Environmental Performance Statement

Moss Lane East, Manchester



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This environmental performance report has been produced in response to Manchester City Council's Guide To Development in Manchester 2007.

Part 4 of this Guide, Environmental Standards, sets out the requirements for Energy Efficiency, and Renewable Energy as follows:-

Energy Efficiency
Part 1 Policy E1.5 encourages high standards of energy efficiency in new development.
In the Environmental Standards Statement, developers should show how they have considered the steps necessary to reduce energy demand at the earliest stages of design. Developers should aim to reduce CO2 emissions by at least 25% more than the requirements of the current Building Regulations, which at present are Building Regulations: Approved Document L (2006) - 'Conservation of Fuel and Power.'

Renewable Energy
To reduce energy demand and the harmful impact of using energy from non-renewables, in line with UDP Part 1 Policy E1.5, developers should aim for at least 20% of final site energy demand to be met by on-site renewable energy technologies. Renewable energy targets can be achieved more readily by undertaking the measures suggested above to reduce the total energy demand of the building. It is possible to produce developments that use 50% and even 100% energy from renewable sources.

Developers are required to demonstrate the proposed energy requirements and how the targets have been met in the design process. Developers are often required to enter into an agreement (in some cases a condition may be sufficient) with a local authority to ensure the renewable energy production equipment is maintained at the required standard for the life of the building.

Where the targets are not practically achievable on site then the developer may be required to make a financial contribution towards other local renewable energy schemes. The contribution will be negotiated on a case by case basis dependant on scale and impact of the development and the costs of providing the energy schemes.

This report shows how we propose to achieve a percentage of the buildings energy consumption by generating it renewably on site and discusses the renewable technologies available.

The new Part L Regulations require that the residential flats within the scheme will be tested for a carbon index rating based on a new NHER scheme. These ratings will be tested in a separate Building Regulations report.

Whilst looking at the renewable options and proposed engineering services alternatives available we have endeavoured to keep a sensible ratio between the correct solutions for the development against capital investment of the solutions available.

2.0 Executive Summary

A number of systems and potential solutions have been studied in order to achieve the on-site renewable targets for the proposed new development in Moss Lane East, Manchester. Current renewable energy technology has been reviewed and, for the viable systems, we have calculated the percentage contributions from each solution.

It is the intention to strive to achieve an overall 20% on-site renewables contribution, and carbon emission savings of 25%.

The total estimated building Carbon emissions for conventional systems = 130,644 kg C per year, from the consumption of 1,229,650 kWhrs of gas a year, and 569,852 kWhrs of electricity.

In order to achieve a 20% on-site contribution, the renewable solutions would need to provide a total of 359,900 kWhrs per year, and this can provided by any solution either in isolation, or by use of a mixture of compatible renewable solutions.

Detailed assessments of each renewable solution are listed within Appendix 1 of this Environmental Performance Statement, with an assessment of a low carbon solution, in the form of gas fired mini-CHP being listed within Appendix 2.

The solutions and savings are summarised as follows:-

Solar Panels providing 26.4% of the daily domestic hot water, provides a 7.2% on-site renewable contribution, and a 5.18% carbon reduction.

Photovoltaic Panels can provide a 20% renewables contribution if a total active panel area of approximately 2117m² can be incorporated within the building envelope, however it is envisaged that a PV installation would be limited to the roof only, and as such a 300m² installation is considered feasible in this case. The resulting on-site renewable contribution equates to 2.8%. This equates to a 4.7% carbon reduction.

A biomass solution is considered as being not viable due to the spatial requirements for plant and fuel storage, the impact on the number of parking spaces, as well as the potential lack of fuel supply continuity, which would result in the use of a backup fossil fuel.

A Ground Source solution, be it open or closed loop, and only providing Residential heating, makes a 52.7% contribution. The feasibility of the closed loop option is however in doubt due to site constraints, whilst the open loop option would be subject to a detailed hydro-geological study to ascertain the feasibility for this site location. This study has not been commissioned as the indicative cost of installation would be prohibitive for this particular project.

Wind turbines have been considered, however due to the numbers required, their size and close proximity to residential areas, are not considered as being feasible.

Although not a renewable solution, Gas fired Mini-CHP offers carbon emission savings of 40,371 kg C per year, based on the Mini-CHP solution providing 66% of the daily domestic hot water, and 73% of the basement car park lighting. This equates to a 30.9% Carbon reduction.

Following these assessments it is clear that a number of potential solutions are available and are expressed in order of percentage on-site renewable contributions as follows:-

Open Loop Ground Source	- 52.7% on-site renewable contribution
Solar Thermal Panels	- 7.2% on-site renewable contribution
Photovoltaics	- 2.8% on-site renewable contribution

Ground Source offers the potential to meet the 20% on-site renewable requirement, however this would have significant capital cost, and potential risk associated with any implementation as a solution for this development.

