



Greater Manchester Fire & Rescue Service – Blackley Community Fire Station

Environmental Standards Statement

May 2023

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Contents

1.0 Introduction	4
2.0 Manchester City Council, Manchester Core Strategy 2012-2027 (policies EN4 and EN6)	5
3.0 Guide to development in Manchester Supplementary Planning Document and Planning Guidance (Chapter 4)	8

Appendices

Appendix A – BREEAM ENE04 LZC Study	9+
Appendix B – BREEAM ENE04 Passive Design Analysis	

1.0 Introduction

This report has been prepared by Harley Haddow, who are employed as MEP & Sustainability Consultants for the development of the new-build Blackley Community Fire Station.

The report provides the information requested by Manchester City Council as part of the planning application for the project, specifically in relation to the following documents:

- Manchester City Council, Manchester Core Strategy 2012-2027 (policies EN4 and EN6)
- Guide to development in Manchester Supplementary Planning Document and Planning Guidance (Chapter 4)

It should also be noted that the project is currently targeting, and is on track to achieve a BREEAM 'Excellent' rating.

The BREEAM process is being assessed within the wider project team by Ridge & Partners, and the specific checklists and appropriate evidence for this has been provided as part of the planning application.

Blackley Community Fire Station has been designed as a low energy, passive building – with a focus on as close to zero carbon as possible.

In short, a brief non-exhaustive summary of the key design features:

- Building fabric and glazing performance to a higher specification than that required by Building Regulations
- Building air tightness of 3m³/m²/hr@50Pa (Building Regulations calls for 8m³/m²/hr@50Pa)
- Natural ventilation where possible, including the option for large purge openings for occupants
- No natural gas on the site
- Air source heat pumps providing the heat source for both the heating and the domestic hot water load
- Significant sized PV array, coupled with battery storage
- Green roof to improve bio-diversity to the site

2.0 Manchester City Council, Manchester Core Strategy 2012-2027 (policies EN4 and EN6)

2.1 EN4 Reducing CO₂ Emissions by Enabling Low and Zero Carbon Development

The requirements of EN4 are shown below:

Policy EN 4

Reducing CO₂ Emissions by Enabling Low and Zero Carbon Development

The Council will seek to reduce fuel poverty and decouple growth in the economy, growth in CO₂ emissions, and rising fossil fuel prices, through the following actions:

- All development must follow the principle of the Energy Hierarchy, being designed:
 - to reduce the need for energy through design features that provide passive heating, natural lighting and cooling
 - to reduce the need for energy through energy efficient features such as improved insulation and glazing
 - to meet residual energy requirements through the use of low or zero carbon energy generating technologies
- Wherever possible new development and retrofit projects, including energy generation plant, must be located and designed in a manner that allows advantage to be taken of opportunities for low and zero carbon energy supplies.
- Where possible new development and retrofit projects will be used as a mechanism to help improve energy efficiency and provide low and zero carbon energy supplies to existing buildings.
- Where appropriate new development and retrofit projects will be required to connect to and/or make contributions to low or zero carbon energy schemes and/or to incorporate provision to enable future connection to any existing / potential decentralised energy schemes.
- The use of building materials with low embodied carbon in new development and refurbishment schemes.

- **Energy Hierarchy principles** – please refer to appended BREEAM report, titled ‘ENE04 Passive Design Analysis’.
- **Opportunities for low and zero carbon energy supplies** – GMFRS and the GMCA are committed in the first instance to ‘clean’ electricity. Coupled with this, the proposed fire station is an ‘all electric’ building, i.e. has no reliance or call for natural gas. There is also a large PV array (200sqm+) proposed, plus battery storage to push the project to being as self-sufficient as possible in use; lowering the demand on the grid.
- **Improve energy efficiency and provide LZC supplies** – every aspect of the project has been engineered to be as low energy as possible. This includes a fabric-first approach (reducing the energy required to heat the space), natural ventilation, variable speed drives on mechanical plant, heat recovery on the areas where mechanical ventilation is required, and an advanced controls system to ensure that systems only operate when they need to.

- **Connect to / make contributions to LZC energy schemes** – at present there are no nearby schemes that make this an appropriate requirement, however the design of the scheme is that it will provide any surplus electricity generated from the PV array back into the local grid. This has the net effect of reducing requirements in the vicinity at periods of the year
- **Building materials with low embodied carbon** – where practical and affordable, the building materials used on the project have been selected to be as carbon efficient as possible (i.e. as low an embodied carbon as possible). More details on this can be found in the architectural and structural specifications.

2.2 Target Framework for CO₂ reductions from low or zero carbon energy supplies

The requirements of EN6 are somewhat dated now, as such we have provided information in a manner that meets the spirit of the Policy, albeit applied to current standards.

It should also be noted that the size of the proposed fire station falls below the 1,000sqm threshold that triggers the requirement for an energy statement.

A draft BRUKL for the Fire Station has been produced, to give an early stage indication of performance of the building against the requirements of Part L of the Building Regulations. This has demonstrated that the building is exceeding the requirements by a significant amount:

Target CO ₂ emission rate (TER), kgCO ₂ /m ² annum	18.71
Building CO ₂ emission rate (BER), kgCO ₂ /m ² annum	10.86
Target primary energy rate (TPER), kWh _{PE} /m ² annum	201.36
Building primary energy rate (BPER), kWh _{PE} /m ² annum	112.25
Do the building's emission and primary energy rates exceed the targets?	BER ≤ TER BPER ≤ TPER

It is also noted that EN6 allows other green systems such as green walls, green roofs, street trees etc to be used in the assessment. At present our assessment does not include any of these items, however the design of the building itself **does include** for green roofs on both the main building, and the appliance bay. This will significantly assist with improving biodiversity to the site, which by nature of the use of the building has to have vast areas of concrete/apron/yards.

To add to the above, early 'in-use' modelling of the building, in accordance with CIBSE TM54, suggests that over a period of 12 months, all of the power required for the regulated energy (the heating, ventilation, lighting, etc) will be generated by the PV array.

3.0 Guide to development in Manchester Supplementary Planning Document and Planning Guidance (Chapter 4)

Chapter 4 of the Guide refers specifically to Environmental Standards, with the aim to make Manchester the 'Greenest City in Britain'.

In the first instance, to demonstrate compliance with the requirements, the project is being assessed under BREEAM, with a required 'Excellent' rating. The pre-assessment for this assessment is available as part of the wider planning package.

