Camden Mixed Developments Limited

Grand Union House

Energy Strategy & Overheating Assessment

February 2021
70009120

Public

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PROJECT NO. 70009120

February 2021

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CONTENTS

TABLES

FIGURES

APPENDICES

1 EXECUTIVE SUMMARY

This Energy Strategy ('the Strategy') is submitted in support of a detailed planning application ('the Application') made on behalf of Camden Mixed Developments Limited ('the Applicant') for the adaptive re-use, alterations and extensions ('the Proposed Development') to Grand Union House, 16-20 Kentish Town Road, London ('the Site').

WSP has been commissioned by the Applicant to develop the energy strategy for the Proposed Development in Camden, which will be submitted as part of the planning application.

The proposed development comprises the partial demolition, re-build and upward extension to provide additional Class E office and commercial floorspace, six residential units (Class C3), new areas of landscaping and public realm.

The development will provide approximately 6,656 m^2 GIA of office space, 251 m^2 GIA of ground floor retail space and 523 m^2 GIA of residential space, 6No. units (3 x 2 Bed, 3 x 1 Bed, one of which is fully wheelchair accessible).

1.1 ENERGY AND CARBON TARGETS

There are national, regional and local policies which set targets for energy and carbon emission reduction. The development will be designed to target the most onerous requirements applicable at each phase of development.

On that basis, the implications of the relevant targets for the proposed development can be summarised as follows:

- § All development must meet the prevailing Building Regulations requirements. The development will be brought forward under Part L 2013 and this has been used as the basis of the energy strategy.
  - The development will also be assessed using the recently proposed SAP 10 carbon emissions factors for reference.
- § Camden requires new residential and non-residential developments to achieve an on-site reduction of 35% reduction in carbon emissions.
- § Camden Planning Guidance – Sustainability states any shortfall must of the 35% on-site target may require a s106 financial contribution to Camden's carbon offset fund.
- § Connection to a district heat network and evaluate the feasibility of CHP systems.
- § Non-residential development should be designed to meet BREEAM Excellent; and
- § Major developments should provide a reduction in expected CO_2 emissions through the use of on-site renewable energy generation, where feasible to do so.

1.2 ENERGY STRATEGY

The energy strategy has been structured in accordance with the energy hierarchy: Be Lean, Be Clean, Be Green. The proposals for the scheme have been developed in accordance with the desire to achieve an energy efficient and sustainable development. The building will be designed to achieve optimum energy performance and will incorporate the following design features:

NON-RESIDENTIAL

- § 5,296 m^2 of office space (NIA) and 236 m^2 of ground floor commercial space (NIA).
- § Significantly exceed the limiting fabric requirements of Part L2A (2013) of the Building Regulations.
- § Energy efficient building services plant (including low specific fan power air handling units with heat recovery and DC variable speed fan coil units) will be specified throughout where it is to be provided as part of the base building scheme.
- § Low energy LED/fluorescent lighting incorporating daylight and motion controls will be specified throughout.
- § The non-residential will be served by a central variable refrigerant flow (VRF) system. Refrigerant pipework will be distributed from the external units in the plant enclosure at Level 4, via risers located strategically throughout the building.
- § It is not currently possible to serve the development from a district heating network as there are currently no existing networks near to the development.
- § A CHP engine has not been proposed for the site as the true carbon savings of the technologies have diminished with the decarbonisation of the grid. Using up to date carbon emission factors for grid electricity causes CHP engines to produce more carbon than a standard boiler system.
- § Therefore, the space heating and DHW demand shall be met with VRF.
- § A significant PV array is proposed to be located on the roof of the level 04. This will provide a further reduction in carbon emissions from the development.
- § The retail units will be completed to shell and core standard only, providing base services for future extension by tenants, who will be responsible for provision of services to suit their particular requirements. Retail units to be served by individual direct expansion units, with adequate provision for installation by tenants provided. The retail areas will be separately metered.

RESIDENTIAL

- § Significantly exceed the limiting fabric requirements of Part L1A (2013) of the Building Regulations.
- § A CHP engine has not been proposed for the site as the true carbon savings of the technologies have diminished with the decarbonisation of the grid. Using up to date carbon emission factors for grid electricity causes CHP engines to produce more carbon than a standard boiler system.
- § The residential apartments will be provided with heating and domestic hot water (DHW) from a packed heat pump (per apartment). The heat pump is located within the utility cupboard of each apartment, connected to a roof mounted external unit via pipework located in the risers. The heat pump also contains an internal DHW tank for storage.
- § Low energy LED lighting will be specified throughout; and
- § A PV array is proposed to be located on the roof of the residential block. This will provide a further reduction in carbon emissions from the development.

1.3 SAP 2012 RESULTS

Accredited thermal simulation software IES VE 2021 was used to determine the regulated carbon emissions for the non-residential element of the development. Elmhurst Design SAP 2012 software was used to determine the regulated carbon emissions for the residential element of the development.

Table 1-1 Non-residential carbon emissions reductions

	NON-RESIDENTIAL REGULATED EMISSIONS (MT CO_2)	UNREGULATED EMISSIONS (MT CO_2)	REDUCTION IN REGULATED EMISSIONS (%)
Part L 2013 Compliant Non-Residential*	133.71	156.85	-
Be Lean	116.75	156.85	12.7%
Be Clean	116.75	156.85	12.7%
Be Green	75.64	156.85	43.4%

Table 1-2 Residential carbon emissions reductions

	RESIDENTIAL REGULATED EMISSIONS (MT CO_2)	UNREGULATED EMISSIONS (MT CO_2)	REDUCTION IN REGULATED EMISSIONS (%)
Part L 2013 Compliant Residential*	7.40	0.12	-
Be Lean	6.75	0.12	8.8%
Be Clean	6.75	0.12	8.8%
Be Green	4.08	0.12	44.9%

Table 1-3 Development carbon emissions reductions

	TOTAL REGULATED EMISSIONS (MT CO_2)	UNREGULATED EMISSIONS (MT CO_2)	REDUCTION IN REGULATED EMISSIONS (%)
Part L 2013 Compliant Development*	141.11	156.97	-
Be Lean	123.50	156.97	12.5%
Be Clean	123.50	156.97	12.5%
Be Green	79.72	156.97	43.5%

Using SAP 2012 carbon factors, both the residential and non-residential elements significantly exceed the 35% on-site reduction target set in the London Plan.

1.4 SAP10.0 RESULTS

Using the *'GLA carbon emissions reporting spreadsheet v1.1'* the carbon emissions can be updated to reflect more up to date carbon factors for each fuel type. The updated results are as below

Table 1-4 Non-residential carbon emissions reductions

	NON-RESIDENTIAL REGULATED EMISSIONS (MT CO_2)	UNREGULATED EMISSIONS (MT CO_2)	REDUCTION IN REGULATED EMISSIONS (%)
Part L 2013 Compliant Non-Residential*	72.82	70.42	-
Be Lean	70.06	70.42	3.8%
Be Clean	70.06	70.42	3.8%
Be Green	33.96	70.42	53.4%

Table 1-5 Residential carbon emissions reductions

	RESIDENTIAL REGULATED EMISSIONS (MT CO_2)	UNREGULATED EMISSIONS (MT CO_2)	REDUCTION IN REGULATED EMISSIONS (%)
Part L 2013 Compliant Residential*	6.60	0.06	-
Be Lean	5.76	0.06	12.7%
Be Clean	5.76	0.06	12.7%
Be Green	1.83	0.06	72.3%

Table 1-6 Development carbon emissions reductions

	TOTAL REGULATED EMISSIONS (MT CO_2)	UNREGULATED EMISSIONS (MT CO_2)	REDUCTION IN REGULATED EMISSIONS (%)
Part L 2013 Compliant Development*	79.42	70.48	-
Be Lean	75.81	70.48	4.5%
Be Clean	75.81	70.48	4.5%
Be Green	35.79	70.48	54.9%

Using SAP10.0 carbon factors, both the residential and non-residential elements significantly exceed the 35% on-site reduction target set in the London Plan.

1.5 OVERHEATING SUMMARY

The strategy for minimising cooling demand in accordance with London Plan Policy SI 4 and Camden Policy CC2 for the Proposed Development is as follows:

- The residential elements do not have any South facing glazing which helps to reduce the solar gains entering the dwellings.
- The bedrooms are on the East side of the dwellings. Therefore, there is reduced solar gains entering these rooms reducing the risk of sleep being disturbed in the night due to increased temperatures.
- 100% low energy lighting will be provided to reduce internal heat gains within the apartments.
- A highly efficient fabric specification is proposed incorporating glazing with low-e solar shield glass to protect the interior from solar gain.
- MVHR has been specified throughout to provide background ventilation.
- When natural ventilation is applied, the development complies with CIBSE TM59.
- However, due to air quality and acoustic issues a natural ventilation strategy may not be appropriate and comfort cooling will be required.

2 PROJECT BACKGROUND

2.1 DEVELOPMENT DESCRIPTION

This Energy Strategy ('the Strategy') is submitted in support of a detailed planning application ('the Application') made on behalf of Camden Mixed Developments Limited ('the Applicant') for the adaptive re-use, alterations and extensions ('the Proposed Development') to Grand Union House, 16-20 Kentish Town Road, London ('the Site').

WSP has been commissioned by the Applicant to develop the energy strategy for the Proposed Development in Camden, which will be submitted as part of the planning application.

The proposed development comprises the partial demolition, re-build and upward extension to provide additional Class E office and commercial floorspace, six residential units (Class C3), new areas of landscaping and public realm.

The development will provide approximately 6,656 m^2 GIA of office space, 251 m^2 GIA of ground floor retail space and 523 m^2 GIA of residential space, 6No. units (3 x 2 Bed, 3 x 1 Bed, one of which is fully wheelchair accessible).

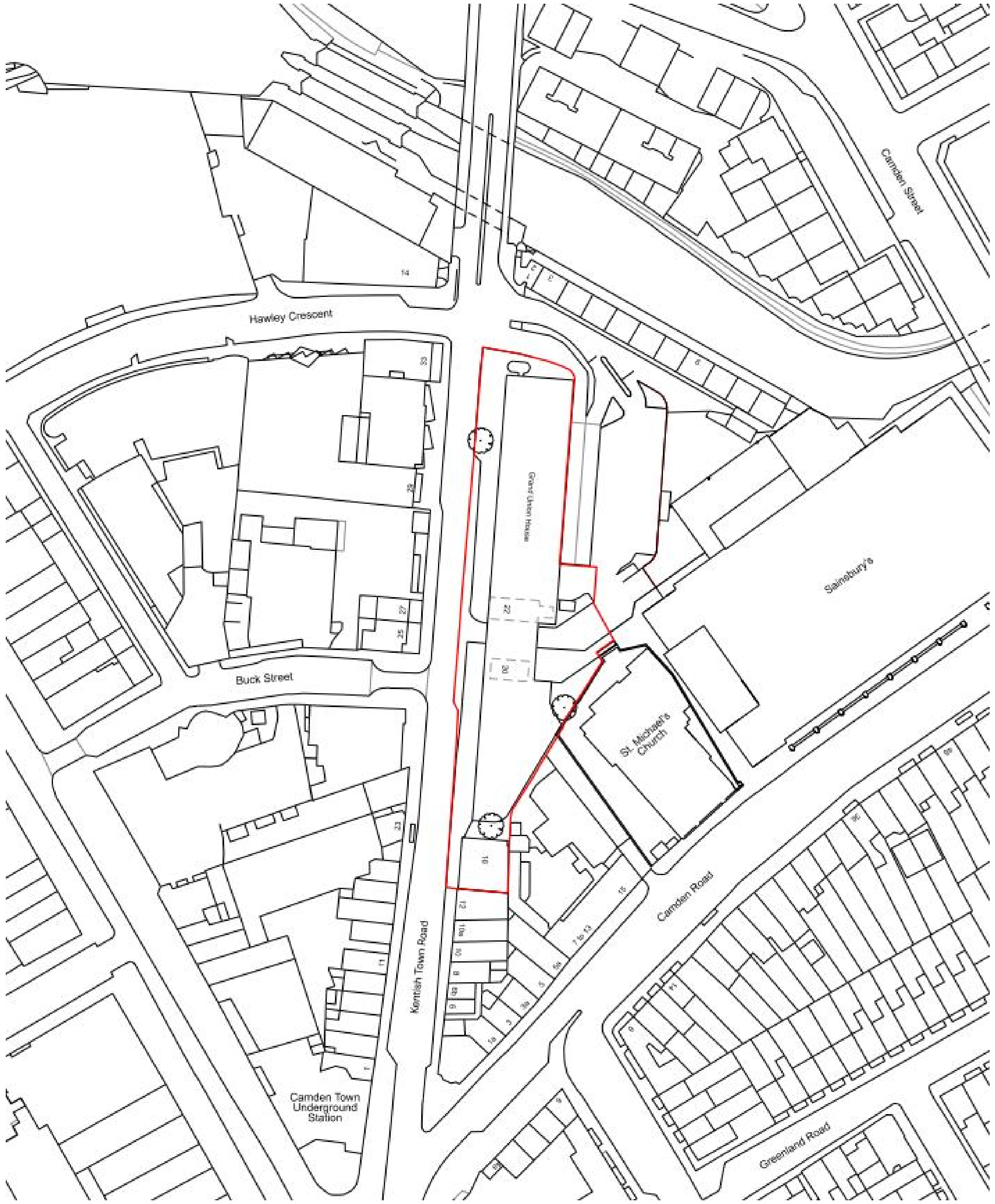

Figure 2-1 Site plan of the Proposed Development (within red line boundary)

3 POLICY CONTEXT

The London Borough of Camden's approach to sustainable development is underpinned by the National Planning Policy Framework (NPPF) and policies from the current and draft New London Plan (minor suggested changes August 2018) and the Camden Local Plan.

3.1 NATIONAL PLANNING POLICY FRAMEWORK

The National Planning Policy Framework (NPPF) was updated initially in July 2018 with minor amendment in February 2019, which replaces the 2012 NPPF. Plans and decisions should apply a presumption in favour of sustainable development.

The NPPF sets the planning context for sustainable design and construction. It is this that Local Planning Policies are based on and adapted to account for regionally specific requirements.

The NPPF identifies three dimensions to sustainable development - economic, social and environmental – which should be applied jointly and simultaneously:

§ **Economic objective** – to help build a strong, responsive and competitive economy, by ensuring that sufficient land of the right types is available in the right places and at the right time to support growth, innovation and improved productivity; and by identifying and coordinating the provision of infrastructure;

§ **Social objective** – to support strong, vibrant and healthy communities, by ensuring that a sufficient number and range of homes can be provided to meet the needs of present and future generations; and by fostering a well-designed and safe built environment, with accessible services and open spaces that reflect current and future needs and support communities' health, social and cultural well-being; and

§ **Environmental objective** – to contribute to protecting and enhancing our natural, built and historic environment; including making effective use of land, helping to improve biodiversity, using natural resources prudently, minimising waste and pollution, and mitigating and adapting to climate change, including moving to a low carbon economy.

The NPPF promotes the pursuit of sustainable development by seeking positive improvements to the built and natural environment, and to people's quality of life. This will include:

§ Delivering a sufficient supply of homes

§ Building a strong, competitive economy

§ Ensuring the vitality of town centres

§ Promoting healthy and safe communities

§ Promoting sustainable transport

§ Supporting high quality communications

§ Making effective use of land

§ Achieving well-designed places

§ Protecting green belt land

§ Meeting the challenge of climate change, flooding and coastal change

§ Conserving and enhancing the natural environment

§ Facilitating the sustainable use of materials.

3.2 NEW LONDON PLAN (2021) & SUSTAINABLE DESIGN AND CONSTRUCTION SPG

ENERGY AND CARBON DIOXIDE EMISSIONS

§ The overall carbon dioxide emissions from a development should be minimised through the implementation of the energy hierarchy.

§ Development should be designing to meet the following Regulated carbon dioxide standards:

- Residential and Non-residential buildings: Zero Carbon - 35% carbon emissions improvement upon Building Regulations Part L 2013 on site with shortfalls paid up to zero for both categories of building.

§ Developments should contribute to ensuring resilient energy infrastructure and a reliable energy supply, including from local low and zero carbon sources.

§ Developers are encouraged to include innovative low and zero carbon technologies to minimise carbon dioxide emissions with developments and keep up to date with rapidly improving technologies.

ENERGY DEMAND ASSESSMENT

§ Applications are to be accompanied by an energy demand assessment

USE LESS ENERGY

§ The design of developments should prioritise passive measures

§ Developers should aim to achieve Part L 2013 Building Regulations requirements through design and energy efficiency alone, as far as is practical.