If expressed in terms of percentage carbon reduction, in order to bring the gas fired Mini-CHP solution into the equation, the solutions are summarised as follows:-

Gas fired Mini-CHP	- 30.9% carbon reduction
Open Loop Ground Source	- 29.1% carbon reduction
Solar Thermal Panels	- 5.18% carbon reduction
Photovoltaics	- 4.7% carbon reduction

Therefore to meet a 25% carbon reduction target, ground source, and Gas fired mini-CHP have the capability of meeting such a target.

In conclusion, the recommendation for this scheme is to provide a solution that aims to achieve a percentage renewable energy contribution, and carbon saving, whilst not incurring prohibitive cost or risk.

To this effect, roof mounted Solar Thermal Panels, providing approximately one quarter of the developments annual domestic hot water demand, will provide a 7.2% on-site renewable contribution, and a 5.18% carbon reduction are recommended for this development.

Gas fired mini-CHP, although <u>not</u> a renewable solution, has the potential of offering substantial energy savings that would achieve the 25% carbon saving target.

The implementation of solar thermal into this development will require a community heating scheme.

It should be noted that gas fired mini-CHP would utilise a community scheme, therefore it is feasible for both Solar Thermal, and mini-CHP to operate in combination, however to maximise the operational hours of the CHP equipment, it is suggested that the CHP scope should be reduced to 33% of the annual hot water demand. This would halve the mini-CHP carbon savings, however the following combined totals could be achieved:-

Solar Thermal & mini-CHP	- 7.2% on-site renewable contribution
Solar Thermal & mini-CHP	-20.63% carbon reduction

3.0 What is Renewable Energy

"Renewable energy" refers to energy sources that occur naturally and repeatedly in the environment and can be harnessed for human benefit. Renewable energy sources include solar, wind, hydro, geothermal, tidal, wave energy and bio-fuels.

Decreasing the consumption of non-renewable "fossil fuel" reserves such as coal, oil and gas, and reducing our dependency on them for energy generation by seeking alternative renewable energy technologies, is one of the key elements in reducing carbon emissions and in turn global warming.

The implementation of renewable energy technologies can achieve significant environmental, health, social and financial benefits. They include:

- A reduction in carbon emissions and depletion of fossil fuels and in turn the amount of greenhouse gases produced and contributing to global warming.

- A reduction in the dependence on network systems, as renewable energy systems create their own energy.

- Improved reputation for companies that adopt the renewable energy philosophy to become environmentally responsible.



Fig. 1 Photovoltaic Installation

4.0 Renewable Energy Technologies

Energy efficiency is inextricably linked with the use of renewable energy technologies. If buildings become more energy efficient, they require less overall energy.

A number of available technologies for renewable energy generation have been considered. These can be used individually or in combination with other methods, all which if applied to an efficiently constructed development can produce effective sustainable energy results. These are described below:

4.1 Photovoltaic Cells (PV Cells)
4.2 Solar Water Heating Systems
4.3 Wind Generation
4.4 Biomass Heating
4.5 Heat Pumps
4.6 Combined Heat and Power Plants (CHP)
4.7 Geothermal

4.1 Photovoltaic Cells (PV Cells)

Photovoltaic solar cells or panels use the sun's energy to generate electricity which can be used on site or exported to the local electricity network.

A Photovoltaic cell is a complex device consisting of semi conductors and silicon.

The successful application of PV technology can be affected by factors including the intended use of the system, expectations of generation output, scale or project, use of the appropriate PV technology, the level of sunlight exposure, building design and equipment positioning factors.

4.2 Solar Water Heating Systems

Solar water heating systems use the sun to heat either water or a heat transfer fluid (eg. Glycol and antifreeze) in collectors. That water is then stored for use as needed with a conventional system providing any necessary additional heating.

Solar water heating systems are generally either active or passive systems. An active system uses electric pumps, valves and controllers to circulate the water/heat transfer fluids through the collectors, while a passive system moves water/heat transferred fluid through the system by relying on natural heat convection.

The main benefit derived from solar water heating systems is that less direct energy input is required to heat the already warm water to the desired temperature, saving carbon energy and money.

4.3 Wind Generation

Wind turbines operate on a simple principle – wind turns propeller-like blades around a rotor and the rotor, which is connected to a main shaft, spins a generator producing electricity.

Crucial to the success of a wind generator is a constant supply of wind energy. Wind turbines generally have limited application in many urban settings due to the need for large areas of open space, potential visual impacts on the surrounding environment, noise, low wind speeds and high turbulence levels.