Addressing other specific individual requirements:

- Energy Efficiency – 'aim to reduce CO2 emissions by at least 25% more than the requirements of the current regulations' – refer to Section 2.2 of this report.
- Renewable Energy – 'reduce energy demand and the harmful impact of using energy from non-renewables, aiming for at least 20% of the final site energy demand to be met by on-site renewable energy technologies. The site does not rely on natural gas at all, hence is all-electric. Electricity supplies for the site are also 'green' hence zero carbon (despite the grid at present not yet being fully decarbonised). As the grid decarbonises the electricity supplies will truly become zero carbon. To compliment this, the project has a large PV array (over 200sqm of panels) coupled with battery storage (circa 45kWh).
- Environmental Design – 'encourage developers to achieve BREEAM Very Good' – this project is targeting BREEAM Excellent.
- Water Management and Weather Resilience – Refer to general planning package, and BREEAM Pre-assessment
- Waste Management – Refer to general planning package, and BREEAM Pre-assessment
- Construction Management – Refer to general planning package, and BREEAM Pre-assessment
- Biodiversity – Refer to general planning package, and BREEAM Pre-assessment
- Waterways – Refer to general planning package, and BREEAM Pre-assessment

Appendix A



Blackley Fire Station

BREEAM Ene 04 LZC Study

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Contents

Executive Summary	4
1.0 Introduction	5
2.0 'Be Lean' Energy Efficiency Measures	8
3.0 Feasible LZC Technologies.....	9
4.0 Unfeasible Technologies	11
5.0 Recommendations	16
6.0 Funding Opportunities	18

Executive Summary

In this report the results of a Low and Zero Carbon (LZC) technology feasibility study, undertaken for the Blackley Fire Station development, are presented.

The following technologies were highlighted as being appropriate to the site and the energy demand of the development, and as such have been included within the feasibility study:

- Biomass
- Air Source Heat Pumps
- Photovoltaics

The results of this study demonstrated that heat pumps were the most appropriate technology, specifically an air to water heat pump utilising a thermal store to feed underfloor heating and radiators throughout the building, with supplementary photovoltaics and battery storage provided to offset the electricity demand.

Other low and zero carbon technologies have been discounted due to a range of reasons such as initial costs, limited space, noise and air quality issues.

1.0 Introduction

1.1 General

In this report the results of a Low and Zero Carbon (LZC) technology feasibility study, undertaken for the Blackley Fire Station development, are presented.

The feasibility study considered a number of local onsite LZC technologies appropriate to the site and the energy demand of the development.

The project comprises of the development of a new fire station on the existing Blackley site.

This report has been prepared based upon the most up to date design drawings as of April 2023.

1.2 LZC Technologies

The design approach is to target energy efficiency measures to reduce resource demand as much as possible before introducing LZC technologies to locally offset the minimised resource demand.

The following technologies have been highlighted as potentially being appropriate to the site and energy demand of the development and are included in the feasibility study:

- Biomass
- Air Source Heat Pumps
- Photovoltaics

The study has discounted the following technologies for this project:

- Water Source Heat Pumps and Hydro Power were not considered due to the lack of available and appropriate water source.
- Fuel cells were not considered due to the relative infancy of the technology and high capital cost.
- Energy from waste and Anaerobic Digestion were not considered due to the restricted site location and available plant space.
- Wind Turbines were also not considered due to the geographical location and location constraints onsite.
- Solar hot water panels were discounted due to the predicted low DHW demand of a building of this type.
- Ground Source Heat Pumps were not considered due to the high capital costs associated with the boreholes and installation.

The study has included the potential for connection to any existing local community CHP system or source of waste heat or power, however there has been found to be no local community CHP plant within the vicinity. This can be reviewed again in the future if required.

1.3 Objectives

The primary objective of the feasibility study was to fulfil the requirements of BREEAM credit Ene 4 Low Carbon Design to gain one credit relating to the provision of an LZC Feasibility study.

The calculations have been undertaken based on the current design information for the proposed development. Any further amendments to the design will be required to be reflected in the Energy Strategy before construction commences.

As this is a new development the building will be required to meet the Part L 2021 carbon reduction requirements. The building fabric elements and services will also be required to meet the minimum efficiency standards as set by the building regulations.

1.4 Site Conditions

The proposed development will be situated on the existing Blackley Fire Station site, in Blackley, Greater Manchester.

1.5 Energy Strategy Approach

A comprehensive strategy approach was adopted to address the energy and renewable technologies used on the scheme and how they will be integrated into the proposed development.



Figure 1. Energy Hierarchy Approach

1.6 Dynamic Simulation Modelling

Dynamic thermal simulation is a sophisticated form of building energy modelling used for non-domestic buildings. IES Version 2022.3.0.0 software has been used, which is approved National Calculation Method (NCM) simulation software.

The software is able to base its performance calculations upon incremental time steps as low as two minutes. This allows realistic variations in fabric thermal storage (thermal mass effects), weather conditions, occupancy, internal and solar gains to be taken into account and their implications upon building/plant operation to be modelled effectively.

Dynamic thermal simulation uses zone specific operational profiles (occupancy, lighting, ventilation and domestic hot water demand) and plant performance data to effectively model and predict the energy performance of a building. This comprehensive approach is considered best practice for assessing building energy performance.

To accurately model the dynamic nature of the building's thermal response, hourly recorded weather data is used in dynamic thermal simulations. Such weather data contains records of radiation, temperature, humidity, sunshine duration and additionally wind speed and direction.



Figure 2. IES Model Image

In order to benchmark the various LZC options for the development, the project has been modelled using IES dynamic simulation software. The baseline scenario of a Gas Boiler has been used to benchmark the energy and carbon savings for each of the options within the report.

2.0 'Be Lean' Energy Efficiency Measures

2.1 General

A comprehensive assessment of Energy Efficient measures has been carried out to calculate the energy consumption and CO₂ emissions for the proposed Blackley Fire Station to allow a comparison between the predicted CO₂ emissions with the LZC technologies to the existing configuration without the LZCs.

During the assessment of the proposed building the following 'Be Lean' measures have been implemented to maximize the opportunities available in energy efficient design without reliance on 'Be Mean' and 'Be Green' measures.

The 'Be Lean' measures may include:

- Assessment of fabric insulation with U-values meeting/exceeding compliance with Part L U-value levels.
- The use of low energy variable speed drives and motors.
- The installation of automated controls to limit plant and lighting operation where practical.

2.2 U-Values

Table 1 shows the proposed U-values proposed, the brief of the proposed works is to achieve an EPC rating of an A and the building will be required to meet the Part L 2021 building regulations. The below U-values are what has been proposed for the project at the current stage and may change as the project progresses.

Building Element	Proposed U-Values
External Wall	0.15
Ground Floor	0.15
Roof	0.12
Door	1.6
Vehicle Door	1.3
Glazing	1.0

Table 1. Proposed Target U-Value Levels

3.0 Feasible LZC Technologies

The following technologies have been highlighted as being appropriate to the site and energy demand of the development and have been reviewed in more detail as below.

