# Slateford Green and Lasswade Road, Edinburgh:

## A case study on small scale communal heating

May 2011

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# 1. Introduction

Home energy use is responsible for over a quarter of UK carbon dioxide ($CO_2$) emissions, which contribute to climate change. To help mitigate the effects of climate change, the Energy Saving Trust has a range of technical solutions to help UK housing professionals build to higher levels of energy efficiency.

The Energy Saving Trust have produced this case study to provide an overview of the key sustainability features of the Slateford Green housing development in Edinburgh. With a focus on the communal heating system, this case study highlights the practical challenges, experiences and lessons learned in delivering such a system on a relatively small scale.

Communal and district heating is increasingly being promoted as part of the drive for low carbon and decentralised energy solutions but there are relatively few examples of recent successful installations on smaller scale developments.

This case study outlines the design issues, performance, operational and management arrangements, running costs and occupant feedback for the communal system installed at Slateford Green. The lessons learned in the design and operation of the system are explained, but most importantly, it examines how the development at Slateford Green influenced the design of Lasswade Road, a subsequent residential site with communal heating developed by the same housing association.

**Figure 1: Images of Slateford Green**

## 2. Background to Slateford Green

Slateford Green consists of 120 flats in the heart of Edinburgh and was developed by Dunedin Canmore Housing Association with Hackland-Dore Architects. The site, which was opened in 2000, was predominantly funded by the housing association and aimed to test new approaches that could improve the sustainability of housing in Scotland.

Both the housing association and the design team had ambitions to incorporate as many innovative technologies as possible. Although several of the innovations did not come to fruition (as explained in section 4) the developers decided to focus on delivering high fabric specifications and to incorporate a communal heating network.

## 3. Design

The Slateford Green development is a tear drop shaped block of flats centred around a communal pond and gardens. The architects, Hackland-Dore, specified a timber frame and joist structure based on concrete foundations with an aluminium roof. The timber was sustainably sourced, under the Forest Stewardships Council scheme, and the concrete contained recycled aggregates. A warm-cell wall was specified with a breathing wall membrane. This consisted of reused newspapers blown into the wall cavities with water that caused the starch within the paper to solidify, thereby providing an effective insulating material.


**Figure 2: Satellite Image of Slateford Green Site, Edinburgh. © Google 2010.**

The services incorporated an assisted passive stack ventilation system and the stairwells positioned around the block were designed to have an additional cooling 'chimney' effect. Sun spaces were added to each of the units to increase passive solar gain, and help to heat the units in winter. The sun spaces have proved to be very successful but resulted in units in the south-west corner of the block suffering from minor over-heating problems, which was mitigated by adding solar shading.

The dwellings performed extremely well against building regulations at the time of construction, achieving an average SAP score of 96 (under SAP 1998). The development was completed before air-tightness testing was required for building regulations, and tests were not carried out. However, since the development has been in operation thermal imaging tests have been commissioned by the housing association to see how well the development is able to retain heat. The thermal images indicate that there is a relatively low level of heat loss and that the Slateford development performs well compared to other dwellings of their type, built during this period.

