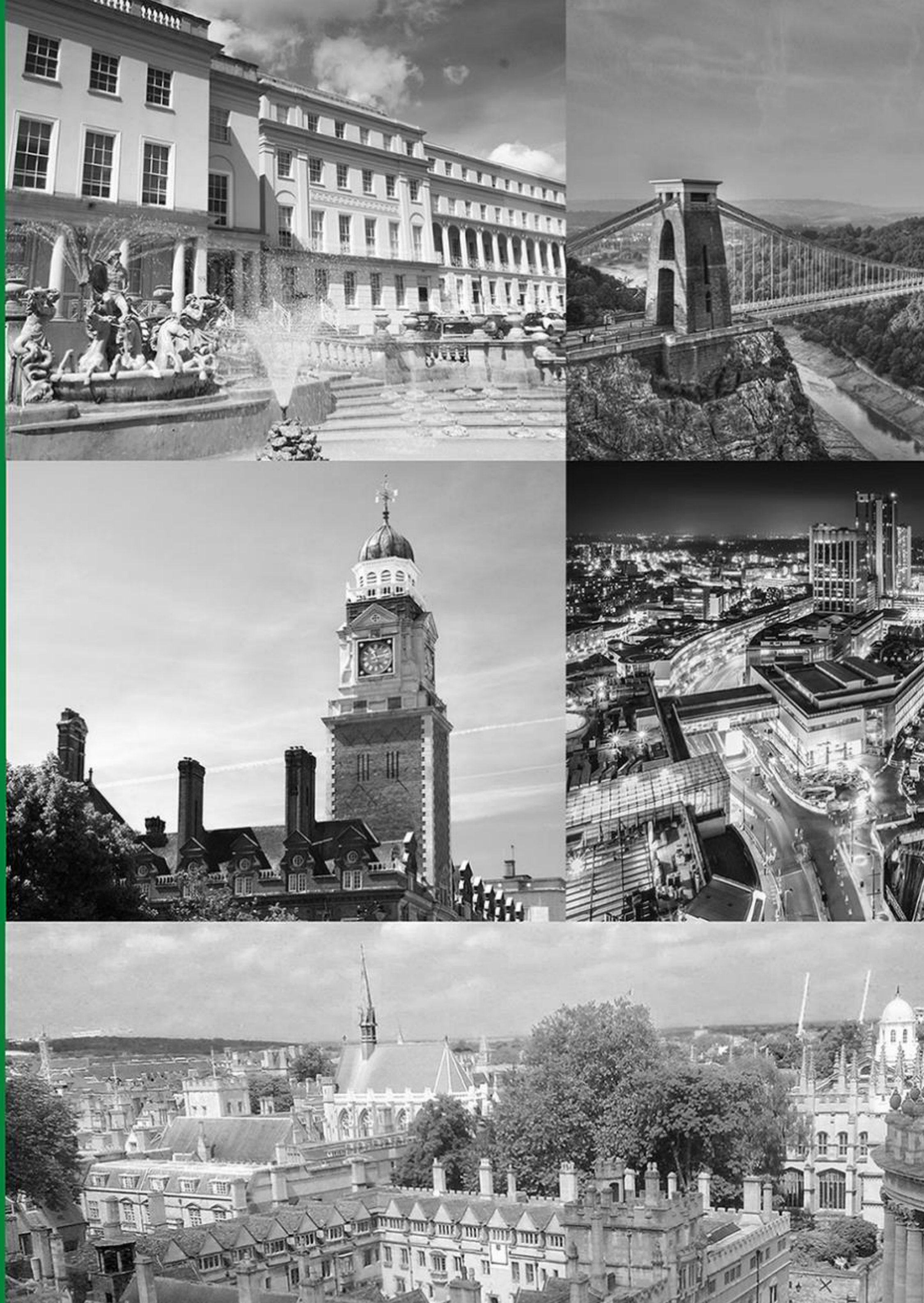
RIDGE

WIGAN GALLERIES ENERGY STATEMENT FOR PLANNING APPLICATION
CITYHEART / BCEGI
VERSION 4
15/06/2021



CONTENTS

1. INTRODUCTION

This report sets out the proposed Energy Strategy for the Wigan Galleries Redevelopment as part of the overall planning application.

The report explains the evaluation of the technical and feasibility of using Passive Energy Efficiency, Energy Efficiency measures and low and zero carbon technologies for the re-development in accordance with the Wigan Council Policy, planning requirements, along with regional and national policy:

- Wigan Council - Wigan Local Plan Core Strategy September 2013
- Wigan Local Development Framework Core Strategy Final Topic Paper 1 – Energy

The report explains our strategic approach to low energy sustainable design and how the teams have optimised the passive measures of design and complemented energy efficient and low carbon technologies. Furthermore, the report concludes the results of Energy Modelling for the detailed element of the planning application and predicted carbon savings.

2. DESCRIPTION OF DEVELOPMENT

<u>Description of Development</u>

1. *Full planning application for the demolition of the existing Wigan Market and The Galleries Shopping Centre buildings and structures and the erection of four residential blocks (F, G, H and J) totalling circa 218 units (Use Class C3); two commercial units (Use Class E); a 4/6 storey Hotel (Use Class C1); a Pavilion to include a food and beverage establishment and events space (Use Class Sui Generis); and a new Market Hall with market stalls, food and beverage stalls, coworking space and ancillary facilities within the existing Marketgate Shopping Centre site (Use Class E) together with associated highways works, works to basement, car parking, outdoor events space, public realm and ancillary works.*

2. *Outline planning application for the erection of four plots (Plot 1: Multi-Media Centre, Plot 2: Blocks A, B and C, Plot 3: Block E and Plot 4: Block D) of up to 8 storeys to include a maximum of 265 residential units (Use Class C3); 1,000sqm maximum commercial floorspace (Use Class E) and a Multi-Media Centre including a multiscreen cinema, multi-purpose event space, bowling alley, indoor mini golf, food and beverage units up to a maximum 9,250sqm (Use Class E / Sui Generis) with associated access, parking, servicing and public realm, all matters apart from access reserved.*

<u>Quantum of Development</u>

- ***Four Residential Blocks*** *(F, G, H and J) ranging from 4 to 9 storeys totalling 218 units –*
    - *Block F: 8/9 storeys - 81 units – Open Market Rent*
    - *Block G: 6/7 storeys - 48 units – Affordable Rent*
    - *Block H: 6/8 storeys - 59 units – Open Market Rent*
    - *Block J: 4/6 storeys - 30 units – Rent to Buy/Shared Ownership*
- *a **commercial unit** on the ground floor of Block J (circa 500sqm GEA)*
- *a **commercial unit** on the ground floor of Block H (circa 300sqm GEA)*
- *a **Hotel** – 4-6 storey's (circa 5857sqm GEA) – 140-150 rooms;*
- *a **Pavilion** (circa 2,413sqm GEA) - which will provide an opportunity for food and drink establishments and day to evening entertainment and co-working; and*
- *a **Market Hall** (circa 11,842sqm GEA) - sui generis in use - which will provide traditional market stalls, retail units, co-working spaces and small offices, contemporary food hall and flexible internal public space.*

<u>Outline application</u>

- *A **Multimedia Centre** (Plot 1), including a multiscreen cinema, multi-purpose event space, bowling alley, indoor mini golf, food and beverage units (up to a maximum 9,250sqm GEA)*
- ***Four residential blocks*** *(Plot 2: Blocks A, B and C, Plot 3: Block E and Plot 4: Block D) of up to 8 storeys, to include a maximum of 265 residential units; and*
- *Up to 1,000sqm maximum **commercial floorspace** (Use Class E).*

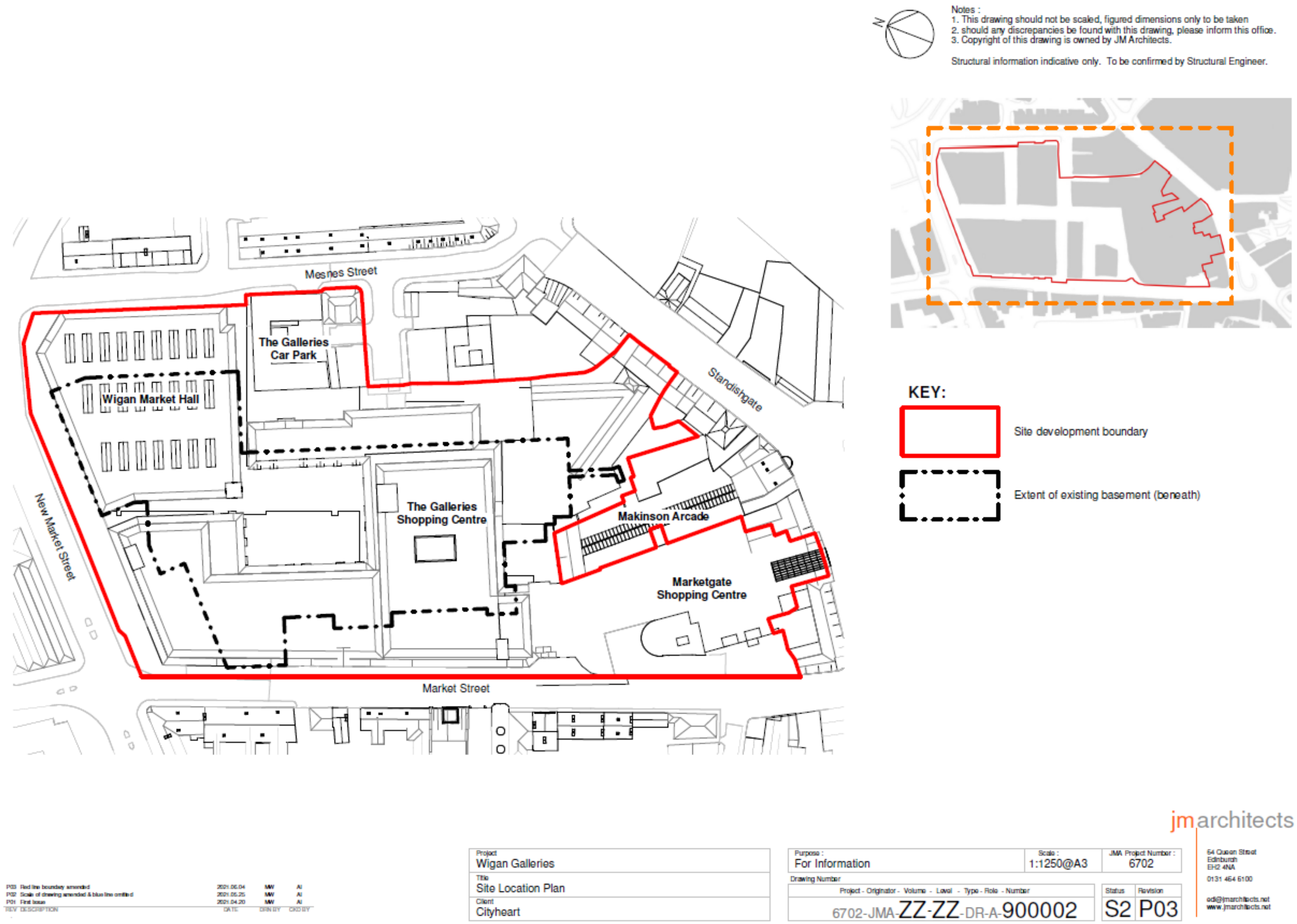


Figure 1 Site location plan

3. DESIGN APPROACH

As part of the technical appraisal, it is key that energy modelling and technical reviews are carried out at the earliest possible stage to ensure a 'holistic' and 'best value' approach' to energy use is adopted where the whole building is optimised, including the building envelope and orientation. Also, the earlier in the design process that the potential carbon savings are analysed and implemented, the more cost effective and dramatic they can be as shown in the graph below.

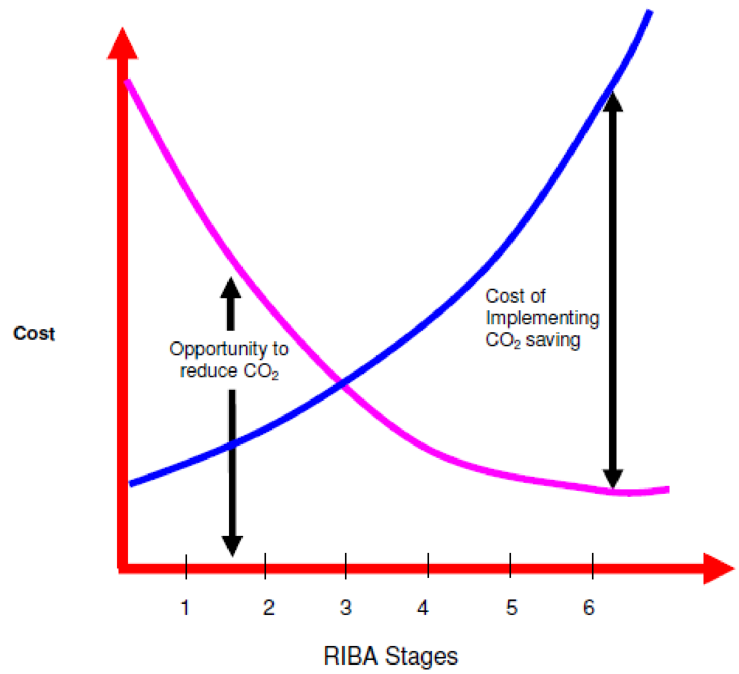


Figure 2 Opportunities to Reduce CO2 Emissions During Design

A fundamental aspect of our design process has been to follow a strategic approach to steer the design to integrate sustainable low energy and carbon reduction strategies. The following chart explains this strategic route:

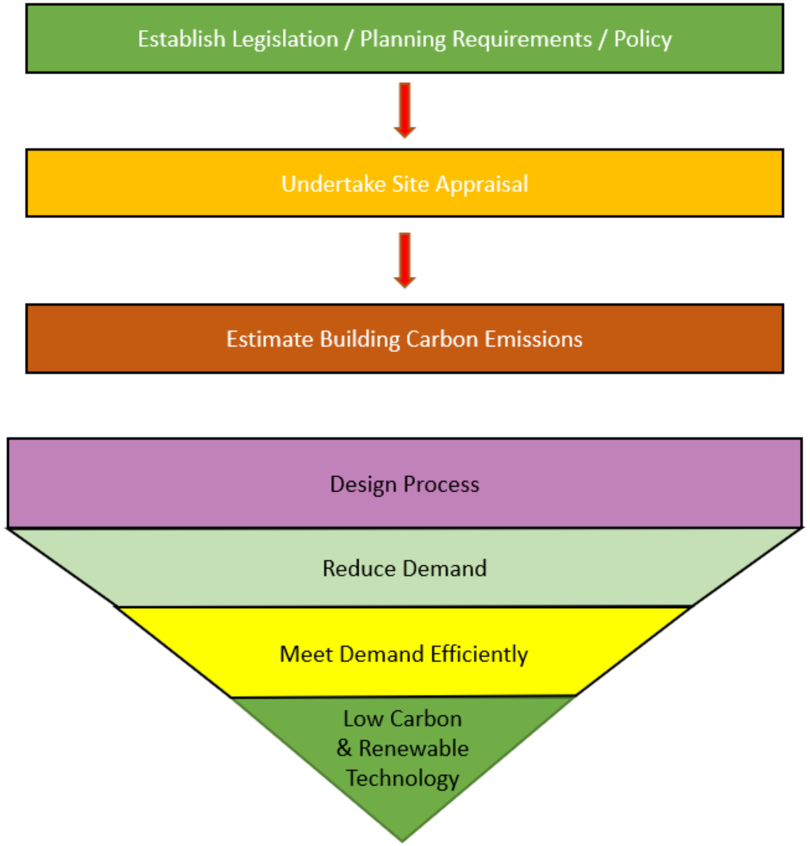


Figure 3 Strategic Energy Hierarchy Approach

Following this approach has ensured that key design solutions have been incorporated at the appropriate time in the design process and that our approach offers best value. A further key aspect is the balance of Capex and Opex and how the investment in technology will offer future income for the Council and their partners.

First policy is reviewed, then the site is analysed, then the opportunities and restrictions of the site are explored, then the design is reviewed against the energy hierarchy, results of the energy modelling are discussed and then a selected energy strategy is presented.

4. LEGISLATION, PLANNING AND POLICY

The following section sets out the relevant energy, sustainability and renewables policies that are applicable to the development, looking at a local level, a regional level and a national level. First local policy for the Borough of Wigan is reviewed, then Regional Policy for Manchester and finally, National Policy.

4.1. Local Policy

Wigan Council declared a climate emergency on the 18th July 2018 and is aiming to be carbon neutral by 2038.

Wigan Local Development Framework Core Strategy Sustainability Appraisal Final Topic Paper 1 - Energy

Wigan Council have issued a suite of documents called the Wigan Local Development Framework Core Strategy that includes Final Topic Paper 11 which reviews the current status (2011) of the Borough's energy use. The document reviews key plans, policies and strategies, both national and regional, in relation to Wigan and give the following key messages:

- Follow the principles of the energy hierarchy, which means reducing the need to use energy as a priority; being more efficient; generating energy from cleaner sources; and reducing the environmental impact of fossil fuel combustion as a 'last resort'.
- Support a switch to low carbon technologies for power, heat and transport, in line with:
- UK Target - 80% reduction in carbon emissions by 2050 as stated in policy (p.39) but now superseded by government to 100% on June 2019.
- Encourage decentralised energy generation and supply using low carbon technologies such as biomass, combined heat and power and renewable technologies. Encourage or require near and on-site generation of energy from renewable and low carbon sources.
- Maintain the reliability of energy supplies, ensuring that we are not dependent on any one supplier, country or technology. Promote competitive markets in the UK and beyond, helping to raise the rate of sustainable economic growth and improve our productivity.
- Ensure that every home is adequately and affordably heated.
- The market for renewable energy technologies and investments will grow. We need to maximise the benefits for local businesses and jobs.
- Develop a suite of decentralised renewable and low carbon energy policies. Set evidence based renewable / low carbon energy targets for the local authority as a whole. Where particular local opportunities exist higher site or area specific targets should be set. Explore policies that require new developments to connect to existing decentralised energy networks.
- There are opportunities to increase Wigan's generation of energy from low carbon and renewable sources.

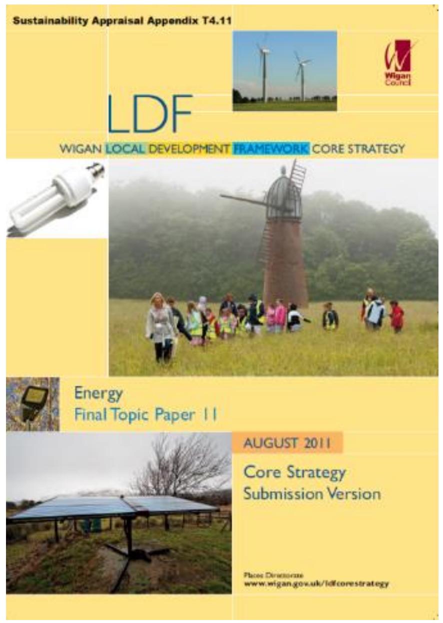


Figure 4 Wigan Local Development Framework

The Core Strategy also give the below sustainability objective:

Sustainability Objective(s)	Appraisal criteria / sub-questions
Objective 15. To ensure the borough has a secure supply of energy that meets current and future needs and minimises our contribution to climate change.	Will it minimise the requirement for energy use and improve energy efficiency in new and existing buildings and infrastructure as a priority?
	Will it lead to an increased proportion of energy generated from decentralised and renewable / low-carbon sources?
	Will it lead to a higher proportion of buildings with sustainable design features (energy efficient, water saving, good access, etc) and using sustainable materials with lower embodied energy.

Wigan Local Plan – Core Strategy – Development Plan Document 2013
This Core Strategy document looks forward to 2026 and gives key issues that need to be addressed and strategic objectives for achieving Wigan's vision. It looks at the regeneration of Wigan's communities and addresses the social, environmental and economic challenges the borough faces. It links to and supports Wigan's transport strategy, economic framework, housing strategy and corporate strategy amongst others.

The following objectives in the Core Strategy relate to energy use:

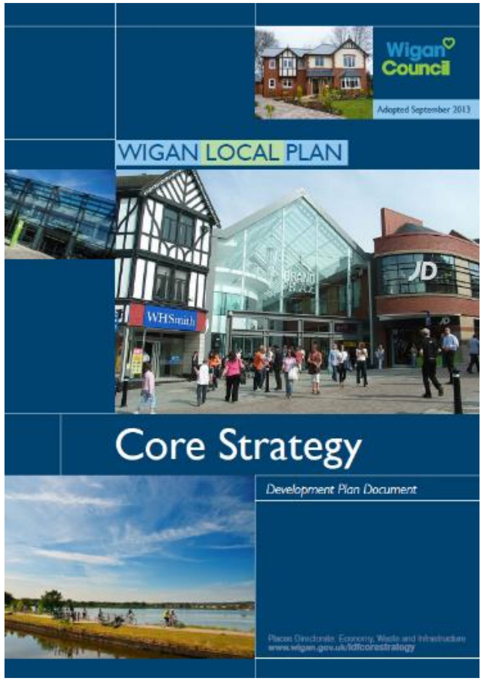


Figure 5 Wigan Local Plan Core Strategy

Objective E 1

To strengthen our energy infrastructure and minimise emissions of greenhouse gases.

Objective CC 1

To help mitigate the borough's greenhouse gas emissions and adapt to the impacts of climate change.

The Core Strategy then gives several spatial policies and core policies, with Policy CO10, CP13 and CP17 relevant to energy use as below:

Policy CP 10

Design

We will improve the built environment of the borough and help make it a better place to live, visit and for businesses to locate and thrive by ensuring that, as appropriate, new development:

1. Respects and acknowledges the character and identity of the borough and its locality, in terms of the materials, siting, size, scale and details used.
2. Is integrated effectively with its surroundings and helps to create attractive places.
3. Meets established standards for design.
4. Includes measures to minimise the impact of and adapt to climate change and conserve natural resources and meets established national standards for sustainability and national carbon reduction targets.
5. Is accessible for all in terms of movements to, through and within it, providing recognisable routes, junctions and focal points and a clear definition between public and private space.
6. Incorporates high quality landscaping.
7. Is designed and uses materials that facilitate easy maintenance.
8. Is designed to reduce the risk of crime and anti-social behaviour.
9. Can be well serviced, including making provision for waste storage and collection.
10. Incorporates, or makes provision for, public art.

Policy CP 13

Low-carbon development

We will reduce the emissions of carbon dioxide arising from new development and help reduce the impacts of climate change on our environment, economy and quality of life by:

1. Encouraging all development, where relevant, to conform to the energy hierarchy by:
    1. minimising the demand for energy, before
    2. maximising the efficiency of energy use, before
    3. implementing low-carbon dioxide and renewable energy technologies.
2. Encouraging those proposing residential development of 10 units or more and/or non-residential development of more than 700 square metres to produce and submit a carbon reduction strategy setting out how the development will incorporate or make provision for, subject to viability, decentralised, renewable or low carbon energy sources to reduce the carbon dioxide emissions of energy use by at least 15%.
3. Encouraging new development to be designed, orientated and constructed so that it can maximise energy efficiency, reduce reliance on fossil fuel energy and take advantage of opportunities for renewable or low carbon dioxide technologies.
4. Encouraging reasonable improvements to be made to the energy performance of the existing building when an extension or other change to a building is proposed.

Policy CP 17

Environmental protection

We will help maintain, enhance and protect our environment for the benefit of people and wildlife, and make the borough a better place for people to live and businesses to locate and thrive, by:

1. Protecting our 'best and most versatile' agricultural land from irreversible loss in accordance with national planning policy and where appropriate seeking to retain and re-use soils on major development sites.
2. Actively seeking the reclamation and re-use of derelict and other previously-developed sites to bring land back into positive use.
3. Tackling land contamination and land stability issues, primarily on sites affected by past industrial uses and coal mining activities, by promoting the appropriate re-use of sites, supporting the identification of contamination and stability issues and requiring appropriate remediation.
4. Managing air quality, particularly in our Air Quality Management Areas, including by minimising the air pollution (and carbon dioxide emissions) likely to arise from new development.
5. Ensuring that new development does not give rise to the pollution of any watercourse, groundwater or mossland or result in the transfer of contaminated run-off to surface water sewers.

