Small scale community heating

CARBON TRUST

Energy Saving Trust

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1 Introduction

1.1 ABOUT THIS GUIDE

This Guide is intended for those considering, or intending to implement or refurbish, a small scale community heating (CH) scheme. It is primarily written for housing managers, technical services and maintenance staff within local government, housing associations and community groups. Community heating can be installed in new build or as part of a refurbishment of existing build. Whilst aimed primarily at a Scottish audience, it is likely to be relevant to other parts of the UK.

1.2 WHAT IS SMALL-SCALE COMMUNITY HEATING?

Community heating describes a heating system where 'more than one building or dwelling is heated from a central source'. There is no universal definition of 'small scale' CH, however for the purposes of this Guide, small scale refers to schemes within the following parameters:

- Less than 100 new-build domestic dwellings or refurbishments with less than 150 dwellings, corresponding to a total heated floor of up to 10,000m2
- A heat capacity of up to about 500kWth and electrical capacity of about 200kWe in the case of CHP
- A total cost up to about £0.5m.

High density housing like tower blocks or blocks of flats present excellent opportunities for CH. The existence of complimentary heat loads nearby can also increase the viability of community heating by maximising the load factor of the heating system. An example might be combining an office block with residential dwellings.

A small scale community heating scheme may, or may not, include CHP (Combined Heat & Power) and may be fuelled by a wide range of energy sources from fossil fuels through to new and renewable sources of energy. The specific circumstances of any given site together with the priorities of the organisations involved will dictate the most appropriate application in each case.

Note that small-scale community heating does not include 'micro (or domestic) CHP', which in the UK generally refers to CHP units for a single dwelling.

1.3 WHAT ARE THE BENEFITS OF COMMUNITY HEATING?

Compared to alternative sources of provision of heat (usually individual gas systems, electric heating or solid fuels) modern community heating schemes can deliver more effective, and economical space and water heating to communities both on and off the gas grid. Schemes can also supply electricity, through the inclusion of Combined Heat and Power (CHP units).

Since the Ronan Point disaster[1] gas use in dense dwellings has been constrained, with buildings required to meet requirement to withstand explosions set out in Building Regulations (Approved Document A). Community heating minimises the risk of explosion, so allowing high density housing to benefit from economical and effective heating.

The benefits of community heating include:

Environmental

Community heating allows the use of fuels and technologies that would not be possible in individual dwellings. Where renewables or CHP is used, schemes offer significant carbon emissions.

Economic

Although initial capital costs are higher, when considered over the life of community heating system (typically 25 years) the lifecycle costs are often significantly less than alternative heating systems. This is because of reduced primary energy use, and reduced annual inspection, maintenance and kit replacement costs.

1 In May 1968 a gas explosion caused the collapse of one corner of a 23 storey block of flats in a block called Ronan Point in Newham in east London.

Social

The provision of economical and effective heating has multiple benefits for occupant health and the maintenance of buildings. The Scottish House Condition Survey of 2002[2] indicates that 286,000 households are fuel poor. It should be noted that these figures are currently (at March 2004) subject to review.

For the consumer, a modern community heating scheme offers all the flexibility of an individual heating system. Modern consumer interface units present the user with the same controllability as individual central heating. The consumer need not be concerned with annual maintenance of household heating system and benefits from a secure, uninterrupted heat supply.

Security of supply

The fuel source of a community heating scheme can be changed without changing the whole energy system. In addition, many new and alternative sources of heat, such as biomass, are best utilised in communal systems. This is particularly relevant to Scotland, in view of the large number of off-gas grid communities and the declining North Sea oil and gas reserves.

Regulatory

Small-scale community heating is an important option in dense new build, and evidence shows community heating with CHP is, on a *prima facae* basis more cost effective than other routes for reducing energy use, at densities of around 55 dwellings per hectare and above.

Community Heating, CHP and Renewable energy can be promoted under a range of planning guidance. The EU Buildings Directive, will, from the end of 2005, require that developers of any new building over $1000m^2$ (equivalent to around a dozen flats) show that they have considered implementation of renewables, combined heat and power, or connection to a community heating network[3]. It will thus be easier to get developments through planning if developers consider renewables at an early stage.

A guide to Community heating for planners and developers, including case studies of a range of policy tools available to planners, and a range of community heating schemes, is available from www.est.co.uk/community energy.

2 Scottish Household Condition Survey 2002, Scottish Executive, Communities Scotland, 2003, http://www.communitiesscotland.gov.uk/web/FILES/SHCS2002report_revised.pdf

3 www.odpm.gov.uk/stellent/groups/odpm_planning/documents/downloadable/odpm_plan_022139.pdf

2 Technology for small scale community heating systems

This section briefly describes the technology used in small scale Community Heating schemes. The three main elements of a small scale community heating scheme are:

- The central plant (or 'energy centre')
- The heat main, which carries hot water to building to be heated
- The heating systems within the building(s)

2.1 CENTRAL PLANT

Modern heat only boilers are available to burn a variety of fuels and in a wide range of sizes. Most are capable of automatic operation and remote monitoring and can be maintained by local heating companies without special training.

Solid fuel systems (e.g. biomass) need more regular attention for re-fuelling and basic maintenance, however such services are often available as part of the fuel supply contract. The central plant is usually located in the basement or ground floor of building, or in a separate boiler house (or 'energy centre').

Where available, natural gas remains the fuel of choice for community heating schemes. However, with the exception of minor enclaves, the following areas of Scotland are not served by the gas grid: Rural areas of the South West, Borders, Central Lowlands and the West Coast, Grampian Highlands, Rural NE Scotland, the NW Highlands, the Inner and Outer Hebrides, Orkney and Shetland. In these areas the following fuels can be used for community heating schemes:

- Oil. The light heating oils are the most popular due to their price, availability and relative easy of transport and storage. Biofuels (such as bio-diesel from vegetable oil) can also be burnt in some compression ignition reciprocating engines with minor modification although the fuels are not widely available and the legislative framework for such usage is still underdeveloped.
- Petroleum Gas (LPG). Although LPG is much more expensive than heating oil and rarely used for heating.
- Coal. Although the use of coal is in decline due to the popularity of other fuels and the environmental impact of coal combustion. Burning coal releases more CO_2 than other fossil fuel and impacts on local air quality.

