On Site Generation

Biomass District Heating Scheme Feasibility Appraisal

for

Sustaining Dunbar

Final
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On Site Generation Ltd
Midlothian Innovation Centre
Roslin
Midlothian
EH25 9RE
Tel: 0131 440 9020
Email: info@onsitegeneration.co.uk
Web: www.onsitegeneration.co.uk

Biomass District Heating Scheme
Feasibility Appraisal

Prepared for

Phillip Revel
Project Coordinator
Sustaining Dunbar
16 Westport
Dunbar
EH42 1BU

Checked & Approved by

Richard Witney, Director

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1.0 Introduction

On Site Generation Ltd has been commissioned by Sustaining Dunbar to undertake an appraisal of biomass district heating (DH) schemes in domestic retrofit situations to provide community groups with information that can be used to appraise the viability of similar schemes.

The aim of this study is to produce basic information that will guide community groups to carry out an initial appraisal of potential retrofit biomass DH projects and enable them to take their project forward with confidence, identify areas of particular challenges that would need to be overcome, or to discard the project based on clear barriers.

Development scales of <10 units; 10 to 30 units; 30 to 100 units; and >100 units have been considered, based on a review of available case studies, feasibility studies and guidance.

The report is supplemented by a checklist to assist the user to collate the required information on the proposed scheme and score the likely success of the project.

How to use this document

The remainder of this report provides general information and guidance on domestic retrofit biomass DH systems as follows:

- Section 2 defines biomass DH;
- Section 3 summarises the main issues to be considered when assessing the viability of a DH scheme;
- Section 4 provides guidelines for completion of the checklist; and
- Section 5 indicates sources of further guidance.

Appendix 1 contains a checklist that can be filled out by the community group to enable them to identify their requirements, options and potential barriers or issues that need to be addressed. The checklist also contains an indicative cost matrix to allow a rough estimate of likely costs to be determined (to be completed using Microsoft Excel). Should the community decide that a biomass DH scheme has promise, guidance on the next steps is provided.

Note: The information provided in this document is intended as a general guide to highlight the major considerations involved in installing a biomass DH system, and therefore should not be considered definitive or exhaustive. Every site and situation is different and may have specific challenges that have not been considered here. In particular, costs vary widely and indicative costs suggested in this document are intended as a rough guideline only. Detailed cost estimates and economic appraisals should be sought following a detailed feasibility study.

The guidance in this report is largely based on a small number of case studies. Whilst every effort was made to research as many case studies as possible, it was found that very few domestic retrofit biomass DH systems exist in Scotland / UK and therefore experience and information in this area was found to be very limited, particularly with regard to cost. Often this information was commercially sensitive and therefore unable to be disclosed. Please note that costs will vary over time and that the current situation with regard to grant funding and support under the Renewable Heat Incentive is subject to change.

2.0 Biomass District Heating

A DH scheme can be defined as where more than one building or unit is heated from a central source (see *Figure 2.1*). Whilst a variety of fuel types could be used, this study focuses specifically on biomass.

A biomass boiler is used to heat water, which is then pumped around a DH main (usually underground) to each building, where the heat is transferred to the building via a heat exchanger. Within each dwelling the heat is used for space heating (via a wet radiator or underfloor heating system) and hot water in the conventional way.