4.2. Regional Policy

5-Year Environment Plan for Greater Manchester 2019-2024

This document sets out steps required in the next 5-years to keep on track to meet the target of being carbon neutral by 2038. It focuses on a number of key areas and gives priorities to address, such as travel and transport, natural environment and resilience to climate change including those shown below which are relevant to the Wigan Galleries redevelopment Energy Strategy.

Our energy supply – the source of the power and heat to our buildings and transport.

Increasing local renewable electricity generation	Decarbonising how we heat our buildings
Increasing the diversity and flexibility of our supply	

Our homes, workplaces and public buildings – the demand for energy to heat the places we live and work.

Reducing the heat demand from existing homes	Reducing the heat demand from existing commercial and public buildings
Reducing the heat demand in new buildings	

The 5 Year Environment Plan then discusses in detail actions domestic and commercial energy users should take to meet the priorities identified.

Manchester Zero Carbon Framework 2020-2038

Manchester City Council has declared a climate emergency and has set out its plan for becoming a zero-carbon city by 2038 consistent with the 2°C Paris Agreement as below:

1) Carbon Reduction and Contributing to the Paris Agreement

Manchester will play its full part in limiting the impacts of climate change by adopting and meeting science-based targets, in line with the Paris Agreement.

Our current targets are based on analysis by the Tyndall Centre at the University of Manchester[1] and were adopted by Manchester City Council in November 2018:

- 15 million tonne carbon budget for 2018-2100,
- Urgent and deep carbon reduction; 50% reduction by 2022, from 2018 levels,
- Zero carbon by 2038.

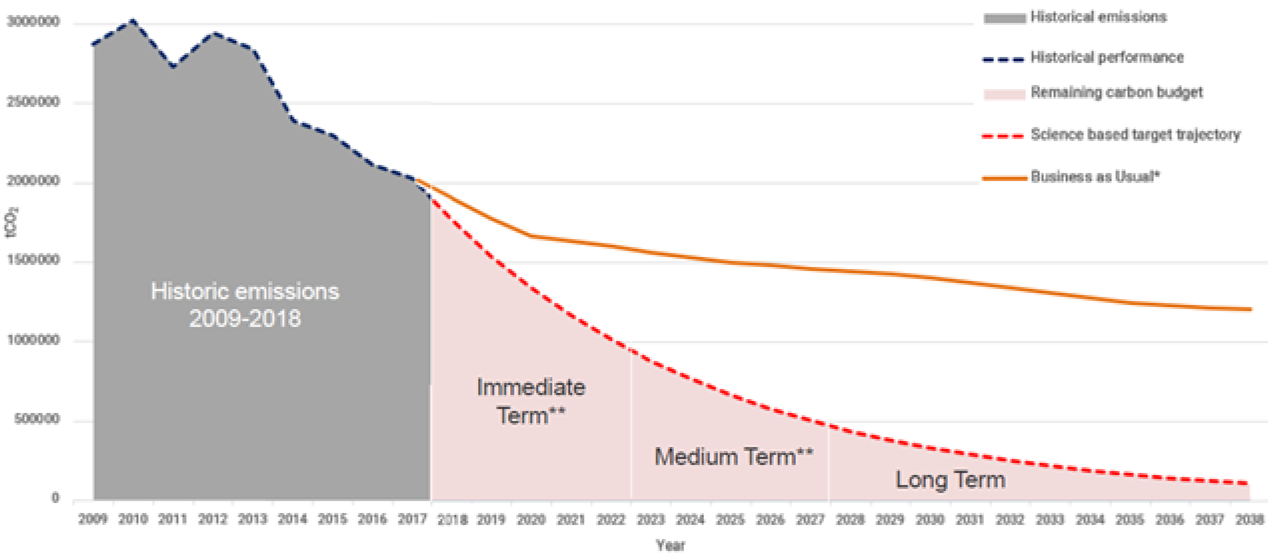


Figure 6 Manchester's Projected CO2 Emissions to 2038

4.3. National Policy

National Planning Policy Framework 2019

The National Planning Policy Framework gives the following guidance:

148. The planning system should support the transition to a low carbon future in a changing climate, taking full account of flood risk and coastal change. It should help to: shape places in ways that contribute to radical reductions in greenhouse gas emissions, minimise vulnerability and improve resilience; encourage the reuse of existing resources, including the conversion of existing buildings; and support renewable and low carbon energy and associated infrastructure.

151. To help increase the use and supply of renewable and low carbon energy and heat, plans should:

a) provide a positive strategy for energy from these sources, that maximises the potential for suitable development, while ensuring that adverse impacts are addressed satisfactorily (including cumulative landscape and visual impacts);

b) consider identifying suitable areas for renewable and low carbon energy sources, and supporting infrastructure, where this would help secure their development; and

c) identify opportunities for development to draw its energy supply from decentralised, renewable or low carbon energy supply systems and for co-locating potential heat customers and suppliers.

Climate Change Act 2008

The UK is the first country to enter binding long-term carbon budgets into legislation, first introduced as part of the 2008 Climate Change Act. Since then, 5 carbon budgets have been put into law putting the UK on track to meet their ambitious goal to eliminate our contribution to climate change by 3050 and achieve net zero emissions.

The sixth Carbon Budget will commit the UK in law to the fastest fall in greenhouse has emissions of any major economy between 1990 and 2035, making it one of the most ambitious climate targets in the world on 9 December, the Climate Change Committee (CCC) published its advice on the level at which to set Carbon

Budget 6 (CB6), covering 2033 to 2037. The CCC recommended that CB6 should be set at 965 MtCO2e, reducing emissions 78% from 1990 to 2035 (including international aviation and shipping emissions).

This is a highly ambitious target for the mid-2030s – close to the UK's previous 2050 target (an 80% reduction on 1990) just 2 years ago and consistent with the Paris Agreement temperature goal to limit global warming to well below 2 °C and pursue efforts towards 1.5°C

Building Regulations
Building Regulations Part L2A 2013 gives guidance and target CO_2 emission rates that all new buildings must meet as below:

Part L of Schedule 1: Conservation of fuel and power

Requirement	*Limits on application*
Schedule 1 – Part L Conservation of fuel and power	
L1. Reasonable provision shall be made for the conservation of fuel and power in buildings by:	
(a) limiting heat gains and losses–	
(i) through thermal elements and other parts of the building fabric; and	
(ii) from pipes, ducts and vessels used for space heating, space cooling and hot water services;	
(b) providing fixed building services which–	
(i) are energy efficient;	
(ii) have effective controls; and	
(iii) are commissioned by testing and adjusting as necessary to ensure they use no more fuel and power than is reasonable in the circumstances.	

Minimum energy performance requirements for buildings

25. Minimum energy performance requirements shall be set by the Secretary of State calculated and expressed in accordance with the methodology approved pursuant to regulation 24, for–

(a) new buildings (which shall include new dwellings), in the form of target CO_2 emission rates; and

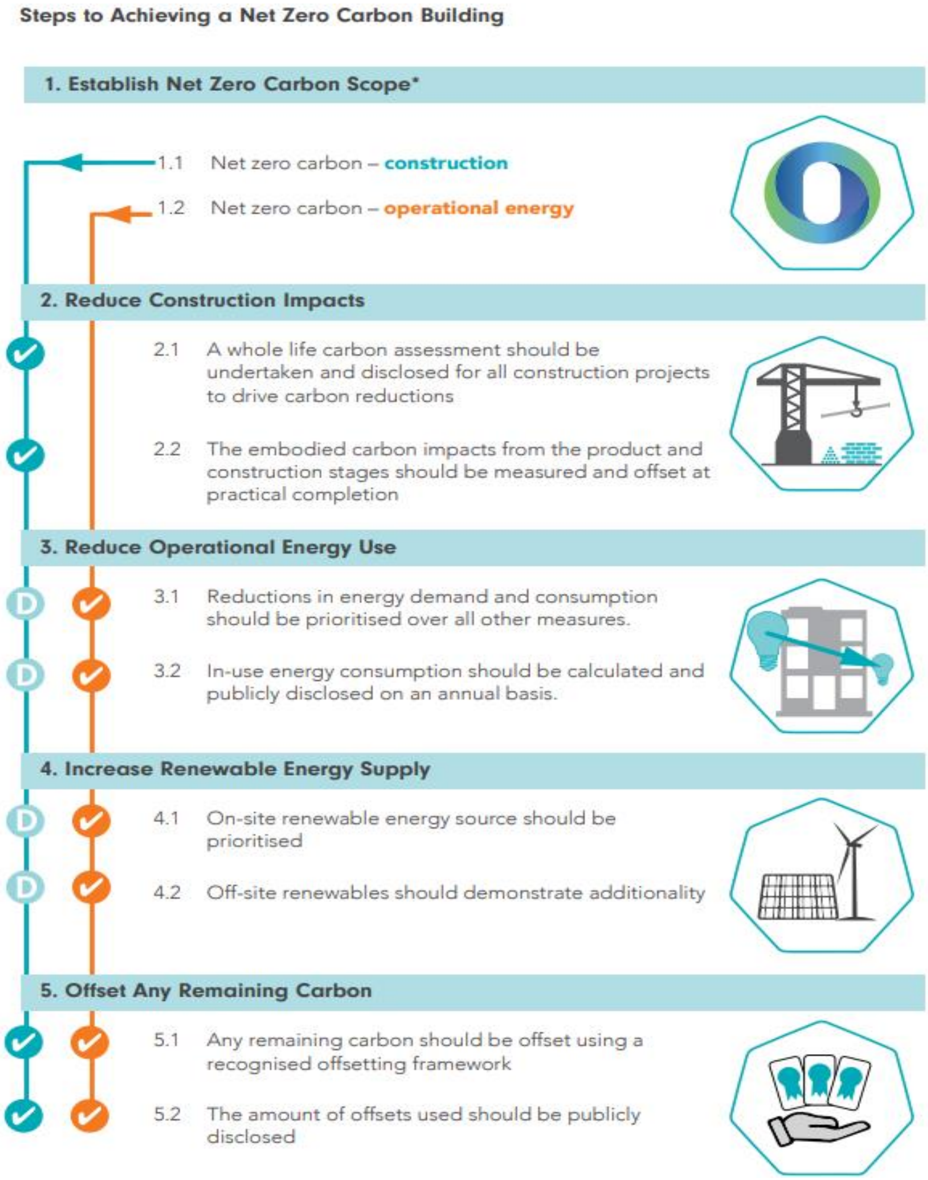
(b) new dwellings, in the form of target fabric efficiency rates.

CO_2 emission rates for new buildings

26. Where a building is erected, it shall not exceed the target CO_2 emission rate for the building that has been approved pursuant to regulation 25 applying the methodology of calculation and expression of the energy performance of buildings approved pursuant to regulation 24.

UK Green Buildings Council - Net Zero Carbon Buildings a Framework Definition

The UK GBC has set out steps to achieve net zero carbon below:



4.4. Decarbonisation of the National Grid

Decarbonisation of the national grid means reducing its carbon factor: that is, reducing the emissions of carbon per unit of electricity generated (and is a key factor in influencing the Energy Strategy). This is necessary to achieve the mandatory greenhouse gas emission targets set in the UK Climate Change Act (2008). The central target was amended in June 2019, for emissions to reach 'net zero' by 2050.

Decarbonisation is being achieved by increasing the share of low-carbon energy sources, particularly renewables, and a corresponding reduction in the use of fossil fuels. Capping greenhouse gas emissions from fossil fuel power stations by installing carbon capture and storage (CCS) technology is also expected to play an increasing role.

The gird carbon factor (GCF) of electricity has seen significant reductions in previous years and is predicted to fall further as shown in the graph below.

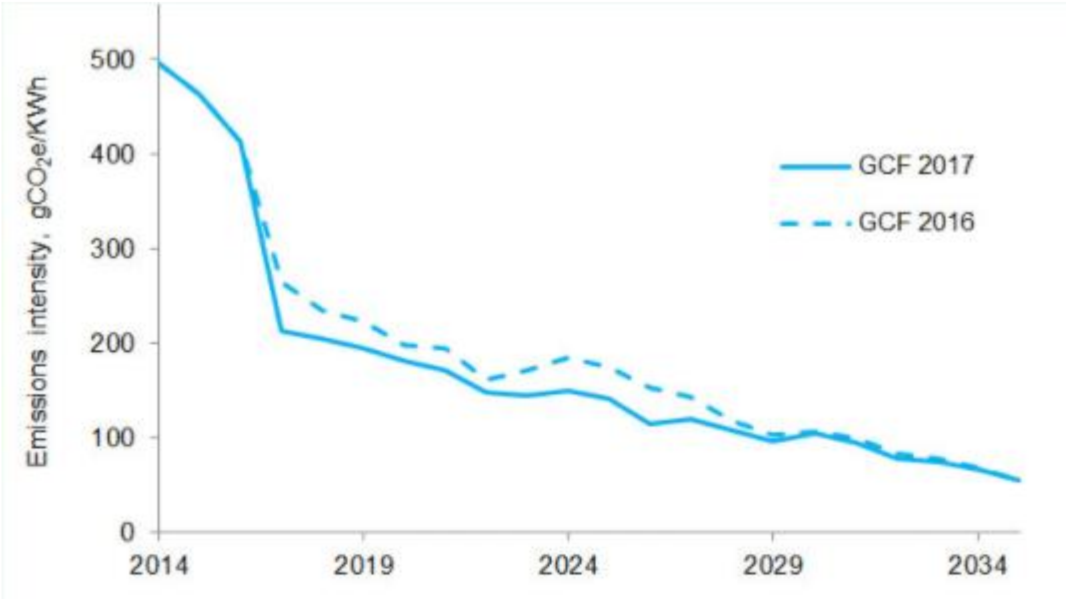


Figure 7 Predicted Reduction in Grid Carbon Factor

Decarbonising the grid would mean the carbon emissions from any systems using electricity would fall further in the future and make grid electricity supplied technology potentially more attractive and futureproof compared to fossil fuel burning technologies such as gas boilers.

The roadmap below shows the route to net zero carbon for the UK, with the electric route on the left showing the decreasing grid carbon factor to 2038 and then the use of zero carbon fuels or carbon offsetting to 2050, and on the right the route for fossil fuels to a potential hydrogen economy in 2037. If the Hydrogen fuel route is not realised, fossil fuel burning appliances will need to be replaced by 2038 for grid supplied electricity heat pumps.

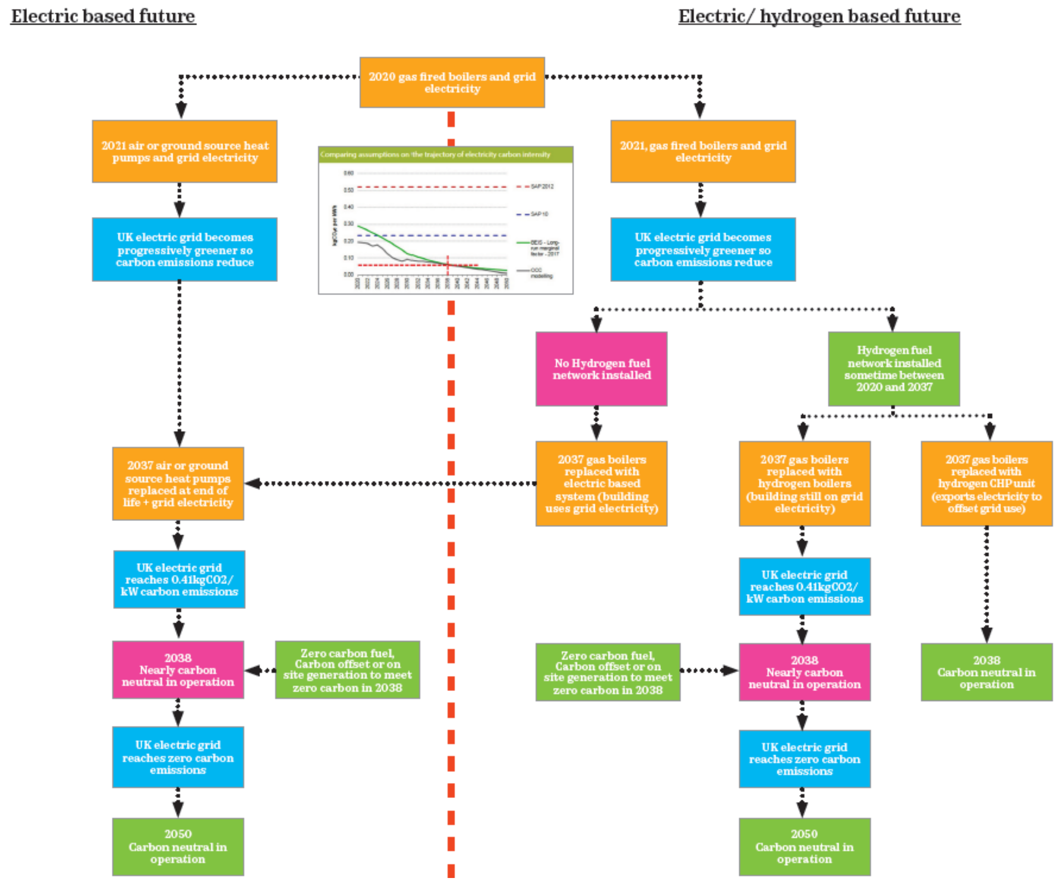


Figure 8 Roadmap to Zero Carbon 2038

4.5. Heat Network: Code of Practice for the UK

The Heat Networks Code of Practice sets out minimum requirements and best practice options through the whole life cycle of a heat network project, from the quality of feasibility studies, design, construction, commissioning and operation.

The code focuses on delivering a high-quality installation offering good reliability, a long life, low carbon intensity of heat supplies and low operating costs will be key. It also notes the cost-effectiveness of the heat supply will depend on achieving low-cost finance over a long period of time and funders will also be looking for long term performance and reliability.

The core of the Code is structured as follows:

- The typical sequence of a project by stage from initial brief and feasibility through to operation and maintenance.
- For each project stage, a number of objectives are set.
- For each objective a number of minimum requirements are defined to achieve the objectives.

The Government funded Heat Network Investment Project mandates the adoption of this code of practice for projects to be eligible.

The strategic aims of the Code are shown in the diagram below:

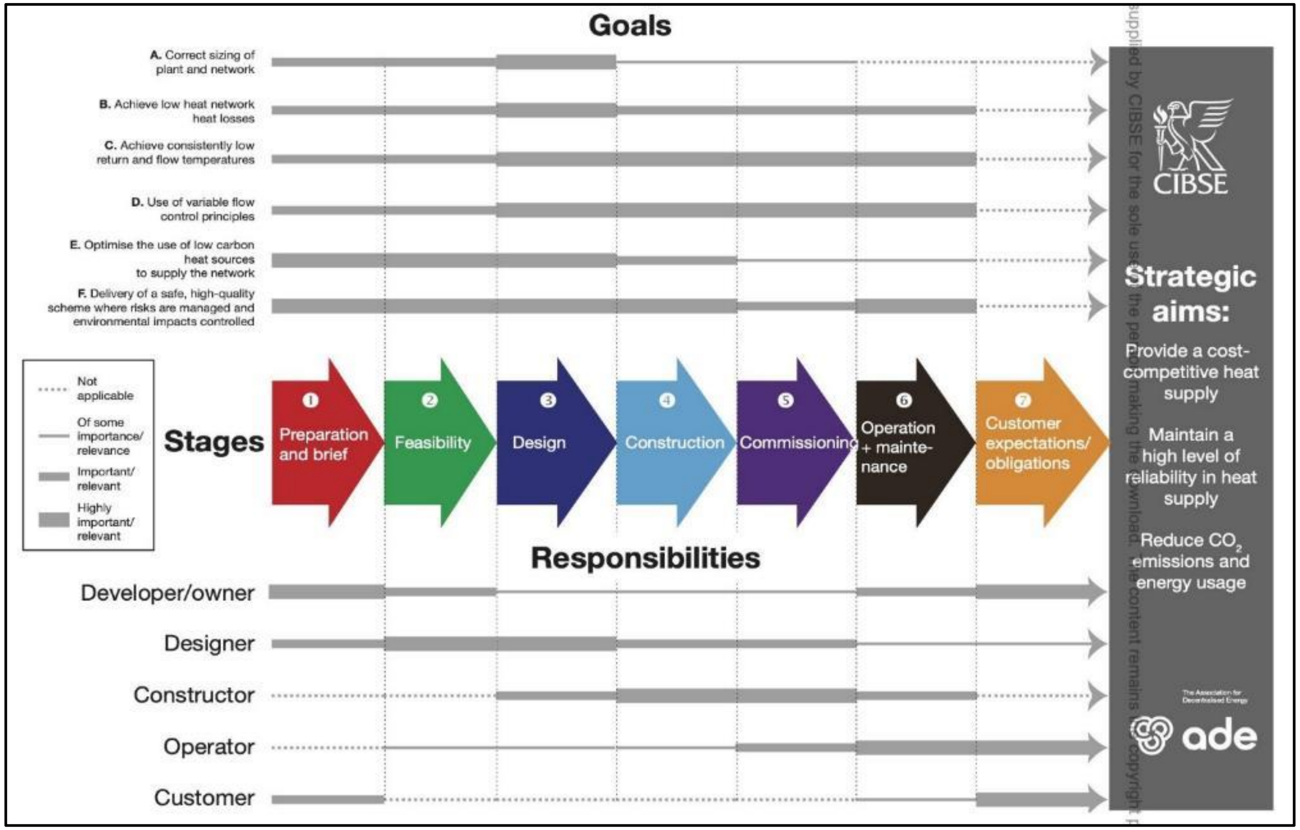


Figure 9 Heat Network Design Process

5. SITE APPRAISAL

All sites offer differing opportunities and limitations when considering the Energy Strategy.

Key Questions: -

- What opportunities are available to promote sustainable and low energy design?
- What are the restrictions and challenges of the site?
- What future opportunities should be considered?
- Are primary utilities infrastructure available to the site?

The site comprises of approximately 3.2 hectares within Wigan Town Centre. The site is bound by New Market Street to the north, Market Street to the West, Mesnes Street to the east, and a number of commercial properties along Standishgate to the south, with Makinson Arcade being included within the site boundary.

The map figure (Figure 10) and aerial photo show the red line boundary of the site.

Figure 10 Site Location Plan

Figure 11 Site Aerial Photo

There are a number of aspects of the site that need to be considered to appraise the suitability of the low and zero carbon opportunities available. The following have been reviewed:

- Mean Wind Speed
- Land Use
- Proximity to Heat Network / Feasibility of Sharing Energy
- Acoustic Environment

- Air Quality
- Natural Solar Shading
- Primary Utility Services

5.1. Mean Wind Speeds

Wind speeds on the site will determine if wind energy can be harnessed to generate power on the site. Annual mean wind speeds from the 'Department for Business Innovation and Skills' website for the site are as follows:

- 45m above ground level 6.0 m/s
- 25m above ground level 5.5 m/s
- 10m above ground level 4.7 m/s

These mean wind speeds do not take account of topography on a small scale or local surface roughness, they are calculated for each 1km grid across the UK.

On the whole wind turbines require 'mean' wind speed air velocities in excess of 4-5m/s and as some of the Residential blocks are over 25m then the site could adopt small scale wind turbines.

Relatively high anticipated daytime electricity demand for the hotel/retail/market buildings. Therefore, no potential issues with utilisation, i.e. availability will match demand. Capital cost has dropped significantly in recent years. Economic viability potentially affected by recent proposed changes to feed in tariff.

Figure 12 Typical Building Mounted Wind Turbine

However, the principle limitations and considerations being:-

- Local noise generated from the turbines
- Stroboscopic effect of turbines or surrounding buildings
- Increased structural requirements to house turbines
- Maintenance requirements
- Visual Impact

For the items listed above wind turbines will not be specifically pursued as a principle design option at the next stage.

