



RIDGE

Appraisal of Low and Zero Carbon
Technologies
50 Fountain Street
Manchester
Ask Real Estate
16th August 2021

**APPRAISAL OF LOW AND ZERO CARBON TECHNOLOGIES,
50 FOUNTAIN STREET**



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MANCHESTER
ASK REAL ESTATE**

16th August 2021

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APPRAISAL OF LOW AND ZERO CARBON TECHNOLOGIES, 50 FOUNTAIN STREET

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APPRAISAL OF LOW AND ZERO CARBON TECHNOLOGIES, 50 FOUNTAIN STREET

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APPRAISAL OF LOW AND ZERO CARBON TECHNOLOGIES, 50 FOUNTAIN STREET

1. INTRODUCTION

Ask Real Estate have commissioned Ridge & Partners LLP to undertake an appraisal of Low and Zero Carbon technologies for the proposed redevelopment of the existing office block located at 50 Fountain Street in Manchester City Centre.

The brief is to target a BREEAM rating under the BREEAM New Construction 2018 Assessment Criteria.

With the focus placed on energy efficiency, the proposed design will incorporate low and zero carbon technologies in addition to best practice measures therefore exceeding the current Building Regulations Part L Requirements.

This report has been compiled in accordance with the requirements of BREEAM New Construction 2018 credit Ene 04 criteria 7-8 "Low Zero Carbon Feasibility Study" to summarise the most appropriate Low or Zero Carbon (LZC) energy source(s) for the proposed development. This study covers:

- Energy generated from LZC energy source per year
- Carbon dioxide savings from LZC energy source per year
- Life cycle cost of the potential specification, accounting for payback
- Local planning criteria, including land use and noise
- Feasibility of exporting heat/electricity from the system
- Any available grants
- All technologies appropriate to the site and energy demand of the development
- Reasons for excluding other technologies

Initially, all low and zero carbon technologies were reviewed, and following a review of the site and building constraints, some technologies were discounted, with the remaining technologies analysed before the final recommendations made.

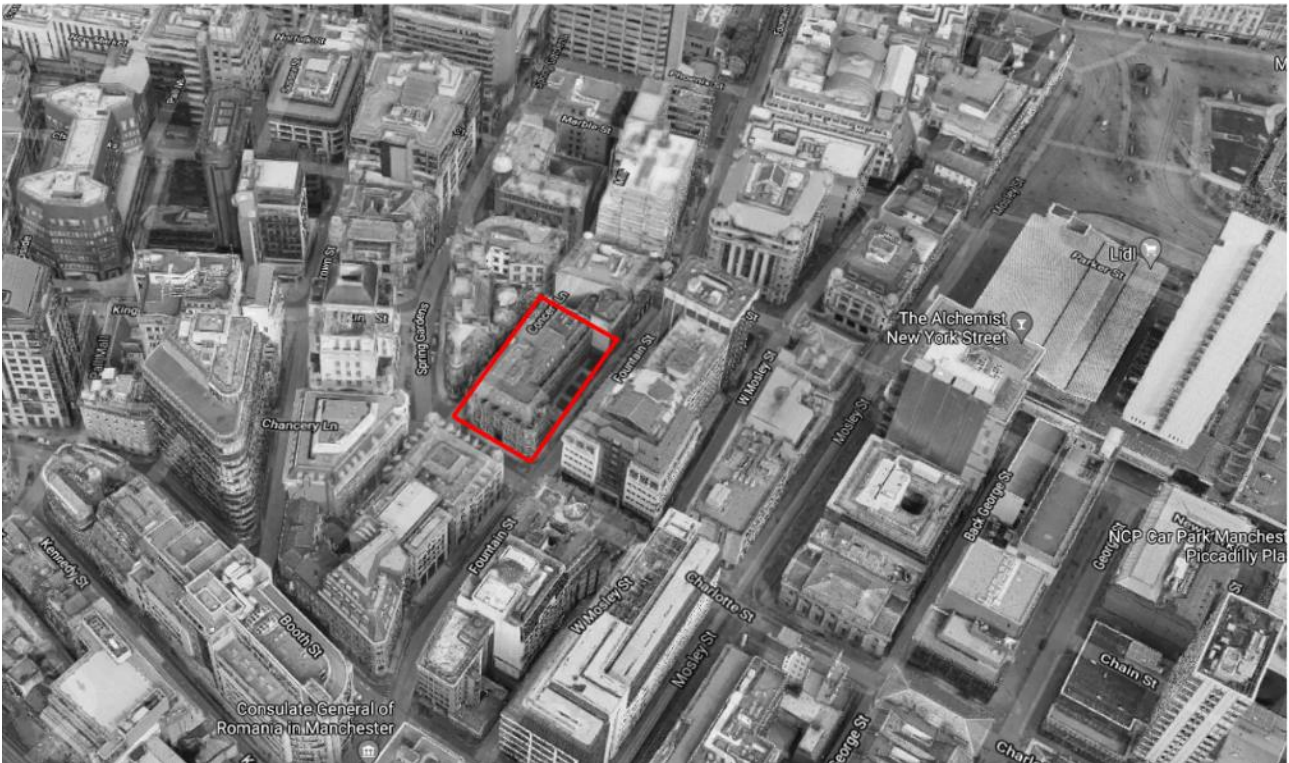
Following the appraisal of all the low and zero carbon technologies, an installation of XXX m² of roof mounted photovoltaic panels and the use of Air Source Heat Pumps for the heating is the most suitable LZC technologies for the development. A combination of these technologies allows to save XX % of energy and offset XXX % of CO₂ emissions per year.

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2. DEVELOPMENT PROPOSALS

2.1. Description of Development Site

The site is located in Manchester and is bounded by Fountain Street to the South East, Spring Gardens to the South West, Concert Lane to the North West and existing buildings off York Street to the North East.



3D View of the site and the surrounding area

The site has all major services (gas, water, telecoms and electricity) within the surrounding roads which do not present any risk in terms of requiring diverting or disconnections to develop the project.

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2.2. Development Proposals

The proposed development is for the redevelopment of 50 Fountain Street to provide office accommodation. The majority of the building will be demolished but the front façade will be retained.