Combined Heat and Power (CHP)

Combined Heat and Power (CHP) systems provide simultaneous heat and power from the combustion of fuel. This can yield greater overall energy conversion efficiency, when compared to separate heat and electricity generation, resulting in lower energy costs and environmental benefits. CHP can enhance the economic value of a community heating project. In certain cases, the addition of CHP can make community heating feasible at a scale or location that would not otherwise be economically feasible with heat only boilers.

In current CHP plant, electricity is produced by mechanically rotating a generator[4]. The prime mover, a turbine or a generator, provides this rotational power. The prime mover of small scale units are typically spark or compression ignition reciprocating engines (see case studies 2, 3 & 5), although turbines down to about 50kWe are now commercially available (see cases study 4).

Such equipment typically burn only gaseous and liquid fuels. Solid fuel-fired CHP tends to require steam turbines to driver the generators, which is only feasible at larger scales. However there have also been some small-scale biomass CHP gasification demonstration projects, such as at Boughton Hall in Ollerton and as a part of the Bed-Zed project in South London, but capital costs are high.

CHP units must be correctly sized to the heat load to obtain optimal environmental benefits. The inclusion of CHP also increases the scheme complexity in design, operation and commercial aspects. CHP units are often installed to meet the base heat loads of a site, to maximise operating hours hence their economic return. Supplementary heat only boilers are required to cover all heating loads experienced through the year. Nonetheless,

4 Fuel cells have no moving parts and produce electricity from a chemical reaction, but are still only at the early stages of commercialisation and capital costs are still high.

some modern systems are designed to be 'electricity led' to maximise their economic returns, whilst also avoiding wasteful heat dumping through advanced controls, modulation and energy storage (see case study 5).

The number of commercially available small scale CHP units is limited, although new products have entered the UK market in recent years which are already operating successfully in large numbers on the continent. Small scale CHP units can have lower efficiency and high maintenance costs on a p/kWh basis compared to larger machines.

Connecting CHP to the electrical network can bring unexpected cost. Guidance on Connecting CHP in community heating to the electrical network is available from www.est.co.uk/communityenergy

New and renewable sources

New and renewable sources include biomass (wood, biogas, landfill gas), ground source heat pumps, geothermal, coal mine methane and waste-to-energy. They are attractive both off-gas network, and in urban centres where there is a fuel source available, for example, tree waste, or anaerobic digestion of food wastes, or an existing energy from waste plant.

Separate guideance is available on Community heating using new or renewable sources from www.est.co.uk/communityenergy

2.2 THE HEAT MAIN

The heat main is one of the major design challenges of a community heating scheme and its optimum design has a large impact on cost and feasibility. The design of the heat main has to take into account a number of factors, including the minimisation of heat losses, suitable operating temperatures and pressures, costs of the mains and pumping costs. An optimisation process is therefore necessary for each scheme.

Small Scale community heating systems usually use low temperature systems (typically 80°C flow, and 40°C return and 6 Bar) – indeed all the case studies reviewed in this report are low temperature systems. Low temperatures allow the use of all-plastic pipe distribution systems and direct connection with building space heating systems (i.e. no heat exchangers), which lowers the cost. Heat exchangers may be used in certain situations, bringing the following benefits:

- Greater flexibility as regards network expansion.
- Allowing buildings internal system to be the responsibility of the customer rather than the community heating company.
- Safety in the event of damage to the internal heating system of building.

2.3 HEATING SYSTEMS WITHIN BUILDINGS

Internal heating systems within the buildings are broadly the same for conventional central heating systems, comprising heat emitters (such as radiators and under floor heating), connecting pipe work and controls. Under floor heating is particular suitable for low constant temperature systems.

Whether or not heat exchangers are used for space heating, some form of heat exchanger will be required to provide domestic hot water in most dwellings. This can be either through an instantaneous heat exchanger for small dwellings or via an indirect coil within a hot water storage tank for larger homes.

2.4 OPTIMISING SCHEME DESIGN

Some schemes feature multiple heat-only boilers, which allow boilers to operate at optimum efficiency, while just one boiler is modulated to follow the load. This design also gives good back-up capacity.

It is common to install small CHP units in parallel to obtain energy outputs which are not available from individual units. Buying two or more units in this way yields slight unit cost savings due to cost savings in delivery and installation.

Maximising the load factor (i.e. the proportion of time in operation) of community heating equipment is important at any scale of development in order to maximise the technical and economic operational performance of a scheme. The load factor is in part a function of the energy demand profile – the more constant the demand, the easier it is achieve a high load factor. A key element of this is a heat store, to allow the CHP engine to run for longer periods of time, and still meet peak heat demands.

Metering and selling heat

Heat meters are readily available that measure the quantity of heat consumed by buildings or dwellings. Prepayment meters can be used in the same way as electricity prepayment meters, to reduce administrative effort and to avoid problems with arrears[5].

Heat metering offers a number of advantages.

- Charging for actual heat usage which is more equitable than charging heat at a flat rate and which promotes responsible use of heat. Heat consumption can be reduced markedly when every single end consumer has a meter and pays for heat accordingly in comparison to non-metered heat provision.
- System efficiency can be accurately monitored.
- Enabling the sale of heat to a range of heat consumers (e.g. owner occupiers, commercial entities) and hence the maximisation of the number and diversity of connections.

However, with smaller schemes the value of metering must be considered on a case by case basis. Some scheme operators typically incorporate the charge within the rent, varied by size of the dwelling e.g. the number of rooms or dwelling surface area). This approach has the advantage of being administratively simple and avoids the upfront capital cost of installing heat meters. It may be especially appropriate for sheltered or special needs accommodation, where issues of ease of use and fuel poverty are paramount.