Fig. 2 Photovoltaic Cells



Fig. 3 Wind Generation

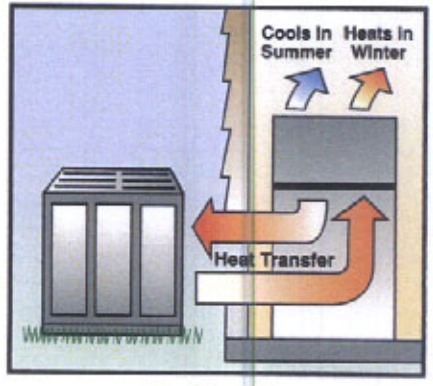


Fig. 4 Heat Pumps

4.4 Biomass Heating

Biomass Heating involves using plant material (usually wood but can also include wetter green waste which can be anaerobically digested) as fuel. It can be used as an alternative to, or can complement, conventional heating systems. Biomass is considered a renewable energy if the wood comes from a sustainable source or involves use of wood that would otherwise be a waste product. The CO_2 emitted from burning biomass is equivalent to the amount of CO_2 absorbed when the wood grows and is therefore "carbon neutral".

4.5 Heat Pumps

A heat pump is a device that transfers heat from one medium at a cooler temperature to another medium at a higher temperature. The process is similar to that of a refrigerator, which transfers heat from inside the unit, therefore cooling it and releasing it to the outside. The basic components of a heat pump are a compressor, a condenser, an expansion valve, an evaporator and a working fluid such as any of a number of industrial gases, ammonia, CO_2, hydrofluorocarbons (HFC's).

4.6 Combined Heat and Power Plants (CHP)

Combined Heat and Power (CHP), also known as Cogeneration, is the simultaneous generation of heat and electrical power in a cost effective and environmentally responsible way. Recent technological advances enable "trigeneration" – production of heating, cooling and power.

CHP uses heat that is otherwise discarded from conventional power generation to produce thermal energy. This energy is used to provide cooling or heating for industrial facilities, district energy systems and commercial buildings.

Through beneficial use of the waste heat, CHP systems achieve typical effective electric efficiencies of 50% to 70% – a dramatic improvement over the average 33% efficiency of conventional fossil-fuelled power plants.

CHP is not strictly a form of renewable energy; it is simply a more carbon efficient way of generating heat and power in a building.

4.7 Geothermal (Ground Source)

The Geothermal concept utilises the worlds largest heat reserve storage facility and solar collector – the ground.
Depending upon the geological strata, either open or closed loop ground source systems can be used.
Open loop systems utilise natural below ground water resources, via submersible pumps in boreholes, as either a heating or cooling medium for water to water ground source heat pumps.

Closed loop systems utilise a below ground pipe network, being either in vertical or horizontal arrangement, in which to circulate water which either picks up, or rejects heat to/from the ground in winter and summer months.