Proposed Area Schedule

Floor	Gross Internal Area (GIA) (m ²)	Net Internal Area (NIA) (m ²)
Basement	826	
Ground	1045	418
Mezzanine	94	94
1st	1045	877
2nd	1045	877
3rd	927	760
4th	918	751
5th	875	708
6th	811	644
7th	234	
Total	7820	5129

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3. BREEAM

The Building Establishment's Environmental Assessment Method (BREEAM) is the world's leading and most widely used voluntary environmental assessment method for commercial buildings that aims to quantify and reduce the environmental impact of buildings in a robust and cost effective manner.

This is achieved by the use of the scheme by clients and their project team at key stages during the design and construction process.

The performance based assessment awards credits within the following categories:

- Energy
- Water
- Transport
- Materials
- Land use and ecology
- Pollution
- Health and wellbeing
- Management
- Waste

The assessment process provides in a report that covers the areas assessed, along with a formal certification on a scale of UNCLASSIFIED, PASS, GOOD, VERY GOOD, EXCELLENT and OUTSTANDING.

The diagram below shows how the BREEAM assessment scores and rates a building:

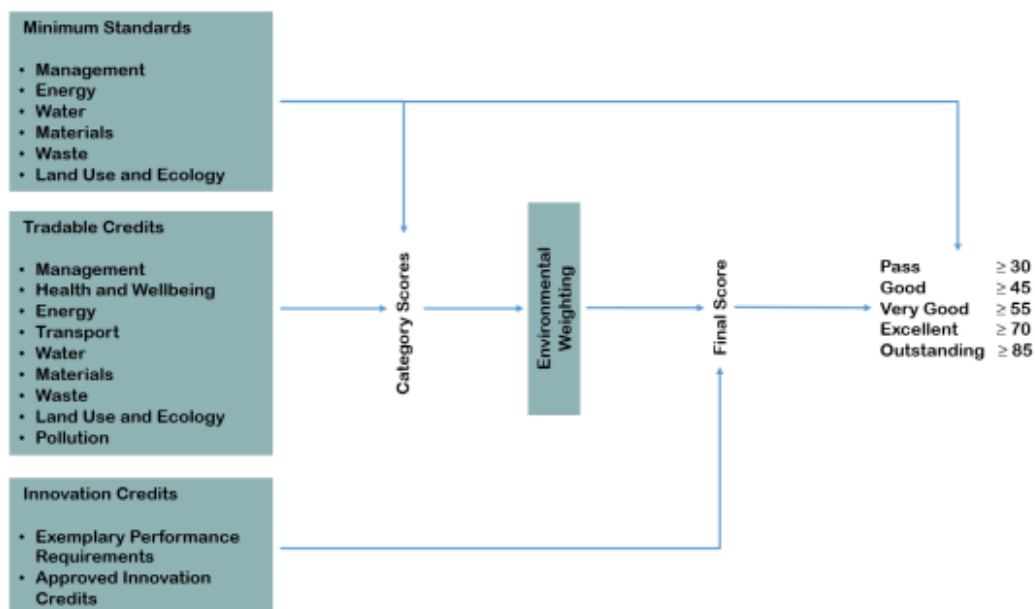


Figure 1 Process for Awarding BREEAM Ratings

The BREEAM categories include a number of environmental elements that reflect the different options available when designing, procuring and constructing a building. Each environmental element has credits available that are awarded when compliance has been demonstrated.

For the building to meet a specific BREEAM rating, there are a series of minimum standards that must be achieved for that rating to be awarded.

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In addition to the credits, there are also innovation credits available that provide additional recognition of sustainable performance that goes beyond what is currently recognised and rewarded by the standard BREEAM credits.

The innovation credits are awarded for either meeting the BREEAM exemplary level requirements or by an application to BRE to have a specific feature, system or process recognised as 'innovative'.

Each different BREEAM section has an environmental weighting applied to the scores which calculates the final BREEAM score. These factors have been derived from consensus based research with groups such as the government, suppliers and lobbyists.

The weightings are:

BREEAM SECTION	WEIGHTING (%)	BREEAM SECTION	WEIGHTING (%)
Management	12.0	Materials	12.5
Health and Wellbeing	15.0	Waste	7.5
Energy	19.0	Land Use and Ecology	10.0
Transport	8.0	Pollution	10.0
Water	6.0		

Once the weightings have been applied, the score is then assigned a BREEAM rating as follows:

BREEAM RATING	SCORE (%)
UNCLASSIFIED	<30
PASS	≥30
GOOD	≥45
VERY GOOD	≥55
EXCELLENT	≥70
OUTSTANDING	≥85

At this stage it is difficult to predict the exact number of BREEAM credits achievable by each Low and Zero Carbon Technology. These technologies will have an influence over the following:

- Ene 01 – Reduction of CO₂ Emissions – Up to 15 (+5 innovation) credits are available
- Ene 04 – Low and Zero Carbon Technologies – Up to 3 (+1 innovation) credits are available
- Po12 – NO_x Emissions – Up to 3 credits are available.

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4. ENERGY BENCHMARKING

4.1. Estimated Energy Demand and CO2 emissions

In order to benchmark the proposed redevelopment of 50 Fountain Street, the estimated energy and CO2 emissions have been calculated. These are indicative only at this stage but can be used as a guideline to assess the percentage of the building's total energy consumption and CO2 emissions that could be reduced or offset by applying suitable renewable and/or low carbon technology energy options.

Because BRE Global only accepts results from approved models when verifying the reduction in CO2 emissions for credits Ene 01 and Ene 04, this report uses the energy data from the approved Dynamic Simulation Model (DSM) software which uses government and industry agreed National Calculation Method (NCM) room templates containing standard operating conditions.

The total predicted building energy consumption is: 231,598.50 kWh/year

Estimated CO2 emissions: 461.03 Tonnes/CO2/Annum

The CO2 emission factors of Gas (0.216) and Electricity (0.519) have been used to calculate the above figures and have been taken from Building Regulations Approved Documents

4.2. Indicative Payback

At this stage, it is difficult to measure precisely the payback period of any investment, particularly when there is a range of low and zero carbon technologies being adopted, due to the volatility of prices in the current fuel market and also the changing cost of the technology.

