Method Consulting

Intelligent engineering, sustainable buildings

10 – 12 Cave Street, Bristol

Energy and Sustainability Strategy

For Rengen Limmer Cave ltd

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Document History

This document has been revised and issued as below:

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P02	07/10/2022	Additional Comments	RDM	RDM
P03	22/03/2023	Revised Strategy	RDM	RDM
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P05	23/03/2023	Further Comments	RDM	RDM
P06	23/02/2024	Updated to address planning pre-commencement conditions	DMS	MAS

Contents

1 Executive Summary

Method Consulting LLP has been appointed to produce an Energy Strategy Report and Sustainability Statement as part of the Planning Application for the change of use and internal and external alterations of the Grade II listed Georgian buildings at 10 - 12 Cave Street, Bristol. The proposed change of use involves the internal and external refurbishment of the buildings and then conversion from offices into student accommodations.

This report outlines the sustainable features to be incorporated into the conversion works, and the approach taken to minimise energy demand without impacting on the character of this Grade II listed building and surrounding area. This report is written with particular reference to Bristol City Council's Climate Change and Sustainability Practice note, policies BCS13-16 of the Development Framework Core Strategy.

1.1 BCS13 Climate Change

The development will aim to mitigate the effects of climate change through the proposed use of passive design measures and water efficient fittings.

Passive design measures are to be incorporated in order to minimise the risk of overheating. The existing structure of the building is largely high in thermal mass, which will help to reduce the risk of overheating in summer. Dynamic overheating analysis has been completed using IES modelling software, and shows that the flats are not at significant risk of overheating. Additionally, as the building is intended and designed for student residential living, it is unlikely that the dwellings will be occupied during the hottest months of the year.

The existing site has limited landscaping, and this is proposed to be improved in order to aid in the improvement of Bristol's green infrastructure. This will also help to reduce the urban heat island effect to a limited extent.

1.2 BCS14 Sustainable Energy

Due to the limitations of working with a listed building, compliance with Policy BCS14 on Sustainable Energy cannot be demonstrated in full. However, the aspirations of Policy BCS14 have been followed where feasible. This is demonstrated by the energy strategy which is summarised by the graph below:

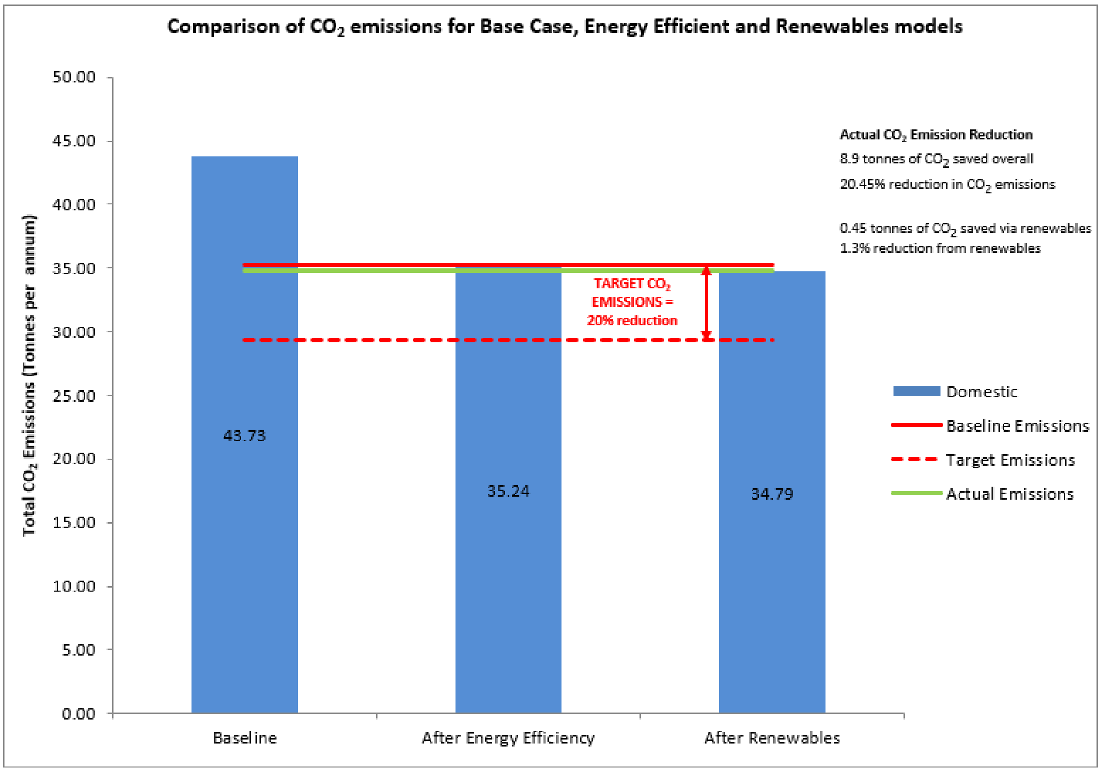


Figure 1: Graph showing the estimated annual carbon emissions for the baseline, residual and proposed scheme

The baseline scheme assumes building regulations compliant services with the existing, unimproved building fabric, assuming a gas heated scheme as the emissions standard. The energy efficient (residual) case upgrades the thermal envelope of the building where feasible, and uses 100% energy efficient lighting, and, in line with Planning Policy, assumes a communal gas-fired boiler for the flats. A carbon reduction of 19.4% over the existing baseline scheme is currently predicted through energy efficient design.

