3-5 Bedford Row, London, WC1R 4BU
Energy Statement

Project number: 2220153

Revision: 1

Date: 13/10/2022

engineering a better **society**

		Remarks:	Issued for planning submission				
Revision:	P1	Prepared by:	Purvesh Bharadwaj BA (Hons) MA	Checked by:	Ben Holmes BREEAM AP WELL AP	Approved by:	Penny Gowler MEng(hons) CEng MIStructE
Date:	13/10/2022	Signature:	PBh	Signature:	[signature]	Signature:	[signature]

Contents

Our practice ... 1
Policy Guidance ... 4
Introduction ... 5
Methodology ... 6
Be Lean (demand reduction) ... 7
Be Clean (heat supply) ... 9
Be Green (renewable energy) ... 10
Be Seen ... 11
Carbon summary ... 12
Extension carbon summary ... 13
Existing building summary ... 14
Conclusion ... 15

Appendices

A GLA Summary Tables ... A
B Proposed Energy Centre ... B
C Low / Zero carbon feasibility ... C
D Building Regulations UK Part L Reports (BRUKL) ... D

Our practice

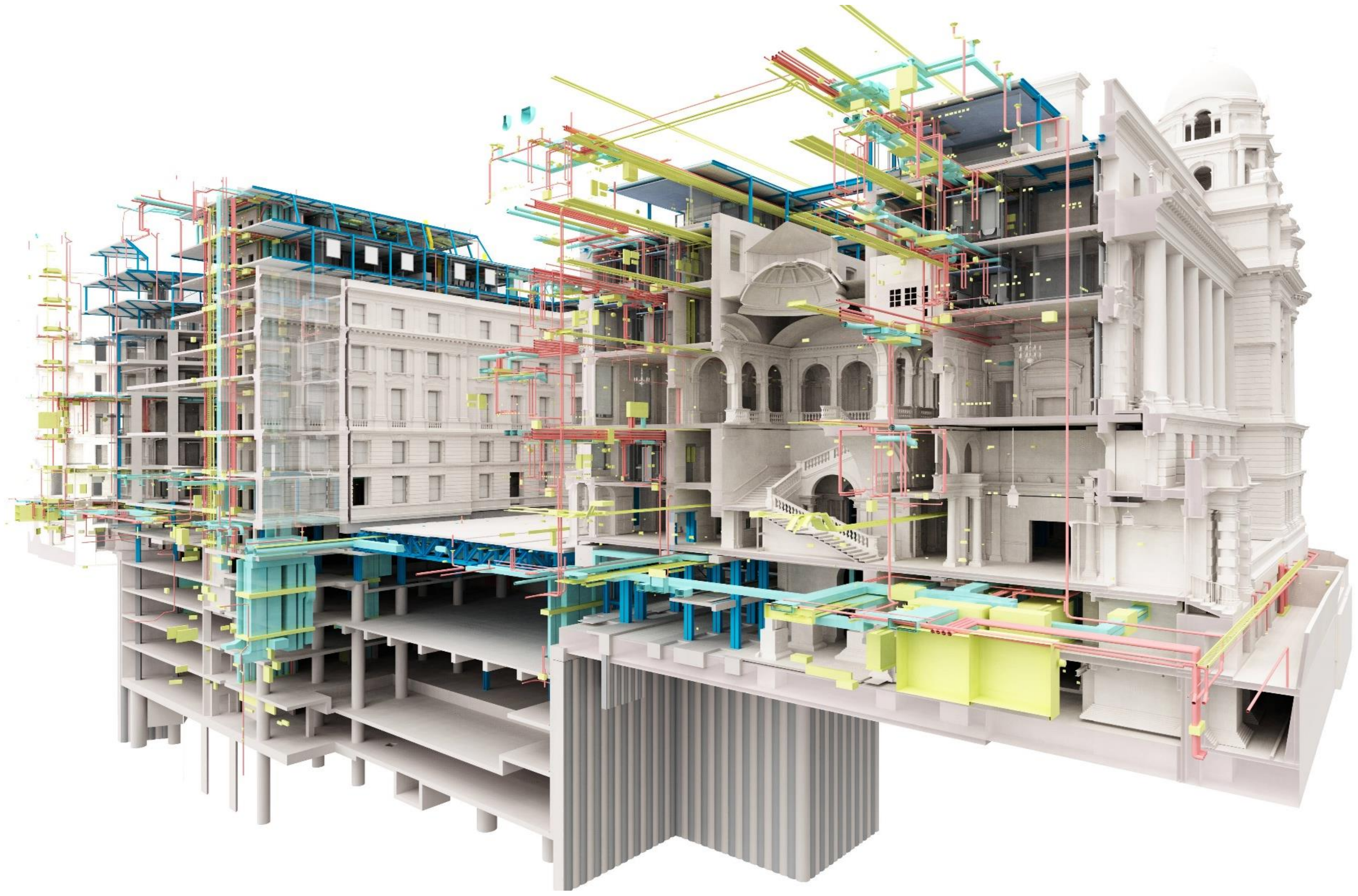
Elliott Wood work with likeminded people to engineer a better society

Our portfolio is extraordinarily diverse, and we particularly enjoy those projects which provide the opportunity to engineer for the common good – from making dramatic improvements to the life of a town or city, through to nurturing a new generation of exceptional engineers in our own in-house academy.

Despite more than twenty years in practice, we continue to be curious and find ways to pass on the benefit of our collective experience. We foster enquiring minds and share ideas because we know that this knowledge can make a real difference to our clients.

Engineering is often about the unseen: much of what we do is hidden when a building is complete. But engineering is not a necessary evil – it's much cleverer than that. Our role is to demystify the invisible workings of a structure, to reveal unexpected opportunities and to make the existing engineering work harder.

We value both technical and creative thinking and are activists for a new kind of engineering profession in which our craft is pivotal to the design process. We are no ordinary engineers.



Reveal / Materialise / Impact

Engineers make a difference

We like to be involved at the start of our clients' creative and commissioning journey, because we are concerned that not enough people are realising the full potential of their buildings. They are only working with what they can see.

Our process challenges usual perceptions of the engineer's role, because we help clients to see the unseen and achieve results beyond the aspirations of the brief – and which have a positive legacy for their wider communities.

Reveal

We ask questions. With innovative thinking, we reveal the unexpected opportunities in an already ambitious brief.

Materialise

We give ideas life. Using expertise and imagination, we materialise new assets for our clients.

Impact

We make a difference. Our work not only benefits our clients, it has a positive impact on society as a whole.

elliottwood | engineering a better society

Executive summary

Elliott Wood is appointed by FREP 4 (Bedford Row) Limited ('the Applicant') to produce an Energy Statement in support of an application for full planning permission for the proposed refurbishment of 3-5 Bedford Row and 3-5 Jockey's Fields ('the Site'), a Grade II Listed building within the London Borough of Camden.

The purpose of this statement is to demonstrate the alignment of the energy strategy of the development with relevant national, regional, and local planning policy requirements.

The proposal is for the refurbishment and extension of the existing office building. The site is 3-5 Bedford Row and Jockey's Fields, WC1R 4BU with an approx. 3,400m^2 site area. This is split into a refurbished building with an area of approx. 2,629 m^2 an new build extension of approx. 749 m^2.

As per current requirements we have utilised the 'GLA Guidance on Energy Assessments 2020, as per Paragraph 6.15:

> "*Where an existing building or group of buildings is refurbished and the development qualifies as a major refurbishment, applicants are required to provide an energy assessment demonstrating how the individual elements of the energy hierarchy have been implemented and how reductions in regulated CO2 emissions have been achieved.*"

This energy assessment has therefore been produced to demonstrate the implementation of the London Plan energy hierarchy to achieve reductions in regulated CO2 emissions.

The energy strategy follows the energy hierarchy:

- Use Less Energy (Be Lean),
- Supply energy efficiently (Be Clean), and
- use Renewable and low carbon energy (Be Green),

as per Policy CC1 of the Camden Local Plan (2017).

The scheme adopts a fabric-first and passive design approach to reduce energy demand for space heating and reduce the demand for active cooling.

Key design elements of the proposals comprise of:

- An upgraded, well-insulated building fabric shell.
- Being airtight, reducing draughts and heat-loss.
- Provision for ventilation and wastewater heat recovery systems.
- Energy efficient lighting and controls.
- Energy efficient heat pump and cooling systems.
- Low operational costs and carbon emissions.
- Improved air quality on-site due to zero combustion on site, benefitting the health & wellbeing of occupants.
- Photovoltaic solar panels are the preferred on-site renewable generation technology as electricity is offset on-site.

The scheme aims to achieve Net-Zero Carbon performance for Operational Energy, in reference to the London Plan energy hierarchy (Policy SI 2). An SBEM model was used to calculate the space heating, hot water, lighting, cooling, fans and pumps energy, improvements from low carbon technologies, and therefore the on-site operational energy consumption.

Following the latest updates to the Building Regulations Part L 2021 which are in force from June 2022, the GLA Energy Assessment Guidance, June 2022 states that major non-domestic developments must meet a 35 per cent on-site carbon reduction beyond Part L 2021. However, as the software is currently in an interim period between Part L 2013 and Part L 2021 that is yet to be tried and tested, the GLA have stated the following:

> *"However, as the accompanying Part L 2021 software is not yet available, planning applicants should continue to use the 2020 guidance, spreadsheet and the Part L 2013 methodology until the software has been approved by government and is fully functional."*

Therefore, this energy assessment has been proceeded using the 2013 methodology by running SBEM calculations against Part L 2013 carbon factors and notional baselines. The outputs were then used in the GLA Carbon Emissions Reporting Spreadsheet 2020 which uses Part L 2013 as a baseline.

This energy assessment has split the results into new build, existing building, and site-wide summaries. Based on refurbishment and new construction, there is a cumulative CO_2 reduction of 60% compared with the 2013 baseline. The extension has a total of 56% savings and the existing building refurbishment has a 61% saving.

The cumulative site-wide CO_2 reduction is broken down by the following:

- 47% at Be Lean
- 0% at Be Clean
- 13% at Be Green

The new build targets over15% CO2 reduction at the 'Be Lean' Stage as per the Adopted London Plan 2021 targets. The scheme also significantly exceeds the 35% CO2 reduction on-site target compared to Part L 2013 baselines to make an allowance for the new Part L 2021 Building Regulations. Where space on the roof is available photovoltaic solar panels are provided.

Executive summary
(continued)

The 3-5 Bedford Row development will be fossil-fuel free; the energy strategy includes for a centralised supply and extract system with heating and cooling (using a DX coil system).

The heat source for delivering space heating will be from heat pump technology. The heat pumps will also be capable of operating in reverse mode and provide cooling across the site. The full details of the specification will be developed post-planning.

As the scheme is primarily an office, hot water demand will be met via point-of-use systems for hand washing and tea points with the exception of the shower rooms that will be provided with an energy efficient heat pump solution with hot water tank for storage.

For this site, it is possible that the fan power and lighting may account for over 50% of the total operational regulated energy demand, so there is a real focus on maximising the lighting efficacy and reduced specific fan power to ventilation equipment.

All fixed light fittings will be low-energy lamps designed to achieve an approx. over 110 lm/cW, including storage and infrequently accessed areas. Offices, transient spaces and toilets will have automatic lighting using PIR sensors and time switches. Daylight switching will also be configured for areas where appropriate.

The centralised ventilation units will explore options for utilising gas sensors or occupation sensors along with damper or speed control to help reduce unnecessary bulk-air flow movement at low occupancies. The unit will also be capable of operating in 'night-cooling' mode.

Furthermore, the centralised ventilation unit will be specified with a heat recovery unit within, with a minimum COP of 4.0, utilising a thermal wheel component); the heat recovery aspect will lower space heating demand.

The option for including Waste Water Heat Recovery Systems (WWHRS) within the shower systems will be explored at the detailed design stage.

The scheme adopts a fabric-first and passive design approach to reduce energy demand for space heating and active cooling and its building fabric and air tightness will look to improve significantly upon the existing building with a target of 5.0 @50Pa (m3/h.m2).

A roof area of approx. 26.25 m^2 is available for the use of PV panels and has been utilised for the PV array. The scheme may offset the remaining emissions through a carbon offset payment.

