this source. This information was requested for the study, but at the time of writing this report, has not been received.

6.3 Arboricultural Thinnings

6.3.1 Council operations

In terms of residues stemming from Council controlled sites, there are 2 main sources:

- Trimmings from highway and park trees, and trees in school grounds, carried out by the main arboriculture contractor – Fountain Forestry.
- Tree trimmings carried out by Contract Services, from parks and shrubberies, woodland activities, and housing estates

The largest concentrations of street tree trimmings go to Ashton Court – there is a pile of woodchip in Bower Ashton Estate yard. Based on discussions with the main contractor, Fountain Forestry, the Urban Forestry manager estimates the volume of green wood chip that goes to the yard each year to be about 2000m^3. This equates to approximately 700 green tonnes, or 378 odt (oven dry tonnes) of wood available for combustion, which has an energy content of 1,953 MWh[9]. As mentioned above, this quantity of wood chip at Ashton Court also includes occasional thinnings from the Ashton Court woodland.

Not all of this, however, will be suitable for use in a biomass boiler. Some of it will either be leaf material, or out-size pieces that would be removed when screened. Also, if the material begins to compost, then this would reduce the energy value.

Currently, all of this wood chip is sold off to Fountain bark products for a nominal sum of £2/tonne, who then compost it and sell it on as soil improver. The Urban Forestry manager has stated that he would be happy to see the wood chip being used for energy production instead, and would not miss the revenue from compost sales.

The quality of the wood chip is variable – in the summer it contains a high proportion of green matter, whereas in winter, it is mainly branchwood. Therefore, some sort of screening would be necessary to ensure that the chip is of sufficient quality to feed into a biomass boiler. Generally, the wood chip should be within the range of 2-25mm in size. It is particularly important to remove long, springy pieces of wood, known as "slivers", that can block the fuel feed mechanism.

During the detailed design of the biomass boiler and feed system, if it is to take arboricultural wood chip, then it will be very important to ensure that the fuel handling system will be matched to the grade and quality of wood chip being supplied.

Failure to do this will lead to repeated blockages of the fuel feeding system.

[9] Assuming a basic density of 0.54odt/m^3 for hardwood, energy content of 5167kWh/odt, and a packing density for wood chip of 0.35.

At present, the wood chip is stored out in the open – again, it would be preferable to keep in under cover, to allow drying to take place to reduce the moisture content of the wood.

There is also a considerable quantity of wood chip that is stored and delivered to Blaise nursery by Contract Services. However, it appears that all of this woodchip gets re-used as compost and mulch on the Council shrub beds around the city. Therefore, this resource cannot not be relied upon for energy production.

6.3.2 Tree surgeons

As part of the study, a telephone survey was conducted with the 12 tree surgeons listed in Yellow Pages for the Bristol area. A summary of the results is shown in the figure below:

Fig 10. table showing results of survey with Bristol tree surgeons

Name	Estimated Annual Green Tonnes	Oven dry tonnes	Energy content (MWh)
Connick Tree Care	315	170	879
All Season Tree Service	390	211	1,088
All Tree Services	390	211	1,088
Aspen	260	140	725
Bitton Tree Care	52	28	145
Bristol Urban Forestry	130	70	363
Bryant Mathew NCH	60	32	167
Craig Veale Tree Surgery	n/a	n/a	n/a
Heritage Tree Surgeons	520	281	1,451
Modern Arboreal Consultancy	104	56	290
Chameleon Tree Services	12	6	33
Instant Tree Care	312	168	871
Subtotals	**2,545**	**1,374**	**7,101**

For the full results of the survey, see Annex D2.

Although the figures are only very rough, they do suggest that there is a considerable potential biomass resource from this source. However, several of the tree surgeons said that there was a seasonal variation in the amounts they collected. As the survey was carried out in September/ October time – which would be a busy time, the figures may well be an overestimate for other times of the year.

The survey suggests that at least some of the tree surgeons find it difficult to dispose of residues, and it is either being burnt, or taken to landfill. Indeed, two of the tree surgeons are paying to either dump the tree resource, or to have it taken away. However, some are able to sell the wood chip, e.g. to garden centres, and therefore would presumably have less interest in free disposal to a wood fuel depot. Most of the tree surgeons said that they would be interested in being able to leave the residues free of charge at a local Council controlled site. However, they stressed that the site would need to be in relatively close proximity to where they were working.

One of the tree surgeons already leaves their wood chip at Blaise nursery, and another at the Avonmouth civic amenity site.