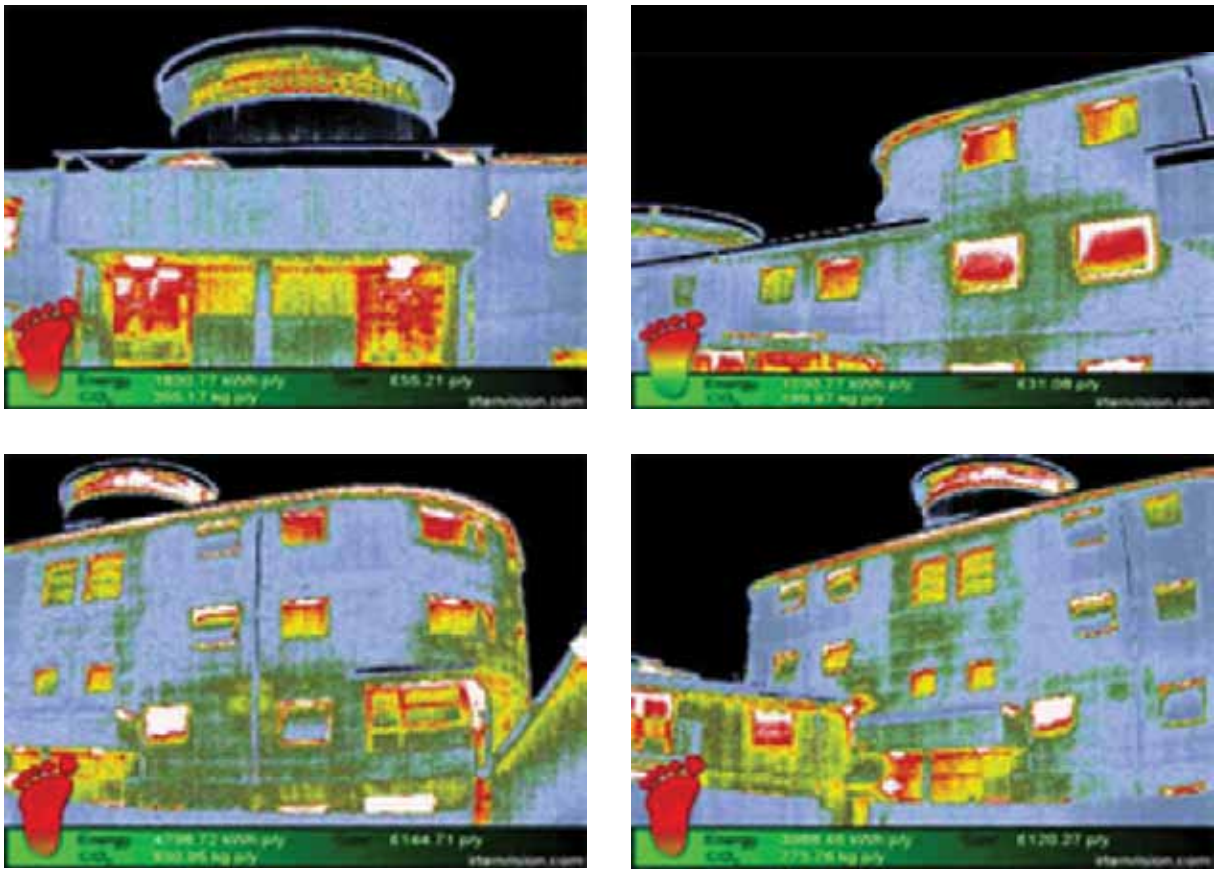

**Figure 3: Thermal Imaging results for Slateford Green, © IRT Energy Limited.**

## 4. Choosing a communal heating system

One of the primary drivers for Dunedin Canmore housing association selecting a communal heating system was to reduce the utility cost for residents and reduce the issues associated with obtaining access for maintenance of individual gas boilers. They had experienced cases in the past where access to dwellings had been refused, which resulted in expensive legal action to gain access to the boilers to carry out required maintenance.

The site is situated close to Caledonian Brewery and the initial design for the scheme proposed to use the waste heat from the distillery to supply the 120 flats with their heating and hot water demand. This waste heat would then be piped from the distillery up to the development's energy centre where it would be stored within insulated water tanks before being distributed to the site via a communal heating system.

It was envisaged that a small gas boiler would also be connected to the communal system to act as a backup if the system failed. Unfortunately, the plans to utilise the distillery's waste heat did not come to fruition (see section 8). As the plans to use the distillery's heat fell through quite late on in the design, the plan to install communal heating infrastructure was retained and the energy supply was replaced with two large gas boilers.

## 5. Specifying communal heating

The energy centre at the Slateford Green site is located approximately 150m from the southern tip of the site. It is a standalone building with a footprint of about 4m by 6.5m and 1.5m in height.