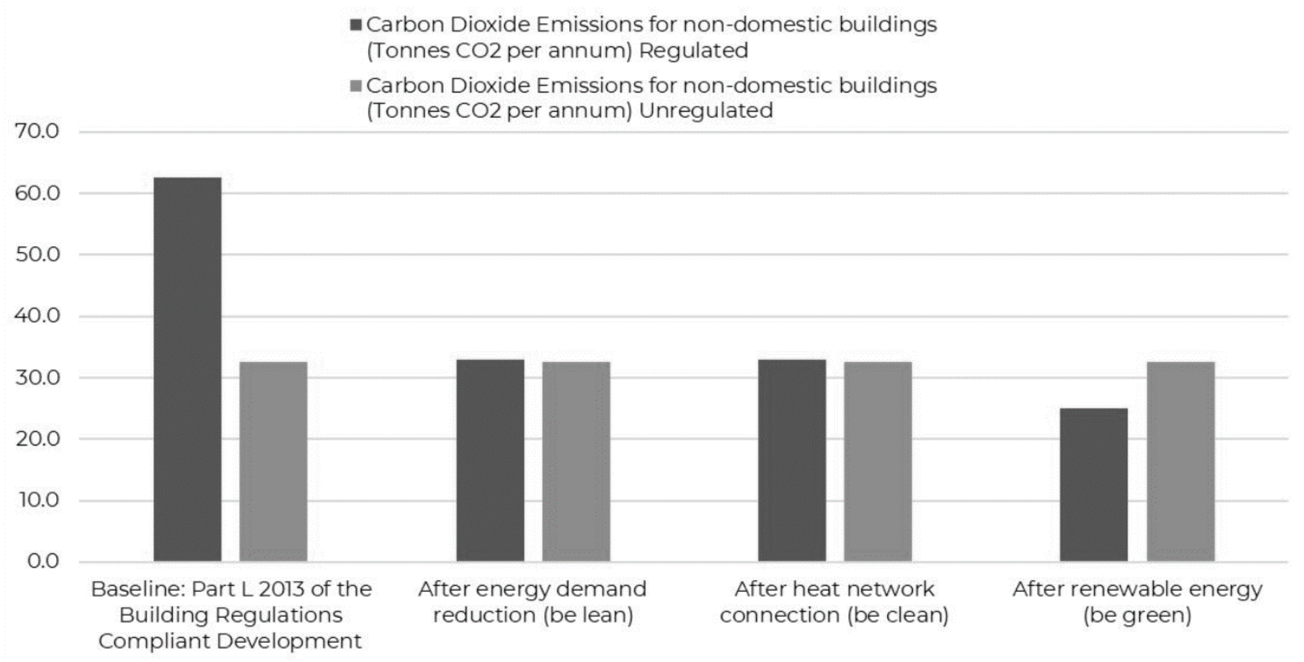


Figure 1: Site-wide savings at each stage of the energy hierarchy using Part L 2013 baseline

	Regulated non- domestic carbon dioxide savings	
	Tonnes CO2 / year	(%)
Savings from energy demand reduction	29.6	47
Savings from heat network/CHP	0	0%
Savings from renewable energy	8	13%
Cumulative savings	37.6	60%

60%

Site-wide CO_2 reduction (Part L 2013 Baseline)

One

Policy Guidance

1.1 Regional policy

The scheme has been developed in accordance with the London Plan 2021 "The Spatial Development Strategy for Greater London, March 2021" and with the Sustainable, Design and Construction SPG. According to the planning policies, the scheme should achieve:

Policy SI 2 Minimising Greenhouse Gases:

- Zero carbon target
- A minimum on-site CO2 reduction of at least 35% beyond Building Regulations
- Residential development should achieve 10% CO2 improvement through energy efficiency measures, 'Be Lean' stage
- At least 20% CO2 improvement through renewable technologies, 'Be Green' stage
- Where it is clearly demonstrated that the zero-carbon target cannot be fully achieved on-site, any shortfall should be provided, in agreement with the borough, either:
    - through a cash in lieu contribution to the borough's carbon offset fund, or
    - off-site provided that an alternative proposal is identified, and delivery is certain
- Monitor, verify and report on energy performance, Be Seen stage.

Other policy extracts from the London Plan that are deemed relevant to Energy and/or Sustainability have been set out below for reference:

- Policy SI: 1 Improving Air Quality
- Policy SI: 3 Energy Infrastructure
- Policy SI: 4 Managing Heat Risk
- Policy SI: 5 Water Infrastructure
- Policy SI: 7 Reducing Waste And Supporting The Circular Economy

1.2 Local policy

Policy within the Borough of Camden is formed of the Camden Local Plan (2017) and it is the key document in Camden's development plan which is a group of documents that set out Council's planning policies.

In November 2019, the council declared a climate and ecological emergency, committing to achieving zero carbon emissions. Council planning policies include requirements relating to carbon reduction, flood risk measures, cycle parking and biodiversity improvements.

The Council aims to tackle the causes of climate change in the borough by ensuring developments use less energy and assess the feasibility of decentralised energy and renewable energy technologies. Camden Planning Guidance (CPG) is prepared by the Council on Energy and resources to support the policies in the Camden Local Plan 2017. It provides key energy and resource issues within the borough and supports following policies.

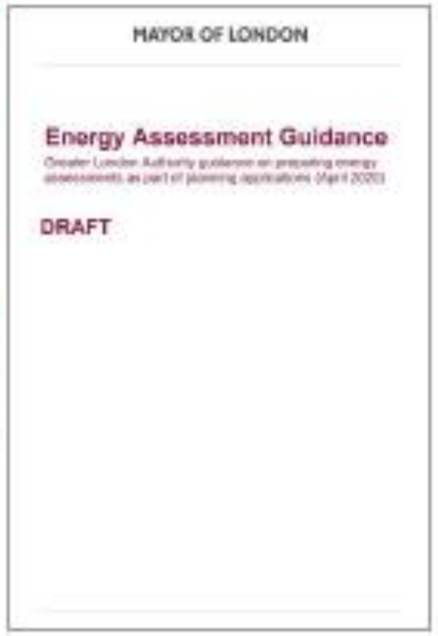
Policy CC1 Climate change mitigation:

a. promote zero carbon development and require all development to reduce carbon dioxide emissions through following the steps in the energy hierarchy.
b. require all major development to demonstrate how London Plan targets for carbon dioxide emissions have been met.

The Council will expect developments of five or more dwellings and/or more than 500 sqm of any gross internal floorspace to achieve a 20% reduction in carbon dioxide emissions from on-site renewable energy generation (which can include sources of site related decentralised renewable energy), unless it can be demonstrated that such provision is not feasible.

1.3 Assessment guidance

The guidance for the methodology of energy assessments is set out in the Greater London Authority's Energy Assessment Guidance (June 2020). This document sets out the required scope of a GLA compliant assessment. Therefore, this energy assessment complies with the requirements of the Energy Assessment Guidance (June 2020)



1. London Plan (2021)
2. Camden Local Plan (2017)
3. GLA Energy Assessment Guidance (2020)
4. CIBSE TM54

Two

Introduction

2.1 Scope

Elliott Wood is appointed by FREP 4 (Bedford Row) Limited ('the Applicant') to produce an Energy Statement in support of an application for full planning permission for the proposed refurbishment of 3-5 Bedford Row and 3-5 Jockey's Fields ('the Site'), a Grade II Listed building within the London Borough of Camden.

The purpose of this statement is to demonstrate the alignment of the energy strategy with relevant national regional and local planning policy requirements.

As per current requirements we have utilised the 'GLA Guidance on Energy Assessments 2020'; as per Paragraph 6.15:

> "*Where an existing building or group of buildings is refurbished and the development qualifies as a major refurbishment, applicants are required to provide an energy assessment demonstrating how the individual elements of the energy hierarchy demonstrating how the individual elements of the energy hierarchy have been implemented and how reductions in regulated CO2 emissions have been achieved.*"

This energy assessment has therefore been produced to demonstrate the implementation of the London Plan energy hierarchy to achieve reductions in regulated CO2 emissions.

2.2 Development description

Internal refurbishment of 3-5 Bedford Row and 3-5 Jockey's Fields for continuing commercial use of the building (Class E), together with external alterations to all elevations, and the erection of roof extensions at fourth, third and second-floor levels, roof terraces at levels four and three, green roofs and basement courtyard garden, cycle parking, waste/recycling storage, plant, and other associated works.

Illustrated to the right is the 3,377m^2 site area for 3-5 Bedford Row, WC1R 4BU. This is split into a refurbished building with an area of 2,629 m^2 an new build extension of 749 m^2. The site is bounded by Jockey's Fields to the east and Bedford Row to the west and south. The sites surrounding the proposal is a mixture of commercial, residential, and open spaces.

Figure 2 Site plan indicating 3-5 Bedford Row (red) and surrounding properties

Three

Methodology

3.1 Aims of the scheme

The scheme aims to achieve low and where possible Net-Zero Carbon for Operational Energy, in reference to the London Plan energy hierarchy (Policy SI 2 'Minimising Greenhouse Gases'):

1. Be Lean: use less energy and manage demand during operation.
2. Be Clean: exploit local energy resources (such as secondary heat) and supply energy efficiently and cleanly.
3. Be Green: maximise opportunities for renewable energy by producing, storing, and using renewable energy on-site.
4. Be Seen: monitor, verify and report on energy performance.

3.2 GLA Energy assessment guidance

Following the latest updates to the Building Regulations Part L 2021 which are in force from June 2022, the GLA Energy Assessment Guidance, June 2022 states that major non-domestic developments must meet a 35 per cent on-site carbon reduction beyond Part L 2021. However, as the software is currently in an interim period between Part L 2013 and Part L 2021 that is yet to be tried and tested, the GLA have stated the following:

> *"However, as the accompanying Part L 2021 software is not yet available, planning applicants should continue to use the 2020 guidance, spreadsheet and the Part L 2013 methodology until the software has been approved by government and is fully functional."*

3.3 Approach

This energy assessment has followed the 2013 methodology by running SBEM calculations against Part L 2013 carbon factors and notional baselines. The outputs were then used in the GLA Carbon Emissions Reporting Spreadsheet 2020 which uses Part L 2013 as a baseline.

Paragraphs 6.15 - 6.25 of the GLA Energy Assessment Guidance (June 2022) have been used primarily as the assessment criteria.

IES VE software was used to create a 3D model of the development, as illustrated to the right. An SBEM model was used to calculate the space heating, hot water, lighting, cooling, fans and pumps energy, improvements from low carbon technologies, and therefore the on-site operational energy consumption.

The passive measures for the new build were incrementally improved to meet a minimum of 15% carbon reduction at the 'Be Lean' stage, as per Policy SI 2.

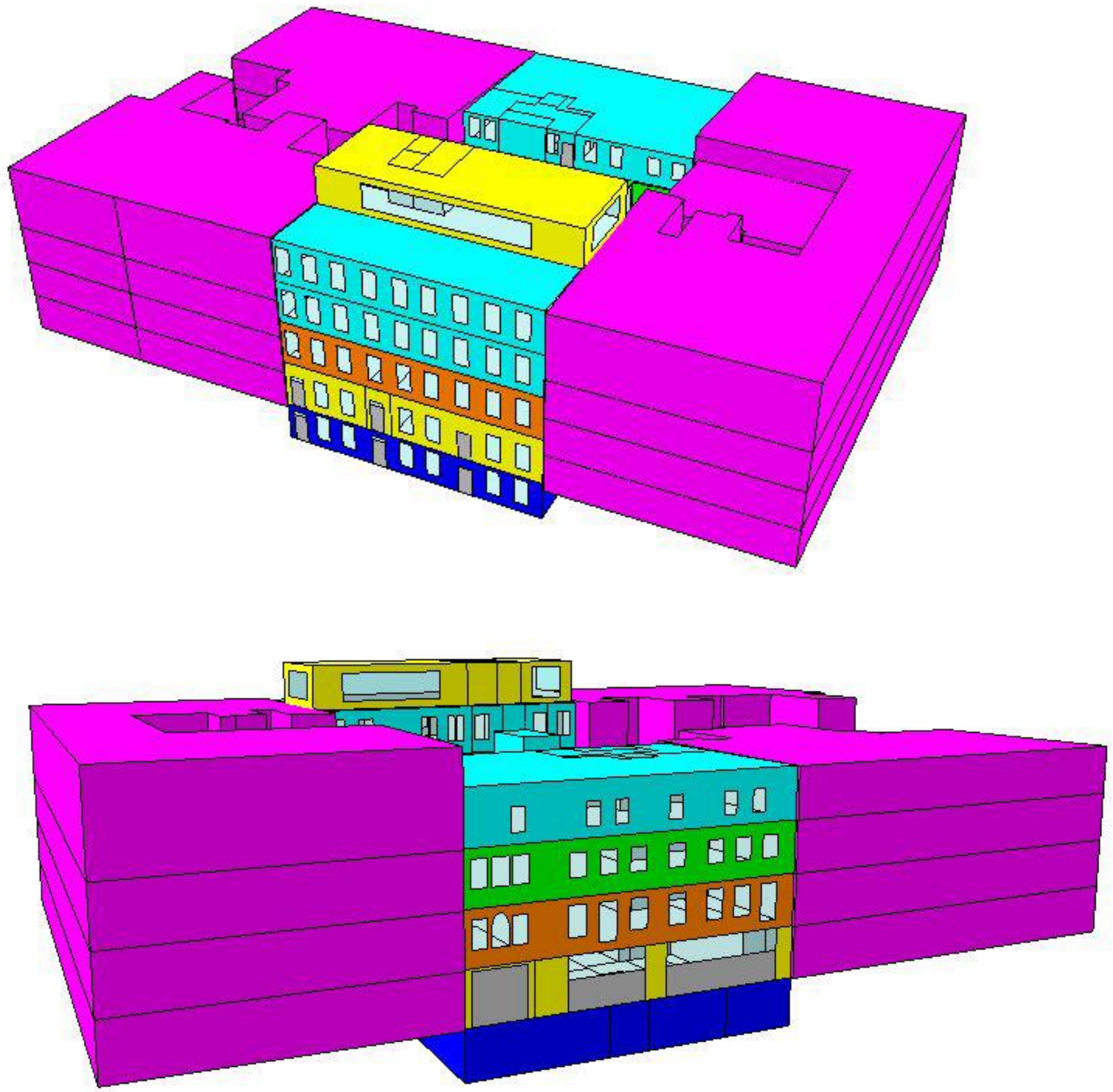


Figure 3. Axonometric view of the 3d model of the proposed scheme developed using IES VE software; southeast view (top), southwest view (bottom)

Four

Be Lean (demand reduction)

4.1 Introduction

Passive design measures, including optimising orientation and site layout, natural ventilation and lighting, thermal mass and solar shading are set out in this document. Active design measures, including high efficiency lighting and efficient low-energy extract systems, are also set out below. Building fabric details are set out in the tables to the right.