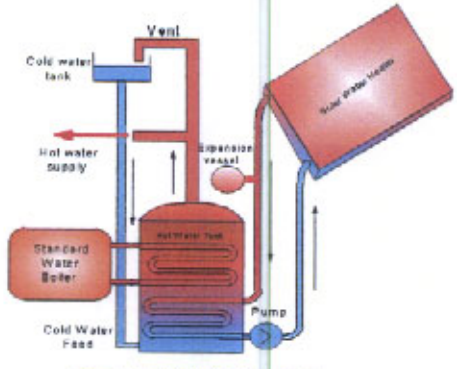


Fig. 5 Solar Water Heating



Fig. 6 Biomass Heating



Fig. 7 CHP Absorption Chiller

5.0 Building Regulations Part L (Conservation of Fuel & Power) 2006

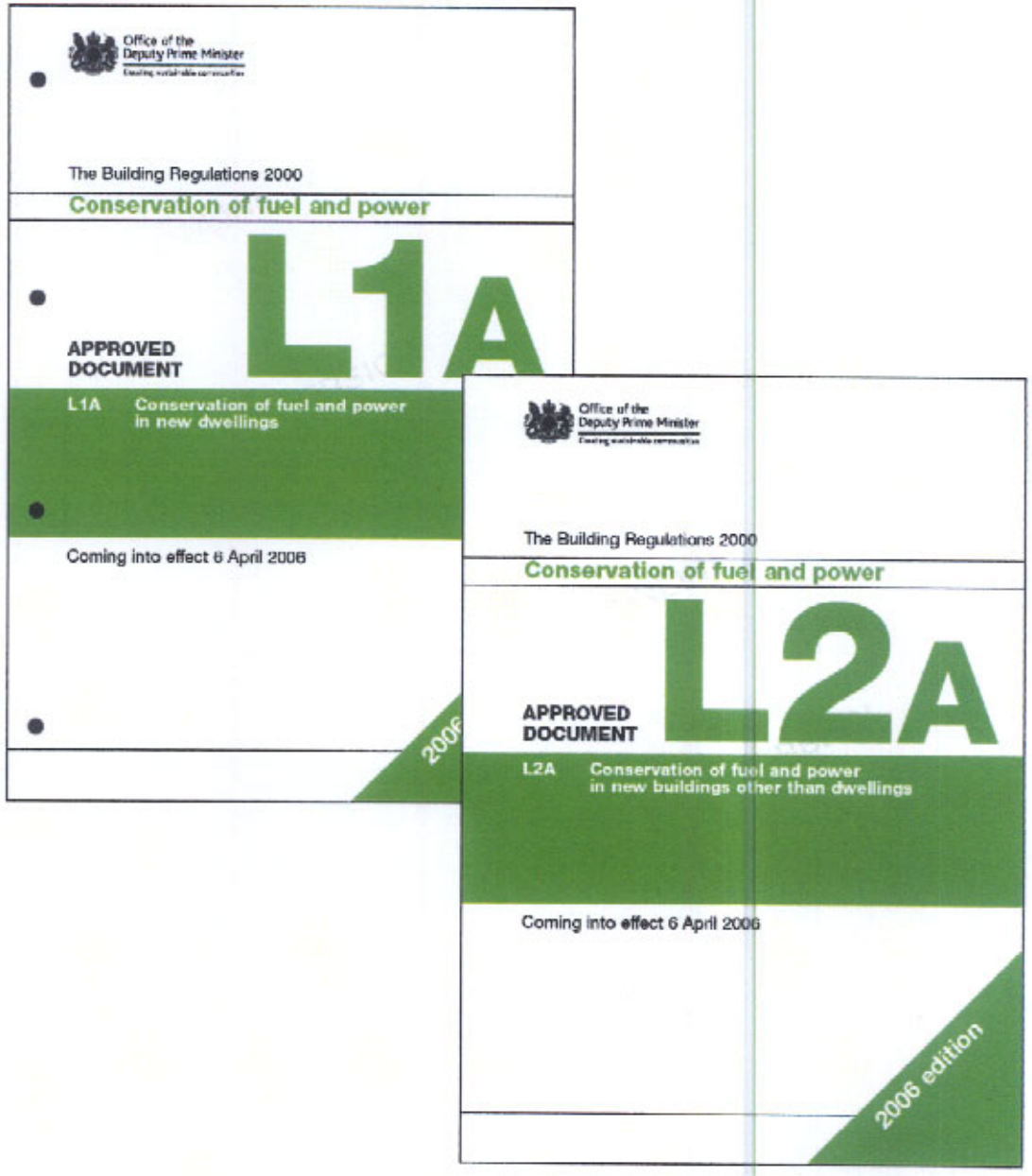
The new Building Regulations (Part L) came into force in April 2006.

The new Part L1 changes require that a notional "target" carbon output is calculated for each dwelling which is compared against the "actual" carbon output. A 20% reduction in carbon output is inherently built into the target "TCER" calculation, therefore the actual "DCER" has to be at least equal to the "TCER" .

(TCER = Target Carbon Emissions Rate and DCER = Dwellings Carbon Emissions Rate).

There were no proposals to further improve the baseline U values beyond the current Regulations.

The results of the above calculations will be issued as part of a separate Building Regulations SAP compliance report.



6.0 Building Energy Consumption

Utilising the London Energy Partnership "renewables toolkit", the Moss Lane East development total energy consumption has been estimated. The total consumption has been studied in depth, details of which are within Appendix 1 of this Environmental Performance Statement.

A summary the development energy consumption is as follows:

Residential Areas – The renewables toolkit (Section 4.12.10) gives a global carbon emission figure of 9.04kgC/m² for residential developments, with no detailed breakdown for the use of gas an electricity. Our assessments have allocated the consumption of gas and electricity in line with typical domestic use, and to give a total of 9.04kgC/m² for the Residential part of the development.

Residential Gas Consumption	1,158,840 kWhr/year
Residential Electricity Consumption	476,412 kWhr/year

Commercial Space – The renewables toolkit gives benchmark gas and electricity consumption figures for a number of Commercial Unit types. This assessment has been based on a Type 3 Standard Office with gas consumption at 97 kWhr/m² , and electricity consumption at 128 kWhrs/m²/year.

Commercial Gas Consumption	70,810 kWhr/year
Commercial Electricity Consumption	93,440 kWhr/year

Basement Car Park – Based on a lighting level of 5 W/m², and 24 hours a day, 365 days a year.

Car Par Electricity Consumption	207,086 kWhr/year

Development Total Consumption

Gas	1,229,650 kWhr/year
Electricity	569,852 kWhr/year
Total	**1,799,502 kWhr/year**

Using Building regulation Carbon emission factors of 0.053 kg C/kWh for use of gas, and 0.115 kg C/kWh for use of grid supplied electricity, the following annual building carbon dioxide emissions have been estimated:-

Residential	116,143 kg C/year
Commercial	14,501 kg C/year
TOTAL	**130,644 kg C/year**

In order to achieve a 20% on-site renewable contribution, 359,900 kWhrs/year would need to be provided by renewable solutions.