Maximising the value of CHP electricity

There are several ways of using electricity generated in CHP. These include:

- Selling to a supplier
- Displacing electricity purchases for the landlord owned, or common parts of a development
- Selling direct to residents or other customers, either over private wires or over the public network.

In new build, it is common, once an electrical network has been installed, to hand it over to the Distribution Network Operator to maintain and manage it. The DNO covers these costs from a Use of System Charge on electricity sold over the network by suppliers. However, one option for a developer is to hand over the network to an Energy Services Company which may then sell electricity direct to residents without itself incurring Use of System Charges. This may make CHP cost effective in new build in circumstances in which it would not otherwise have been.

Each of these routes has a different set of costs and benefits. Any development study should include identification of which route is most cost effective. Separate guidance from the programme explores the costs and benefits of each option.

Guidance on Getting best value from electricity generated in community heating is available from www.est.co.uk/community energy.

2.5 SYSTEMS DEVELOPMENT

Some scheme suppliers are developing a modular approach with the opportunity to install a controller, boilers, heat storage devices, CHP and even additional sources of heat and electricity such as heat pumps and solar thermal. A modular

5 Prepayment heat meters are use in the community heating scheme at Lynn Road, Orkney. See case study in Community Energy Programme Guidance Note 'A guide to new and renewable energy in community heating'

approach allows a basic system to be installed and additional components added later, and with minimal disturbance, depending on need and operating experience. It also allows operating strategy to be varied, for example:

- Installing two or three small CHP engines allows the maximum amount of heat on a site to be generated from the CHP engine, minimising the use of top-up boilers. This maximises emissions savings for a given heat load.
- An alternative approach (where export of electricity is not justified financially) is to deploy CHP alongside a heat pump, with CHP electricity used to power the heat pump. This arrangement achieves an efficiency of gas used to heat provided in excess of 100%.

3 Whole life costing

CH schemes have higher up-front capital costs than individual heating systems whether gas central heating or electric heating. However running costs should be lower due to simplified inspection and maintenance, longer system life, bulk purchase of fuels and the economic value of CHP (where included).

Developers are strongly encouraged to use Whole Life Costing analysis when comparing the economics of various heating options.

Whole Life Costing allows the evaluation of different options (gas boilers, electric heating and community heating using CHP and or renewables), on the same economic basis taking into account all capital costs, running costs, replacement costs and revenue streams. Future costs and revenue streams are discounted back to current values. Treasury Green Book guidance for evaluation of public expenditure is to use a 25 year assessment period, and a discount rate of 3.5%.

Guidance on Whole Life Costing is available in Financing Community Energy Schemes, available from the Community Energy website (www.est.co.uk/communityenergy)

3.1 SCHEME COSTS

Provision of heating services in dense housing is not straightforward whatever the option. Developers have to manage Building Regulations requirements to make buildings explosion-proof (Part A) and energy efficient (Part L). In dense developments this encourages many developers to avoid the additional construction costs of making a building (and gas network) explosion resistant, and opt instead for electric heating.

The costs of electric heating can be £1500 per dwelling. Network reinforcement to cope with the increased electrical load is difficult to quantify. It may be that this is met by the DNO (Distribution Network Operator) and costs recovered from Use of System Charges. Power station build to supply is difficult to quantify, but would be around £400 per kW. An average home might have a typical electrical demand of 2-3 kW. The costs of new build power stations would not be met by the developer but by electricity customers.

The costs of a whole wet central heating system including radiators, internal pipes, controls and boiler can be £3000. Installation of a gas main to individual dwellings is additional. Some of the cost may be met by a gas network operator who recovers the installation costs through a charge on gas use.

The costs of community heating are £3-6,000 per dwelling. The internals (radiators, controls are similar in cost to a wet central heating system, though currently (because of the volume of production) a heat meter is more expensive than a gas meter. A heat exchange unit is cheaper than a boiler. A heat network can be more expensive to install than a gas network, because of the additional controls. However, it is safer than a gas network, and there may be construction costs avoided in making the building explosion proof. The energy centre is an additional cost.

New-build projects typically offer an opportunity for the capital costs of a heat main to be kept to a minimum, as the work can be programmed into the construction process. Retrofitting heat mains to existing housing stock is typically more problematic than new build, especially if there physical obstacles to laying the heat main, such as roads.

Thus the additional capital costs of community heating over electric heating may be around £3500 per dwelling, or up to £3000 per dwelling compared to gas.

Table 1: Capital cost indicators of new build small scale (<100 dwellings) Community Heating systems (£/dwelling. NB this is total cost, not the cost compared to the alternative.)

	Energy Centre[6]	Electrical Connection	Heat Network	Internal heat distribution systems	Consumer connection	Total
Low estimate	750	40	400	800	100	2,090
High estimate	2,400	160	4,000	3,000	300	9,860
Typical heat only system	875	/	1,500	2,000	125	4,500
Typical CHP systems*	2,100	150	1,500	2,000	250	6,000

* *Small scale reciprocating CHP units (<25kWe) are typically £1000-2250/kWe installed.*

Costs of small schemes should come down as the market expands. At present design costs and connection to the electrical network are all bespoke, and similar to larger schemes. Hardware costs are for a very low volume market, with no economies of scale. Experience and volume may reduce costs perhaps by 20-40%.

3.2 RUNNING COSTS

To justify itself economically, a community heating network must make significant savings over its life compared to the alternatives.

- The key factor is reduced maintenance. Avoiding a gas boiler in managed housing avoids the need for an annual gas safety inspection, typically costing £100. Over the life of a scheme, this can account for most of the cost differential alone.
- Longer equipment life. The life expectancy of community heating is around 25 years (although elements of the system may need replacing during that time). The life of individual gas and oil boilers is around 15 years, and electric storage heating around 10 years
- Energy savings (and therefore carbon savings) are typically 25% compared to gas boilers, and up to 50% compared to electric heating.
- Supply of electricity is a potential additional benefit. This can be supply to the Landlord, in which case the landlord typically avoids around 5 pkWh, or supply to the resident. This can be worth 6 pkWh income to a scheme, and still provide a 10-20% saving to residents.