5.2. Land Use

The principal reason for determining the extent of available land is to establish the possibility of utilising technologies such as ground source heat pumps (GSHP). These technologies utilise the ground to operate efficient heat pumps to generate low grade heat but require a significant area to install below ground pipes in either horizontal or vertical systems. The following can be used for ground source:

- Energy Piles
- Ground Arrays
- Bore Holes
- Aquifers

The site covers a large area with an existing below ground car park which will be retained. The structure of the Market Hall will also be retained, meaning this area of the site will not be available for ground source heat pumps.

The proposed buildings will be piled meaning there are opportunities to install energy piles to utilise the ground to extract energy for ground source heat pumps. The existing below ground car park that is being retained presents an opportunity to install ground source collectors below to extract energy from the ground. There is also scope for closed loop bore holes to be drilled on the site and to tap into aquifers on the site to extract energy.

For the reasons above ground source heat pumps are seen as a viable technology for this development and will be pursued as a design option.

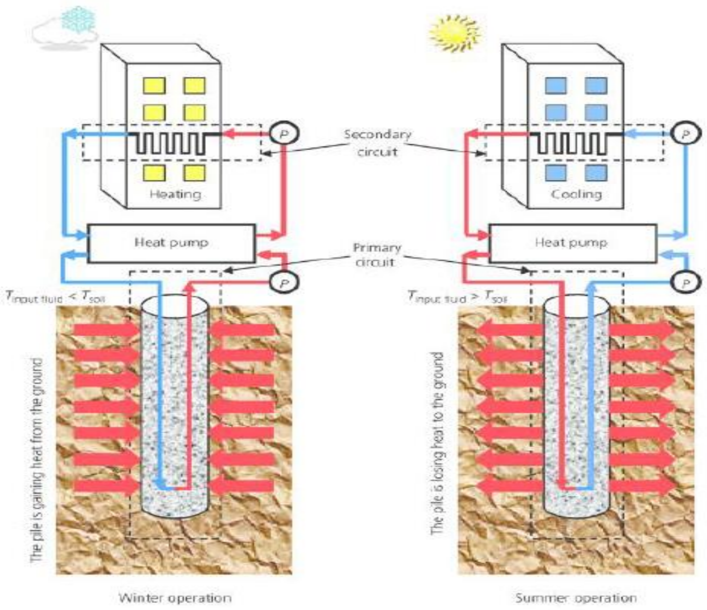


Figure 13 Ground Source Heat Pump in Summer and Winter

5.3. Proximity to Heat Network / Energy Sharing

The reason for determining if there are local heat networks or energy sharing networks allow is to establish if efficiently generated heat is locally available or if waste heat and cooling can be shared by buildings in the locality. If these networks are available they can provide a low cost, low carbon solution to heat and cool the buildings.

There is also potential for a wider energy sharing network to be implemented off the site allowing a wider sharing of energy to neighbouring buildings in Wigan Town centre. There is an Olympic sized swimming pool at the Wigan Life Centre around 200m from the site, Wigan College sits on the other side of New Market street and there is existing retail all around the site, which could use be linked to the new development for energy sharing.

Waste heat and cooling energy could be exchanged with all these buildings to enable an energy efficient heat network to be established.

Waste heat from cooling of the cinema, hotel and pavilion could be used to heat the Life Centre pool and also waste heat from the pool could be used for space heating and domestic water heating in the Galleries.

There can be a high cost of extending distribution mains and establishing energy sharing networks between sites but the payback in effectively free energy for buildings can outweigh this.

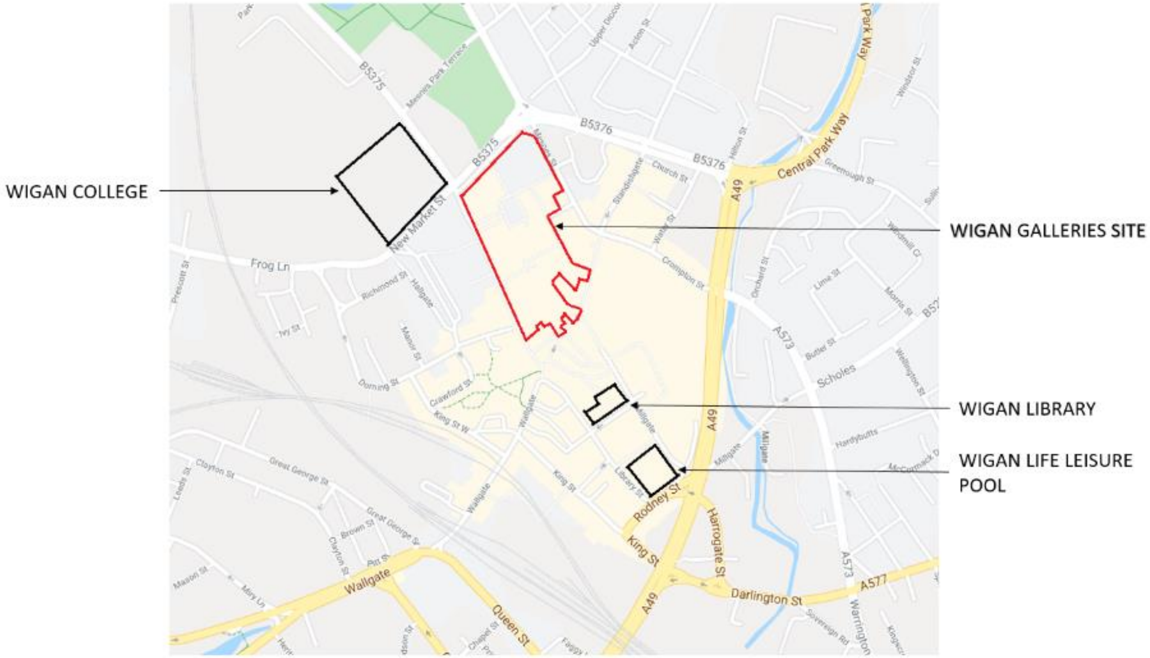


Figure 14 Proximity of Other Buildings to Galleries Site

5.4. Future 3rd Party Heat Generating Plant

Wigan Low Carbon Energy Park

There are plans of a low carbon energy park that currently has planning permission. The site is located on land off Green Street, WN3 4DQ, close to Wigan Town Centre, being a former gas holding site. In summary the details are as follows:

- The Wigan Energy Park site is a former gas holder site with remediation plans in place to be carried out by National Grid.
- The site is approximately 8,622m^2 with the site boundary highlighted in yellow on the picture below.

- DNO engagement has highlighted potential capacities of 30MW on the 33kV and 10MW on the 11kv network. 20 MW gas peaking plans.
- Wigan Energy Park is approximately 1 kilometre from the Wigan Galleries development, giving potential for a sleeved supply from the Energy Park to the Galleries development.
- The site is bordered by mixed retail and commercial on the West boundary, by a train line to the East and the Liverpool-Leeds Canal to the South.

Figure 15 Wigan Energy Park Site

Potential Technology Appraisal (Extract from Technology Provider)

Technology Type	Relevant to Site	Funding Potential
Solar PV	We have identified potential for solar PV on the site following remediation of the land. Initial concept designs have highlighted potential system sizing of 700kWp to 1MWp. Generation from the Wigan Energy Park could potentially be sleeved from the Green Street site to the Galleries development	There is definite funding potential for solar on the site on the basis of entering power purchase agreements (PPA's).
Battery Storage	Battery storage is applicable to the site, with potential to deploy between 1MW and 10MW. Battery solutions will provide additional flexibility to the Galleries scheme and will aid modulation and distribution of power around the site.	Commercial battery storage is a key target market for corporate funders in the current market.
Heat Pumps	Due to the close proximity of the Liverpool-Leeds Canal on the Southern boundary of the site, there is considerable opportunity for water source heat pumps, were additional heat load be needed	Heat pumps have funding potential on a PPA rate.

	for the Galleries development. In addition to water source, the site is applicable to ground source heat pumps to be deployed.	
Fuel Cells	Fuel cells may provide future-proofed option for heat or electricity on the Energy Park as gas driven fuel cells can be converted hydrogen when the supply chain is available.	There is considerable potential for PPA funding for fuel cells.
Co-located Technologies	Co-located technologies such as solar PV and battery storage can provide added flexibility for the Galleries development if required, allowing mitigation of expensive peak power times and emergency supply.	Similar to stand-alone solar and batteries, there is appetite for funders to deploy capital for co-located solutions, on the basis of PPA agreements.

There are two opportunities that exist with this site:

- Connect to waste heat from the plant to utilities at the Galleries site
- Connect into a “private wires**”** to the site for off peak electricity.

The challenge with both of these options is the distance of the site, 1 kilometre from the Galleries site and the initial capital cost of installing this infrastructure. The technology provider is unable to disclose at this stage the carbon intensity and cost of heat & electricity and hence a financial appraisal cannot be undertaken for the suitability of connecting the low carbon park to the Galleries site.

Not withstanding this, the park does potentially offer an attractive proposition in terms of supplying low carbon and cost heat & electricity and will be investigated further once more details are available from the technology provider.

5.5. Acoustic Environment

The acoustic environment is assessed to understand any limitations that exist on the site that will affect the use of natural ventilation via opening windows in the buildings, especially the residential blocks.

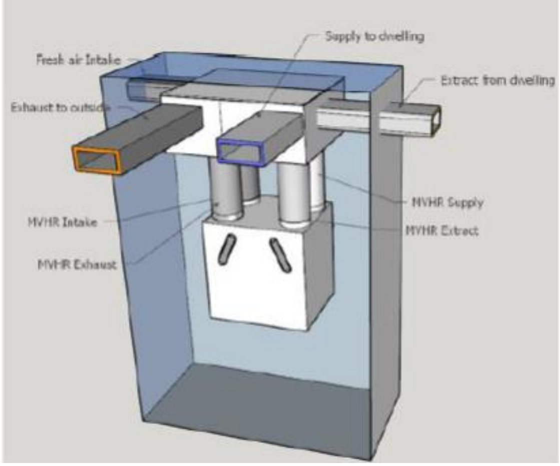


Figure 16 Residential Mechanical Ventilation and Heat Recovery Unit

The site is in the centre of Wigan bounded by roads on all sides which will be sources of noise. The residential blocks face directly on to Market Street, New Market Street and Mesnes Street with New Market Street being the busiest of these.

An acoustic survey and report by Hoare Lea has determined that the site is not wholly suitable for natural ventilation.

Opening windows on a frequent basis will cause excessive noise ingress into the apartments, so the conclusion of the report has determined that a mechanical ventilation with heat recovery solution will be most appropriate with the potential for a hybrid solution. This would use opening windows in tandem with mechanical ventilation to boost ventilation in the summer to prevent overheating.

The mechanical ventilation systems for the commercial buildings will incorporate the necessary attenuation to meet the acoustic criteria which will be critical in some space, such as the cinema screens.

5.6. Air Quality

The air quality on the site is assessed to understand the limitations that areas of poor air quality that will preclude the use of natural ventilation or impose a requirement for filtration in the air handling units.

The site is in the centre of Wigan bounded by roads on all sides which will be sources of pollution. New Market Street is especially busy and is an Air Quality Management Area, as shown on the map below. This means level of pollutants above a certain level have been recorded there.

Air filtration will be provided to an appropriate standards where dictated by the Air Quality report.

5.7. Use of Solar/Passive Design

It is important to ascertain the shading and solar characteristics of the site to enable the analysis of the suitability of passive solar heating, daylighting, photovoltaic panels and solar water heating on the site. These factors can allow low energy solutions and contribute to well being of occupants in the residential areas.

The existing buildings surrounding the Galleries site are relatively low rise, in the region of 4 stories (13m), with the Market Clock tower at the centre being 28m, although this will be demolished. This means there is little shading across the site and gives opportunities for roof mounted photovoltaic panels and solar water heating panels.

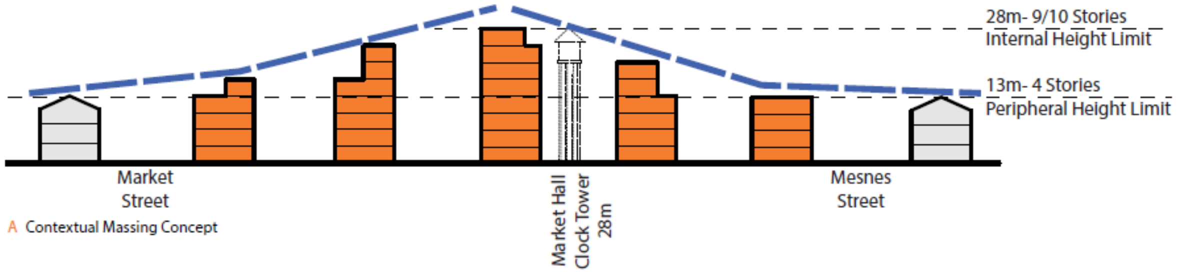


Figure 17 Existing Galleries Site Building Height

As there is little solar shading there are also opportunities to examine the orientation of the buildings on the site and the size of windows to use heat from solar gains to provide passive heating in winter and natural light to reduce artificial lighting.

There are a number of documents and standards which give guidance on daylighting and solar gains including the BRE Site Layout Planning for Daylight and Sunlight.

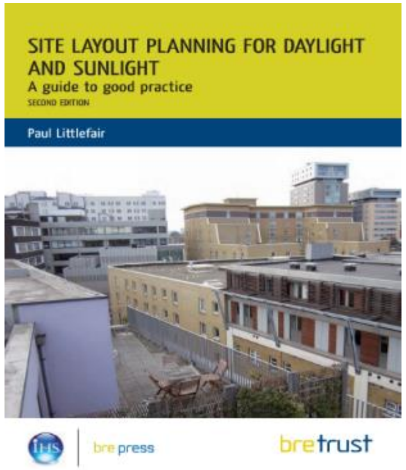


Figure 18 BRE Guidance

5.8. Passive Heating

As the path and angle of the sun changes throughout the year windows can be designed so when heating is required in winter, low angle sun can be allowed into spaces to heat them and to provide useful daylight. These solar gains in winter can contribute to the heating load of a space by providing 'free' thermal energy which reduces the energy use of a space.

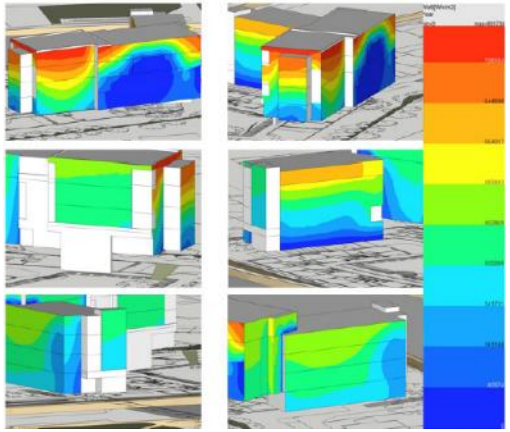


Figure 19 Solar Gains Analysis

To make the most of solar gain the solar collecting façade should face within 30° of due south. Orientations further east or west than this will receive less solar gain, particularly in winter when it is of most use.

Modest levels of passive solar heating, also called sun-tempering, can reduce building auxiliary heating requirements from 5% to 25% at little or no incremental first cost. More aggressive passive solar heated buildings can reduce heating energy use by 25% to 75% compared to a typical structure while remaining cost-effective on a life-cycle basis.

Overheating avoidance of cooling

To prevent solar gains causing overheating in summer or unwanted glare, solar shading and brise soleil can be designed to shade windows from the sun when it is at a higher angle. Large unshaded openings on south facing facades should be avoided as these will cause overheating and increase cooling loads.

<u>Morning Sun from the East</u>

During winter mornings low angle sun from the east can provide useful heating to rooms. A number of the residential blocks will have windows that can take advantage of this heat.

<u>Midday Sun from the South</u>

At midday the sun is as it's most intense and careful analysis of heat gains need to be carried out to prevent overheating which introduces a need for cooling. The design of window shades and brise soleil reduces solar gain when the sun gets above a certain height in the sky and can be used to block the sun when it becomes too intense in the summer months and passive heating is not required.

<u>Evening Sun from the West</u>

During the afternoon and evening sun from the west can provide passive solar gains, however most occupied spaces will be up to temperature by this time. Careful consideration needs to be given to these gains to ensure they do not cause overheating.

5.9. Natural Lighting

Assessment of natural lighting is important, especially in the residential blocks to help the occupant's wellbeing by giving them a view out, a connection to the outside and natural light.

As the path and angle of the sun changes throughout the year windows can be designed so low angle winter sun can be allowed into spaces to provide useful daylight. During the summer building facades can be designed to reflect light into rooms to provide daylighting. This indirect light reduces glare over direct sunlight and means artificial lighting demands are reduced. Careful consideration must be given to shading to ensure it does not cause excessive glare and still allows occupants a view out of the windows.

The design of the interior environment is also important for daylighting and the size, position of windows, the depth of rooms and the colours of internal surfaces all have an impact on effectiveness.

On the site there are opportunities to utilise natural daylight in the commercial buildings in open plan spaces such as the Market and Pavilion. North facing windows in the Market could provide valuable daylight to reduce the need for artificial lighting which coupled with the proposed indoor gardens will give the building a natural feel.

Natural daylight will not be suitable for the Multimedia Building due to the nature of the spaces, such as the cinema screens.

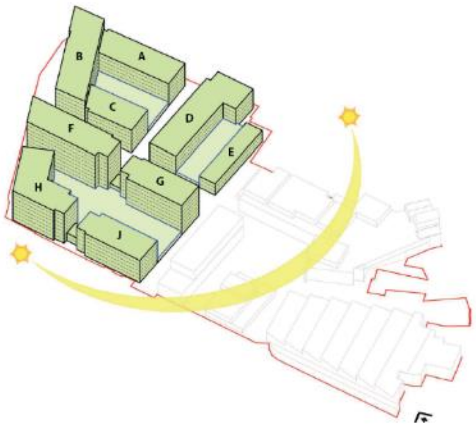


Figure 20 Sun Path Around Residential Building

As there is little solar shading of this development solar technologies, daylighting and passive solar gains will be pursued as a design option.

5.10. Primary Utility Services

Utility searches have been undertaken which show there are extensive electricity, gas and water utility services running around the site.

There are a number of substations on the existing site serving the existing buildings on the site and other buildings which are not on the site. These existing substations will be removed, consolidated and relocated and new substations provided to serve the new development.

There are water and gas networks serving the site currently and major infrastructure running on all side of the site which can be used for the new buildings if required.

5.11. Summary

The key points from this section are summarised in the table below:

Wind Power	Noise, structural requirements, maintenance and visual impact mean the site is not considered suitable for wind power
Land Use	The area of the site below the car park lends itself to utilising ground source heat pumps
Proximity to Heat Network / Energy Sharing	Ongoing
Acoustic Environment	There are A Roads around the site which will impact on the extensive use of natural ventilation in the residential blocks.
Air Quality	Part of the site is in an Air Quality Management Area which will impact the use of natural ventilation and may require filters on some mechanical ventilation units.
Use of Solar Shading / Passive Design	The buildings adjacent to the site are relatively low rise and allow the use of photovoltaic panels
Natural Lighting	The orientation of buildings on the site will allow natural lighting to be utilised especially in the residential blocks and market.
Primary Utility Services	All the primary utilities of electricity, water, gas and telecoms are readily available at the site.

6. DESIGN

Following the strategic approach of our design process and how policy has been established, the site opportunities and constraints determined, and the Energy dynamics of the individual buildings established the design can be developed. The design development follows the recognised approach of:

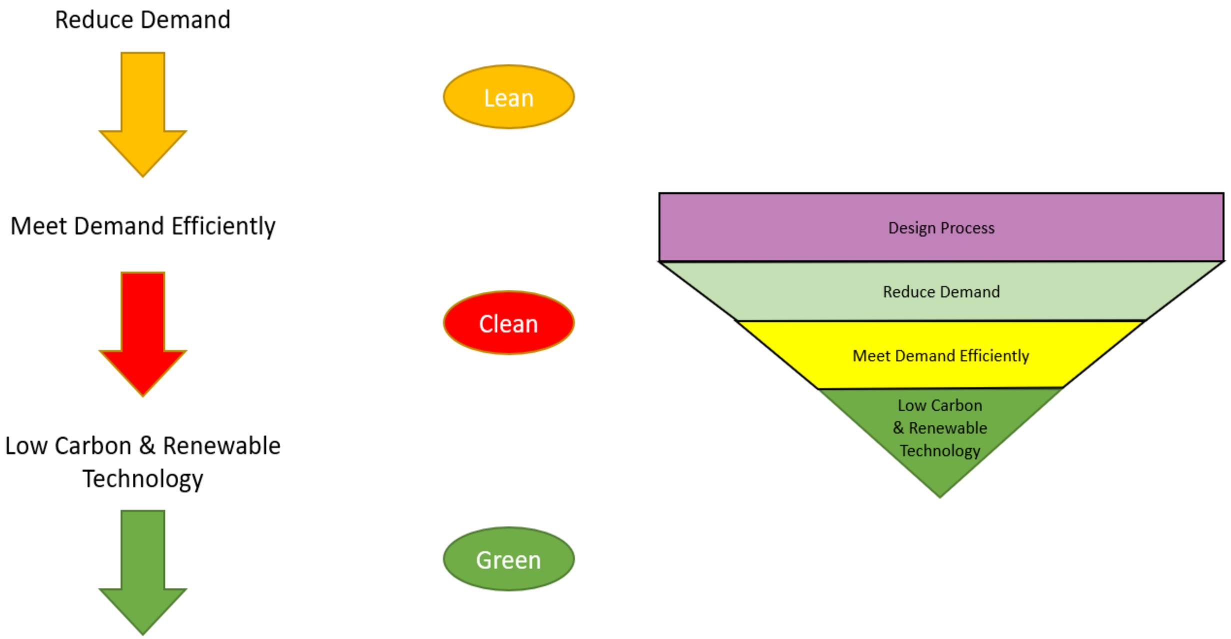


Figure 21 Strategic Approach to Energy Strategy

We have also evaluated the impact of embodied carbon on the proposed development. This looks at the carbon that is inherent in the fabric of buildings, how much carbon is generated during the manufacture of the materials, transportation of the materials and what happens to the materials at the end of their life.

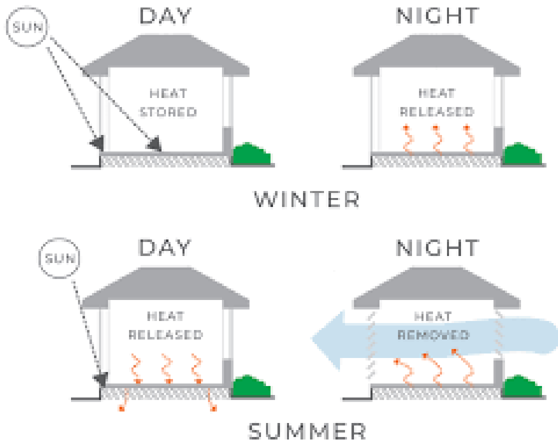
6.1. Reduce Demand – Be Lean

This section looks at the proposed measures that will ensure the initial demand for energy in the building is low from the outset using passive measures.

The following measures are to be incorporated in the design and are discussed in more detail in the table below:

- Passive Design
  - Thermal Insulation and Thermal Bridging
  - Air tightness
  - Natural Ventilation
  - Natural Daylight
  - Solar Shading
  - Thermal Mass
- Low energy fit out
- BMS Optimisation
- Energy monitoring/metering

These measures promote the reduction of Energy use and carbon emission in the first instance.



<table>
<tr><td>Thermal Insulation</td><td>The building regulations set out limiting efficiencies for thermal insulation which we intend to improve on, as shown in the table below. This will reduce the energy required to heat the spaces in the proposed new buildings.