If the tree surgeons who already sell their residues are excluded, as well as the quantities left at Blaise, which is accounted for above, then this leaves a figure of about 892 green tonnes, which is equivalent to about 482 oven dry tonnes. Therefore, a rough estimate is that the additional amount of biomass supply that could be gained from providing tree surgeons in Bristol with alternative disposal sites, is likely to be similar to that already available at Ashton Court.

6.3.3 Wood Fuel Storage and Quality Control

If the arboricultural wood chip currently stored at Ashton Court, and any potential additional supply from tree surgeons is to be used to fuel a biomass boiler, then it will need to be kept in a covered fuel store. This is necessary to prevent rain increasing the moisture content (MC) of the fuel.

The type of moving grate boiler mentioned for use at Blaise nursery is capable of burning wood chip with a MC as high as 60%. However, there are several reasons for wanting to reduce the moisture content below this level, namely:

1. During intermittent operation of the boiler, there may be occasional problems with smoking, if the MC is above 55%
2. The boiler efficiency begins to drop if the MC is above 45%
3. The energy content of the fuel decreases as the MC increases – this, in conjunction with (2) means that to meet the same heat load, more fuel must be loaded into the boiler, which increases the labour time and hence running cost for the boiler, as well as the storage volumes required
4. If green wood chip is stored without being dried, there is a danger that it will begin to compost. In order to prevent this, the wood chip needs to be “stabilised” by drying it so that the moisture content falls below 40%. This would mean storing it in a covered fuel store, with a drying floor. It is possible to still burn wood chip that has begun to compost, but it may have lost up to 50% of its energy content.

Generally, hardwood thinnings, which would come from street trees, have a green MC of less than 50%, and almost all softwoods are in the range of 50-60%. Therefore, as long as the chip is kept dry, it can be burnt in the boiler. However, for the reasons mentioned above, it would also be beneficial to also allow some drying of the fuel.

The fuel store can be of varying levels of sophistication, and hence cost. The most basic would be to have a pole barn, with 3 sides, and slatted walls, with a cost concrete, vented floor. Wood chip could be stacked in this up to 3-4m high, and some limited drying would take place, through natural air movement, and warming from the beginnings of composting in the centre of the wood chip pile. There would be some loss of energy content in the wood chip due to composting.

The boiler at Blaise nursery would consume about 700m^3 of green wood chip during the 3 month heating season. This would need a barn of about 250m^2 floor area to store a year's supply. There would be space to accommodate this on the Blaise nursery site.

In addition to keeping the fuel dry it will also be necessary to screen it, as mentioned above. The chip could either be screened on a batch basis, or a vibrating screen could be permanently installed, that would process the arboricultural chip through into the store. The batch screening could either be carried by Council staff, which involves investing in a screen, or a contractor could come in to do it. The cost of a drying barn, screener, and tidying up a corner of the site and laying hardcore would be in the region of £20-30,000. Funding for this could potentially come from Landfill Tax money, or from the new DEFRA bio-energy infrastructure grants scheme (see section 7, for more information on grants).

As well as just providing screening and storage for a boiler at Blaise nursery, the site also has the potential to be a wood fuel supply depot for other biomass energy sites within the city. As well as just storing and screening chip, the site could also have a chipper, and possibly a shredder, which would convert any sort of woody material into chip suitable for a biomass boiler (e.g. logs, pallets, branches).

6.4 Recycled Wood Waste

6.4.1 Joinery Workshops

A telephone survey was carried out with 10 joinery and sawmill companies in the Bristol area, as listed in Yellow Pages. For the full results of the survey, see Annex D. These are potentially a good source of untreated wood waste in the form of sawdust. Sawdust can be palletised, and then used in automatic pellet burning biomass boiler – either for household use, or small scale institutional use (e.g. schools). In a parallel project (not included in the scope of this study), Bristol City Council's Energy management Unit at looking at the potential for pelletising sawdust form the Council's joinery workshop in Wellington Road, for use in an on-site boiler and/or to supply pellets to other users in the Bristol area. The quantities of residues available at Wellington Road are not included in this analysis.

The survey shows that the sawdust is currently a "problem waste" for most of the businesses – and is being disposed of as a waste, either going to landfill, being burnt or being stockpiled. Some of the businesses are able to pass on the sawdust for animal litter. One business is selling the sawdust/ wood chips to a chipboard manufacturer. Apart from this business, all of the others were interested in an alternative disposal route. Based on the responses, about 80 tonnes of sawdust per year could be available from this source, with an approximate energy content of 360MWh. This would be enough to meet the typical annual space and water heating needs of 18 households[10].