Through addition of a new PV array on the roof, a further 1.3% saving in carbon emissions is anticipated, with an overall carbon reduction of 20.45% against the baseline.

The development proposes to use gas boilers due to the limited improvements that can be made to the existing external fabric, given its listed status. As the heating loads are reasonably high, alternative technologies such as ASHP's will struggle to meet the required demand without much larger pipework and larger heat emitters throughout the property.

The site is located within the Bristol Heat Priority area and so has considered connection to the planned Bristol Heat Network. However, following correspondence with Jon Sankey at Vattenfall UK, he has confirmed that the DH network will not be in a position to provide a day one connection to the development. Vattenfall have suggested that efforts should be made to ensure that the building is ‘heat network ready’ so that it is future proofed for later decarbonisation.

The development proposes to provide sufficient space within the plantroom to allow future DH substation/plate heat exchanger to be installed and pipework connections between the plantroom (located within the basement of No. 10 Cave St) and Chapter street, for future connection to the DH Network once available. The internal heating distribution system will be designed to suit the flow and return temperatures required by the network.

1.3 BCS15 Sustainable Design and Construction

Compliance with BCS15 can be demonstrated through using materials as per the Green Guide to Specification, by specifying A and A+ rated materials where new materials are specified. Additionally, low flow sanitaryware fittings will be required to minimise water consumption, and low energy light fittings will be required to reduce energy consumption. The reuse of an existing building will reduce the embodied carbon associated with demolition and construction of a new building in place of the proposed conversion works.

1.4 BCS16 Flood Risk and Water Management

The site is located in Flood Zone 1 and is identified as being at low risk of flooding.

In addition, low flow water fittings are required throughout in order to reduce water consumption in each dwelling and improve over the Building Regulations limit/Bristol Water estimation of 125 litres/person/day. No planting is anticipated on site, which reduces the potential for unregulated water demand.

2 Introduction

2.1 Background and Proposal

Method Consulting LLP has been appointed to produce an Energy Strategy Report and Sustainability Statement as part of the Planning Application for the change of use, internal alterations, and building upon the Cave Street Grade II listed Georgian properties in Bristol.

The proposed change of use involves the conversion of the former office space into 19 self-contained student accommodations, with refurbishment of the external façade and windows, demolition of the existing extension to the rear elevation and remedial works to subsurface drainage, damp proofing works, roof, gutters, and hard and soft landscaping.

This report outlines the sustainable features to be incorporated into the conversion works, and the approach taken to minimise energy demand without impacting on the character of this Grade II listed building. This report is written with particular reference to Bristol City Council's Climate Change and Sustainability Practice note, policies BCS13-16 of the Development Framework Core Strategy.

2.2 Policy Context

Bristol City Council's Core Strategy requires developments to demonstrate how they will be designed and constructed in a sustainable manner in order to minimise natural resource use. Specifically, the policies pertinent to this energy and sustainability strategy are:

- BCS13 Climate Change: requires new developments to include adaptation and mitigation measures against the effects of climate change.
- BCS14 Sustainable Energy: requires new developments to minimise their energy requirements and incorporate renewable and low-carbon energy supplies to reduce their associated CO_2 emissions.
- BCS15 Sustainable Design and Construction: requires new developments to demonstrate how they will be designed and constructed to minimise their environmental impact and contribute to meeting CO_2 emissions reduction targets.
- BCS16 Flood Risk and Water Management: requires new developments to be resilient to flooding and include mitigation measures where necessary.

3 Energy Strategy

The proposed development is seeking to reduce carbon emissions by promoting the 'energy hierarchy' as follows:

- Prioritise being LEAN – use less energy, in particular by the use of sustainable design and construction measures
- Then CLEAN – supply energy efficiently and give priority to decentralised energy supply, and
- Then GREEN – use renewable energy

A detailed description of how these principles have been applied to the project can be found in the following sections of this report.

3.1 Establishing Baseline CO_2 Emissions

3.1.1 Domestic Emissions

The entire development was modelled in SAP to provide a best estimate of energy and carbon performance for the purposes of this Planning Application. Stroma FSAP 2012 software Version 1.0.5.50 has been used to model each of the sample dwellings.

The geometry of the dwellings has been modelled based on the following Studio Hive drawings, dated September 2021:

- 20100 - Basement floor, Proposed Plan, Rev P2
- 20110 - Ground floor, Proposed Plan, Rev P2
- 20120 - First floor, Proposed Plan, Rev P2
- 20130 - Second floor, Proposed Plan, Rev P2
- 20140 - Third floor, Proposed Plan, Rev P2
- 00002 – Roof Plan, Rev P2

In order to establish the baseline carbon emissions for the site, the methodology above has been used to model a 'base case scenario' for each element. The existing building fabric as defined for buildings build before 1900 has been taken from the SAP 2012 Guidance document, and used to provide an "as existing" baseline.

For the purposes of establishing the baseline emissions, building services are assumed to be centralised gas-fired boilers (85% efficiency) serving radiators; continuous mechanical extraction ventilation to bathrooms and kitchens; bedrooms naturally ventilated.

Note that these initial SAP calculations have only been produced to inform this sustainability strategy (these should not be used for building control).