- Biomass
- Air Source Heat Pumps
- Photovoltaics

3.1 Biomass

Biomass fuel could be made use of as an alternative fuel to gas for the boilers. Biomass is typically either wood chips or wood pellets and as a replenishable source which absorbs CO₂ it is considered a carbon neutral fuel.

A waterproof and fire separated enclosure would be required for the biomass boiler and the fuel store. An outside air supply would be required for the combustion process.

The fuel store must be accessible to receive deliveries of wood chips or wood pellets which can be tipped or blown. The fuel store and boiler enclosure must be adjacent to allow a mechanical feed to deliver the fuel to the boiler. A reliable, preferably local, source of fuel must be secured.

Biomass systems are more management intensive than gas boilers and demand regular maintenance including ash removal.

A flue will be required to disperse the particulates and combustion gases generated by the boiler at high level. The flue pollutants will be subject to analysis by the planning authority.

A biomass system has been recommended for further analysis with the system being considered suitable for the energy demands of the development.

However, it should be noted that further consideration should be given to biomass due to limited plant space which will mean that more regular delivery of biomass fuels may be required. This could end up negating carbon savings associated with the technology through more regular delivery of biomass fuels.

3.2 Air Source Heat Pumps

Air Source Heat Pumps (ASHP's) could be used to meet the buildings heating and cooling demand.

ASHP's extract heat directly from the outside air and transfer it to water (in a water-based central heating system) or air inside buildings.

ASHP's require evaporator units to be exposed to ambient air. This is most effectively achieved by mounting the units external to the building which may have planning implications. This may be overcome by utilising internally mounted units ducted to atmosphere. This would require additional internal plantroom space.

For calculation purposes the ASHP Coefficient of Performance (CoP) used is 3.5 therefore, this assumes that each 1 kW of electricity used to drive the ASHP, generates 3.5 kW of heat energy from the outside air to heat the building.

The ASHP plant should meet the standards highlighted in the Microgeneration Certification Scheme (MCS). MCS is an independent scheme that certifies microgeneration products and installers in accordance with consistent standards. The scheme is designed to evaluate the microgeneration products and installers against robust criteria and provides consumers with an independent indication of the reliability of products, and on assurance that the installation will be carried out to the appropriate standard.

The noise emitted from the ASHP units will require to be considered when locating the ASHP units externally. This will require further detailed analysis.

ASHP can therefore be considered suitable for the energy demands of the development and has been recommended for further analysis.

3.4 Photovoltaics

Photovoltaic systems use solar cells to convert sunlight into electricity. The PV solar cells consist of one or two layers of a semi-conducting material, usually silicon and when the light shines on the cell it creates an electric field across the layers, causing electricity to flow, the greater the light intensity, the greater the flow of electricity.

It should be noted that planning permission would be required for the installation of this type of system as the panels would be visible outside the building.

There is adequate space available on the roof to incorporate a photovoltaic panel system and therefore it has been recommended for further analysis.

Utilising battery storage will allow for excess energy captured by the PV panels during peak outputs to be stored. The stored energy can then be used at a later period when the PV panels are unable to meet the electricity demand of the building. This will help to reduce the running costs associated with the electricity usage.

The negative impact of having battery storage is that excess electricity will not be exported to the grid, unless the batteries are already fully charged, this may reduce the impact of any export tariff associated with the renewable electricity generating system on the building.

As a photovoltaic panel system is being considered for this development it is recommended that a battery storage is utilised to make the most of the electricity generated throughout the whole year.

4.0 Unfeasible Technologies

4.1 Ground Source Heat Pumps

Ground Source Heat Pumps (GSHP's) could be made use of to meet the buildings heating demand by using the earth as a heat source through the installation of a series of underground piping. Thermal energy recovered from the earth could be upgraded via an electrically driven heat pump in order to generate useful water temperatures for heating.

GSHP's provide extracted heat from the ground or water during the winter months and via a heat pump and circulates hot water into a building to provide space-heating and pre-heated domestic hot water.

In the summer months the process can be reversed to provide cooling.

The feasibility of the GSHP will be dependent on the suitability of the ground conditions and the usable area available.

Due to the limited site space of the project, given that the development will be utilising the existing fire station site location, combined with the high capital costs that will be required for the boreholes and installation of such a system this technology has been deemed not viable for this project.

A Ground Source Heat Pump system is therefore not recommended for further analysis.

4.2 Wind Turbines

The feasibility of wind turbines has been studied in terms of:

- Size and visual impact on the building
- Power output
- Noise generation

Wind turbines extract energy from the wind using a rotor which usually comprises of two or three blades similar in profile to the wing of an aeroplane. Most small wind turbines generate direct current (DC) electricity. Systems that are not connected to the national grid require battery storage and an inverter to convert DC electricity to AC.

Wind systems can also be connected to the national grid. A special inverter and controller convert DC electricity to AC at a quality and standard acceptable to the grid, hence no expensive battery storage is required. Any unused or excess electricity may be able to be exported to the grid and sold to the local electricity supply company.

Planning permission would be required as the turbine will be visible outside the building, consideration would also have to be given to the impact on adjacent properties including noise implications.

However due to the site location, low wind speeds, aesthetic impact and potential detrimental impact on wildlife a roof mounted wind turbine is not considered suitable for this application.

A wind turbine installation is therefore not recommended for further analysis.

4.3 Water Source Heat Pumps

Water source heat pumps work on the same basis as ground source whereby heat is extracted in this case from a water source rather than the ground during the winter months and via a heat pump and circulates hot water into a building to provide space-heating and pre-heated domestic hot water. In the summer months the process can be reversed to provide cooling.

Thermal energy recovered from the water could be upgraded via an electrically driven heat pump to generate useful water temperatures for heating.

However due to the lack of a water source to the site WSHP are not considered suitable for the development and are not recommended for further analysis.

4.4 Fuel Cells

A potential low and zero carbon technology for the development is hydrogen fuel cells. This type of technology is in its infancy in the UK, with the majority of the current installations being used for demonstration purposes.

Hydrogen gas is produced by passing an electrical current, preferably from a renewable source such as a wind turbine, through tap water. The hydrogen gas produced is then stored in a tank before being fed through a fuel cell. The fuel cell generates electricity by the reverse process of electrolysis – combining hydrogen and oxygen atoms to make water; this produces electricity as a by-product.

The resulting water is pure and can be safely drained or used on-site for example, toilet flushing.

Alternatively, the hydrogen can be produced from extraction from the mains gas supply via a reformer and oxygen in the air; this has been carried out successfully in Transport for London Offices in Greater London.

The fuel cells can then be used to supply DC electricity to the building via an inverter and LTHW to a thermal store serving the heating system.