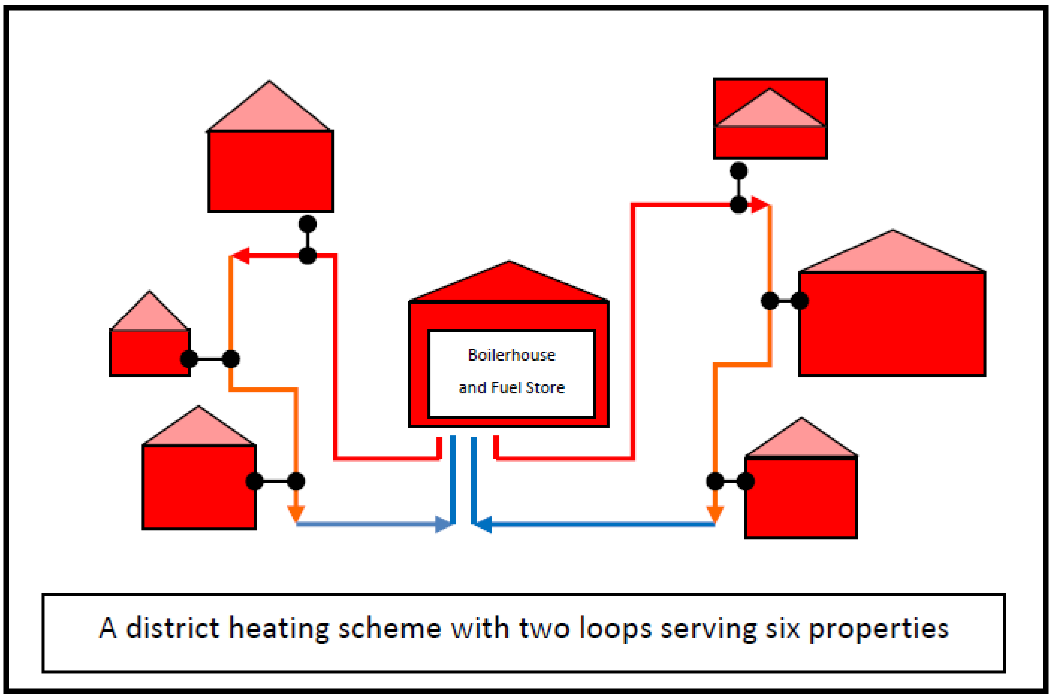

Figure 2.1: Schematic of a DH Scheme
(Source: Community Renewable Energy Toolkit)

3.0 Main Considerations

The main points to consider when assessing the viability of a DH system are:

- Community commitment and timescales
- Heat demand
- Fuel availability
- Boiler system , boiler house and fuel store
- Distribution system
- Connection to properties
- Permissions
- Management of the system and charging structure
- Project Finance

3.1 Community commitment and timescales

In order for the project to proceed smoothly, a high level of community commitment will be required. Biomass DH schemes can vary widely in scope and design and therefore there will be a number of key decisions to be made and it is crucial that a structure for decision making is established.

Advice on the organisation of community groups, consultation and development planning is available from the Community Renewable Energy Toolkit on the Community Energy Scotland website[1].

Timescales for DH schemes vary widely depending on the size and complexity of the scheme, but it is likely that at least a year will be spent in planning and design and the actual installation could be in the order of 2 months to 1 year. The physical works may include:

- Construction of the boiler house
- Construction of the biomass fuel store
- Installation of the boiler
- Installation of the DH main
- Installation of interface units in individual properties
- Installation / upgrade of wet heating system in individual properties if required
- Connection of individual properties to DH main
- Scheme commissioning

The bulk of the installation works could generally be carried out in 3-4 months with connection to individual properties phased as convenient.

It is possible to connect more properties to the system at a later date, however this needs to be accounted for in the design of the scheme, therefore the total number of properties needs to be established early in the process.

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[1] http://www.communityenergyscotland.org.uk/community-renewable-energy-toolkit.asp

3.2 Heat Demand

In order to accurately determine the size of boiler required to power the system and the size of the DH main it is necessary to determine the space heating and hot water demand. Heat demand is based on the number, size and type of properties and will vary according to factors such as level of occupancy, age and energy efficiency.

The heat demand of each property can be calculated using a combination of assessment of available information including current fuel bills and modelling using Standard Assessment Procedure (SAP) or Reduced SAP (RdSAP) software. This will need to be carried out by a competent professional unless suitable skills are available within the community. As much of the following information as possible should be collated for each property to assist with this process:

- annual energy bills for the last two years
- building size, age, construction, services provision, current space and water heating and electricity connection
- current occupancy information - who uses the building and how often
- description of levels of comfort / inadequacies
- energy efficiency levels
- room dimensions for heat loss and heating system sizing

Although a comprehensive heat demand assessment **will be required** for detailed design as described above, for the purposes of quickly calculating an initial estimate of the heat demand *Table 3.1* can be used as a rough guide. The assumptions behind these figures are provided as Appendix 2.