The centre houses two large boilers approximately 270kW in size, both are 'MHS Regency Series 4' models (90% net and 81% gross efficiency). The same boilers have been running over the 10 years that the site has been in use.

Communal heating proved to be more expensive to install than individual boilers and as a consequence, other areas of the design of the development were compromised, including several low and zero carbon technologies which were subsequently not included in the final design. The development was designed around the communal heating system, with a teardrop shaped block being created to allow for a loop in the pipe work (see Figure 2). The table below summarises the responsibilities for each of the stages in the implementation of the communal heating network:

**Figure 4: Slateford Green Energy Centre**

| Process | Who carried this out? | How was this done? |
|---|---|---|
| Design | Harley Haddow Partnerships | Designed the pipe network. |
| Build | Sub-contractor and Harley Haddow Partnership | The pipe-work was delivered and installed by a sub-contractor. Harley Haddow Partnerships fitted the heat exchangers within the units. |
| Operate and Maintain | Housing Association | Maintenance Contract adopted Jaydee Heating. Site Warden employed to ensure system runs smoothly. |
| Billing and Metering | Housing Association | Flat fixed rate charged, moving onto individually metered system. |

**Table 1: Implementation stages for the community Heating System at Slateford Green**

## 6. Running the communal heating system

Individual metering for the flats were not specified at the time of installation due to the cost associated with providing individual flow meters (£500-700 each in 1999). This was an excessive capital outlay, totalling approximately £72,000 for the 120 units and was not deemed to be affordable. At the time, the housing association did not want to be involved in taking regular meter readings, organising separate billing and the administration associated with this. A fixed price system was therefore selected, on the basis that it would be simple to apply. A charge was set as a flat rate per month based on anticipated consumption and inflation increases in cost each year and was applied proportionally amongst the 120 units based on the flat size. The current charges (at the time of writing) range between £28.75 to £60.41 per month depending of the size of flat, which range from 1 bed to 3 bed units.

On average the housing association spend £65,000 a year on gas for the Slateford site, which equates to £540 per unit per year on average. The costs have increased significantly since the development opened due to the increase in gas prices and inflation.

The two gas boilers installed have performed as expected, although several maintenance problems have been logged over the ten years that the system has been in operation. The issues have mainly been due to corrosion occurring in the boilers leading to repeat failures. As a result, a smaller additional boiler was fitted to cover periods when the boilers were under repair or not available. A specialist engineer was called who reported on a defect caused by misspecification of the pumps which allowed water to cycle through the boilers. Once identified the problem was fixed and the boilers have since operated without significant problems.

The housing association stated that the maintenance costs had been higher than anticipated due to these issues. The graph below (Figure 5) outlines a breakdown of the system's annual maintenances costs. The system had an average annual maintenance cost of £3,711 which equates to an average cost per property per year of £30.92.