There is an additional, larger, resource from these sites in the form of wood offcuts, wood chips, and shavings. In order for these to be converted to pellets, they would first need to be macerated into wood powder, similar to sawdust. Some of this

[10] based on typical annual space heating demand of 13650kWh, and 2500kWh for water heating (typical figures for semi-detached 3 bedroom house), and assuming 80% biomass boiler efficiency

residue is used for firewood, but most appears to also go to landfill. The quantity of these residues potentially available is estimated to be 189 tonnes per year, with a potential energy content of 839MWh.

An alternative use for the wood chips and wood offcuts components of this waste is to chip the wood offcuts and use them to supply a biomass boiler. This could be feasible if a biomass boiler was installed at Social Housing Tower Block in South Bristol, and it was optimised to run off pallet chip. However, this would not necessarily be a free source, as at least one of the joineries is selling wood chip for £6/tonne. It could, however, be a cheaper source than from a waste management contractor. In order to do this, it would be necessary to tackle the logistical difficulties of collection, where to store the fuel, and maintaining fuel security.

As with the survey of tree surgeons, this data is only rough, and there will be a margin of error to do with:

- Quantities based on rough verbal estimates from the business contacts
- Assumptions about the volume of bags, and bins

It is important to stress that the type of wood residues for use in biomass combustion plant must be ***untreated*** - to ensure that it falls outside of the Waste Incineration Directive.

6.4.2 Civic Amenity (CA) Sites

Within the boundaries on Bristol City, there are two CA sites, at Avonmouth, and Days, Rd, St. Phillips. There are large quantities of waste wood going to these sites

According to Roger Young, of the WDA, there are about 200 tonnes per month of wood waste delivered to the site. However, most of this is treated wood waste – for example, old furniture, and wooden floors. This is smashed up, and goes to Churngold, a waste management contractor.

There is also garden waste delivered to the site, some of which includes branches that would be suitable for chipping. The quantities of this are not known at this stage. The WDA currently pay Hinton Organics £18 per tonne to remove this green waste.

It is known that there are also other CAs in neighbouring Authority areas – for example South Glos – that are used by Bristol residents. The potential resource at these sites has not been investigated.

6.4.3 Waste management companies and Packaging Recycling Notes (PRNs)

In 1997, the UK government introduced packaging waste regulations in order to meet the European Directive on packaging and packaging waste. In order to ensure that packaging is recycled, the UK developed a system of tradeable permits called Packaging Waste Recovery Notes, or PRNs. A site with a biomass boiler, burning recycled wood waste, can register with the Environment Agency to be a reprocessor. They are then able to write out PRNs and sell them in the open market. Currently, PRNs for recycled wood waste are trading at about £20-25 per tonne.

This offers the potential, in theory, for zero net fuel cost for biomass boilers burning this sort of wood waste (based on a purchase price of chipped pallet wood of £22 per tonne, for example). However, there are a few points to bear in mind about this option:

- The market for PRNs is volatile, and therefore future prices are difficult to predict
- The recycling/ waste management companies are well aware of the value of PRNs, and therefore will begin to raise the prices of the packaging chip as a result

However, unless locked into a long term supply contract, there is no reason why biomass boiler could not start by burning packaging waste, and then switch to burning arboricultural residues at a later date. As long as the boiler is designed to cope with wet fuel (i.e. moving grate) then it can be re-optimised to burn the wetter fuel. The two types of fuel should preferably not be mixed together, as this would spoil the optimisation, and reduce the efficiency of the boiler.

6.5 Conclusions and recommendations

1. The quantity of green wood chip currently available at Ashton Court is roughly estimated to be 378 oven dry tonnes. All of this is potentially available for use in a biomass boiler, at little opportunity cost, as it is currently being sold for a nominal sum for compost.

2. Allowing for errors in this coarse estimate, this is almost certainly enough to supply a biomass boiler at Blaise nursery, which would require about 100 odt per year. It may also be enough to supply a boiler at Social Housing Tower Block in South Bristol, which would require about 300 odt per year. However, based on the rough estimate provided, it would probably not be enough to supply boilers at both Social Housing Tower Block in South Bristol and Blaise nursery.