The principal potential benefits of the technology are follows:

- On-site generation of electrical power and low-grade heat, i.e. a zero-carbon on-site CHP solution
- Hydrogen represents a potential zero-carbon fuel (if the hydrogen is created via 100% renewable power e.g. wind energy)

There are barriers to the widespread adoption of Fuel Cells in the building and property sector which are as follows:

- Fuel cells are still very expensive compared to alternative on-site generation
- Hydrogen production, distribution and /or storage is not practicable in most building locations
- Fuel cell production to suit capacity of typical building applications is not yet at high volume/mass production levels to support large scale application of the technology.
- Fuel cell life – for building applications, fuel cell lives of 5-10 years are quoted meaning that payback is difficult to achieve.

Also, as such a system has been found to have low energy content per unit volume and a large amount of space is required for hydrogen storage tanks therefore, it is not thought to be viable in this instance. There are also safety concerns in locating hydrogen storage tanks plus a high capital cost. Therefore, this technology is not recommended for further analysis.

4.5 Energy from Waste

Energy from Waste (EfW) is basically taking waste and transforming it into a useable form of energy. This can include electricity, heat and transport fuels and can be achieved in several ways, with incineration the most widely known.

Future trends and legislation are aiming to prevent, reuse and recycle more of our waste, so the amount of residual waste that can be used for an EfW scheme should also decrease. Therefore, to maintain the energy output from a reducing waste resource a successful EfW scheme should ensure that we divert as much residual waste that is available from landfill to use as energy.

However due to the site location, this is not a viable solution in this instance.

4.6 Hydro Power

Hydraulic power can be captured wherever a flow of water falls from a higher level to a lower level. This may occur for example in a man-made weir as part of the canal network.

The vertical fall of the water, known as the “head”, is essential for hydropower generation; fast-flowing water on its own does not contain sufficient energy for useful power production except on a very large scale. Therefore, two elements are required: a flow rate of water and a head. It is generally better to have more head than more flow, since this keeps the equipment smaller.

The water is directed to a hydro-turbine which converts water pressure into mechanical shaft power, which can be used to drive an electricity generator, or other machinery. This could then be used to offset some of the electrical demand from the building.

However due to the lack of a water source to the site Hydro is not considered suitable for the development.

4.7 Solar Hot Water

Solar hot water heating could be used to reduce dependence on fossil fuel plant to generate domestic hot water. Roof mounted thermal panels would collect and absorb solar radiation and then transfer the solar heat directly to the storage system. During times when the solar thermal system cannot provide adequate heat a backup unit would be used.

It should be noted that planning permission would be required for the installation of this type of system as the panels would be visible outside the building.

Although there is adequate space on the roof of the development to install a solar hot water panel system, the low expected DHW demand of the building renders this technology unsuitable for the project.

A solar thermal panel system is therefore not recommended for further analysis.

4.8 Combined Heat and Power (CHP)

The feasibility of Combined Heat and Power (CHP) as a 'clean' measure has been assessed and requires consideration of multiple factors and influences.

CHP is considered a 'clean' technology because it is a cogeneration of heat and electricity which increases the overall utilisation efficiency of primary energy and reduces the reliance on grid supplied electricity.

CHP generates electricity and captures heat that is produced in this process. The captured heat can be used to pre-heat hot water, which can be used within a centralised heat network.

Typically modulating CHP engine(s) can be used as the lead heat generator. The engine will provide heat both for the domestic hot water (DHW) and space heating subject to the demand profile. The CHP engine(s) feed storage vessels which subsequently deliver heat to a header. Subject to periods of high heat demand, highly efficient condensing boilers will provide backup heat should it be required.

To be economical, a CHP unit generally needs to operate for a minimum of 4,000 hours per year, around 14 hours per day. Furthermore, CHP units cannot be easily switched off and on to reflect loading variations and doing so dramatically affects its operation and efficiency. To overcome these limitations CHP units are sized on the base heat load.

As the fire station is unlikely to have a high enough heat load to warrant a CHP unit, this technology has been considered unsuitable for the development.

4.9 Anaerobic Digestion

Anaerobic Digestion (AD) has in the past been used in the UK for the treatment of sewage. However, only recently has it begun to be used more widely to generate renewable energy and divert waste from landfill.

AD is a natural process where micro-organisms break down organic matter or bio-waste (e.g. food waste) in the absence of oxygen into Biogas and digestate/biofertiliser. AD can be used to manage waste and/or to release energy. The Biogas can then be used in several ways:

- Directly into a CHP unit in place of natural gas
- Burned to produce heat
- Cleaned to produce bio-methane and used in the same way as natural gas or as a vehicle fuel.

The process by-product of digestate/biofertiliser can then be used or sold as a fertiliser.

Biogas CHP works in the same way as regular CHP, with exception to the type of fuel used.

Biogas is less straightforward to transport and store and typically it is produced 'on-site'. Anaerobic digestion by its very nature tends to involve large amounts of waste material, which can raise issues and create resistance in local communities.

Biogas fuelled CHP has been modelled on the base heat load, as similarly to solid biomass fuelled CHP, the base electrical and electrical load following models are not possible due to the heat to power ratios that are achieved, the size of available plant is also limited.

An anaerobic plant producing biogas on site is in this case, not viable. The existing site does not have a process on site that produces the relevant bio-waste nor is it a viable solution to ship waste into the site to then treat. Anaerobic digestion on site is not recommended for the project as relevant waste would be required to be brought into site to be treated. There is no current viable local source for this type of waste and it would not be economical or carbon beneficial to ship waste into the site. This type of technology is generally only viable where there is an onsite process which is producing the waste.

5.0 Recommendations

Table 2 shows indicative energy consumption figures associated with each proposed heating system and the associated carbon emissions and running costs. It is shown that an ASHP system is predicted to provide the most significant benefit in reducing energy consumption and CO₂ emissions. Table 3 summarises the approximate capital cost and estimated energy and carbon savings associated with the photovoltaic system.

Scenario	Option ⁽¹⁾	Total Energy Consumption ⁽²⁾		Carbon Emissions ⁽³⁾		Running Cost ⁽⁴⁾	
		(kWh)	% Saving to baseline	(tonnesCO ₂ /yr)	% Saving to baseline	(£/annum)	% Reduction to baseline
Baseline	Gas (no PV)	403,207.80	-	76.26	-	£48,585.43	-
1	Biomass	359,002.80	10.96%	18.59	75.62%	£43,201.98	11.08%
2	ASHP	147,539.10	63.41%	20.51	73.11%	£36,589.70	24.69%

Table 2. Indicative Total Consumption and Running Cost Summary

(1) Each option, except for the gas baseline, is proposed to have 219.2m² of photovoltaic panels with an inclination of 10°. Generating 44,205 kWh/annum of electricity, as per initial PV SOL analysis.