6 See Community Energy Programme Guidance Note 'New and Renewable Energy for Community Heating – a guide for project developers' for indicative costs of renewable energy systems.

4 Key lessons from previous schemes

This section reviews the key practical problems and lessons from a number of small scale Community Heating (CH) schemes in Scotland, either already in operation or under development at the time of writing.

All of these issues need to be addressed in an option appraisal and business plan. Support for development work may be available from a number of Government programmes, including the Community Energy programme.

4.1 THE ROLE OF A PROJECT CHAMPION

The existence of a project 'champion' within the client organisation has been key feature of all successful schemes reviewed. This is especially true of CHP and renewable energy schemes which can have additional complexity and for which there are few example schemes to refer to and (usually) less experience amongst local equipment suppliers and contractors. Champions draw on the support of a network of other practitioners. They make best use of support and funding opportunities available, and need support from senior colleagues.

4.2 STRATEGIC APPROACHES TO SCHEME DEVELOPMENT

Strategies for development include:

- Building experience gradually. Various organisations have succeeded with small scale schemes because they took developments slowly, starting with a simple project, learning from it and applying to the next usually more ambitious scheme i.e. following an "evolutionary not revolutionary" approach. In practice this meant, first implementing a simple heat only scheme, then later trying CHP or renewables.
- Developing a strategic approach. It can be useful to use development funding (where available) to carry out option appraisals for a number of sites. In this way, the easiest, least risk projects can be selected first.
- Making use of internal skills and resources. Developing and community heating schemes requires skills and knowledge in a number of disciplines. It can also be useful to bring in people from different areas of the organisation that have relevant skills, particularly at the design & planning stage.
- Creating economies of scale. There are a number of ways of creating economies of scale from procurement through to reducing management effort. Possible strategies include: using the income generated from one scheme to pay for the development of a scheme on another site, bulk purchase of kit or fuel for multiple sites, development of a business plan that covers more than one site (e.g. establishing an energy service company (ESCO) to serve a number of sites rather than one individual site.)

4.3 COMMUNITY ASPECTS

Support from other stakeholder organisations is also important, such as within the local council and the local community. In some instances, the record of old poorly designed and maintained schemes have led people to view community heating as being expensive and unreliable. It is important to counter this with explanations of the benefits of modern community heating (see section 1.3). In this way community heating can be seen in the context of local strategic objectives such as fuel poverty, reducing energy costs, environmental protection and stimulating the local economy (e.g. with biomass schemes). To this end, community heating should be explicitly mentioned in policy and strategy documents to pave the way for implementation of schemes.

Good relations between the scheme operators and the scheme users are essential, and work on building this relationship should start at an early stage. Stakeholders should have ample opportunity voice concerns and have their questions answered.

For refurbishments, a consultation process is required to canvass opinion from residents and gain their approval for the disruption caused by scheme implementation. In some cases sign up from all residents may be required to proceed which can take time and effort to achieve.

Experience shows that if a CH scheme is well designed and managed, dwellings will become sought after due to the low cost good quality heating. It can lead to a sense of pride and community in the development that has other positive knock on effects. Finally, all users will need clear instruction on how best to operate the heating controls in their dwelling and on the billing arrangements.

4.4 MAKING BEST USE OF HELP AVAILABLE AND PREVIOUS EXPERIENCE

A good deal of support and advice is now available to potential developers, in recognition of the fact that modern Community Heating systems are often the best practical environmental option in high density developments. Further reading and other contacts are listed at the back of this publication.

A key issue is for those considering applying for grant support from a Government programme, including Community Energy. Be sure to make contact with the relevant programme early, in order to understand the requirements of the programme and make use of the support available. This is frequently key to a successful application.

5 Key questions for potential developers

This section contains key questions for potential developers of small scale community heating schemes, to assist those at the initial stages of scheme development. The feasibility and cost of small scale community heating scheme depends on many factors and *can only be determined on a case-by-case basis by an experienced consultant*.

It is difficult to set firm rules to determine either the viability of community heating or which approach should be taken in each case. Nonetheless there are a number of fundamental issues, both commercial and technical, which have a bearing on the applicability of community heating.

5.1 DEVELOPER AND OPERATOR PRIORITIES

The design of any community heating scheme is a process of optimisation and the drivers for the scheme will naturally influence the most appropriate choice of community heating system. It is therefore important to be clear about the objectives from the start.

Many public sector developers will need to comply with the Treasury's 'Green Book' for public sector investments, and thus should select schemes with the lowest 'Whole Life Costs' (see section 3 and Appendix 1.1).

Community heating schemes can also help address a number of common objectives of local communities, such as: combating fuel poverty, stimulating the local economy (e.g. with the fuel supply chain for biomass schemes), contributing to sustainable development, reducing expenditure on energy and attracting inward investment. Articulating such drivers at the outset should allow the scheme to be optimised to deliver those objectives.

DEVELOPER / OPERATOR PRIORITIES:

- What are the key drivers for the scheme?
- What are the views of the local community?
- What funding opportunities are available for different types of scheme?

5.2 FINANCE

Financing community heating schemes can be difficult, due to the high upfront costs compared to the alternatives, even if the scheme is the best Whole Life Costs option. Financing arrangements for small scale schemes need to be as simple as possible, otherwise the administrative and management effort can become disproportionate to project scale.

Most small scale schemes, where implemented individually are financed on balance sheet. However, where an organisation (such as a Housing Association) develops a more strategic approach across its portfolio, eg with an Energy Services Company partner, it may be appropriate to consider off-balance sheet arrangements. In general, care must taken that sufficient benefits of the scheme are kept locally to allow the supply of affordable heat and also that there are not financial incentives to operate the scheme in an inefficient manner.