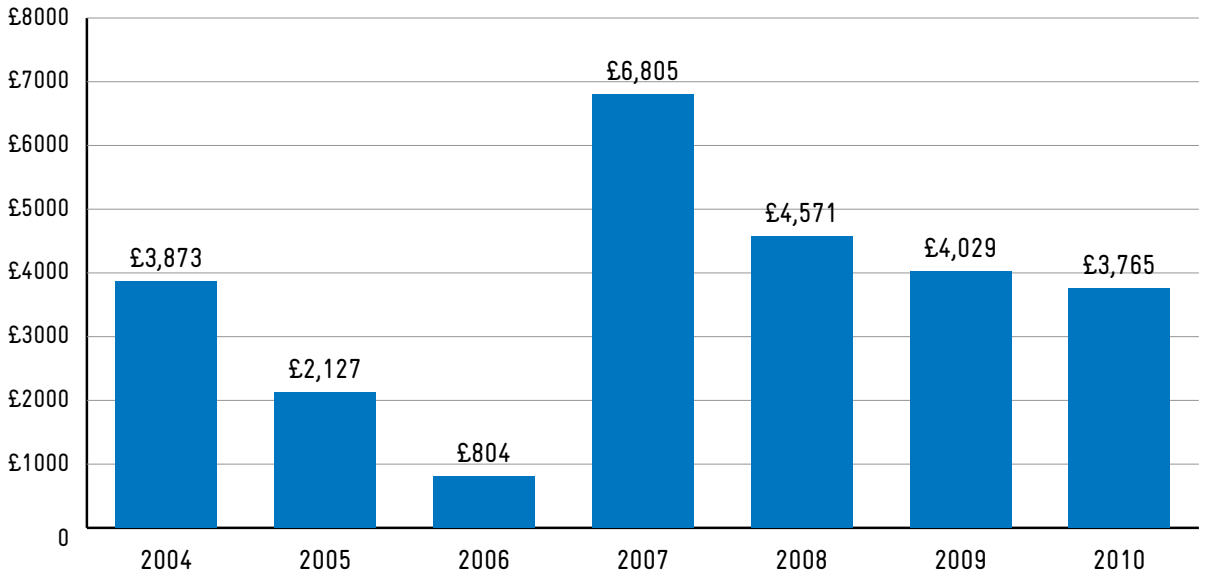


**Figure 5: Breakdown of Maintenance Costs for the district heating scheme at Slateford Green**

## 7. Operational feedback

Despite suffering from several maintenance problems, down-time in the boiler function has had minimal impact on the residents. This is because the housing association employs a warden who is on call 24 hours a day, who can monitor the boilers and, if a problem occurs, contact the relevant maintenance team which the housing association has a contract with.

The housing association's overarching aim of providing the tenants with inexpensive energy costs has unfortunately not been realised at the Slateford site. They found that, over the last 10 years, the flat fee approach has allowed tenants to take advantage of the system by using as much energy as they like with no cost penalties. This has encouraged energy waste, and also disadvantages those tenants that are careful with their energy as they make no financial saving. Also, several residents have raised complaints that the flat rate system does not allow them to make savings on their energy costs.

In response to this, the housing association has issued information to residents on how they can save energy and therefore help to reduce the bills for the community. Residents were advised that the future fixed rates would reflect demand, however, the usage rates were not seen to decline following this action. In conjunction with this, there was pressure from some of the residents to find a more equitable and consistent charging system.

At this time the housing association were also becoming increasingly aware of a need for a more sustainable approach and in an effort to control ever increasing energy costs it was proposed

that individual meters for each flat would be installed. The housing association have more recently obtained quotes to have individual flow meters installed in each flat at a unit cost of approximately £400 per unit which represents an investment of £48,000 across the whole site. Clearly flow meters have come down in price since 1999 (see section 6) due to improved technology and increased demand and the housing association now feel that the individual meters are a worthwhile investment as they are programmed to be fitted at the end of 2011.

## 8. Waste heat recovery

The housing association had opted for a community heating system in order to utilise waste heat supplied by the nearby Caledonian Brewery. However, there were several problems with this solution.

Firstly there was a high cost associated with the pipe work required to transport the heat from the distillery to the site's energy centre. Secondly, because a railway line runs just metres from the site, there were concerns that the railway would be disrupted during the pipe's installation, imposing costly and difficult construction logistics. Finally, an issue was raised with guarantee of supply as, at the time of negotiation, the distillery would only be willing to offer a seven year guaranteed supply, however, the housing association felt that they needed a longer guarantee in supply to make the capital outlay of the system worthwhile. The deal with the Caledonian Brewery fell through at a late stage in the planning process, although as mentioned earlier, the communal heating system infrastructure remained in the design.

In early 2010, Tynecastle High School, which is adjacent to Slateford Green was able to strike a deal with the brewery to use their waste heat and this scheme is reported to be working successfully. The proposal was a more attractive offering due to the proximity of the school, fewer obstructions, which meant less costly connection works and pipe-runs and a sufficiently long guarantee of supply. On reflection, it appears that the Slateford site was a little ahead of its time in attempting to connect their site to a remote heat source. It is possible that as more solutions of this type are adopted they can be repeated elsewhere more easily.