In terms of percentage carbon savings, the buildings solutions would need to reduce carbon emissions By 32,661 kg C per year



Fig. 8 North & South Elevations – Courtesy of Hodder Associates

Early CHP technology was too large in terms of output to offer an effective solution for the multi-tenanted residential sector, however many manufacturers can now offer much smaller CHP engines. Because of the relatively low outputs and small footprint the benefits can now be offered to this type of development.

Based on the same principle as the large scale CHP equipment, Mini-CHP plant includes a fuel fired water cooled engines linked to a turbine which generates electricity.

Mini-CHP units are designed to transfer the heat generated in the engine into a conventional boiler circulation system, whilst producing electricity for use within the building.

For multi-tenanted residential properties, Mini-CHP is selected based on two methods.

For installations that will utilise the CHP generated electricity within landlords areas only, the landlords base electrical load is used. This allows the residents to continue to purchase their electricity from their choice of local electricity supply company.

If the landlord were to operate a "private-wire" network, thus selling electricity to the residents, the number of Mini-CHP units installed is selected on the base electrical load of the entire property.

The latter option, when utilised with district heating, allows the landlord to sell both heat and electricity to the residents, both at an agreed tariff. Both the landlord and the residents then benefit from cheap CHP generated electricity all the time that there is a demand for heat.

This is illustrated schematically in fig. 8.

A detailed analysis of the gas fired mini-CHP option is listed within Appendix 2 of this Environmental Performance Statement.

This assessment has been made on the basis that the number of mini-CHP units is targeted at meeting 66% of the annual domestic hot water demand, with the by-product of electricity being use to serve the basement car park lighting installation.

The analysis indicates that the DHW demand would be met by two number mini-CHP units, with the generated electricity delivering 73% of the basement car park energy.

The gas fired mini-CHP option can not be classed as a renewable solution, however, a percentage carbon saving can be offered.

Our analysis suggests that the gas fired mini-CHP solution would offer an 30.9% carbon emission saving.

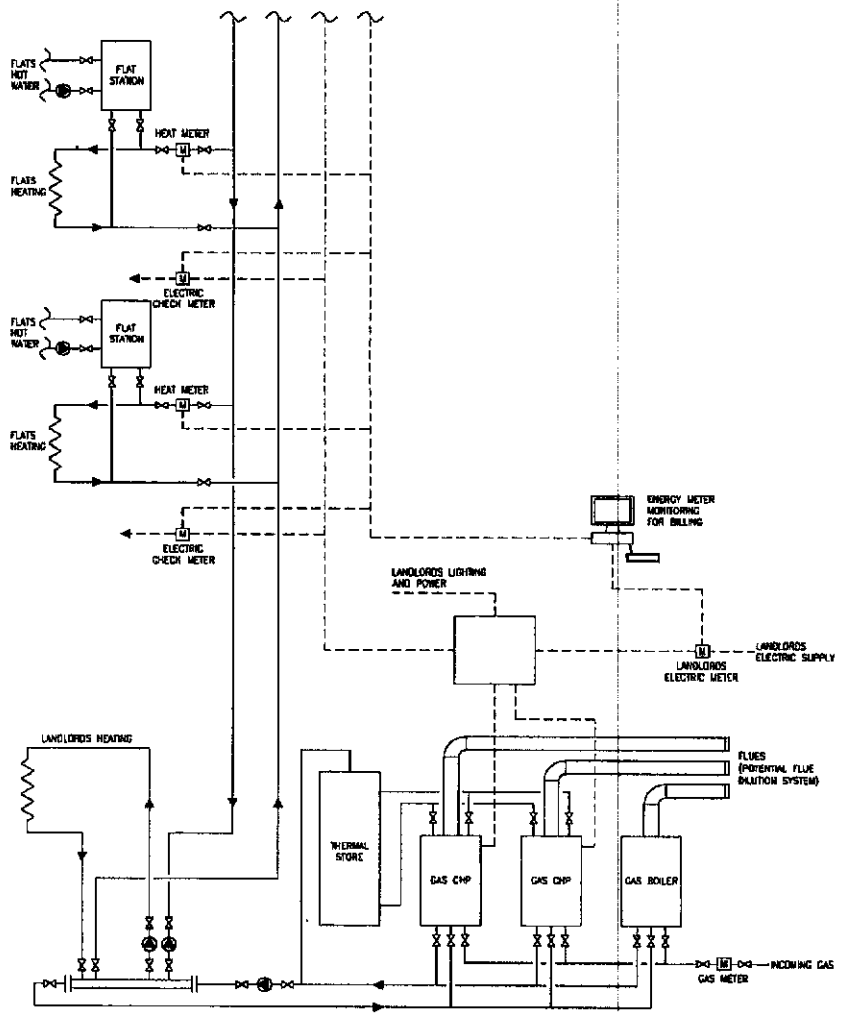


Fig. 9 Mini-CHP schematic

8.0 Overview of Solar Panels

The use of solar panels for generation of domestic hot water within residential buildings is common-place.