<table>
<tr><th>Building Fabric</th><th>Minimum Standard</th><th>Targets Standard</th><th>Target Improvement %</th></tr>
<tr><td>External Wall</td><td>0.35 W/m^2.K</td><td>0.18 W/m^2.K</td><td>49%</td></tr>
<tr><td>Roof</td><td>0.25 W/m^2.K</td><td>0.15 W/m^2.K</td><td>40%</td></tr>
<tr><td>Ground Floor</td><td>0.25 W/m^2.K</td><td>0.18 W/m^2.K</td><td>40%</td></tr>
<tr><td>External Glazing</td><td>2.20 W/m^2.K</td><td>1.60 W/m^2.K</td><td>40%</td></tr>
<tr><th>Air Permeability</th><th>Minimum Standard</th><th>Targets Standard</th><th>Improvement %</th></tr>
<tr><td>Air Tightness Standard</td><td>10 m^3/h.m^2 @50Pa</td><td>3 m^3/h.m^2 @50Pa</td><td>70%</td></tr>
</table></td></tr>
<tr><td>Air Tightness</td><td>The building will target an air tightness far greater than the requirement from building regulations to reduce air infiltration and so heating and cooling energy demand.</td></tr>
<tr><td>Natural Ventilation</td><td>The buildings will use natural ventilation where possible to eliminate electrical energy use for ventilation. However, this will not be applicable to all the spaces in the buildings but will be used where possible, especially in the residential blocks.</td></tr>
<tr><td>Natural Daylight</td><td>To reduce the energy used for artificial lighting the natural daylight entering occupied spaces will be maximised by optimising window size and orientation. Dimmable lighting with photocells will sense if the illuminance level of the space has been met and reduce lighting levels as required. North facing windows are particularly effective at providing useful daylight and will be incorporated on the Market Building.</td></tr>
<tr><td>Solar Shading</td><td>Whilst maximising daylight care must be taken to ensure that direct sunlight does not cause glare in the spaces and does not cause excessive solar gains in summer which will cause spaces to overheat. This will be managed by solar shading on affected windows.</td></tr>
</table>

Thermal Mass	This is an effective passive measure to manage heat gains in buildings. Thermal mass such as concrete can absorb large amounts of heat energy which prevents spaces from overheating. The thermal mas can be cooled overnight when the space is not occupied to further reduce energy needed for cooling when the space is occupied.
Low Energy Fit Out	All goods and appliances will be highly energy efficient to reduce energy demand.
BMS Optimisation	The commercial buildings will be provided with an intelligent building management system that will learn how the building operates and optimise the function of the ventilation, heating and cooling systems to minimise energy use.
Sub-metering	Power, lighting, plant and separate tenancy areas will be metered to allow energy consumption to be pinpointed and reviewed if it is excessive. Baselines and targets will also be set to help reduce energy use.

6.2. Meet Demand Efficiently – Be Clean

This section looks at technologies that will be used to ensure that energy demand is further reduced and met efficiently

- Ventilation
- Heat recovery
- Demand Operated Systems
- Variable Speed Drives on fans and pumps
- Power Management
- WiFi Controllers in apartments
- LED Lighting
- Waste Water Heat Recovery

Heat recovery	Where fresh air is supplied, and stale warm air extracted by mechanical ventilation, heat recovery will be used to recycle up to 85% of the heat from the extracted air to warm the incoming air. This greatly reduces heating cost compared to a natural ventilation system.
Demand Operated Systems	Where ventilation, heating and cooling is provided to a space that may not always be in use, occupancy sensors will be used. These will shut down the systems serving the spaces when they are not required and turn them back on when instantly when they are required. This will utilise presence sensors in areas like toilets, and CO_2 sensors in other spaces
Variable Speed Drives	All pumps and fans will be provided with variable speed motors which will speed up and slow down as the demand increases or reduces to conserve energy.
Power Management	Power Factor correction will be used on the electrical supplies to all the building to improve energy efficiency
Wi-Fi controller in the apartments	The residential blocks will be provided with internet enabled Wi-Fi controllers that allow occupants to remotely switch their heating on or off and alter the set point. This means occupants only need their heating on

	when they are actually at home and will cause less wasted heating when apartments are empty.
LED Lighting	Highly energy efficient LED lighting will be used throughout the development which are very efficient and will reduce energy use.
Waste Water Heat Recovery	Waste water heat recovery utilises heat from water going down the shower drain to preheat the cold water going to the shower. This can reduce hot water demand by around 50%. The system is virtually maintenance free. Applicable to the Residential blocks only where each apartment will have at least one shower.

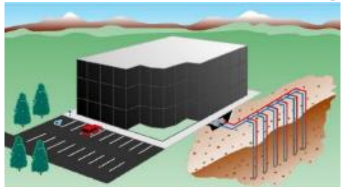
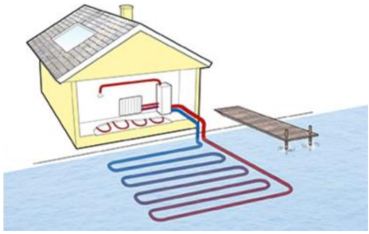
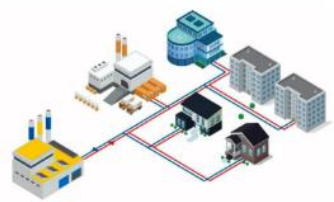
6.3. LZC technology – Be Green

The following Low Zero Carbon (LZC) technologies have been identified and reviewed against their suitability on the Wigan Galleries site:

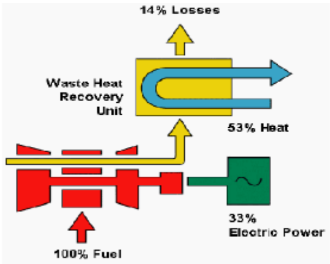
- Solar Water Heating
- Ground Source Heat Pumps
- Water Source Heat Pumps
- District Heating
- Biomass
- Wind Power
- Photovoltaic Electricity Generation
- Combined Heat and Power
- Air Source Heat Pumps
- Battery Storage

These services are described in more detail below and their suitability discussed.

Solar Water Heating 	Solar water heating systems use heat from the sun to pre-heat domestic hot water. Solar water heating systems are generally composed of solar thermal collectors and a fluid system to move the heat from the collector to a storage tank to store the heat for subsequent use. The system requires solar panels on the roof, ideally south facing, linked to hot water storage cylinders.	Renewable Heat Incentive (RHI) payments are available In the case of multi-dwelling, multi-storey blocks the available roof area, pitch and orientation is critical. The solar and pipework distribution strategy would centre on collecting and storing thermal energy in cylinders or tanks in plant rooms. Solar thermal alone will not meet the scheme's targets and would require large roof areas to make any meaningful contribution to the energy strategy. Additionally, the Multimedia Building and general retail domestic hot water loads are relatively small.

Ground Source Heat Pumps 	Ground Source Heat Pumps (GSHP) can be used to extract heat from the ground by circulating a fluid through a system of pipes buried underground to a heat exchanger which transfers the energy to the distribution network. This can provide space heating and/or domestic hot water. Ground source heat pumps have the advantage that they can act as a source of both heating and cooling for the buildings. Ground source heat pumps are either open-loop (abstracting and rejecting water to the aquifer below the site) or closed-loop. aquifer below the site) or closed-loop using boreholes and energy piles.	Low grade heat generated; efficiency of system dependent on low distribution temperatures. Availability of 'free' or mechanical cooling, applicable to hotel, market, multimedia, food and beverage and retail. Compatible with future decarbonisation of the grid which would reduce emissions further. Relatively high capital cost, but Renewable Heat Incentive (RHI) payments and HNIP funding are available.
Water Source Heat Pumps 	Water Source Heat Pumps (WSHP) work in a similar way to GSHP, with the exception that the pipes are submerged into a river, stream, lake or the sea. The fluid is pumped through the system and absorbs energy from the surrounding water. WSHP can be either an open-loop or closed-loop system.	No suitable water courses nearby. Low grade heat generated; efficiency of system dependent on low distribution temperatures. Availability of 'free' or mechanical cooling, applicable to hotel, market, multimedia, food and beverage and retail. Ability to share energy between blocks when heating or cooling is rejected by one building and required by another via an ambient loop.
District Heating 	Energy sources include heat from CHP and to a lesser extent, geothermal.	Low carbon emission factors. Potentially able to achieve renewable targets without other technologies. Reduced plant requirements within buildings. Proposed development site remote from any network. Possibility of energy sharing network around Wigan Town Centre

Biomass 	Biomass heating systems burn biomass material in a biomass boiler in order to heat water in the same way that gas boilers burn gas. Biomass materials include all land and water based vegetation, e.g. wood chips, wood pellets, wood waste and fast growing coppice trees such as willow. The carbon dioxide emitted from burning biomass is balanced by that absorbed during the fuel's production. Biomass heating therefore approaches a carbon neutral process. Biomass boilers require fuel storage near the boiler to be provided.	Sourcing of materials, transporting large volumes into the site. Wood chips require a large storage area, usually equivalent to the plant room size. Maintenance requirements and reliability. Small systems fuelled by wood pellets, requiring less storage. Wood pellets typically more expensive than gas, although there is equivalence with heating oil and LPG. High capital and, potentially, operating (maintenance) cost. Plant usually supplemented by back-up (gas fired) boiler. Renewable Heat Incentive (RHI) payments are available. Can achieve high % renewables contribution. However, less advantageous under latest building regulations, as the Notional and Actual buildings are both fuelled by biomass. Deliveries, storage, maintenance and a substantial site electrical energy demand mean that biomass is not a favoured technology.
Wind Power 	Wind turbines use the wind's forces to turn a rotor which in turn generates electricity. Wind power is used in large scale wind farms for national electrical grids as well as in small individual turbines or building integrated turbine.	Relatively high anticipated daytime electricity demand for the hotel/retail/market buildings. Therefore no potential issues with utilisation, i.e. availability will match demand. Capital cost has dropped significantly in recent years. Economic viability potentially affected by recent proposed changes to feed in tariff. Turbine size and height requirements, potential turbulence and noise mean that this is not a preferred technology.

Photovoltaic Electricity Generation 	Photovoltaic (PV) modules are devices or banks of devices that use the photovoltaic effect to generate electricity directly from sunlight. Until recently, their use has been limited due to high manufacturing costs. In buildings current applications include PV on the roof, PV curtain walling systems and PV louvred external shading devices. Typically, photovoltaics would be installed on a south facing roof.	Relatively high anticipated daytime electricity demand for the hotel/retail/office buildings. Therefore, no potential issues with utilisation, i.e. availability will match demand. Capital cost has dropped significantly in recent years. Photovoltaic (PV) systems on this type of development would not meet energy targets, simply because the size of the array required would be impractical. However, PV can contribute to meeting the target, alongside a compatible technology, on a block by block basis. The PV panels can also be integrated with proposed battery storage technology to utilise more energy generated on site
Combined Heat and Power (CHP)  	A CHP unit provides heating as well as electrical power. The electricity generated by the CHP plant can be distributed around a development and into the electrical network if needed. The use of this co-generation improves the overall efficiency of the primary energy delivered to the site with a corresponding reduction in the development's CO_2 emissions. The amount of thermal energy provided by the CHP unit will be dependent on the calculated thermal base load for the buildings.	Relatively low cost of CHP unit if integrated into a gas boiler and domestic water cylinder strategy High maintenance costs result in marginal returns on small to medium sized installations Best suited to community or district heating systems with significant thermal loads The application of CHP to the site will be dependent on establishing a heating baseload, which in this instance will essentially comprise the domestic hot water service (DHWS). Potentially a number of energy centres required located around the development. Not compatible with future de-carbonisation of the grid and reduction of use of fossil fuels

Battery Storage 	Modern batteries can store large amounts of electrical energy in a development. Any technology that generates electricity such as PV panels, wind turbines or CHPs can charge the batteries if there is not sufficient demand on the site to utilise energy. This is more efficient than exporting to the grid and saves the consumer more money.	In combination with a private wires electricity network across the site, battery storage can store energy generated on site smoothing out peaks and troughs in electrical demand and on site generation. The battery storage will be used to 'peak lop' the peaks in demand, where electricity is most expensive and use stored energy to overcome these. A Local Clean Energy Marketplace will be established.

6.4. Summary

The following table sets out the initial appraisal of the available solutions and what can be discounted and why at the initial design stages.

Y – Yes Suitable   N – Not Proposed/Suitable   P – Possible

Reduce Demand						
	Multimedia	Market Hall	Hotel	Pavilion	Residential	Comments
Thermal Insulation	Y	Y	Y	Y	Y	Essential to minimise heat losses. Our solution exceeds Part L requirements.
Air Tightness	Y	Y	Y	Y	Y	Essential to minimise heat losses. Our solution exceeds Part L requirements.
Natural Ventilation	N	P	N	P	Y	Areas of façade of Residential blocks away from main roads are suitable for opening windows coupled with MVHR
Natural Daylight	N	Y	Y	Y	Y	As part of the master planning and individual block design daylighting can be incorporated to provide useful light
Solar Shading	N	P	P	P	P	Can be adopted to limit solar gains in peak summer if required but not essential
Thermal Mass	Y	Y	Y	Y	Y	Considered to minimise cyclical energy fluctuations by absorbing heat gains in summer.
Low Energy Fit Out	Y	Y	Y	Y	Y	This will be an integral part of the fit-out requirements in all the buildings including the residential blocks
BMS Optimisation	Y	Y	Y	Y	P	This will be applied to the commercial buildings and could be used to a lesser extent on the residential blocks with Wi-Fi controllers
Energy Monitoring / Metering	Y	Y	Y	Y	Y	Will be used in the commercial buildings. Not applicable to Residential

Meet Demand Efficiently						
	Multimedia	Market Hall	Hotel	Pavilion	Residential	Comments
Heat Recovery	Y	Y	Y	Y	Y	Will be adopted to all mechanical ventilated spaces to recover energy.
Demand Operated Systems	Y	Y	Y	Y	Y	The use of sensors for lighting, heating, ventilation will reduce energy use. CO2 sensors also feasible on ventilation systems.
Variable Speed Drives	Y	Y	Y	Y	Y	To be adopted on all pumps and fans to reduce energy use.
Power Management	Y	Y	Y	Y	Y	To be used on all buildings to ensure electrical equipment operates as efficiently as possible.
Wi-Fi controllers	P	P	P	P	Y	To be provided in the Residential Blocks
LED Lighting	Y	Y	Y	Y	Y	Will be adopted in all spaces to
Waste Water heat recovery	N	N	N	N	P	Potential return on investment with large waste water flow rates

1 – Mixed Mode Ventilation 2 – WiFi controllers in residential blocks

Y - Yes N - No P – Possible

Low and Zero Carbon Technology						
	Multimedia	Market	Hotel	Pavilion	Residential	Comments
Solar Water Heating	N	N	N	N	P	Deemed not a attractive as PV due to hot water demands and roof area available
Ground Source Heat Pumps	Y	Y	Y	Y	Y	Feasible due to site size and layout and energy demands. The yield from the GSHP is subject to TRT testing.
Water Source Heat Pumps	P	P	P	P	P	Not feasible as no water courses near by
District Heating	P	P	P	P	P	Potential for a heat sharing network to be established
Biomass	N	N	N	N	N	Deliveries, storage, air quality and maintenance issues mean this is not suitable
Wind Power	N	N	N	N	N	Discounted due to noise generated, structural and visual impacts
PV Panels and battery storage	Y	Y	Y	Y	Y	Adopted due to electrical demand and inclusion of battery storage
CHP	N	N	N	N	N	Strategy to avoid the use of fossil fuels
Air Source Heat Pumps	P	P	P	P	P	Could be used if GSHP cannot provide required outout
Battery Storage	Y	Y	Y	Y	Y	Used in combination with PV panels

Embodied Carbon						
	Multimedia	Market	Hotel	Pavilion	Residential	Comments
Re-use materials	N	Y	N	N	N	Re-use of the Market frame, also re-use demolished building to make up car park levels.

6.5. Overview

This Energy Strategy report has set out to explain the policies that affect development in the Wigan Borough, reviewed the existing Galleries site and its surroundings, establishing the opportunities for energy reduction and Low and Zero Carbon technology on the site, presented results from the energy models and commented on demand curves of the buildings and presented our proposals.

The approach of our design for the development is to embed the low carbon appraisal through a range of design measures based on part of the Wigan Council Local Development Strategy Energy Hierarchy, 'Be Lean, Be Clean, Be Green'.

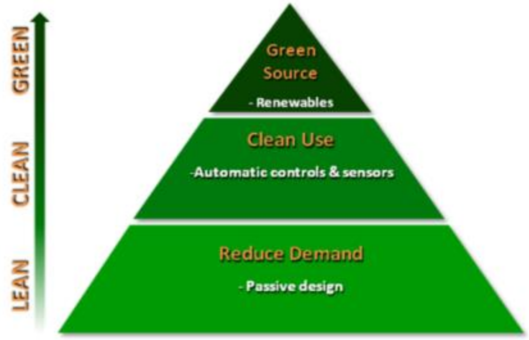


Figure 22 Energy Hierarchy

Our proposal seeks to access central government funding to eliminate fossil fuel combustion by unlocking local energy resources and distributing them widely to customers over a local private electricity and heat network. Demand flexibility and energy storage is used to exploit favourable trading on the day-ahead wholesale electricity markets with smart building controls managing this flexibility to minimise overall costs. Electrical vehicles will be fully supported by deploying advanced load sharing algorithms saving infrastructure and network connection and capacity costs.

Fundamental to this approach is the proposal to adopt a site wide Energy strategy with the use of what is called a 'private wires' electricity high voltage system and the use of 'ground source heat pumps'. This platform enables the optimum opportunities to realise the objectives that have been set out.

The strategy is named the "Local Clean Energy Marketplace (LCEM)" as all consumers and prosumers are connected together on a single local private electricity distribution network and act together in a renewable energy marketplace. This is complemented by a heat network to distribute clean heating /cooling sourced from a large on-site ground heat collector array.

The Wigan "The Galleries" Heat Network + Microgrid are complementary systems which will provide the development with a system that can ultimately provide zero carbon coupled with future offsetting the decarbonisation of the national electricity grid.

These systems underpin the new business model whereby grid supplied electricity becomes the main energy supply vector along with Solar Photovoltaics. Grid supplied gas combustion has been eliminated and 1.5MW/4.5MWh of energy storage is directly connected to the Microgrid and provides the means to reduce the reliance on grid electricity.

The overall energy network concept is shown in Figure 23.

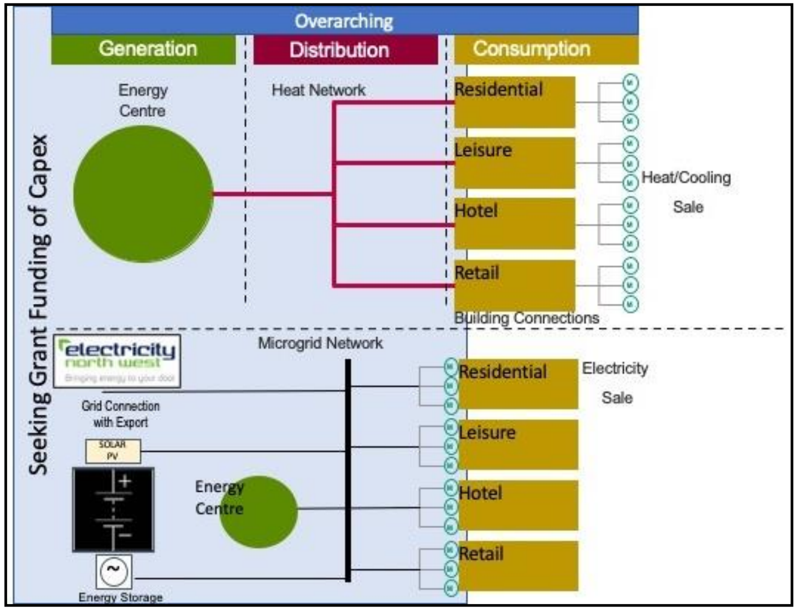


Figure 23 Heat Network + Microgrid

Our appraisal strategy can be summarised as:

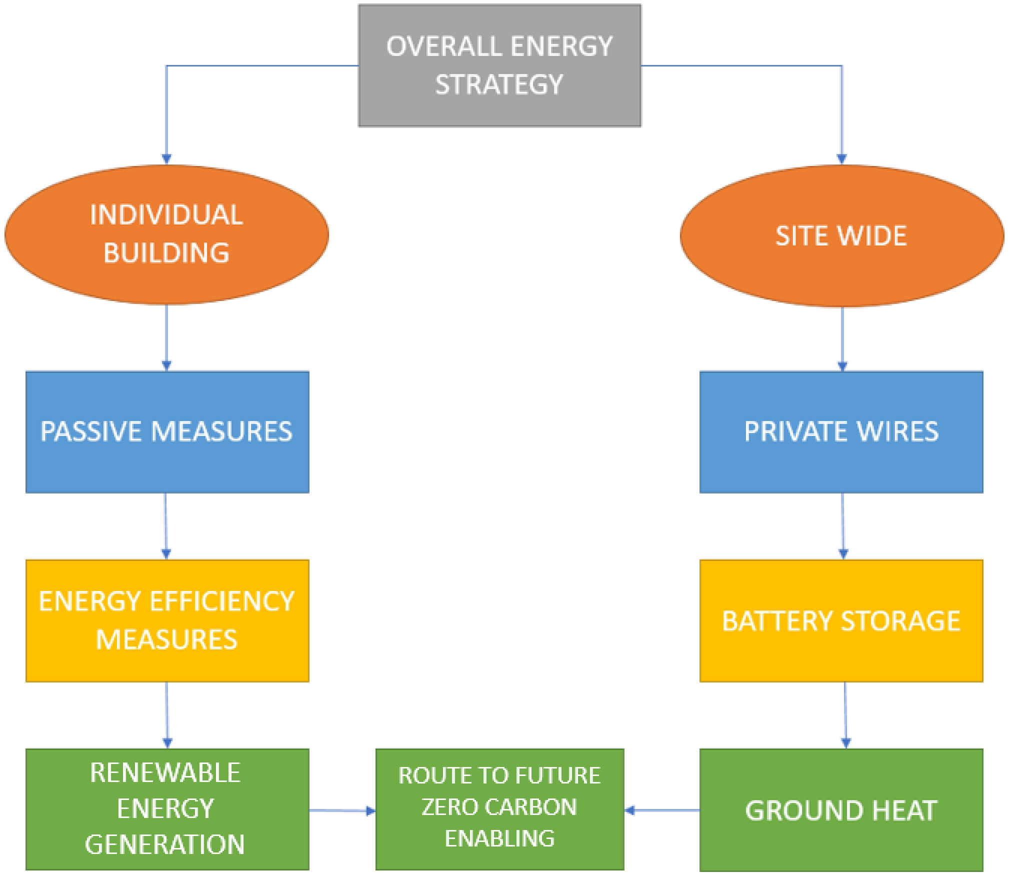


Figure 24 Overview of Appraisal Strategy

6.6. Energy Hierarchy approach

We have followed the Energy Hierarchy is our strategic approach to carbon reductions. These measures can be summarised as follows:

Reduce Demand – Be Lean

First energy demand has been minimised by the following measures:

Building insulation, U values and air tightness	Values that improve on the values set out in Part L of the Building Regulations will be used. These improved insulation levels result in heat losses significantly lower than those set out in the Notional Building model.
Suitability of using natural ventilation	This was found to be applicable in the Market and Residential Blocks and will reduce the energy required for mechanical ventilation.
Natural daylighting and solar shading	The Residential Blocks orientation and fenestration strategy will take advantage of passive solar gains and natural daylight to reduce heating energy and the need for artificial lighting.
Thermal mass	will be incorporated to minimise cyclical energy fluctuations and to reduce the need for daytime cooling.
BMS Optimisation	Reduce energy use by learning how the buildings react to heating and cooling and tailoring the response of the system to minimise energy use
Energy monitoring	This will show any areas that have unusually high energy use and these can be targeted and reviewed to help understand why energy use is high and then minimise it.
Fit out of white goods	The final aspect of the initial reduction in demand will be the eventual fit out of white goods within the apartment blocks and commercial units which will promote high efficiency rated goods.

Meet Demand Efficiently – Be Clean

After reducing demand, the following measure will be implemented to meet the demand efficiently.