## 9. Further sustainable design considerations

During Slateford Green's preliminary design stages, the design team had ambitions to incorporate more low and zero carbon technologies than were actually realised in the final design. The high cost of the communal heating system limited the other technologies that could be implemented on the site. Photovoltaics (PV) were considered, but were removed due to budget limitations. In 1999, the PV systems were comparably more expensive when compared to the present market, in addition there were no Feed In Tariffs (FITs) or other fiscal incentives to help offset the burden of the initial capital outlay, as are available presently.

A grey water treatment system was also considered within preliminary plans for the Slateford site. It was proposed that the used grey water from the block would run into the central pond (see Figure 6), where it would be treated via the reed bed system, and could then be reused within the WC's for example. However this proposal was rejected by Scottish Environmental Protection Agency (SEPA) and was therefore not realised.

**Figure 6: Central pond at Slateford Green**

## 10. Subsequent communal heating trials following lessons learned

Following the Slateford Green project, Dunedin Canmore Housing Association have trialled alternative communal heating solutions at other sites. An example of this is Lasswade Road, a residential development located on the southern approach to the city with 20 flats and 11 houses. The site's communal heating system design has been strongly influenced by the lessons learned by the housing association at Slateford Green. The Lasswade Road development was completed in 2009 and the heating system has been running since this date.

As with Slateford Green, there was an ambition to deliver low carbon affordable heating and on this basis a communal biomass heating system was chosen based on a feasibility study carried out by Harley Haddow Partnerships.

A good fabric specification was specified using a lightweight timber frame with recycled insulation throughout, along with passive ventilation and heat recovery. This allowed the development to surpass the building regulations standards and achieve an average SAP rating of 106 (under SAP 2005).

**Figure 7: Lasswade Road**

## 11. The Energy Centre and biomass boiler at Lasswade Road

The Energy Centre at Lasswade Road incorporates two Twin CS 150i biomass boilers, sized to meet the full heating and hot water demand, including peak loads; the second boiler acts as a backup. In practice, the boilers must be stopped once a week so that the debris left from the woodchips can be cleared. During these times the other 'back-up' boiler takes over. The biomass systems were installed and continue to be maintained by Vital Energi. The pipe work and associated radiator system was installed by Harley Haddow Partnerships. The system has been set up with an intelligent alert system. If a problem occurs a text message will immediately be sent to the local Vital Energi engineer, who will then investigate the problem.

The biomass is sourced in the form of wood pellets imported from Balcas in Northern Ireland. The housing association have found that the cost of fuel has been higher than they anticipated, however there are proposals to use a more local source of supply which may become available within the next few months, which could be cheaper. It is also expected that gas prices will be seen to rise significantly in the coming years, meaning that the system's running costs would become more affordable than grid prices. The development was built prior to the launch of the Renewable Heat Incentive (RHI), although the housing association are aware that this may benefit future projects.

The total cost of the biomass communal system was £549,000 including associated equipment as outlined in table below:

| Equipment | Cost (£) |
|---|---|
| Boilers | 68,008 |
| Controls & specialist equipment | 72,012 |
| Cost of pluming installation (mains supply) | 1,500 |
| Cost of electrical installation (mains supply) | 1,500 |
| Energy centre | 37,500 |
| Heating installations within flats | 93,000 |
| District heating mains | 96,916 |
| Trenches/chambers for district mains | 4,312 |
| Heat meter/smart card system | 53,066 |
| Main contractor attendances | 69,158 |
| Contractor professional fees | 52,928 |
| Gross Total | 549,000 |

**Table 2: Cost Breakdown of Fitting the Biomass Boiler System at Lasswade Road.**

The housing association received £50,000 of funding from the Scottish Community and Householder Renewable Incentive (SCHRI), plus £50,000 of funding from the Energy Saving Trust with the rest of the funding coming from the housing association's own housing budget.