Property Size	**Energy Efficiency**		
	High	Medium	Low
Small	7 kW	8 kW	11 kW
Medium	9 kW	11 kW	16 kW
Large	12 kW	16 kW	22 kW

Guidance notes:
- Energy efficiency: newer buildings will have higher levels of insulation and air tightness than older buildings. However, take account of retro-fitted measures, such as loft insulation, cavity wall insulation and draught-proofing
- Property size: small (1-2 bedroom); medium (3-4 bedroom); large (5 bedroom +)
- Heat demand makes an allowance for hot water as well as space heating requirement

Table 3.1: Estimated heat demand per property type

Using the information in Table 3.1 the heat demand (kW) for each type of property can be added together to give the total heat demand.

For example:

Assume there are 10 houses to be connected to the DH system. Five houses are small and of medium energy efficiency, three are medium and highly energy efficient and two are large and of low energy efficiency.

Total heat demand = (5 x 8kW) + (3 x 9kW) + (2 x 22kW) = **111kW**

This guide assumes residential buildings only are to be included with the scheme, but if it is possible to also service community buildings such as schools or leisure centres this is generally advantageous as it normally gives a more consistent heat load distribution.

3.3 Fuel Availability

The source of fuel is a critical factor in the success and economics of a scheme. A reliable source must be secured and secondary sources identified in case of problems with the primary source.

The main biomass fuels are logs, wood chip and wood pellets.

Logs are generally the cheapest option. They need to be well seasoned before use to reduce the moisture content, ideally for 18 months – 2 years. Wood chips are made by shredding whole trees, branches or coppice products with a chipping machine, which are then dried to reduce the moisture content. Wood pellets are made from compressed sawdust or wood shavings. They have lower moisture content therefore a higher calorific value than chip and logs (e.g. more energy per volume). However, they are more expensive, more energy intensive to manufacture and less likely to be manufactured locally.

More detailed information on biomass fuels is available at from the Forestry Commission's Wood Energy Scotland website[2].

If a community owned or local woodland is available, a resource assessment carried out by a forestry management consultant will be required to establish whether the resource can sustainably meet the proposed schemes heating demand over the short, medium and long term.

If a local resource, such as a saw mill, is available, it would be prudent to explore the possibility of setting up a long term (c. 5 year) contract which guarantees cost and fuel quality. One way of ensuring the quality of the fuel supplied is to base payments to the supplier on the amount of energy produced by the fuel (by monitoring the heat output using a heat meter) rather than paying for the fuel by weight or volume.

[2] http://www.usewoodfuel.co.uk/Typesofwoodfuel.stm

As a rough indication, the cost of wood chip and pellets are shown in *Table 3.2.* Indicative costs of mains gas, LPG and oil have been included for comparison.

Fuel type	**Fuel Price**	**Fuel price p/kWh**
Logs	£50/tonne	1.2
Wood chip (30% moisture)	£80/tonne	2.3
Wood pellet	£160/tonne.	3.4
Mains Gas	-	3.6
LPG	-	5.1
Oil	-	4.5

Table 3.2: Fuel Price Comparison

The cost of wood fuel will decrease if greater quantities are purchased. Some companies offer a fuel supply contract i.e. costs which include supply, operating and maintenance.

3.4 Boiler systems , boiler house and fuel store

Biomass boiler systems comprise a boiler, fuel store and a feed mechanism to deliver the fuel to the boiler.

Boiler

The most suitable system will be determined by the available space, level of automation required, cost and importantly, fuel type. Unless there is a high level of confidence in the security of fuel supply it is prudent to choose a boiler that can accept biomass of varying quality (and moisture content). Some wood chip boilers can accept pellets, but in general pellet boilers cannot accept wood chip.

The cost will obviously vary depending on the size, type, make and model of boiler. Biomass boilers are most efficient when operated relatively continuously and some can modulate to operate at between 30-100% of their rated output. The boiler can be sized to meet the sites entire heat demand (peak load) or the continuous heat load required all year round (base load) with another system installed to meet excess demand.