EFFICIENT ENERGY SUPPLY

§ Developers should assess the potential for their development to:

- Connect to an existing district heating or cooling network;
- Expand an existing district heating or cooling network, and connect to it; or
- Establish a site wide network, and enable the connection of existing buildings near the development

RENEWABLE ENERGY

§ Major developments should incorporate renewable energy technologies to minimise overall carbon dioxide emissions, where feasible.

CARBON DIOXIDE OFF-SETTING

§ Where developments do no achieve the Mayor's carbon dioxide reduction targets set-out, the developers should contribute to the local borough's carbon dioxide off-setting fund.

MONITORING ENERGY USE

- Developers are encouraged to incorporate monitoring equipment and systems where appropriate to enable occupiers to monitor and reduce their energy use.

SUPPORTING A RESILIENT ENERGY SUPPLY

- Developers are encouraged to incorporate equipment that would enable their schemes to participate in demand side response opportunities.

3.3 CAMDEN LOCAL PLAN (2017) & CPG: ENERGY EFFICIENCY AND ADAPTATION 2021

The Camden Local Plan (adopted in June 2017) set out the Council's planning policies and its replace the current Core Strategy and Development Policies planning documents (adopted in 2010). It ensures that Camden continues to have robust, effective and up-to-date planning policies that respond to changing circumstances and the borough's unique characteristics and contribute to delivering the Camden Plan and other local priorities. The Local Plan covers the period from 2016-2031.

ENERGY HIERARCHY

- All development is expected to reduce their carbon dioxide emissions by the following the steps in the energy hierarchy to reduce energy consumption.
- Developments involving 500sq m (gross internal) floor-space or more are required to submit an energy statement which demonstrates how carbon dioxide emissions will be reduced in line with the energy hierarchy.

ENERGY EFFICIENCY: NEW BUILDINGS

- All new development is to be designed to minimise carbon dioxide emissions by being as energy efficient as is feasible and viable.
  - Natural systems
  - Preventing Overheating
  - Thermal Performance
  - Mechanical Systems
  - Other energy efficient technology
- Development will be expected to achieve 60% of the un-weighted credit in the Energy category of their BREEAM Assessment.

DECENTRALISED ENERGY NETWORKS AND COMBINED HEAT AND POWER

- Developments will aim to connect to a decentralised energy network and use the heat unless developers can demonstrate it is not technically feasible or financially viable.
- Where a development is not connecting immediately to a network the following measures need to be included in your scheme:
  - space in the plant room for a heat exchanger, any other plant and pipe and electricity connections; and
  - Pipes from the plant room to the property boundary where the decentralised energy pipe is most likely to be located.
- Financial Contribution: if your scheme does not connect to a Decentralised energy network or have a secure agreement to do so within 3 years, and does not include combined heat and power, a financial contribution may be required to enable expansion of the network and future connection.

RENEWABLE ENERGY

- To ensure that the Council can monitor the effectiveness of renewable and low carbon technologies, major developments will be required to install appropriate monitoring equipment.
- All developments are to target at least a 20% reduction in carbon dioxide emissions through the installation of on-site renewable energy technologies.
- When assessing the feasibility and viability of renewable energy technology, the Council will consider the overall cost of all the measures proposed and resulting carbon savings to ensure that the most cost-effective carbon reduction technologies are implemented in line with the energy hierarchy.

3.4 BUILDING REGULATIONS (PART L)

All new buildings constructed in the UK must meet the minimum requirements of the UK Building Regulations. With regards to energy and carbon compliance, all buildings must meet the building regulations Part L 'Target Emission Rate' (TER) requirements for the Part L revision which is current at the time of initial construction works for each particular developmental phase. Part L 2013 has been used as the basis of this energy statement, however the development will need to comply with the revision of Part L which is current at the start of construction.

The current proposed date for Part L 2021 to be implemented is June 2022. A meaningful start to construction on site will need to have been achieved before the implementation date of Part L 2021 to lock the development into being assessed against Part L 2013.

4 BASELINE CARBON EMISSIONS

The first stage of the energy assessment is to establish the baseline site energy demand and CO_2 emissions based on dynamic energy modelling software.

Detailed energy modelling was undertaken based on the methodology from Part L2A 2013 of the Building Regulations in order to establish the baseline carbon emissions for the development. Any building services installed will comply with the limiting values listed in the relevant Non-Domestic Building Services Compliance Guide.

WSP utilised a dynamic simulation software package, the Virtual Environment (VE) suite from Integrated Environmental Solutions (IES). This is a fully validated commercially available software package that is available for the purpose of demonstrating compliance with the Building Regulations. IES VE is an integrated suite of applications based around a 3D geometrical model.

This process enabled the optimum fabric and building services specification to meet Camden's planning targets.

4.1 SAP 2012 RESULTS

Table 4-1 to Table 4-3 summarise the baseline carbon emissions for the whole development.

Table 4-1 Non-residential baseline regulated and unregulated carbon emissions for the scheme

	NON-RESIDENTIAL REGULATED EMISSIONS (MT CO_2)	UNREGULATED EMISSIONS (MT CO_2)	REDUCTION IN REGULATED EMISSIONS (%)
Part L 2013 Compliant Non-Residential*	133.71	156.85	-

Table 4-2 Residential baseline regulated and unregulated carbon emissions for the scheme

	RESIDENTIAL REGULATED EMISSIONS (MT CO_2)	UNREGULATED EMISSIONS (MT CO_2)	REDUCTION IN REGULATED EMISSIONS (%)
Part L 2013 Compliant Residential*	7.40	0.12	-

Table 4-3 Development baseline regulated and unregulated carbon emissions for the scheme

	TOTAL REGULATED EMISSIONS (MT CO_2)	UNREGULATED EMISSIONS (MT CO_2)	REDUCTION IN REGULATED EMISSIONS (%)
Part L 2013 Compliant Development*	141.11	156.97	-

Figure 4-1 shows the geometry of the Proposed Development within the Energy Model using accredited thermal simulation software IES VE. This model has been utilised to undertake the Part L 2013 and Energy Hierarchy calculations.

4.2 SAP 10.0 RESULTS

Table 4-1 to Table 4-3 summarise the baseline carbon emissions for the whole development using SAP10.0 carbon factors.

Table 4-4 Non-residential baseline regulated and unregulated carbon emissions for the scheme

	NON-RESIDENTIAL REGULATED EMISSIONS (MT CO_2)	UNREGULATED EMISSIONS (MT CO_2)	REDUCTION IN REGULATED EMISSIONS (%)
Part L 2013 Compliant Non-Residential*	72.82	70.42	-

Table 4-5 Residential baseline regulated and unregulated carbon emissions for the scheme

	RESIDENTIAL REGULATED EMISSIONS (MT CO_2)	UNREGULATED EMISSIONS (MT CO_2)	REDUCTION IN REGULATED EMISSIONS (%)
Part L 2013 Compliant Residential*	6.60	0.06	-

Table 4-6 Development baseline regulated and unregulated carbon emissions for the scheme

	TOTAL REGULATED EMISSIONS (MT CO_2)	UNREGULATED EMISSIONS (MT CO_2)	REDUCTION IN REGULATED EMISSIONS (%)
Part L 2013 Compliant Development*	79.42	70.48	-

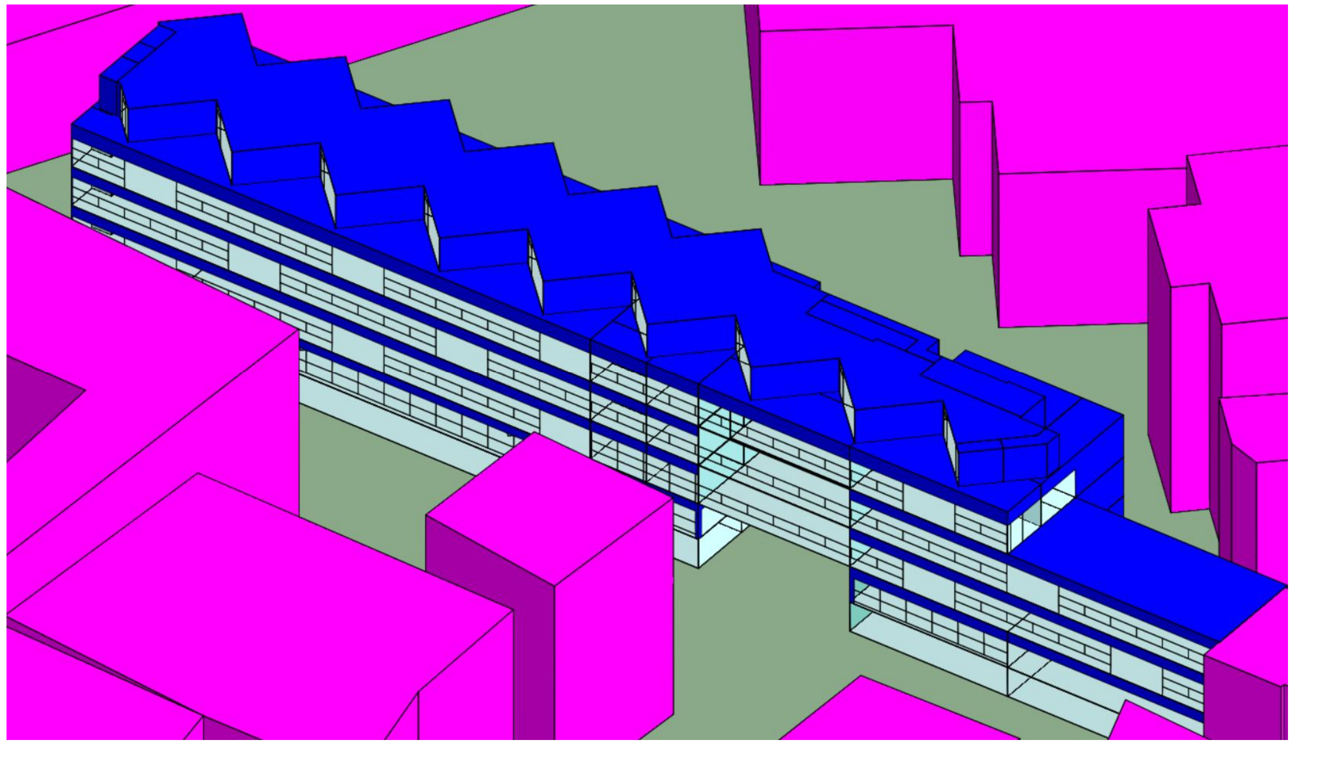

Figure 4-1 Render of the IES model of the development

5 BE LEAN: DEMAND REDUCTION

The first step to achieving Building Regulations compliance and the targets outlined previously is to reduce energy demand. The measures associated with reducing demand can be termed as 'Energy Efficiency Measures'.

5.1 BUILDING FABRIC

The proposed building will be clad with a curtain walling system comprising high performance insulating glass units.

At this stage it is anticipated that an overall U-value for the curtain walling system of 1.4 W/m^2K will be achieved. For the purposes of this assessment these values have been used, though solutions will be sought to optimise the U-value further where possible in order to realise further carbon reductions.

Glazing will be specified to achieve a g-value of 0.40 for ground and mezzanine floors, 0.30 for the remaining office floors and 0.50 for the residential areas. This will provide the necessary solar control to assist in minimising summertime solar gains and reducing the overheating risk whilst helping to improve daylighting.

The current proposals for the building fabric performance for Grand Union House are summarised in Table 5-1

Table 5-1 Fabric performance targets

ELEMENT	NON-RESIDENTIAL	RESIDENTIAL
Curtain wall/glazing U-value (W/m^2K)	1.40	1.40
External Wall U-value (W/m^2K)	0.15	0.15
Common Area Core Wall U-value (W/m^2K)	N/A	0.25
Glazing g-value	0.30/0.40	0.50
Ground floor U-value (W/m^2K)	0.13	0.13
Roof U-value (W/m^2K)	0.13	0.13
Residential Front Doors U-value (W/m^2K)	N/A	1.00
Air permeability ($m^3/hr.m^2$ @ 50 Pa)	3.0	3.0
Thermal Bridging	Include in the façade U-value where appropriate. Otherwise 10% of associated U-value	Default (y = 0.15)

5.2 THE BUILDING SERVICES

High performance MEP building services are proposed for the scheme. Table 5-2 lists the general specification for the heating and cooling system, and lighting and ventilation strategy for the proposed development.

OFFICE AREAS (USE CLASS E)

All office areas are to be fitted to a Cat A standard. Heating and cooling will be provided to all office areas by EC/DC controlled low energy VRF Fan Coil Units (FCU's).

Fresh air will be provided by central air handling units with high efficiency heat recovery. Louvres for intake and exhaust air will be located on the building façade.

Domestic hot water will be provided by the VRF for the building.

All spaces will include 100% low energy lighting, including LED light fittings to the open plan office areas. Photoelectric sensors will be applied to building perimeter areas and motion sensors will be applied throughout.

OFFICE LOBBY AREAS

The reception lobby shall be fitted with high level FCUs. At stage 3, thermal analysis shall determine whether over door heaters are going to be required over the entrance to the reception.

SHOWER/CHANGING/CYCLE STORE AREAS

The cycle changing rooms will be provided with either FCUs or some form of under floor heating, this shall be developed at the next design stage.

The cycle changing and on floor WCs shall be served by a local extract system. A high-level extract fan shall extract air from each of the WCs and changing areas, exhausting directly through the façade. Make up air shall be via the adjacent office space.

FLEXIBLE RETAIL AND LEISURE USES (CLASS E)

The units will be completed to shell and core standard only, providing base services for future extension by tenants and temporary life safety systems protecting the building while the units are unoccupied. The tenants will be responsible for provision of services to suit their requirements.

For the Part L2A analysis, reasonable assumptions have been made for the fit-out design typical of the units. This includes heating and ventilation via fan coil units, mechanical ventilation using in-ceiling air handling plant, and low energy shop and display lighting with efficient controls.

Table 5-2 Proposed energy conservation measures for non-domestic areas

ELEMENT	RATIONALE AND PERFORMANCE TARGET
Air Handling Plant	Fresh air to office areas will be provided by central AHUs to achieve an SFP of **1.8Wl/s**. Other areas will also be served by on floor AHUs. Supply and exhaust ventilation to ancillary spaces (including retail and plant space) will be designed to exceed the minimum performance criteria outlined in the Non-Domestic Building Services Compliance Guide with the performance validated during the subsequent design stages.
Energy Recovery	Air handling systems will incorporate heat recovery systems. These transfer waste heat from the exhaust air stream to the supply air stream via a honeycomb matrix of heat absorbing material, which is slowly rotated within the supply and exhaust air streams.
Terminal Units	All office areas are to be fitted to a Cat A standard. Heating and cooling will be provided to all office areas by EC/DC controlled low energy VRF Fan Coil Units (FCU's). These are designed to achieve a specific fan power in operation as low as **0.18 W/l/s**, which is significantly lower than the Part L 2013 limiting SFP. Ground floor flexible retail and leisure spaces will be developed to a shell and core standard only and be fitted out by tenants.

ELEMENT	RATIONALE AND PERFORMANCE TARGET
Heating and Cooling Plant	All office areas will be served by the main energy centre, with VRF distribution throughout. The energy centre will comprise of reversible Air Source Heat Pumps which are capable of providing both heating and cooling to the building. The ASHP will have a heating COP of around **4.5** and a cooling SEER in the region of **4.5**.
Lighting Technology	Detailed lighting proposals will be developed during the subsequent design phases. High efficiency lighting will be provided throughout to significantly exceed the minimum requirements of the Non-Domestic Building Services Compliance Guide. This includes the use of high efficiency fluorescent and/or LED luminaries to all spaces. Lighting to achieve a lighting power density of **1.2 W/m^2/100 lux** or less in the office spaces and **2 W/m^2/100 lux** elsewhere.
Display Lighting	Display lighting can be a significant source of energy consumption. High efficiency display lighting will be specified throughout to reduce the carbon emissions and cooling loads associated with display lighting provision. This will better than Part L limiting values and the notional building's design and will achieve a minimum efficacy of **80 lm/W**.
Lighting Control	Occupancy sensing and daylight harvesting will be specified to an appropriate level throughout the different areas of the building. This assists in reducing the use of artificial lighting when areas are not occupied.