4.2 Building insulation

This scheme will provide building insulation U-values improved upon the Building Regulations standard. The scheme adopts a fabric-first and passive design approach to reduce energy demand for space heating and active cooling and its building fabric and air tightness will look to improve significantly upon the existing building with a target of 5.0 @50Pa (m^3/hm^2). At the detailed design stage both standard and natural insulation materials will be considered on merit, feasibility, and pricing.

4.3 Orientation and site layout

The orientation of the offices is key in maximising the benefits of solar gain in the winter and improving daylight & sunlight access given the constraints of the site.

The scheme is predominantly west-east facing with buildings adjacent to it. Maximum office space utilises dual aspect façade, where possible.

The site benefits from utilising courtyard garden, roof terrace and open planning of the offices.

Adjacent development blocks any direct southwest and northwest prevailing winds (typically the most prevalent wind direction for London) improving comfort to amenity landscaping by providing microclimates that are cooler in summer and warmer in winter.

4.4 Natural Ventilation

Natural ventilation is a method of supplying fresh air to a space through passive means, typically by utilising differences in pressure and/or temperatures within a space.

Offices will have openable windows to allow the occupant the flexibility to use passive ventilation prior to utilising mechanical ventilation/cooling.

The courtyards and roof terrace also help with forming dual aspect rooms where available, capable of providing cross-ventilation.

4.5 Lighting

Within the scheme, all fixed light fittings will be low-energy lamps designed to achieve an approx. over 110 lm/cW, including storage and infrequently accessed areas. The lux levels within each space will be designed to match relevant Building Regulations and industry guidance to reduce the requirement for additional unregulated lighting. Offices, transient spaces and toilets will have automatic lighting using PIR sensors and time switches. Daylight switching will also be configured for areas where appropriate.

4.6 Thermal Mass

Thermal mass is important to help with night-cooling. Night-cooling uses the thermal mass of a building to absorb heat during the day, and then cools the building at night using external air, discharging accumulated heat to the outside so the temperature of the thermal mass is lowered ready for the next day. This method helps to provide a buffer to the diurnal temperature effects and can reduce internal temperature rises during the day by around 2°C to 6°C in the UK. Both 'passive' and 'active' night-cooling strategies will be explored post-planning (i.e., either using windows on actuators versus mechanical ventilation).

Table 1: The SBEM model input variables for reference.

Building Fabric	Input	Unit	Comments
New			
External Wall U-Value	0.26	W/m2k	Include unheated areas
Roof U-Value	0.18	W/m2k	-
Ground Floor U-Value	0.18	W/m2k	-
Window U-Value	1.6	W/m2k	-
Doors U-Value	2.2	W/m2k	-
Thermal Bridge Y-Value	NCM	W/m2k	Assumed NCM standards
Window G-Value	0.4	-	-
Air Permeability	5	@50Pa (m.h3/m2)	A low air permeability required to improve mech vent efficiency

4.7 Overheating Mitigation

London Plan 2021 Overheating Policy

Policy SI4 'Mitigating Heat Risk' establishes the need for developments to mitigate the impacts of the urban heat island effect. It states that major developments should adhere to the following cooling hierarchy:

1. Reduce the amount of heat entering a building through orientation, shading, high albedo materials fenestration, insulation, and the provision of green infrastructure
2. Minimise internal heat generation through energy efficient design
3. Manage the heat within the building through exposed internal thermal mass and high ceilings
4. Provide passive ventilation
5. Provide mechanical ventilation
6. Provide active cooling systems

Camden Council Policy

Policy CC2 'Adapting to Climate Change' states that, "All developments should adopt appropriate climate change adaptation measures including application of cooling hierarchy". The cooling hierarchy comprises of the following measures:

1. Minimise internal heat generation through energy efficient design
2. Reduce the amount of heat entering a building in summer
3. Manage the heat within the building through exposed internal thermal mass and high ceilings
4. Passive ventilation
5. Mechanical Ventilation
6. Active Cooling

Cooling Demand

All passive design measures for the scheme have been investigated before considering cooling. Using the London Plan Hierarchy:

1. The scheme has been specified with openable windows for natural ventilation
2. Internal curtain or blinds will be provided
3. Mechanical ventilation will be provided to each office space
4. The provision for cooling will be provided across the site by way of an energy efficient heating/cooling Variable Refrigerant Flow (VRF) system, details mentioned in the later sections of this report.

4.8 Heat recovery systems

Although passive ventilation should be maximised during temperate conditions, as this requires no fan power, there is the potential for heat to be lost to the atmosphere when fresh air is required (from opening windows) simultaneously with heating during colder seasons; therefore, it is advantageous to provide a form of heat recovery that allows for an efficient system that captures the heat exhausting from a room being heated in colder conditions.

The building will be provided with a centralised supply and extract system with heating and cooling (using a DX coil system) and heat recovery unit within (utilising a thermal wheel component); the heat recovery aspect will lower space heating demand.

A thermal wheel rotates within an Air Handling Unit and acts as a heat exchanger positioned within the supply and exhaust air ducts to recover the heat energy that would otherwise have been lost. The efficiency of the system has been assumed to be 70% at this stage. Further exploration of more efficient systems will be considered at the detailed design stage.

The centralised ventilation units will explore options for utilising gas sensors or occupation sensors along with damper or speed control to help reduce unnecessary bulk-air flow movement at low occupancies. The unit will also be operating in 'night-cooling' mode.

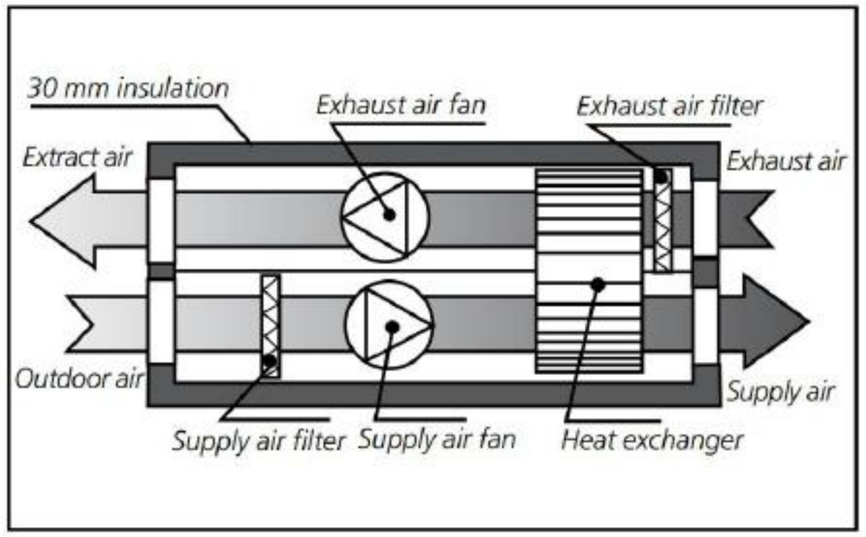


Figure 4: ©Swegon Image of a typical thermal wheel heat recovery unit

Five

Be Clean (heat supply)

5.1 Introduction

Once demand for energy has been minimised, planning applications should demonstrate how their energy systems will exploit local energy resources (such as secondary heat) and supply energy efficiently and cleanly to reduce CO2 emissions.

As well as carbon dioxide emissions, all combustion processes can emit oxides of Nitrogen (NOx) and, solid or liquid fuelled appliances (such as those using biomass or biodiesel) can also emit Particulate Matter. These pollutants contribute to poor air quality and can have negative impacts on the health of residents and occupants of the development. It is important that these impacts are considered in determining the heating strategy of a development.

5.2 Existing networks, planned networks and supplying heat beyond the site boundary

Where a heat network exists in the vicinity of the proposed development, the applicant should look to prioritise connection and provide evidence of active two-way correspondence with the network operator.

If there is no existing network, the applicant must investigate whether a network is being planned for the area. Applicants should also investigate opportunities for expanding their heat network to supply heat to local developments and buildings outside the boundaries of their site, particularly if this has the potential to facilitate an area-wide heat network. As shown on the image to the right, the scheme (WC1 highlighted red) is not within the vicinity of any existing or proposed heat networks (highlighted orange). Heating demand is considered low due to the quality building fabric; Therefore, individual efficient space heating and domestic hot water systems are advised. There are no CO_2 savings at this stage of the energy hierarchy.

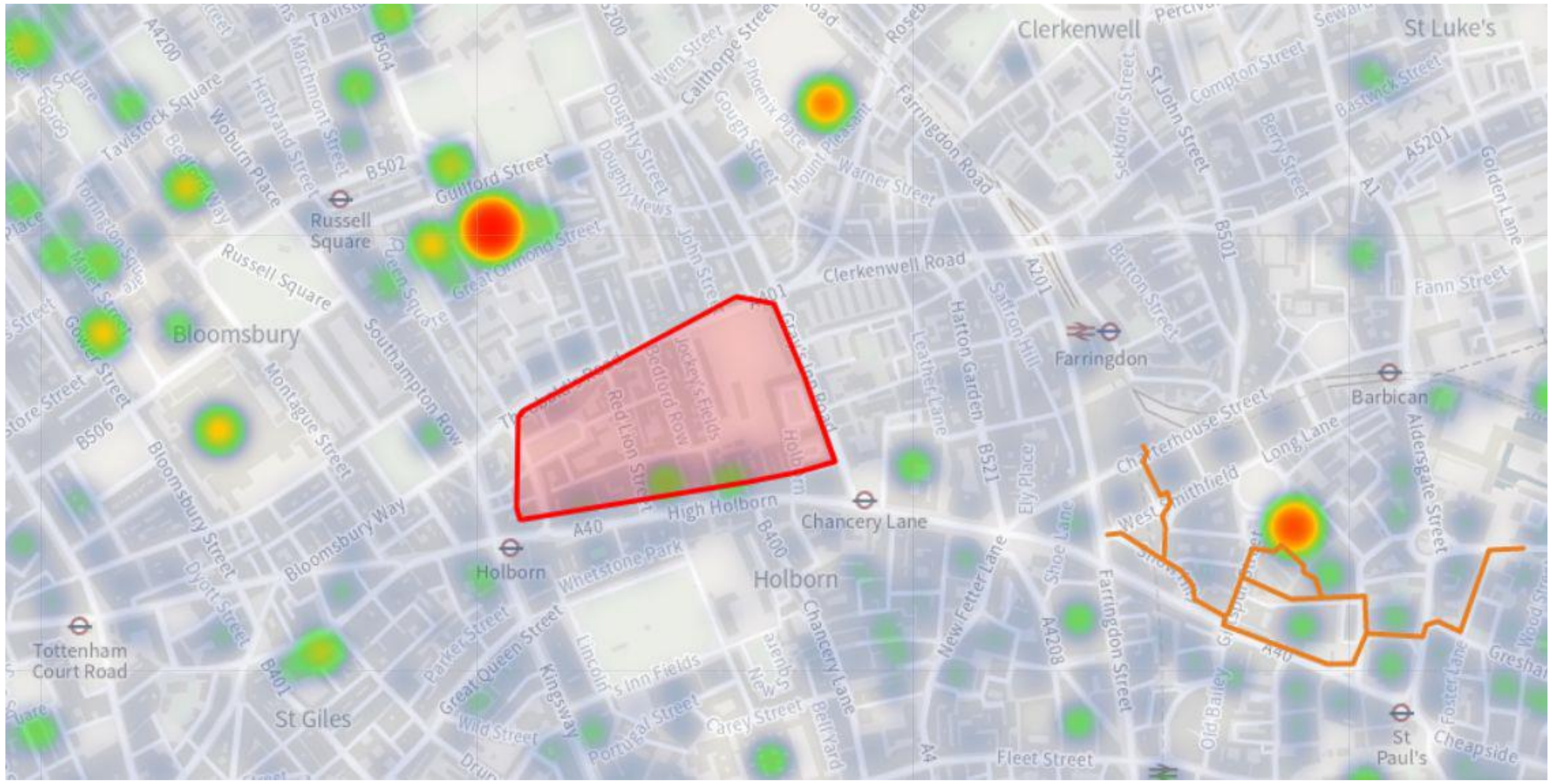


Figure 6. Location of site postcode (WC1, red) in relation to proposed heat networks (orange).