Heat Recovery	This will be used on all mechanical ventilation units in the commercial and residential blocks to reduce the energy required for heating by recovering waste heat from extracted air.
Demand operated systems	This will be used on the ventilation systems to reduce the speed or shut down ventilation to areas when they are not occupied. This includes occupied spaces and ancillary areas such as toilets.
Variable speed drives	These will be used in conjunction with the demand operated systems to reduce the speed of pumps and fan motors to a minimum to conserve energy.
Power management	This will use power factor correction on incoming supplies to ensure motors and electrical systems work as efficiently as possible to reduce energy use.
WiFi controllers	WiFi controllers will allow building occupiers to review energy use remotely and adjust set points and timeclocks to suit their changing needs.
LED Light fittings	These will be used throughout the development in both the commercial and residential areas with demand operated controls. Typically, this will be in the form of PIR sensors in small spaces and microwave sensors in larger areas.
Waste water heat recovery	This will be implemented (subject to fund design consideration) in the residential blocks to use warm water going down shower drains to preheat the cold water supplied to the shower, greatly reducing the energy required.

Low Zero Carbon Technology – Be Green

Once demand is minimised the following LZC technologies will be implemented.

Ground source heat pumps	These will use energy from the ground to heat water for space heating and domestic hot water production. The heat pumps can also produce cooling from energy in the ground. The heat pumps are highly energy efficient and only require 1kW of electrical energy to produce 4kW of heating and cooling energy.
Energy sharing network	An energy sharing network will allow waste heat and cooling to be exchanged with other buildings to provide 'free' energy. This network also has the possibility to be extended around Wigan Town centre to serve other buildings.
PV panels	These will be used on several the buildings to generate electricity reducing CO_2 emissions and also saving money for building occupiers.
Battery storage	These will be used on the site to store energy from the PV panels when it cannot be used on site. This is more efficient than exporting to the grid and it is more cost effective to utilise energy on site than to export to the grid.

6.7. Renewable & Low Carbon Technolgies

Our strategy is proposing to use ground source heat pumps to serve the buildings to provide low carbon highly energy efficient heating, cooling and hot water. Heat pumps are relatively simple but work somewhat courter-intuitively compared to fossil fuel burning methods of heating. Their operation is explained below.

How Heat Pumps Work

A heat pump is simply a device that transfers thermal energy from one point to another. Naturally thermal energy moves from an area of high temperature to an area of low temperature but in a heat pump thermal energy is 'pumped' from an area of low temperature to an area of high temperature.

Ground source heat pumps take heat from the ground, raise its temperature and use the energy to heat buildings and produce domestic hot water. Ground source heat pumps operate on the same refrigeration cycle principles as a domestic fridge but use the cycle in reverse to generate spatial heating. The advantage of using a ground source heat pump is its efficiency. For every kWh of electricity used to power the heat pump, about four kWh of energy is extracted from the ground. This ratio of heat supplied to the building and the electrical energy consumed is what makes heat pumps so efficient.

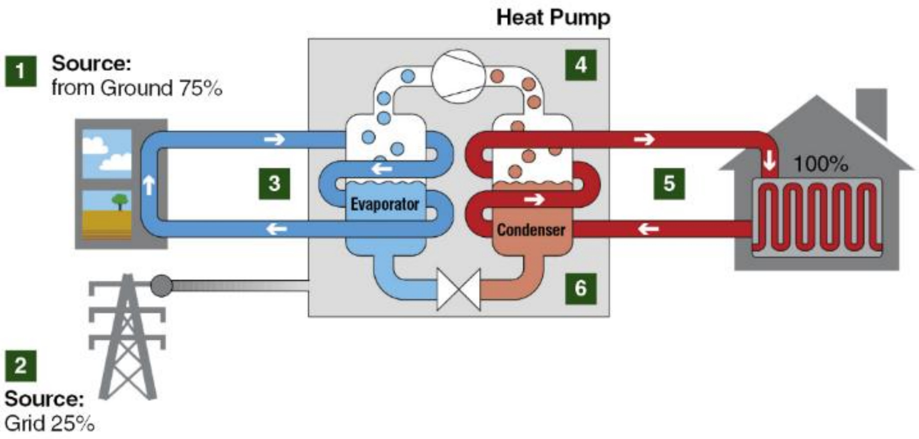


Figure 25 Heat Pump Overview

A heat pump installation will typically consist of a heat pump, ground collector array to absorb energy from the ground, circulation pumps to move the energy around the system, and a hot water cylinder for heating domestic hot water.

Basic Principles

The basic principles of a closed loop GSHP system begins with the absorption of heat from the ground heat source. We are proposing an array of pipes buried underground vertically in bore-holes beneath each building.

Heat absorption is achieved by circulating water mixed with antifreeze (Glycol) through a closed collector pipework system. The temperature of the earth at one metre below ground level remains fairly consistent between approximately 6 - 12°C throughout the year and this can be used to extract heat.

The stages of the Ground Source Heat Pump

1. Energy in the form of heat is absorbed from the heat source, in this case the ground, through a closed collector system containing water mixed with antifreeze.
2. The collector fluid then transfers this energy to the refrigerant in the heat pump's evaporator heat exchanger.
3. The refrigerant vaporises, due to its low boiling point, and is then compressed in the compressor which is where most of the electricity is consumed. When the refrigerant is compressed its temperature increases to around 50°C.
4. The refrigerant, with its increased temperature, enters the condenser heat exchanger where it transfers its energy to the heat medium circuit. This then provides spatial heating to the radiator, the hot water cylinder or a combination of heat emitters.
5. The cool refrigerant then passes through the expansion valve and flows back to the evaporator and the cycle begins again.

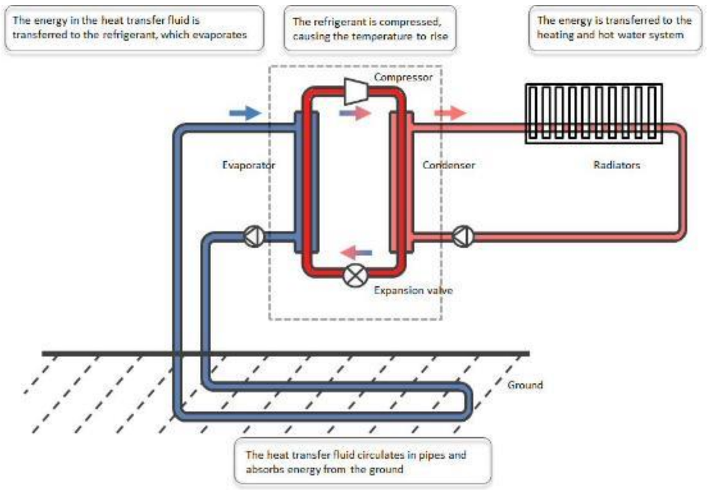


Figure 26 Heat Pump Cycle

The ground source heat pumps can also operate in reverse to provide cooling to the buildings on the site. In this instance the heat pumps reject energy heat energy to the ground and use the cool water returning from the boreholes to generate cooling.

Although heat pumps require energy, in the form of electricity, they are considered highly efficient and clean because they utilise heat from the external environment to convert 1kW of electrical energy into 4kW of heat energy.

The heat pumps and ground source network is classified as innovative technology and therefore is eligible for Grant Funding to reduce Cap Ex costs.

Our Ground Source Heat Pump Proposal

The ground source heat pump network we are proposing will absorb energy from the ground using boreholes. These holes are in the region of 200m deep holes cored into the ground with pipework feeding down to the bottom of the hole and then returning to the surface in a loop. This pipework will absorb energy from the ground and then circulate it to the heat pumps.

The yield from the Ground Source Heat Pump system is subject to a Theraml Response Test (TRT).

We are proposing to drill bore holes under the residential blocks and car park to serve the apartments. Each block will have its own borefield beneath it, connected directly into the apartment building. Then, each apartment will have its own heat pump, generating hot water and heating, fed from the boreholes via pipework running throughout each residential block.

For the commercial buildings we are again proposing each building will have its own borefield. The borefields for the Hotel, Pavilion, and Multimedia building will be below ground in the public realm areas and car park, and the borefield for the Market will be directly below the building itself. Each commercial building will have its own central heat pumps providing heating, cooling and domestic hot water to the buildings.

In the commercial buildings each separate demise will have its own heat pumps, for example the Food and Beverage units or large retail units, to allow for easy billing, maintenance and management.

It is envisaged the Hotel and Pavilion will be their own demises managed as separate entities so they will be provided with central heat pumps feeding the whole building.

The heat pumps will take the energy from, and reject energy to the boreholes and, through the refrigeration cycle described above, use it to generate energy for heating, cooling and domestic hot water in all the buildings.

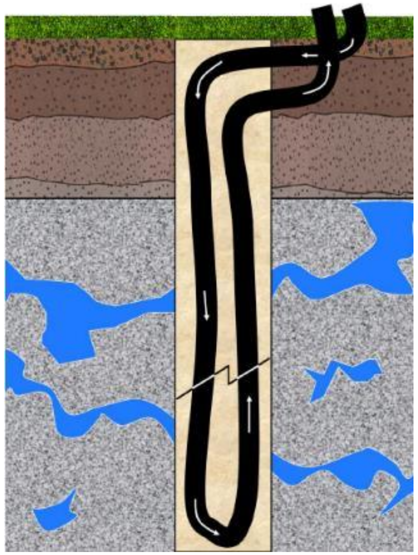


Figure 27 Borehole and Pipework

Figure 28 Ground Source Heat Pump Pipework

Figure 29 Ground Source Heat Pump Pipework Connecting to Boreholes

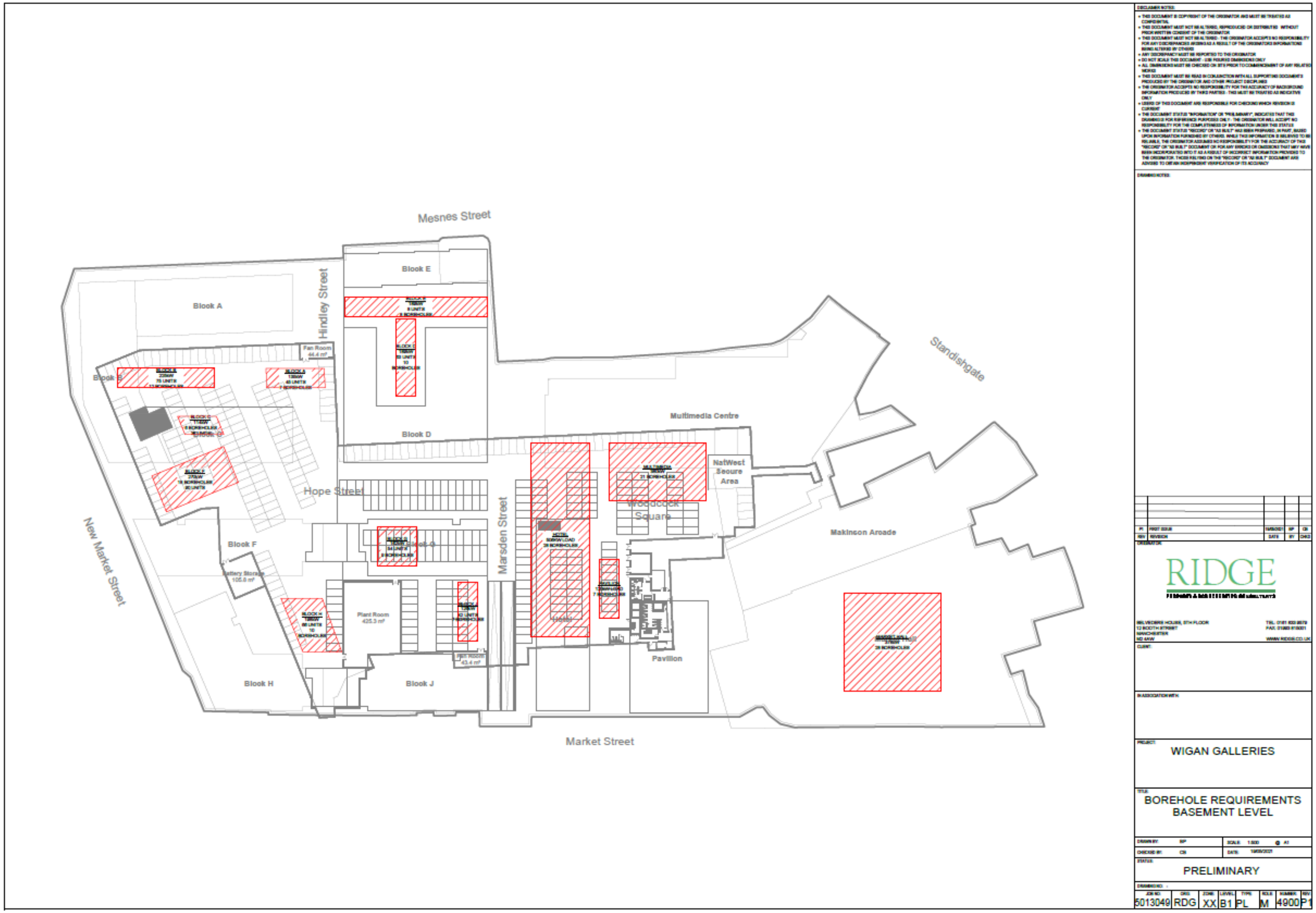


Figure 30 Borefields to the development

6.8. Photovoltaic Panels

As part of the design proposals, extensive photovoltaic solar panels are proposed to be installed on the following roof top areas:

- Hotel

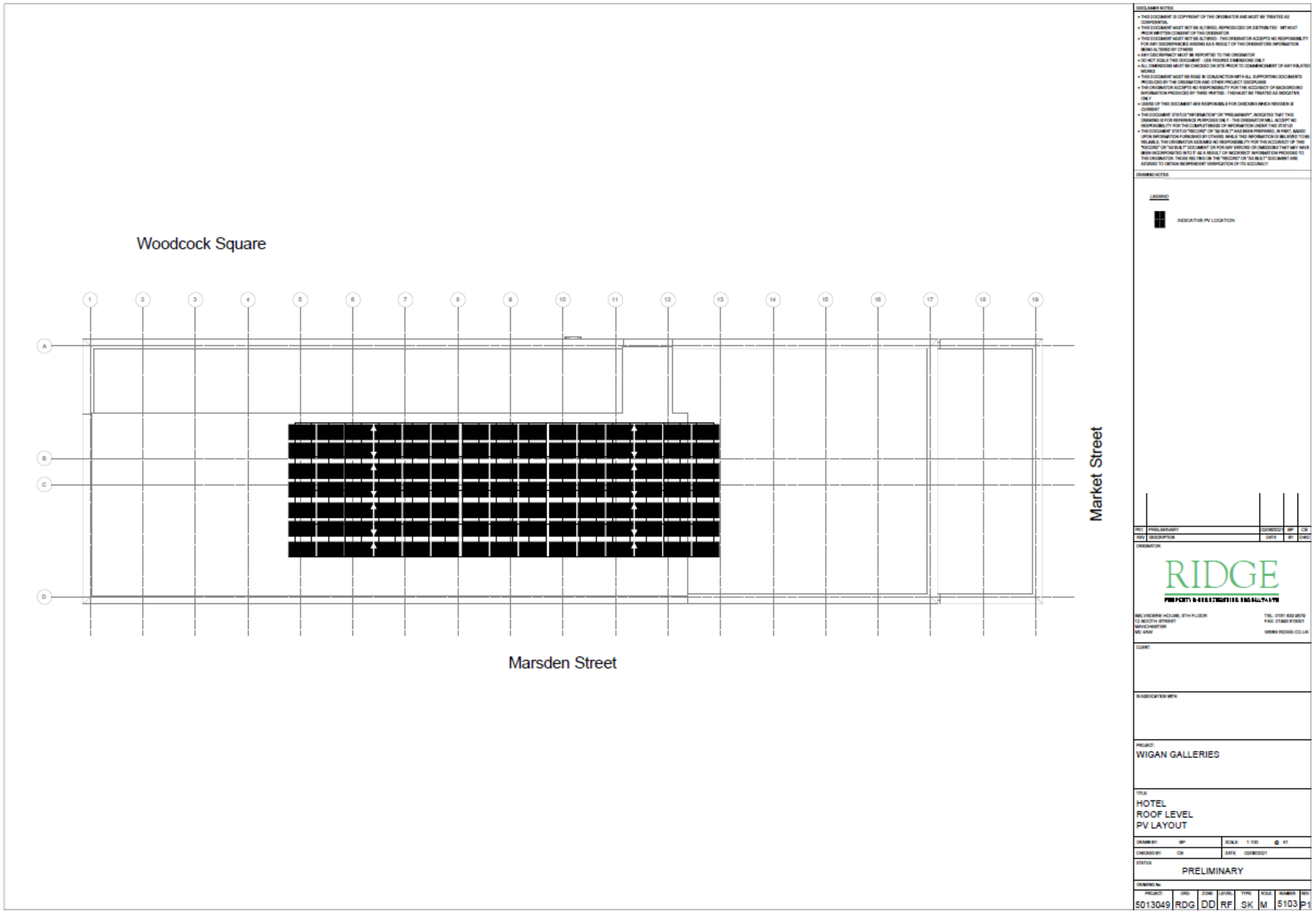


Figure 31 Hotel roof level PV layout

- Pavilion

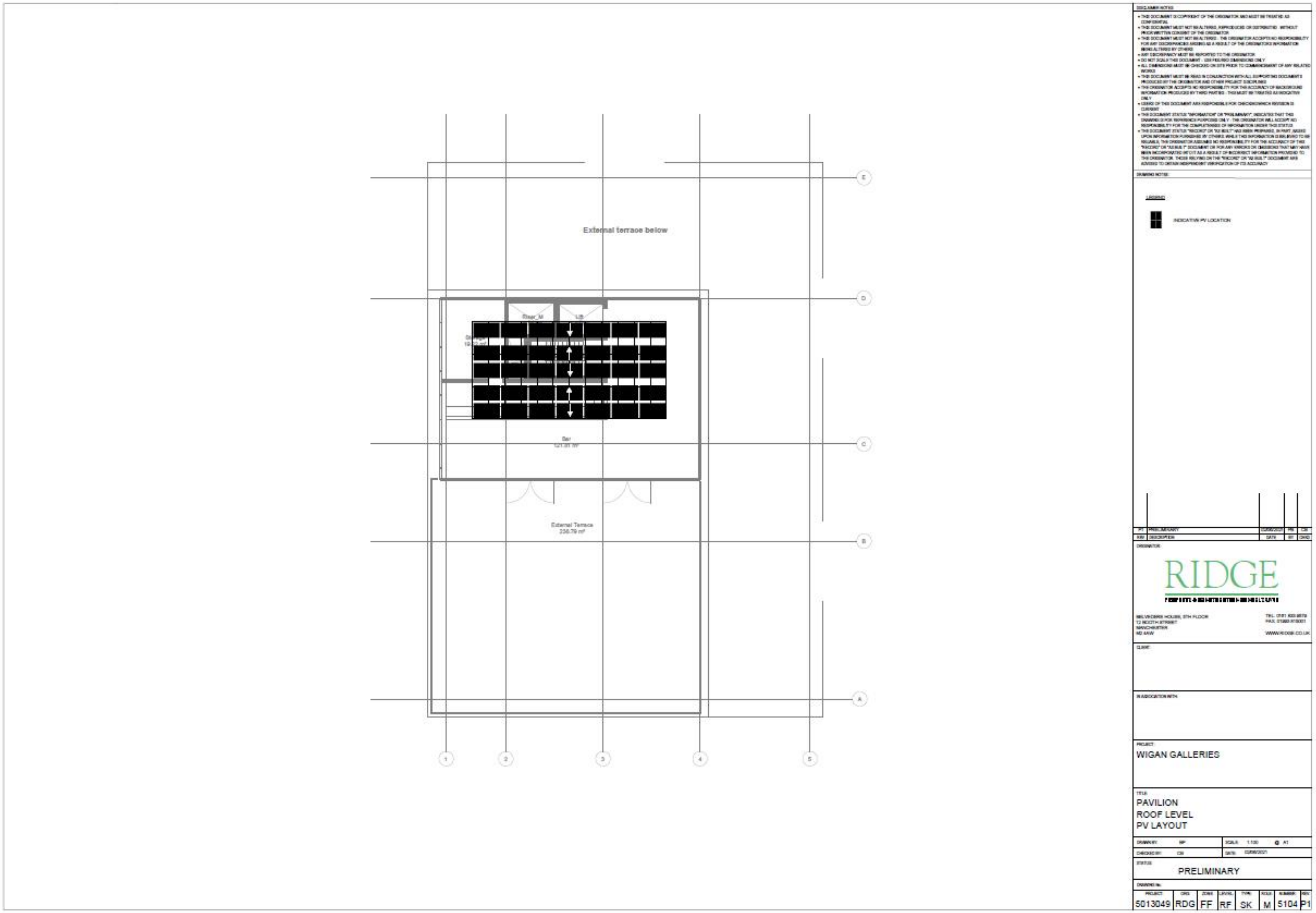


Figure 32 Pavillion roof level PV layout

- Residential Blocks

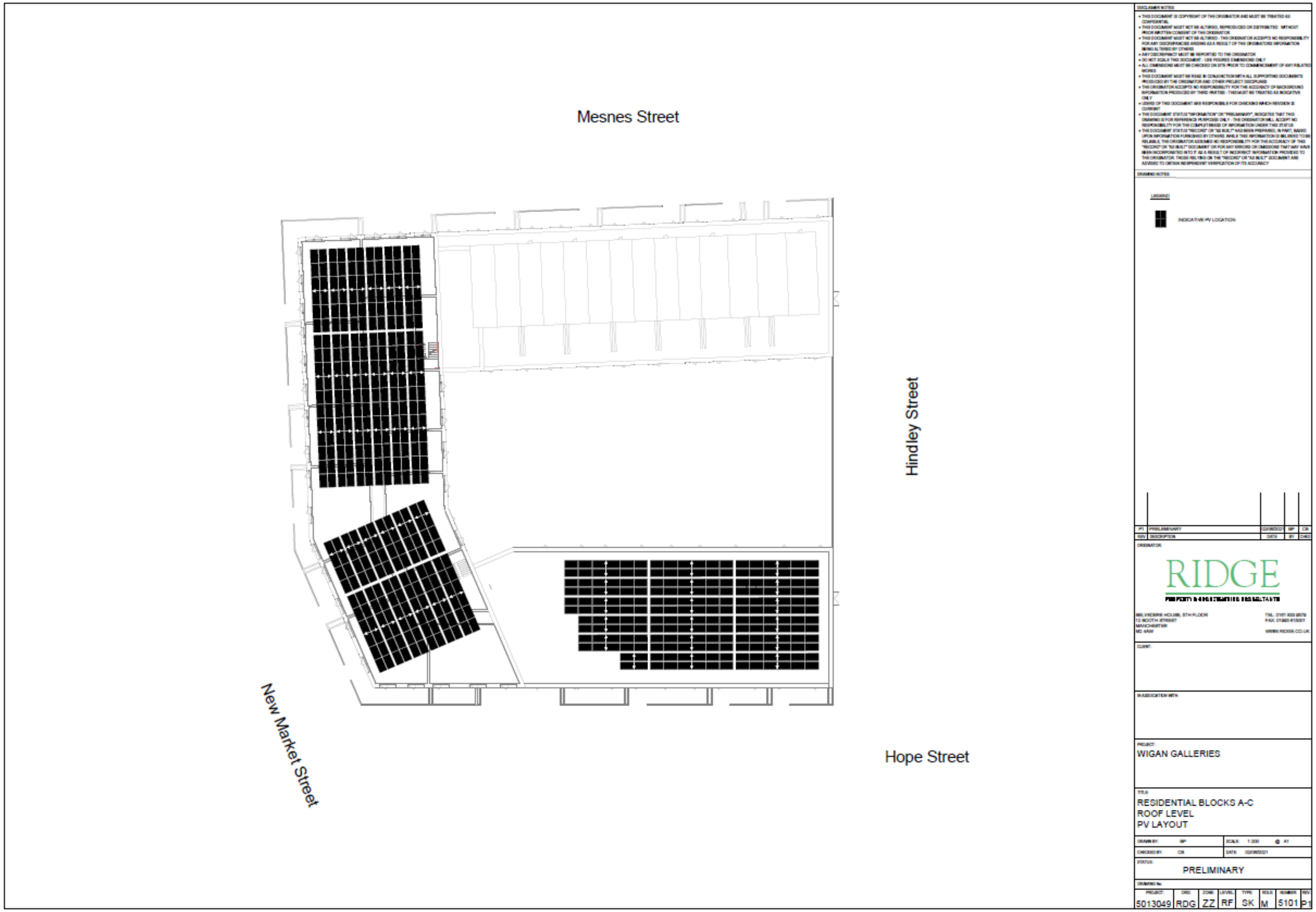


Figure 33 Residential blocks A-C roof level PV layout

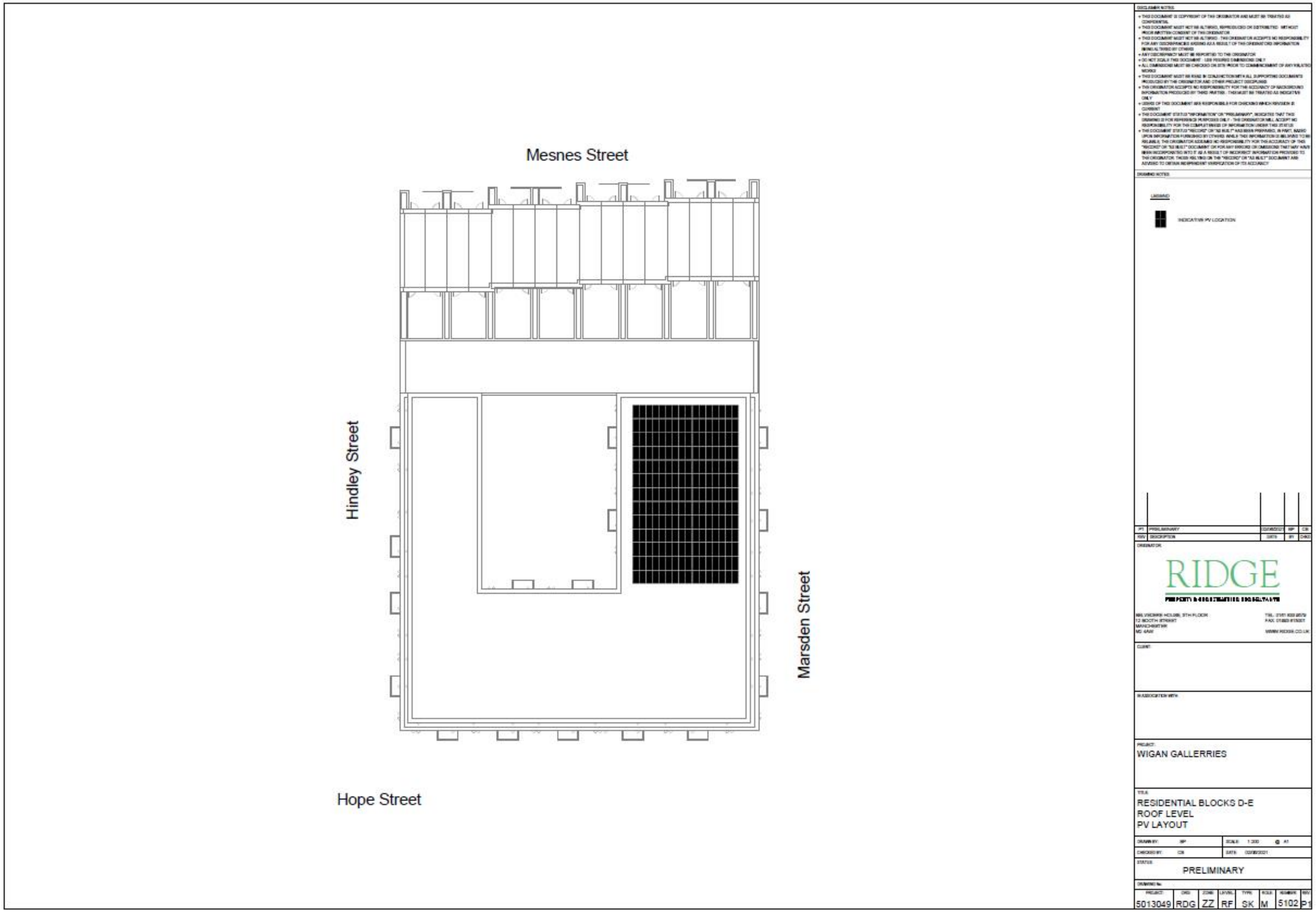


Figure 34 Residential blocks D-E roof level PV layout

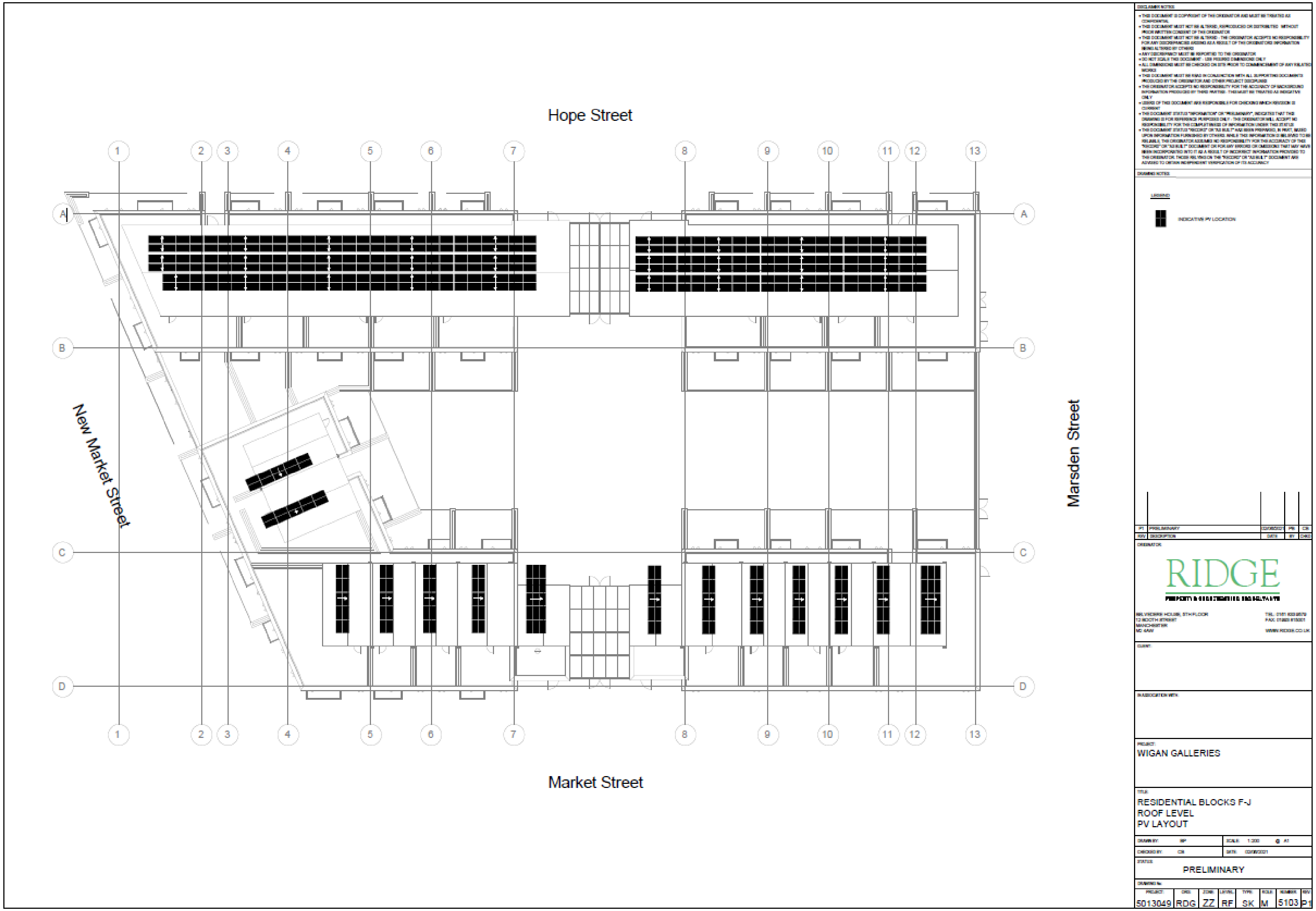


Figure 35 Residential blocks F-J roof level PV layout

6.9. Battery Storage

A 1.5 Megawatt battery storage system is proposed to be housed in the basement car park area. The principal of the battery storage system will be to store low cost and low carbon intensive electricity at off peak periods and then utilise this stored energy to offset higher cost and carbon intense electricity at peak periods.

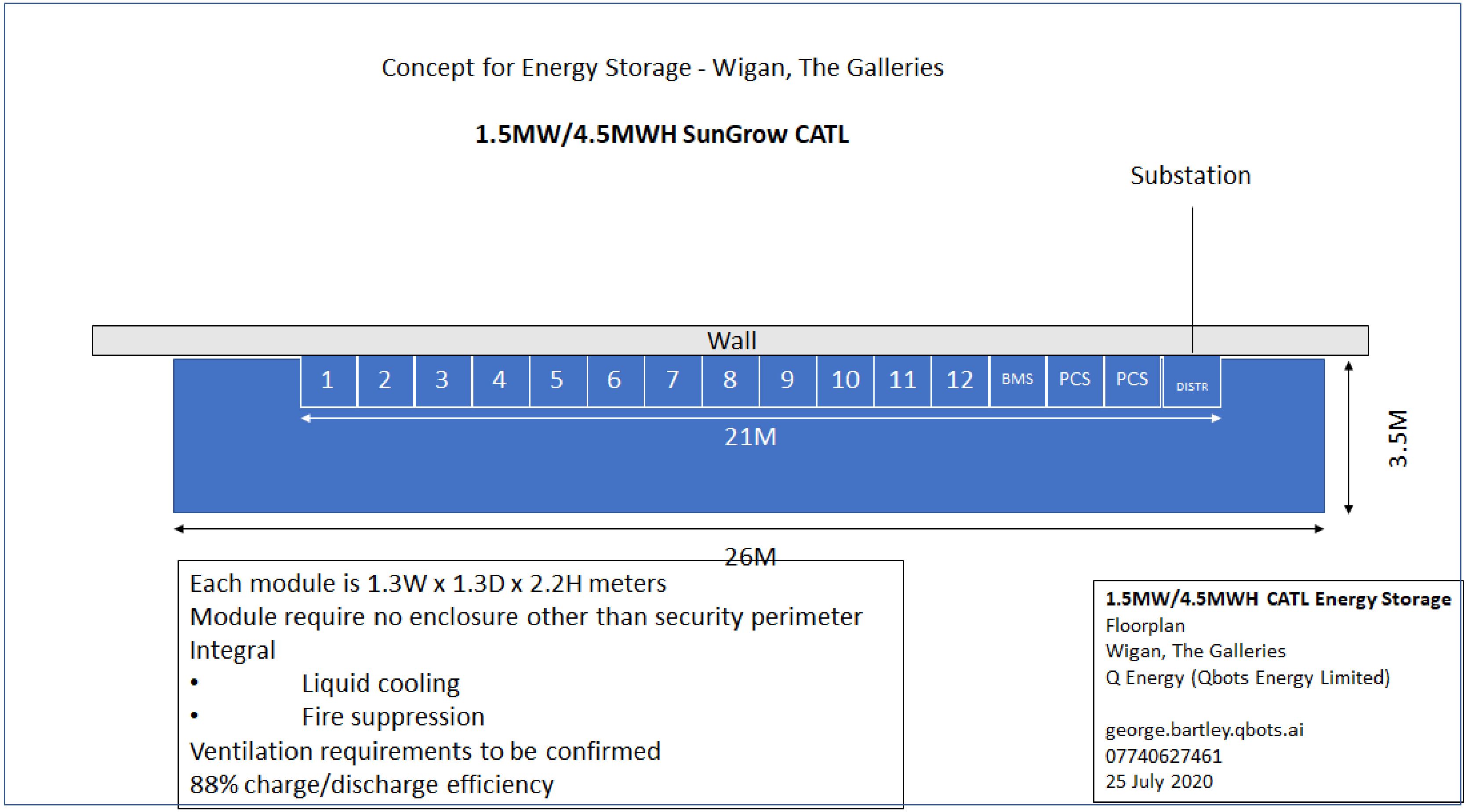


Figure 36 Concept for energy storage

6.10. Policy Compliance

In conclusion our solution directly addresses the Wigan Local Development Framework Key Strategies by:

Policy Objective	How this is met
Using the energy hierarchy be lean, be clean, be green	Our strategic approach uses the energy hierarchy at its core implementing the lean, clean, green methodology
Supporting a switch to low carbon technologies for power, heat and transport, in line with: o UK Target - 100% reduction in carbon emissions by 2050 (From 1990 levels) o UK TARGET – 78% by 2035 (From 1990 levels) o MCC Framework – 50% reduction by 2025 o Wigan CC Strategy – carbon neutral by 2038	Our proposal has low carbon technology at its core using ground source heat pumps, PV panels and battery storage. It also uses grid electricity which can take advantage of the reducing carbon factors in the future.
Encourage or require near and on-site generation of energy from renewable and low carbon sources.	Our solution incorporates on site generation from photovoltaic panels
The market for renewable energy technologies and investments will grow. We need to maximise the benefits for local businesses and jobs.	Our solution provides local jobs in the renewables sector as part of the private wires and battery storage system.
Minimising on site burning of fossil fuels to improve air quality	Our solution uses grid electricity at its heart and avoids fossil fuels.
Increase Wigan's generation of energy from low carbon and renewable sources.	Our proposal provides on-site PV generation and Heat Pumps to provide zero carbon energy on site.
Minimise the requirement for energy use and improve energy efficiency in new buildings	Our strategic approach minimises energy use and maximises efficiency.
Contribute to an increased proportion of energy generated from decentralised and renewable / low carbon sources	Our proposal provides onsite PV generation and Heat Pumps to provide zero carbon energy on site.

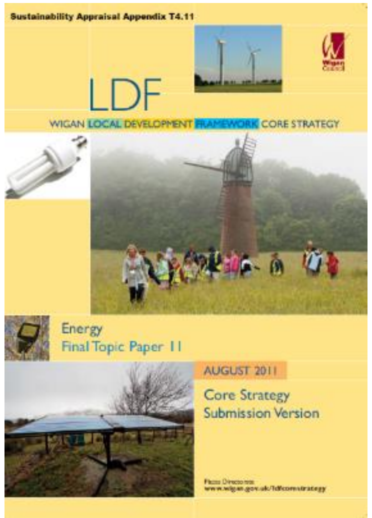


Figure 37 Wigan Local Plan Core Strategy

Our solution also meets the Wigan Local Plan Core Strategy by:

Policy Objective	How this is met
Objective E1 Minimising emissions of greenhouse gas	Our strategic approach uses the energy hierarchy at its core implementing the lean, clean, green methodology to minimise greenhouse gas emissions
Objective CC1 Help mitigate the borough's greenhouse gas emissions	Our proposals minimise greenhouse gas emissions on our site and also looks at the feasibility of a wider energy sharing network to further reduce energy use of other buildings around the site.
Policy CP10 • Meet established standards for design • Include measures to minimise the impact of and adapt to climate change and conserve natural resources and meets established national standards for sustainability and national carbon reduction targets.	We have applied all relevant standards for design including, CIBSE, BSRIA and BRE. Our proposals are in line with national carbon reduction and sustainability targets

Policy CP13 • Using the energy hierarchy be lean, be clean, be green • Submit an energy strategy and provide a reduction of carbon dioxide emissions of energy use by at least 15% • Development is designed, orientated and constructed that maximises energy efficiency, reduces reliance in fossil fuels and takes advantage of renewable and or low carbon technologies.	Our strategic approach uses the energy hierarchy at its core implementing the lean, clean, green methodology. We will achieve an energy reduction of 15%. Our solution maximises energy efficiency and minimises reliance on fossil fuels taking advantage of renewable and low zero carbon technologies.
Policy CP17 Manage air quality, particularly in air quality management areas by minimising the air pollution and CO_2 emissions from new development.	Our solution minimises CO_2 emissions on site and so will not contribute to air pollution.

7. PREDICTED CARBON EMISSIONS

As part of the analysis of the development to determine the most appropriate Energy Strategy, it is essential to establish the individual Energy Characteristics of each type of building so technology/ approaches can be matched accordingly.

All the building types under the detailed planning application have been modelled to ascertain the energy dynamics and characteristics of the buildings to enable a detailed assessment to be undertaken of design options and technologies.

The dynamic simulation modelling process can be used to model and analyse a range of sustainability factors typically arising from planning or building regulations drivers. These include energy compliance and CO_2 emissions, overheating (thermal comfort) and daylighting analysis.

The dynamic thermal modelling process involves creating a 3D model of the building, assigning constructions to all the thermal elements, modelling the proposed mechanical and electrical systems and then running a simulation. This simulation models how the building fabric and systems will perform against real weather data over the course of a year and produces outputs showing the energy use of each system.

Buildings under the outline planning application have been reviewed using CIBSE Benchmark data only at this stage.

All inputs to the detailed energy model have been based on RIBA Stage 2 design and assumptions made may alter during the next RIBA design stage.

The Energy Modelling can be split into two elements:

- Non-Residential Part L2A SBEM
- Residential – Part L1A SAP Calculations

The non-residential buildings have been modelled as follows:

- Pavilion – Detailed Energy Model (Detailed Planning)
- Hotel – Detailed Energy Model (Detailed Planning)
- Market Hall – Detailed Energy Model (Detailed Planning)
- Multimedia Building – Benchmark (Outline Planning only)

For the residential element of the site, SAP assessments (Part L1A) have been modelled for Blocks F, G, H & J.

Blocks A, B, C, D & E are outline planning only and are benchmark calculations at this stage only; using Blocks F, G, H & J as a reference guide.

The following graphs and tables reveal the individual energy characteristics of each building highlighting where energy is used and the respective typical time properties, and also the anticipated Energy Use carbon emissions.

The SBEM calculations Building Emission Rating (BER) and the Target Emission Rating (TER) only incorporate the building energy and not the energy for connected equipment- such as TVs, computers or for cooking facilities etc. It also does not allow for the actual number of occupants nor the actual hours of operation to be taken into account; this data is fixed per building type (e.g. food preparation area or general retail space) to ensure comparasions can be made for all types of the same building.

The output BRUKL document and SAP calculations breakdown the energy consumed by different end-uses, namely the heating, cooling, auxillary, lighting and hot water.

The predicted carbon emissions do not allow for the use of ancillary equipment such as TVs, computers and cooking equipment.

The predicted carbon emissions also do not allow for any future Electric Vechile (EV) charging.

7.1. Pavilion (Detailed Analysis)

The Pavilion's primary function is a food and beverage outlet and therefore a large percentage (25%) of its energy use is from hot water. The heating and the cooling contribute less significantly to the overall energy consumption with 8% each.

The lighting contributes significantly to the overall energy consumption with 25% attributed to the lighting.

As you can see in the line chart below, there is low energy demand in the morning with a gradual increase to the lunchtime peak, before decreasing slightly in the afternoon before a second, lower peak when serving evening meals.

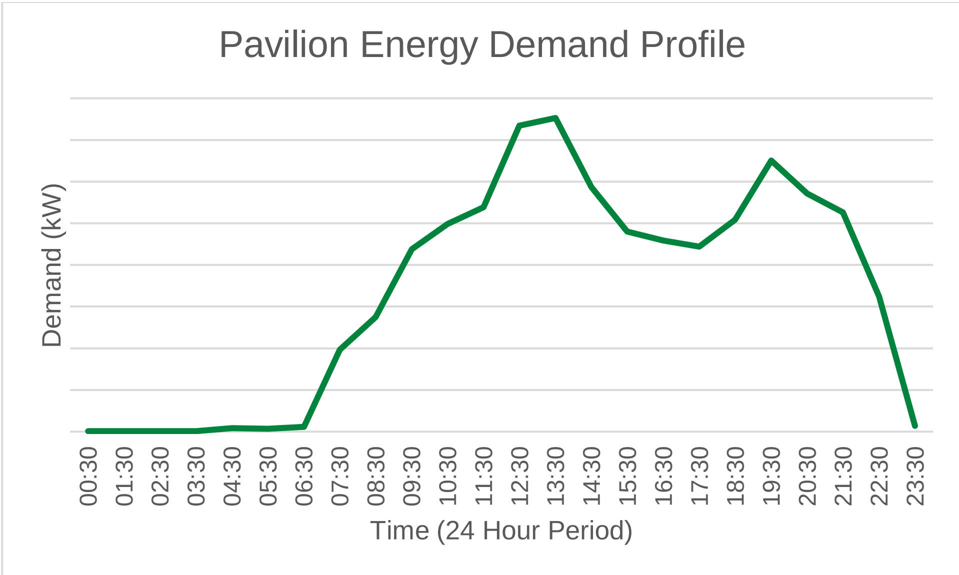


Figure 38 Pavillion energy demand profile

As shown in Figure 40 Energy Consumption by End Use, the heating & cooling consumption in addition to the lighting and hot water consumption in the actual building are lower than that in the notional building. This has been achieved through the use of efficient LED lighting, in addition to the inclusion of mechanical ventilation with heat recovery system, where the heat recovery efficiency is up to 96% efficient.

The following inputs have been incoportated into the detailed design model:

Criterion 2: The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Values which do not achieve the standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.25	0.42	01000010:Surf[4]
Floor	0.25	0.22	0.22	NR000021:Surf[0]
Roof	0.25	0.18	0.18	NR00001C:Surf[1]
Windows***, roof windows, and rooflights	2.2	1.58	1.6	NR000021:Surf[1]
Personnel doors	2.2	-	-	No Personnel doors in building
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m²K)]
$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [W/(m²K)]

* There might be more than one surface where the maximum U-value occurs.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
*** Display windows and similar glazing are excluded from the U-value check.
N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
m³/(h.m²) at 50 Pa	10	3

Figure 39 Allowed for U-value's in the detailed analysis.

1- EO + Elec Panel

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.95	-	0	0	-
Standard value	2.5*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

2- MVHR + FCU

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.95	5.79	0	0.3	0.96
Standard value	2.5*	3.2	N/A	1.6^	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

^ Limiting SFP may be extended by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.

3- DX (Comms)

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	3.9	4.16	-	0	-
Standard value	2.5*	2.6	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

4- NV

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.95	-	0	0	-
Standard value	2.5*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

5- AHU (Kitchen)

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.95	-	-	0	0.74
Standard value	2.5*	N/A	N/A	N/A	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

1- DHW

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	3.37	0.005
Standard value	2*	N/A

* Standard shown is for all types except absorption and gas engine heat pumps.

Figure 40 Allowed for system efficiencies in the detailed analysis.

Criterion 1: The calculated CO_2 emission rate for the building must not exceed the target

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	56.2
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	56.2
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	42.1
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

Figure 41 Building Emission Rating < Target Emission Rating

Energy Consumption by End Use [kWh/m^2]

	Actual	Notional
Heating	5.38	9.33
Cooling	6.78	8.96
Auxiliary	31.07	26.57
Lighting	21.72	40.95
Hot water	21.62	25.2
Equipment*	86.72	86.72
TOTAL**	**86.56**	**111.01**

* Energy used by equipment does not count towards the total for consumption or calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Figure 42 Energy Consumption by End Use

The current design results in a betterment of 25% of the Target Emission Rating (TER).

7.2. Hotel (Detailed Analysis)

The Hotel's major energy use, 65%, comes from hot water production for guests showering, with signifcantly less energy use from the heating, cooling and the lighting (7%, 5%, 8% respectiverly) in the bedrooms and communal spaces.

There is consistent energy demand through the night with the first peak in the in the morning when guests shower, and breakfast is prepared before dropping for the rest of the morning and afternoon, until a second peak forms for the guests evening meal.