RESIDENTIAL UNITS (USE CLASS C3)

The building services for all residential units will be fully fitted as part of the development and will consist of heating and domestic hot water (DHW) from a packed heat pump (per apartment). The heat pump is located within the utility cupboard of each apartment, connected to a roof mounted external unit via pipework located in the risers. The heat pump also contains an internal DHW tank for storage. Each individual apartment will be provided with a Mechanical Ventilation Heat Recovery (MVHR) unit to provide whole house ventilation. Fresh air and exhaust ducts will connect to the façade at high level. Each apartment will be provided with 100% low energy lighting. A PV array of approximately 8kWp (48m^2) is to be provided and connected to the landlord's supply.

5.3 CARBON EMISSION REDUCTION

Based upon the energy efficiency measures outlined, and excluding the contribution of the ASHP and PV systems the following total carbon emissions are calculated in Table 5-3 to Table 5-5.

The carbon emissions for the development are shown to be lower than the minimum requirements of the Building Regulations.

This is achieved via the use of the energy efficiency measures proposed (including a highly efficient building fabric, 100% low energy lighting and high efficiency building services) which far exceed the minimum requirements of the Regulations.

5.4 SAP 2012 RESULTS

Table 5-3 Be Lean: Non-residential carbon emissions after the application of energy efficiency measures

	NON-RESIDENTIAL REGULATED EMISSIONS (MT CO_2)	UNREGULATED EMISSIONS (MT CO_2)	REDUCTION IN REGULATED EMISSIONS (%)
Part L 2013 Compliant Non-Residential*	133.71	156.85	-
Be Lean	116.75	156.85	12.7%

Table 5-4 Be Lean: Residential carbon emissions after the application of energy efficiency measures

	RESIDENTIAL REGULATED EMISSIONS (MT CO_2)	UNREGULATED EMISSIONS (MT CO_2)	REDUCTION IN REGULATED EMISSIONS (%)
Part L 2013 Compliant Residential*	7.40	0.12	-
Be Lean	6.75	0.12	8.8%

Table 5-5 Be Lean: Development carbon emissions after the application of energy efficiency measures

	TOTAL REGULATED EMISSIONS (MT CO_2)	UNREGULATED EMISSIONS (MT CO_2)	REDUCTION IN REGULATED EMISSIONS (%)
Part L 2013 Compliant Development*	141.11	156.97	-
Be Lean	123.50	156.97	12.5%

**The energy efficiency savings have been calculated on the basis that the building is served by a central heating system served by gas fired boilers only.*

5.5 SAP 10.0 RESULTS

Table 5-6 Be Lean: Non-residential carbon emissions after the application of energy efficiency measures

	NON-RESIDENTIAL REGULATED EMISSIONS (MT CO_2)	UNREGULATED EMISSIONS (MT CO_2)	REDUCTION IN REGULATED EMISSIONS (%)
Part L 2013 Compliant Non-Residential*	72.82	70.42	-
Be Lean	70.06	70.42	3.8%

Table 5-7 Be Lean: Residential carbon emissions after the application of energy efficiency measures

	RESIDENTIAL REGULATED EMISSIONS (MT CO_2)	UNREGULATED EMISSIONS (MT CO_2)	REDUCTION IN REGULATED EMISSIONS (%)
Part L 2013 Compliant Residential*	6.60	0.06	-
Be Lean	5.76	0.06	12.7%

Table 5-8 Be Lean: Development carbon emissions after the application of energy efficiency measures

	TOTAL REGULATED EMISSIONS (MT CO_2)	UNREGULATED EMISSIONS (MT CO_2)	REDUCTION IN REGULATED EMISSIONS (%)
Part L 2013 Compliant Development*	79.42	70.48	-
Be Lean	75.81	70.48	4.5%

**The energy efficiency savings have been calculated on the basis that the building is served by a central heating system served by gas fired boilers only.*

5.6 PART L FABRIC ENERGY EFFICIENCY

The introduction of the FEE standard is arguably the most significant change introduced with Part L 2013.

The TFEE (Target Fabric Energy Efficiency) standard is the maximum amount of energy which can be used to heat and cool a new dwelling. The TFEE standard is calculated by using a building of the same size and shape as the actual dwelling, but with the fabric and building services performance stipulated within Appendix R of SAP 2012. A 15% increase to this value is then added, ostensibly to avoid setting overly restrictive targets.

As the compliance with the TFEE standard falls under the requirements of Criterion 1, it is also seen as required by law, rather than statutory guidance.

The thermal performance of the façade has been considered in detail early on in the design process and close consideration has been given to the thermal performance of the façade based on the emerging design.

Accredited Design SAP2012 software was used to determine the FEE standards for a sample of typical apartments. An analysis has been undertaken on the all residential units to establish the performance of the fabric in relation to the TFEE. Results for TFEE and the Dwelling FEE (DFEE) for all residential units are as follows:

Table 5-9 Fabric energy efficiency and carbon emissions results by residential block

	AVERAGE DFEE (KWH/M²)	AVERAGE TFEE (KWH/M²)	% DFEE<TFEE
Residential Block	52.06	52.88	1.6%

5.7 OVERHEATING ANALYSIS

Policy 5.9 of the London Plan requires major development proposals to reduce potential overheating and reliance on air conditioning systems and demonstrate this is in accordance with the following cooling hierarchy:

1. Minimise internal heat generation through energy efficient design;

2. Reduce the amount of heat entering a building in summer through orientation, shading, albedo, fenestration, insulation and green roofs and walls;

3. Manage the heat within the building through exposed internal thermal mass and high ceilings;

4. Passive ventilation;

5. Mechanical ventilation; and

6. Active cooling systems.

Residential units within this development present a challenge, as comfort cooling systems are not desirable due to the running costs associated with them which could lead to higher service charges; and the ambient noise levels and local air pollution mean that natural ventilation is not an option.

The passive design of these units has been considered in great detail, and the orientation and massing has considered its position on the application site relative to other buildings which will provide an element of shading but also to maximise daylight opportunities. Internal layouts have also been refined to allow the daylighting requirements to be achieved without reliance on excessive amounts of glazing. Façade options have been studied to minimise heat loss and solar gains, and to investigate the introduction of external shading measures.

A range of overheating studies have been undertaken in line with guidance in industry documents such as CIBSE TM52, CIBSE TM59 and CIBSE Guide A, and a dynamic simulation model has been developed in order to test the influence of various parameters and ensure that overheating will not be an issue. The environmental solution involves an increased volume of mechanical ventilation with boost facilities during warmer weather. Future weather files have also been studied to understand the impact of climate change.

The strategy for minimising cooling demand in accordance with Policy 5.9 for the Proposed Development is as follows:

§ The residential elements do not have any South facing glazing which helps to reduce the solar gains entering the dwellings

§ The bedrooms are on the East side of the dwellings. Therefore, there is reduced solar gains entering these rooms reducing the risk of sleep being disturbed in the night due to increased temperatures.

§ 100% low energy lighting will be provided to reduce internal heat gains within the apartments.

§ A highly efficient fabric specification is proposed incorporating glazing with low-e solar shield glass to protect the interior from solar gain.

§ MVHR has been specified throughout to provide background ventilation.

§ When natural ventilation is applied, the development complies with CIBSE TM59.

§ However, due to air quality and acoustic issues a natural ventilation strategy may not be appropriate and comfort cooling will be required.

The Domestic Overheating Checklist is contained within the Appendices of this report.

<u>Overheating in Corridors</u>

In addition, it is recognised that market feedback on internal heat networks (particularly within multi storey residential buildings) in recent years has highlighted a common, significant failing; the overheating of internal corridor spaces particularly in summer. However, the proposed development does not have a centralised heat network for the residential units. Therefore, CIBSE TM59 states that the corridors do not need to be assessed but will still be included in the model.

OVERHEATING ANALYSIS

According to the results of the SAP calculations, all apartments modelled pass Building Regulations Part L Criterion 3 with the building fabric specifications set in section 5 and with the assumption that apartments benefit from internal curtains as specified in SAP 2012 guidance: *"Unless specifically included in the design specification a default of dark coloured curtains should be assumed closed during daylight hours (f=1)"*

A further dynamic model overheating analysis was carried out for all dwellings at the proposed development. The aim of the analysis was to evaluate the internal temperatures in the apartments to assess the potential for overheating, in line with the requirements of the GLA. The GLA requires overheating modelling to be undertaken using the following three design years:

§ DSY 1 - 1989: a moderately warm summer.

§ DSY 2 - 1976: a year with a prolonged period of sustained warmth.

§ DSY 3 - 2003: a year with a very intense single warm spell.

Due to location of the development being outside of the Central Activity Zone, compliance with the criteria is required when assessing against using the following weather file:

§ London LHR DSY1 2020s, high emissions, 50 percentile scenario.

The dwellings must be assessed against DSY 2 and DSY3 but do not need to achieve compliance in order to satisfy the TM59 criteria. Also, the dwellings must be assessed against a future weather profile.

CIBSE TM59 OVERHEATING CRITERIA

CIBSE TM59 sets out criteria based on the adaptive approach to thermal comfort of CIBSE TM52. The 'adaptive' approach to thermal comfort shows that the temperature at which the majority of people are comfortable 'tracks' the mean indoor temperature because of the correlation between indoor and outdoor temperature in naturally ventilated (free-running) buildings.

The following two criteria, taken together, provide a robust yet balanced assessment of the risk of overheating of residential buildings in the UK and Europe. If a room fails either of the two criteria then the whole associated dwelling is classed as overheating.

The first criterion states the number of hours (He) during which ΔT (the difference between the actual operative temperature in a room and the limiting maximum acceptable air temperature) is greater than or equal to one degree (K) during the period May to September inclusive shall not be more than 3% of occupied hours.

The second criterion deals with the severity of overheating overnight in bedrooms only. To guarantee comfort during the sleeping hours the operative temperature in the bedroom from 10pm to 9am shall not exceed 26°C for more than 1% of the annual hours (equivalent to 32 hours).

There are four assessment categories within TM52 which is dependent on the acceptable temperature range of free-running buildings. The CIBSE suggestion is that designers should aim to remain within the Category II limits.

MODELLING ASSUMPTIONS

For the purposes of this analysis the following key assumptions have been made based on CIBSE TM59 guidance:

Occupancy and Equipment gains

- Maximum sensible heat gain of 75W/person and a maximum latent heat gain of 55W/person are assumed in living spaces.
- Lighting energy is assumed at 2W/m^2 from 6pm to 11pm.
- Gain profiles are as described on the table below:

ROOM TYPE	OCCUPANCY	EQUIPMENT LOAD
Studio	2 people at all times	Peak load of 450W from 6pm to 8pm 200W from 8pm to 10pm 110W from 9am to 6pm and from 10pm to 12pm Base load of 85W for the rest of the day
1 bedroom apartment Kitchen/Living/Dining	1 person from 9am to 10pm; room is unoccupied for the rest of the day	Peak load of 450W from 6pm to 8pm 200W from 8pm to 10pm 110W from 9am to 6pm and from 10pm to 12pm Base load of 85W for the rest of the day
2 bedroom apartment Kitchen/Living/Dining	2 people from 9am to 10pm; room is unoccupied for the rest of the day	Peak load of 450W from 6pm to 8pm 200W from 8pm to 10pm 110W from 9am to 6pm and from 10pm to 12pm Base load of 85W for the rest of the day
3 bedroom apartment Kitchen/Living/Dining	3 people from 9am to 10pm; room is unoccupied for the rest of the day	Peak load of 450W from 6pm to 8pm 200W from 8pm to 10pm 110W from 9am to 6pm and from 10pm to 12pm Base load of 85W for the rest of the day
3 bedroom apartment Kitchen	3 people at 25% gains from 9am to 10pm; room is unoccupied for the rest of the day	Peak load of 300W from 6pm to 8pm Base load of 50W for the rest of the day
3 bedroom apartment Living Room	3 people at 75% gains from 9am to 10pm; room is unoccupied for the rest of the day	Peak load of 150W from 6pm to 8pm 60W from 9am to 6pm and from 10pm to 12pm Base load of 35W for the rest of the day
Double bedroom	2 people at 70% gains from 11pm to 8am 2 people at full gains from 8am to 9am and from 10pm to 11pm 1 person at full gains from 9am to 10pm	Peak load of 80W from 8am to 11pm Base load of 10W during sleeping hours
Single bedroom (too small to accommodate double bed)	1 person at 70% gains from 11pm to 8am 1 person at full gains from 8 am to 11pm	Peak load of 80W from 8am to 11pm Base load of 10W during sleeping hours

Ventilation

- The primary means of reducing overheating risk is to open windows. Occupants are considered to open windows when the internal temperature exceeds 22°C and the room is occupied. Due to noise and air quality restrictions utilising a natural ventilation strategy may not be applicable. Therefore, the impact of windows being shut will also be assessed.
- Wherever possible, opening windows will be provided to meet the purge ventilation requirements of Part F of the Building Regulations.
- MVHR units operate in 'bypass mode' in summer to better reduce the risk of overheating. MVHR is assumed to operate continuously in kitchen/living/dining and bedrooms at 0.3/l/s/m^2 to meet minimum fresh air requirements.
- Infiltration is assumed at 0.15ACH continuously.
- No MVHR boost has been considered for the purposes of assessing overheating risk but this could be used in extreme weather situations
- Corridors are unventilated, stairs are only ventilated by infiltration

Shading

- A g-value of 0.5 has been assumed without the incorporation of blinds, subject to design development. Varying g-values were assessed but overheating compliance was not achieved when reducing the g-value to 0.3. Also, this had a negative impact on the carbon emission, so the g-value was kept at 0.5.

5.8 OVERHEATING RESULTS

The overheating analysis was carried out to CIBSE TM59 requirements. All dwellings were assessed against Category II criteria. Overheating analysis was carried out using the four weather files as described in section 9.1. A summary of the results is provided below.

Table 5-10 Summary of overheating analysis results

	NO. OF TM59 COMPLIANT OCCUPIED ROOMS		
WEATHER FILE	With windows open	With West facing windows closed	With all windows closed
DSY 1	15 of 15	9 of 15	0 of 15
DSY 2	0 of 15	0 of 15	0 of 15
DSY 3	0 of 15	0 of 15	0 of 15

5.9 OVERHEATING CONCLUSION

The strategy for minimising cooling demand in accordance with Policy 5.9 for the Proposed Development is as follows:

- The residential elements do not have any South facing glazing which helps to reduce the solar gains entering the dwellings.
- The bedrooms are on the East side of the dwellings. Therefore, there is reduced solar gains entering these rooms reducing the risk of sleep being disturbed in the night due to increased temperatures.
- 100% low energy lighting will be provided to reduce internal heat gains within the apartments.
- A highly efficient fabric specification is proposed incorporating glazing with low-e solar shield glass to protect the interior from solar gain.
- MVHR has been specified throughout to provide background ventilation.
- When natural ventilation is applied, the development complies with CIBSE TM59.
- However, due to air quality and acoustic issues a natural ventilation strategy may not be appropriate and comfort cooling will be required.

6 BE CLEAN: HEATING INFRASTRUCTURE

After consumption has been reduced through the application of energy efficiency measures, the next step is to consider low carbon technologies in order to provide further reduction in carbon dioxide emissions.

6.1 DISTRICT HEATING NETWORK

The London Heat Map identifies existing and potential opportunities for decentralised energy projects in London. It builds on the 2005 London Community Heating Development Study. An excerpt from the London Heat Map across (Figure 6-1) shows the location of any existing and proposed district heating systems within the vicinity of the development (existing networks are shown in yellow and proposed/future networks in red).

Local Plan Policy CS15 requires new developments to connect to any district heating networks available. The nearest existing district heating network is the Bunhill network which is approximately 4km away from the development (shown in yellow). The distance to the existing network makes it an unviable solution as the capital cost and network losses would be too great.

The limited space and constrained site for an energy centre means it is only possible to provide heat for the proposed development alone and not to connect to and serve other buildings

6.2 FUTURE DISTRICT HEATING NETWORK CONNECTION

A possible future district heating network is shown closer to the site (Euston Road), with the closest connection point on Goldington Street to the South East of the development which is approximately 1km. Again, the distance is too great to make connection a viable solution.