Six

Be Green (renewable energy)

6.1 Introduction

For the last step of the Energy Hierarchy, opportunities for producing, storing, and using renewable energy on-site are investigated and maximised to the extent feasible. The capacity for renewable technologies at the site has been explored with the wider design team. The following technologies were considered:

- Air Source Heat Pump (ASHP)
- Ground Source Heat Pump (GSHP)
- Water Source Heat Pump (GSHP)
- Photovoltaic Solar Panels
- Solar Thermal Hot Water
- Wind Technology

Of the above technologies ASHPs were deemed the most appropriate to supply heating, on the grounds of feasibility, viability, and location of whole life energy and carbon savings. Photovoltaic Solar Panels were deemed the most suitable strategy for generating electricity onsite if the space allows.

6.2 Air Source Heat Pumps (ASHPs)

ASHPs were deemed the most appropriate to supply heat, on the grounds of feasibility, viability and scale of whole life energy and carbon savings. Where heat pumps are proposed, the system needs to be sized appropriately and specified to achieve a high seasonal coefficient of performance to ensure optimum, low carbon operation and peak demand. This applies to any type of heat pump proposals including air source heat pumps (ASHPs), ground source heat pumps (GSHPs), water source heat pumps (WSHPs) or hybrid and ambient loop types of systems. The heat source for delivering space heating will be from heat pump technology.

The minimum COP of heat pumps has been specified to be 4.0, these will also be capable of operating in reverse mode able to deliver cooling across the site. The full details of the specification will be developed post-planning.

As the scheme is primarily an office, hot water will be provided via point-of-use systems for hand washing and tea points with the exception of the shower rooms that will be provided with an energy efficient heat pump solution with hot water tank for storage. The details of the systems will be provided at the detailed design stage on the appointment of Building Services Engineers; therefore, conservative efficiencies for space heating and hot water have been used for the purpose of this report.

Refrigerant pipe-runs will be minimised and in accordance with guidance from the specific supplier. The hot water storage introduces an element of demand-side flexibility, which, combined with smart controls, will further optimise the scheme's energy and carbon performance, and positively contribute to grid decarbonisation. The location of the outdoor condenser will be on the roof of the development out of site from any noise-sensitive neighbouring properties and with appropriate acoustic mitigation where required. Further detail will be mapped out at the detailed design stage.

Figure 7: (Top) ©Mitsubishi, Y Series VRF Standard Heat Pump (YNW) (Bottom) ©Daikin, example VRF system on roof

6.3 Photovoltaic Panels (PV)

Photovoltaic solar panels are the preferred on-site renewable generation technology as electricity is offset on-site. The variables used are set out in the table below and location of the array in the adjoining figure.

The scheme will provide space for approximately 26.25m^2 of PV Panels, displacing 355 $kgCO_2/m^2$ per year. The indicative location for the PV panels is displayed on the right (red).

Table 2: Photovoltaic solar panel parameter assumptions

PV Item	Description	Unit
Approx. PV array size	26.25	m2
Assumed panel power	300	Watt panel
Length of panel	1.6	m
Width of panel	1.1	m
Total panel size	1.76	m2
Inclination of panel	Horizontal	-
Total peak power	~4.5*	kWp
Assumed # of panels	15	# panels
Total CO2 savings	355	kgCO2

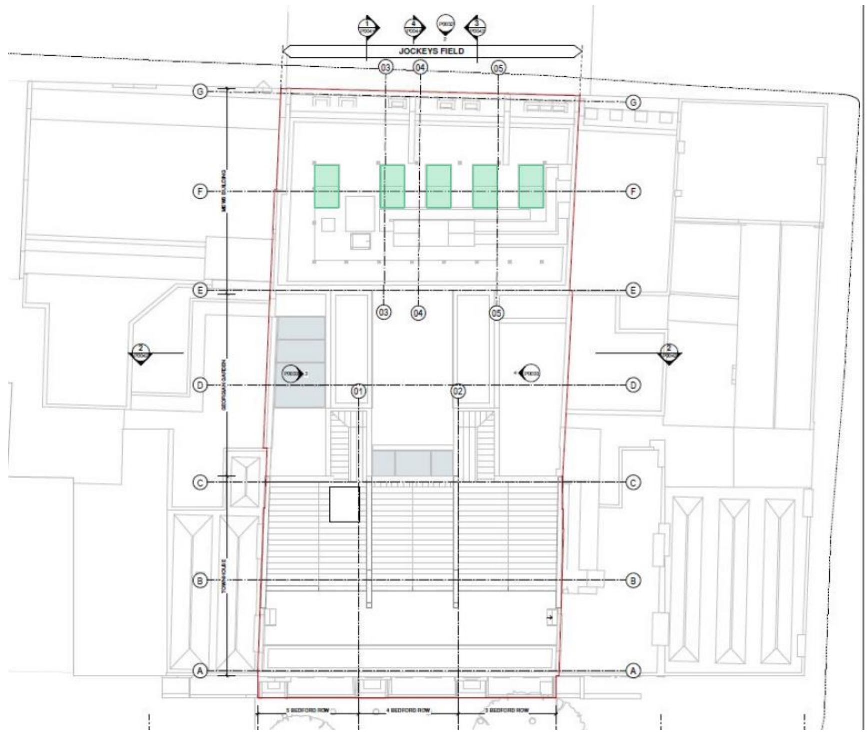


Figure 8: Roof Plan indicating possible location for PV Panels (red).

Seven

Be Seen

7.1 Introduction

To truly achieve net zero-carbon buildings, there needs to be a better understanding of the actual operational energy performance of a development and work towards bridging the 'performance gap' between design theory and actual energy use. London Plan Policy SI 2 sets out the 'be seen' requirement for all major development proposals to monitor and report on their actual operational energy performance.

The applicant complies with the requirement to provide accurate and verified estimates of each of the performance indicators of each reporting stage through the appropriate 'be seen' reporting template. To comply with Policy SI 1, this scheme will provide accurate and verified estimates of each of the performance indicators at the relevant reporting stage through the appropriate 'be seen' reporting templates.

Performance Indicator Group	Requirements at Planning Stage
Contextual	• Location Unique Property Reference Number (UPRN) or Address • Site plan • Typology/use • GIA for each typology/use • Anticipated target dates for each 'be seen' reporting stage
Building Energy Use	• Grid electricity consumption (kWh) • Gas consumption (kWh) • Other fuels consumption (kWh) • District heating/ cooling consumption (if applicable) (kWh)
Renewable Energy Use	• Energy generation (kWh)
Energy Storage	N/A
Plant parameters	N/A
Carbon	• Carbon emissions estimates (tonnes CO2/m2) for residential, nonresidential and whole development • Carbon shortfall for the entire development (tonnes CO2) • Estimated carbon offset amount (£)

Eight

Carbon summary

The energy strategy follows the energy hierarchy; Use Less Energy (Be Lean), Supply energy efficiently (Be Clean) and use Renewable and low carbon energy (Be Green) as per Policy CC1 of the Camden Local Plan (2017).

The scheme adopts a fabric-first and passive design approach to reduce energy demand for space heating and eliminate the need for active cooling. Key design elements of the proposals comprise of:

- An upgraded, well-insulated building fabric shell.
- Being airtight, reducing draughts and heat-loss.
- Provision for ventilation and wastewater heat recovery systems.
- Energy efficient lighting and controls.
- Energy efficient heat pump and cooling systems.
- Low operational costs and carbon emissions.
- Improved air quality on-site due to zero combustion on site, benefitting the health & wellbeing of occupants.
- Photovoltaic solar panels are the preferred on-site renewable generation technology as electricity is offset on-site.

Following the new Part L 2021 Building Regulations that came into effect in June 2022, the GLA Energy Assessment Guidance (June 2022) states that major non-domestic developments must meet a 35 per cent on-site carbon reduction beyond Part L 2021. However, as the software is currently in an interim period between Part L 2013 and Part L 2021 that is yet to be tried and tested.

As per Paragraphs 6.15 and 6.16 in the GLA Guidance on Energy Assessments 2020, an energy assessment has been performed to demonstrate the implementation of the energy hierarchy using the refurbishment and extension methodologies to achieve reductions in regulated CO2 emissions.

Based on refurbishment and new construction, there is a cumulative CO2 reduction of 57% compared to the 2013 baseline. The cumulative CO2 reduction is broken down by the following:

- 47% at Be Lean
- 0% at Be Clean
- 13% at Be Green

Camden ask developers of major developments to achieve a 20% reduction in carbon dioxide emissions from on-site renewable energy generation. This scheme falls just short of that target; this is mainly due to the restricted opportunity for providing more photovoltaic solar panels on the roof area due to limitations from heritage/listed building con

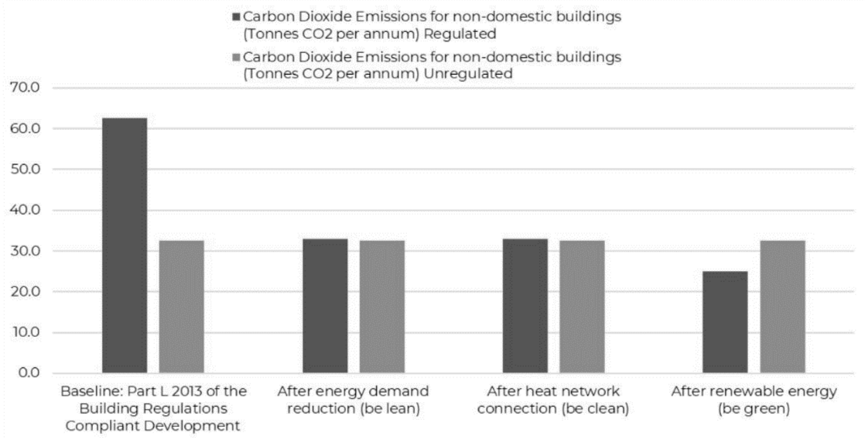


Figure 9: New build savings at each stage of the energy hierarchy using Part L 2013 baseline

Table 3: Regulated non-domestic carbon dioxide savings

	Regulated non- domestic carbon dioxide savings	
	Tonnes CO2 Per Annum	(%)
Savings from energy demand reduction	29.6	47%
Savings from heat network/CHP	0	0%
Savings from renewable energy	8.0	13%
Cumulative savings	**37.6**	**60%**

60%

Site-wide CO_2 reduction
(Part L 2013 Baseline)

Nine

Extension carbon summary

For developments consisting of a refurbishment with a new build extension, the CO2 savings for the new and refurbished elements should be presented separately within the energy strategy. The new build elements should be assessed in line with the methodology for new build development and will be expected to comply with London Plan policy.

Based on the SBEM energy modelling, the regulated carbon emissions of the scheme are 39% lower than the 2013 baseline scheme. The proposed energy strategy therefore delivers an energy efficient, low carbon office that substantially exceeds the on-site carbon reduction target of 35% stipulated by the London Plan (2021).

The new build extension results summary for the carbon emissions are set to the right.