For the purposes of this report, simple payback periods have been considered which are based on current prices with no consideration for future value and is just comparing the annual savings to the initial capital expenditure.

This is not an accurate prediction of payback, but it does however provide a consistent comparison between the different low and zero carbon technologies being considered.

4.3. Grants

At present, there are currently no grants available to businesses or commercial buildings for the adoption of low and zero carbon technologies.

The Non-Domestic Renewable Heat Initiative (RHI) closed to new applicants on 31st March 2021 although there are some exceptions such as being granted an extension application of have a Tariff Guarantee extended commission date.

Likewise, the Feed in Tarriff scheme closed on 1st April 2019 to new applicants.

One scheme that is currently open is the Smart Export Guarantee (SEG). The Smart Export Guarantee requires some electricity suppliers to pay small scale generators for low carbon electricity, which is exported to the National Grid, as long as certain conditions are met.

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The scheme covers up to 5MW from the following technologies (in the case of the micro-CHP up to 50kW):

- Solar photovoltaic (solar PV)
- Wind
- Micro combined heat and power (micro-CHP)
- Hydro
- Anaerobic digestion (AD)

5. APPRAISAL OF SOLUTIONS

5.1. Low to Zero Carbon Technologies

Options have been reviewed for the use of on-site Low or Zero Carbon Technology (LZT) in line with the Manchester City Council's policy aspirations.

This Low to Zero Carbon Technology statement reviews the technical and economic feasibility of the following technologies –

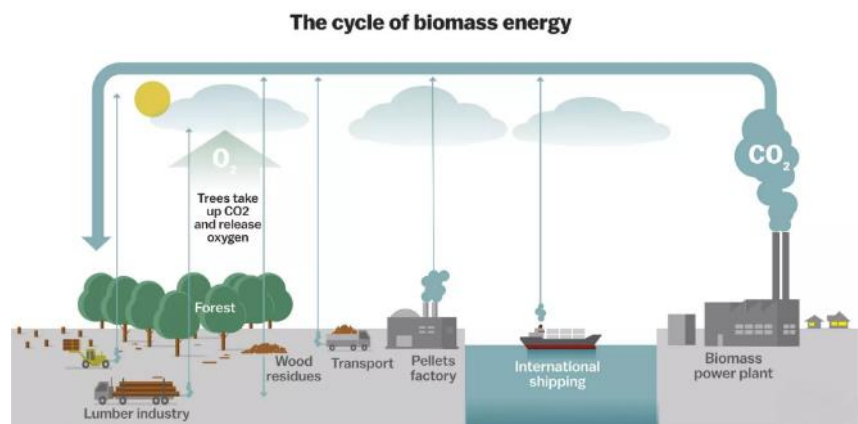
- Biomass
- Wind power
- Biogas/ Anaerobic Digestion
- Geothermal
- Ground Source Heat Pump
- Air Source Heat Pump
- Combined Heat & Power (CHP) [Natural gas and Biomass]
- Solar Hot Water
- Photovoltaic Panels
- Hydrogen
- Manchester District Heating

5.1.1. Biomass

Biomass is a generic name for any fuel produced from organic sources and falls into mainly two categories:

- Woody biomass- forest products, untreated wood products, energy crops and wood pellets
- Non-wood biomass – liquid biofuels (such as biodiesel, bioethanol) or animal waste, industrial municipal products, and high energy crops such as rape seed, sugar cane and maize.

Woody biomass is almost carbon neutral as an energy source as the tree growing process effectively absorbs the CO₂ that is emitted during combustion.



The exact mix of the biomass fuels will depend on the prevailing economic conditions which allows the supplier to keep costs to a minimum and minimise risks of fuel supply disruption. Currently, the hierarchy in fuel prices is:- Tree Surgery Waste (lowest) < Recycled Packaging Waste < Short Rotation Coppice (SRC) Willow Chips < Forestry Chips < Miscanthus Pellets (highest).

The specification for fuel supplied is described in the European Technical Specification (CEN/TS 14961 'Solid Biofuels – Fuel Specifications and Classes') which has been adopted by BSI as a 'Draft for Development' (DD CEN/TS 14961:2005). Fuel can be supplied below a maximum moisture content of 30% (M30), but a higher maximum of 50% (M50) would allow greater flexibility in fuel sources.

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For domestic properties, the fuel used is normally wood pellets, wood chips or wood logs. For larger applications, biomass boilers replace conventional fossil fuel boilers and come with an automated feed by screw drives from hoppers.

Biomass systems require more cleaning than gas or oil boilers and they must be capable of being taken out of service for cooling and cleaning whilst maintaining the building heating supply particularly in communal heating systems. Centralised gas boilers are therefore still required to support the biomass boiler, which would be the lead boiler. The size of the dedicated plant rooms is substantial. Fuel availability, delivery and storage are also important issues to consider as for a typical 500kw capacity, an underground bunker of 5m x 5m x 3m is required for storage.

Air quality issues are also an important factor when looking to install biomass, especially in the Manchester area, however modern wood fuel boilers are highly efficient, clean and smokeless.

With biomass systems it is important to comply with the Clean Air Act. The open chimney is a source of noxious gases and its location has important environmental consequences and demands some attention at the planning stage. The minimum height of the outlet will be determined by The 1956 and 1993 Clean Air Acts. The actual height of the outlet is subject to approval by the local planning authority. The location of the outlet should take into account the effect of gases on the occupants of nearby buildings. In addition, The Clean Air Act stipulates that during full load conditions, the velocity for appliances up to 2,500kW should be a minimum of 6m/s.

There is noise, transportation and delivery of fuel and air quality issues associated with biomass technology which could be problematic for a city centre development and for this reason biomass is discounted.

5.1.2. Wind Power

Wind power is one of the cleanest and safest methods of generating electricity. Small scale wind turbines are typically in the range of 1kW – 15kW, with rotor diameters of 2.5m – 9.0m respectively. These systems can be stand-alone or, in some cases, building mounted. However, wind power is unfeasible due to the fact the development is in an urban area and local wind conditions would not be sufficient to provide enough power.