Separate Guidance covers arrangements for financing Community Heating, including both on balance sheet and off balance sheet arrangements, and sources of funding, including bank finance, leasing, grants and other sources. See Financing Community Energy Schemes at www.est.co.uk/communityenergy.

FINANCE STRUCTURE:

- What finance structure options are available?
- What constraints are imposed by the availability of finance?
- What are project partners' appetite for risk and reward? And are the rewards in proportion to the risks?
- Are project risks (e.g. technology, bill collection & fuel supply) managed by parties most able to manage them? (E.g. maintenance risk by the technology provider, fuel supply by a dedicated fuel supply company…etc)

5.3 HEAT DEMAND

HEAT:

- What is the annual heat consumption of the potential consumers?
- What is the density of heat demand?
- What is the profile of the heat demand?
- Are there any large heat consumers locally that could be connected to the heat network?
- Are there prospects for future expansion of the heat network? If so, can the scheme be designed accordingly?
- What are the main physical constraints for community heating infrastructure?

5.4 ELECTRICITY DEMAND AND CONSIDERATION OF CHP

ELECTRICITY

- What is the electrical demand of the buildings to be supplied by the community heating scheme?
- Are there any large consumers or consumers with constant demand? (e.g. electricity for communal areas)
- What is the daily and annual profile of this demand?
- Are there any other electricity consumers nearby who could possibly be supplied by the CHP plant?
- What physical infrastructure would need to be put in place to produce and sell electricity?
- How will metering and billing be handled?
- Is a local maintenance contractor available for the plant considered?

6 Case studies

This section contains five case studies of small scale community heating – four from Scotland and one from Denmark, as an example of an innovative application of community heating technology.

The case studies display a range of scheme sizes from around 15 to 90 dwellings and include one heat-only and four CHP schemes. The client organisations are housing associations in each case. This is not intentional, but rather reflects the fact that housing associations are particularly active in the field of small scale community heating.

The range of case studies

	Circa 15 dwellings	Circa 30 dwellings	Circa 90 dwellings
Example	• Cloch Housing Association, Greenock	• Perthshire Housing Association	• Cloch Housing Association
	• Grampian Housing Association		
	• Randers Housing Association		
Cost	• £35,000 to 70,000	• £170,000	• £519,000
Cost per dwelling	• £3000 – £6000 per dwelling (NB this is total cost, not additional cost compared to the alternative)		
CHP	• Cloch, heat only boilers	• 2x5.5 kWe engines	• 60 kWe micro turbine
	• Grampian, 5.5 kWe engines		
	• Randers17 kWe oil fired engine, plus 2 heat pumps		
CHP/dwelling	• 0.3 kWe to 1 kWe per dwelling		

6.1 HEAT-ONLY COMMUNITY HEATING FOR 15 HOMES (CLOCH HOUSING ASSOCIATION)

Cloch Housing Association has incorporated a community heating system in a new development of residential care units at Regent Street in Greenock near Glasgow. The scheme, which is due for completion during 2004, provides accommodation for 11 residents with dementia, 1 support staff and 3 conventional apartments for rent. The development is well insulated and the units achieve a SAP rating of 102-108.

The total capital cost for the community heating installation is £68,800 of which 40% (£27,520) has been secured from the Community Energy Programme. The total cost of the development is expected to be £1,415,528 and this is being financed primarily by Communities Scotland and Cloch Housing Associations with a £10,000 contribution from the local council. The total carbon saving is expected to be 10 tonnes/year and the cost per tonne of carbon saved over a 25 year period is calculated to be £110 using a figure of 0.18kgC/kWh for the displaced electric heating.

The communal boiler, located on the ground floor, delivers heat to each unit via under-floor heating. The annual heating demand is predicted to be 87,620kWh and the boiler output is rated at 88kW. Cloch Housing considers all new schemes for community heating but if this policy was not in place the default heating system for this development would be electric heating and hot water production. Consideration was given to a CHP installation but at the time the scheme was thought to be too small.

There are a number of advantages to the communal heating scheme in this development:

- Avoidance of individual boilers and associated maintenance and access problems
- Suitability for under-floor heating which avoids bulky low surface temperature radiators
- Removing gas appliances from residential units reduces risks for residents
- Valuable saving in space in small units

Cloch Housing Association learned useful lessons from a previous unsuccessful application to the Community Energy Programme which helped secure funds for this project. They will consider Community Energy Programme funding for future schemes.

Further information: Andrew Cassels, Cloch Housing, a.cassels@clochhousing.org.uk

Elevation of Regent Street, Greenock, Cloch Housing Association residential care home.

6.2 CHP FOR 14 HOMES (GRAMPIAN HOUSING ASSOCIATION)

Grampian Housing Association provides services to almost 3,000 households in North-East Scotland. In February 2003, the Association completed a new build development of 14 semi-detached 2-3 bedroom houses at Station Street, Newmachar about 10 miles North of Aberdeen. The construction was contracted as a 'design – build' development, financed by Communities Scotland and Grampian Housing Association.

The capital cost of the community heating scheme was £71,400 (£5,100 per dwelling). The energy centre is located in a separate boiler house at one end of the row of houses and comprises a 5.5kWe 12.5kWth gas-fired DACHS CHP unit and two 38kW condensing gas-fired boilers. The heat main runs under the pavement in front of the houses and has a direct connection an under floor heating system in each house through inlet control valves. The valves limit the amount of heat supplied to each dwelling to prevent over consumption.

Each dwelling has a separate hot water storage tank preheated by communal heat with an immersion heater for top up. This system promotes responsible use of communal heat. If excessive heat is drawn for space heating, residents have to use the immersion heaters for Domestic Hot Water for which they have to pay themselves.

The system has been operating successfully for 1 year, with a high degree of tenant satisfaction. Tenants range from young families to the elderly. The cost of heating is charged as a flat rate as part of the rent, whereas electricity is sold through prepayment cards available at the local supermarket. The CHP unit provides about 50-60% of the tenants needs.