(2) Energy figures based on IES modelling. Total energy consumption is the combination of lighting, miscellaneous and heat source energy.

(3) Based on current NCM CEFs of 0.210 kgCO₂/kWh for gas, 0.139 kgCO₂/kWh for electricity, and 0.029 kgCO₂/kWh for biomass.

(4) Running costs based on typical tariffs for gas (6.74 p/kWh), biomass (8.7 p/kWh) and electricity (24.8 p/kWh).

LZCT	Capital Cost (£) ⁽¹⁾	Running Cost Saving (£/yr) ⁽²⁾	Simple Payback (Years)	Energy Saving (kWh/yr) ⁽³⁾	Carbon Emissions Saved (TonnesCO ₂ /yr) ⁽⁴⁾
Photovoltaic Panels	56,147.20	10,962.84	5.1	44,205	6.14

Table 3. Indicative summary of PV Capital cost and energy/CO₂ saving data

(1) Capital costs based upon UK Government Solar Photovoltaic (PV) cost data from BEIS of £1,132 per kW of PV installed (219.2m² system is roughly 49.6kW).

(2) Running Cost saving is based upon typical electricity tariff of 24.8p/kWh.

(3) Energy generated by the PV system is based upon initial PV SOL analysis conducted.

(4) CO₂ figure based upon current NCM CEF for electricity of 0.139 kgCO₂/kWh.

This assessment has identified that the preferred, technically viable, technology that can provide some of the development's energy from a renewable source is an Air Source Heat Pumps (ASHP) combined with 219.2m² of photovoltaic panels. It is proposed that the ASHP will feed underfloor heating, radiators and the DHW of the building, with a predominantly natural ventilation and mechanical ventilation where required.

The ASHP with photovoltaic panels has been chosen as the preferred LZC technology due this system contributing the largest energy and running cost reductions, with the carbon emissions being just behind that experienced by a biomass system. The biomass system however doesn't provide the same energy and running cost reductions over a non LZC technology.

Consideration must be taken in regard to the Local Planning criteria including use of land and noise restrictions. It has been considered that all major mechanical plant shall be located on the roof within an acoustic enclosure if it is required. The plant area shall be complete with

louvred surrounds and shall be open to atmosphere to ensure correct heat dissipation. This may change as the design progresses.

We have recommended that the system specified should be of a high standard and that a suitable maintenance agreement could be put in place with the installer or manufacturer to help ensure continued efficient operation.

The feasibility of exporting both heat and electricity from the proposed system has been assessed. It has been determined that due to the buildings heating demands that all heat generated by the plant will be used within the building therefore it will not be able to be exported. However, as the photovoltaic system does generate its own electricity there is the opportunity for electricity to be exported back to the grid, this would have to be analysed in further detail to determine the extent to which will be available for exporting.

6.0 Funding Opportunities

There are currently not any available grants for the low and zero carbon technologies that have been recommended within this report. This may change in the future and therefore this should be continually monitored throughout the project to ensure that funding opportunities are not missed.

Although there are currently no direct grants offered, there is the ability to reduce the payback period of the Photovoltaic panels, through the Smart Export Guarantee. This scheme allows the building user to be paid for every unit of excess renewable electricity that is fed back into the grid. To be eligible for this scheme the renewable electricity generating system would need to meet the SEG eligibility requirements and the installation and installer must both be certified through the microgeneration certification scheme (MCS) or equivalent.



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Blackley Fire Station

BREEAM Ene 04 Passive Design Analysis

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Document Revision Control

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Contents

1.0 Introduction	4
2.0 Fundamentals	5
3.0 Building Envelope	1
4.0 Ventilation	4
5.0 Adaption to Climate Change	5
6.0 Summary	6

1.0 Introduction

In this report the passive design analysis undertaken for the Blackley Fire Station development to deliver energy benefits are described and quantified.

When designing an energy efficient building, an exemplar approach is required to be followed based on low energy design principles to ensure that the building itself is one of the main contributors to the minimisation of energy demand. This can be achieved through effective building form and orientation, good envelope design and proficient use of services.

It is vital that to achieve long term energy benefits that the inherent energy demand of the building is considered at the first instance.

2.0 Fundamentals

2.1 Site Location and Weather

The location will have a significant effect on the energy consumption associated with a building. A building located at higher altitudes will generally be subjected to colder external temperatures as opposed to a building located at a lower altitude.

Having a building with a colder external temperature will mean that a greater heating demand is required to bring the building to a comfortable internal thermal comfort for occupants during the winter period.

A building that is located within an urban or rural space will also further dictate the heating and cooling demands of a development with urban spaces more likely to experience higher ambient air temperatures due to the urban heat island effect.

The Blackley Fire Station development is located in Blackley, Greater Manchester and is North of Manchester City Centre, west of Oldham.

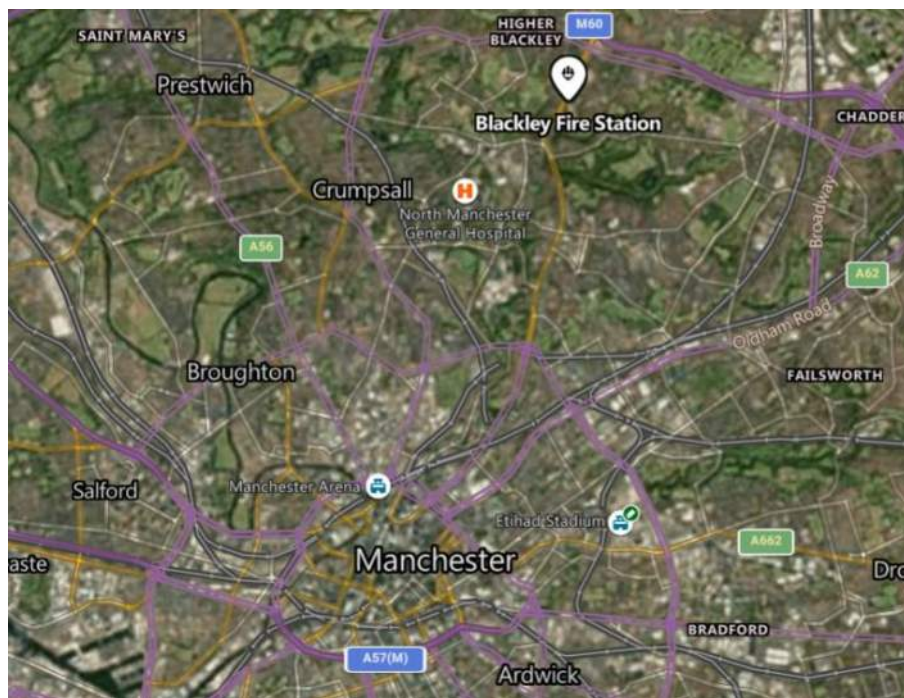


Figure 2.1 Map location of Blackley Fire Station

2.2 Weather and Microclimate

The local weather will influence the energy usage expected of the building. With developments that are located on the coast experiencing milder winters and cooler summers than developments that are situated further inland. Developments that are on the coast are considered to be in a maritime climate, whereas those inland are classified as having a continental climate.