3. Although large quantities of wood chip are stored at Blaise nursery, all of this chip appears to be re-used for mulch and path surfacing by Contract Services, and therefore would not be available for biomass energy.

4. The survey of tree surgeons suggests that in the region of approx. 482 odt additional supply of green wood chip could be available if tree surgeons were provided with a site where they could dispose of their wood chip for free. This is the quantity for which there currently appears to be no alternative outlet other than dumping, incineration or disposal at CA sites.

5. Before any of the arboricultural wood chip, either from Ashton Court, or from tree surgeons, could be used, it would need to be screened, to remove oversize slivers, foreign objects and green matter. Furthermore, it should also be kept in covered barn, to prevent it from getting any wetter, and to allow preliminary drying to take place.

6. If the Council wish to proceed with installation of a biomass boiler, at either Social Housing Tower Block in South Bristol, or Blaise nursery, or both, then it should consider establishing one or more wood fuel supply depots, to enable arboricultural wood chip to be used as the fuel. Potential sites for this could be either at Bower Ashton Estate Yard, or Blaise nursery. As a minimum, this should include a covered barn, for storing the wood chip, to protect it from rain, and to allow preliminary natural drying. It could also include a screener, although this function could also be carried out by a contractor. A ballpark cost for this facility is in the region of £20-30,000.

7. The Forest of Avon Co-op has expressed interest in being involved in a partnership with the Council to develop such a facility. There are uncertainties over their current tenure at Bower Ashton due to plans to re-develop the site, and they have expressed interest in the idea of re-locating to Blaise nursery as an alternative site. The facility also has the potential to act as a broader outlet for logs, and timber products from the Forest of Avon.

8. This idea of a wood fuel depot is likely to be attractive to funders, with the potential to tap into grant funding sources from Landfill Tax revenues, New

Opportunities Fund, and DEFRA Biomass Infrastructure grants (see section 7 for more information on funding sources).

9. The advantages of such a wood fuel depot would be as follows:

   - The economic viability of a biomass boiler at Blaise nursery depends on being able to make use of virtually free arboricultural wood chip
   - Although the economics of a biomass boiler at Social Housing Tower Block in South Bristol do not depend on using this green wood chip – recycled untreated wood waste could be used instead – it would shorten the payback time
   - It opens up the possibility of attracting residues from tree surgeons, which would provide sufficient resource for boilers at both Blaise nursery and Social Housing Tower Block in South Bristol. This would also be diverting this tree waste from being dumped or going to landfill.
   - In the longer term, it could act as focal point for establishing a biomass wood fuel supply chain within the City
   - Strong synergy and partnership with the Forest of Avon project

7 SOURCES OF GRANT FUNDING

Name of Grant	Bioenergy Capital Grants
Description and main criteria	Funding to promote the efficient use of biomass heat and power generation, with a particular emphasis on energy crops. There are 3 priorities within the scheme: deployment of high efficiency electricity generation and CHP using energy crops/forestry & agricultural waste; demonstration of new, high efficiency technology for generating electricity from energy crops; and deployment of biomass heating and small scale CHP. Large and small scale deployment and demonstration projects are included. Generation output should be made available to suppliers. Projects will be assessed on global and local impacts, social and economic impacts including alleviation of fuel poverty, job creation and educational opportunities created. One application per bidding round permitted from an organisation. The results of the first round were announced at the end of January, and several biomass boiler installers were successful for clusters of small-scale heating systems, including both Econergy Ltd and Wood Energy Ltd.
Funder	DTI, New Opportunities Fund & DEFRA (Energy Crops Infrastructure Support Scheme)
Funding type	Capital grants
Amount of Funding per project & Leverage	Grants will not normally exceed 40% of total project costs (including grant funding from other state or European funding sources). For supporting clusters of small-scale biomass heat installations, it is likely that biomass boiler installers will be able to offer a subsidy of turn-key installation up to 25%, to a limit of £50/kW.
Date of next call	April 2003 (if funding remains from early calls)
Contact for more information	http://www.dti.gov.uk/renew/eoi.htm http://www.nof.org.uk/