Baseline energy demand (kWh pa)	165,133
Baseline CO_2 emissions (kg CO_2 pa)	43,731

Table 1: Baseline Energy Demand and CO_2 Emissions

3.2 Demand Reduction (Be Lean)

In order to comply with Part L1B of the Building Regulations, thermal elements must be improved to achieve the U-values outlined below, where technically, functionally, and economically feasible:

Element	Part L1B U-values ($W/m^2/K$)
Floor	0.25
Walls – cavity insulation	0.55
Walls – external or internal insulation	0.30
Pitched roof – insulation between rafters	0.18
Flat roof or roof with integral insulation	0.18
Windows and rooflights	1.60
Doors	1.80
	Limiting $m^3/h/m^2$
Air Permeability	15

Table 2: Limiting U-values for typical building elements under Part L1B

The proposed development will seek to achieve the U-values in Part L1B for new roof areas, along with any new doors and walls. Where existing roof spaces are above a dwelling, these will be packed with 300mm of new insulation where feasible, as this should not impact on the building character but will help to improve energy efficiency. Windows are also to be upgraded to double glazing to improve thermal performance where possible and in-line with the conservation officers' requirements.

However, due to the building being Grade II listed, the architect has identified that attempting to improve the fabric efficiency of the existing elements would impact on the character and appearance of the building. As such, the existing walls and floors will not be assessed in accordance with Part L1B.

Existing U-values are summarised in Table 3, based on assumptions due to the age of the building.

Element	Part L1B U-values (W/m^2K)	Target U-values (W/m^2K)
Existing basement floor	0.25	1.20* (assumed)
Existing walls – no insulation	0.55	2.10* (assumed)
New corridor walls	0.28	0.3
Existing pitched roof – insulation between rafters	0.18	0.14
Existing doors	N/A	3.00* (assumed)
New doors	1.80	1.8
Existing windows	N/A	4.8
New windows / rooflights	1.60	1.6

Table 3: Proposed U-values for building elements

**These elements cannot be improved without impacting on the character/appearance of the building, so are exempt from Part L1B.*

3.3 System Description (Building Services)

The flats are proposed to be continuously mechanically ventilated to studio ensuites and kitchen areas. The bedroom areas naturally ventilated. As part of the proposed works, heating is to be provided by a high-efficiency (95.5%) centralised gas boiler, which will serve each flat directly via radiators. Domestic hot water is to be provided by a centralised hot water cylinder (500L, standing loss of 3.12kWh/24hr).

Lighting in all spaces is assumed to be 100% low energy LED fittings.

3.4 Demand Reduction Results

As a result of the above energy-efficient measures and building elements, the development is anticipated to achieve a small reduction in CO_2 over the notional building, which is in line with the Bristol Plan requirements. The table below summarises the Be Lean results.

Sitewide Part L 2013 Emissions	Energy demand (kWh pa)	Energy saving achieved (%)	Regulated CO_2 emissions (kg pa)	Saving achieved on baseline CO_2 emissions (%)
Existing Building ("Baseline" energy demand and emissions)	165,133		43,731	
Proposed scheme after energy efficiency measures ("Residual" energy demand and emissions)	148,814	9.9%	35,238	19.4%
Total savings on baseline emissions	**16,319**	**9.9%**	**8,493**	**19.4%**

Table 3: Energy Efficiency Stage summary table

Through use of additional insulation in existing roof areas, upgraded windows (where possible) and doors and insulated corridors, energy demand can be reduced by around 10%, with a 19.4% reduction in regulated carbon emissions.

3.5 Heating Infrastructure (Be Clean)

The review of low and zero carbon technologies carried out for the scheme (see Section 3.6) concludes that the majority of these technologies would not be suitable for the development due to the nature of the existing protected building.

However, a communal heating network is proposed to serve the flats. It has been confirmed with Jon Sankey at Vattenfall UK that the DH network will not be in a position to provide a day one connection to the development. Vattenfall have suggested that efforts should be made to ensure that the building is ‘heat network ready’ so that it is future proofed for later decarbonisation.

The development proposes to provide sufficient space within the plantroom to allow future DH substation/plate heat exchanger to be installed and pipework connections between the plantroom (located within the basement of No. 10 Cave St) and Chapter

Street, for future connection to the DH Network once available. The internal heating distribution system will be designed to suit the flow and return temperatures required by the network.

In the meantime, a gas-fired communal heating system will be provided, as this will allow for a future connection of the heating plant to the Bristol Heat Network as it expands, helping to futureproof the development further and ultimately switch to a low carbon or renewable heating source, without requiring significant alteration to the building's character.

Gas boilers are proposed for this development due to the limited improvements that can be made to the existing external fabric, given its listed status. As the heating loads are reasonably high, ASHPs will struggle to meet the required demand without much larger pipework and larger heat emitters throughout the property. Larger distribution pipework would result in reduced ceiling heights, and act to reduce the available space within the flats.

The communal gas boilers are designed to operate at 60/40^{o}C flow/return. These temperatures allow hot water to be heated and pasteurised without the need for large electrical immersion heaters, which are very energy intensive. They also reduce the size of the pipework and emitters to a much more reasonable/standard size. It is not possible to achieve 60/40 using ASHP's without significantly compromising the system's efficiency (COP).

The gas boilers can also provide a "back-up" option if there were ever any issues with the BCC DH connection in the future. They could also provide "top-up" to heating system during colder winter periods, where additional heating output could be achieved by increasing the circulation flow temperature.

3.6 Low and Zero Carbon Technologies for Energy Production (Be Green)

In order to comply with the requirements of BCS14, a 20% reduction on CO_2 emissions must be provided through the use of renewable technologies. The following review of possible suitable technologies has been carried out to identify the suitability of select renewable technologies in this application.