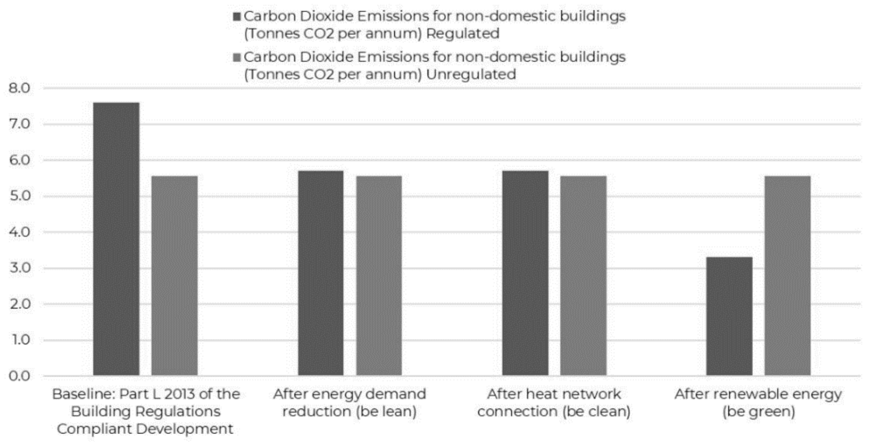


Figure 10: New build savings at each stage of the energy hierarchy using Part L 2013 baseline

Table 4: Regulated non-domestic carbon dioxide savings for the new build extension

	Regulated non- domestic carbon dioxide savings	
	Tonnes CO2 Per Annum	(%)
Savings from energy demand reduction	1.9	25%
Savings from heat network/CHP	0	0%
Savings from renewable energy	2.4	31%
Cumulative savings	**4.3**	**56%**

56%

Extension CO_2 reduction
(Part L 2013 Baseline)

elliottwood | engineering a better society

Ten

Existing building summary

Where major refurbishments are being carried out an estimate of the CO2 savings from the refurbishment of the building will be expected. To provide this, we have estimated the CO2 emission baseline performance of the existing building using Building Regulations approved compliance software.

We have generated the baseline CO2 emissions assuming the notional specification for existing buildings, shown in Appendix 4 (of GLA Guidance on Energy Assessments (June 2020), and which is based on Approved Documents L2B as well as the Government's Building Services Compliance Guidance. This provides a consistent baseline across all refurbishments and clearly distinguishes the improvements in CO2 emissions that are over and above what would ordinarily be undertaken through meeting Building Regulation requirements.

It is generally acknowledged that the level of carbon savings that can be achieved through a refurbishment can vary considerably, however every effort should be made to improve the energy performance of the building in line with London Plan carbon targets and to follow the energy hierarchy.

The existing building refurbishment results summary for the carbon emissions are set to the right.

Building Fabric	Input	Unit	Comments
Existing			
External Wall U-Value	0.55	W/m2k	Include unheated areas
Roof U-Value	0.18	W/m2k	-
Ground Floor U-Value	0.25	W/m2k	-
Window U-Value	1.8	W/m2k	-
Doors U-Value	2.2	W/m2k	-
Window G-Value	0.4	-	-
Air Permeability	25	@50Pa (m.h3/m2)	buildings built to Building Regulations pre 1995

Table 4: The SBEM Baseline model input variables for reference as per Appendix 4 of the GLA Guidance on Energy Assessments (June 2020).

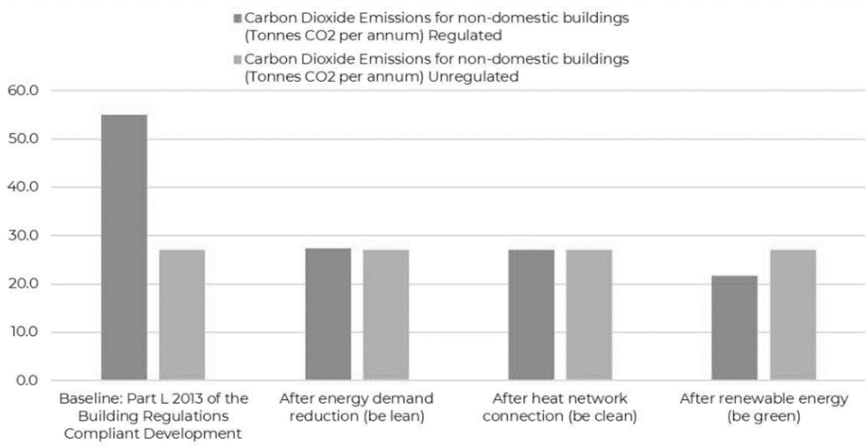


Figure 11: New build savings at each stage of the energy hierarchy using Part L 2013 baseline

	Regulated non- domestic carbon dioxide savings	
	Tonnes CO2 Per Annum	(%)
Savings from energy demand reduction	27.7	50%
Savings from heat network/CHP	0	0%
Savings from renewable energy	5.6	10%
Cumulative savings	**33.3**	**61%**

61%

Existing Building CO_2 reduction
(Part L 2013 Baseline)

elliottwood engineering a better society

Eleven

Conclusion

Elliott Wood Partnership have prepared this Energy and Sustainability Statement on behalf of The Applicant) as part of a planning application to the London Borough of Camden (the Local planning Authority).

The proposal is for the refurbishment and extension of the existing office building. The site is 3-5 Bedford Row, WC1R 4BU with approx. 3,400m2 site area.

Energy Breakdown

As per current requirements we have utilised the 'GLA Guidance on Energy Assessments 2020'; As per Paragraph 6.15:

> *"Where an existing building or group of buildings is refurbished and the development qualifies as a major refurbishment, applicants are required to provide an energy assessment demonstrating how the individual elements of the energy hierarchy have been implemented and how reductions in regulated CO2 emissions have been achieved. "*

This energy assessment has therefore been produced to demonstrate the implementation of the London Plan energy hierarchy to achieve reductions in regulated CO2 emissions. The energy strategy follows the energy hierarchy; Use Less Energy (Be Lean), Supply energy efficiently (Be Clean) and use Renewable and low carbon energy (Be Green) as per Policy CC1 of the Camden Local Plan (2017).

The scheme adopts a fabric-first and passive design approach to reduce energy demand for space heating and reduce the demand for active cooling.

Key design elements of the proposals comprise of:

- An upgraded, well-insulated building fabric shell.
- Being airtight, reducing draughts and heat-loss.
- Provision for ventilation and wastewater heat recovery systems.
- Energy efficient lighting and controls.
- Energy efficient heat pump and cooling systems.
- Low operational costs and carbon emissions.
- Improved air quality on-site due to zero combustion on site, benefitting the health & wellbeing of occupants.
- Photovoltaic solar panels are the preferred on-site renewable generation
- Technology as electricity is offset on-site.

The scheme looks to meet Net-Zero Carbon for Operational Energy, in reference to the London Plan energy hierarchy (Policy SI 2). An SBEM model was used to calculate the space heating, hot water, lighting, cooling, fans and pumps energy, improvements from low carbon technologies, and therefore the on-site operational energy consumption.

Following the new Part L 2021 Building Regulations that came into effect in June 2022, the GLA Energy Assessment Guidance (June 2022) states that major non-domestic developments must meet a 35 per cent on-site carbon reduction beyond Part L 2021.

However, as the software is currently in an interim period between Part L 2013 and Part L 2021 that is yet to be tried and tested, the GLA have stated the following:

> "*However, as the accompanying Part L 2021 software is not yet available, planning applicants should continue to use the 2020 guidance, spreadsheet and the Part L 2013 methodology until the software has been approved by government and is fully functional.*"

Therefore, this energy assessment has proceeded using the 2013 methodology by running SBEM calculations against Part L 2013 carbon factors and notional baselines. The outputs were then used in the GLA Carbon Emissions Reporting Spreadsheet 2020 which uses Part L 2013 as a baseline.

Furthermore, this energy assessment has split the results into new build, existing building, and site-wide summaries. Based on refurbishment and new construction, there is a cumulative CO2 reduction of 60% compared to the 2013 baseline. The extension has a total of 56% savings and the existing building refurbishment has a 61% saving.

The cumulative site-wide CO_2 reduction is broken down by the following:

- 47% at Be Lean
- 0% at Be Clean
- 13% at Be Green

The new build targets over15% CO_2 reduction at the 'Be Lean' Stage as per the Adopted London Plan 2021 targets. The scheme also significantly exceeds the 35% CO2 reduction on-site target compared to Part L 2013 baselines to make an allowance for the new Part L 2021 Building Regulations. Where space on the roof is available photovoltaic solar panels are provided.

elliottwood

Appendices

engineering a better society

A GLA Summary Tables

Site Wide SAP Table

Site Wide SAP Table

SAP 2012 Performance

Domestic

Table 1: Carbon Dioxide Emissions after each stage of the Energy Hierarchy for domestic buildings

	Carbon Dioxide Emissions for domestic buildings (Tonnes CO_2 per annum)	
	Regulated	Unregulated
Baseline: Part L 2013 of the Building Regulations Compliant Development	0.0	
After energy demand reduction (be lean)	0.0	
After heat network connection (be clean)	0.0	
After renewable energy (be green)	0.0	

Table 2: Regulated Carbon Dioxide savings from each stage of the Energy Hierarchy for domestic buildings

	Regulated domestic carbon dioxide savings	
	(Tonnes CO_2 per annum)	(%)
Be lean: savings from energy demand reduction	0.0	0%
Be clean: savings from heat network	0.0	0%
Be green: savings from renewable energy	0.0	0%
Cumulative on site savings	**0.0**	**0%**
Annual savings from off-set payment	0.0	-
	(Tonnes CO_2)	
Cumulative savings for off-set payment	**0**	-
Cash in-lieu contribution (£)	**0**	

*carbon price is based on GLA recommended price of £95 per tonne of carbon dioxide unless Local Planning Authority price is inputted in the 'Development Information' tab

SAP 10.0 Performance

Table 1: Carbon Dioxide Emissions after each stage of the Energy Hierarchy for domestic buildings

	Carbon Dioxide Emissions for domestic buildings (Tonnes CO_2 per annum)	
	Regulated	Unregulated
Baseline: Part L 2013 of the Building Regulations Compliant Development	0.0	
After energy demand reduction (be lean)	0.0	
After heat network connection (be clean)	0.0	
After renewable energy (be green)	0.0	

Table 2: Regulated Carbon Dioxide savings from each stage of the Energy Hierarchy for domestic buildings

	Regulated domestic carbon dioxide savings	
	(Tonnes CO_2 per annum)	(%)
Be lean: Savings from energy demand reduction	0.0	0%
Be clean: Savings from heat network	0.0	0%
Be green: Savings from renewable energy	0.0	0%
Cumulative on site savings	**0.0**	**0%**
Annual savings from off-set payment	0.0	-
	(Tonnes CO_2)	
Cumulative savings for off-set payment	**0**	-
Cash in-lieu contribution (£)	**0**	

*carbon price is based on GLA recommended price of £95 per tonne of carbon dioxide unless Local Planning Authority price is inputted in the 'Development Information' tab

Site Wide SAP Table

Non-domestic

Table 3: Carbon Dioxide Emissions after each stage of the Energy Hierarchy for non-domestic buildings

	Carbon Dioxide Emissions for non-domestic buildings (Tonnes CO_2 per annum)	
	Regulated	Unregulated
Baseline: Part L 2013 of the Building Regulations Compliant Development	97.2	72.6
After energy demand reduction (be lean)	53.3	72.6
After heat network connection (be clean)	53.3	72.6
After renewable energy (be green)	55.7	72.6

Table 4: Regulated Carbon Dioxide savings from each stage of the Energy Hierarchy for non-domestic buildings

	Regulated non-domestic carbon dioxide savings	
	(Tonnes CO_2 per annum)	(%)
Be lean: savings from energy demand reduction	43.9	45%
Be clean: savings from heat network	0.0	0%
Be green: savings from renewable energy	-2.4	-2%
Total Cumulative Savings	**41.5**	**43%**
Annual savings from off-set payment	55.7	-
	(Tonnes CO_2)	
Cumulative savings for off-set payment	**1,670**	-
Cash in-lieu contribution (£)	**158,652**	

*carbon price is based on GLA recommended price of £95 per tonne of carbon dioxide unless Local Planning Authority price is inputted in the 'Development Information' tab

Table 3: Carbon Dioxide Emissions after each stage of the Energy Hierarchy for non-domestic buildings

	Carbon Dioxide Emissions for non-domestic buildings (Tonnes CO_2 per annum)	
	Regulated	Unregulated
Baseline: Part L 2013 of the Building Regulations Compliant Development	62.6	32.6
After energy demand reduction (be lean)	33.0	32.6
After heat network connection (be clean)	33.0	32.6
After renewable energy (be green)	25.0	32.6

Table 4: Regulated Carbon Dioxide savings from each stage of the Energy Hierarchy for non-domestic buildings

	Regulated non-domestic carbon dioxide savings	
	(Tonnes CO_2 per annum)	(%)
Be lean: savings from energy demand reduction	29.6	47%
Be clean: savings from heat network	0.0	0%
Be green: savings from renewable energy	8.0	13%
Total Cumulative Savings	**37.6**	**60%**
Annual savings from off-set payment	25.0	-
	(Tonnes CO_2)	
Cumulative savings for off-set payment	**750**	-
Cash in-lieu contribution (£)*	**71,225**	

*carbon price is based on GLA recommended price of £95 per tonne of carbon dioxide unless Local Planning Authority price is inputted in the 'Development Information' tab