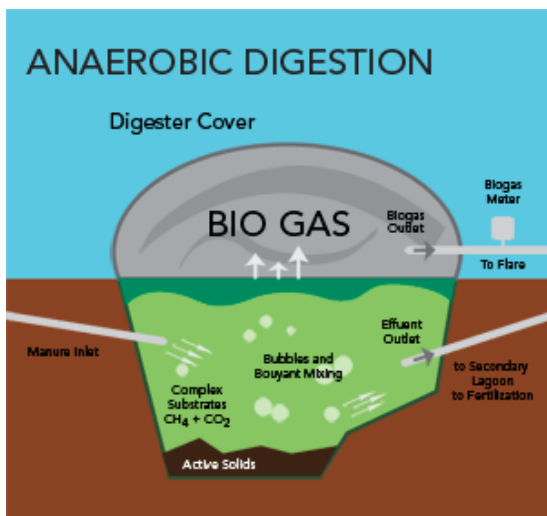


Furthermore, as this development is in an urban area with numerous tall buildings in close proximity, there will be obstacles which reduce wind speed. The average wind speed in this area is 2.4 m/s which is much less than the 6 m/s required. Therefore, wind is not a viable technology for this development.

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5.1.3. Biogas / Anaerobic Digestion (AD)

Anaerobic Digestion (AD) is a collection of processes by which microorganisms break down biodegradable material in the absence of oxygen. The process is used for industrial or domestic purposes to manage waste and/or to produce fuels. Anaerobic digestion is widely used as a source of renewable energy. The process produces a biogas, consisting of methane, carbon dioxide and traces of other 'contaminant' gases. This biogas can be used directly as fuel, in combined heat and power gas engines or upgraded to natural gas-quality bio-methane. The nutrient-rich digestate also produced can be used as fertilizer.



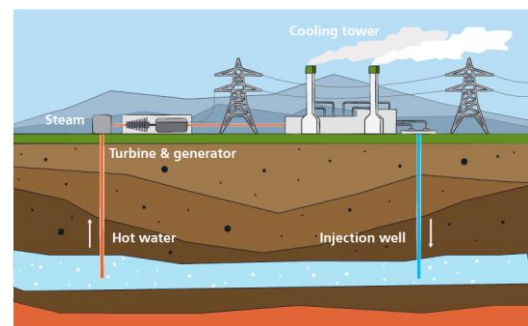
Biogas typically refers to a mixture of different gases produced by the breakdown of organic matter in the absence of oxygen. Biogas can be produced from raw materials such as agricultural waste, manure, municipal waste, plant material, sewage, green waste or food waste. It is a renewable energy source and, in many cases, exerts a very small carbon footprint.

Biogas can be produced by anaerobic digestion with anaerobic bacteria, which digest material inside a closed system, or fermentation of biodegradable materials.

As the site is extremely efficient in terms of available space the anaerobic digestion solution is not deemed practical and discounted.

5.1.4. Geothermal

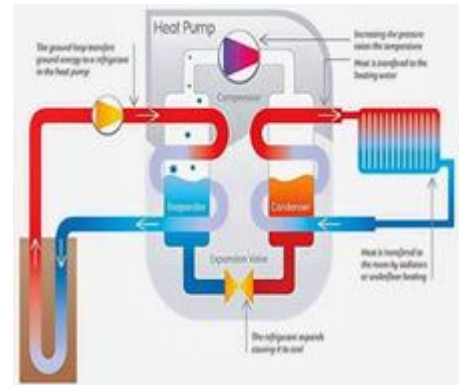
Geothermal energy is thermal energy generated and stored in the Earth. The geothermal energy of the Earth's crust originates from the original formation of the planet and from radioactive decay of materials. The geothermal gradient, which is the difference in temperature between the core of the planet and its surface, drives a continuous conduction of thermal energy in the form of heat from the core to the surface. Geothermal power is cost effective, reliable, sustainable, and environmentally friendly, but has historically been limited to areas near tectonic plate boundaries. Recent technological advances have dramatically expanded the range and size of viable resources, especially for applications such as home heating. As a result, geothermal power has the potential to help mitigate global warming if widely deployed in place of fossil fuels. The geothermal energy can be used to heat homes directly or can be used to drive steam turbines to generate electricity.



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5.1.5. Ground Source Heat Pump (GSHP)

GSHP's have been developed specifically for the housing market and are now considered to be an established reliable technology. The GSHP would be sized to cater for the heating and domestic hot water requirements. Typically, they are more suited to a centralised system with multiple bore holes to a depth of up to 150-250 metres depending on the ground conditions. GSHP's use a heat exchanger to extract heat from the earth where the temperature of the ground remains a constant 12°C throughout the year.



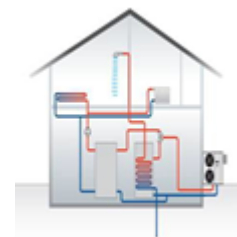
The efficiency of ground source heat pumps is measured by Coefficient of Performance (CoP), this is the ratio of units of heat output for each unit of electricity used to drive the compressor and pump for the ground loop. Average CoP is around 3-5 although some systems may produce a greater rate of efficiency. This means that for every unit of electricity used to pump the heat, 3-5 units of heat are produced, making it an efficient way of heating a building. If grid electricity is used for the compressor and pump, then there is the opportunity to consider a range of energy suppliers to benefit from the lowest running costs, for example by choosing an economy 10 or economy 7 tariff.

The viability of the Ground Source Heat Pump is dependent upon the local geology conditions and the land available. A desktop based preliminary site investigation can usually determine the viability of the GSHP but a Thermal Response Test (TRT) may be required to test the actual thermal conditions of the site.

Although they reduce CO₂ emissions, GSHP's rely directly on electricity for power and therefore are not fuel or energy efficient. The cost and practicalities to install GSHP's on this type of scheme is also prohibitive - GSHP are typically £20-30k per borehole. There is insufficient space at ground level to accommodate the number of boreholes to service the development, which makes this option unviable. GSHP's are not considered appropriate for this scheme.

5.1.6. Air Source Heat Pump (ASHP)

Air source heat pumps work in a similar way to GSHPs but extract thermal energy from the surrounding air and transfer it into water. Air source heat pumps can be fitted on the façade or on the roof but care should be taken when mounting the units to avoid any acoustic problems associated with operating the fans as the outdoor units typically operate with sound levels in the range 55 - 60dB(A).