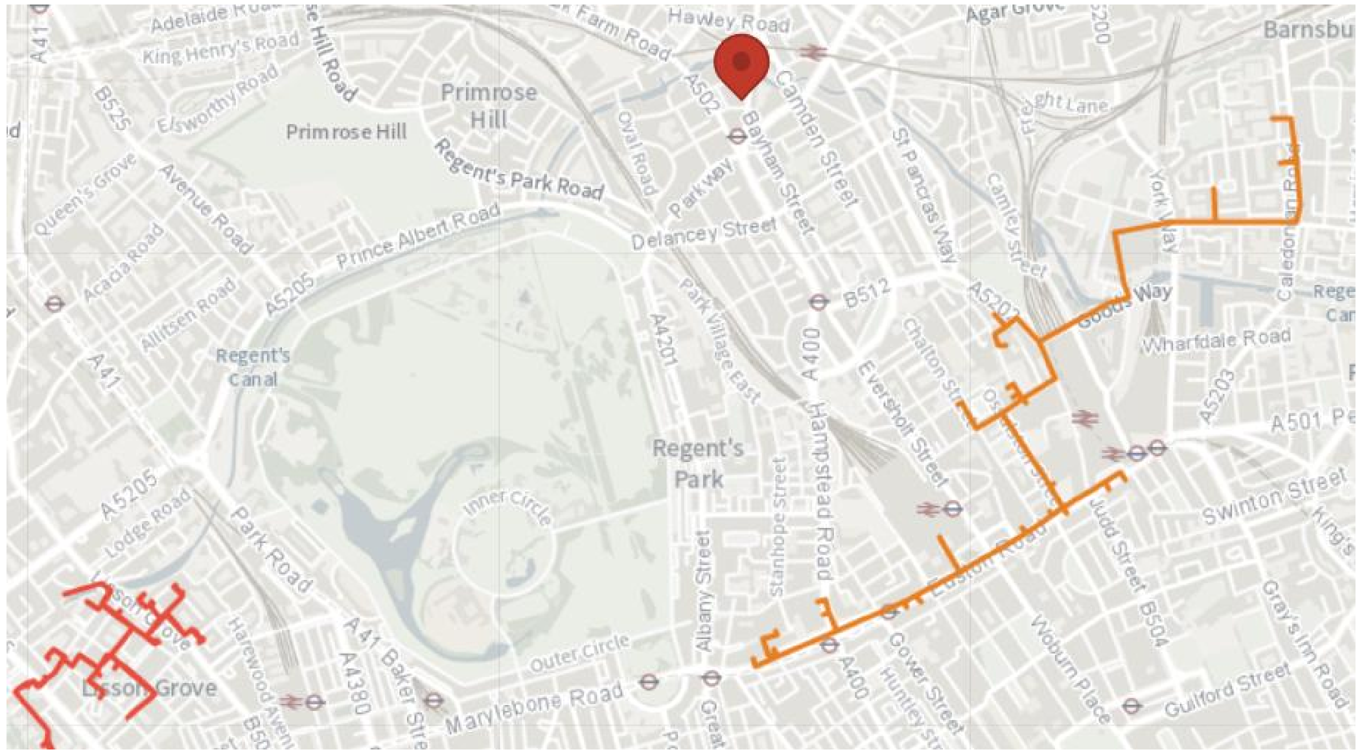

Figure 6-1 Excerpt from the London Heat Map showing areas of high heat demand and existing/proposed district heating networks

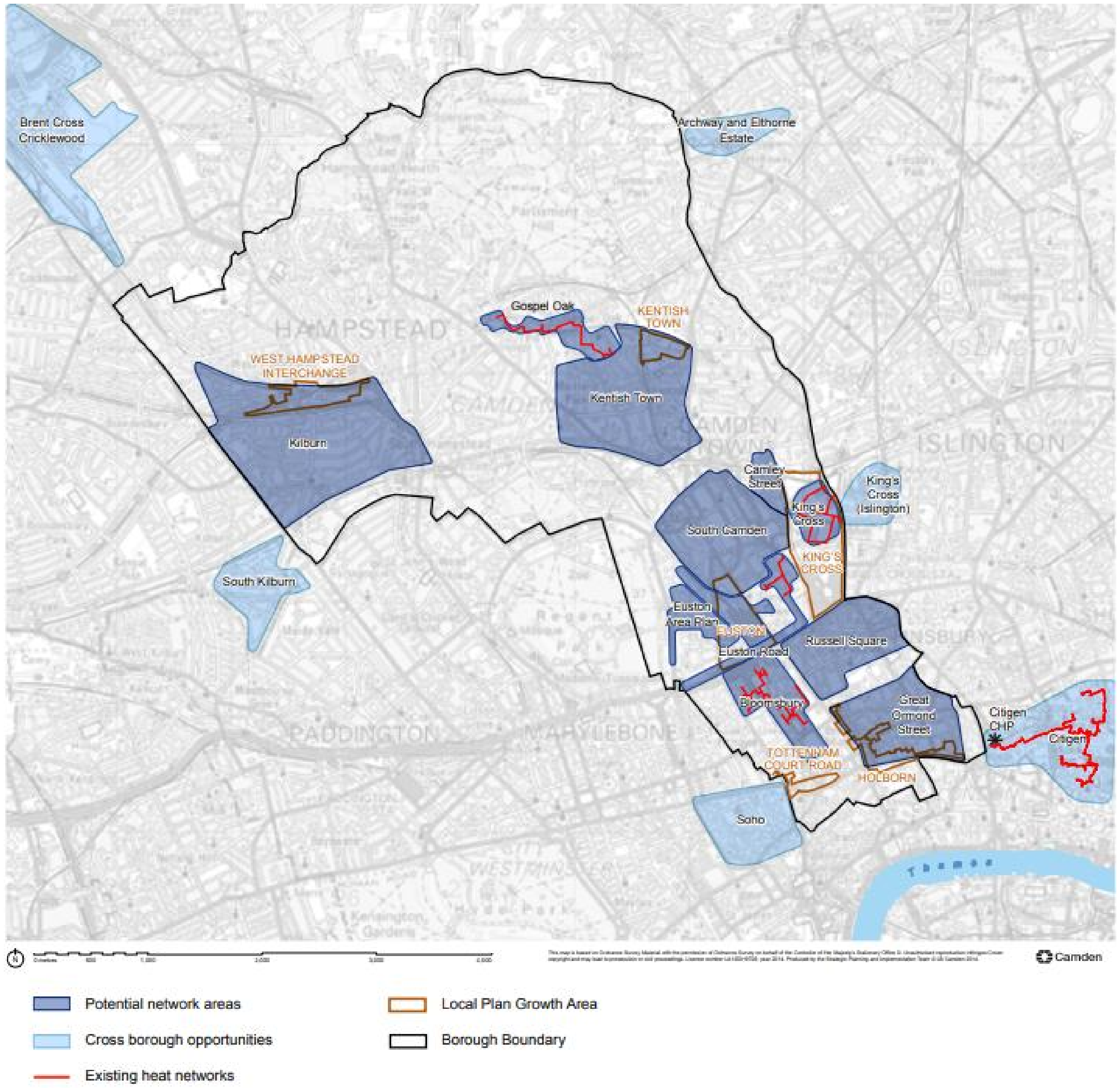

Figure 6-2 Excerpt from Camden Local Plan (2017) showing the Development located outside of areas highlighted as potential network areas

6.3 COMBINED HEAT AND POWER (CHP)

The predominant use for the development is proposed to be Class E office space with some flexible Class E retail and leisure spaces at ground level and C3 residential units. This development mix provides a low hot water demand and combined with a highly efficient building fabric contained within the "Be Lean" stage of the Energy Hierarchy, the development is not anticipated to have a significant demand for heat. The predominant regulated energy uses in the development will be for cooling, ventilation and lighting.

Due to the low demand for space heating and domestic hot water (DHW) the anticipated run hours of a CHP unit would fall below the GLA target of 5,000 run hours per year. This reduces the total heat contribution of CHP to the Proposed Development to fall below a target of 60%.

Recent guidance from the GLA states 'as the electricity grid decarbonises the carbon savings achieved from gas-engine CHP will decrease and with growing concerns of the impact of the technology on air quality, applicants will be expected to utilise other low carbon technologies'. Also, the GLA lists CHP engines as not applicable for small-medium residential developments and non-domestic developments with a simultaneous demand for heat and power that do not have a year-round base load for optimum operation of CHP such as offices.

6.4 CENTRALISED COOLING SYSTEM

As noted previously, the office areas will be provided with cooling, served by a centralised VRF system. The preferred solution at present is to generate chilled water for comfort cooling with reversible Air Source Heat Pumps (ASHPs) located at Level 4.

6.5 LOCAL PLANNING CRITERIA, INCLUDING LAND USE AND NOISE

Previously, the GLA encouraged the use of CHP systems; however, recent GLA guidance discourages the use of CHP. As CHP is not proposed for the development this minimises the noise levels on site. The development will be served by reversible Air Source Heat Pumps (ASHPs) which will provide space heating and cooling, and domestic hot water, and are located on the roof of the proposed building.

The reversible ASHPs will be located on the roof of the development and will not use additional land adjacent to the Proposed Development.

The location of the units on the roof has been selected to minimise impact on adjacent properties. Noise levels will comply with local planning requirements.

6.6 FEASIBILITY OF EXPORTING HEAT/ELECTRICITY FROM THE SYSTEM

It is anticipated that the ASHP units will be sized to serve only the requirements of the Proposed Development as there is not a heat network in place to facilitate the exportation of heat to other buildings in the local area. In addition, the low temperature heat generated from the ASHPs would not be compatible with any of the existing heat networks in the City.

The significant PV arrays on both the office building and residential block will generate a significant quantity of renewable electricity. Offices typically have high electrical loads that coincide with the PV arrays generating electricity during the day, so all will be used on site. However, the residential PV array is significant and may produce more electricity than is required on site. Therefore, it is anticipated that excess electricity will be exported from the site.

6.7 ENERGY CENTRE

Detailed energy centre layouts will be developed as part of the schematic design phase post planning, however sufficient space has been allowed for all plant to be accommodated as the design develops. Refer to Figure 6-3 and Figure 6-4 for a plan of the proposed MEP plant at mezzanine level and level 4.

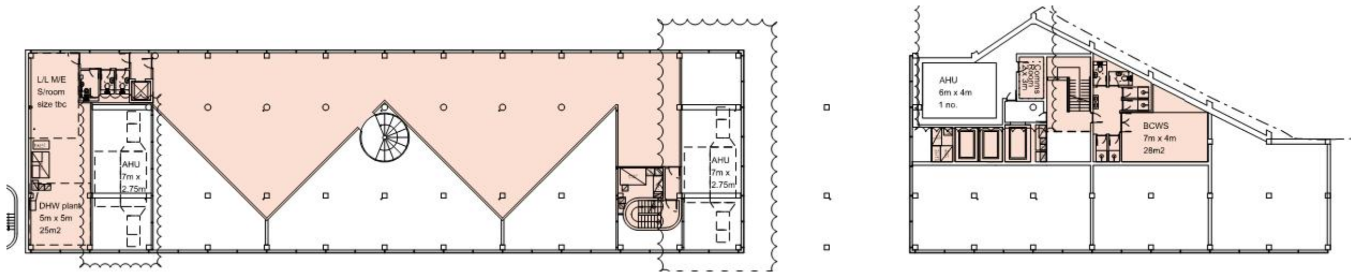

Figure 6-3 Plant area located at mezzanine Level

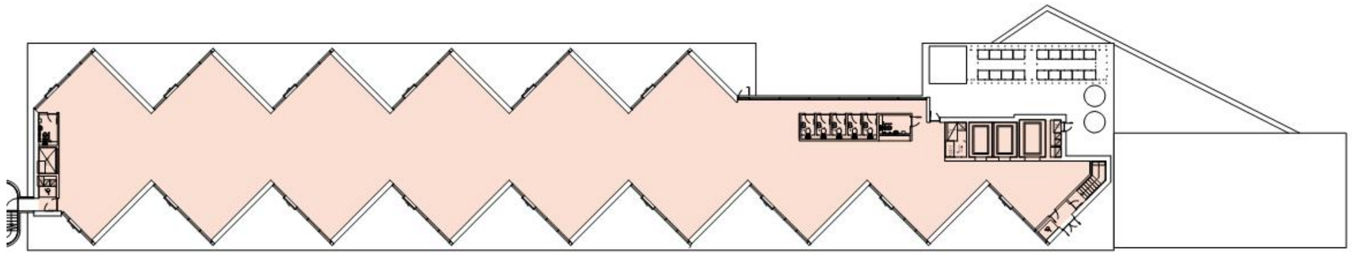

Figure 6-4 Plant area located at Level 4

6.9 CARBON EMISSIONS REDUCTION

As the development is not proposing to connect to a district heating network or be served by CHP, the carbon emissions savings remain unchanged from the "Be Lean" stage of the Energy Hierarchy. The overall carbon emissions for the development is shown in Table 6-1 to Table 6-3.

6.10 SAP 2012 RESULTS

Table 6-1 Be Clean: Non-residential carbon emissions after the provision of energy efficiency supply measures

	NON-RESIDENTIAL REGULATED EMISSIONS (MT CO_2)	UNREGULATED EMISSIONS (MT CO_2)	REDUCTION IN REGULATED EMISSIONS (%)
Part L 2013 Compliant Non-Residential*	133.71	156.85	-
Be Lean	116.75	156.85	12.7%
Be Clean	116.75	156.85	12.7%

Table 6-2 Be Clean: Residential carbon emissions after the provision of energy efficiency supply measures

	RESIDENTIAL REGULATED EMISSIONS (MT CO_2)	UNREGULATED EMISSIONS (MT CO_2)	REDUCTION IN REGULATED EMISSIONS (%)
Part L 2013 Compliant Residential*	7.40	0.12	-
Be Lean	6.75	0.12	8.8%
Be Clean	6.75	0.12	8.8%

Table 6-3 Be Clean: Development carbon emissions after the provision of energy efficiency supply measures

	TOTAL REGULATED EMISSIONS (MT CO_2)	UNREGULATED EMISSIONS (MT CO_2)	REDUCTION IN REGULATED EMISSIONS (%)
Part L 2013 Compliant Development*	141.11	156.97	-
Be Lean	123.50	156.97	12.5%
Be Clean	123.50	156.97	12.5%

**The energy efficiency savings have been calculated on the basis that the building is served by a central heating system served by gas fired boilers only.*

6.11 SAP 10.0 RESULTS

Table 6-4 Be Clean: Non-residential carbon emissions after the provision of energy efficiency supply measures

	NON-RESIDENTIAL REGULATED EMISSIONS (MT CO_2)	UNREGULATED EMISSIONS (MT CO_2)	REDUCTION IN REGULATED EMISSIONS (%)
Part L 2013 Compliant Non-Residential**	72.82	70.42	-
Be Lean	70.06	70.42	3.8%
Be Clean	70.06	70.42	3.8%

Table 6-5 Be Clean: Residential carbon emissions after the provision of energy efficiency supply measures

	RESIDENTIAL REGULATED EMISSIONS (MT CO_2)	UNREGULATED EMISSIONS (MT CO_2)	REDUCTION IN REGULATED EMISSIONS (%)
Part L 2013 Compliant Residential*	6.60	0.06	-
Be Lean	5.76	0.06	12.7%
Be Clean	5.76	0.06	12.7%

Table 6-6 Be Clean: Development carbon emissions after the provision of energy efficiency supply measures

	TOTAL REGULATED EMISSIONS (MT CO_2)	UNREGULATED EMISSIONS (MT CO_2)	REDUCTION IN REGULATED EMISSIONS (%)
Part L 2013 Compliant Development*	79.42	70.48	-
Be Lean	75.81	70.48	4.5%
Be Clean	75.81	70.48	4.5%

**The energy efficiency savings have been calculated on the basis that the building is served by a central heating system served by gas fired boilers only.*

7 BE GREEN: RENEWABLE ENERGY

Renewable Energy Technologies can provide a source of energy on-site that is not primarily based on the consumption of fossil fuels or grid electricity and/or utilises a heat source that is renewable such as ground source and solar thermal systems.

In accordance with the requirements of Section 5.2 of the London Plan and Camden's Local Plan, we have evaluated a number of renewable energy technologies and outlined how they may be applied to the development.

7.1 WIND POWER

Harnessing the kinetic energy of wind can provide a renewable source of onsite electricity generation. Wind turbines need to be positioned where a frequent and steady source of wind is available that is not too turbulent or uneven in direction.

Typically, wind turbines are located in open areas where there is minimum disruption to prevailing winds. Locating wind turbines on the top of commercial buildings is not normally feasible due to the acoustic and vibrations impacts associated with nearby dwellings.

Wind conditions prevent the implementation of wind power generation from being feasible. In addition, it is not considered to be appropriate in townscape and architectural terms to provide wind turbines on top of the building. On that basis they are not proposed for the Proposed Development.

7.2 BIOMASS HEATING

Biomass heating has embodied environmental impacts from transport and fuel combustion which makes it less desirable in Air Quality Management Areas (AQMAs).