Bromley Road has the potential for the inclusion of solar panels on the various areas of roof, however the benefits to be gained need to be established in relation to the operation of the Mini-CHP plant.

Whilst there is a demand for generating domestic hot water, any implemented Mini-CHP plant will be in operation due to the constant requirements for the landlords electrical distribution systems, therefore benefits will be gained from the generated electricity as a result.

The best efficiency from any Mini-CHP plant is gained when operating hours are maximised, therefore the introduction of solar panels may well result in reduced operating hours for the Mini-CHP equipment.

From the current building plans, it is estimated that a total of 300m² of solar and/or photovoltaic panels could be provided.

It is estimated that 26.4% of the building total domestic hot water demand could be met by the installation of 300m² of active solar thermal panels.

The operation of the solar thermal panels would contribute approximately 135,971 kWh/yr, which equates to a carbon saving of 6,438 kg C per year, offering a 7.2% on-site renewable contribution, and a 5.18% carbon reduction.

In this case the solar panels would best be installed in a "community scheme" with central pumping equipment delivering the solar heated water to each dwelling. It would be difficult to achieve a dedicated solar panel to each dwelling as a dedicated solar water circuit would need to be taken from the roof to each flat, clearly with the numbers of flats involved this would be impractical.

In order to achieve the total 20% on site renewable, and the 25% carbon savings targets, the use of solar panels would need to be supplemented with the use of another compatible renewable system.

Photovoltaic panels are compatible for use alongside solar thermal, however the above estimates are based on solar thermal panels occupying all of the available roof space.

A detailed breakdown of energy and carbon savings is listed within Appendix 1 of this Environmental Performance Statement.



Fig. 10 Solar Panel

9.0 Overview of Photovoltaic Panels

In order to meet the 20% on-site renewable target, a PV installation in isolation would need to contribute 211,797 kWh per year.

Typical energy yields for roof mounted PV's are 170 kWh/m2/year, this would require an "active" PV panel area of 2117m2 , making a 20% allowance for PV panel frames would mean a total PV installation area of 2540m2. This area is too large for the roof area of this development and therefore is not considered as being feasible for installation in that location.

It is feasible to locate 300m² of active PV panel on the roof with the space that is available, and an installation of this size would provide 51,000 kWh/year of electricity, which equates to an on-site contribution of 2.8%. This solution would reduce carbon emissions by 5,869 kg C/year, which equates to an 4.7% carbon reduction.

The compatibility of Photovoltaic panels with other renewable solutions is good, therefore a partial PV installation would be well suited to delivering a proportion of the renewable energy needs of the development in conjunction with contributions from other methods.

A detailed breakdown of energy and carbon savings is listed within Appendix 1 of this Environmental Performance Statement.