The efficiency of ASHP is measured by Coefficient of Performance (CoP); this is the ratio of units of heat output for each unit of electricity used to drive the system. Average CoP is around 2-4 although some systems may produce a greater rate of efficiency.

Variable Refrigerant Flow (VRF) technology can be incorporated which allows individual spaces to be either heated or cooled whilst recovering the heat between them.

A disadvantage of Air Source Heat Pumps is that in extreme conditions a defrost cycle is required which has a negative impact on the system efficiency. In addition to this, when the ambient temperature drops below 5°C, the heating capacity also reduces but an 80% efficiency can still be maintained when the ambient temperature is -5°C.

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The ASHP system does offer an attractive solution in terms of the de-carbonisation of the grid and the omission of natural gas to the site.

An Air Source Heat Pump system is proposed to be installed; the following table summarises the capital costs, payback and both the energy and CO2 savings by introducing Air Source Heat Pumps in place of gas.

Energy Saving	149,326.18 kWh/yr
% Energy Saving	39.2%
CO2 saving	16,222.71 kG/CO2/yr
% CO2 saving	11.86%

5.1.7. Combined Heat & Power (CHP)

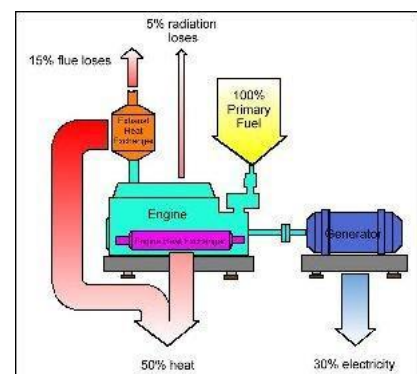
Combined heat and power (CHP) is a highly efficient process that captures and utilises the heat that is a by-product of the electricity generation process from an engine. CHP is strictly an energy efficiency measure rather than a renewable energy technology. By generating heat and power simultaneously (co-generation) CHP can reduce carbon emissions by up to 30% compared to the separate means of conventional generation via a boiler and power station. Typically, a CHP would use natural gas as the main fuel source, although other forms of fuel can also be considered.

The main components of a typical system are:

- the engine which drives the generator.
- the generator which produces electricity.
- the heat recovery system that recovers the waste heat from both the engine water cooling jacket and exhaust gases.
- the exhaust system to take away the products of combustion.
- the control panel to monitor the operation.

The heat generated during this process is supplied to an appropriately matched heat demand that would otherwise be met by a conventional boiler. CHP systems are highly efficient, making use of the heat which would otherwise be wasted when generating electrical or mechanical power. This allows heat requirements to be met that would otherwise require additional fuel to be burnt.

The viability of CHP is dependent upon the building base load for both heat and power. As a result, buildings which operate 24 hours with a high heat and constant power demand lend themselves to CHP.



For many developments CHP is the measure that offers the most significant single opportunity to reduce energy costs and to improve environmental performance with existing users of CHP typically saving around 20% of their energy costs.

Advantages of CHP include:

- CHP typically has an efficiency of 80-90%
- Operators typically saving around 20% on energy bills
- Significant carbon dioxide emission savings can be made
- Transmission and distribution losses are reduced

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- Increases fuel supply security

However as the design intent and client brief is to have a strategy non reliant on fossil fuel and embrace the decarbonisation of the Electricity Grid, CHP is discounted.

CHP Quality Assurance Programme (CHPQA)

The CHP Quality Assurance Programme (CHPQA) is a Government initiative that monitors, assesses and improves the performance of CHP schemes.

All CHP installations must meet the criteria of the 'Good Quality' for the purpose of the Enhanced Capital Allowances (ECA) scheme.

The voluntary CHPQA schemes main aims are:

- *Define, assess and monitor the quality of CHP Schemes based on energy efficiency and environmental performance.*
- *Ensure fiscal and other benefits available to CHP Schemes are in line with environmental performance.*
- *Provide clear signals to users and potential users of the scope to reduce the costs of satisfying energy requirements through the use of CHP.*
- *Achieve the above at minimum cost to CHP users and to government*

The CHPQA Standard Version 8 (March 2021) provides the following criteria for a 'Good Quality' CHP:

- *For Fuel Inputs under Annual and Initial Operation: A Scheme that qualifies as Good Quality CHP for its entire annual energy inputs is one where the Power Efficiency equals or exceeds 20%.*
- *For Power Outputs under Annual Operation: A Scheme that qualifies as Good Quality CHP for its entire annual energy outputs is one where the Quality Index equals or exceeds 100. Normally, the Threshold QI Criterion is based on Annual Operation, but it can be based on other periods, for example on the Heating Season in the case of RCH Schemes.*
- *For Power Outputs under Initial Operation: A Scheme that qualifies as Good Quality CHP for its entire annual energy outputs is one where the Quality Index equals or exceeds 95. Normally, the Threshold QI Criterion is based on Annual Operation, but it can be based on other periods, for example on the Heating Season in the case of RCH Schemes.*
- *For Power Generation Capacity under Annual Operation: The Threshold Criterion for existing Good Quality CHP Capacity is that the CHP Scheme achieves a QI of at least 100 at its Maximum Heat Output under Normal Operating Conditions.*
- *For Proposed New Power Generation Capacity: Threshold Criteria for proposed new Good Quality CHP Scheme Capacity, at design, specification, tendering and approvals stages, are $QI \geq 105$ (at Maxheat) and Power Efficiency $\geq 20\%$, both under Annual Operation*

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5.1.8. Solar Thermal HW Panels

Solar panel heating uses the radiant energy from the sun to heat hot water, most commonly for domestic hot water as the solar availability during the space heating season is limited. The systems function successfully in all parts of the UK as they work in diffuse light conditions.

There are two types of collectors used for solar water heating – flat plate collectors and evacuated tube collectors.

Flat plate collectors are generally more robust and reliable whilst evacuated tube collectors offer better all-round performance, especially in the winter.