Site Wide SAP Table

SITE-WIDE

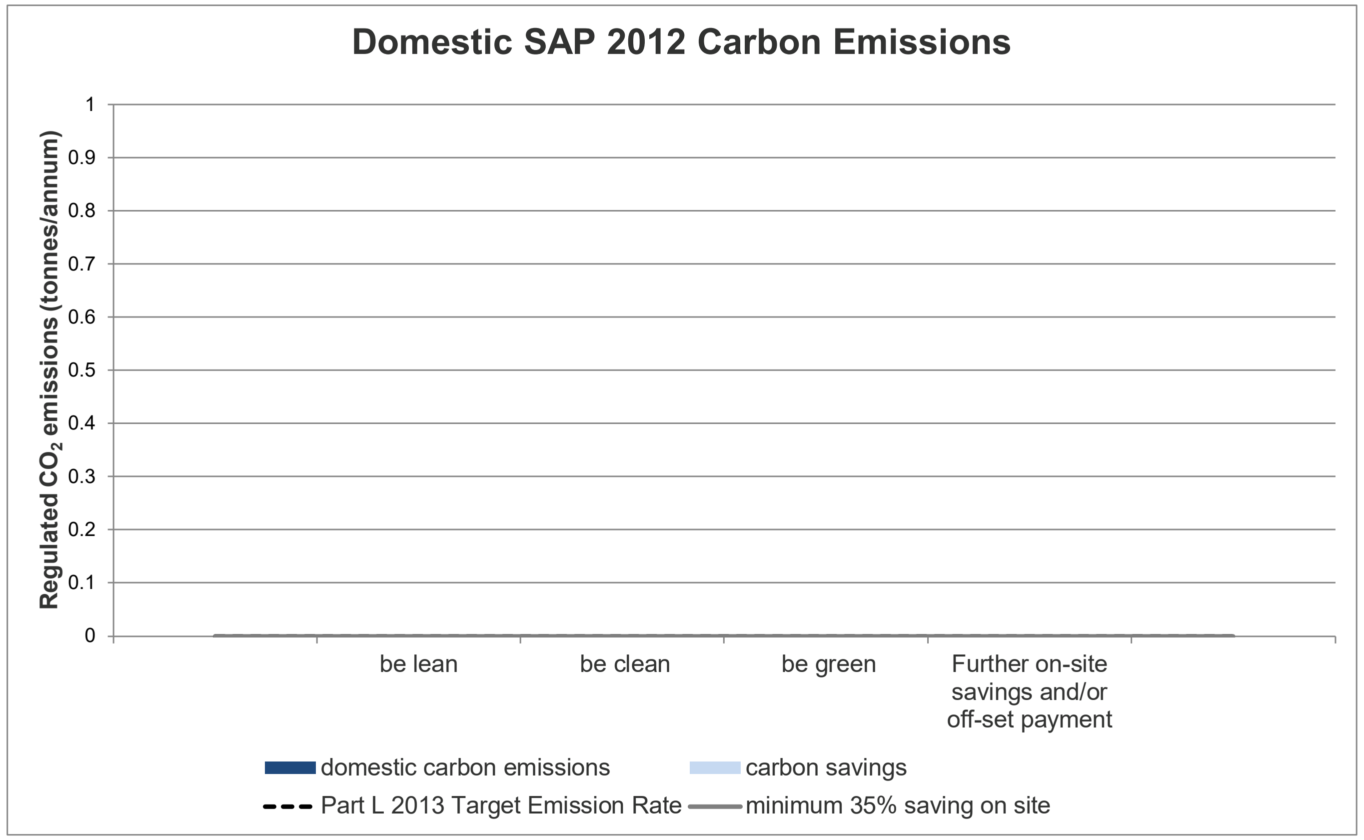
	Total regulated emissions (Tonnes CO_2 / year)	CO_2 savings (Tonnes CO_2 / year)	Percentage savings (%)
Part L 2013 baseline	97.2		
Be lean	53.3	43.9	45%
Be clean	53.3	0.0	0%
Be green	55.7	-2.4	-2%
Total Savings	-	41.5	43%
	-	**CO_2 savings off-set (Tonnes CO_2)**	-
Off-set	-	**1,670.0**	-

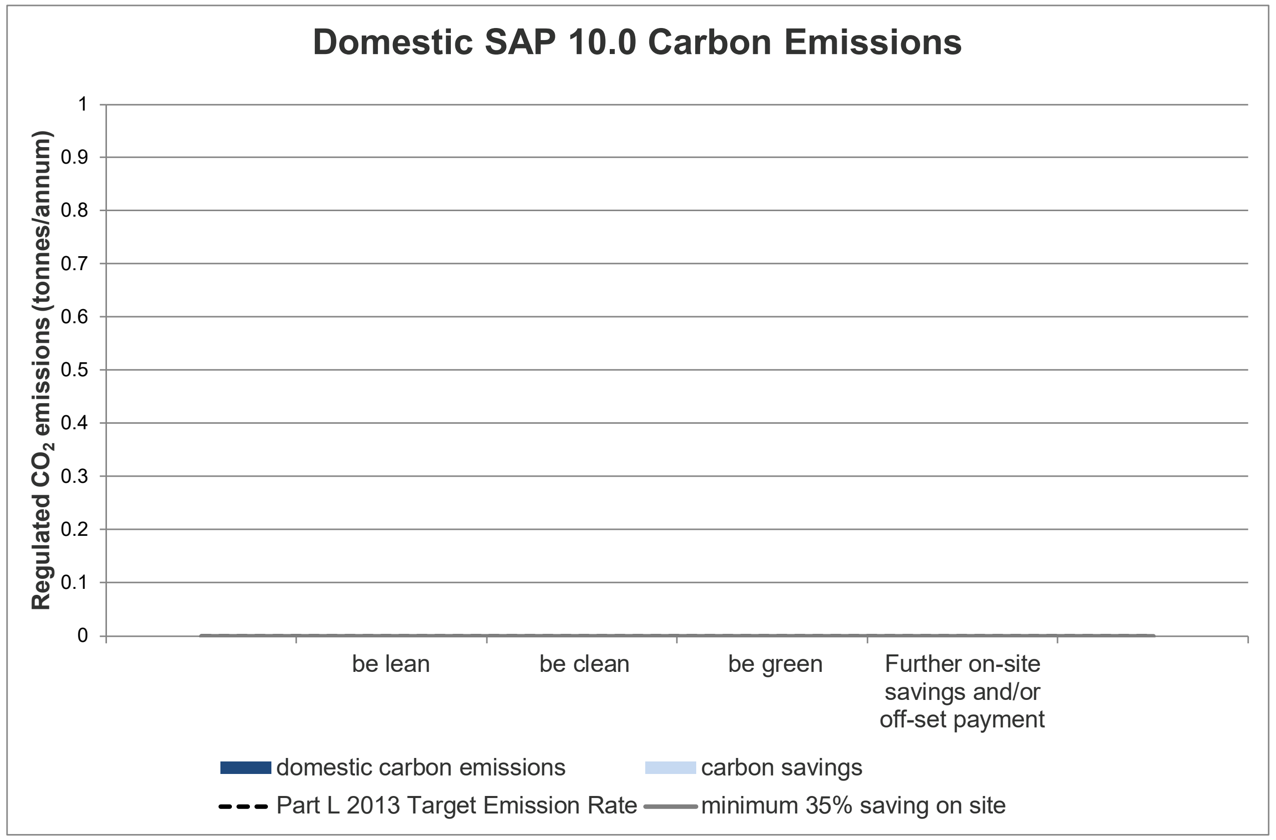
	Total regulated emissions (Tonnes CO_2 / year)	CO_2 savings (Tonnes CO_2 / year)	Percentage savings (%)
Part L 2013 baseline	62.6		
Be lean	33.0	29.6	47%
Be clean	33.0	0.0	0%
Be green	25.0	8.0	13%
Total Savings	-	37.6	60%
	-	**CO_2 savings off-set (Tonnes CO_2)**	-
Off-set	-	**749.7**	-

Site Wide SAP Table

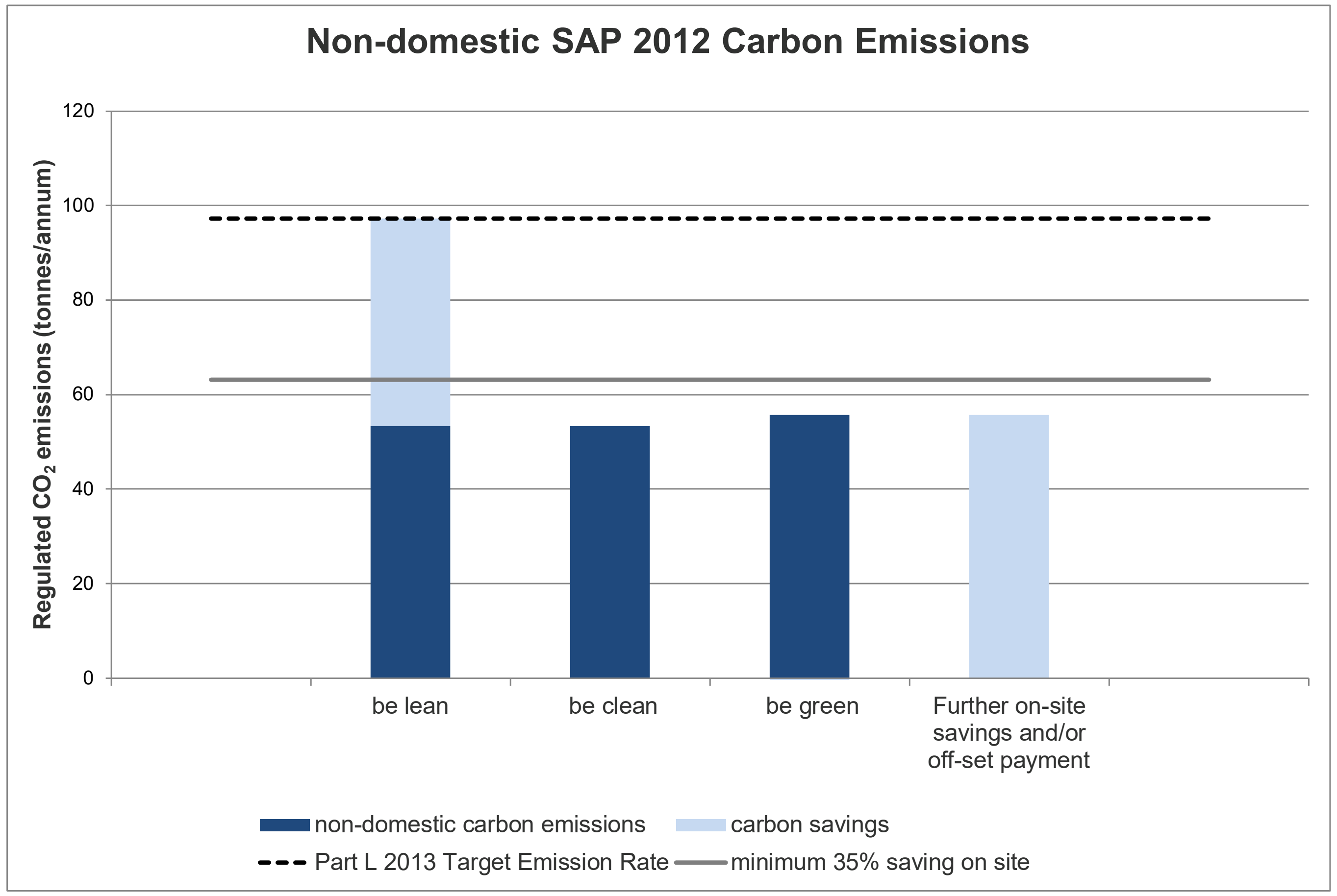
	Target Fabric Energy Efficiency (kWh/m²)	Dwelling Fabric Energy Efficiency (kWh/m²)	Improvement (%)
Development total	0.00	0.00	