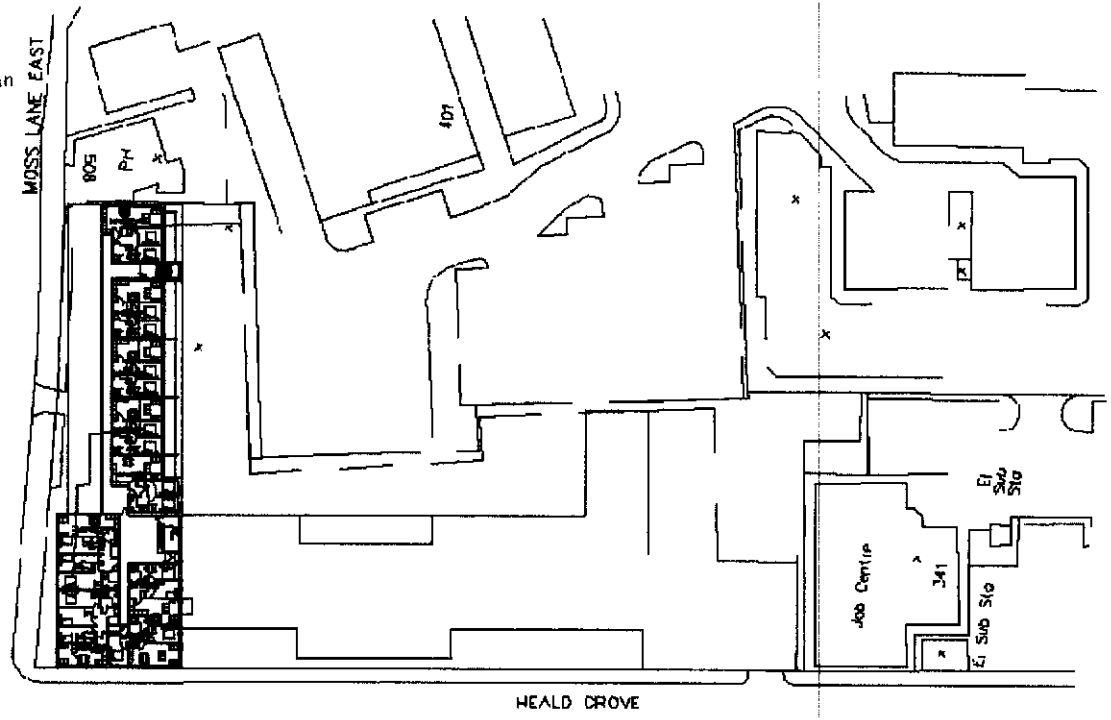


Fig. 11 Fifth Floor Level courtesy of Hodder Associates

Biomass heating has been considered as a potential "carbon neutral" solution for the provision of heating and hot water for this development.

The maximum size of biomass boiler allowable within the constraints of the Clean Air Act is 300kw.

If biomass plant was to be used there would be a requirement for an on-site fuel silo, which would require a physical connection between the silo and the boiler plant for transfer of the fuel feed to the burners.

It would be necessary for the basement to be utilised for fuel storage, and for practicality, the most efficient location for the biomass boilers would be the basement also.

Fuel storage for any biomass plant is a large space requirement which has an impact on any design and layout.

Limited height within the basement may require the plant to be located at Ground Floor which would have an adverse impact upon the frontage the public realm. Furthermore, there would be additional vehicle movements accessing the site from Heald Road, or Moss Lane resulting in potential conflict with other service deliveries and refuse collection.

There would also be a requirement for a flue to be taken from the plant, to discharge above roof level.

The availability, and continuity of supply of biomass fuel is questionable, and in some instances, local authorities prevent biomass as being offered as a viable renewable solution for this reason.

It should be noted that the biomass installation would require to be supplemented by a gas fired boiler plant, and as such there is a risk that the end user would revert to gas in the event of biomass fuel supply failure. The renewable contribution from a biomass solution would therefore be in jeopardy.

It is considered therefore, that because of a number of spatial, operational, and financial issues, biomass as a renewable solution for this scheme is not viable.

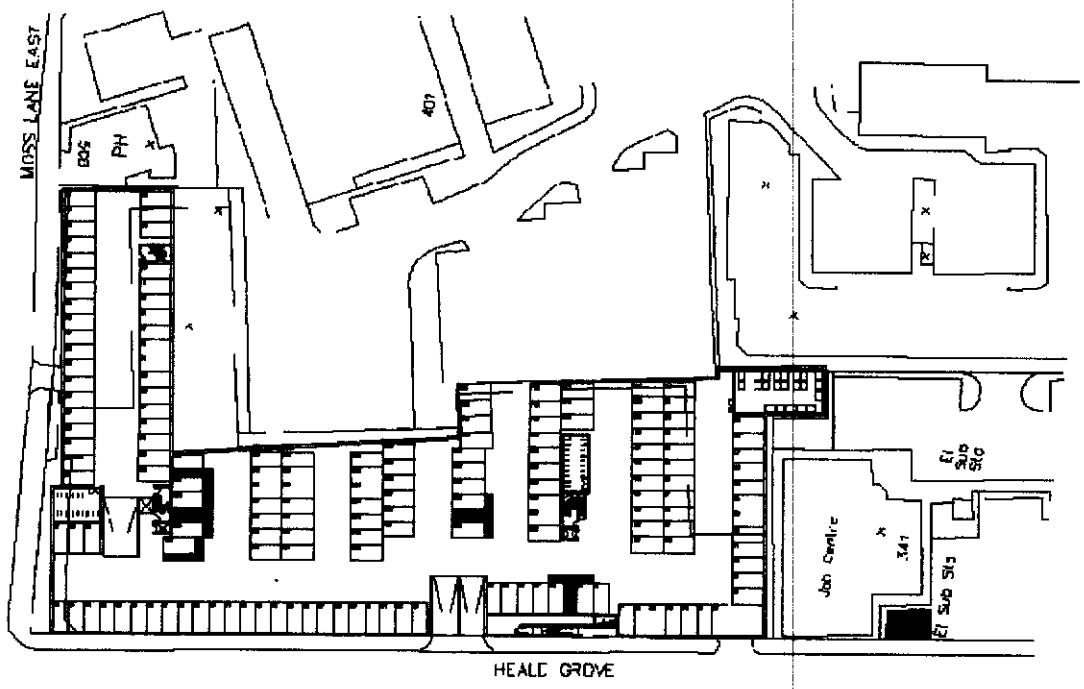


Fig. 12 Lower Ground Floor – Courtesy of Hodder Associates

The feasibility of a Ground Source solution for this development would be subject to a detailed study of the local geology. This study would assist in the decision of whether an open loop, or closed loop system is suitable.