Evacuated tube collectors consist of double wall glass tubes with a space in the middle of the collector containing a heat pipe and a liquid. The absorber plate absorbs the sun's rays and transfers the energy to the water flowing through the tubes. Either collector are generally located at roof level or support frames at a 10-60 degree pitch facing south, although other less efficient directions can be used.

The inner glass coating ensures that approximately 93% of the absorbed heat is retained and the vacuum prevents the loss of heat through conduction and convection. The heat pipes within the panels are connected to a manifold that circulates water.

The liquid within the heat pipes is evaporated by the sun's energy and rises to a heat exchanger within the manifold where it condenses and the latent heat is transferred to the water. This heated water is then pumped to a hot water cylinder, sized to meet the demand of the installation, where there is often a second coil providing top-up heating from a conventional boiler.

Evacuated tube panels deliver a higher temperature compared to flat plate types thus making them more effective with thermal storage solutions.

Typically, when located in an optimum orientation, evacuated tube collectors deliver around 700kWh/m²/yr compared to 580kWh/m²/yr for the flat plate collectors in the same conditions.

Solar thermal installations can be designed to accommodate available roof space of the building façade.

A typical installation in the UK has a panel size of 3-5m² which is used in conjunction with a hot water storage tank with a capacity of 180-300 litres, of which 90-150 litres must be dedicated to solar hot water storage.

The cost of installing the system is dependent on the distance between the solar collector and the hot water storage. The closer the collectors are to the hot water storage, the less pipe work is required. Annual maintenance checks are recommended and a check by a professional installer of pumps, valves and anti-freeze mixture every 3-5 years is usually sufficient.

They are a 'simple' and guaranteed technology which will act as a pre-heat for the Hot Water and Heating usage. Payback between capital cost and energy saving can normally be achieved within 12–20 years, subject to usage and dwelling type. They work best on individual singular dwellings with a small HW cylinder. As the available roofspace for solar panels is limited and the use of photovoltaic panels is considered more effective in reducing carbon emissions, then solar thermal panels are discounted.

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5.1.9. Photovoltaic Panels (PV)

Photovoltaic panels use cells to convert light into electricity and are available in a number of different types:

Mono-crystalline Silicon Cells: These are made using cells saw-cut from a single cylindrical crystal of silicon. The principle advantage of mono-crystalline cells is their high efficiency, typically around 15 – 20%, although the manufacturing process required to produce mono-crystalline silicon is complicated, resulting in slightly higher costs than other competing technologies.

Polycrystalline Silicon Cells: These are made from cells cut from an ingot of melted and re-crystallised silicon. In the manufacturing process, molten silicon is cast into ingots of polycrystalline silicon. The ingots are then saw-cut into very thin wafers and assembled into complete cells giving a granular textured finish. Polycrystalline cells are cheaper to produce than mono-crystalline types, due to the simpler manufacturing process but tend to be slightly less efficient, with average efficiencies of circa 12 – 15%.

Thick-Film Silicon: This is another polycrystalline technology where the silicon is deposited in a continuous process onto a base material giving a fine grained, sparkling appearance. Like all crystalline PV, this is encapsulated in a transparent insulating polymer with a tempered glass cover and usually bound into a strong aluminium frame.

Thin-Film Amorphous Silicon: Amorphous silicon cells are composed of silicon atoms in a thin homogenous layer rather than a crystalline structure. Amorphous silicon absorbs light more effectively than crystalline silicon, so the cells can be thinner. For this reason, amorphous silicon is also known as a 'thin film' PV technology. Amorphous silicon can be deposited on a wide range of substrates, both rigid and flexible, which makes it ideal for curved surfaces and 'fold-away' modules. Amorphous cells are, however, less efficient than crystalline based cells, with typical efficiencies of around 6%, but they are easier and, therefore, cheaper to produce.

Other Thin Films: A number of other promising materials such as cadmium telluride (CdTe) and copper indium diselenide (CIS) are now being used for PV modules. The attraction of these technologies is that they can be manufactured by relatively inexpensive industrial processes, certainly in comparison to crystalline silicon technologies, yet they typically offer higher module efficiencies than amorphous silicon. New technologies based on the photosynthesis process are at early stages of commercialisation.

When light shines on a cell it generates energy causing electricity to flow, the higher the light intensity is, the more electricity flows.

Solar louvres can use PV panels to provide solar shading as part of the brise soleil. This serves the dual function of controlling overheating and helping to reduce glare.

Solar glazing uses a combination of PV and glass where the PV is laminated between two panes of glazing. This creates energy at the same time as providing shade, thus reducing the risk of overheating. It is essential that the panels remain unshaded as even a small shadow can significantly reduce the output.

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The amount of energy PV cells generate is referred to as Kilowatt Peak (KWp). PV arrays now come in a variety of shapes and colours, ranging from grey 'solar tiles' that look like roof tiles to panels and transparent cells that you can use on conservatories and glass to provide shading as well as generating electricity. Panels can be mounted flat or on A-frames to give the optimum angle. The optimum panel inclination for solar collection is 35°, oriented due south; however panels that are inclined between 35° and 45° and oriented south of west or east are also generally suitable. If solar collectors are oriented away from due south then a larger surface area will be required to generate a set amount of energy.



The use of photovoltaic panels is considered attractive as this system offers an effective method of offsetting carbon emissions and has little/no maintenance or ongoing costs. The installations are scalable with size only restricted by façade and/or roof space.

50m² of PV panels mounted on the roof have been proposed on the redevelopment.

The following table summarises the capital costs, payback and both the energy and CO₂ savings by introducing the PV in addition to the Air Source Heat Pumps.

Energy Saving	8961.12 kWhr/yr
% Energy Saving	3.87%
CO ₂ saving	4635.06 kG/CO ₂ /yr
% CO ₂ saving	3.84%

5.1.10. Hydrogen

Hydrogen is a low carbon alternative fuel source for traditional boilers, replacing gas. Hydrogen boilers would be installed in the same manner as traditional gas boilers, but it is not currently possible to purchase a 100% hydrogen ready boiler and therefore hydrogen is discounted from the development.

5.1.11. Battery Storage

Battery storage allows the low and zero carbon technology that can generate electricity – such as PV panels, wind turbines and CHPs – to charge the batteries if there is not sufficient demand from the development to utilise the energy.