Many schemes also have a fossil fuel boiler either to support the biomass boiler in times of peak demand (auxiliary boiler) and / or to provide security due to boiler or fuel supply failure (back-up boiler). The optimum choice will depend on the demand profile of the site; domestic properties typically have a low base load through the summer when space heating is generally not required, therefore the boiler needs to be capable of modulating down to supply hot water demand efficiently. Most systems use the boiler to heat a thermal store (essentially a large tank / tanks of hot water) from which the properties are fed. This helps to even out peaks in demand and optimises boiler efficiency by allowing the boiler to work continuously for long periods.

Boiler House
Ideally the boiler house and store should be as close to the properties as possible to minimise the length of pipe required. However this is dependant on suitable land being available and potential planning issues (see Section 3.7). It may be possible to modify an existing building or a purpose built boiler house can be constructed.

Fuel Store
The size of the fuel store is dependant on the fuel type (wood chips require a greater storage volume than pellets for the same quantity of heat delivered). In general it will be more cost effective to have large deliveries; however this requires a larger storage area and access for heavy haulage vehicles.

There are many storage options, including subsurface stores, hoppers etc and the choice will depend on the fuel type, available space, vehicle access and method of transferring the fuel from the store to boiler. The time and labour requirements needed to make a delivery (for example, from a simple tipping operation from manually transferring a pile of fuel to the store) and potential disturbance through noise and disruption need to be considered in the design.

More detail on the different biomass systems and plant available is presented in the Carbon Trust document 'Biomass Heating: A practical guide for potential users'[3].

Figure 3.1 shows a pre-plumbed container with a biomass boiler and integral wood chip store at one side. Fuel is delivered and blown into the hopper.

(Photo courtesy of Highland Wood Energy)
Figure 3.1: Pre plumbed container with wood chip boiler and integral hopper.

[3] http://www.carbontrust.co.uk/Publications/pages/PublicationDetail.aspx?id=CTG012

Figure 3.2 shows an underground store, which allows many different types of tipper vehicles to reverse and deliver fuel.

Figure 3.2: Below ground wood chip storage at Inverness College.
(Photo courtesy of Highland Wood Energy)

3.5 Distribution System

The distribution system comprises the DH main and additional pipes connecting individual properties to the main. The size of the pipework required depends on the heat demand, distance between properties and distance to the boiler.

The cost of the pipe varies depending on the depending on the quantity required, the diameter (related to the size of the system) and quality. The pipe must be well insulated to keep heat loss to a minimum (Figure 3.3); typically a heat loss of <0.01°C per 100m can be achieved. Some modern DH pipes are fitted with an integral leak detection system, where detection wires trigger an alarm if water is detected in the insulation between the pipe and casing.

Figure 3.3: Pre-insulated heat main
(Source: Community Heating – a guide[4])

[4] http://www.energysavingtrust.org.uk/Publication-Download/?p=1&pid=337

If the properties are connected (such as in terraces) it may be possible to run the DH pipework internally, for example horizontally through the roof void with vertical pipes connecting each property. However, if the properties are individually owned this could create problems if some households do not wish to be connected and will not allow pipework to run through their property to serve neighbouring properties. Whilst it may save the cost of excavation, there may be access issues to be overcome depending on the building layouts.

It is much more common for DH pipework to be laid externally underground. The cost of the pipe installation is significantly affected by the ground conditions, i.e. excavating through tarmac or concrete will be more costly than through soil (*Figure 3.4*). The pipes need to be laid at a minimum depth of 0.6m below ground level (typically 1.0m) with a trench width of around 1.2m to accommodate flow and return pipes, although this will vary depending on the pipe diameter.

Figure 3.4: Trench for DH pipe
(Source: Rehau)

Information required to assess distribution system requirements includes:

- Site layout plans to scale
  The location of the boiler plant and all properties to be connected should be indicated
- Ownership boundaries
  To establish whether there are any potential problems with land ownership for installation of the biomass plant and pipework
- Building plans
  To determine the pipework requirements for each individual connection
- Proposed site development

If applicable, for example any additional properties that may wish to connect in the future

- Neighbourhood development
  Any other proposed development that may impact on the DH network
- Details of the local area topography and ground conditions
  To aid excavation and pipework design
- Service Plans
  Indicating the location of existing services

Some of this information will involve site visits and surveys by system designers, but where possible information could be collated by the community.