## Carbon savings

The biomass system was predicted to save 120 tonnes of carbon per year compared with an oil fired boiler. The boiler has met demand as expected and it is therefore assumed likely that this estimate has been realised, although system returns have not been formally calculated since operation began.

## Operation and Maintenance

The maintenance provided by Vital Energi had a cost of approximately £26,400 during the first year of operation, whilst the wood pellets cost £12,600. Running costs have not yet been comprehensively analysed but the housing association aim to carry out a full assessment of the scheme in the near future to see if their aim to provide an overall more affordable long term heating system has been met.

The biomass system is reported to have worked well to-date. Some minor problems were experienced however when localised power cuts occurred as this meant that the system's operating controls switched off which in turn prevented the boilers from working. This required an engineer to be called out to reset the system. This problem could potentially be avoided by fitting a backup electricity generator within the energy centre, however there are no plans to install this at present.

## Metering and billing system

Slateford Green's unsuccessful flat rate monthly charge system influenced the decision to fit individual meters within the units at Lasswade Road. The meters are part of a pre-payment Smart Card system. This had a capital cost of £53,066 to install (£1,608 per unit). The system allows residents to 'top-up' their card at the local shop by the amount they require, and ensures they only pay for what they require and use. The residents pay 4p per kWh, reflecting mains gas prices at the time of writing.

At weekends there is an over-ride system in operation which allows energy to continue to be used and the negative credit to be recorded. This ensures that if the shop is shut during this period and the topping up of cards not possible, the residents can still utilise their heating and hot water. This over-ride system can also be switched on if the shop were to close down suddenly, therefore, allowing time for the housing association to organise a contract with a new local store to provide the top-up service, without preventing the residents from using their heating and hot water as normal.

The housing association have found the Lasswade Road metering system much more effective compared to the system installed at Slateford Green. Initial feedback from the tenants has also been good and the housing association intend to carry out a tenant survey in due course.

## 12. Lessons learned from Lasswade Road

Several lessons have been learnt from the Lasswade Road exercise. Firstly, that the biomass system is slightly oversized because both boilers were designed to serve the peak loads. The housing association are currently looking into extending the pipe work to two housing association-owned cottages adjacent to the site in order to use some of this excess heat.

Secondly, on review, they would look at applying this system to a site with more units. It is thought that a site with 60 units or more would have the economies of scale to make the cost of installation, maintenance and running costs more viable in the current market. However, they noted that in time they anticipate that competition within the market will lead to more competitive capital, fuel and maintenance tenders, allowing smaller scale installations to become more financially viable. Differences between the two systems are summarised in table 3 below:

| Specification Choices | Slateford Green | Lasswade Road | Reasons for Change in the Lasswade Road project |
|---|---|---|---|
| Fuel Type | Gas | Biomass | To specify a lower carbon energy solution. To provide more affordable heating and hot water to the residence. |
| Metering & Billing Strategy | Flat rate scheme | Individually metered pre-pay scheme | To encourage economic use of energy.<br>To reduce the administrations costs in billing and collecting fees. |
| Procurement Procedure | Each Installation stage procured separately | System procured through one supplier | Provides continuity through the installation process. |

**Table 3: Summarises how the lessons learned at Slateford Green has influenced specification choices at Lasswade Road**

### Planning

Another factor the housing association would need to consider when specifying the next communal heating system will be planning restrictions for installing biomass. Since the Lasswade site was completed, the City of Edinburgh Council have adopted a more stringent approach to planning applications that incorporate biomass installations. Any planning applications of this kind are currently required by Edinburgh Council to provide evidence to show that the proposed system will not increase the level of particulate matter (PM) within the air. Air pollutants emitted from all combustion appliances including biomass boilers include oxides of nitrogen, oxides of sulphur and PM. Of particular concern for biomass combustion is the emission of particulates $PM_{10}$ and $PM_{2.5}$, which are associated with respiratory and cardiovascular illness, as well as other ill-health effects.