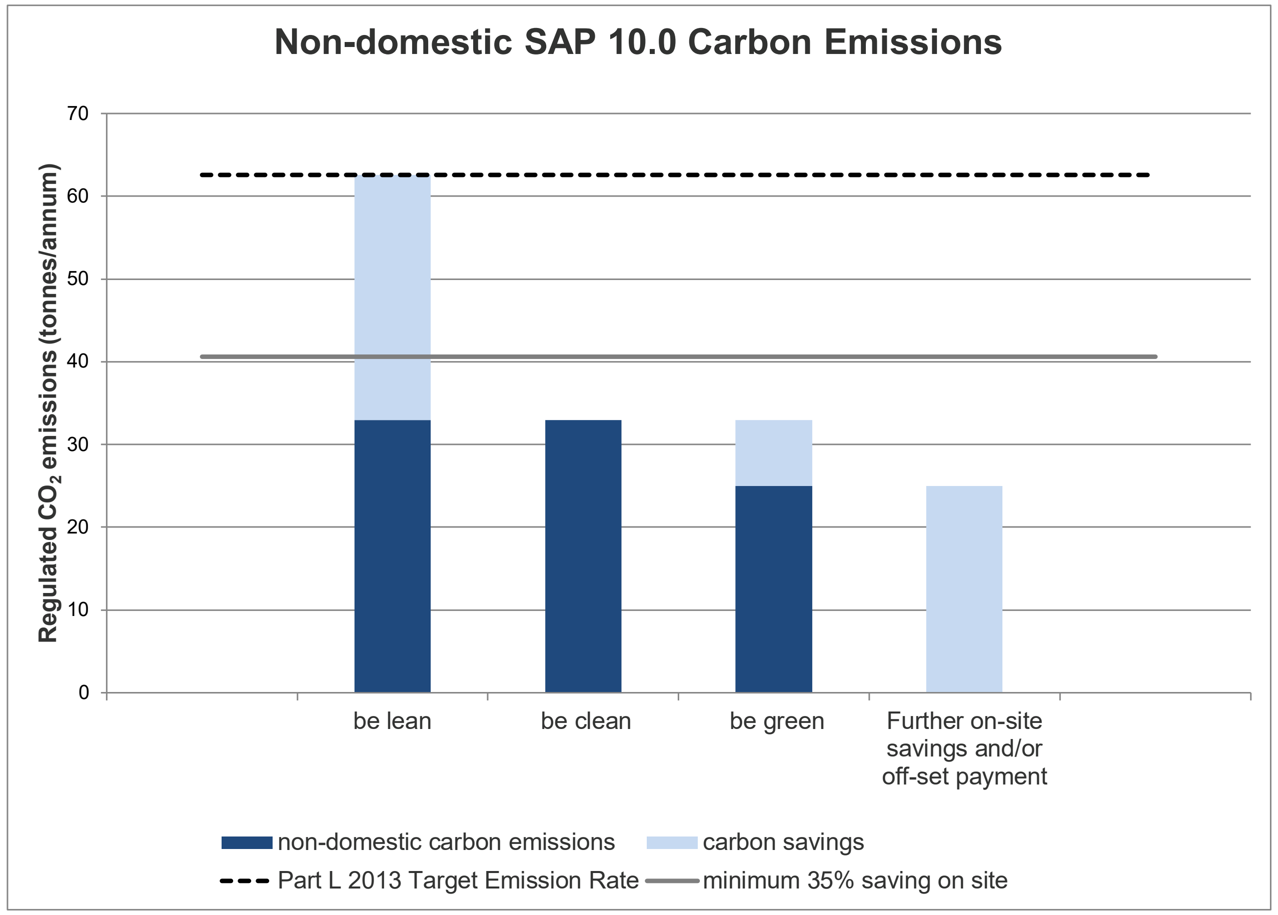
	Area weighted non-domestic cooling demand (MJ/m ^{2})	Total area weighted non-domestic cooling demand (MJ/year)
Actual		
Notional		





Site Wide SAP Table





B Proposed Energy Centre

N/A

C Low / Zero carbon feasibility

Description	Advantages	Things to consider
Air Source Heat Pumps Air Source Heat Pumps Heating and/or Hot Water		
An air source heat pump (ASHP) works by transferring heat absorbed from the outside air to an indoor space, such as a home or an office via the wet central heating systems to heat radiators and provide domestic hot water. Heat pumps work similarly to a refrigerator: they absorb heat and transfer it to another medium. Typically, two types: - Air to air heat pumps, which absorb heat from the outside air and then transfer it directly into your home via a fan system to heat a room. Air-to-air heat pumps require a warm air circulation system to move the warm air around your home. They will not provide you with hot water as well. Air-to-air heat pumps are not eligible for the UK government's Renewable Heat Incentive (RHI) scheme. - Air to water heat pumps, which absorb heat from the outside air and then transfer it via your central heating system to provide hot water heating, radiator, or underfloor heating in an indoor space (or all three). An air-to-water system distributes heat via your wet central heating system. Heat pumps work much more efficiently at a lower temperature than a standard boiler system would. This makes them more suitable for underfloor heating systems or larger radiators, which give out heat at lower temperatures over longer periods of time. You'll need a place outside where a unit(s) can be fitted to a wall or placed on the ground. It will need plenty of space around it to get a good flow of air. The external unit is connected to an internal unit containing circulation pumps and hot water, which is usually smaller than the average boiler. As a general rule, air source heat pumps are easier to install than ground source heat pumps, as they do not require any land to be dug up for installation. The size of the air source heat pump will vary depending on your home's heat demand – the bigger the home, the bigger the heat pump unit you'll need. Air-to-water heat pumps are the most common model in the UK. Air source heat pumps perform particularly well with underfloor heating systems or warm air heating because they operate at low temperatures. Homes without an existing central heating system will require one to be installed for an air source heat pump to work. An air source heat pump is subject to fluctuating air temperatures and has to work harder to produce heat when the outside air temperature is lower. This means that in the colder months, when the heat pump is likely to be relied on the most, it will use more units of electricity to produce the same amount of heating as a ground source heat pump in the same period of time.	- It could lower your fuel bills, especially if you replace conventional electric heating - It could provide you with an income through the UK government's Renewable Heat Incentive (only applies to air-to-water heat pumps) - It could lower home carbon emissions - There are no fuel deliveries needed - It can heat your home as well as your water - It can be easier to install than a ground source heat pump - While air source and ground source heat pumps function differently, with air source heat pumps absorbing heat from the air outside while ground source heat pumps extract heat from the ground via pipes, they can bring the same benefits to your underfloor heating system. Due to the low temperatures required for underfloor heating, air source and ground source heat pumps are an ideal way to heat the system at a lower running cost.	- Running costs will vary depending on several factors including the size of the development, how well insulated it is, and what room temperatures you are aiming to achieve. - Although swapping a gas/oil boiler with ASHPs typically helps the environment by using high efficiency systems with electricity; electricity is still approximately 3-4 times more expensive than natural gas, so efficiency of the system is key. - ASHP efficiencies are most effective with lower temperatures i.e. 30degC-50degC so work well with underfloor heating solutions; however, if they are paired to hot water solutions that require higher temperatures 60degC+ then the efficiency rapidly drops and often immersion heaters within the tanks automatically switch on which can significantly increase the electricity bills. - While air source heat pumps don't take up too much outdoor space, the unit will be visible from the outside of the property (unless located on a roof or behind a barrier), so it's best to check with the local planning authority first, to find out if you need planning permission. As the unit is above ground, it will produce a noise similar to that of an air conditioning unit, which could be bothersome to you or your neighbours. More info: https://energysavingtrust.org.uk/advice/installing-renewables/ - If the heat pump is providing hot water, then this could limit the overall efficiency. You might want to consider solar water heating to provide hot water in the summer and help keep your heat pump efficiency up. - Learn how to control the system so you can get the most out of it. You will probably need to set the heating to come on for longer hours, but you might be able to set the thermostat lower and still feel comfortable. The installer should explain to you how to control the system so you can use it most effectively.

Description	Advantages	Things to consider
Ground Source Heat Pumps Ground Source Heat Pumps Heating and/or Hot Water		
Ground source heat pumps (GSHPs) use pipes that are buried in the garden to extract heat from the ground. This heat can then be used to heat radiators, underfloor or warm air heating systems and hot water in your home. A ground source heat pump circulates a mixture of water and antifreeze around a loop of pipe, called a ground loop, which is buried in your garden. Heat from the ground is absorbed into the fluid and then passes through a heat exchanger into the heat pump. The ground stays at a fairly constant temperature under the surface, so the heat pump can be used throughout the year. The length of the ground loop depends on the size of your home and the amount of heat you need. Longer loops can draw more heat from the ground, but need more space to be buried in. If space is limited, a vertical borehole can be drilled instead.	- It could lower your fuel bills, especially if compared to conventional electric heating. - It could provide an income through the government's Renewable Heat Incentive (RHI). - It could lower home carbon emissions, depending on which fuel you are replacing. - There are no fuel deliveries needed. - It will heat your home as well as your water. - There is minimal maintenance required. - Unlike gas and oil boilers, heat pumps deliver heat at lower temperatures over much longer periods. - In winter, it may need to be on constantly to heat buildings efficiently, but radiators won't feel as hot to the touch as with a gas or oil boiler. - Often they are more difficult to install than air source heat pumps, but ground source heat pumps are often more energy efficient. - Ground source heat pumps can perform better with underfloor heating systems or warm air heating than with radiator-based systems because of the lower water temperatures required. - When you consider the time of year you would typically rely on your heat pump the most – when temperatures drop during the winter months – it's easy to understand why the ground source heat pump wins in terms of efficiency. The temperature of the ground is fairly fixed at a constant 10 – 13°C all year round, so a ground source heat pump remains consistently efficient throughout the year, unaffected by seasonal changes. - While air source and ground source heat pumps function differently, with air source heat pumps absorbing heat from the air outside while ground source heat pumps extract heat from the ground via pipes, they can bring the same benefits to your underfloor heating system. Due to the low temperatures required for underfloor heating, air source and ground source heat pumps are an ideal way to heat the system at a lower running cost.	- The ground needs to be suitable for digging a trench or a borehole and accessible to digging machinery. - The ground loop can be installed in two ways, vertically or horizontally, but each will take up a certain amount of space in the garden/site boundary and you'll need to check the ground is suitable for digging. - If you want to put the pipes in vertically, you'll need specialist machinery to drill a borehole, which will increase the cost of installation. Opting to lay the pipework horizontally is a cheaper method of installing a ground source heat pump, but you'll need a lot more space, so it's only suitable if you've got a large garden. - GSHP efficiencies are most effective with lower temperatures i.e. 30degC-50degC so work well with underfloor heating solutions; however, if they are paired to hot water solutions that require higher temperatures 60degC+ then the efficiency rapidly drops and often immersion heaters within the tanks automatically switch on which can significantly increase the electricity bills. Sizing: The heat loss of the property is determined by how well the building is insulated. If the insulation is not known then it becomes difficult to size the heat pump accurately. The only way this can be achieved with any degree of accuracy is to commission a Heat Loss calculation according to BS EN12831 which takes into account the build, insulation, heating system, etc and can be used to determine a peak heat load. This is a key requirement of the Renewable Heat Incentive Scheme. Insulation: Insulation plays a big part in how effective a heat pump operates. Reducing the energy requirement for any building should be a central theme to the design process. Any investment in an upgraded insulation specification will have a far swifter pay-back than the return on any renewable technology. For this reason, consideration should be given to improving the insulation level as much as practically possible. There is also a concern for un-insulated buildings that the actual heat emitting device, i.e. radiators, under-floor, etc. will not output enough heat at the heat pump's lower flow temperatures to obtain a warm enough temperature within the building. This is a particular concern when the temperature outside is cold. As a guide, a building post 1985 with cavity wall insulation, double glazing and 300mm thick loft insulation, will have a peak heating load of ~50W/m2. A property built before 1985 with single glazing we would assume has a peak heating load of 70W/m2 or greater. In cases of very poor insulation the low temperature output from the heat pump may mean that the building will never get warm and that the running costs for the heat pump are increased. It is important to ensure that the correct amount of pipe for the application is buried and that it is buried correctly. If insufficient pipe is installed then the ground could potentially run out of energy mid heating season, leaving the occupants without heat. It is important to remember that if the heat pump is producing Domestic Hot Water as well as space heating, an additional amount of ground array is required simply as there is an additional all year round load on the ground. As a guide, roughly 2 to 2.5 times the area being heated is required to install horizontal ground arrays. If there is insufficient land available an alternative to horizontally laid ground arrays is a vertical drilled borehole. These can be down to a depth of over 100m. Drilling a borehole is a specialist activity and as such can be expensive.