3.6 Connection to properties

The properties will require a wet heating system (*i.e.*, pipework through which hot water is circulated to radiators or underfloor heating). If a wet system is already present, it will need to be checked by a heating engineer to determine whether it is suitable or requires replacement / upgrading.

Each property is connected to the DH network via an interface unit (*Figure 3.4*), through which the space heating and hot water within the individual property can be controlled and the property can be isolated from the main network for maintenance. The interface unit contains the incoming and outgoing heat pipes and heat exchangers, control valves and metering equipment (if the heat is to be metered, which is recommended to enable accurate billing).

The connection to the DH main can either be direct or indirect. In a direct system the hot water circulating in the main DH network is simply transferred directly to the space heating network in the property. In an indirect system, the heat from the water in main network is transferred to the properties space heating circuit via a heat exchanger in the interface unit. The indirect system is safer in the event of a leak as less water can potentially escape, but requires a separate circulation pump and pressurisation unit and therefore is more expensive. In both systems hot water is supplied via a heat exchange unit and can either be delivered on demand (as with a combi boiler) or stored in a hot water cylinder within the property. The choice is down to individual preference and availability of space for the hot water cylinder.

Figure 3.5: Typical Interface Unit
(Source: Community Heating – a guide[5])

3.7 Permissions

Planning Permission
The use of DH schemes is encouraged in planning policy. Scottish Planning Policy (SPP) document dated February 2010 (Section 182 Renewable Energy) states that:

'Production of heat and electricity from renewable resources will also make an important contribution both at a domestic scale and through decentralised energy and heat supply systems including district heating and biomass heating plants for businesses, public buildings and community / housing schemes.'

However, there are several potential planning issues that may need to be addressed and it is advisable to contact the Local Authority Development Control department at an early stage of the project. Potential issues include:

- Permissions for building and area designations
  e.g., buildings which have a listed status or are located within a conservation area or national park etc.

- Landscape and visual impact
  How will the boiler house, fuel store and flue impact visually on the area? The flue can be powder coated in a wide variety of colours to allow it to blend in with its surroundings or provide a feature. A photomontage demonstrating the likely visual impact of the boiler house and flue from sensitive angles may be useful.

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[5] http://www.energysavingtrust.org.uk/Publication-Download/?p=1&pid=337

- Transport
  There will be increased levels of transport during construction and, depending on the fuel supply, potentially heavy haulage vehicles requiring access for fuel delivery. Is the existing road system suitable for haulage vehicles (e.g. are the roads narrow, are there weight / height restrictions on bridges) and is adequate space available for turning? What impact would increased transport have on residents and users of the community (e.g. schools)?

- Noise impact
  Associated with boiler operations and deliveries

Air quality
The combustion of biomass (in common with other combustion systems) contributes to emissions of air pollutants such as nitrogen and sulphur oxides and particulate matter (PM_{10} and $PM_{2.5}$). A well maintained biomass boiler will generally produce more emissions than a gas boiler but less than coal or oil equivalents. The additional contribution of particulate matter in urban areas has the potential to lead to exceedances in areas already close to particulate matter target concentrations. The use of abatement technologies (such as flue gas cleaning devices) can reduce PM_{10} and $PM_{2.5}$ emissions and may help to ensure that there is no significant contribution to overall particulate matter concentrations. It may be necessary to carry out confirmatory monitoring post installation.

Check with the local authority whether the site is in a Smoke Control Zone or Air Quality Management Area (AQMA) and the implications for a biomass installation. In a smoke control zone, the boiler will need to be approved as an 'exempt appliance'.

Building Warrant
A building warrant will be required for a biomass installation. Contact should be made with the local authority building control department.

Listed Building Consent
Listed building consent requires accurate scaled drawings showing the existing situation and the proposed scheme. Detailed technical information and photographs should be provided.

Guidance on renewables in historic buildings is available from Historic Scotland, who emphasise the need for careful siting and design, for example placing the boiler plant and fuel store in existing outbuildings / ancillary buildings where possible. The re-use of existing chimneys is encouraged but where not possible the flue should be located and designed to be unobtrusive.