In order for a like for like comparison to be made, an assessment has been made on the basis that ground source heating only is provided, this is because we are comparing against conventional central heating within the residential areas, with no comfort cooling.

Utilising figures given within the "renewables toolkit", and taking the residential areas only, the Ground Source solution would need to offset the space heating and domestic hot water energy for the Apartments which would conventionally be gas fired.

The use of a geothermal solution is well suited to domestic space heating in the form of underfloor heating due to the lower water temperatures used in the underfloor circuits.

There is the potential for provision of comfort cooling, as the heat pumps used in geothermal systems are available in "reverse cycle" form. There is a relatively small increase in plant cost, however it is feasible to utilise the same underfloor pipework used for heating. This would clearly increase the quality and marketing potential for any of the residential units that have comfort cooling provided.

In terms of feasibility, it is unlikely that there is sufficient space within the site boundary for a closed loop borefield, be it either vertical, or horizontal. It is therefore expected that an open loop ground source solution would be suitable, although the availability of sufficient ground water would be subject to a detailed Hydro-Geological Appraisal.

A ground source solution would provide all of the residential heating and domestic hot water energy requirements, being 1,158,840 kWhrs of energy per year, which equates to a 52.7% on-site renewable contribution.

In terms of carbon reduction, the ground source solution would offer carbon savings of 28,923 kg C/year, equivalent to a 29.5% carbon reduction.

It should be said that there is significant capital expenditure associated with this type of installation, along with an element of risk, in that the success of open loop ground source is very much dependant upon realising sufficient ground water from drilling boreholes on site.

A detailed breakdown of energy and carbon savings is listed within Appendix 1 of this Environmental Performance Statement.

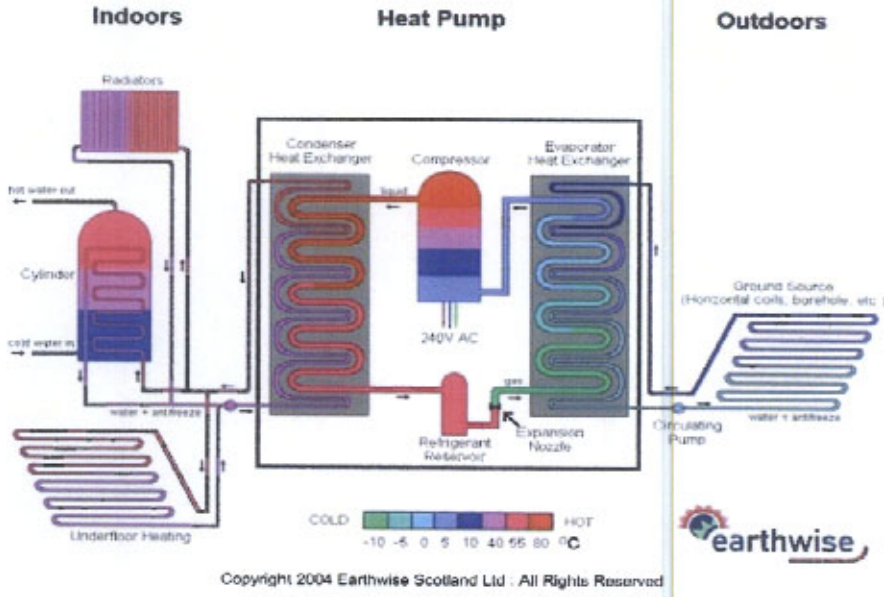


Fig. 13 Image courtesy of Earthwise

12.0 Overview of Wind Turbines

There are many considerations that need to be made in order to establish the feasibility of wind turbines for any development, primarily these are:-

Average site wind speed
Local wind obstructions, i.e. adjacent buildings
Planning implications
Noise output from turbines
Distance from turbine to residential and school buildings
Distance from turbine to roads
Structure borne vibration for building mounted turbines.

In order to provide a 20% on-site contribution a wind turbine installation would need contribute 359,900 kWh per year.

The renewables toolkit suggests a typical annual electrical generation of 16,912 kWh from a 15kW turbine at an average wind speed of 4 m/s.

This would require 22 number 15 kW wind turbines to meet the 20% target.

Each 15kW turbine would have a motor height of 15 metres, with a rotor blade diameter of 9 metres.

Considering the number of turbines required, and the risk of shadow flicker from the rotor blades due to the close proximity of the turbines to the residences, we consider that this solution is not feasible for this development.



Fig. 14 Image courtesy of Proven

Bibliography:

Manchester City Council - Guide to Development in Manchester 2007

London Energy Partnership - London renewables toolkit