This is more efficient than exporting the electricity to the grid, as the battery storage can 'peak lop' the peaks in the demand i.e., smoothing out the peaking and troughs in electrical demand and the onsite generation, saving the client money as the demand for higher cost and more carbon intense electricity at peak periods would be offset by the stored low cost and low carbon intensive electricity.

Battery storage is a viable solution to be adopted, but the required battery must be assessed in relation to the amount of stored electricity from the proposed PV system and the daily electricity usage.

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5.2. Low / Zero Carbon Technologies (LZT) Discounted (Summary)

- Biomass has been discounted as it poses problems in terms of air quality, delivery of fuel, storage, and transportation for deliveries etc. It would require a larger plant space for storing fuel, which is not currently included and is not conducive to city centre developments.
- Wind turbines are not seen to work particularly well on this type of development as it is an urban development and due to problems with wind turbulence and mounting of the units. The wind speeds in the area are not conducive to wind power electricity generation and there would be issues with shading, noise, and air traffic.
- Biogas/ Anaerobic Digestion (AD). Emissions are likely to cause local air pollution and compliance with the Clean Air Act is problematic. Finding a secure supply of fuel can be difficult. The environmental impact of fuel transportation can be expensive. AD used to generate gas for heat or electricity requires pollution prevention and a control permit or waste management license. Digester, storage areas and delivery areas can cause problems via escape of odour and liquids. High installation costs make the technology unviable.
- Geothermal. Availability of suitable location poses serious problem in adopting a geothermal solution. Extensive research is required prior to investing to ensure the location is suitable and sites do not 'run out of power' over a period of time. It may release harmful gases from deep within the Earth. High installation and investigation costs make the technology unviable.
- Ground Source Heat Pump's (GSHP) are not viable for this site because of spatial constraints and financial costs. There is insufficient space on the site to install GSHP vertical bores.
- Biomass CHP. As with standard biomass, this technology's problems lie in air quality, delivery of fuel, storage, and transportation for deliveries etc. It would require a larger plant space for storing fuel, which is not currently included, and it is not conducive to city centre developments.
- Gas Fired CHP – Although a viable technology in terms of cost and carbon reductions the system is discounted on the basis of the move towards the decarbonisation of the Electrical Grid and the phasing out of Fossil fuels.
- Solar Thermal – Although a viable solution, the system is discounted in favour of the adoption of Photovoltaics at roof level which after a more reliable cost-effective method of carbon emissions reduction.
- Hydrogen – Boilers that run solely on hydrogen are not currently available and will require gas to be installed instead until hydrogen is available.

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5.3. Summary of Technologies & Measures Considered & Adopted

Key:

Y	–	Yes could be incorporated
P	–	Possible
N	–	Not appropriate

REDUCE DEMAND	SUITABLE FOR CONSIDERATION	COMMENTARY
RENEWABLE AND LOW CARBON TECHNOLOGY		
Solar		
Solar hot water	P	Possible but minimal roof space and low hot water demand
Photovoltaics (PV's)	Y	Can be used to offset electrical demand subject to financial appraisal. - but minimal roof space available. Excess electricity can be exported to the grid
Water		
Small scale hydro power	N	Not feasible as no significant water source available
Tidal power	N	Not Applicable
Wave power	N	Not Applicable
Wind		
Wind turbines	N	Not suitable for city centre environment although excess electricity can be exported to the grid
Biomass		
Biomass single room heaters/stoves	N	Not appropriate for Application
Biomass boilers	P	Possible but due to the air quality issues, biomass boilers have been discounted.
Biomass community heating schemes	N	No significant energy sharing in the area.
Combined Heat and Power (CHP) for use with the following fuels:		
Biofuel	N	Gasification process too large for scale of site. Biodiesel considered immature feedstock and unreliable.
Gas Fired CHP	N	Not sufficient hot water demand within building although excess electricity can be exported to the grid
Sewerage gas and other biogases	N	Scale of site too small.
Heat Pumps		
Ground source heat pumps	N	There is insufficient capacity for the schemes requirements.

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Water source heat pumps	N	No significant water sources to reject / absorb heat.
Geothermal heating systems	N	Not available.
Air source heat pumps	Y	This technology is feasible to generate hot water & for heating.
For heat pumps to comply, the heat source (ground or water) must be from a renewable source, for example soil, outside air, ground water, or a river.		
Other		
Fuel cells using hydrogen generated from any of the above 'renewable' sources.	N	Technologies not yet mature enough for application.
Rainwater recycling	P	Rainwater collection system could be adopted to recycle rainwater for toilet flushing purposes but minimal space to provide below ground tanks.
Green roofs	P	Could be adopted
Battery Storage	P	Battery Storage could be adopted but the amount of stored electricity must be calculated to determine the size of the battery.

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5.4. District Heating Network

This section outlines how consideration of energy supplied efficiently from a district heating network can be provided to the proposed redevelopment in line with the Energy Hierarchy.

De-Centralised/ District Heating Networks (DHN)

The energy policy reaffirms the view that energy generated by centralised power stations and transmitted through the national grid is highly inefficient and wasteful.

One of priorities for reducing CO₂ emissions is to reduce the city's reliance on centralised power stations. This means increasing the use of local, low-carbon energy supplies through de- centralised energy systems.

Decentralised plant generally means any heating and hot water and/or electricity generation provided on a site or district wide basis. District heating is generally provided from Combined Heat and Power equipment (CHP). CHP is an engine which, when running, generates electricity and heats water which can then be distributed around a development.

Manchester City Council are working in partnership with Vital Energi to create the Manchester Civic Quarter Heat Network.

The network will provide heat and power solution for a number of buildings, making significant carbon reductions.