Land Ownership and Wayleaves
Permission will need to be sought from the owners of the land for the siting of the boiler, associated plant and store and for all the district heating pipework.

3.8 Management of the system and charging structure

The community group can manage all or some of the necessary management activities or outsource them to contractors. Some companies will provide a comprehensive management service, or look after specific elements, such as boiler maintenance. Outsourcing will obviously reduce the work load for the community group, but is likely to be more expensive.

Management activities include:

- Securing fuel supply and purchasing fuel
- Boiler Maintenance (annual checks and routine maintenance)
- Maintenance of the distribution system
- Troubleshooting and repairs
- Charging for the fuel

Guidance on the various types of community organisation that may be appropriate in different circumstances is available in the Community Renewable Energy Toolkit[6].

The fuel supply is often managed by an Energy Services Company (ESCO) which can also be responsible for meter readings, customer billing and payment collection. A community group can set up an ESCO or can employ an ESCO.

ESCOs are difficult to define as the term covers a number of differing entities; however they are usually businesses where the aim is to procure energy efficiency or energy savings or reductions in CO_2 emissions.

An ESCO can be a company limited by shares, a company limited by guarantee, an industrial and provident society, a trust, or even an unincorporated body. Advice should be sought regarding the legal nature of the entity established to maximise the funding opportunities and deliver the range of energy services required. Further information regarding community ownership models for renewable energy can be found in a report prepared for Highlands and Island Enterprise[7]. Guidance will also be available from Co-operative Development Scotland[8] and the Development Trust Association.

Different types of ESCOs are reviewed by Brodies LLP in the work undertaken for the London Energy Partnership entitled “Making ESCOs Work: Guidance and Advice on Setting Up & Delivering an ESCO” [9] and in work undertaken by TNEI Services Ltd as part of the Manchester Is My Planet Climate Change Programme.[10] Both studies discuss examples of ESCO models.

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[6] http://www.communityenergyscotland.org.uk/community-renewable-energy-toolkit.asp
[7] Community Ownership Vehicles for Renewable Energy, Highlands and Islands Enterprise,
[8] http://scottishsocialenterprise.org.uk/about-us/directory/30
[9] Making ESCOs Work: Guidance and Advice on Setting Up & Delivering an ESCO, Brodies LLP for
London Energy Partnership, February 2007. Available from
http://www.london.gov.uk/mayor/environment/energy/partnership-steering-group/docs/makingescos-work.pdf
[10] ESCO Feasibility Study, July 2007 TNEI, for Manchester Knowledge Capital

Practical guidance in considering the ESCO structure to adopt and taking energy projects forward can be found in the Energy Services Directory prepared by the Energy Saving Trust[11].

Potential risks to consider when setting up an ESCO include:

- Demand – must be accurately determined - if too low the scheme won't pay, if too high, can demand be met?
- Fuel supply, quality and price
- Boiler reliability / longevity
- Penalties for non-supply
- Credit risk of potential customers

The cost of the heat sold to householders per kWh will be based on the cost of the fuel, but will also need to account for overheads such as system maintenance, management / administration costs and electricity for running the boiler plant and pumps.

3.9 Project Finance

It may be possible to secure grant funding towards the cost of a biomass DH system and Community Energy Scotland should be contacted for advice to explore the options available[12]. They will also provide practical project development support and advice.

Further general guidance on grant funding is available from the Community Renewable Energy Toolkit[13].

The UK government has recently completed a consultation on a Renewable Heat Incentive scheme, due to commence in April 2011[14]. The details of the scheme are yet to be finalised, but look set to pay a fixed rate for every kWh of renewable heat generated, guaranteed for a fixed period (likely 15 years). This may significantly alter the economics of a biomass DH scheme.

The proposed tariff levels for biomass schemes are tabulated below.