Buildings that are located within the North of the UK will also on average be in a cooler external environment than that found within the South. This will increase the heating demand for North situated developments, and cause an increase in the potential for cooling required for developments found further South.

The weather in North West England where the development is situated, is exposed to the prevailing westerly winds. The area also has the cloudiest and coolest summers in England. Mean annual temperatures depend on altitude and proximity to the coast. As the Fire Station is located just outside Manchester it is expected to be at the top end of the temperature ranges expected in the North West of England.

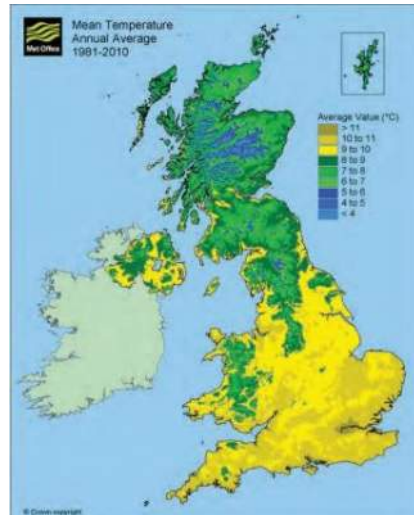


Figure 2.2 UK Annual Average Mean temperature (1981-2010) – CIBSE Guide A

2.3 Building Use and Occupancy Type

The occupants, lighting and equipment within a building will all emit sensible and latent heat, this will contribute towards increasing the temperature and humidity within the spaces and will have an impact on the heating and cooling demands associated to the building.

Within CIBSE Guide A, typical values are provided for the internal heat gains expected for varying building types and their uses based upon benchmarking.

Building type	Use	Floor area per person / m ²	Sensible heat gain / W·m ⁻²			Latent heat gain / W·m ⁻²	
			People	Lighting*	Equipment†	People	Other
Offices	General	12	6.7	8–12	15	5	—
		16	5	8–12	12	4	—
	City centre	6	13.5	8–12	25	10	—
		10	8	8–12	18	6	—
	Trading/dealing	5	16	12–15	40+	12	—
	Call centre floor	5	16	8–12	60	12	—
	Meeting/conference	3	27	10–20	5	20	—
Airports‡ and stations	IT rack rooms	0	0	8–12	200	0	—
	Airport concourse	0.83	75	12	5	4	—
	Check-in	0.83	75	12	5	50	—
	Gate lounge	0.83	75	15	5	50	—
	Customs/ immigration	0.83	75	12	5	50	—
	Circulation spaces	10	9	12	5	6	—
	Shopping malls	2–5	16–40	6	0	12–30	—
Retail	Retail stores	5	16	25	5	12	—
	Food court	3	27	10	†	20	§
	Supermarkets	5	16	12	†	12	§
	Department stores:						
	— jewellery	10	8	55	5	6	—
	— fashion	10	8	25	5	6	—
	— lighting	10	8	200	5	6	—
	— china/glass	10	8	32	5	6	—
	— perfumery	10	8	45	5	6	—
Education	— other	10	8	22	5	6	—
	Lecture theatres	1.2	67	12	2	50	—
	Teaching spaces	1.5	53	12	10	40	—
Hospitals	Seminar rooms	3	27	12	5	20	—
	Wards	14	57	9	3	4.3	—
	Treatment rooms	10	8	15	3	6	—
Leisure	Operating theatres	5	16	25	60	12	—
	Hotel reception	4	20	10–20	5	15	—
	Banquet/conference	1.2	67	10–20	3	50	—
	Restaurant/dining	3	27	10–20	5	20	—
	Bars/lounges	3	27	10–20	5	20	—

Figure 2.3 Benchmark allowances for internal heat gains in typical building (CIBSE Guide A)

Latent heat gains result in the instantaneous addition to the moisture content of the air, whereas sensible heat gain is absorbed by the surrounding surfaces and stored in the material.

Internal heat gains are dependent upon the specific building type and room use, with greater heat gains originating from occupants when they are performing physical exercise within a gym, rather than sitting within an office working on a computer. However, the equipment and computers utilised within the office will also contribute to the internal heat gains. The type of lighting within the building will also contribute to this, and as such it is important that internal heat gains are considered as a whole for the space being assessed.

Blackley Fire Station will consist of office spaces, dorm rooms, changing facilities, kitchen and dining facilities, kit rooms and a mess hall among other rooms. Internal heat gains will be highest within rooms with the most equipment, as it is unlikely occupants will be congregating within spaces for an extended period of time due to call outs, expect perhaps for the mess hall area. LED lighting will be used throughout the project, which will reduce internal gains and also reduce the energy and associated carbon emissions.

2.5 Building Layout, orientation and form

The building layout, orientation and form will influence many key features of the development. The design should therefore incorporate an effective use of space and appealing layout, with opportunities to benefit from natural daylight balanced with achieving solar gains but minimising overheating. A higher thermal performance can be achieved by limiting the surface area to volume ratio as this will minimise the heat losses experienced through external wall areas.

Having a building oriented in such a way that the longest external sides of a building are facing North and South, will result in reductions to glare arising from the low early morning and evening sun. It is sometimes not possible to implement the best practice measures in regards to building form and orientation for developments on existing land that may have limitations based upon available space.

Solar gains are often welcome within the winter months to help heat up the building, but can be detrimental during the summer, causing overheating issues that will require cooling measures to offset. These can be designed out from careful attention to the building orientation and design.

Internal rooms should therefore be planned to maximise the benefits of solar gains and minimise any disadvantages. If spaces are prone to overheating, then these should be placed on the north side of the building or solar shading measures used to protect from excessing solar gains.

Lower g-values for glazing for South and West facing windows, along with solar shading measures will be utilised to reduce the risk of overheating for spaces which have the highest potential to do so. This will allow for adequate daylighting but reduce the instances of disadvantages from solar gains.

The proposed Blackley Fire Station will also utilise an orientation that has the majority of the longest external sides facing roughly North and South, which should reduce instances of glare. A site plan drawing showing the buildings orientation has been provided on the next page in figure 2.4.