There were some problems with the heat network at commissioning, which delayed the occupation of tenants by 3 months. Heat was not successfully reaching dwellings at the end of network. The problem was eventually solved by improvements made to the air bleeding system and by checking certain sections for blockages, which entailed uncovering some sections of the heat main. These problems caused additional expense to the contractor, as well as to the Housing Association through lost rent.

Further information: Mike Allan, Grampian Housing Association, mike.allan@grampianhousing.co.uk

Station Road, Newmachar, Scotland, with energy centre building in foreground and interior view showing the 5.5Wke CHP unit and two wall-hung gas condensing boilers.

6.3 OIL-FIRED CHP FOR 12 BUNGALOWS (RANDERS HOUSING ASSOCIATION DENMARK)

Randers Housing Association HA manages a portfolio of housing in around the town of Randers in Denmark. In the year 2000, the Association built 12 bungalows in the village of Ramten in association with Carl Bro a|s. The apartments are occupied by mostly elderly people and have a floor area of 75-90 m2 each.

The scheme features a CHP system with potential application in Scotland, particularly in areas not served by the gas grid. The energy centre comprises a 17 kWp EC Power (diesel) CHP plant and two 12 kWth heat pumps (i.e. there are no supplementary or back up boilers). The CHP plant modulates according to the actual electricity consumption in the buildings. This arrangement maximises the electrical generation of the plant, and hence it's economic and environmental value, whilst avoiding wasteful heat dumping.

Excess heat is stored in a 1,500 litre hot water storage tank with a heat capacity of 70 kWh. When the storage capacity is exhausted, the plant stops operating, and power is imported from the grid. If, on the other hand, the heat output of the CHP unit is insufficient to meet demand, the two heat pumps start operating successively. This creates an additional electrical load for the CHP plant and utilises ambient heat energy for heating. The plant is thus capable of meeting a demand ranging from 2kWpe/40kWhth to 17kWpe /28kWhth with an efficiency from 145 percent to 90 percent (the inclusion of heat pumps allows the plant efficiency to exceed 100%, as the heat pumps make use of ambient heat energy).

The system has now been in operation for over 2 years. Annual heat consumption in the buildings was approximately 110,000 kWh. The annual power consumption is approximately 17,000 kWh, of which over 99% has been provided by the CHP unit. Approximately 11,250 litres of oil were consumed a year. The overall efficiency of the system was 111 percent. Heat storage and distribution losses are calculated to be 20%.

The total capital cost of the system was £35,000 excluding VAT[7]. Annual fuel costs are £5,400, representing an estimated annual cost saving of £2,700 and carbon saving of 15 tonnes/year compared to the alternative of oil-fired boilers and electricity from the grid. A reserve of £1,350 is set aside annually for engine rehabilitation and maintenance.

Under floor heating is used in all buildings. This works well with the low return temperatures required by the heat pumps. A period of adaptation was required by tenants to become accustomed to a more evenly distributed heat supply and long reaction time of under floor heating.

Further information: Mr Per Diget,
Carl Bro a|s Energy Division,
Tel (UK): 020 7566 1400,
Tel (Denmark): 0045 4348 6060.
E-mail: per.diget@carlbro.com

The plant room at Ramten, Denmark

The apartments in Ramten, Denmark

7 At February 2004 exchange rates

6.4 CHP FOR 30 FLATS (PERTHSHIRE HOUSING ASSOCIATION)

Perthshire Housing Association (HA) has a strong commitment to sustainable development and has implemented several energy efficiency and renewable energy projects. In 1998 PHA commissioned its first Community Heating CHP scheme, in partnership with Servite Housing Association. The scheme on Scott Streetñ Canal Street in Perth comprises a 30 unit sheltered accommodation block run by Perthshire HA with offices on the ground floor and a 33-flat housing development run by Servite HA. The two blocks are connected to the same energy centre and linked by underground heat mains. The scheme has been operating successfully for several years and with a high degree of tenant satisfaction.

PHA is currently taking the lessons learnt from the previous Scott Street – Canal Street development and applying them to a new build development further along the same road at Scott Street – Victoria Street. This four storey new build housing development will contain 32 flats for mostly elderly tenants. Two 5.5kWe 12.5kWth DACHS CHP units will supply heat and electricity, supplemented by heat only gas boilers. Heat will be charged for with the rent based on flat size, whereas electricity will be metered and paid for by prepayment meters.

The alternative heating system would have been gas-fired condensing combi-boilers and mains electricity. However, the Community Heating scheme was shown to be the lowest Whole Life Cost option over 25 years and at 6% discount rate.

The £2,000,000 building is being primarily funded by Communities Scotland, Perthshire HA and a £40,000 grant from the Community Energy programme. The total capital cost of the heating scheme is approximately £170,000.

The principle lessons that have been incorporated into the new Victoria Street development are:

- Simplified scheme ownership. Canal Street is owned and operated by Perthshire HA and Servite HA. This complicates metering and billing as well as the general scheme management. The Victoria Street scheme will be wholly owned and operated by Perthshire HA.

Scott Street – Canal Street Development, Perth.

- Simplified contractual arrangements. Victoria Street is being built as a single 'design-build' contract, including the CHP installation. Canal Street used a separate contract for the CHP unit which led to disagreements between contractors over who had responsibility for certain issues.
- Pre-heating domestic water. Perthshire HA's flats in Canal Street uses electric immersion heaters for domestic hot water, which reduces the environmental benefit of the scheme and increases tenants' electricity bills. Victoria Street will use communal heat to preheat domestic hot water, with immersion heaters for top up. This should promote the responsible use of communal heat, while avoiding the cost and administrative effort of individual heat metering.
- Comprehensive CHP maintenance contract with a local contractor. The initial CHP maintenance contract for Canal Street was provided by the CHP supplier who did not provide a sufficient level of cover, partially due to a lack of local presence. The CHP maintenance contract for Victoria Street is more comprehensive and is placed with local maintenance company who has been trained by the CHP equipment supplier. This arrangement should provide good maintenance support at a reasonable price, as well as improving the local skills base.