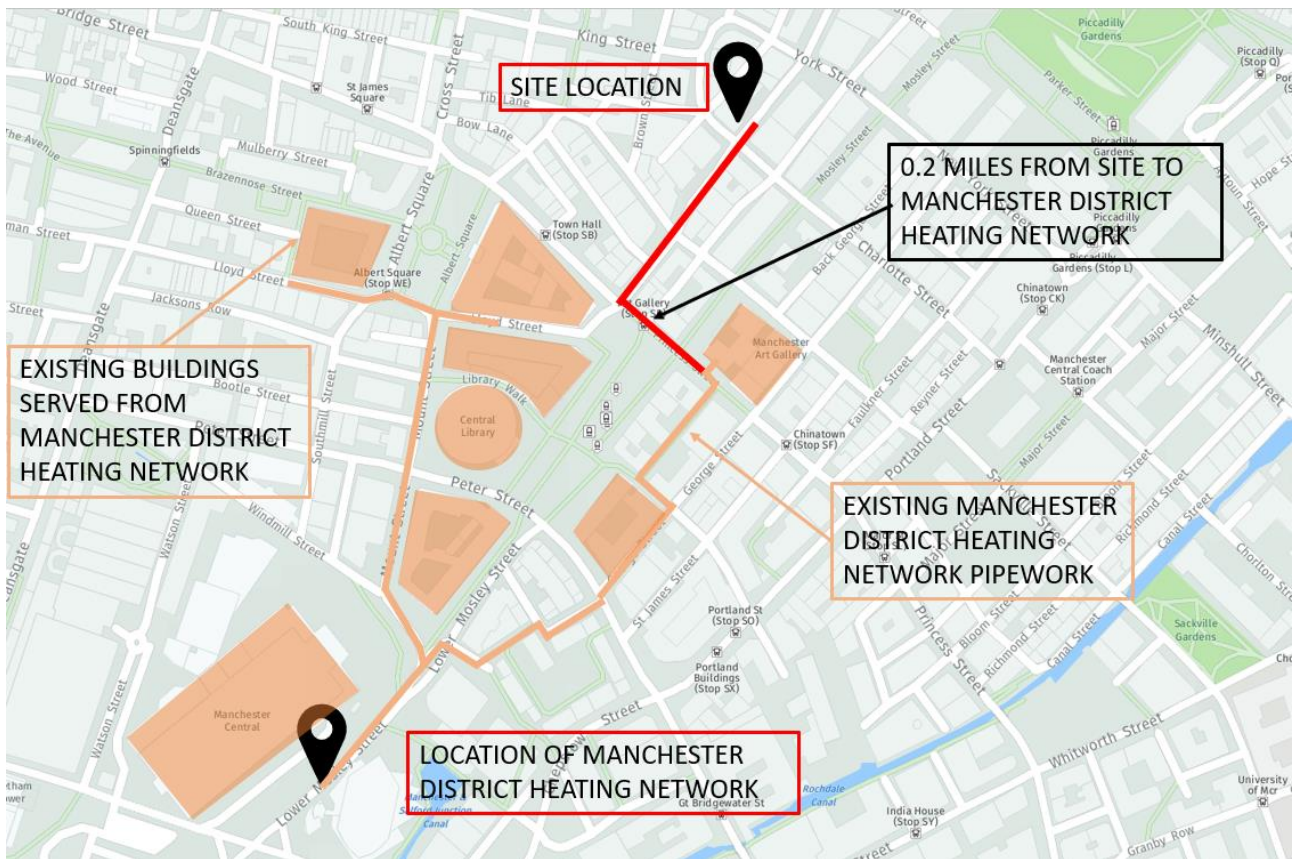
The first buildings to be connected are:

- Town Hall
- Town Hall Extension and Central Library
- Manchester Central Convention Centre
- The Bridgewater Hall
- Heron House

The network will contain power cables to distribute the electricity generated and underground pipes that deliver heat and hot water to connected buildings – one of the most cost-effective ways of reducing carbon emissions from heating. The network has been designed to enable future expansion, with efficiency and carbon savings increasing as more buildings join.

Heat will be generated from an energy centre, which is being built near to Manchester Central Convention Centre, at the junction of Great Bridgewater Street and Lower Mosley Street.

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The diagram above shows the current Manchester District Heating network and the location of the buildings that are served by it, in relation to the location of 50 Fountain Street.

50 Fountain Street is approximately 0.2 miles to the nearest point on the Manchester District Heating network. However, it is in our view that a connection into the District Heating Network would not be appropriate for the proposed redevelopment due to the relatively low heating load of the office in relation to the cost of a potential connection into the Heat Network.

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6. CONCLUSION

This report has set out the low and zero carbon technologies incorporated within the redevelopment of 50 Fountain Street and has established the renewable and low carbon technologies can be adopted with air source heat pumps (ASHP) to generate the heating and hot water to the building being selected.

This system was chosen to align with the government's policy on the phasing out of fossil fuels and the subsequent decarbonisation of the National Grid.

The ASHP solution will generate hot water to the development with high efficiency system where the typical 1 kWh of electricity input will generate 3 kWh of heat output (known as the co-efficient of performance or COP).

To further supplement this system with renewable technology, rooftop photovoltaic panels will be provided to generate electricity, contributing 1.16kWh/m² to the development.

The redevelopment will adopt the following renewable and Low Carbon Technologies:

- Air Source Heat Pumps, as shown in the image on the left below,
- Photovoltaic Panels, as shown in the image on the right below.



6.1. Summary

In summary, by adopting the Low and Zero Carbon technologies identified in section 5, the redevelopment's building emission rate is lower than the target emissions rate and passes criterion 1 as follows:

CO ₂ emission rate from the notional building, kgCO ₂ /m ² . annum	22.7
Target CO ₂ emission rate (TER), kgCO ₂ /m ² . annum	22.7
Building CO ₂ emission rate (BER), kgCO ₂ /m ² . annum	15
Are emission from the building less than or equal to the target?	BER=<TER

The proposed option provides a 33.92% improvement on Part L2A baseline calculation.

If these Low and Zero Carbon technologies were not adopted, the redevelopment would only have a 25.3% improvement on Part L2A baseline calculation.

CO ₂ emission rate from the notional building, kgCO ₂ /m ² . annum	24.9
Target CO ₂ emission rate (TER), kgCO ₂ /m ² . annum	24.9
Building CO ₂ emission rate (BER), kgCO ₂ /m ² . annum	18.6
Are emission from the building less than or equal to the target?	BER=<TER

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By adopting the Low and Zero Carbon technologies, there is a 24% improvement in the Buildings CO₂ emission rate (BER).



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