The council are required to adhere to meeting Air Quality Objective background levels for the particulates set by Air Quality Strategy for England, Scotland, Wales and Northern Ireland (2007)[1]. In addition to this, the Scottish Government have now adopted more challenging air quality objectives than the remainder of the UK for both $PM_{10}$ and $PM_{2.5}$ (18µg $m^{-3}$ as an annual mean for $PM_{10}$, and 12µg $m^{-3}$ as an annual mean for $PM_{2.5}$). Air quality monitoring and pollution modelling is therefore required in order for a biomass installations to be granted planning permission. This can be onerous to achieve for small developers.

A recent paper from the Scottish Government[2] outlines that biomass boilers will not be the major source of $PM_{10}$ or $PM_{2.5}$ in urban areas. However, in areas that are already close to $PM_{10}$ Air Quality Objective limits the additional contribution of biomass may lead to an excess of background levels at some city locations. It is possible that biomass may be a more accepted solution within coming years if background levels from other sources of PM such as vehicle traffic etc were to fall.
In addition to this, the Biomass Action Plan for Scotland[3] and the proposed Renewable Heat Action Plan formulate policy and action within Scotland to encourage the take up of biomass as a heat fuel source, as part of a range of measures to reduce $CO_2$ emissions and energy costs.

## Fuel storage specification

Another lesson learnt at Lasswade Road relates to the importance of the biomass fuel storage specification. The biomass store is located in a raised hopper within the energy centre which must be accessed via a lorry with a blower attachment. During operation of the system the housing association have learnt that pellet supply can be more competitively priced if it can be tipped, as there are limited suppliers who have access to lorries with blower attachments.

In future developments the project team would aim to place the store below ground or with a ramp to allow tipping access. It was also noted that it was important to allow more storage capacity within the hopper than one lorry load of pellets because the hopper requires re-stocking before the previous pellet stock has run out.

1 The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (Volume 1), Presented to Parliament by the Secretary of State for Environment, Food and Rural Affairs, July 2007.

2 Measurement and Modelling of Fine Particulate Emissions (PM10 & PM2.5) from Wood-Burning Biomass Boilers AEA Energy & Environment Report to The Scottish Government, September 2008

3 Biomass Action Plan for Scotland, Scottish Executive, March 19, 2007.

## 13. Dunedin Canmore Housing Association's communal heating network – summary of lessons learnt

Several key lessons have been learnt by the Dunedin Canmore Housing Association in fitting the communal heating networks at Slateford Green and Lasswade Road. Firstly, it has proved to be essential that residents' energy use is charged on an individual basis, so that there is a personal incentive to reduce energy consumption and thereby minimise costs.

An individual metering system was adopted and applied successfully at Lasswade Road, the pre-paid Smart Card system removed the housing association's administration costs involved in taking meter readings, billing and collecting money but ensured that residents were encouraged to reduce energy consumption. This metering system remains the housing association's favoured system for future schemes.

Table 4 below outlines the key benefits and risks to the housing association when designing and installing a community heating system:

| Risks | Benefits |
|---|---|
| Higher cost of installation | Can remove the administration required for individual meter readings and billing. |
| Requires planning at design stage, may affect design layout of the development. | Removes need for individual boiler maintenance, and difficulties associated with gaining access to properties. |
| Requires a continued maintenance contract. Can require staff member/warden to be on call in case system fails. | Provides flexibility allowing expansion of the network and connection of future energy technologies. |
| Removes tenants choice of heating system | Has potential to offer lower heating costs to residents. |
| | Allows potential to adopt technologies, such as biomass, which can benefit from the Renewable Heat Incentive and help to meet carbon reduction targets. |

**Table 4: Benefits and risks of installing a communal heating network**

## 14. Next steps

As well as retro-fitting meters, the housing association are considering expanding Slateford Green's communal heating network. They have ownership of an adjacent site called Georgie Park Close (Figure 8) which comprises 60 residential units with workshops and eight office units which may provide a suitable point of connection.