[11] Energy Services Directory, Energy Saving Trust; http://www.energysavingtrust.org.uk/Publication-Download/?p=2&pid=994

[12] http://www.communityenergyscotland.org.uk/grant-funding.asp

[13] http://www.communityenergyscotland.org.uk/community-renewable-energy-toolkit.asp

[14] http://www.decc.gov.uk/en/content/cms/consultations/rhi/rhi.aspx

Technology	Scale	Tariff p / kWh	Tariff lifetime
Solid Biomass	Up to 45 kW	9	15
	45 -500 kW	6.5	15
	500 kW +	1.6 - 2.5	15

Figure 3.6: Proposed tariff levels for RHI

The RHI consultation included a call for evidence to support possible additional funding for district heating schemes.

It is not yet confirmed that the RHI will be brought in, how much RHI payments will be and if a project will be able to receive a capital grant and also qualify for the RHI.

4.0 Guidelines for Completion of Checklist & Economic Appraisal

Checklist

The checklist provided in Appendix 1 is intended to provide a framework for information gathering and to be used an aide memoir for the main issues to be explored when considering a biomass DH scheme.

It can be completed progressively as information becomes available and used to direct discussions at community meetings.

Economic Appraisal

An economic appraisal worksheet is also included, but is only available electronically as it is designed to be completed using Microsoft® Excel®.

The appraisal is designed to give a rough indication of likely costs only and should not be used for detailed economic planning. There are many site specific variables that could significantly affect costs and therefore a comprehensive economic appraisal should be carried out following a detailed feasibility study.

To assist with estimating the capital costs associated with installing a biomass DH scheme, a range of values is suggested for various elements of the scheme at each scale of development, i.e. <10, 10-30 and 30-100 properties. Proposed schemes of more than 100 properties should use the top end of the 30-100 range and increase proportionally. If a scheme is at the high or low end of the scale, the range entered can be altered as appropriate. Examples of schemes at different scales are provided for guidance.

The appraisal also provides guideline running cost estimates and allows an estimation of the likely payback periods with and without RHI revenue and with and without a 50% capital funding grant. As discussed in Section 3.9 the situation with regard to the RHI and grant funding is uncertain at the time of writing. The simple payback calculations do not include the cost of financing the project, for example, interest paid on loans.

In order to calculate the estimated profit and payback, the cost of fuel sold to householders needs to be entered into the model. This figure can be varied to demonstrate the effect on payback period, but should be set to give a payback within the anticipated lifetime of the boiler system, which is likely to be in the order of 15-20 years. It should be noted that the RHI tariffs are likely to be paid for 15 years only; therefore this should be taken into account when considering acceptable payback periods.

The fuel cost likely to be acceptable to householders will vary depending on the motivations of the community and their current fuel costs, but if it is substantially greater than they are currently paying it is unlikely a biomass DH scheme will be attractive. It is more likely that biomass DH schemes will be competitive economically where there is a large heat demand, a local reliable source of cheap fuel, low capital cost and where mains gas is not available.

5.0 Available Guidance

Community Energy Scotland should be contacted for practical project development support and advice[15].

The following are useful sources of information on biomass and DH systems.

Title	Author	Date	Available From
General Biomass			
Wood Energy Scotland Website	Forestry Commission Scotland	2010	http://www.usewoodfuel.co.uk/Index.stm
Biomass Heating: A Practical Guide for Potential Users	The Carbon Trust	2009	http://www.carbontrust.co.uk/Publications/pages/PublicationDetail.aspx?id=CTG012
Woodfuel Heating in the North of England: A Practical Guide	NNFCC (National Non Food Crop Centre)	-	http://www.biomassenergycentre.org.uk/pls/portal/docs/PAGE/RESOURCES/REF_LIB_RES/PUBLICATIONS/WOODFUEL%20HEATING%20IN%20THE%20NORTH%20OF%20ENGLAND.PDF
Information Sheet No. 1 Biomass Pellets and Briquettes	Biomass Energy Centre	2008	http://www.biomassenergycentre.org.uk/portal/page?_pageid=74,15256&_dad=portal&_schema=PORTAL
Woodfuel Meets the Challenge	Forestry Commission	2009	http://www.biomassenergycentre.org.uk/portal/page?_pageid=74,15256&_dad=portal&_schema=PORTAL
Woodfuel for Warmth	Sustainable Development Commission Scotland	2005	http://www.sd-commission.org.uk/publications.php?id=248
Biomass Action Plan for Scotland	Scottish Executive & Forestry Commission Scotland	2007	http://www.scotland.gov.uk/Publications/2007/03/12095912/0
Community Heating			
Community Renewable energy Toolkit	Community Energy Scotland	2009	http://www.communityenergyscotland.org.uk/community-renewable-energy-toolkit.asp and http://www.scotland.gov.uk/Publications/2009/03/20155542/0