3.7 Chosen Technologies

3.7.1 Future Connection to District Heating Network

Due to the constraints of the site itself and the listed status of the buildings to be refurbished, there are limited options to employ renewable or low carbon technologies. As the development is within a heavily urbanised area, many of the technologies discussed as a result of this report are unsuitable, either due to space limitations (either storage/ plant issues), planning requirements, visual or acoustic concerns, or cost of upkeep.

Connecting to Bristol's Heat Network, which is currently undergoing construction in close proximity to the site, represents the best way to reduce the potential emissions associated with Cave Street. As very little is able to altered with regards to the fabric of the building, connection to the network represents a low impact method of providing low/zero carbon energy to the development for the foreseeable future.

This option also adheres to the the BCS13 policy by helping to mitigate the city's impact on climate change, and policy BCS14. BCS15 is enabled by this technology due to Bristol Heat Network's target of decarbonising the energy supply via the use of a water-source heat pump. As the local heat networks are developed and steadily decarbonised, the effective carbon emissions associated with the development's regulated energy demand will be reduced significantly, though this cannot be quantified at this stage.

3.7.2 Photovoltaics

Solar energy can be converted to electricity using the photo-electric effect. Simply, Photo Voltaic (PV) cells use the energy from the sun to induce a current in a circuit. The cells are encapsulated between a sheet of toughened glass at the front and a moisture sealing membrane on the back to make them weatherproof.

In the UK PV panels are usually installed on roofs of buildings. The optimum position is facing south with a tilt angle of around 30°. PV cells can be purchased in the form of Building Integrated PV (BIPV) products such as roof tiles and glazing products. PV is potentially the easiest of all renewable energy technologies to embed into the built environment.

3.7.3 Suitability of Photovoltaics for the Proposed Development

The development has some roof space for the installation of solar power, which makes solar capture a potential option. Repair works are proposed for the existing roof, which should allow for a PV array of up to 6m^2 to be installed without compromising the structural integrity of the roof. This equates to approximately 1 kWp of PV, generating around 840 kWh/year. A small carbon reduction is anticipated as a result of the installation of this array, as detailed in Table 4.

Exact details of the PV system are yet to be confirmed

3.8 Discounted Technologies

3.8.1 Solar Hot Water Heating

There are two common types of solar collector that are used to provide hot water and space heating in domestic and commercial situations: flat plate collectors and evacuated tube collectors.

In flat plate collectors, the working fluid (typically a water/glycol mixture) is directly heated as it circulates through pipework within the collector. The absorber plate and associated pipe work usually sits below a glass cover within a heavily insulated enclosure to reduce heat loss.

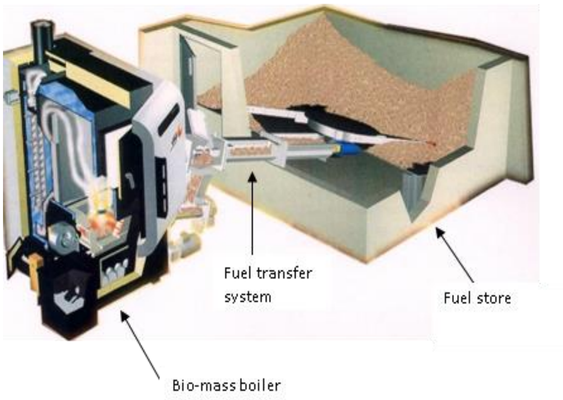
Evacuated tube collectors increase the efficiency of the system by enclosing the absorber plate it in a near vacuum. This dramatically reduces the heat loss by convection from the absorber surface. The fabrication of the glass tube is expensive and leads to a collector that will perform better, but at higher cost. Flat plate collectors are generally used on residential buildings and evacuated tube collectors on larger commercial buildings.

3.8.2 Suitability of Solar Hot Water Heating for the Proposed Development

Solar hot water heating arrays are associated with increased costs over traditional PV units, and require additional pipework and storage tanks for hot water. Despite the fact that these can be used year-round, such arrays typically require additional heating to provide adequate hot water during winter months. Due to significant additional cost of a solar hot water heating array, and the difficulty of providing standard solar PV, this technology has been discounted.

3.8.3 *Biomass Heating*

Biomass refers to burning natural, vegetative matter to produce heat. This heat can be used both to temper the building, and to meet the hot water requirements. The fuel used for the boiler is typically wood, which comes in the form of either chips or pellets. The CO_2 released when burning this matter is equivalent to the CO_2 the trees have absorbed in their lifetime. Thus, the whole process becomes almost carbon neutral. The only additional emissions will be from processing and transportation of the fuel to the site.



Biomass, like any solid fuel, requires storage on site, and to minimise the frequency of deliveries, significant space needs to be allowed for storage of fuel on site and associated access for delivery. Wood pellets have a higher energy density and more consistent size, shape and moisture content so are better suited to smaller boiler installations and where fuel delivery access is restricted.

Currently the cost of woodchips is slightly cheaper than the cost of natural gas, whereas the cost of wood pellets is similar to that of oil. However, the price of natural gas and oil has been very volatile in recent years and for many customers has doubled in price since 2002. In contrast the price of wood fuel has been much more stable, and it is thought that this is likely to remain the case in the medium to long term.

3.8.4 *Suitability of Biomass for the Proposed Development*

As the development does not incorporate any suitable communal access spaces for significant fuel deliveries, there is no space on the site for a suitably-scaled communal biomass heating system. Individual biomass boilers are not suitable for smaller properties or apartments due to the storage space required for fuel. As a result of these issues, the use of biomass has been discounted.