A review of the potential impact on air quality from increased wood fuelled biomass use in London has been carried out by AEA Energy & Environment, and was published in December 2007. The assessment indicates that potentially increasing the contribution from small-scale wood fuelled biomass combustion may lead to a substantial increase in nitrogen dioxide and particulate matter concentrations. Further to this, solid biomass relies on a reliable fuel supply which must be delivered and stored on site.

The site would therefore require good access routes and space for fuel storage and plant, which could not feasibly be incorporated within the proposed scheme due to its location within the London Borough of Camden and the limited space for the development. It also has relatively high maintenance requirements and fuel costs. This technology is therefore deemed to be unsuitable for the Proposed Development.

7.3 GROUND SOURCE HEATING AND/OR COOLING

Ground source heating and/or cooling may be incorporated to make use of the thermal storage and ground temperature to provide heating and/or cooling to a building. Ground source heating is an effective renewable energy source when used to provide space heating via low grade heating system such as underfloor heating.

The ground plus 4-storey development is located in the London Borough of Camden with a small building footprint which will be inadequate space to locate sufficient horizontal or vertical ground loops to provide meaningful contributions to the heating and/or cooling to the development. In addition, the basement level of the development is part of the neighbouring Sainsbury's and is not within the red line boundary of the Proposed Development.

Therefore, the use of ground source heating and/or cooling is not considered feasible for the Proposed Development.

7.4 SOLAR THERMAL HOT WATER HEATING

Solar thermal hot water (STHW) generation involves capturing solar radiant heat to preheat or heat domestic hot water.

Correctly located and orientated, solar thermal systems can meet a proportion of a building's domestic hot water dependent on the expected demand profile and available space for locating STHW panels.

The limited roof space available of the Proposed Development is insufficient to provide any meaningful contribution to the development's heating requirements from solar. The limited availability of roof space is partly due to the provision of a publicly accessible roof terrace. On that basis STHW is not proposed for inclusion within the scheme.

7.5 PHOTOVOLTAIC PANELS

The feasibility of providing photovoltaic (PV) panels has been assessed based upon estimated energy production (kWh) from the installed location along with manufacturers cost data to enable a life cycle cost analysis to be undertaken. Panels correctly oriented, maintained and not obscured by shading can be expected to provide in the region of 120kWh/m^2/year in London.

The office building roof and residential roof areas have been identified as a potential location to accommodate PV panels to serve the development. The office roof would accommodate approximately 279 m^2 of PV lying at an incline of 5°. Also, there is sufficient space for approximately 48m^2 of PV on the roof of the residential block. The office and residential PV arrays are orientated South West and West respectively.

This would equate to a carbon reduction of approximately 25.81 MT CO_2 when using SAP 2012 carbon factors or 11.59 MT CO_2 when using SAP10.0 carbon factors.

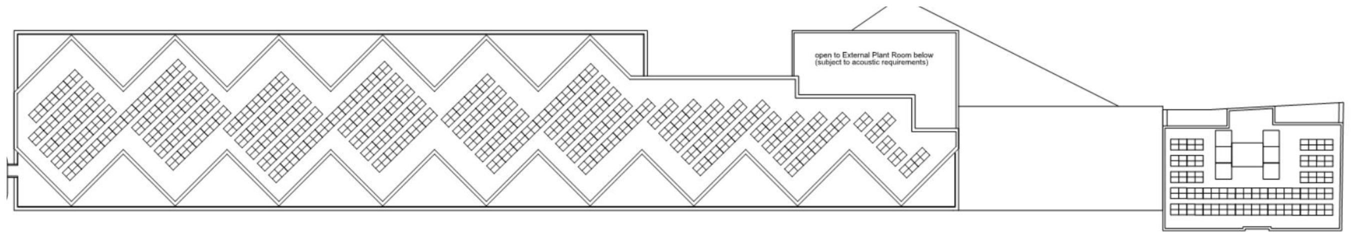

Figure 7-1 Proposed PV array layout

7.6 AIR SOURCE HEAT PUMPS (ASHPS)

Air source heat pumps (ASHPs) can provide heating and/or cooling utilising air temperatures. The use of ASHPs are an effective LZC technology as they have high efficiencies for both heating and cooling.

Due to the increase in decarbonisation of the National Grid, the use of high efficiency electric based systems provides a long term low carbon development. The use of ASHPs has a considerable positive effect on local air quality as there is no combustion on site.

The local air quality in London is poor and steps undertaken to improve air quality are beneficial. ASHPs generate no local emissions which has a considerable effect on local air quality.

Due to the low heat demand for the office and ground floor commercial units through highly efficient building fabric and low hot water demand, the VRF system can utilise ASHPs as an ideal method of providing space heating, cooling and DHW and is considered feasible for the development.

7.7 WATER SOURCE HEAT PUMPS

WSHPs have a significantly higher coefficient of performance (COP) than ASHPs due to the higher temperature of the heat source which is constant throughout the year. A highly efficient building fabric combined with low hot water demand provide an ideal method of providing space heating and DHW to the development. Low flow temperatures from the WSHPs further reduce the energy consumption and carbon emissions for the Proposed Development.

WSHPs are powered by grid supplied electricity. As mentioned in the ASHP section above, the National Grid is increasingly decarbonising due to an increase in renewable energy generation and a reduction in coal power generation. This leads to a long term low carbon solution for the Proposed Development.

The use of external water sources, such as The Regents Canal, provides the opportunity to be a heat sink for chiller heat rejection. The relatively low river water temperatures compared to ambient air temperatures mean that better efficiencies can be achieved by the chillers.

However, the canal is situated at a considerable distance to the North of the application site and similar to the issues with connecting to existing DHNs, the distances would make connection to the river expensive with little benefit for the Proposed Development.

7.8 CARBON EMISSIONS REDUCTION

All renewable energy technologies which may be considered feasible for the scheme have been assessed, the outcomes of which are summarised above. From that exercise, it was concluded that only ASHPs and PV systems could be suitable for inclusion in the proposal as the low-grade heat is ideal for the development that has a highly efficient building fabric and low demand for hot water.

The use of high efficiency electrically based systems provides a long term low carbon solution and minimises impacts on local air quality. As the National Grid is becoming increasingly decarbonised, the use of an ASHP solution will continue to provide progressively lower carbon emissions in operation. In addition, as the ASHPs are not a combustion technology, there are no emissions from the system, thus helping to improve air quality in the Camden.

It is proposed to install ASHPs to provide heating, cooling and hot water to the development which will work towards the Mayor's aims in the forthcoming draft New London Plan.

The use of ASHPs provides a carbon saving of 17.97 MT CO_2 and the PV array provides a carbon saving of 25.81 MT CO_2.

7.9 SAP 2012 RESULTS

Table 7-1 Non-residential carbon emissions reductions

	NON-RESIDENTIAL REGULATED EMISSIONS (MT CO_2)	UNREGULATED EMISSIONS (MT CO_2)	REDUCTION IN REGULATED EMISSIONS (%)
Part L 2013 Compliant Non-Residential*	133.71	156.85	-
Be Lean	116.75	156.85	12.7%
Be Clean	116.75	156.85	12.7%
Be Green	75.64	156.85	43.4%

Table 7-2 Residential carbon emissions reductions

	RESIDENTIAL REGULATED EMISSIONS (MT CO_2)	UNREGULATED EMISSIONS (MT CO_2)	REDUCTION IN REGULATED EMISSIONS (%)
Part L 2013 Compliant Residential*	7.40	0.12	-
Be Lean	6.75	0.12	8.8%
Be Clean	6.75	0.12	8.8%
Be Green	4.08	0.12	44.9%

Table 7-3 Development carbon emissions reductions

	TOTAL REGULATED EMISSIONS (MT CO_2)	UNREGULATED EMISSIONS (MT CO_2)	REDUCTION IN REGULATED EMISSIONS (%)
Part L 2013 Compliant Development*	141.11	156.97	-
Be Lean	123.50	156.97	12.5%
Be Clean	123.50	156.97	12.5%
Be Green	79.72	156.97	43.5%

7.10 SAP10.0 RESULTS

Table 7-4 Non-residential carbon emissions reductions

	NON-RESIDENTIAL REGULATED EMISSIONS (MT CO_2)	UNREGULATED EMISSIONS (MT CO_2)	REDUCTION IN REGULATED EMISSIONS (%)
Part L 2013 Compliant Non-Residential*	72.82	70.42	-
Be Lean	70.06	70.42	3.8%
Be Clean	70.06	70.42	3.8%
Be Green	33.96	70.42	53.4%

Table 7-5 Residential carbon emissions reductions

	RESIDENTIAL REGULATED EMISSIONS (MT CO_2)	UNREGULATED EMISSIONS (MT CO_2)	REDUCTION IN REGULATED EMISSIONS (%)
Part L 2013 Compliant Residential*	6.60	0.06	-
Be Lean	5.76	0.06	12.7%
Be Clean	5.76	0.06	12.7%
Be Green	1.83	0.06	72.3%

Table 7-6 Development carbon emissions reductions

	TOTAL REGULATED EMISSIONS (MT CO_2)	UNREGULATED EMISSIONS (MT CO_2)	REDUCTION IN REGULATED EMISSIONS (%)
Part L 2013 Compliant Development*	79.42	70.48	-
Be Lean	75.81	70.48	4.5%
Be Clean	75.81	70.48	4.5%
Be Green	35.79	70.48	54.9%

7.11 AIR QUALITY

It has been recognised in the Draft New London Plan (with minor suggested changes 2018) that there is a movement towards electrical heating systems and moving away from gas fired systems to improve air quality in London. Below is an extract from Policy SI3 Energy Infrastructure of the Draft New London Plan:

"Major development proposals within Heat Network Priority Areas should have a communal low-temperature heating system

- *the heat source for the communal heating system should be selected in accordance with the following heating hierarchy:*
  - *connect to local existing or planned heat networks*
  - *use zero-emission or local secondary heat sources (in conjunction with heat pump, if required)*
  - *use low emission combined heat and power (CHP) (only where there is a case for CHP to enable the delivery of an area-wide heat network)*
  - *use ultra-low NOx gas boilers.*
- *CHP and ultra-low NOx gas boiler communal or district heating systems should be designed to ensure that they meet the requirements of policy SI1 (A)*
- *Where a heat network is planned but not yet in existence the development should be designed for a connection at a later date"*

This demonstrates that the Mayor recognises the air quality issues within London and is prioritising the use of existing and proposed heat networks, lower temperature heating systems and using zero emission sources to generate clean heat and/or power. These are being prioritised over the use of gas fired systems including, gas fired fuel cells, CHP and gas boilers.

The use of ASHPs for this development will help to improve the local air quality in Camden as the proposed Energy Strategy contained in this document will have no direct emissions from site. This reduces the NOx and particulate emissions in the vicinity of the Proposed Development.

Policy SI1 Improving Air Quality of the draft New London Plan states:

London's air quality should be significantly improved and exposure to poor air quality, especially for vulnerable people, should be reduced:

- *development proposals should not:*
  - *lead to further deterioration of existing poor air quality*
  - *create any new areas that exceed air quality limits, or delay the date at which compliance will be achieved in areas that are currently in exceedance of legal limits*
  - *reduce air quality benefits that result from the Mayor's or boroughs' activities to improve air quality*
  - *create unacceptable risk of high levels of exposure to poor air quality.*
- *development proposals should use design solutions to prevent or minimise increased exposure to existing air pollution and make provision to address local problems of air quality. Particular care should be taken with developments that are in Air Quality Focus Areas or that are likely to be used by large numbers of people particularly vulnerable to poor air quality, such as children or older people.*
- *masterplans and development briefs for large-scale development proposals subject to an Environmental Impact Assessment should propose methods of achieving an Air Quality Positive approach through the new development.*
- *major development proposals must be at least air quality neutral and be submitted with an Air Quality Assessment.*
- *development proposals must demonstrate how they plan to comply with the Non-Road Mobile Machinery Low Emission Zone and reduce emissions from the demolition and construction of buildings following best practice guidance.*
- *development proposals should ensure that where emissions need to be reduced, this is done on-site. Where it can be demonstrated* that on-site provision is impractical or inappropriate, off-site measures to improve local air quality may be acceptable, provided that equivalent air quality benefits can be demonstrated.

Table 7-4 Air quality impacts

STRATEGY	TOTAL FUEL CONSUMPTION – RESIDENTIAL	TOTAL FUEL CONSUMPTION – NON-RESIDENTIAL
Grid electricity	15.43 MWh/year	495.20 MWh/year
Domestic/communal gas boilers	0 MWh/year	0 MWh/year
Gas CHP	0 MWh/year	0 MWh/year
Connection to existing DH network	0 MWh/year	0 MWh/year
Other gas use (e.g. cookers)	0.08MWh/year	0 MWh/year

8 RESULTS

The three principal steps taken; Be Lean (Use Less Energy), Be Clean (Supply Energy Efficiently) and finally Be Green (Renewable Technology measures) are summarised below. The target (Building Regulations compliant) carbon emissions for the Proposed Development are calculated to be 141.11 MT CO_2 per annum.

8.1 DEMAND REDUCTION (BE LEAN)

Through the application of the measures identified in Section 5 the regulated carbon emissions are shown to be 123.50 MT CO_2 per annum.

8.2 HEATING INFRASTRUCTURE (BE CLEAN)

As the development is not proposing to connect to a district heating network or to provide a CHP to serve the building, there are no subsequent carbon savings in this stage of the Energy Hierarchy. Therefore, the total carbon emissions are the same as the Be Lean stage of the hierarchy and total 123.50 MT CO_2 per annum.

8.3 RENEWABLE ENERGY (BE GREEN)

The feasibility of a range of renewable technologies has been assessed in the context of the London Plan. It was concluded that only the incorporation of ASHPs and PV could be suitable for inclusion in the proposals; these are ideal technologies to serve the heating load of the highly efficiency building fabric and also low domestic hot water demand as well as generating zero carbon onsite electricity. This reduces the regulated carbon emissions to 79.72 MT CO_2 per annum.

8.4 PART L FABRIC ENERGY EFFICIENCY

Accredited Design SAP2012 software was used to determine the FEE standards for a sample of typical apartments. An analysis has been undertaken on the all residential units to establish the performance of the fabric in relation to the TFEE. Results for TFEE and the Dwelling FEE (DFEE) for all residential units are as follows:

Table 8-1 Fabric energy efficiency and carbon emissions results by residential block

	AVERAGE DFEE (KWH/M^2)	AVERAGE TFEE (KWH/M^2)	% DFEE<TFEE
Residential Block	52.06	52.88	1.6%

8.5 GUIDANCE ON PREPARING ENERGY ASSESSMENTS

In direct response to the information outlined within the 2020 Greater London Authority (GLA) Guidance on preparing Energy Assessments, the results outlined previously are summarised in the tables across, with the results presented against the overall carbon reduction target.

The proposals for the Proposed Development outlined within this energy strategy are considered to maximise the potential carbon savings which can be achieved on site through the provision of:

- A highly efficient building fabric and optimal g-values to reduce the cooling load.
- Efficient building services plant, including air handling plant with low specific fan powers and heat recovery.
- Maximised use of LED and low energy fixtures elsewhere.
- The use of ASHPs to provide low energy and low carbon heat to the building. This is a long-term low carbon solution as the National Grid is decarbonising.
- Onsite zero carbon electricity generation through PV arrays.

Overall, the development is shown to achieve a 54.9% reduction in carbon emissions compared to the Part L 2013 baseline. This significantly exceeds the on-site target of a 35% reduction in carbon emissions from Part L 2013 for the development. The proposed energy strategy for the development is a long-term low carbon solution, has significant benefits relating to improving local air quality within the Camden and aligns with the Mayor's plans in the forthcoming New London Plan.