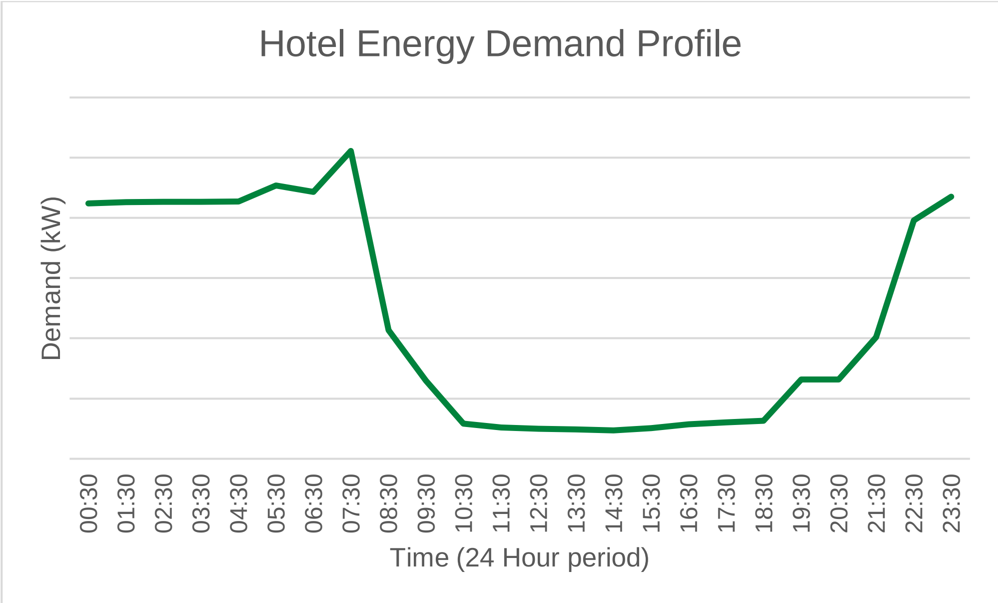


Figure 43 Hotel energy demand profile

Criterion 2: The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Values which do not achieve the standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{a-Limit}$	U_{a-Calc}	U_{i-Calc}	Surface where the maximum value occurs*
Wall**	0.35	0.23	0.33	06000001:Surf[7]
Floor	0.25	0.22	0.22	NR000007:Surf[0]
Roof	0.25	0.18	0.18	0200000E:Surf[0]
Windows***, roof windows, and rooflights	2.2	1.6	1.6	NR000013:Surf[1]
Personnel doors	2.2	2.2	2.2	NR00001D:Surf[2]
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building

$U_{a-Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
U_{a-Calc} = Calculated area-weighted average U-values [W/(m²K)]
U_{i-Calc} = Calculated maximum individual element U-values [W/(m²K)]

* There might be more than one surface where the maximum U-value occurs.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
*** Display windows and similar glazing are excluded from the U-value check.
N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
m³/(h.m²) at 50 Pa	10	3

Figure 44 Allowed for U-value's in the detailed analysis.

1- Toilet Extract

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.95	-	0	0	-
Standard value	2.5*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

2- FCU (FoH)

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.95	5.79	0	0.3	0.96
Standard value	2.5*	3.2	N/A	1.6^	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

^ Limiting SFP may be extended by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.

3- NV

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.95	-	0	0	-
Standard value	2.5*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

4- Extract Only

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.95	-	0	0	-
Standard value	2.5*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

5- Kitchen AHU

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.95	-	0	0	0.74
Standard value	2.5*	N/A	N/A	N/A	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

6- AHU S+E

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.95	-	-	0	0.74
Standard value	2.5*	N/A	N/A	N/A	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

7- DX (Comms)

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	3.9	4.16	-	0	-
Standard value	2.5*	2.6	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

8- FCU (Hotel Rooms - Extract)

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	3.27	-	0	0	0.74
Standard value	2.5*	N/A	N/A	N/A	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

9- FCU (Hotel Rooms - VRF)

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	3.27	9.63	0	0	0.74
Standard value	2.5*	2.6	N/A	N/A	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

1- DHW

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	3.37	0.005
Standard value	2*	N/A

* Standard shown is for all types except absorption and gas engine heat pumps.

Figure 45 Allowed for system efficiencies in the detailed analysis.

Criterion 1: The calculated CO_2 emission rate for the building must not exceed the target

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	51.9
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	51.9
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	41.5
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

Figure 46 Building Emission Rating < Target Emission Rating

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	6.14	12.81
Cooling	4.45	2.54
Auxiliary	12.83	9.66
Lighting	6.92	11.36
Hot water	55.95	66.13
Equipment*	59.25	59.25
TOTAL**	86.29	102.5

* Energy used by equipment does not count towards the total for consumption or calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Figure 47 Energy Consumption by End Use

Figure 47 Energy Consumption by End Use shows that the heating, lighting and hot water consumption in the actual building is less than that in the notional building. This is achieved through the use of efficient LED's and absence/presence control.

The current design results in a betterment of 20% of the Target Emission Rating (TER).

7.3. Market Hall (Detailed Analysis)

The Market Building has a diverse mix of uses including retail, cafes, bars and co-working spaces all with a differing energy demand. The major energy uses in the market are equipment and lighting, with the remaining energy usage evenly split between the heating, cooling and the hot water.

As the energy demand profile below shows, there is no overnight energy demand with a steady increase to a daily peak at lunchtime when the café, restaurant and food hall will be at their busiest, before levelling off for the afternoon before a second, slightly lower peak, for evening meals before gradually decreasing until close.

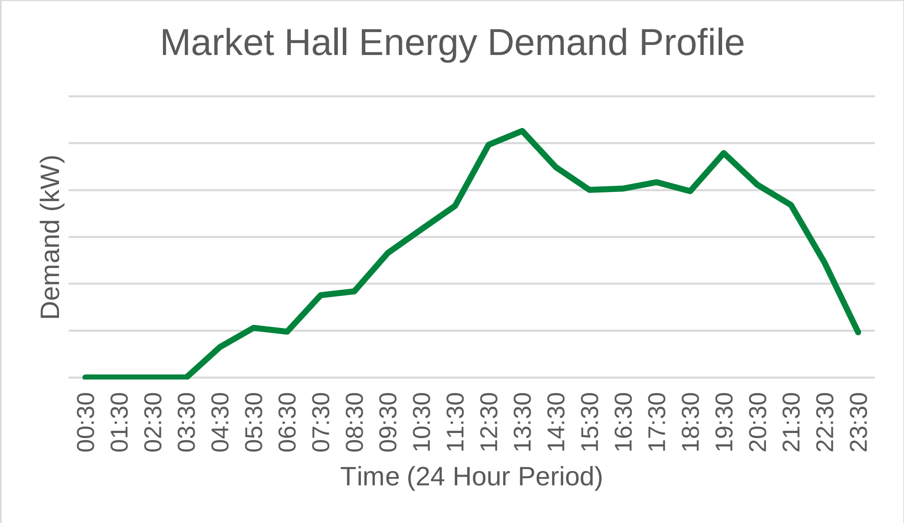


Figure 48 Market hall energy demand profile

Criterion 2: The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Values which do not achieve the standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.21	0.36	00000001:Surf[9]
Floor	0.25	0.22	0.22	NR000011:Surf[0]
Roof	0.25	0.18	0.18	NR000008:Surf[1]
Windows***, roof windows, and rooflights	2.2	1.6	1.6	NR00001C:Surf[1]
Personnel doors	2.2	-	-	No Personnel doors in building
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m²K)]
$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [W/(m²K)]

* There might be more than one surface where the maximum U-value occurs.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
*** Display windows and similar glazing are excluded from the U-value check.
N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
m³/(h.m²) at 50 Pa	10	3

Figure 49 Allowed for U-value's in the detailed analysis.

1- EO

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficie
This system	1	-	0	0	-
Standard value	N/A	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

2- NV

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficie
This system	1	-	0	0	-
Standard value	N/A	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

3- Supply & Extract

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficie
This system	4.95	5.79	0	1.8	0.74
Standard value	2.5*	3.2	N/A	1.6^	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN for limiting standards.

^ Limiting SFP may be extended by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system inclu additional components as listed in the Guide.

4- FCU

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficie
This system	4.95	5.79	0	1.8	0.74
Standard value	2.5*	3.2	N/A	1.6^	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN for limiting standards.

^ Limiting SFP may be extended by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system inclu additional components as listed in the Guide.

1- DHW

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	3.37	0.005
Standard value	2*	N/A

* Standard shown is for all types except absorption and gas engine heat pumps.

Figure 50 Allowed for system efficiencies in the detailed analysis.

Criterion 1: The calculated CO_2 emission rate for the building must not exceed the targ

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	50.1
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	50.1
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	37.4
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

Figure 51 Building Emission Rating < Target Emission Rating

Energy Consumption by End Use [kWh/m^2]

	Actual	Notional
Heating	12.52	5.67
Cooling	18.17	9.07
Auxiliary	39.71	20.31
Lighting	29.17	47.91
Hot water	15.23	17.9
Equipment*	81.69	81.69
TOTAL**	**114.79**	**100.86**

* Energy used by equipment does not count towards the total for consumption or calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Figure 52 Energy Consumption by End Use

As you can see in Figure 52 Energy Consumption by End Use, the lighting is improved in the actual building compared to the notional due to the efficient LED and lighting controls used.

The current design results in a betterment of 25% of the Target Emission Rating (TER)

7.4. Multimedia Centre (Benchmark Analysis)

The Multimedia Building has a diverse mix of uses including entertainment, dining, and retail all with a differing energy demand. Using benchmarking analysis, the major energy uses in the multimedia centre are split almost equally between equipment, heating, hot water and lighting with the rest of the energy being by auxiliary power to the pumps and fans in addition to the cooling.

The energy demand in the Multimedia Centre builds throughout the day to a peak in the evening when the food and beverage units will be at their busiest and the cinema and bowling will also be full of customers.

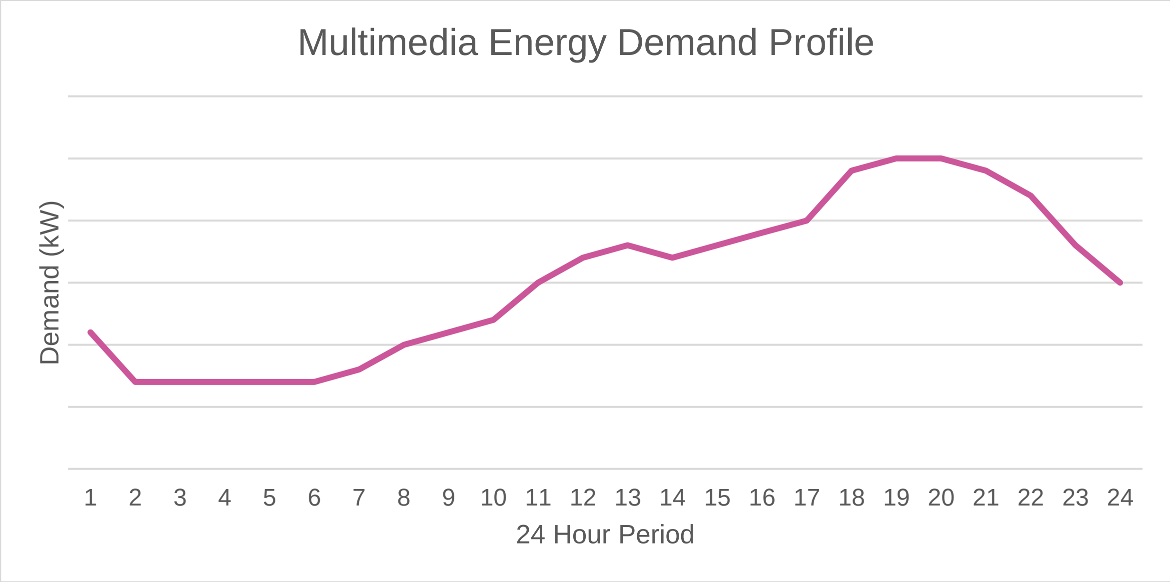


Figure 53 Multimedia energy demand profile

Detailed modelling has not been undertaken, but using benchmarking figures, the typical energy C02 emission rate and the total energy consumption can be shown in the table below:

BUILDING	KG/CO2/M2/ANN	KWH/M2
Multimedia Centre	92.54	175.94

7.5. Car Park & External Lighting (Benchmark Analysis)

The energy demand of the car park is made up of lighting and auxiliary power used for the ventilation fans.

The energy demand in the Car Park will increase as people leave in the morning, with some fluctuation over the afternoon before a second lower peak when people arrive home in the evening.

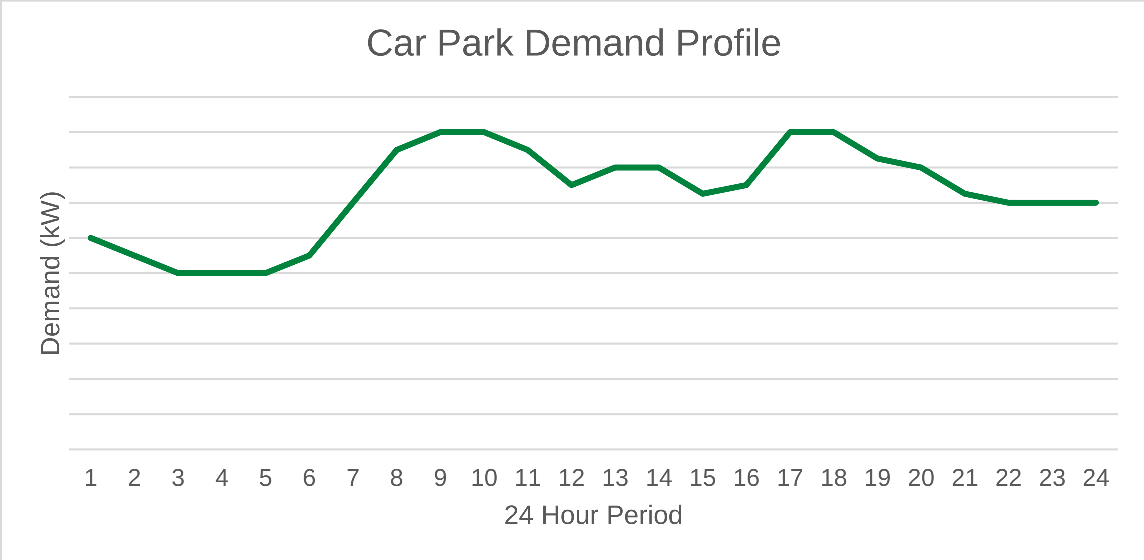


Figure 54 Car park demand profile

Detailed modelling has not been undertaken, but using benchmarking figures, the typical energy CO2 emission rate and the total energy consumption can be shown in the table below.

BUILDING	KG/CO2/M2/ANN	KWH/M2
Car Park	43.66	83.00

An allowance for Electric Vechile (EV) charging has been made, but a detailed analysis is needed to be undertaken:

RESIDENTIAL	NON-RESIDENTIAL
33No Positions complete with charging unit	40No Positions complete with charging unit
295No Positions with infrastructure only (No charging unit)	

7.6. Residential (Detailed and Benchmark Analysis)

SAP calculations have been carried out as part of the detailed design analysis for residential blocks F, G, H, J. The apartments have an individual EPC rating of A or B.

Blocks A, B, C, D, E are outline planning only and are only benchmark calculations at this stage, based on the SAP calculations for Blocks F, G, H, J

The energy demand profile, below, shows a consistent energy usage throughout the day, with a peak at lunchtime and again in the evening.

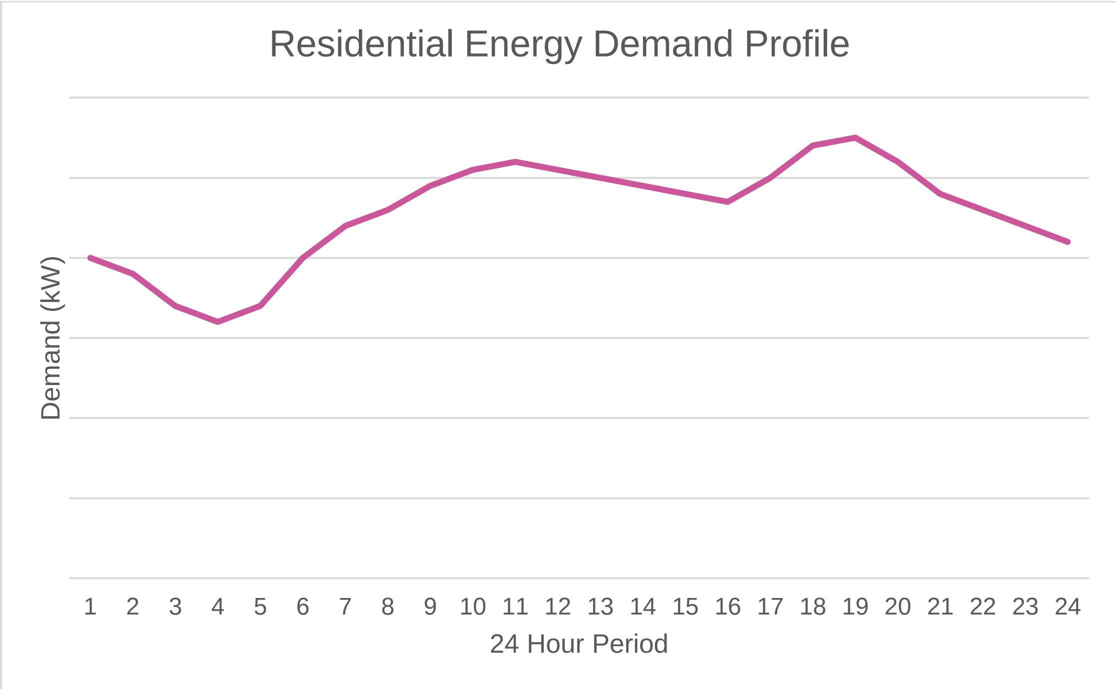


Figure 55 Residential energy demand profile

Unlike the BRUKL output document for the commerical spaces, the SAP calculations only provide the Dwelling Emission Rate (DER) and the Target Emission Rate (TER) for each individual apartment and as a block compliance.

The average Dwelling Emission Rate (DER) and the Target Emission Rate (TER) for all the blocks have been calculated as per the following table

DER (KGCO2/M2)	TER (KGCO2/M2)
7.13	23.55

The energy consumption in the apartments have been minimised by the inclusion of high efficiency LED lighting, mechanical ventilation with a heat recovery efficiency of 92.9%and summertime openable windows.

The specific inputs in the SAP calculations are:

Building Fabric

Element	Target U-Value (w/m2K)	G-Value
Wall	0.20	
Glazing	1.40	0.63
Exposed Floors	0.15	
Roof	0.15	

Air permeability	**Worst acceptable standard**	**This building**
$M^3/(h.m^2)$ at 50 Pa	10	5

The following building service parameters were used:

Main Heating	Community Heating
Description	Space + water combined
SAP Code	2310

Water Heating	Community Heating
SAP Code	901
Hot Water Cylinder	
Cylinder in Heated Space	Yes
Insulation Type	Measured Loss
Cylinder Volume	210L
Loss	1.34kWh/day

Mechanical Ventilation	
Windows Open in Hot Weather	Windows fully open
Air Change Rate	6
Mechanical Ventilation System Present	Yes
Type	Balanced Mechanical Ventilation with Heat Recovery
MV Reference	500447
Configuration	2
MVHR Duct Insulated	Yes
Manufacturer SFP	0.46
Duct Type	Rigid
MVHR Efficiency	92

The SAP calculations have allowed for circa 550kWh/year per dwelling of PV to offset the remaining carbon emissions.

SUMMARY FOR INPUT DATA
Calculation Type: New Build (As Designed)

Design SAP
elmhurst energy

Property Reference	F-00-002	Issued on Date	10/05/2021
Assessment Reference	001	Prop Type Ref	
Property			

SAP Rating	82 B	DER	9.36	TER	30.81
Environmental	94 A	% DER<TER	69.62		
CO_2 Emissions (t/year)	0.38	DFEE	48.20	TFEE	54.44
General Requirements Compliance	Pass	% DFEE<TFEE	11.45		

Assessor Details	Mr. Steven Johnson, Steven Johnson, Tel: 0795607219, steven.johnson@twcconsulting.com	Assessor ID	Z708-0001
Client			

SUMMARY FOR INPUT DATA FOR: New Build (As Designed)

Orientation	North East
Property Tenure	Owner-occupied
Transaction Type	New dwelling
Terrain Type	Suburban
1.0 Property Type	Flat, Mid-Terrace
2.0 Number of Storeys	1
3.0 Date Built	2021
4.0 Sheltered Sides	2
5.0 Sunlight/Shade	Average or unknown

6.0 Measurements

	Heat Loss Perimeter	Internal Floor Area	Average Storey Height
Ground Floor:	14.62 m	51.15 m²	2.60 m

7.0 Living Area 27.20 m²

8.0 Thermal Mass Parameter Simple calculation - Low

Thermal Mass 100.00 kJ/m²K

9.0 External Walls

Description	Type	U-Value (W/m²K)	Gross Area (m²)	Nett Area (m²)
External Wall 1	Steel Frame	0.20	38.01	25.70

9.1 Party Walls

Description	Type	Construction	U-Value (W/m²K)	Area (m²)
Party Wall/Heated Corridors	Filled Cavity with Edge Sealing		0.00	37.21

11.0 Heat Loss Floors

Description	Type	Construction	U-Value (W/m²K)	Area (m²)
Heat Loss Floor 1	Ground Floor - Solid		0.15	51.15

12.0 Opening Types

Description	Data Source	Type	Glazing	Glazing Gap	Argon Filled	G-value	Frame Type	Frame Factor	U Value (W/m²K)
Glazing	BFRC data	Window	Double Low-E Soft 0.1			0.63			1.40
Door	Manufacturer	Solid Door							1.20

13.0 Openings

SUMMARY FOR INPUT DATA
Calculation Type: New Build (As Designed)

Design SAP
elmhurst energy

Name	Opening Type	Location	Orientation	Curtain Type	Overhang Ratio	Wide Overhang	Width (m)	Height (m)	Count	Area (m²)	Curtain Closed
Windows	Window	[1] External Wall 1	North East	None	0.00					9.84	
Door	Solid Door	[1] External Wall 1	North East							2.47	

14.0 Conservatory	None	
15.0 Draught Proofing	100	%
16.0 Draught Lobby	No	

17.0 Thermal Bridging Calculate Bridges

17.1 List of Bridges

Source Type	Bridge Type	Length	Psi	Imported
Table K1 - Approved	E2 Other lintels (including other steel lintels)	5.13	0.300	No
Table K1 - Approved	E4 Jamb	14.40	0.050	No
Table K1 - Approved	E5 Ground floor (normal)	14.62	0.160	No
Table K1 - Approved	E7 Party floor between dwellings (in blocks of flats)	14.62	0.070	No
Table K1 - Approved	E16 Corner (normal)	2.50	0.090	No
Table K1 - Approved	E18 Party wall between dwellings	7.80	0.060	No
Table K1 - Default	P1 Party wall - Ground floor	14.31	0.160	No
Table K1 - Default	P3 Party wall - Intermediate floor between dwellings (in blocks of flats)	14.31	0.000	No

Y-value 0.097 W/m²K

18.0 Pressure Testing	Yes	
Designed AP_{50}	5.00	m³/(h.m²) @ 50 Pa
Property Tested ?		
As Built AP_{50}		m³/(h.m²) @ 50 Pa

19.0 Mechanical Ventilation

Summer Overheating

Windows open in hot weather	Windows fully open
Cross ventilation possible	Yes
Night Ventilation	No
Air change rate	6.00

Mechanical Ventilation

Mechanical Ventilation System Present	Yes
Approved Installation	Yes
Mechanical Ventilation data Type	Database
Type	Balanced mechanical ventilation with heat recovery
MV Reference Number	500447
Configuration	1
MVHR Duct Insulated	Yes
Manufacturer SFP	0.39
Duct Type	Rigid
MVHR Efficiency	93.00
Wet Rooms	1

20.0 Fans, Open Fireplaces, Flues

	MHS	SHS	Other	Total
Number of Chimneys	0		0	0
Number of open flues	0		0	0
Number of intermittent fans				0
Number of passive vents				0

Number of flueless gas fires	0	
21.0 Fixed Cooling System	No	
22.0 Lighting		
Internal		
Total number of light fittings	10	
Total number of L.E.L. fittings	10	
Percentage of L.E.L. fittings	100.00	%
External		
External lights fitted	No	
23.0 Electricity Tariff	Standard	
24.0 Main Heating 1	None	
26.0 Community Heating		
Community Heating	Space and Water Combined	
Space Community Heating		
PCDF Index	n/a	
Distribution Loss	Piping system >= 1991, pre-insulated, medium temp, variable flow	
Controls	CCJ Charging system linked to use of community heating, TRVs	
SAP Code	2310	
PCDF Index	n/a	

	Heat Source	Fuel Type	Heating Use	Efficiency	Percentage Of Heat	Heat	Heat Power Ratio	Electrical
Heat Source 1	Heat pump	Electricity	Space and Water	320.00	100.00%			

28.0 Water Heating	HWP From main heating 1	
Water Heating	Community Heating	
Flue Gas Heat Recovery System	No	
Waste Water Heat Recovery Instantaneous System 1	No	
Waste Water Heat Recovery Instantaneous System 2	No	
Waste Water Heat Recovery Storage System	No	
Solar Panel	No	
Water use <= 125 litres/person/day	Yes	
SAP Code	901	
29.0 Hot Water Cylinder	Hot Water Cylinder	
Cylinder Stat	Yes	
Cylinder In Heated Space	Yes	
Insulation Type	Measured Loss	
Cylinder Volume	210.00	L
Loss	1.34	kWh/day
Pipes insulation	Fully insulated primary pipework	
32.0 Photovoltaic Unit	More Dwellings, One Block	
Apportioned	550.00	kWh/Year

Recommendations

Lower cost measures

None

Further measures to achieve even higher standards

None

7.7. Overall Energy Demand

The graph below shows each building has a different energy demand profile and these are overlaid to give an understanding of the overall site energy demand throughout the day and the opportunities for sharing and storing energy.