3.8.5 Wind Turbines

Wind turbines use energy from the wind to produce electricity. This electricity can be used on site or sold back to the national grid. The suitability of installing wind turbines is largely dependent on local wind speeds. Accurately estimating the energy available from wind at a specific site is a complex task and requires knowledge of the long-term wind speeds at height, taking into account climatic variations, the effect of topological features and ground friction factors. Average wind speeds of 7 m/s or above are required for large scale wind turbines, although average speeds in the region of 4-6m/s can be sufficient to make smaller turbines viable.

Turbines are rated by the power generated at a specific wind speed. At very low wind speeds turbines do not operate. When they reach their critical cut-in wind speed they generate at a lower level than the rating, and finally once the rated wind speed is reached the turbine is designed to maintain a fairly constant power output. As a turbine is not generating all of the time, and sometimes at part load, a good approximation of annual output is 20-30% of that expected if the turbine was operating continuously at its rated level throughout the year. This percentage is known as the capacity factor.

3.8.6 Suitability of Wind Turbines for the Proposed Development

Initial investigations suggest that the site is not well suited to a wind turbine, due to the urban location and associated local planning issues. Furthermore, turbines are associated with operational noise which is unsuitable for an urban area. It should also be noted that with the heating and hot water demand exceeding the energy able to be provided by wind turbines, the technology has been discounted from the analysis. Initial investigations of Wind speed at the site suggest an average speed of 4.8m/s at 25m, and therefore is not enough for the technology to be effective.

3.8.7 Combined Heat and Power (CHP)

Combined Heat and Power (CHP) machines are in effect mini power stations. When a power station burns gas, coal or oil to generate electricity, large amounts of heat is given off as a by-product. Large power stations waste this heat (via large cooling towers – it is simply emitted to atmosphere). A CHP unit aims to make use of this waste heat by putting it into a hot water cylinder or heating system when it generates electricity. The electricity can either be used within the building or sold back to the national grid if output exceeds demand.

A 5.5kWe output and 12.5t CHP Machine

The sizing of a CHP unit is complex and requires accurate analysis of the likely thermal and electrical loads within a building. As a guide, a CHP unit will also be financially viable if it can usefully run for more than 4,500 hours per year.

3.8.8 Suitability of CHP for the Proposed Development

CHP is typically identified as only being viable in large scale developments of around 200 dwellings, however micro-CHP units are available for smaller developments such as this. CHP typically has a high capital cost, and increased maintenance requirements when compared to a traditional gas boiler.

A typical 90% efficient CHP unit with a thermal efficiency of 60% and an electrical efficiency of 30%, which would provide a ~30% reduction in overall CO_2 emissions, would provide an estimated saving of ~50,000 $kgCO_2$ per annum. However, due to the lack of suitable plant space, the reduced real-world carbon savings (caused by the decarbonisation of the grid), and the increased maintenance costs of a CHP engine, this option has been discounted.

3.8.9 Heat Pumps

A heat pump uses the same 'vapour compression' technology that is used in a domestic refrigerator, but the cycle can be reversed to provide both heating and cooling to internal spaces. A heat pump uses electricity to transfer heat from one source to another rather than actually generating energy, with most of the energy coming from the ambient ground or water to which it is connected. The coefficient of performance (COP) is the ratio of the heat output to the electricity input. With most modern equipment the Seasonal COP will typically range from 3 to 5, i.e. for 1 kW of electrical input up to 5 kW of heating or cooling can be achieved.

Typical Air Source Heat Pump

It should be noted that because of the higher CO_2 emissions associated with the grid electricity supply, COPs have to be better than 2.5 before there is any reduction in CO_2 emissions compared to heating via gas fired condensing boilers. However, if the electricity is generated from renewable energy sources, then heat pumps can be part of a carbon neutral servicing strategy of providing both heating and cooling to buildings.

Heat pumps are characterised depending on the source of the heat and the sink used for the heat. In the heating mode, energy can be extracted from the air, water or from the ground and delivered to the space via fan powered air supply or a water circuit (such as underfloor heating or radiators). It should be noted that high COPs are generally only obtained when the flow temperature of the heating circuit to the building is relatively low, so they are often used with underfloor heating.

3.8.10 Suitability of Heat Pumps for the Proposed Development

Heat pumps for domestic heating and hot water demand have been discounted due to the significant heating demand for the flats, which cannot realistically be met with a typical heat pump installation (due to ineffectiveness of underfloor heating where heat losses are so large). Additionally, there are spatial limitations which prevent this from being a viable solution, both for Air Source Heat Pumps (limited external space in a suitable location) and for Ground Source Heat Pumps (no suitable locations for a borehole or ground loops).

3.9 LZC Options Summary

Due to the limitations brought about by the existing building being Grade II Listed, options for renewable/ low carbon technology are very limited. The addition of PV panels on the roof space will provide a small energy and carbon reduction, as demonstrated in Table 4 below.

It is believed that through reuse of the existing building structure and fabric the embodied carbon associated with the proposed development is significantly reduced. This achieves the aspirations of local planning policy through reuse rather than new construction. Future connections are also included within the proposal to connect to the Bristol Heat Network as this develops.

3.10 Energy Strategy Summary

The following table summarises the energy and carbon savings that could be achieved by the proposed development, by applying the energy strategy outlined above and demonstrates compliance with the Bristol City Council Climate Change and Sustainability Practice note.