Description	Advantages	Things to consider
Water Source Heat Pumps Open/Closed Loop System Heating/Cooling and/or Hot Water		
Water source heat pumps (WSHPs) work by extracting heat from a body of water and converting it into useful energy to heat your home. They use a series of submerged pipes containing a working fluid to absorb the heat from a river, lake, large pond or borehole. This is then turned into useful heat for space heating and hot water, through compressing the working fluid so it can give the heat off at a higher temperature. Closed loop systems These water source heat pumps have sealed pipes filled with fluid (antifreeze), which are submerged beneath the water, never coming into contact with water directly. As the fluid flows through the pipes it is heated by the water body and returns to the heat pump. Open loop systems Water flows through the pump to extract its heat in an open loop system, before being discharged back to its source. These can be more efficient than closed loop pumps, but you need to gain consent from either the Environment Agency, for England or Wales, or the Scottish Environment Protection Agency (SEPA) in Scotland to discharge the water, and possibly additional permission to extract it. Accessing the aquifer's water directly and extracting heat from that is a way of using an open-loop system. This is usually done with two boreholes. One abstraction borehole with a pump at the bottom to lift the water to the surface for the heat pump to use and another borehole some distance away to re-inject the water back into the aquifer. Hence open-loop. Hybrid heat pumps These involve a second heating source running alongside the water source heat pump system. These are particularly suited to older homes, where it's not possible to insulate the property sufficiently to optimise the pump's performance.	Water source heat pumps are often more efficient than ground and air source devices. This is because heat transfers better in water, while water temperatures are generally more stable throughout the year (between 7 and 12 degrees on average), which is higher than the average air and ground temperature in winter. Submerged pipework in a body of water absorbs heat energy from its surroundings in the same manner as it would if buried in the ground. The submerged pipes, typically closed loop systems such as pond mats, transfer the water's heat energy to the heat pump. The water source heat pump then compresses and upgrades this temperature, delivering heating and hot water to radiators or underfloor heating inside the property. When water is used as the heat source in open loop systems, a secondary heat exchanger is used, so the heat pump itself remains on a closed loop containing glycol. A secondary exchanger can take several forms; loops of pipe or metal panels immersed in the source water, or a gasket plate heat exchanger with the water piped to it. Water has a high capacity to hold heat in relation to its volume; it readily absorbs heat and readily delivers it: it enjoys a high transfer rate. It is more efficient for a heat pump to exchange heat with water than air – which enables a water source heat pump to outperform an air source heat pump. The thermal capacity and thermal inertia of water enables it to retain some of the solar heat gained in the summer through to the winter. Groundwater in aquifers is warmer than the air temperature on cold winter days and thus provides a more attractive input temperature to a heat pump. The London Aquifer, for instance, maintains a steady temperature of 14°C throughout the year. A well engineered groundwater heat pump system has access to a large volume of water: this enables it to extract heat from a very large heat source whose temperature will not change significantly as relatively small amounts of heat are extracted from it. It is possible to access financial support for installing a water source heat pump through the Renewable Heat Incentive scheme, which pays a rate for units of heat generated. In Scotland, water source heat pumps may also qualify for funding through the Scottish Government funded Home Energy Scotland Loan. Both these schemes require that the installer and product installed are certified under the Microgeneration Certification Scheme (MCS) and all MCS installers must be members of a consumer code and work must adhere to their code's standards.	When you install a water source heat pump, you might need to install underfloor heating and larger radiators to get the best performance out of the technology, similar to when you install an air or ground source heat pump. Overall, this could represent an expensive undertaking. The disadvantages of an open loop heat pump system include the need to meet the additional engineering challenges of dealing with water which may contain debris, unstable pH values or biological growth and may call for additional pumping loads. It will also be necessary to meet the abstraction requirements of the Environmental Agency on all but the smallest of schemes. The key disadvantage of using a very large body of water to achieve heat exchange with a relatively constant temperature is that you are not able to store summer heat in that body of water – to have the benefit of retrieving those higher temperatures in winter. As using an open-loop system negates the need for the glycol/water solution and hundreds of meters of 40mm collector array pipe, it is often quoted as being cheaper to install. There are of course good reasons why we will not normally specify an open-loop system, the main one being hidden costs. The hidden costs of an open-loop system come from the need to regularly clean the heat exchanger, run and service the abstraction pump and obtaining and maintaining a water abstraction licence from the Environment Agency, the cost of which varies by region across the UK. Another consideration should be the cost of pumping water from the bottom of a borehole to the surface. A recent example for a modest domestic dwelling showed that a 30kW heat pump system would require about 13,000m3 of water each year to be pumped from the bottom of the borehole to the heat pump at ground level. At the abstraction cost of £0.02751p per m3 this equates to around £360 each year. A cost not required for a closed-loop system. The running costs of an abstraction pump are much higher than those of a closed-loop system circulation pump. A closed-loop system requires a much smaller pump due to the balance of pressure in the loop, rather than having to lift vast volumes of water from a great depth. Based on a 2,200 run-hour cycle per year, an open-loop pump would cost about £ 860 in electricity as opposed to the £60 a year running cost of a closed-loop pump.

Description	Advantages	Things to consider
Solar Panels Photovoltaic Electricity Generation		
Solar electricity panels, also known as photovoltaics (PV), capture the sun's energy and convert it into electricity that you can use in your home. By installing solar panels you can generate your own renewable electricity. Solar PV cells are made from layers of semiconducting material, usually silicon. When light shines on the material, electrons are knocked loose, creating a flow of electricity. The cells don't need direct sunlight to work, they can work on a cloudy day. However, the stronger the sunshine, the more electricity generated. Solar PV cells are grouped into modules, and modules are usually grouped into solar arrays. Modules and arrays come in a variety of shapes and sizes. Most PV systems are made up of panels that fit on top of your roof, but you can also install on the ground, or fit solar tiles. The electricity generated is direct current (DC), whereas the electricity you use for household appliances is alternating current (AC). An inverter is installed along with the system to convert DC electricity to AC.	During daylight hours, you'll be generating electricity even on cloudy days, but during the evening you'll be using electricity from the mains. Reducing your electricity use can help lower your bills and reduce your carbon footprint. You can combine PV with other space-heating renewable technologies such as heat pumps, solar thermal systems and wind turbines. These technologies work well with each other, as PV can be set up to help power a heat pump, for example, or several of these systems can feed into a thermal store. With most PV systems, there will be times when the electricity you generate is more than you can use or store, so the surplus will be exported to the grid to be used by somebody else. If you want to be paid for exporting, you need to make sure you're getting an export payment. If you were able to claim the feed-in tariff (this closed to new applications at the end of March 2019), then you will be getting export payments as part of that. If not, you need to find an energy company that will pay you for this surplus. Following the closure of the Feed-in Tariff scheme to new solar PV system applicants in March 2019, the Smart Export Guarantee (SEG) was introduced to provide financial support to small-scale renewable energy generators for the electricity they export to the grid. The savings from solar PV with the SEG are considerably higher than without it. In Great Britain, the Smart Export Guarantee pays you for the electricity you generate. PV Divert Most of the time your solar PV system either: isn't generating enough energy for your household's demand, and is supplemented by importing electricity from the grid, or is generating excess electricity surplus to your demand, and exporting that electricity back to the grid. If you are getting export payments via Smart Export Guarantee or if you aren't getting paid for exports at all, you might be looking for a way to use more of your generated energy within your home. Instead of sending it to the grid, that surplus electricity could power the immersion heater in a hot water tank, storing hot water for you to use later. A PV diverter would allow you to do this, provided you have a hot water cylinder. This is typically the lowest upfront cost option for increasing in-home use, particularly if you install at the same time as your panel installation. It is a reliable and low maintenance piece of kit that directs your excess energy to power your immersion heater, instead of exporting to the grid. On its own, excess solar energy is unlikely to meet all of your hot water needs, but it can help reduce your bills. If you're interested in using PV diverter, speak with your installer. They might also suggest increasing the number of panels on your roof to provide more electricity for your hot water needs.	For domestic systems, PV systems will be working at its peak during daylight hours, so it's a good idea to think about reorganising domestic activities such as washing, dishwashing and ironing. If you're home most of the day, then this will be easier to do, but if you work during the day then try setting up timers for your dishwasher and washing machine. Solar PV needs little maintenance. Keep an eye on nearby trees to ensure they don't begin to overshadow them. In the UK, panels that are tilted at 15° or more have the benefit of being cleaned by rainfall to ensure optimal performance. Debris is more likely to accumulate if you have ground mounted panels, or if you live in an area with more dust in the air. In these cases, you might need to have the panels cleaned. Once fitted, your installer should leave written details of any maintenance checks that you should carry out from time to time to ensure everything is working properly. This should include details of the main inverter fault signals and key troubleshooting guidance. Ideally, your installer should demonstrate this to you at the point of handover. Keeping a close eye on your system and the amount of electricity it's generating (alongside the weather conditions) will familiarise you with what to expect and alert you to when something might be wrong. The panels should last 25 years or more, but the inverter is likely to need replacing sometime during this period. Consult with your installer for exact maintenance requirements before you commit to installing a solar PV system.

Description	Advantages	Things to consider
Solar Panels Solar Thermal Heating and/or Hot Water		
Solar water heating systems use solar panels, called collectors, fitted to your roof. These collect heat from the sun and use it to heat up water that is stored in a hot water cylinder. A boiler or immersion heater can be used as a back up to heat the water further to reach the temperature you want. There are two types of solar water heating panels: - evacuated tubes – a bank of glass tubes mounted on the roof tiles - flat plate collectors, which can be fixed on the roof tiles or integrated into the roof	- The system works all year round, though you'll need to heat the water further with a boiler or immersion heater during the winter months. - Sunlight is free, so once you've paid for the initial installation your hot water costs will be reduced. - Solar hot water is a green, renewable heating system and can reduce your carbon dioxide emissions.	- The cost of installing a typical solar water heating system is in the region of £4,000 – £5,000 for a home system. Savings are moderate – the system can provide most of your hot water in the summer, but much less during the winter months. - You'll need around five square metres of roof space for a typical house, which faces East to West through South and receives direct sunlight for the main part of the day. The panels don't have to be mounted on a roof, however. They can be fixed to a frame on a flat roof or hang from a wall. - If a dedicated solar cylinder is not already installed, then you will usually need to replace the existing cylinder or add a dedicated cylinder with a solar heating coil. - Many conventional boiler and hot water cylinder systems are compatible with solar water heating. If your boiler is a combination – or combi – boiler and you don't currently have a hot water cylinder, a solar hot water system may not be compatible. - You don't need planning permission for most home solar water heating systems, as long as they're below a certain size. However, you should check with your local planning officer, especially if your home is a listed building, or in a conservation area or World Heritage Site. - A competent accredited installer will be able to assess your home and help you choose the best setup to meet your needs.

Description	Advantages	Things to consider
Wind Turbines		
Wind turbines harness the power of the wind and use it to generate electricity. When the wind blows, the blades are forced round, driving a turbine that generates electricity. The stronger the wind, the more electricity produced. There are two types of domestic-sized wind turbine: pole mounted – these are free standing and are erected in a suitably exposed position, with generation capacity of about 5-6kW building mounted – these are smaller than mast mounted systems and can be installed on the roof of a home where there is a suitable wind resource. Often these are around 1-2kW in size Battery-less grid tied systems: Often considered to be the best kind of wind turbine, the battery-less grid tied systems are simple, environmentally friendly, and high performance. These turbines produce as much electricity as possible, also feeding into the grid. They're great for anybody wishing to reduce reliance on energy companies, but not so good if you're looking to go off-grid entirely. The problem is that there's no storage for the energy, so when the wind stops blowing you're back to buying energy from the grid. Grid-tied system with battery backup: The problem we mentioned above can be remedied by using a grid-tied turbine with battery storage. It's the same premise, but with a bank of batteries that stores electricity and feeds it back into the system if there is a grid power cut. The only downside is that the battery can be expensive. Off-grid systems: If you are hoping to limit your dependence on the mains as much as possible, you will need a larger turbine, or multiple smaller turbines – size matters. If you're just looking to produce enough electricity for some garden lights then you'd be okay with a smaller one.	You may be able to claim Smart Export Guarantee (SEG) payments for any surplus electricity you export to the grid. The Smart Export Guarantee replaced the previous Feed-in Tariff, which closed to new applications at the end of March 2019. A well-sited 6kW pole mounted turbine could typically earn about £440 per year in SEG payments.	The cost of a system will depend on the size and the mounting method. Building-mounted turbines cost less to install than pole-mounted ones, but they tend to be less efficient. For equipment and installation, a 6kW pole-mounted system costs between £23,000 and £34,000. Building-mounted turbines tend to be less efficient than pole-mounted ones. A well-sited 6kW turbine can generate around 9,000kWh a year, which could save you around £250 a year on your electricity bills. Maintenance checks are necessary every few years, and will generally cost around £100 to £200 per year depending on turbine size. A well-maintained turbine should last more than 20 years, but you may need to replace the inverter at some stage during this time, at a cost of £1,000 to £2,000 for a large system. For off grid systems, batteries will also need replacing, typically every six to 10 years. The cost of replacing batteries varies depending on the design and scale of the system. Any back-up generator will also have its own fuel and maintenance costs. The building may require increased structure to support the turbine if a turbine is included as part of the building.

elliottwood | engineering a better society

D Building Regulations UK Part L Reports (BRUKL)

Attached Separately

elliottwood | engineering a better **society**

London
55 Whitfield Street
Fitzrovia
W1T 4AH
+44 207 499 5888

Wimbledon
241 The Broadway
London
SW19 1SD
+44 208 544 0033

Nottingham
1 Sampsons Yard
Halifax Place
Nottingham
NG1 1QN
+44 870 460 0061

www.elliottwood.co.uk