Name of Grant	**Clear Skies (Community Stream)**
Description and main criteria	Fixed grants are available on a range of community renewable installations. Technologies supported include solar water heating, micro-wind, micro-hydro, ground source heat pumps powered by renewable electricity, automated wood pellet fuel stoves and wood fuelled boiler systems. Community applications must demonstrate evidence of real community involvement and engagement and must enhance public awareness/ understanding of renewable energy. Schemes must use components on the DTI's approved product list. Preference is shown for schemes that; are located in an area of social need; can demonstrate cross-community involvement; have evidence of match funding.
Funder	DTI
Funding type	Feasibility and Capital funding available
Amount of Funding per project & Leverage	Maximum of 50% of total capital and installation costs or £100,000, whichever is smaller. 75% of feasibility study costs or £10,000, whichever is smaller
Date of next call	TBA. Four competitive funding rounds will be held per year. Application forms available from mid-February 2003 from the Clear Skies website
Contact for more information	www.clear-skies.org

Name of Grant	**SWEB Green Fund**
Description and main criteria	Green funds are set up by electricity suppliers which have fund-based green electricity tariffs. The premium paid by customers contributes to the fund to support the development of new renewable energy projects. All projects funded under the scheme must be located within the SWEB or LE supply areas, and be for the installation of a renewable energy generation plant. Limited funds are available for feasibility studies. Preference is given to projects that with demonstrable community engagement and benefits.
Funder	SWEB/LE
Funding type	Development and capital funding
Amount of Funding per project &	A maximum of £30,000 capital funding, or £5000 toward cost of feasibility studies.

Leverage	Partnerships are not essential.
Date of next call	Submissions are invited at any time, and funding decisions are made approximately every 3-6 months, depending on the number of applications received.
Contact for more information	Adam Thompson, SWEB – Tel: 01454 452129;

Name of Grant	**Community Energy**
Description and main criteria	Provides capital and development grants, advice and support for new installations and refurbishment of existing CHP and district heating schemes. It is one of the key mechanisms for the Government to achieve targets set in the Fuel Poverty Strategy for eradicating fuel poverty in vulnerable households by 2010. Grants are available to Local Authorities, Registered Social Landlords (RSLs), Hospitals, Universities and other public service organisations. Applications are assessed against three main criteria: reduction in CO2 for every £1 CE support; cost savings per household over the life of the scheme for every £1 of CE support; and cost savings for public services in fuel bills over the life of the scheme for every £1 of CE support.
Funder	Energy Saving Trust & Carbon Trust
Funding type	Capital and Development
Amount of Funding per project & Leverage	40% of the capital costs of a project, and up to 50% of development costs.
Date of next call	Capital funding rounds are assessed quarterly. The latest bidding deadline is 31/1/03. Applications for development funding of under £10,000 are considered on submission. Development funding bids of over £10,000 are considered quarterly.
Contact for more information	http://www.est.co.uk/communityenergy Helpline: 0870 8506085

Name of Grant	**The Landfill Tax Credit Scheme**
Description and main criteria	The LTCS offers tax breaks to Landfill Operators to support environmental projects. Environmental organisations can receive landfill money either directly, by registering with ENTRUST as an Environmental Body, or indirectly, via a Distributive Environmental Body. The LTCS website gives lists of DEBs by geographical region. There are several local and national DEBs servicing the Bristol area. Each has different funding priorities and programmes

	LTCS funds must be spent in compliance with landfill tax regulations – e.g. projects that encourage the development of projects from waste, land reclamation, pollution reduction, education on waste issues and other schemes promoting environmental improvement. Some projects must be within 10 miles of a landfill site
Funder	Individual LOs or DEBs (see LTCS website for a directory)
Funding type	Capital and development
Amount of Funding per project & Leverage	Varies according to DEB and programme. Most expect a 10% third party contribution (which may be other grant funding). **Landfill tax credits collected after 1/4/03 will no longer be eligible for distribution to waste and recycling projects. Funds available are likely to diminish quickly after this date.**
Date of next call	Varies according to DEB and programme
Contact for more information	http://www.ltcs.org.uk http://www.entrust.org.uk

Name of Grant	**SEED**
Description and main criteria	Projects funded through the SEED programme aim to support local community development and support the development of community enterprise. They must focus on helping disadvantaged communities improve the quality of their environment and promote a more sustainable lifestyle. Community renewables projects, including biomass are supported via the energy efficiency stream. Other streams include waste minimisation, recycling and reuse; environmental education; consumption and lifestyles; sustainable transport; local food initiatives and biodiversity. Preference will be given to projects that address more than one programme theme.
Funder	The New Opportunities Fund (National Lottery
Funding type	Major capital outlay cannot be funded.
Amount of Funding per project & Leverage	Grants will rarely exceed £50K. Those that do must achieve 50% match funding and submit a business plan. Applicants must attract at least 50% match funding, of which 30% must be cash. There is a fast track programme for projects between £500 and £4999.
Date of next call	SEED is a rolling programme. Applications are considered in Feb 2003, May 2003, Aug 2003, Nov 2003, Feb 2004. Work must be completed by Dec 04.
Contact for more information	http://www.rsnc.org/seed/