Sitewide Part L 2013 Emissions	Energy demand (kWh pa)	Energy saving achieved (%)	Regulated CO_2 emissions (kg pa)	Saving achieved on residual CO_2 emissions (%)
Existing Building ("Baseline" energy demand and emissions)	165,133		43,731	
Proposed scheme after energy efficiency measures ("Residual" energy demand and emissions)	148,814	9.9%	35,238	
Proposed scheme after on-site renewables	147,952	0.6%	34,790	
Proposed scheme offset for financial contribution or other "allowable solution"				
Total savings on residual emissions			**448**	**1.3%**
Total Carbon Savings			8,941	20.45%

Table 4: Energy strategy summary table as required by Bristol City Council

3.11 Energy Strategy Summary

Through effective use of energy-efficient design, the proposed development is set to achieve a 20.45% reduction in carbon emissions. A total of 1.3% of this reduction is anticipated from renewable technologies, but the site is also proposing to connect to the expanding Bristol Heat Network, which is thought to be a reasonable approach and will secure future carbon reductions.

Whilst this does not demonstrate the 20% reduction in CO_2 emissions from renewables required for Policy BCS14, it does demonstrate the performance achievable given the feasibility of incorporating technologies into the change of use. This is believed to be an acceptable compromise given the nature of the development.

4 Sustainability Statement

4.1 BSC13 Climate Change

Policy BCS13 requires new developments to include adaptation and mitigation measures against the effects of climate change.

4.1.1 Design and Construction for Resilience/Green Infrastructure

Adequate cycle storage shall be provided as there is a secure area in the yard area to the rear of number 12, to encourage occupants to adopt sustainable travel practices, reducing reliability on cars. No additional parking is to be provided, and parking will be limited to on-street spaces, which will help to further discourage use of cars. The development is within close proximity to several bus stops on the A38 and City Road, and Bristol Temple Meads is a twenty-minute walk or 8-minute cycle away, further enabling use of sustainable transport. The development is also within close walking distance of several amenities such as Cabot Circus, The Bristol Shopping Quarter, along with Castle Park, providing access to local amenities via safe pedestrian routes, and encouraging occupants to walk.

The existing site has limited landscaping, and this is proposed to be improved in order to aid in the improvement of Bristol's green infrastructure. This will also help to reduce the urban heat island effect to a limited extent, and to improve the health and wellbeing of residents by providing a communal breakout area with natural shading.

4.1.2 Built Form/Avoiding Increase in Carbon Emissions

The units are proposed to be naturally ventilated, with mechanical extract in bathrooms and kitchens. The risk of overheating is to be limited through passive design measures, such as use of the existing heavyweight thermal mass structure, and use of surrounding structures for shading.

Building orientation across the development results in no occupied spaces having windows facing south, with recessed sash windows providing large opening area for natural ventilation. Communal corridors have openable windows to limit the risk of overheating of these spaces. Due to the significant heat loss resulting from the existing fabric, and the high thermal mass, overheating risk is generally low.

This risk is further reduced through the proposed nature of the development. As the building is intended and designed for student residential living, it is unlikely that the dwellings will be occupied during the hottest months of the year, as students typically return to their family homes during summer breaks.

Full, dynamic overheating has not been proposed, as it is thought to be of limited benefit to model a building of this nature. The heavyweight thermal mass, relatively small glazing area (reducing potential solar gains on each façade), and overshading from adjacent buildings will help to reduce the risk of occupant discomfort.

Blinds or curtains are proposed to be provided to provide occupants with the ability to manage solar gains according to their personal comfort levels. In the future, if solar gains were an issue, solar film could be utilised on any south-west facing windows. Windows are openable and can be kept open overnight to further aid in combating overheating.

Future measures that could be implemented in order to reduce overheating risk in future climate scenarios can include non-intrusive measures such as applying solar film to south-west-facing glazing, or more intrusive solutions such as installing phase change materials to the inner elements of each dwelling to further increase the thermal mass of the building.

4.1.3 Conserving Water Supplies

Sanitaryware fitting proposals are detailed in section 4.3.3 in more detail, with the aim of achieving or improving over the Building Regulations and Bristol Water requirements of ≤125 litres/person/day.

4.2 BCS14 Sustainable Energy

Policy BSC14 on Sustainable Energy has four main strands:

- To encourage major freestanding renewable and low carbon energy installations
- To promote an energy hierarchy prioritising energy efficiency
- To secure at least a 20% saving on CO_2 emissions from energy use in new developments through on-site generation from renewable energy
- To encourage the use of district heating schemes in new development

Attempted compliance with BCS14 can be demonstrated through the energy strategy as detailed in this report and summarised below:

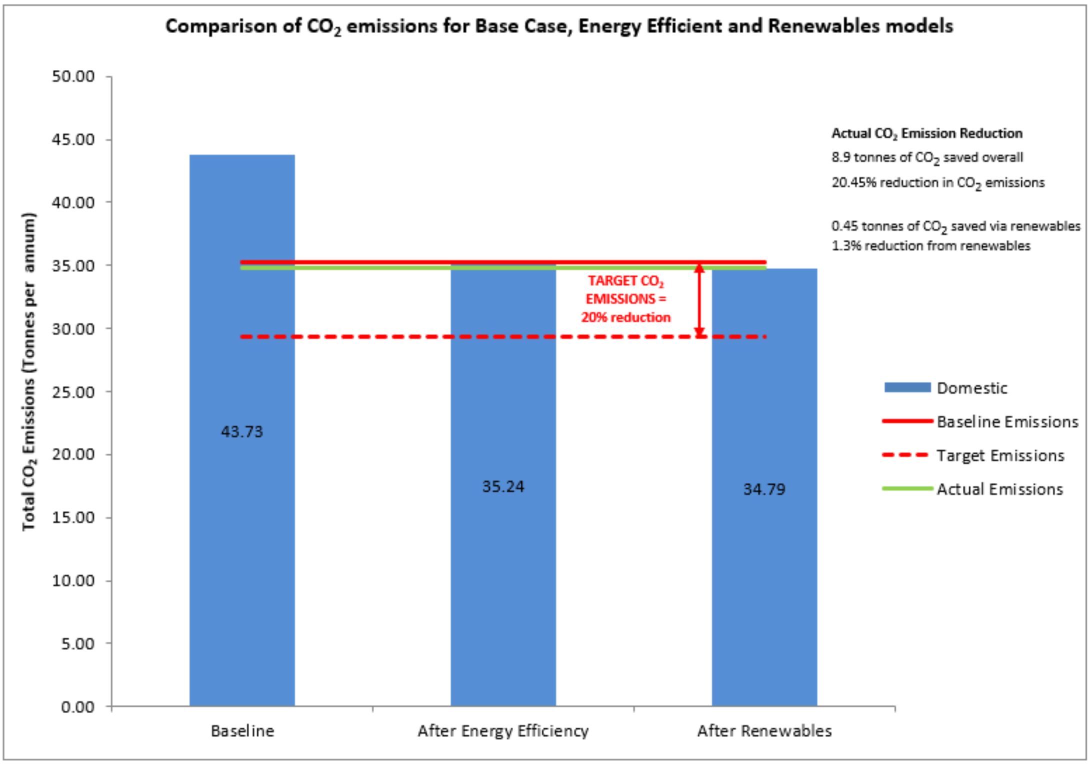


Figure 2: Graph showing the estimated annual carbon emissions for the baseline, residual and proposed scheme

The baseline scheme assumes building regulations compliant services with the existing, unimproved building fabric, assuming a gas heated scheme as the emissions standard. The energy efficient (residual) case upgrades the thermal envelope of the building where feasible, and uses 100% energy efficient lighting, along with a centralised gas-fired boiler for the flats. A carbon reduction of 20.45% over the existing baseline scheme is currently predicted through energy efficient design and use of a small PV array.

Beyond these initial calculations, where communal gas boilers have been assumed in order to establish predicted carbon emissions, as the site is located within the Bristol Heat Priority area, future connections to the district heat network will be provided and the heating distribution systems designed to allow simple connection to the network once this is available.

Although the proposed approach is not fully complaint with Policy BCS14, as a 20% reduction beyond the residual case is not achieved, the level of carbon reduction is deemed reasonable due to the building's Grade II listed status.

4.3 BCS15 Sustainable Design and Construction

Policy BCS15 requires developments to demonstrate how the key issues outlined in the section are to be addressed.

4.3.1 Maximising Energy Efficiency and Integrating Renewable and Low Carbon Energy

Where possible, new energy efficient insulation is to be specified for the development, with low U-values assigned to all new elements. Refer to the energy strategy (section 3) for full details.

100% low energy lighting is to be specified in the development in order to reduce energy consumption and building CO_2 emissions.

4.3.2 Waste and Recycling During Construction and in Operation

A compliant Site Waste Management Plan will be required for the duration of site works.

The development is to include appropriate waste and recycling storage for occupants, which will comply with the waste management scheme run by Bristol City Council.

4.3.3 Conserving Water Resources and Minimising Vulnerability to Flooding

In order to meet the Bristol City water consumption requirement of 125 litres/person/day, the following low-flow sanitaryware items are suggested:

- WCs: 4/2.5 litre dual flush
- Basin taps: 4 litres/minute
- Showers: 10 litres/minute
- Baths: 140 litres
- Kitchen taps: 5 litres/minute
- Dishwasher: 2 litres/place setting
- Washing machine: 9 litres/kg

Using the BRE’s average water efficiency calculator tool for domestic properties, a daily water consumption of 107.4 litres/person/day is predicted using the above fittings. This would represent a 14.08% improvement on the Building Regulations limit/Bristol Water estimation of ≤125 litres/person/day. No planting is anticipated as part of this development.

4.3.4 *Sustainable Construction Materials, Life Cycles and Sourcing*

Any timber used in the construction of this building will be legally harvested and traded timber (FSC is an example of demonstrating this). The use of environmentally friendly insulation, and where possible, A and A+ rated construction materials is anticipated.

4.3.5 *Flexibility and Adaptability*

Partition walls are not generally anticipated to be loadbearing, allowing for greater flexibility and adaptability beyond the proposed layouts. External extensions of the development are thought to be unlikely due to the site constraints.

As the proposed development means a change of use to the building, it is assumed that if required, the design provides flexibility to later alter the building layouts, such as a return to office spaces.

4.3.6 *Incorporation of Biodiversity Enhancing Measures*

As the development will be built entirely on previously developed land, with no change to the existing building footprint anticipated. Careful consideration of roosting bats and nesting birds should be implemented into the building works, as older buildings such as this can attract bats and birds due to their roof construction.

4.4 BCS16 Flood Risk Management

Policy BCS16 requires developments to be resilient to flooding through design and layout. In addition, it requires that a water management strategy be prepared to cover the reduction of surface water run-off and the reduction of water consumption by maximising water efficiency, and the specification of appropriate drainage methods.