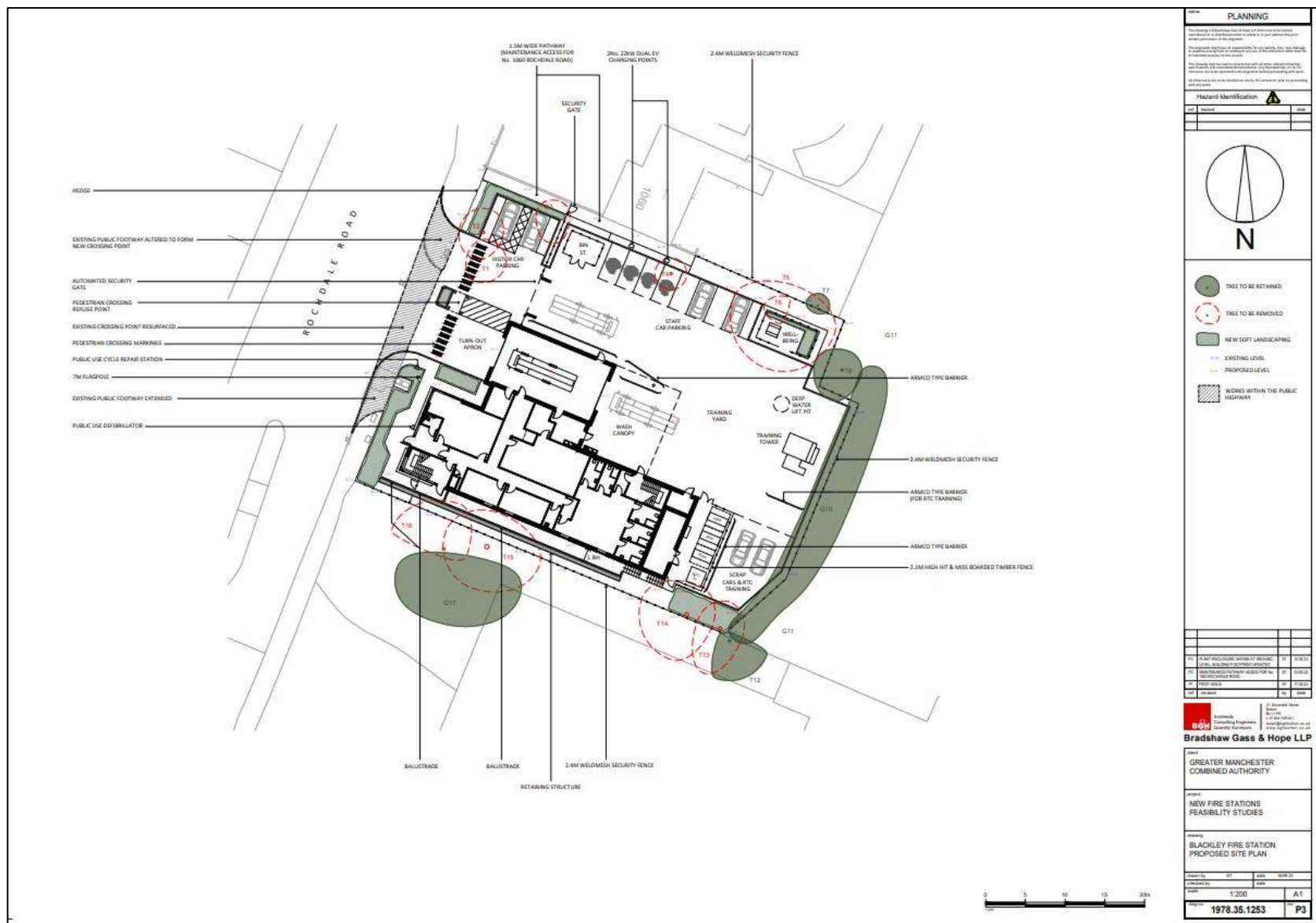


Figure 2.4 Building Site Plan

3.0 Building Envelope

3.1 Building Fabric and air permeability

Where possible the building fabric should be optimised to achieve high performance thermal properties with low u-values, as this will significantly reduce the energy demand of the building associated with heating and thus reduce carbon emissions within the development.

To ensure that the building complies with the Part L 2021 building regulations then the insulation of the building envelope will need to be better than the Part L limiting values, as these are merely the minimum acceptable levels required for each element of the construction.

The more air tight a building is then the less energy that will be required for the heating demand during the winter months. It has been proposed that the Blackley Fire Station will be designed to target an air permeability of $3 \text{ m}^3/\text{m}^2.\text{hr}$ @ 50Pa. This is an improvement beyond the Part L 2021 building regulations that state the air permeability must be below $8 \text{ m}^3/\text{m}^2.\text{hr}$ @ 50 Pa.

The following table details the proposed minimum building envelope thermal performance criteria for the Blackley Fire Station.

Table 3.1 Proposed building envelope thermal performance criteria

EXTERNAL ELEMENT	Part L 2021 (W/m ² K)	Proposed U-Value (W/m ² K)	Notes
External Walls (above ground)	0.26	0.15	
Ground floor	0.18	0.15	
Roof (Flat)	0.18	0.12	
GLAZED ELEMENT	Part L 2021 (W/m ² K)	Proposed U-Value (W/m ² K)	Notes
External Windows (Average)	1.60	1.00	g-value 0.35 for South and West facing, 0.45 for North and East facing
Glazed Entrance Door	1.60	1.00	
Personnel door	1.60	1.60	
Vehicle Door	1.30	1.30	
Air Permeability	Part L 2021	Proposed	Notes
(m ³ /m ² .hr @50Pa)	8	3	

3.2 Thermal Mass

Using heavyweight building materials in certain areas of the construction can provide thermal mass and inertia which will help to regulate the internal temperature and reduce the risks of overheating. This can include heavyweight roof structures and block walls.

These structures, such as exposed concrete, have a high density and heat capacity which allows them to absorb the heat from internal gains throughout the day, then at night they can be cooled through natural or mechanical means. The following day the cooled structure will then release what has been stored, contributing to maintaining a lower internal room temperature to what is experienced outside.

The disadvantages of pursuing this method is that you will encounter issues with both the aesthetic impact and also the acoustic performance, due to hard surfaces promoting the reflection of noise through a building. This can be overcome however, through the use of acoustically absorbent tiles.

It is proposed that the building will incorporate thermal mass measures where appropriate within the construction.

3.3 Daylighting

3.3.1 Daylight and glazing

Through the effective utilisation of window and façade design it is possible to bring light into a building to reduce the artificial lighting required, thus saving energy and reducing carbon emissions.

It is suggested within BREEAM Hea 01 that the daylight factor for rooms should be a minimum of 2-3% dependent upon the rooms function, to allow for the lights to be dimmed. This is lower than the recommendation of other industry publications who suggest a daylight factor of above 5%, as this will usually be an acceptable amount of light to allow all artificial lighting to be switched off altogether.