Name of Grant	**Bio-energy Infrastructure Scheme**
Description and main criteria	The scheme will help develop the supply chain required to harvest, store and supply energy crops and forestry woodfuel to energy end-users. Projects utilising wood thinnings, sawdust and other forestry waste are likely to be eligible for support.
Funder	DEFRA
Funding type	Capital
Amount of Funding per project & Leverage	TBA £3.5 million is available for the UK over 3 years.
Date of next call	The scheme is awaiting state aid approval and relevant legislation and is expected to be in operation in May 2003.
Contact for more information	DEFRA, Agri-Industrial Materials Branch, Tel: 020 7238 6244 http://www.defra.gov.uk/industrialcrops

8 CONCLUSIONS AND RECOMMENDATIONS

8.1 Blaise Nursey

1. The economics of installing a biomass system at this site are marginal, and depend on:

   - making use of arboricultural wood chip, sourced from council operations and, potentially, tree surgeons
   - a level of grant support of 50%
   - the use of the existing barn for use as the boiler house

   If these are possible, then, with a level of grant support of 50%, the simple payback time will be 14 years, due to savings in LPG consumption. Assuming a 50% grant, it is estimated that a capital investment of about £85,000 would be required, either from the Council, or a third party.

2. The economics of any boiler installation, as given above, will be sensitive to the quantity of back-up oil required. The cost of back-up oil has been estimated on the basis (from discussion with the nursery manager) that it is acceptable for the demand temperature not to be reached for about 25% of the time. However, more detailed work would be needed to identify a control strategy to achieve this, in discussion with the nursery manager and a heating engineer.

3. Discussions need to be held with Contract Services staff to ascertain the length of payback time required in order to make a positive investment decision. This would determine the actual level of grant that would be required to make the project work economically.

4. If these payback times are likely to be acceptable, then it should be established as soon as possible whether or not the existing barn could be used as the boiler house, when Contract Services move to Muller Rd. If it cannot, then this will have a significant impact on the capital cost.

5. If the barn can be used, then the Council should consider more detailed investigations for the site, with a view to submitting a bid for capital funding to the Clear Skies funding programme, and other sources.

6. If arboricultural chip, from Council sites, is to be used to run the boiler, then the wood chip that is currently being delivered and stored at Ashton Court will need to be diverted to Blaise nursery, or supply established from another source – e.g. tree surgeons. This fuel will need to be kept in a covered fuel store, preferably with a drying floor, and screened. The wood chip that is currently stored at Blaise is all re-used by Contract Services staff, for paths and mulching (see section 6 for more information on biomass supply).

7. The annual quantities of wood chip delivered to Ashton Court are estimated to be about 278 oven dry tonnes (odt) per year. The consumption of wood chip at Blaise would be in region of about 100 odt per year. Therefore, even allowing for losses due to screening, margins of error in estimates, and loss of energy content due to composting during storage, there should enough wood chip available from

current supplies to Ashton Court to meet the need of a biomass boiler at Blaise nursery (see section 6 for more information on biomass supply).

8. Initial modelling suggests that the optimum size of biomass boiler for Blaise nursery would be about 400kW maximum output. Typically, this would run for the equivalent of about 900-1000 full load hours per year, and would save about 45,000 litres in LPG consumption per year. This would reduce CO_2 emissions from the site by about 70 tonnes per year.

9. In addition to the economic and environmental benefits, a biomass boiler at Blaise would have the following potential benefits and advantages:

   - Nursery staff are present almost every day, so would be able to carry out routine maintenance, and fuelling of the boiler
   - Wood chip is already being stored on the site, so there is existing experience with storing and handling this resource
   - Given its location within the Blaise Castle Estate, there is considerable potential for linking a boiler installation with environmental education and interpretation activities for schools and the general public, and for the Council to be seen to be playing a key role in promoting low carbon technologies
   - Given the above, such a project is likely to be attractive to funders – this opens up the possibility of securing more than 30-50% grant funding for the project
   - A biomass boiler at Blaise would fit well with the idea of establishing a possible wood fuel supply depot at Blaise nursery
   - The site is unlikely to run into any major problems with planning permission, and has very good access for fuel/ wood chip deliveries, and space for wood chip storage
   - The use of a wood chip boiler on the site would fit well with the “green” nature of a plant nursery
   - It would be an important exemplar project within the area, and would play a key role in demonstrating biomass energy technology

10. Potentially, recycled wood waste could be used as an alternative fuel source (e.g. from Churngold). However, this fuel would be 1.5 to 2 times as expensive, which would increase the payback times.