The graph shows the site has defined peak mid-morning then dips mid-afternoon and peaks again in the evening before dropping to a minimum overnight. This profile gives opportunities for utilising battery storage to store energy from the PV panels on site if it cannot be used when it is generated, and to store low cost energy overnight for use in the day.

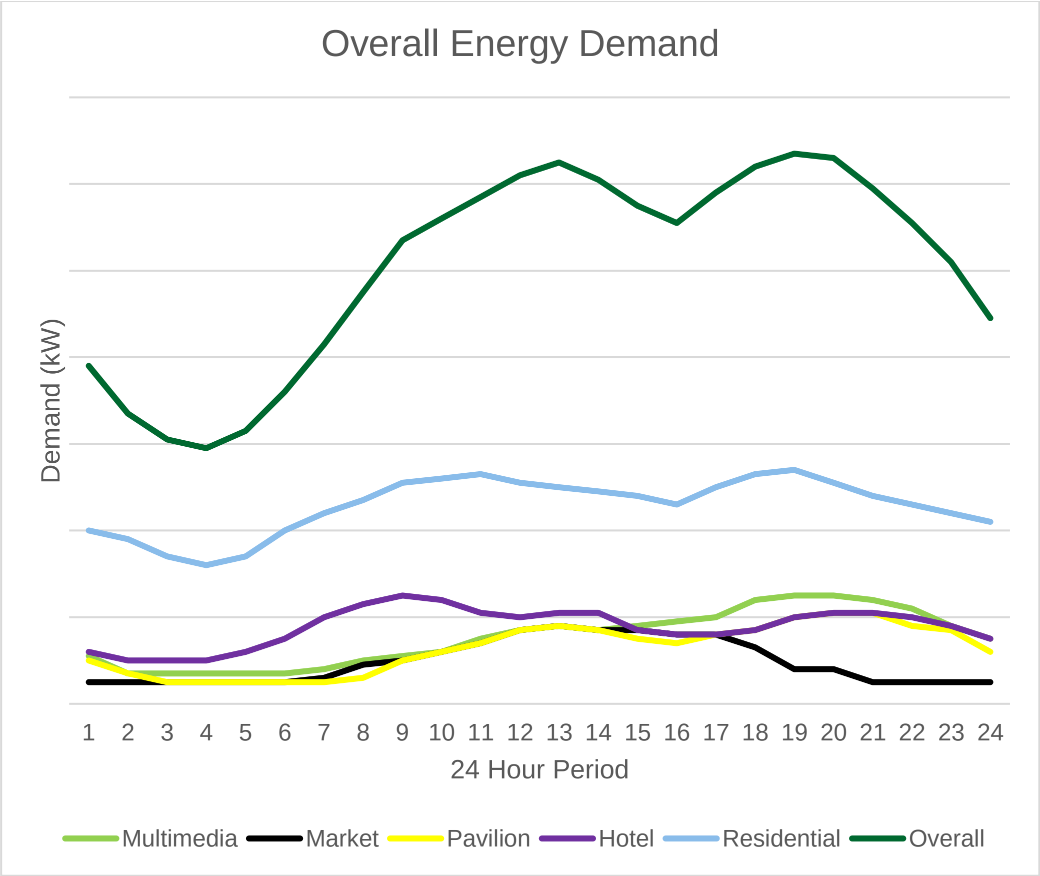


Figure 56 Overall energy demand

7.8. Summary of the Predicted Carbon Emissions (Regulated)

BLOCK	AREA (M2)	TER			BER			% IMPROVEMENT ON TER OVER PART L 2013
		(KGCO2/M2/ANN)	(KGC02/ANNUM)	(TONNESCO2/ANNUM)	(KGCO2/M2/ANN)	(KGC02/ANNUM)	(TONNESCO2/ANNUM)	
				Non-Residential				
Hotel	5581.6	51.9	289,685.04	289.69	41.5	231,636.40	231.64	20%
Pavilion	2407.8	56.2	135,318.36	135.32	42.1	101,368.38	101.37	25%
Market Hall	6943.2	50.1	347,854.32	347.85	37.4	259,675.68	259.68	25%
Multi-Media Building	6442.2	108.87	701,362.31	701.36	92.54	596,161.19	596.16	15% Target Improvement on Benchmark
Car Park	11206	51.36	575,540.16	575.54	43.66	489,253.96	489.25	15% Target Improvement on Benchmark
Total (Non-Residential)			2,049,760.19	2,049.76		1,678,095.61	1,678.10	18%
				Residential				
Block A/B/C	16570.38	23.54	390,066.75	390.07	7.13	118,146.81	118.15	70%
Block D	6605.3	23.54	155,488.76	155.49	7.13	47,095.79	47.10	70%
Block E	1102	23.54	25,941.08	25.94	7.13	7,857.26	7.86	70%

BLOCK	AREA (M2)	TER			BER			% IMPROVEMENT ON TER OVER PART L 2013
		(KGCO2/M2/ANN)	(KGC02/ANNUM)	(TONNESCO2/ANNUM)	(KGCO2/M2/ANN)	(KGC02/ANNUM)	(TONNESCO2/ANNUM)	
Block F	5103.39	23.87	121,817.92	121.82	7.02	35,825.80	35.83	71%
Block G	2871.2	24.07	69,109.78	69.11	5.52	15,849.02	15.85	77%
Block H	4136.42	23.01	95,179.02	95.18	8.59	35,531.85	35.53	63%
Block J	1942.91	23.22	45,114.37	45.11	5.94	11,540.89	11.54	74%
Total (Residential)			902,717.68	902.72		271,847.41	271.85	70%
Total (Whole development)			**2,952,477.88**	**2,952.48**		**1,949,943.02**	**1,949.94**	**34%**

Note 1 – Areas are based on the modelled areas
Note 2 – Benchmark figures include both regulated and unregulated energy.

The overall predicted carbon emissions from the development indicate a significant reuction against the Target Emission Rating (TER):

- 18 % Non- Residential
- 70 % Residential

The current outline planning benchmark figures have been estimated at a target of 15% improvement and it is our aspiration that this improvement will be met and exceeded at the next Stage of design for these elements of the development.

Unregulated emissions

In addition to the regulated carbon emissions shown above, there will also be unregulated carbon emissions which are deemed to be the following. The estimated operational energy has been taken from the BRUKL calculations.

Unregulated emissions (tonnes per annum)	
Residential	504.45
Non Residential	1106.7
Total	1611.15

Note 1 – Allowance only for detailed planning schemes only, as outline operational unregulated energy is included within the figures in the Summary of Predicted Carbon Emissions (Regulated) at the beginning of section 7.8.

Battery Storage

Battery storage allows cheaper and less carbon intense electricity to be captured overnight and used during the day, when the cost of electricity is greater and the electricity is more carbon intense.

The impact of the proposed 1500kVa battery charging for 3 hours per day, for 365 days on the total site carbon emissions is a reduction in carbon emission of 426.25 tonnesCo2/annum, including a 50% utilisation factor which will be subject to a detailed analysis at RIBA Stage 4.

Summary of estimated operational carbon emissions

The table belows shows the total development operational carbon emissions associated with the regulated and unregulated energy use and battery storage:

Operational Carbon Emissions							
Baseline (TER & Unregulated)			Development Proposal (BER & Unregulated)			Impact of Battery Storage (TonnesCO2/Annum)	Total Proposed Residual Carbon Emissions (TonnesCO2/Annum)
Regulated (TonnesCO2/Annum)	Unregulated (TonnesCO2/Annum)	Total (TonnesCO2/Annum)	Regulated (TonnesCO2/Annum)	Unregulated (TonnesCO2/Annum)	Total (TonnesCO2/Annum)		
2,952.48	1611.15	4,563.63	1949.94	1611.15	3561.09	-426.25	3134.84

7.9. Impact of the decarbonisation of the National Electricity Grid

As explained in section 4.4 of this report, the decarbonisation of the Electricity Grid will result in the further reduction in predicted carbon emissions of the development.

The table below sets out the anticipated reduction in carbon emissions, with the future lowering of the carbon factor of the electricity grid.

YEAR	CARBON FACTOR (KGCO2/KWHR)	ANNUAL CARBON EMISSIONS (TONNES/CO2)	% REDUCTION ESTIMATED AGAINST CURRENT CARBON EMISSIONS
Baseline	0.519	4,563.63	N/A
Current Design 2021	0.519	3,134.84	31.31%
2025	0.108	652.34	85.71%
2030	0.085	513.41	88.75%
2038	0.040	241.61	94.71%

The reduced carbon factors have come from the Department of Business, Energy & Industrial Strategy (BEIS) 'Updated Energy and Emissions Projections 2018'

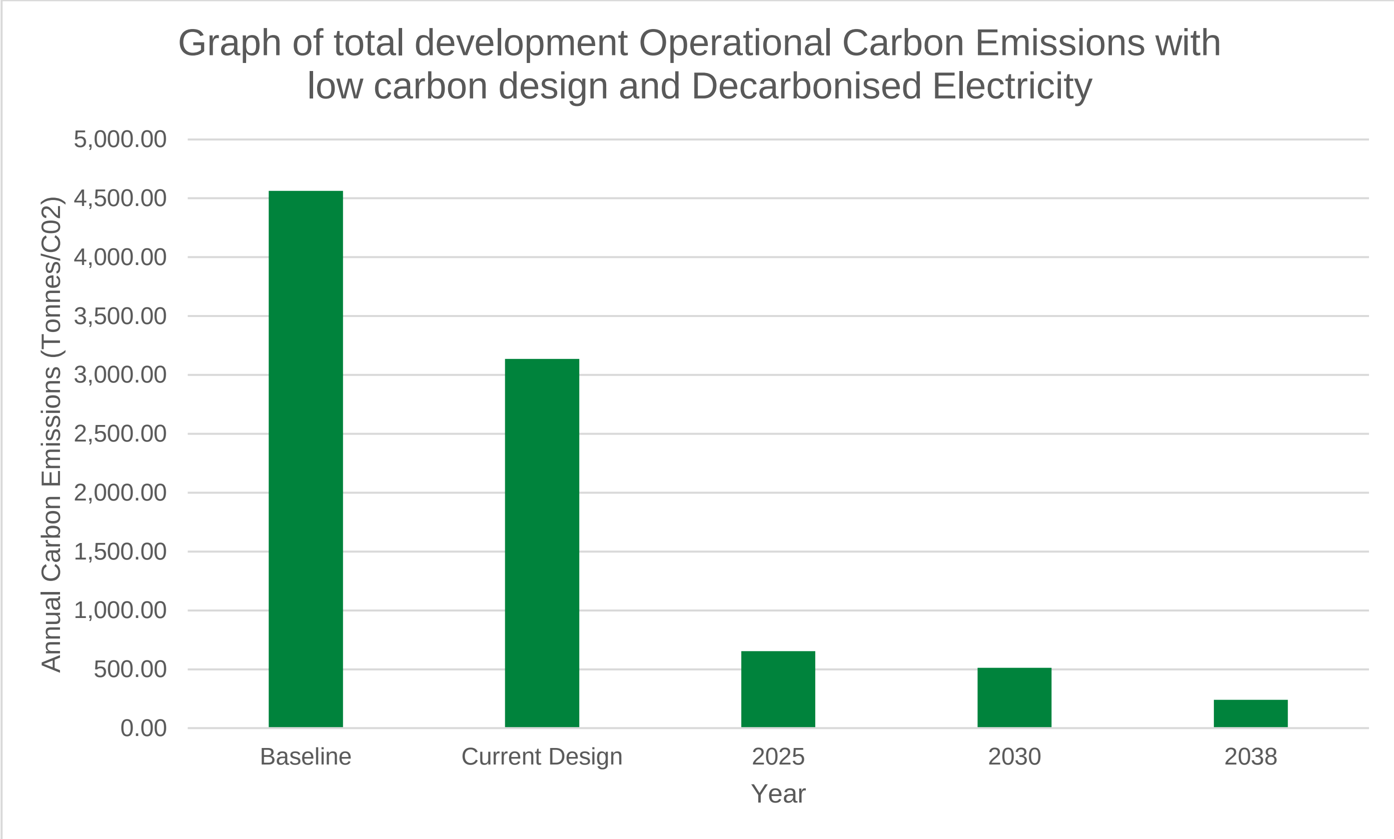


Figure 57 Carbon emissions with decarbonisation of Electricity Grid

8. CONCLUSION

The energy strategy report has set out the design teams approach to delivering a sustainable low carbon development that provides the ability to the operator to deliver a net zero carbon building of the operational base build carbon emissions in the future.

Our approach has followed the recognised strategy of fabric first followed by energy efficiency measures and then applying renewable and low carbon technologies.

The fabric first approach has driven a design intent to provide building U-values, air leakage rates that exceed the minimum requirements of Part L and therefore provide a significant reduction in the heat demand to the buildings.

Furthermore, the passive design, optimised use of natural ventilation where appropriate and reduced unwanted solar gain has minimised the extent of comfort cooling to the buildings.

The combination of these measures has significantly reduced the initial energy demand to the buildings and subsequent carbon emissions.

The next stage of the design process has been to incorporate energy efficiency measures such as:

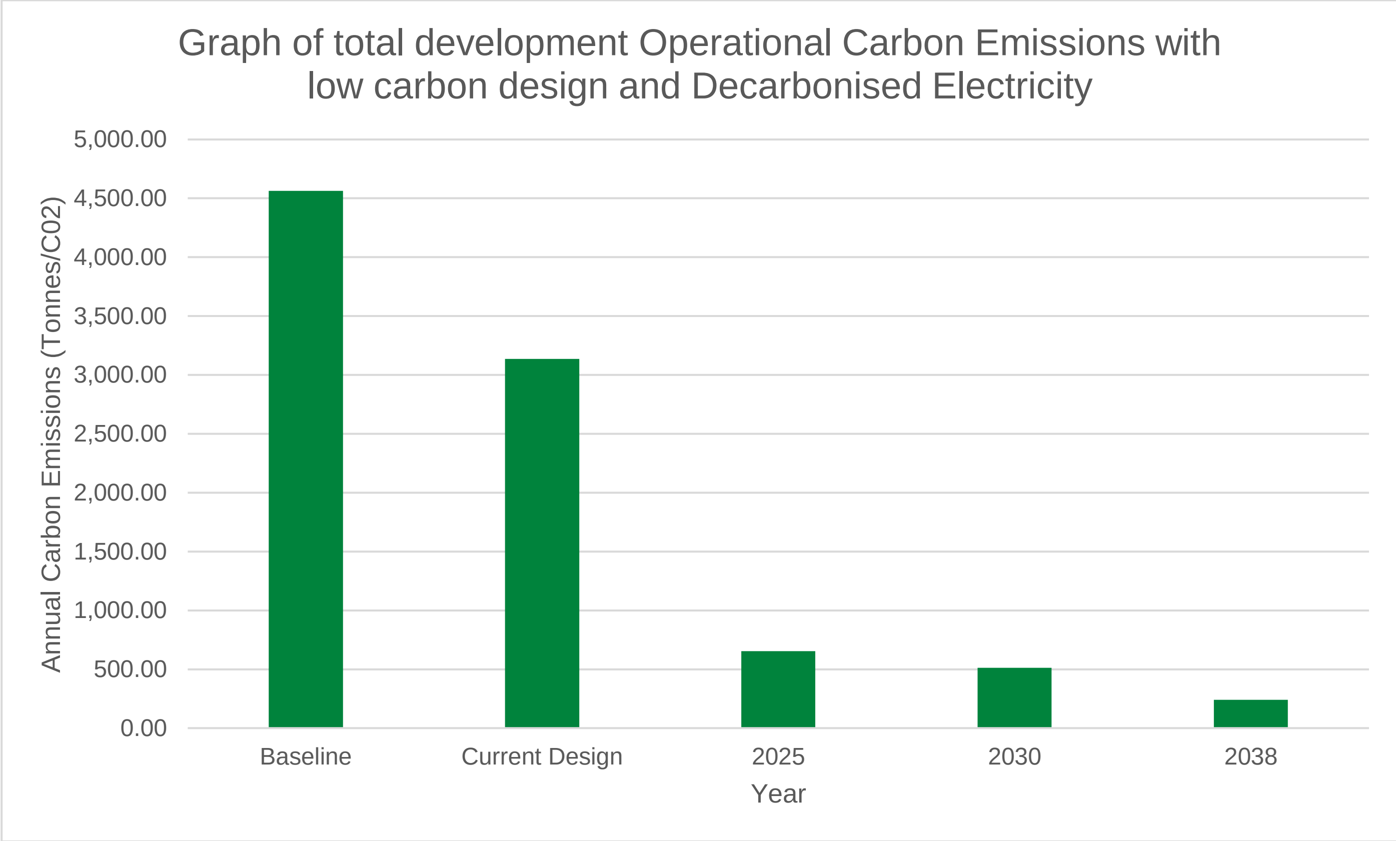
- Ventilation heat recovery
- Low energy LED lighting
- Demand operated controls
- Variable speed drives

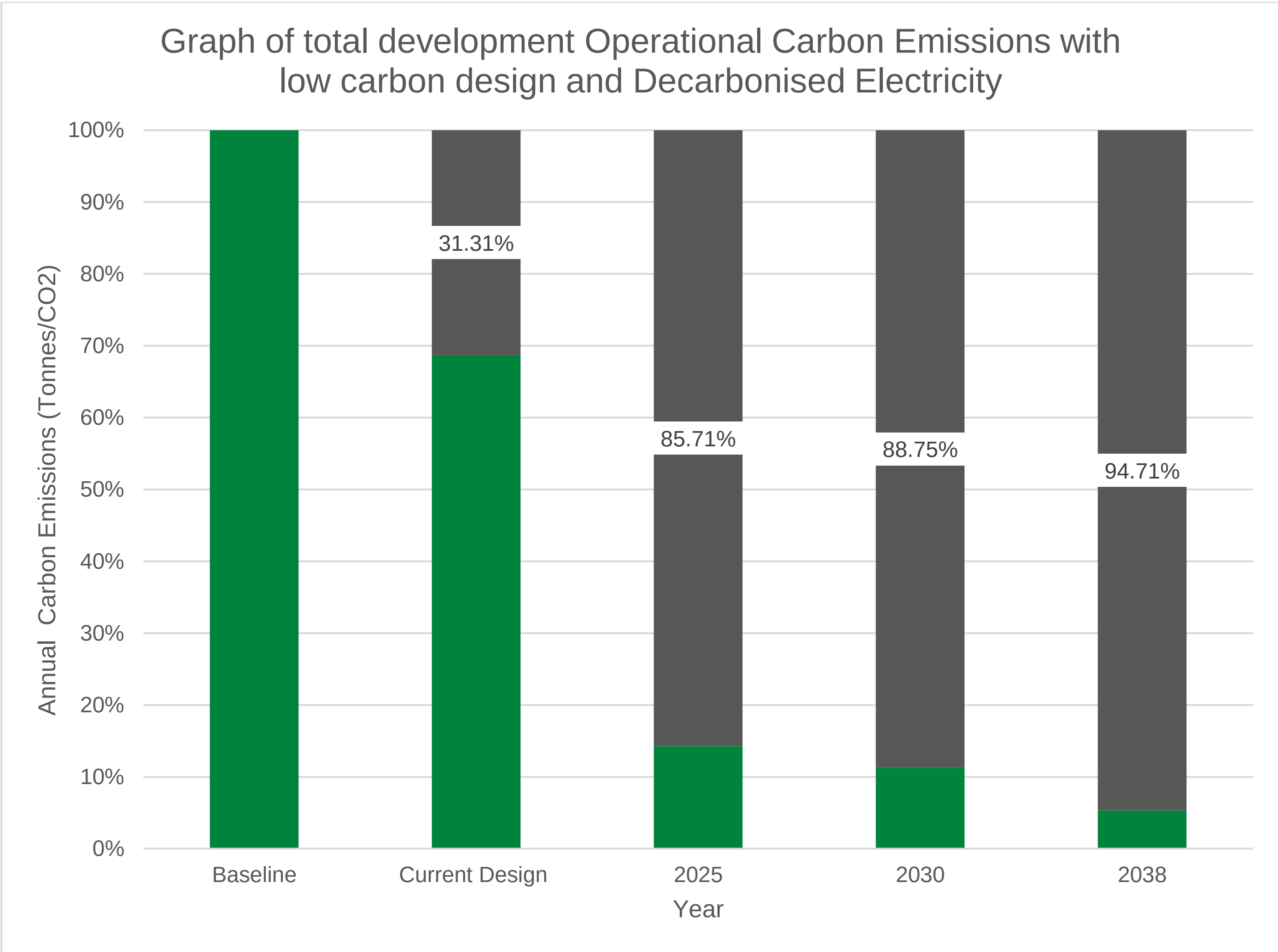
These systems deliver the required services such as heating, ventilation and lighting in an energy efficient manner and therefore further reduce the energy use and subsequent carbon emissions.

The final aspect of the design has been to incorporate the renewable and low carbon technologies such as the:

- Ground Source Heat Pumps
- Photovoltaic panels
- Battery storage

These systems further reduce the energy use, generate renewable electricity and offer the ability to store low carbon electricity. The combination of these measures have resulted in a predicted carbon reduction of the buildings emissions of 31.31% based on the current carbon emission targets but we predict by 2038, given the decarbonisation of the grid, this will deliver a 94.71% reduction.


Graph of total development Operational Carbon Emissions with low carbon design and Decarbonised Electricity
Annual Carbon Emissions (Tonnes/C02)
5,000.00
4,500.00
4,000.00
3,500.00
3,000.00
2,500.00
2,000.00
1,500.00
1,000.00
500.00
0.00
Baseline
Current Design
2025
2030
2038
Year


Graph of total development Operational Carbon Emissions with low carbon design and Decarbonised Electricity
Annual Carbon Emissions (Tonnes/CO2)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
31.31%
85.71%
88.75%
94.71%
Baseline
Current Design
2025
2030
2038
Year