To increase the daylight factors then careful design and consideration must be given to the window size and positioning. If a room has a window with a high head height then daylight will be able to penetrate deeper into the room. If glazing is positioned poorly or there is too much then this can cause excessive glare and result in occupants closing blinds and turning on artificial lights which is counterintuitive to what is being sought.

The Blackley Fire Station development will incorporate daylighting measure where possible, with daylight dimming present with multiple rooms, such as the offices and mess hall.

The choice of glazing will impact the daylighting, heat losses and the solar gains that are experienced through an opening. It is suggested that the optimum glazing area for saving energy is around 30% – 50% depending on the orientation and type of glazing. This is to reduce the instances of overheating.

To maximise the benefits from glazing but reduce the disadvantages, the g-value (solar energy) and light transmittance values should be carefully considered. Utilising a lower g-value will reduce the overheating experienced during the summer, but will reduce the effects of solar gains during the winter. Lowering the g-value tends to lower the light transmittance, it is possible to overcome this but it will increase the costs associated with the glazing therefore it is recommended that a compromise between the two values is needed.

To ensure that the correct quality of daylight is able to be available for the Blackley Fire Station, but overheating is reduced, it has been proposed that the g-value for South and West facing glazing, which are the rooms to suffer the most from any issues arising from overheating, will be 0.35 compared to 0.45 for the North and East facing glazing.

3.4 Solar Shading

To further reduce the effects of overheating and glare within rooms it is suggested that solar shading is incorporated into the design of a building. This can be done through external, internal or mid-pane shading devices, or solar control glazing.

Generally, this is done through external shading which is the most effective as it prevents the solar radiation from entering the building, therefore very little solar gain is transmitted to the occupied rooms. Horizontal shades are the most effective on south facing facades whereas vertical shades are better for east and west facades for when the sun is low in the sky.

All shading devices will block some of the daylight and can affect the view out for occupants, therefore it is important to consider all of this during design, to weight up the benefits against the disadvantages.

For the Blackley Fire Station, it has been proposed that solar shading measures including brise soleil and aluminum feature fins will be utilised to reduce the overheating in areas where it has been found from initial modelling that this is an issue.

4.0 Ventilation

4.1 Natural Ventilation

Utilising natural ventilation where possible, through the opening of windows and other such methods, will reduce the dependency on mechanical systems and also provide a comfortable pleasant working environment for occupants. As natural ventilation doesn't utilise electrical energy within the building then it is encouraged where possible to reduce energy demand.

Natural ventilation however is highly dependent upon outside variables, such as wind, and therefore it can be found during certain circumstances that the opening of windows is not acceptable for occupants' comfort. During the winter, the opening of windows to provide ventilation can also increase the heating demands of the building due to low temperatures and cold draughts.

4.2 Mechanical Ventilation

A solution to the issues associated with natural ventilation, is the implantation of a mechanical ventilation heat recovery unit (MVHR). An MVHR has both supply and extract ducts and removes extracted air from rooms and uses a heat exchanger to add the thermal energy from this extracted air to fresh incoming air to temper it and lessen the heating requirements for the room. If managed and operated correctly under the correct conditions then a well-designed and efficient MVHR system will actually consume less energy than a naturally ventilated building without heat recovery.

Mechanical ventilation can also be used as a method of 'free cooling' in cases where outdoor temperatures are lower than in the building during warmer months when in summer bypass mode. Additionally, mechanical ventilation allows for more control over environmental conditions in relation to air and noise pollution. To minimise the energy associated with the system then high-efficiency fans and motors should be utilised to limit the specific fan power associated with the design flow rates.

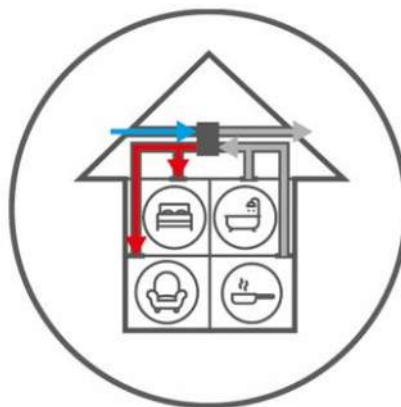


Figure 4.1 Mechanical Ventilation Heat Recovery System

4.3 Summary

The ventilation strategy for the Blackley Fire Station is to utilise natural ventilation where possible as a priority and to introduce mechanical ventilation through MVHR and where applicable, extract fans, to ensure that rooms are not overheating and are receiving an adequate air supply. Initial modelling results have identified the areas to be fed by MVHR.

5.0 Adaption to Climate Change

With Climate Change becoming an ever more prevalent issue within the world and becoming one of the biggest challenges to our generation with irreversible damage already being done to our planet and way of life, we must continue our efforts to achieve net zero and raise the ambitions on adaptation to ensure that the UK is resilient to the challenges of a warming world.

The average surface temperature in the UK has risen by 1.2°C since pre-industrial times, with further warming predicted even if decarbonisation is carried out. The current limits to warming are to aim for 1.5°C, but evidence suggests that we must be prepared for warming up to 4°C. The UK Climate Change Risk Assessment 2022 addresses the risks that are faced by the country from increased external temperatures.

The passive design measure proposed for the Blackley Fire Station will mean that the building is well adapted to these risks, with the energy demand being reduced, resulting in the building being less affected by future energy infrastructure issues. The development will also contribute to a low carbon footprint, which will help to prevent further contributions to climate change.

The risk of overheating due to higher external temperatures has been mitigated by the features proposed within the building design. With efficient lighting and mechanical systems keeping the internal gains to a minimum and high u-values and an efficient building design helping the building to retain heat, but also helping to prevent heat from entering the building through the fabric.

The features mentioned above, in addition to the ventilation strategy, will prevent the need for the building to utilise cooling measures within occupied spaces, keeping the buildings energy demand low.

The passive design measures will therefore contribute to stabilizing internal temperatures within the building to enable that it can adapt to temperature extremes as a result of climate change.

6.0 Summary

A passive design analysis has been undertaken on the proposed Blackley Fire Station to summarise the passive design features that have been incorporated into the building.

To deliver an energy efficient and net zero building, an exemplar approach is required to be followed based on low energy design principles to ensure that the building itself is one of the main contributors to the minimization of energy demand. This can be achieved through effective building form and orientation, good envelope design and proficient use of services.

It is vital that to achieve long term energy benefits that the inherent energy demand of the building is considered at the first instance. The measures that have been adopted include:

- High efficiency LED lighting throughout
- Lighting control system to include daylight sensing and absence detection
- High levels of natural daylight through effective window design
- Optimised glazing to ensure excellent thermal performance combined with solar shading to minimise summer solar gains and maximise daylight factors.
- Enhanced building fabric and air tightness characteristics beyond Part L building regulations standards
- High efficiency MVHR where applicable to reduce overheating and provide adequate air supply, with natural ventilation used where possible.



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