    However, this would open up the possibility of possibly selling Packaging Recycling Notes (PRNs), which would reduce the effective fuel cost (see section 6 for a more detailed discussion)

    One option is to use recycled wood waste in the short term, to establish the biomass plant, before switching to the use of arboricultural chip. This would allow more time to establish a supply chain for the arboricultural chip, and fuel storage, screening and drying facilities. However, this would depend on being able to secure a short term fuel supply contract with a waste management contractor at a reasonable price.

11. There are a number of technical options and choices that are still to be made – as detailed in section 4.4.6 – that would also have an impact on capital costs and hence payback times.

12. It would be worth, at an early stage, discussing with Council staff the likely costs of installing the heat main at Blaise nursery, using in-house expertise. This could lead to a considerable cost saving, as the cost of the heat main is a major part of the capital cost.

13. If a biomass boiler were installed at Blaise nursery, this would open up the potential for growing other crops at Blaise outside of the current heating season (March to May), with minimal energy costs. This might be an option worthy of discussion with the nursery manager and Contract Services. This would increase the number of running hours of the biomass boiler, and hence improve the payback time.

14. Currently there is some uncertainty over the length of the lease between Contract Services and Leisure Services. This would need to be clarified before any investment decision could be made.

8.2 Social Housing Tower Block in South Bristol

15. The gas boilers at Social Housing Tower Block in South Bristol are due to be replaced in 2004. There is a key window of opportunity to include installing of a biomass boiler as part of this replacement.

16. Initial estimates suggest that a 700kW biomass boiler would be the optimum size for the site. This would supply baseload heating needs, and would meet about 70% of the annual heat load, running for about 1640 equivalent full load hours. By displacing the use of mains gas, this would save about 266 tonnes of CO_2 emissions per year.

17. The economics appear favourable. Based on a grant level of 50%, (which is readily achievable given current levels of government support) and allowing for the avoided cost of installing a biomass boiler in place of a gas boiler, then the simple payback is 9 years, based on savings from reduced gas consumption. The total capital investment that would be required from the Council, or a third party, is estimated to be £95,000.

18. This payback is based on the use of relatively expensive (£22/wet tonne) recycled untreated wood waste, bought in from a waste management contractor. The use of arboricultural wood chip sourced from Ashton Court, for example, would significantly improve the payback time, as this is a much cheaper source of fuel. However, due to its lower energy content, more frequent fuel deliveries would be required. The wood chip would also need to be kept in a covered store, and screened before it could be used (see section 6 for a more detailed discussion about a wood fuel depot).

19. It is recommended that the Council should submit a bid to the EST Community Energy Fund for a more detailed feasibility study for Middelford House, as soon as possible. This should cover the following aspects:

    - Consultation with tenants and key stakeholders in NH&S about the proposals

- More detailed engineering survey, to look at modifications to the existing boiler plant room
- More detailed economic analysis, based on discussion with key Council staff, to provide information to make investment decision, and meet Best Value requirements
- Preparation of tender documentation

20. This size of biomass boiler would burn about 278 odt wood chip per heating season – this equates to about 319 wet tonnes of recycled wood waste, or about 615 wet tonnes of green wood chip. This compares with the estimated wood chip resource at Ashton Court of 700 wet tonnes. There would appear to be a sufficient wood fuel resource, of both arboricultural and recycled wood waste, to supply the proposed installation. However, choice of fuel type may affect eligibility for some types of grant funding (see Section 6).

21. Use of arboricultural-derived wood chip would require a more expensive boiler specification. However, subject to boiler control adjustments, this type may also accommodate untreated recycled wood waste. The costings have assumed the use of a boiler that can handle the wetter arboricultural wood chip

8.3 Other potential sites for biomass heating

22. If a decision is made to replace the boiler units at Ashton Court, then this would be an opportunity to look again at the economics of installing a biomass boiler. The key issue would be to assess the cost and planning implications of constructing a new boiler house, external to the mansion, and then connecting this into the existing heat main.