Further information: Trish Baxter, Perthshire Housing Association. E-mail: hainfo@perthha.co.uk

6.5 CHP FOR 87 HOMES (CLOCH HOUSING ASSOCIATION)

Cloch Housing Association has incorporated a combined heat and power plant as part of a community heating installation for a new development of 87 terraced and semi-detached homes at Weir Street / Leitch Street in Greenock near Glasgow. The scheme, which is due to start occupation in mid-2004, is well insulated and the units homes a typical SAP rating of 100.

The capital costs of the installation are:	
Internal distribution system	£179,784
Consumer connection	£10,875
Main heating network system	£110,938
Energy centre	£217,668
Total	£519,265

A proposal for funding of £207,703 from the Community Energy Programme was rejected but Cloch Housing Association decided to proceed with the scheme to derive the maintenance cost savings and lower carbon emissions benefits of the system.

The total carbon saving is expected to be 23.76 tonne/year and the system will generate 378MWh/annum of electricity that will be supplied to residents at a cost which should be considerably lower than typical the retail price. The annual heat demand of 653MWh/annum will be met mostly by the CHP unit (490MWh) with the gas boilers providing the balance. Heat will be charged at a cost of around 2.1p/kWh.

The system comprises a stand alone energy centre houses a 60kWe micro-turbine with a 120kWth waste heat recovery unit and two 150kW gas condensing boilers to provide both top-up and back-up heating. Heat is distributed via an underground heat main to each house and electricity is distributed via a private wire system to all houses within the development.

The heating network consists of pre-insulated polybutylene pipework laid directly into ground trenches located within the site service strips also containing the private electrical distribution, mains water etc. The heating system will operate at flow and return temperatures of 60/40oC respectively. There will be no heat exchange stations within the site. The heating medium from the energy centre will be used directly in each of the dwellings. A key factor in the successful installation of the system has been the presence on site of a full-time mechanical Clerk of Works.

Electricity is metered and paid for using a 'smart card' system that allows for pre-payment. However, heat supplied to each unit is not metered; instead residents are charged a fixed sum as part of the service charge added to the rent. The system will only deliver heat to the under-floor heating or the hot water cylinder, but not both. Hence excessive use of heating (e.g.: by turning up thermostat and opening window) could result in residents having to heat hot water with electric emersion heater for which they will have to pay a higher price. This arrangement is expected to limit heating demand.

Further information: Andrew Cassels, Cloch Housing, telephone: 01475 783637

View of Wier Street Development, Cloch Housing Association.

CHP unit at Weir Street, Cloch Housing Association.

8 At February 2004 exchange rates

7 References and other sources of guidance

A range of guidance is available from the Community Energy Programme, and the Energy Efficiency Best Practice in Housing programme, as well as Action Energy. The diagramme below indicates the range of guidance currently available.

		programme		
		Energy Efficiency Best Practice in Housing (EEBPH) 0845 120 7799 www.est.org.uk/bestpractice	Community Energy All Guides 0870 850 6085 www.est.org.uk/communityenergy	Action Energy 0800 585794 www.actionenergy.org.uk
Resource	Introductory Guidance	• Benefits of Best Practice: Community Heating • Community Heating A guide	A range of publications including programme prospectus, FAQs, Programme indicators	
	Detailed Guidance	• Domestic Ground Source Heat Pumps	• Financing Community Energy schemes • Community heating for planners and developers • Small scale community heating • Community heating using new and renewables sources • Getting best value for electricity generated in community heating • Connecting CHP in community heating to the electrical network	• Guide to community heating and CHP – commercial; public and domestic applications (GPG234) • Energy Services PPP/PFI projects for community heating • Combined heat and power (CHP) in universities (GPG204)
	Case studies	• Refurbishment of a tower block (Aberdeen Heat and Power) • Hard to Treat homes off gas network (Llanwyddn)	• A range of case studies on development grants awardedunder CE, and on capital grants awarded under CE	• The use of combined heat and power in community heating schemes – four case studies (GPCS370) • CHP at the heart of Government (GPCS392) • CHP at a University Campus (GPCS351) • CHP Cast Study Glenfield Hospital, Leicester (CHP004) • An integrated approach to energy services at Woking Borough Council (GPCS434)
	Studies of the potential		• The UK Potential for community heating with Combined Heat and Power • A range of heat maps of major UK cities	

Community Energy Programme

The Community Energy Programme provides guidance and funding, for the refurbishment of existing and installation of new community heating schemes in the public sector across the UK. The programme has £50 million available over 2002-2004 for capital and development grant funding. The programme is managed by the Energy Saving Trust and the Carbon Trust, and works closely with industry through the relevant trade bodies (CHPA and others). For further information visit www.est.co.uk/communityenergy or telephone 0870 850 6085

Scottish Community and Householder Renewables Initiative (SCHRI)

SCHRI is a one-stop shop offering grants, advice and project support to assist the development of new community and household renewable schemes in Scotland. A team of ten SCHRI Development Officers are responsible for providing local advice and project management support to help community groups develop renewable energy projects. SCHRI is funded by the Scottish Executive and managed jointly by EST and Highlands and Islands Enterprise (HIE).