[15] http://www.communityenergyscotland.org.uk/grant-funding.asp

Community Heating - a Guide	Energy Efficiency Best Practice in Housing	2004	http://www.energysavingtrust.org.uk/Publication-Download/?p=1&pid=337
Benefits of Best Practice: Community Heating	EST CE13	2007	http://www.energysavingtrust.org.uk/Publication-Download/?p=1&pid=213
Community Heating for Planners & Developers	Carbon Trust & EST	2004	http://www.energysavingtrust.org.uk/Publication-Download/?p=1&pid=337
District Heating and Community Energy Factsheet	Energy Efficiency Partnership for Homes	2009	http://www.eeph.org.uk/uploads/documents/partnership/District%20Heating%20and%20Community%20Energy%20Sector%20fact%20sheet%20October%202009.pdf.
Information Sheet No. 7 Domestic Heating	Biomass Energy Centre	2008	http://www.biomassenergycentre.org.uk/portal/page?_pageid=74,15256&_dad=portal&_schema=PORTAL
Power in Numbers	EST	2008	http://www.energysavingtrust.org.uk/corporate/Global-Data/Publications/Power-in-numbers-full-report
Guide to Community Heating & CHP	GPG 234	?	http://www.energysavingtrust.org.uk/business/Publication-Download/?oid=478116&aid=1622277
The Potential and Costs of District Heating Networks	DECC (Poyry & Faber Maunsell)	2009	http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/distributed_en_heat/district_heat/district_heat.aspx
ESCOS & Community Organisations			
Making ESCOs Work: Guidance and Advice on Setting Up & Delivering an ESCO	Brodies LLP for London Energy Partnership	2007	http://www.london.gov.uk/mayor/environment/energy/partnership-steering-group/docs/makingescos-work.pdf
Co-operative Development Scotland	Scottish Social Enterprise Coalition	2010	http://scottishsocialenterprise.org.uk/about-us/directory/30
ESCO Feasibility Study	TNEI for Manchester Knowledge Capital	2007	http://www.micropower.co.uk/publications/esco.pdf
Energy Services Directory	Energy Saving Trust	2007	http://www.energysavingtrust.org.uk/Publication-Download/?p=2&pid=994

Appendix 1 – Biomass DH Checklist

Appendix 2 – Heat Demand Assumptions

The heat demand estimates in Table 3.1 of the report (and reproduced as Table B below) were calculated based on the following assumptions (Table A).

Energy Efficiency (w/m^2)	
High	45
Medium	60
Low	90
Property Size (m^2)*	
Small	100
Medium	150
Large	225

Table A

The heat demand for each scenario was calculated by multiplying the heat demand in w/m^2 by the property size (to the nearest kW) and adding 2 kW to allow for hot water demand.

For example:

The heat demand for a small property with low energy efficiency is calculated as follows:

100 m^2 x 90 w/m^2 = 9,000 w / 1000 = 9 kW + 2 kW = 11 kW

Property Size	Energy Efficiency		
	High	Medium	Low
Small	7 kW	8 kW	11 kW
Medium	9 kW	11 kW	16 kW
Large	12 kW	16 kW	22 kW

Table B

In order to calculate the heat demand from each property in kWhs (used for the economic appraisal in Appendix 1), the following calculation was used, based on the method from SAP 2005:

Space heating demand = 0.024 x degree days x heat loss co-efficient

Notes:

- the number of degree days was taken as the latest 20 year average for East Scotland (2495)[16]
- heat loss co-efficient calculated using the heat demand in kW from Table B assuming a delta T of 25.
- the hot water demand was based on floor area from Table 1 of SAP 2005

[16] http://vesma.com/ddd/ (May 2010)