Table 8-2 Development carbon dioxide emissions at each stage of the energy hierarchy (SAP 10)

	TOTAL REGULATED EMISSIONS (MT CO_2)	UNREGULATED EMISSIONS (MT CO_2)	REDUCTION IN REGULATED EMISSIONS (%)
Part L 2013 Compliant Development*	79.42	70.48	-
Be Lean	75.81	70.48	4.5%
Be Clean	75.81	70.48	4.5%
Be Green	35.79	70.48	54.9%

Table 8-3 Development regulated carbon dioxide savings from each stage of the energy hierarchy

	REGULATED CARBON DIOXIDE EMISSIONS SAVINGS (MT CO_2 PER ANNUM)	REGULATED CARBON DIOXIDE EMISSIONS SAVINGS (%)
Savings from energy demand reduction	3.61	4.5%
Savings from energy efficient supply	0.0	0.0%
Savings from renewable energy	40.02	50.4%
Total Cumulative Savings	43.63	54.9%
Total Target Savings	79.42	100%
Annual Surplus	35.79	45.1
Cash in-lieu contribution (£) (Calculated at £95/Tonne CO_2 over the period of 30 years)	£102,001	

APPENDIX A

BE LEAN BRUKL

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

Be Lean

As designed

Date: Mon Feb 08 17:00:53 2021

Administrative information

Building Details

Address: Grand Union House, ,

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.13

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.13

BRUKL compliance check version: v5.6.b.0

Certifier details

Name: Jacob Cox

Telephone number:

Address: , ,

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

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	19.3
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	19.3
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	16.8
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

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

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

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.15	0.15	00000000:Surf[0]
Floor	0.25	0.13	0.13	00000000:Surf[3]
Roof	0.25	0.13	0.13	01000037:Surf[0]
Windows***, roof windows, and rooflights	2.2	1.4	1.4	00000005:Surf[4]
Personnel doors	2.2	-	-	No Personnel doors in building
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building

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

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

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

Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs. Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	>0.95

1- VRF FCU with central AHU

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.98	4	0	0	0.85
Standard value	0.91*	2.6	N/A	N/A	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

2- Retail

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.98	4	0	0	0.9
Standard value	0.91*	2.6	N/A	N/A	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

1- Retail

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	0.98	-
Standard value	0.9*	N/A

* Standard shown is for gas boilers >30 kW output. For boilers <=30 kW output, limiting efficiency is 0.73.

Local mechanical ventilation, exhaust, and terminal units

ID	System type in Non-domestic Building Services Compliance Guide
A	Local supply or extract ventilation units serving a single area
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal supply and extract ventilation units serving a single room or zone with heating and heat recovery
E	Local supply and extract ventilation system serving a single area with heating and heat recovery
F	Other local ventilation units
G	Fan-assisted terminal VAV unit
H	Fan coil units
I	Zonal extract system where the fan is remote from the zone with grease filter

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	**Zone**	**Standard**
00 Reception	-	-	-	1.3	-	-	-	-	-	-	N/A
00 Office P E	-	-	-	1.3	-	-	-	-	-	-	N/A
00 Office P W	-	-	-	1.3	-	-	-	-	-	-	N/A
00 Office C	-	-	-	1.3	-	-	-	-	-	-	N/A
00 Changing Rooms	-	-	-	1.3	-	-	-	-	-	-	N/A
00 Coffee Shop	-	-	-	1.3	-	-	-	-	-	-	N/A
01 Office P	-	-	-	1.3	-	-	-	-	-	-	N/A

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
01 Office P W	-	-	-	1.3	-	-	-	-	-	-	N/A
01 Office P E	-	-	-	1.3	-	-	-	-	-	-	N/A
01 Office C	-	-	-	1.3	-	-	-	-	-	-	N/A
01 Office P W	-	-	-	1.3	-	-	-	-	-	-	N/A
01 Greenhouse	-	-	-	1.3	-	-	-	-	-	-	N/A
02 Office P W	-	-	-	1.3	-	-	-	-	-	-	N/A
02 Office P E	-	-	-	1.3	-	-	-	-	-	-	N/A
02 Office C	-	-	-	1.3	-	-	-	-	-	-	N/A
02 Office P W	-	-	-	1.3	-	-	-	-	-	-	N/A
03 Office P W	-	-	-	1.3	-	-	-	-	-	-	N/A
03 Office P E	-	-	-	1.3	-	-	-	-	-	-	N/A
03 Office C	-	-	-	1.3	-	-	-	-	-	-	N/A
03 Greenhouse	-	-	-	1.3	-	-	-	-	-	-	N/A
03 Office P W	-	-	-	1.3	-	-	-	-	-	-	N/A
02 Greenhouse	-	-	-	1.3	-	-	-	-	-	-	N/A
02 Office P	-	-	-	1.3	-	-	-	-	-	-	N/A
03 Office P W	-	-	-	1.3	-	-	-	-	-	-	N/A
04 Office	-	-	-	1.3	-	-	-	-	-	-	N/A
00 Retail	-	-	-	1.3	-	-	-	-	-	-	N/A
00 Retail	-	-	-	1.3	-	-	-	-	-	-	N/A
0M Office P E	-	-	-	1.3	-	-	-	-	-	-	N/A
0M Office C	-	-	-	1.3	-	-	-	-	-	-	N/A
0M Office P	-	-	-	1.3	-	-	-	-	-	-	N/A

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
00 Circulation	-	254	-	24
00 Circulation	-	304	-	13
00 Cycle Store	-	156	-	169
00 UKPN	90	-	-	84
00 Bin Store	-	155	-	148
00 WC	-	182	-	107
00 Reception	-	153	80	513
00 Office P E	147	-	-	912
00 Circulation	-	316	-	7
00 Circulation	-	257	-	22
00 Office P W	147	-	-	912
00 Office C	145	-	-	608
00 Changing Rooms	-	162	-	79
00 Cycle Store	-	155	-	85
00 Coffee Shop	-	157	80	353
00 Stairs	-	175	-	40

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
00 Circulation	-	161	-	43
01 Office P	151	-	-	1133
01 Office P W	148	-	-	1128
01 Office P E	148	-	-	1381
01 Office C	145	-	-	884
01 Stair	-	192	-	48
01 Circulation	-	307	-	15
01 WC	-	167	-	225
01 Office P W	155	-	-	115
01 Stairs	-	204	-	51
01 Greenhouse	-	147	-	332
01 Circulation	-	352	-	11
01 WC	-	373	-	19
02 Office P W	148	-	-	1128
02 Office P E	148	-	-	1381
02 Office C	145	-	-	884
02 Stair	-	192	-	48
02 Circulation	-	307	-	15
02 Office P W	155	-	-	115
03 Stairs	-	254	-	41
02 Circulation	-	352	-	11
02 WC	-	373	-	19
03 Office P W	149	-	-	1128
03 Office P E	149	-	-	1381
03 Office C	145	-	-	884
03 Stair	-	185	-	83
03 Greenhouse	-	145	-	167
03 Office P W	158	-	-	115
02 Greenhouse	-	145	-	167
03 Circulation	-	391	-	11
03 WC	-	417	-	19
02 Stairs	-	236	-	41
02 Office P	151	-	-	1133
02 WC	-	167	-	225
03 Circulation	-	414	-	10
03 WC	-	171	-	225
03 Office P W	160	-	-	375
04 Circulation	-	311	-	27
04 Office	151	-	-	2878
04 WC	-	224	-	69
04 Stairs	-	367	-	11
04 Circulation	-	398	-	8
04 WC	-	346	-	17

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
04 Circulation	-	333	-	9
00 Retail	-	148	80	2691
00 Retail	-	160	80	1001
0M Circulation	-	389	-	9
0M Plant	83	-	-	193
0M Plant	81	-	-	307
0M Stair	-	195	-	51
0M Stairs	-	178	-	64
0M Plant	82	-	-	294
0M WC	-	251	-	34
0M Circulation	-	398	-	7
0M Plant	77	-	-	562
0M Office P E	148	-	-	878
0M Office C	146	-	-	347
0M Office P	424	-	-	94

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
00 Reception	NO (-27.7%)	NO
00 Office P E	YES (+2.2%)	NO
00 Office P W	NO (-32.8%)	NO
00 Office C	NO (-55.5%)	NO
00 Changing Rooms	YES (+4.7%)	NO
00 Coffee Shop	NO (-51.3%)	NO
01 Office P	NO (-21.3%)	YES
01 Office P W	NO (-38%)	YES
01 Office P E	NO (-14.6%)	YES
01 Office C	NO (-59.7%)	NO
01 Office P W	NO (-11.8%)	YES
01 Greenhouse	YES (+17%)	NO
02 Office P W	NO (-28.4%)	YES
02 Office P E	NO (-5.8%)	YES
02 Office C	NO (-55.2%)	NO
02 Office P W	NO (-1.2%)	YES
03 Office P W	NO (-17.1%)	YES
03 Office P E	NO (-2.4%)	YES
03 Office C	NO (-52%)	NO
03 Greenhouse	NO (-37.6%)	NO
03 Office P W	YES (+5.7%)	YES
02 Greenhouse	YES (+0.1%)	NO
02 Office P	NO (-23%)	YES
03 Office P W	YES (+10.3%)	YES
04 Office	NO (-43.3%)	YES

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
00 Retail	NO (-48.8%)	NO
00 Retail	NO (-69.3%)	NO
0M Office P E	YES (+0.1%)	NO
0M Office C	NO (-36.9%)	NO
0M Office P	NO (-61.8%)	NO

Criterion 4: The performance of the building, as built, should be consistent with the calculated BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	YES
Is evidence of such assessment available as a separate submission?	YES
Are any such measures included in the proposed design?	YES

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m^2]	6944	6944
External area [m^2]	8143.2	8143.2
Weather	LON	LON
Infiltration [m^3/hm^2@ 50Pa]	3	3
Average conductance [W/K]	5788.94	4044.48
Average U-value [W/m^{2}K]	0.71	0.5
Alpha value* [%]	0	10

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
5	**A1/A2 Retail/Financial and Professional services**
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
95	**B1 Offices and Workshop businesses**
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Institutions: Hospitals and Care Homes
	C2 Residential Institutions: Residential schools
	C2 Residential Institutions: Universities and colleges
	C2A Secure Residential Institutions
	Residential spaces
	D1 Non-residential Institutions: Community/Day Centre
	D1 Non-residential Institutions: Libraries, Museums, and Galleries
	D1 Non-residential Institutions: Education
	D1 Non-residential Institutions: Primary Health Care Building
	D1 Non-residential Institutions: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs, and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others: Stand alone utility block

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

	Actual	Notional
Heating	12.79	6.95
Cooling	7.92	7.53
Auxiliary	6.47	4.47
Lighting	9.24	19.09
Hot water	9.69	9.34
Equipment*	43.52	43.52
TOTAL**	**46.11**	**47.39**

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

Energy Production by Technology [kWh/m^2]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m^2]	140.16	124.36
Primary energy* [kWh/m^2]	98.17	112.95
Total emissions [kg/m^2]	16.8	19.3

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Split or multi-split system, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	54.7	113.9	15.8	9.4	6.8	0.96	3.36	0.98	4.5
	Notional	26	121	8.4	8.9	4.5	0.86	3.79	----	----
[ST] Split or multi-split system, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	27.5	134.8	8	11.1	8	0.96	3.36	0.98	4.5
	Notional	24	161.7	7.7	11.9	5.7	0.86	3.79	----	----
[ST] No Heating or Cooling										
	Actual	0	0	0	0	0	0	0	0	0
	Notional	0	0	0	0	0	0	0	----	----

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

Key Features

The Building Control Body is advised to give particular attention to items whose specifications are better than typically expected.

Building fabric

Element	$U_{i\text{-}Typ}$	$U_{i\text{-}Min}$	Surface where the minimum value occurs*
Wall	0.23	0.15	00000000:Surf[0]
Floor	0.2	0.13	00000000:Surf[3]
Roof	0.15	0.13	01000037:Surf[0]
Windows, roof windows, and rooflights	1.5	1.4	00000001:Surf[1]
Personnel doors	1.5	-	No Personnel doors in building
Vehicle access & similar large doors	1.5	-	No Vehicle access doors in building
High usage entrance doors	1.5	-	No High usage entrance doors in building

$U_{i\text{-}Typ}$ = Typical individual element U-values [W/(m²K)] $U_{i\text{-}Min}$ = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	Typical value	This building
$m^3/(h.m^2)$ at 50 Pa	5	3

APPENDIX B

BE GREEN BRUKL

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

Be Green

As designed

Date: Mon Feb 08 17:14:02 2021

Administrative information

Building Details

Address: Grand Union House, ,

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.13

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.13

BRUKL compliance check version: v5.6.b.0

Certifier details

Name: Jacob Cox

Telephone number:

Address: , ,

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

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	19.3
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	19.3
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	10.9
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

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

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

Building fabric

Element	$U_{a-Limit}$	U_{a-Calc}	U_{i-Calc}	Surface where the maximum value occurs*
Wall**	0.35	0.15	0.15	00000000:Surf[0]
Floor	0.25	0.13	0.13	00000000:Surf[3]
Roof	0.25	0.13	0.13	01000037:Surf[0]
Windows***, roof windows, and rooflights	2.2	1.4	1.4	00000005:Surf[4]
Personnel doors	2.2	-	-	No Personnel doors in building
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building

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

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

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

Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs. Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	>0.95

1- VRF FCU with central AHU

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	4.5	4	0	0	0.85
Standard value	2.5*	2.6	N/A	N/A	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.					

2- Retail

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	4.5	4	0	0	0.9
Standard value	2.5*	2.6	N/A	N/A	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES
* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.					

1- Retail

	Water heating efficiency	**Storage loss factor [kWh/litre per day]**
This building	4.5	-
Standard value	1	N/A

Local mechanical ventilation, exhaust, and terminal units

ID	**System type in Non-domestic Building Services Compliance Guide**
A	Local supply or extract ventilation units serving a single area
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal supply and extract ventilation units serving a single room or zone with heating and heat recovery
E	Local supply and extract ventilation system serving a single area with heating and heat recovery
F	Other local ventilation units
G	Fan-assisted terminal VAV unit
H	Fan coil units
I	Zonal extract system where the fan is remote from the zone with grease filter

Zone name	**SFP [W/(l/s)]**									**HR efficiency**	
ID of system type	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	**Zone**	**Standard**
00 Reception	-	-	-	1.3	-	-	-	-	-	-	N/A
00 Office P E	-	-	-	1.3	-	-	-	-	-	-	N/A
00 Office P W	-	-	-	1.3	-	-	-	-	-	-	N/A
00 Office C	-	-	-	1.3	-	-	-	-	-	-	N/A
00 Changing Rooms	-	-	-	1.3	-	-	-	-	-	-	N/A
00 Coffee Shop	-	-	-	1.3	-	-	-	-	-	-	N/A
01 Office P	-	-	-	1.3	-	-	-	-	-	-	N/A
01 Office P W	-	-	-	1.3	-	-	-	-	-	-	N/A

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
01 Office P E	-	-	-	1.3	-	-	-	-	-	-	N/A
01 Office C	-	-	-	1.3	-	-	-	-	-	-	N/A
01 Office P W	-	-	-	1.3	-	-	-	-	-	-	N/A
01 Greenhouse	-	-	-	1.3	-	-	-	-	-	-	N/A
02 Office P W	-	-	-	1.3	-	-	-	-	-	-	N/A
02 Office P E	-	-	-	1.3	-	-	-	-	-	-	N/A
02 Office C	-	-	-	1.3	-	-	-	-	-	-	N/A
02 Office P W	-	-	-	1.3	-	-	-	-	-	-	N/A
03 Office P W	-	-	-	1.3	-	-	-	-	-	-	N/A
03 Office P E	-	-	-	1.3	-	-	-	-	-	-	N/A
03 Office C	-	-	-	1.3	-	-	-	-	-	-	N/A
03 Greenhouse	-	-	-	1.3	-	-	-	-	-	-	N/A
03 Office P W	-	-	-	1.3	-	-	-	-	-	-	N/A
02 Greenhouse	-	-	-	1.3	-	-	-	-	-	-	N/A
02 Office P	-	-	-	1.3	-	-	-	-	-	-	N/A
03 Office P W	-	-	-	1.3	-	-	-	-	-	-	N/A
04 Office	-	-	-	1.3	-	-	-	-	-	-	N/A
00 Retail	-	-	-	1.3	-	-	-	-	-	-	N/A
00 Retail	-	-	-	1.3	-	-	-	-	-	-	N/A
0M Office P E	-	-	-	1.3	-	-	-	-	-	-	N/A
0M Office C	-	-	-	1.3	-	-	-	-	-	-	N/A
0M Office P	-	-	-	1.3	-	-	-	-	-	-	N/A

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
00 Circulation	-	254	-	24
00 Circulation	-	304	-	13
00 Cycle Store	-	156	-	169
00 UKPN	90	-	-	84
00 Bin Store	-	155	-	148
00 WC	-	182	-	107
00 Reception	-	153	80	513
00 Office P E	147	-	-	912
00 Circulation	-	316	-	7
00 Circulation	-	257	-	22
00 Office P W	147	-	-	912
00 Office C	145	-	-	608
00 Changing Rooms	-	162	-	79
00 Cycle Store	-	155	-	85
00 Coffee Shop	-	157	80	353
00 Stairs	-	175	-	40
00 Circulation	-	161	-	43