The development is located within Flood Zone 1 and is therefore considered to be at low risk to flooding.

Refer to paragraph 4.3.3 for details of suggested water minimisation features. Specifying low water consuming fittings to meet the Bristol City Council requirement of ≤125l/person/day means the proposed development will comply with policy BCS16.

5 Conclusion

This report outlines the sustainable features to be incorporated into the proposed change of use of 10 – 12 Cave Street, Bristol. The site proposed to achieve compliance with policies BCS13-16 through increased insulation and the provision of a centralised heating scheme, which will be connected to the expanding Bristol Heat Network as a first priority, and will resort to communal gas-fired boilers as an alternative heating strategy should the network not be ready in the proposed construction timescales. A small PV array is proposed to be installed on the roof.

This report is written with particular reference to Bristol City Council's Climate Change and Sustainability Practice note, and demonstrates that the development achieves compliance with policies BCS13-16 of the Development Framework Core Strategy.

Appendix A – LZC Summary Table

Technology	Biomass	Wind Turbine	Ground / Air Source Heat Pumps	PV Array	CHP - Gas
Recommended?	No	No	No	Yes	No
Energy Generated per year (kWh)	N/A	N/A	N/A	863	N/A
Planning Issue/ Criteria	Compliance with clean air act. Planning permission may be required for external flue & fuel store.	Planning permission required. Potential criteria to consider includes: visual impact, noise, vibration, electrical interference, safety, etc.	GSHP: Planning permission unlikely to be required. ASHP: Planning permission likely to be required including noise assessment.	Planning permission likely to be required due to the alteration to the roof.	Planning permission not required.
Noise Issues	Noise issues with regards to loading and delivery of fuel but not with operation of the boiler.	Less of an issue than commonly perceived. The BWEA Reference Sound levels at 25m and 60m at an 8m/s hub height wind speed are: Lp,25m = 52.5dB(A) Lp,60m = 45dB(A)	GSHP: Noise levels are generally low. ASHP: Acoustic study would be required to determine impact of any external equipment.	No noise associated with the operation of this technology.	CHP engine will generate some noise; however, this may be mitigated by acoustic treatment of the plant room

Land Use Issues	Space required for storage of fuel which must be accessible for deliveries; large plant room required to accommodate boiler. Land use implication in synthesis of fuel.	If not situated on roof a suitable location will need to be found. Potential for land use restrictions beneath turbine location.	GSHP: requires sufficient area of land in order to accommodate horizontal array. Geological suitability would have to be assessed by borehole drilling activity. ASHP: external space will be required.	No extra external space required if mounted on roof.	Requires plant room large enough in size to accommodate engine.
Feasibility of Exporting Energy from System	Likely to be sized to accommodate building baseload only – no surplus available for export.	Excess electricity could be exported to other buildings within the local area/ to the grid during periods of low demand (e.g., outside term time).	Not feasible for either technology.	Excess electricity could be exported to the grid during periods of low demand (e.g. outside of term times).	Potential to export excess energy to the grid. Waste heat however may not be exported.
Availability Of Grants/ Financial Incentives (N.B. Subject to Change)	Domestic Renewable Heat Incentive (RHI)	Various – scheme dependant (e.g., ecotricity/ Good energy).	Domestic Renewable Heat Incentive (RHI)	Various – scheme dependant (e.g., ecotricity/ Good energy).	RHI/ Various Schemes
Lifecycle CO_2 Payback period[1]	Not assessed	Not assessed	Not assessed	Not assessed due to scale of array	Not assessed

[1]Defined as the period when the CO_2 saving from the technology is equal to the emissions associated with the production, installation, maintenance and decommissioning of the technology (From Generating the Future: An analysis of policy interventions to achieve widespread micro-generation penetration, Energy saving trust, Nov 2007, P18)

Appendix B – Carbon Summary

SAP Calculation Summary -
10-12 Cave Street

			Base Case	Communal Gas Boilers Energy Efficient Measures + PV			Regulated Emissions			
Type	Number	Measured Floor Area (m^2)	Dwelling Base Case Energy Consumption (kWh)	Dwelling Energy Efficient Energy Consumption (kWh)	% kWh reduction	% CO_2 reduction	Base Case Emissions ($kgCO_2/m^2$)	Base Case Total kgCO2	Energy Efficient Emissions ($kgCO_2/m^2$)	Energy Efficient + PV Total kgCO2
Flat 03	4	23.66	8836.06	8652.05	2.1%	12.6%	99.12	9381.12	86.63	8198.70
Flat 06	4	19.32	7156.2	6695.5	6.4%	16.4%	98.02	7575.03	81.93	6331.54
Flat 09	4	25.52	9059.26	8595.73	5.1%	15.3%	93.88	9583.61	79.55	8120.86
Flat 11	3	20.4	7527.24	7288.99	3.2%	13.5%	97.90	5991.57	84.64	5179.77
Flat 16	4	27.67	10586.36	7793.61	26.4%	33.9%	101.19	11200.12	66.93	7407.38
PV to landlord's supply	1	N/A	0 (Unassessed)	-863.00	N/A	N/A	N/A	N/A	N/A	-447.90
TOTAL/AVERAGE FOR THE SITE	**19**	**445.88**	**165133.24**	**147,951.53**	**10.4%**	**20.45%**	**98.08**	**43731.44**	**79.03**	**34790.35**

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