SCHRI@est.co.uk
SCHRI Hotline – 0800 138 8858
Web-site: http://www.est.org.uk/schri/

Clear Skies Programme

The Clear Skies programme is the equivalent of SCHRI in England, Wales and Northern Island.
Clear Skies, BRE Ltd, Building 17, Garston, Watford, WD25 9XX
Helpline – 08702 430 930
E-mail: info@clear-skies.org
Website: www.clear-skies.org

Highlands and Islands Enterprise

Cowan House,
Inverness Retail and Business Park,
Inverness IV2 7GF, Scotland
Telephone: 01463 234171
Fax: 01463 244469
E-mail: hie.general@hient.co.uk
Web-site: http://www.hie.co.uk/

SCEN (Scottish Community Energy Network)

SCEN (Scottish Community Energy Network) is an informal network of practitioners, consultants, and other interested professionals who share an interest in community heating in Scotland. The remit of SCEN is to promote community heating by sharing information, ideas and best practice through mail outs and quarterly seminars. Further information: Ken Brady, Scottish Community Energy Programme Co-ordinator,
Telephone: 0131 244 5918.
E-mail: kenb@est.co.uk

Combined Heat and Power Association

Grosvenor Gardens House, 35-37 Grosvenor Gardens, London SW1W 0BS
Telephone: 0207 828 4077 Fax: 0207 828 0310
http://www.chpa.co.uk/
E-mail: info@chpa.co.uk

District Energy Initiative

A CHPA initiative promoting district/community heating
Telephone: 020 7828 4077
E-mail: dei@chpa.co.uk.
Website:www.chpa.co.uk/dei

Other links

Enhanced capital allowance scheme

http://www.eca.gov.uk/

Database of funding sources for housing projects

http://www.est.org.uk/housing/funding.cfm

Transco's affordable warmth programme offers leasing of elements of Community Heating schemes

Telephone: 0121 781 2828
Email: awp@uktransco.com
www.affordablewarmth.co.uk

Appendix: Option appraisal and business planning

1.1 OPTION APPRAISAL

An option appraisal covers everything up to the point where a decision can be recommended on which type of space heating and hot water system option should be implemented, but would not be expected to specify it or outline how implement it.

Planners may request that any potential development includes an option appraisal as part of its application to the local authority. This would demonstrate fulfilment of the Buildings Directive following its implementation.

An outline of an option appraisal

Executive summary

- A summary of the financial and environmental benefits of each of the space heating, domestic hot water and electricity generating systems and make a recommendation based on the results

Introduction

- An indication of the customer, the consultant engineer (who may be the author of the report) and the scope and objectives of the work
- Provision of a map of the site and surrounding areas
- Scope of work description

The site, current heating, hot water and electrical systems, services and estimation of heat demand

- A description of the building and its current services, also outlining the customers likely to be served in early and later phases
- Adjacent sites and customers who may be considered for later phased connection

Heating, hot water and electricity options

- A description of all suitable options considered,
- Assessment procedures (including carbon reduction)
- The proposed Community Heating and embedded generation scheme
- The alternative Scheme(s) such as electric storage heating, individual gas boilers, or no change to the existing provision of energy

Whole Life Costing of the main options

- An analysis showing the Net Present Cost of each alternative using Green Book methodology
- An analysis showing the Net Present Value of alternatives at commercial rates of discount and project life to determine the attractiveness to a developer

Conclusions

- State which is lowest whole life cost heating option
- State whether or not it is technically practical and feasible to pursue this option
- In view of the above, state which option it is recommended to pursue.

Whole Life or 'Life Cycle' Costing is an important part of an option appraisal. It takes account of the total cost of the equipment or service from day zero of the project to its eventual termination or replacement. All capital costs, running costs, replacement costs and revenue streams are calculated before discounting them back to current values. The planning department should encourage the developers to complete whole life costing as part of the scheme proposal. The key stages of Whole Life Costing for community heating and embedded generation are therefore to:

a). Identify the potential heating options for each scheme, domestic or non domestic building generically. For example these may be:

- community heating
- community heating with embedded generation
- individual boilers
- electric storage heating

b). Select an appropriate project life time and equipment life expectancy. It is worth noting the following typical life expectancies of the different space heating and domestic hot water options:

- community heating (approx.25 years, potentially up to 50 years)
- individual gas boilers (approx.15 years)
- electric storage heating (approx.10 years)

c). List and identify the capital costs and the operational running costs along with any revenues and ongoing expenditure for each of the options. Then create the resultant cash flow forecasts for each one of the years to 25.

d). Calculate the net present value and use the discount cash flow technique. Yearly future cash flows can then be calculated to obtain their value in today's terms.

e). Total the discounted cash flows to arrive at a "net present value". Expect the NPV to be negative. Identify the least negative NPV – this is the best option; the lowest Whole Life Costing.

The Community Energy programme uses this method of evaluation, so this process will gather much of the data needed for those considering such an application in the future. Further guidance on whole life costing is available in Financing Community Energy Schemes available from the Community Energy website at www.est.co.uk/communityenergy

1.2 THE BUSINESS PLAN

If the option appraisal study concludes that the refurbishment or installation of Community Heating is the preferred investment, a business plan needs to be developed that outlines the best way of delivering the scheme. The aim of the study is to optimise the whole life costs identified in an option appraisal by exploring a range of issues relevant to delivery.

A typical business plan

Executive summary

Organsiational structure

Examining and concluding (although not establishing) an organisational structure considering an ESCo or partnership and a variety of tendering options.

Finance options

Including evidence of having examined and included or ruled out:

- all funding sources and private investment, and associated costs of capital
- methods of reducing up-front capital needs such as leasing
- options for maximising revenue generation (i.e. sales of heat to other public or private sector customers, sales of electricity from CHP either direct or indirect).

Long term plans for future growth

This might include setting out a timetable for the connection of additional public and non-public sector buildings to the proposed scheme or replication in other areas of the same financial or planning authority.

Cash flow forecasts

Approvals

Outlining the steps necessary to:

- Go through the tendering process
- Gain Planning Consent approval (and Section 14 consent from DTI and emissions consents approvals where appropriate)
- Gain Committee approval (applicant's management at committee or board level)
- Gain resident support.

A project plan

This would include all proposed activities/tasks, deliverables, and timescales

1.3 TYPICAL COSTS

Typical costs of development grants are shown below.

	Cost (£ per dwelling) domestic		Cost (£per m2) non-domestic	
	Range	Average	Range	Average
Option appraisal	10 to 100	30	0.03 to 0.27	0.15
Business plan	10 to 30	20	0.2 to 0.6	0.24
Tender management	20 to 40	40	0.3 to 0.6	0.60
All the above	60 to 120	90	0.8 to 1.4	0.99

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