23. A similar problem exists at Blaise museum – if a biomass boiler were to be installed, a new boiler house would need to be built, in order to provide fuel access. The current heat load at Blaise museum is probably too small to justify this cost, particularly as the site currently runs on relatively cheap mains gas. However, there is the potential to install a larger boiler in the existing stable block, and supply heat to Cannington College, and possibly other nearby buildings, as well as Blaise museum. This would require further work to assess the heat loads, and capital costs.

8.4 Biomass Supply

24. The quantity of green wood chip currently available at Ashton Court is roughly estimated to be 378 oven dry tonnes. All of this is potentially available for use in a biomass boiler, at little opportunity cost, as it is currently being sold for a nominal sum for compost.

25. Allowing for errors in this coarse estimate this is almost certainly enough supply a biomass boiler at Blaise nursery, which would require about 100 odt per year. It may also be enough to supply a boiler at Social Housing Tower Block in South Bristol, which would require about 300 odt per year. However, based on the rough estimate provided, it would probably not be enough to supply boilers at both Social Housing Tower Block in South Bristol and Blaise nursery.

26. Although large quantities of wood chip are stored at Blaise nursery, all of this chip appears to be re-used for mulch and path surfacing by Contract Services, and therefore would not be available for biomass energy.

27. The survey of tree surgeons suggests that in the region of approx. 482 odt additional supply of green wood chip could be available if tree surgeons were provided with a site where they could dispose of their wood chip for free. This is the quantity for which there currently appears to be no alternative outlet other than dumping, incineration or disposal at CA sites.

28. Before any of the arboricultural wood chip, either from Ashton Court, or from tree surgeons, could be used, it would need to be screened, to remove oversize slivers, foreign objects and green matter. Furthermore, it should also be kept in covered barn, to prevent it from getting any wetter, and to allow preliminary drying to take place.

29. If the Council wish to proceed with installation of a biomass boiler, at either Social Housing Tower Block in South Bristol, or Blaise nursery, or both, then it should consider establishing one or more wood fuel supply depots, to enable arboricultural wood chip to be used as the fuel. Potential sites for this could be either at Bower Ashton Estate Yard, or Blaise nursery. As a minimum, this should include a covered barn, for storing the wood chip, to protect it from rain, and to allow preliminary natural drying. It could also include a screener, although this function could also be carried out by a contractor. A ballpark cost for this facility is in the region of £20-30,000.

30. The Forest of Avon Co-op has expressed interest in being involved in a partnership with the Council to develop such a facility. There are uncertainties over their current tenure at Bower Ashton due to plans to re-develop the site, and they have expressed interest in the idea of re-locating to Blaise nursery as an alternative site. The facility also has the potential to act as a broader outlet for logs, and timber products from the Forest of Avon.

31. This is likely to be attractive to funders, with the potential to tap into grant funding sources from Landfill Tax revenues, New Opportunities Fund, and DEFRA Biomass Infrastructure grants (see section 7 for more information on funding sources).

32. The advantages of such a wood fuel depot would be as follows:

- The economic viability of a biomass boiler at Blaise nursery depends on being able to make use of virtually free green wood chip
- Although the economics of a biomass boiler at Social Housing Tower Block in South Bristol do not depend on using this green wood chip – recycled untreated wood waste could be used instead – it would shorten the payback time
- It opens up the possibility of attracting residues from tree surgeons, which would provide sufficient resource for boilers at both Blaise nursery and Social Housing Tower Block in South Bristol. This would also be diverting this tree waste from being dumped or going to landfill.
- In the longer term, it could act as focal point for establishing a biomass wood fuel supply chain within the City
- Strong synergy and partnership with the Forest of Avon project

ANNEX A: GENERAL

Photos of Blaise Castle museum and Ashton Court mansion.

ANNEX B: BLAISE NURSERY

B1. Site Plan
B2. Notes on heat demand model
B3. Photos of site
B4. Map showing location of site

ANNEX C – SOCIAL HOUSING TOWER BLOCK IN SOUTH BRISTOL

C1. Photos of site
C2. Site plan showing location of Social Housing Tower Block in South Bristol
C3. Plan of boiler room and proposed fuel storage area
C4. Schematic of heat main
C5. Fuel consumption data
C6. Specification for Compte boiler

ANNEX D – BIOMASS SUPPLY

D1. Map of Council woodlands
D2. Table showing results of survey of tree surgeons
D3. Table showing results of survey of joinery workshops