**Figure 8: Georgie Park**

This site was built in the early 1990s and the workshops were intended to encourage small home-based businesses to prosper. The workshop scheme was not successful, but the flats and offices continue to be occupied. The Georgie Park building runs on electric storage heaters which have proved to be ineffective and expensive to run, giving more reason to bring in a sustainable source of power to the site.

By connecting to this site, the housing association envisage that this would enable the Slateford Green energy centre to be expanded to incorporate a gas-fed Combined Heat and Power (CHP) system that would serve both residential blocks with heat and electricity. They are also investigating the feasibility of a wider district heating system connecting other businesses to the network, including supplying electricity to McDonald's and Lidl which are located on the Old St Nichols road, just down the hill from the site.

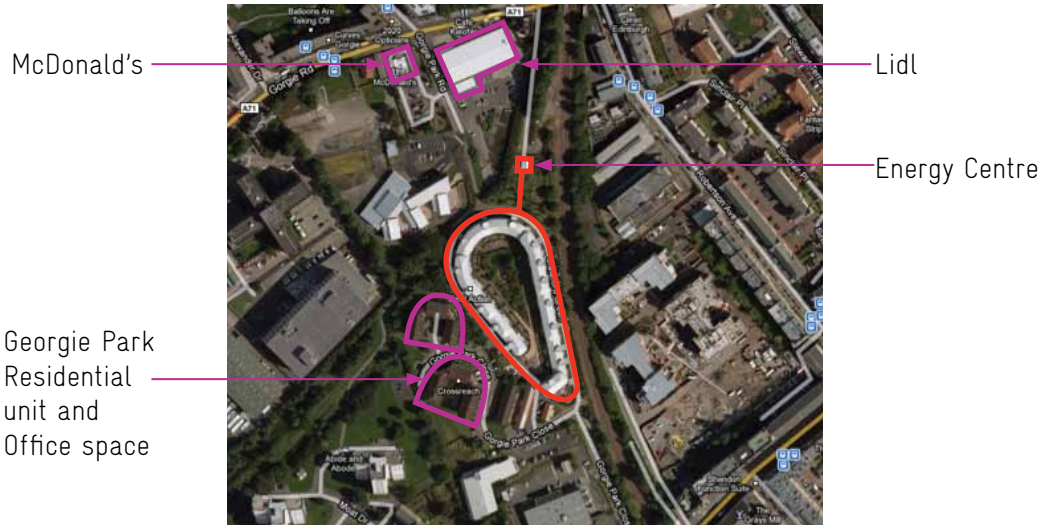


**Figure 9: Birdseye view of Slateford energy centre and potential future connections. © Google 2010.**

At the time of writing these businesses have not yet been approached by the housing association, however, a feasibility study has been commissioned by EnerG to investigate the options for expanding the site's communal heating network into a larger District Heating Network (DHN). The outline for this scheme is still in its infancy but if the scheme is successful, this would be one of the first small-scale DHN's in Scotland, and could potentially provide all the residents and businesses connected to the scheme with a cheaper and more sustainable source of energy.

It is estimated that retro-fitting meters at Slateford Green will deliver a 30% to 40% saving on the residents' current monthly charges. The extension of the system and addition of CHP plant would increase the $CO_2$ savings as well as delivering financial benefits, which could be used to reduce the costs to residents.

## 15. Conclusion

Uptake of sustainable energy and energy efficiency measures have enabled the Dunedin Canmore Housing Association to fulfil national legislative requirements and take steps towards their ultimate aim of delivering a higher standard of sustainable housing that provides a low carbon and inexpensive energy supply.

Over the last 10 years, Dunedin Canmore Housing Association's developments have delivered an increasingly high standard of sustainable housing with dwellings such as those at Slateford Green and Lasswade Road consistently going beyond best practice standards and testing new technologies. These two schemes have direct experience of the benefits, costs and risks of installing communal heating systems. As yet, these solutions have not provided a significant reduction in the resident's heating costs, although it is hoped that future installations will achieve this. In addition it is hoped that existing systems will achieve lower bills with further investment, development and as future regulatory pressures and fiscal incentives are introduced.


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