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
01 Office P	151	-	-	1133
01 Office P W	148	-	-	1128
01 Office P E	148	-	-	1381
01 Office C	145	-	-	884
01 Stair	-	192	-	48
01 Circulation	-	307	-	15
01 WC	-	167	-	225
01 Office P W	155	-	-	115
01 Stairs	-	204	-	51
01 Greenhouse	-	147	-	332
01 Circulation	-	352	-	11
01 WC	-	373	-	19
02 Office P W	148	-	-	1128
02 Office P E	148	-	-	1381
02 Office C	145	-	-	884
02 Stair	-	192	-	48
02 Circulation	-	307	-	15
02 Office P W	155	-	-	115
03 Stairs	-	254	-	41
02 Circulation	-	352	-	11
02 WC	-	373	-	19
03 Office P W	149	-	-	1128
03 Office P E	149	-	-	1381
03 Office C	145	-	-	884
03 Stair	-	185	-	83
03 Greenhouse	-	145	-	167
03 Office P W	158	-	-	115
02 Greenhouse	-	145	-	167
03 Circulation	-	391	-	11
03 WC	-	417	-	19
02 Stairs	-	236	-	41
02 Office P	151	-	-	1133
02 WC	-	167	-	225
03 Circulation	-	414	-	10
03 WC	-	171	-	225
03 Office P W	160	-	-	375
04 Circulation	-	311	-	27
04 Office	151	-	-	2878
04 WC	-	224	-	69
04 Stairs	-	367	-	11
04 Circulation	-	398	-	8
04 WC	-	346	-	17
04 Circulation	-	333	-	9

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
00 Retail	-	148	80	2691
00 Retail	-	160	80	1001
0M Circulation	-	389	-	9
0M Plant	83	-	-	193
0M Plant	81	-	-	307
0M Stair	-	195	-	51
0M Stairs	-	178	-	64
0M Plant	82	-	-	294
0M WC	-	251	-	34
0M Circulation	-	398	-	7
0M Plant	77	-	-	562
0M Office P E	148	-	-	878
0M Office C	146	-	-	347
0M Office P	424	-	-	94

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
00 Reception	NO (-27.7%)	NO
00 Office P E	YES (+2.2%)	NO
00 Office P W	NO (-32.8%)	NO
00 Office C	NO (-55.5%)	NO
00 Changing Rooms	YES (+4.7%)	NO
00 Coffee Shop	NO (-51.3%)	NO
01 Office P	NO (-21.3%)	YES
01 Office P W	NO (-38%)	YES
01 Office P E	NO (-14.6%)	YES
01 Office C	NO (-59.7%)	NO
01 Office P W	NO (-11.8%)	YES
01 Greenhouse	YES (+17%)	NO
02 Office P W	NO (-28.4%)	YES
02 Office P E	NO (-5.8%)	YES
02 Office C	NO (-55.2%)	NO
02 Office P W	NO (-1.2%)	YES
03 Office P W	NO (-17.1%)	YES
03 Office P E	NO (-2.4%)	YES
03 Office C	NO (-52%)	NO
03 Greenhouse	NO (-37.6%)	NO
03 Office P W	YES (+5.7%)	YES
02 Greenhouse	YES (+0.1%)	NO
02 Office P	NO (-23%)	YES
03 Office P W	YES (+10.3%)	YES
04 Office	NO (-43.3%)	YES
00 Retail	NO (-48.8%)	NO

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
00 Retail	NO (-69.3%)	NO
0M Office P E	YES (+0.1%)	NO
0M Office C	NO (-36.9%)	NO
0M Office P	NO (-61.8%)	NO

Criterion 4: The performance of the building, as built, should be consistent with the calculated BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	YES
Is evidence of such assessment available as a separate submission?	YES
Are any such measures included in the proposed design?	YES

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m^2]	6944	6944
External area [m^2]	8143.2	8143.2
Weather	LON	LON
Infiltration [m^3/hm^2@ 50Pa]	3	3
Average conductance [W/K]	5788.94	4044.48
Average U-value [W/m^{2}K]	0.71	0.5
Alpha value* [%]	0	10

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
5	**A1/A2 Retail/Financial and Professional services**
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
95	**B1 Offices and Workshop businesses**
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Institutions: Hospitals and Care Homes
	C2 Residential Institutions: Residential schools
	C2 Residential Institutions: Universities and colleges
	C2A Secure Residential Institutions
	Residential spaces
	D1 Non-residential Institutions: Community/Day Centre
	D1 Non-residential Institutions: Libraries, Museums, and Galleries
	D1 Non-residential Institutions: Education
	D1 Non-residential Institutions: Primary Health Care Building
	D1 Non-residential Institutions: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs, and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others: Stand alone utility block

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

	Actual	Notional
Heating	3.03	6.95
Cooling	6.93	7.53
Auxiliary	6.47	4.47
Lighting	9.24	19.09
Hot water	2.11	9.34
Equipment*	43.52	43.52
TOTAL**	**27.79**	**47.39**

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

Energy Production by Technology [kWh/m^2]

	Actual	Notional
Photovoltaic systems	6.11	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m^2]	132.16	124.36
Primary energy* [kWh/m^2]	83.18	112.95
Total emissions [kg/m^2]	10.9	19.3

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Split or multi-split system, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	59.7	99.2	3.8	8.2	6.8	4.41	3.36	4.5	4.5
	Notional	26	121	8.4	8.9	4.5	2.56	3.79	----	----
[ST] Split or multi-split system, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	28.4	125.8	1.8	10.4	8	4.41	3.36	4.5	4.5
	Notional	24	161.7	7.7	11.9	5.7	2.56	3.79	----	----
[ST] No Heating or Cooling										
	Actual	0	0	0	0	0	0	0	0	0
	Notional	0	0	0	0	0	0	0	----	----

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

Key Features

The Building Control Body is advised to give particular attention to items whose specifications are better than typically expected.

Building fabric

Element	$U_{i\text{-}Typ}$	$U_{i\text{-}Min}$	Surface where the minimum value occurs*
Wall	0.23	0.15	00000000:Surf[0]
Floor	0.2	0.13	00000000:Surf[3]
Roof	0.15	0.13	01000037:Surf[0]
Windows, roof windows, and rooflights	1.5	1.4	00000001:Surf[1]
Personnel doors	1.5	-	No Personnel doors in building
Vehicle access & similar large doors	1.5	-	No Vehicle access doors in building
High usage entrance doors	1.5	-	No High usage entrance doors in building

$U_{i\text{-}Typ}$ = Typical individual element U-values [W/(m^{2}K)] $U_{i\text{-}Min}$ = Minimum individual element U-values [W/(m^{2}K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	Typical value	This building
m^3/(h.m^2) at 50 Pa	5	3

APPENDIX C

BE LEAN DER WORKSHEET

FULL SAP CALCULATION PRINTOUT
Calculation Type: New Build (As Designed)

Design SAP
elmhurst energy

Property Reference	02 S	Issued on Date	19/02/2021
Assessment Reference	02 S Be Lean	Prop Type Ref	2B4P
Property			

SAP Rating	84 B	DER	15.13	TER	17.28
Environmental	89 B	% DER<TER	12.42		
CO_2 Emissions (t/year)	0.76	DFEE	40.17	TFEE	40.31
General Requirements Compliance	Fail	% DFEE<TFEE	0.36		

Assessor Details	Mr. Jacob Cox, Jacob Cox, Tel: 02031165949, jacob.cox@wsp.com	Assessor ID	T241-0001
Client			

REGULATIONS COMPLIANCE REPORT - Approved Document L1A, 2013 Edition, England

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REGULATIONS COMPLIANCE REPORT - Approved Document L1A, 2013 Edition, England
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DWELLING AS DESIGNED

Mid-floor flat, total floor area 57 m²

This report covers items included within the SAP calculations.
It is not a complete report of regulations compliance.
----------------------------------------------------------------------------------------------------
1a TER and DER
Fuel for main heating:Mains gas
Fuel factor:1.00 (mains gas)
Target Carbon Dioxide Emission Rate (TER) 17.28 kgCO□/m²
Dwelling Carbon Dioxide Emission Rate (DER) 15.13 kgCO□/m²OK
----------------------------------------------------------------------------------------------------
1b TFEE and DFEE
Target Fabric Energy Efficiency (TFEE)40.3 kWh/m²/yr
Dwelling Fabric Energy Efficiency (DFEE)40.2 kWh/m²/yrOK
----------------------------------------------------------------------------------------------------
2 Fabric U-values
Element         Average                 Highest
External wall   0.14 (max. 0.30)        0.21 (max. 0.70)          OK
Party wall      0.00 (max. 0.20)         -                        OK
Floor           (no floor)
Roof            (no roof)
Openings        1.36 (max. 2.00)        1.40 (max. 3.30)          OK
----------------------------------------------------------------------------------------------------
2a Thermal bridging
Thermal bridging calculated using default y-value of 0.15
----------------------------------------------------------------------------------------------------
3 Air permeability
Air permeability at 50 pascals:         3.00 (design value)
Maximum                                 10.0                                            OK
----------------------------------------------------------------------------------------------------
4 Heating efficiency
Main heating system:                    Boiler system with radiators or underfloor - Mains gas
Data from manufacturer
123 123

Efficiency: 98%
Minimum: 88%                                      OK

Secondary heating system:               None
----------------------------------------------------------------------------------------------------
5 Cylinder insulation
Hot water storage                       Measured store loss: 1.03 kWh/day
Permitted by DBSCG 2.10                           OK
Primary pipework insulated:             Yes                                             OK
----------------------------------------------------------------------------------------------------
6 Controls
Space heating controls:                 Programmer and at least two room thermostats    OK


Hot water controls:                     Cylinderstat                                    OK
                                        Independent timer for DHW                       OK

Boiler interlock                        Yes                                             OK
----------------------------------------------------------------------------------------------------
7 Low energy lights
Percentage of fixed lights with low-energy fittings:100%
Minimum                                 75%                                             OK
----------------------------------------------------------------------------------------------------
8 Mechanical ventilation
Continuous supply and extract system
Specific fan power:                     0.59
Maximum                                 1.5                                             OK
MVHR efficiency:                        89%
Minimum:                                70%                                             OK
----------------------------------------------------------------------------------------------------
9 Summertime temperature
Overheating risk (Thames Valley):       High                                            Fail
Based on:
Overshading:                            Average
Windows facing East:                    5.25 m², No overhang
Windows facing West:                    11.40 m², No overhang
Air change rate:                        0.10 ach
Blinds/curtains:                        Dark-coloured curtain or roller blind, closed 100% of daylight hours
----------------------------------------------------------------------------------------------------
10 Key features
Party wall U-value                      0.00 W/m²K
Door U-value                            1.00 W/m²K
Air permeability                        3.0 m³/m²h



----------------------------------------------------------------------------------------------------
```

CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Designed) (Version 9.92, January 2014)
CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

1. Overall dwelling dimensions

		Area (m2)			Storey height (m)			Volume (m3)	
Ground floor		57.1900	(1b)	x	2.6500	(2b)	=	151.5535	(1b) - (3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	57.1900								(4)
Dwelling volume					(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =			151.5535	(5)

2. Ventilation rate

	main heating		secondary heating		other		total	m3 per hour	
Number of chimneys	0	+	0	+	0	=	0 * 40 =	0.0000	(6a)
Number of open flues	0	+	0	+	0	=	0 * 20 =	0.0000	(6b)
Number of intermittent fans							0 * 10 =	0.0000	(7a)
Number of passive vents							0 * 10 =	0.0000	(7b)
Number of flueless gas fires							0 * 40 =	0.0000	(7c)

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	0.0000 / (5) =	0.0000	(8)
Pressure test		Yes	
Measured/design AP50		3.0000	
Infiltration rate		0.1500	(18)
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.1275	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.1626	0.1594	0.1562	0.1403	0.1371	0.1211	0.1211	0.1179	0.1275	0.1371	0.1434	0.1498	(22b)

Balanced mechanical ventilation with heat recovery

If mechanical ventilation:	0.5000	(23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =	62.3000	(23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Effective ac	0.3511	0.3479	0.3447	0.3288	0.3256	0.3096	0.3096	0.3064	0.3160	0.3256	0.3319	0.3383	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
Front Door			1.8900	1.0000	1.8900			(26)
Glazing (Uw = 1.40)			16.6500	1.3258	22.0739			(27)
External Wall 1	33.2000	16.6500	16.5500	0.1500	2.4825			(29a)
Common Area	8.9800	1.8900	7.0900	0.2075	1.4710			(29a)
Other Wall	11.8200		11.8200	0.0750	0.8865			(29a)
Total net area of external elements Aum(A, m2)			54.0000					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		28.8038			(33)
Party Wall 1			29.0700	0.0000	0.0000			(32)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		100.0000	(35)
Thermal bridges (Default value 0.150 * total exposed area)		8.1000	(36)
Total fabric heat loss	(33) + (36) =	36.9038	(37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	17.5576	17.3982	17.2387	16.4417	16.2822	15.4852	15.4852	15.3258	15.8040	16.2822	16.6011	16.9199	(38)
Heat transfer coeff	54.4614	54.3020	54.1426	53.3455	53.1861	52.3890	52.3890	52.2296	52.7078	53.1861	53.5049	53.8237	(39)
Average = Sum(39)m / 12 =												53.3056	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.9523	0.9495	0.9467	0.9328	0.9300	0.9161	0.9161	0.9133	0.9216	0.9300	0.9356	0.9411	(40)
HLP (average)												0.9321	(40)
Days in month	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy	1.9012	(42)
Average daily hot water use (litres/day)	79.3529	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	87.2882	84.1141	80.9400	77.7659	74.5917	71.4176	71.4176	74.5917	77.7659	80.9400	84.1141	87.2882	(44)
Energy conte	129.4459	113.2142	116.8269	101.8525	97.7299	84.3335	78.1474	89.6753	90.7463	105.7560	115.4410	125.3614	(45)
Energy content (annual)										Total = Sum(45)m =		1248.5305	(45)
Distribution loss (46)m = 0.15 x (45)m	19.4169	16.9821	17.5240	15.2779	14.6595	12.6500	11.7221	13.4513	13.6119	15.8634	17.3161	18.8042	(46)

CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

Water storage loss:

Store volume	150.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):	1.0300	(48)
Temperature factor from Table 2b	0.7930	(49)
Enter (49) or (54) in (55)	0.8168	(55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Total storage loss	25.3202	22.8698	25.3202	24.5034	25.3202	24.5034	25.3202	25.3202	24.5034	25.3202	24.5034	25.3202	(56)
If cylinder contains dedicated solar storage	25.3202	22.8698	25.3202	24.5034	25.3202	24.5034	25.3202	25.3202	24.5034	25.3202	24.5034	25.3202	(57)
Primary loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(59)
Total heat required for water heating calculated for each month	154.7661	136.0840	142.1471	126.3559	123.0501	108.8369	103.4676	114.9954	115.2497	131.0762	139.9444	150.6816	(62)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63)
Solar input (sum of months) = Sum(63)m =												0.0000	(63)
Output from w/h	154.7661	136.0840	142.1471	126.3559	123.0501	108.8369	103.4676	114.9954	115.2497	131.0762	139.9444	150.6816	(64)
Total per year (kWh/year) = Sum(64)m =												1546.6551	(64)
Heat gains from water heating, kWh/month	63.2969	55.9396	59.1011	53.4687	52.7513	47.6436	46.2401	50.0732	49.7759	55.4200	57.9868	61.9388	(65)

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5. Internal gains (see Table 5 and 5a)

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	95.0588	95.0588	95.0588	95.0588	95.0588	95.0588	95.0588	95.0588	95.0588	95.0588	95.0588	95.0588	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	14.7820	13.1292	10.6774	8.0835	6.0425	5.1013	5.5122	7.1649	9.6167	12.2107	14.2516	15.1928	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	165.8087	167.5293	163.1935	153.9631	142.3114	131.3604	124.0445	122.3239	126.6597	135.8901	147.5418	158.4928	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	32.5059	32.5059	32.5059	32.5059	32.5059	32.5059	32.5059	32.5059	32.5059	32.5059	32.5059	32.5059	(69)
Pumps, fans	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)	-76.0470	-76.0470	-76.0470	-76.0470	-76.0470	-76.0470	-76.0470	-76.0470	-76.0470	-76.0470	-76.0470	-76.0470	(71)
Water heating gains (Table 5)	85.0765	83.2434	79.4369	74.2621	70.9023	66.1717	62.1507	67.3026	69.1331	74.4893	80.5373	83.2511	(72)
Total internal gains	320.1848	318.4195	307.8254	290.8262	273.7738	257.1510	246.2250	251.3091	259.9272	277.1077	296.8484	311.4543	(73)

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6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
East	5.2500	19.6403	0.5000	0.9000	0.7700	32.1553	(76)
West	11.4000	19.6403	0.5000	0.9000	0.7700	69.8229	(80)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	101.9782	199.4910	328.5332	479.1461	587.2115	601.1155	572.2865	491.5856	382.0977	236.7128	127.1548	83.8619	(83)
Total gains	422.1630	517.9105	636.3587	769.9724	860.9854	858.2665	818.5115	742.8947	642.0249	513.8205	424.0032	395.3162	(84)

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7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C) 21.0000 (85)

Utilisation factor for gains for living area, nil,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	29.1695	29.2551	29.3413	29.7797	29.8689	30.3234	30.3234	30.4159	30.1400	29.8689	29.6909	29.5151	
alpha	2.9446	2.9503	2.9561	2.9853	2.9913	3.0216	3.0216	3.0277	3.0093	2.9913	2.9794	2.9677	
util living area	0.9412	0.9004	0.8196	0.6797	0.5222	0.3764	0.2772	0.3162	0.5170	0.7764	0.9098	0.9498	(86)
MIT	19.2824	19.6306	20.1144	20.5875	20.8477	20.9585	20.9877	20.9817	20.8923	20.4785	19.7920	19.2193	(87)
Th 2	20.1233	20.1256	20.1280	20.1397	20.1421	20.1539	20.1539	20.1562	20.1492	20.1421	20.1374	20.1327	(88)
util rest of house	0.9336	0.8884	0.7996	0.6493	0.4830	0.3304	0.2255	0.2606	0.4642	0.7448	0.8968	0.9432	(89)
MIT 2	18.5551	18.8947	19.3583	19.8030	20.0301	20.1287	20.1483	20.1475	20.0786	19.7200	19.0665	18.5004	(90)
Living area fraction									fLA = Living area / (4) =			0.4802	(91)
MIT	18.9043	19.2480	19.7213	20.1797	20.4227	20.5271	20.5513	20.5480	20.4693	20.0842	19.4148	18.8456	(92)
Temperature adjustment												-0.2500	
adjusted MIT	18.6543	18.9980	19.4713	19.9297	20.1727	20.2771	20.3013	20.2980	20.2193	19.8342	19.1648	18.5956	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9178	0.8701	0.7828	0.6414	0.4845	0.3372	0.2346	0.2701	0.4688	0.7323	0.8792	0.9286	(94)
Useful gains	387.4681	450.6572	498.1385	493.8593	417.1337	289.3996	191.9958	200.6410	300.9497	376.2621	372.7986	367.0804	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W	781.7557	765.5516	702.3002	588.3841	450.6295	297.4176	193.9090	203.5919	322.5351	491.1299	645.5282	774.8257	(97)
Month fracti	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000	(97a)
Space heating kWh	293.3500	211.6091	151.8963	68.0579	24.9209	0.0000	0.0000	0.0000	0.0000	85.4616	196.3654	303.3625	(98)
Space heating												1335.0236	(98)
Space heating per m2											(98) / (4) =	23.3437	(99)

CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

8c. Space cooling requirement

Not applicable

9a. Energy requirements - Individual heating systems, including micro-CHP

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(201)
Fraction of space heat from main system(s)	1.0000	(202)
Efficiency of main space heating system 1 (in %)	98.0000	(206)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)
Space heating requirement	1362.2690	(211)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	293.3500	211.6091	151.8963	68.0579	24.9209	0.0000	0.0000	0.0000	0.0000	85.4616	196.3654	303.3625	(98)
Space heating efficiency (main heating system 1)	98.0000	98.0000	98.0000	98.0000	98.0000	0.0000	0.0000	0.0000	0.0000	98.0000	98.0000	98.0000	(210)
Space heating fuel (main heating system)	299.3367	215.9276	154.9963	69.4468	25.4294	0.0000	0.0000	0.0000	0.0000	87.2057	200.3728	309.5536	(211)
Water heating requirement	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water heating requirement	154.7661	136.0840	142.1471	126.3559	123.0501	108.8369	103.4676	114.9954	115.2497	131.0762	139.9444	150.6816	(64)
Efficiency of water heater												98.0000	(216)
(217)m	98.0000	98.0000	98.0000	98.0000	98.0000	98.0000	98.0000	98.0000	98.0000	98.0000	98.0000	98.0000	(217)
Fuel for water heating, kWh/month	157.9246	138.8613	145.0481	128.9346	125.5613	111.0581	105.5791	117.3423	117.6017	133.7512	142.8004	153.7568	(219)

Water heating fuel used	1578.2195	(219)
Annual totals kWh/year		
Space heating fuel - main system	1362.2690	(211)
Space heating fuel - secondary	0.0000	(215)

Electricity for pumps and fans:
(BalancedWithHeatRecovery, Database: in-use factor = 1.4000, SFP = 0.8260)

mechanical ventilation fans (SFP = 0.8260)	152.7235	(230a)
central heating pump	30.0000	(230c)
Total electricity for the above, kWh/year	182.7235	(231)
Electricity for lighting (calculated in Appendix L)	261.0541	(232)
Total delivered energy for all uses	3384.2661	(238)

12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	1362.2690	0.2160	294.2501	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	1578.2195	0.2160	340.8954	(264)
Space and water heating			635.1455	(265)
Pumps and fans	182.7235	0.5190	94.8335	(267)
Energy for lighting	261.0541	0.5190	135.4871	(268)
Total CO2, kg/year			865.4661	(272)
Dwelling Carbon Dioxide Emission Rate (DER)			15.1300	(273)

16 CO2 EMISSIONS ASSOCIATED WITH APPLIANCES AND COOKING AND SITE-WIDE ELECTRICITY GENERATION TECHNOLOGIES

DER		15.1300	ZC1
Total Floor Area	TFA	57.1900	
Assumed number of occupants	N	1.9012	
CO2 emission factor in Table 12 for electricity displaced from grid	EF	0.5190	
CO2 emissions from appliances, equation (L14)		17.1804	ZC2
CO2 emissions from cooking, equation (L16)		2.8786	ZC3
Total CO2 emissions		35.1890	ZC4
Residual CO2 emissions offset from biofuel CHP		0.0000	ZC5
Additional allowable electricity generation, kWh/m²/year		0.0000	ZC6
Resulting CO2 emissions offset from additional allowable electricity generation		0.0000	ZC7
Net CO2 emissions		35.1890	ZC8

CALCULATION OF TARGET EMISSIONS 09 Jan 2014

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SAP 2012 WORKSHEET FOR New Build (As Designed)   (Version 9.92, January 2014)
CALCULATION OF TARGET EMISSIONS      09 Jan 2014
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-----------------------------------------------------------------------------------------------------
1. Overall dwelling dimensions
-----------------------------------------------------------------------------------------------------
                                                                               Area         Storey height              Volume
                                                                               (m2)              (m)                    (m3)
Ground floor                                                                57.1900 (1b)    x      2.6500 (2b)    =    151.5535 (1b) - (3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)             57.1900                                                     (4)
Dwelling volume                                                               (3a)+(3b)+(3c)+(3d)+(3e)...(3n) =    151.5535 (5)



-----------------------------------------------------------------------------------------------------
2. Ventilation rate
-----------------------------------------------------------------------------------------------------
                                                           main           secondary             other              total        m3 per hour
                                                         heating           heating
Number of chimneys                                           0       +         0        +         0       =            0 * 40 =     0.0000 (6a)
Number of open flues                                         0       +         0        +         0       =            0 * 20 =     0.0000 (6b)
Number of intermittent fans                                                                                            2 * 10 =    20.0000 (7a)
Number of passive vents                                                                                                0 * 10 =     0.0000 (7b)
Number of flueless gas fires                                                                                           0 * 40 =     0.0000 (7c)

                                                                                                                     Air changes per hour
Infiltration due to chimneys, flues and fans   = (6a)+(6b)+(7a)+(7b)+(7c) =                                    20.0000 / (5) =     0.1320 (8)
Pressure test                                                                                                                          Yes
Measured/design AP50                                                                                                                5.0000
Infiltration rate                                                                                                                   0.3820 (18)
Number of sides sheltered                                                                                                                2 (19)

Shelter factor                                                                                 (20) = 1 - [0.075 x (19)] =      0.8500 (20)
Infiltration rate adjusted to include shelter factor                                                     (21) = (18) x (20) =      0.3247 (21)

                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Wind speed     5.1000     5.0000     4.9000     4.4000     4.3000     3.8000     3.8000     3.7000     4.0000     4.3000     4.5000     4.7000 (22)
Wind factor    1.2750     1.2500     1.2250     1.1000     1.0750     0.9500     0.9500     0.9250     1.0000     1.0750     1.1250     1.1750 (22a)
Adj infilt rate
               0.4140     0.4058     0.3977     0.3571     0.3490     0.3084     0.3084     0.3003     0.3247     0.3490     0.3653     0.3815 (22b)
Effective ac   0.5857     0.5824     0.5791     0.5638     0.5609     0.5476     0.5476     0.5451     0.5527     0.5609     0.5667     0.5728 (25)



-----------------------------------------------------------------------------------------------------
3. Heat losses and heat loss parameter
-----------------------------------------------------------------------------------------------------
Element                                               Gross       Openings         NetArea        U-value          A x U        K-value           A x K
                                                        m2             m2              m2          W/m2K            W/K         kJ/m2K            kJ/K
TER Opaque door                                                                    1.8900         1.0000         1.8900                              (26)
TER Opening Type (Uw = 1.40)                                                      12.4100         1.3258        16.4527                              (27)
External Wall 1                                     33.2000        12.4100        20.7900         0.1800         3.7422                              (29a)
Common Area                                          8.9800         1.8900         7.0900         0.1800         1.2762                              (29a)
Other Wall                                          11.8200                       11.8200         0.1800         2.1276                              (29a)
Total net area of external elements Aum(A, m2)                                    54.0000                                                             (31)
Fabric heat loss, W/K = Sum (A x U)                                                   (26)...(30) + (32) =      25.4887                              (33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K                                                                                 250.0000 (35)
Thermal bridges (User defined value 0.050 * total exposed area)                                                                      2.7000 (36)
Total fabric heat loss                                                                                              (33) + (36) =    28.1887 (37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)
                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
(38)m         29.2914    29.1250    28.9619    28.1958    28.0525    27.3853    27.3853    27.2617    27.6423    28.0525    28.3425    28.6456 (38)
Heat transfer coeff
              57.4801    57.3137    57.1506    56.3845    56.2412    55.5739    55.5739    55.4504    55.8309    56.2412    56.5311    56.8342 (39)
Average = Sum(39)m / 12 =                                                                                                        56.3838 (39)

                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
HLP            1.0051     1.0022     0.9993     0.9859     0.9834     0.9717     0.9717     0.9696     0.9762     0.9834     0.9885     0.9938 (40)
HLP (average)                                                                                                                     0.9859 (40)
Days in month
                   31         28         31         30         31         30         31         31         30         31         30         31 (41)



-----------------------------------------------------------------------------------------------------
4. Water heating energy requirements (kWh/year)
-----------------------------------------------------------------------------------------------------
Assumed occupancy                                                                                                                  1.9012 (42)
Average daily hot water use (litres/day)                                                                                          79.3529 (43)

                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Daily hot water use
              87.2882    84.1141    80.9400    77.7659    74.5917    71.4176    71.4176    74.5917    77.7659    80.9400    84.1141    87.2882 (44)
Energy conte 129.4459   113.2142   116.8269   101.8525    97.7299    84.3335    78.1474    89.6753    90.7463   105.7560   115.4410   125.3614 (45)
Energy content (annual)                                                                                       Total = Sum(45)m =   1248.5305 (45)
Distribution loss  (46)m = 0.15 x (45)m
              19.4169    16.9821    17.5240    15.2779    14.6595    12.6500    11.7221    13.4513    13.6119    15.8634    17.3161    18.8042 (46)
Water storage loss:
Store volume                                                                                                                     150.0000 (47)
a) If  manufacturer declared loss factor is known  (kWh/day):                                                                      1.3938 (48)
  Temperature factor from Table 2b                                                                                                 0.5400 (49)
Enter (49) or (54) in (55)                                                                                                         0.7527 (55)
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CALCULATION OF TARGET EMISSIONS 09 Jan 2014

Total storage loss	23.3325	21.0745	23.3325	22.5798	23.3325	22.5798	23.3325	23.3325	22.5798	23.3325	22.5798	23.3325	(56)
If cylinder contains dedicated solar storage	23.3325	21.0745	23.3325	22.5798	23.3325	22.5798	23.3325	23.3325	22.5798	23.3325	22.5798	23.3325	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Total heat required for water heating calculated for each month	176.0408	155.2999	163.4218	146.9444	144.3248	129.4254	124.7423	136.2702	135.8381	152.3509	160.5328	171.9563	(62)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63)
Solar input (sum of months) = Sum(63)m =												0.0000	(63)
Output from w/h	176.0408	155.2999	163.4218	146.9444	144.3248	129.4254	124.7423	136.2702	135.8381	152.3509	160.5328	171.9563	(64)
Total per year (kWh/year) = Sum(64)m =												1797.1479	(64)
Heat gains from water heating, kWh/month	80.3167	71.3123	76.1209	69.9394	69.7711	64.1144	63.2599	67.0930	66.2466	72.4398	74.4576	78.9586	(65)

5. Internal gains (see Table 5 and 5a)

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	95.0588	95.0588	95.0588	95.0588	95.0588	95.0588	95.0588	95.0588	95.0588	95.0588	95.0588	95.0588	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	14.7947	13.1406	10.6866	8.0905	6.0477	5.1057	5.5169	7.1711	9.6251	12.2212	14.2640	15.2059	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	165.8087	167.5293	163.1935	153.9631	142.3114	131.3604	124.0445	122.3239	126.6597	135.8901	147.5418	158.4928	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	32.5059	32.5059	32.5059	32.5059	32.5059	32.5059	32.5059	32.5059	32.5059	32.5059	32.5059	32.5059	(69)
Pumps, fans	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)	-76.0470	-76.0470	-76.0470	-76.0470	-76.0470	-76.0470	-76.0470	-76.0470	-76.0470	-76.0470	-76.0470	-76.0470	(71)
Water heating gains (Table 5)	107.9525	106.1195	102.3130	97.1381	93.7784	89.0477	85.0268	90.1787	92.0092	97.3653	103.4133	106.1272	(72)
Total internal gains	343.0736	341.3070	330.7107	313.7093	296.6551	280.0315	269.1058	274.1913	282.8116	299.9943	319.7367	334.3435	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
East	3.9100	19.6403	0.6300	0.7000	0.7700	23.4691	(76)
West	8.5000	19.6403	0.6300	0.7000	0.7700	51.0197	(80)

Solar gains	74.4888	145.7159	239.9733	349.9867	428.9219	439.0779	418.0200	359.0730	279.0989	172.9042	92.8788	61.2560	(83)
Total gains	417.5624	487.0228	570.6840	663.6960	725.5770	719.1094	687.1259	633.2644	561.9104	472.8984	412.6155	395.5995	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C) 21.0000 (85)

Utilisation factor for gains for living area, nil,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	69.0940	69.2946	69.4924	70.4365	70.6160	71.4639	71.4639	71.6231	71.1349	70.6160	70.2538	69.8791	
alpha	5.6063	5.6196	5.6328	5.6958	5.7077	5.7643	5.7643	5.7749	5.7423	5.7077	5.6836	5.6586	
util living area	0.9947	0.9868	0.9584	0.8621	0.6859	0.4902	0.3553	0.4015	0.6588	0.9251	0.9876	0.9960	(86)
MIT	20.0815	20.2538	20.5243	20.8137	20.9570	20.9947	20.9993	20.9986	20.9745	20.7503	20.3600	20.0521	(87)
Th 2	20.0791	20.0815	20.0839	20.0951	20.0972	20.1069	20.1069	20.1088	20.1032	20.0972	20.0929	20.0885	(88)
util rest of house	0.9930	0.9827	0.9462	0.8285	0.6301	0.4238	0.2835	0.3244	0.5837	0.8975	0.9831	0.9947	(89)
MIT 2	18.8628	19.1139	19.4994	19.8934	20.0598	20.1038	20.1067	20.1082	20.0854	19.8250	19.2780	18.8272	(90)
Living area fraction									fLA = Living area / (4) =			0.4802	(91)
MIT	19.4479	19.6612	19.9915	20.3353	20.4906	20.5315	20.5353	20.5358	20.5123	20.2693	19.7975	19.4153	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.4479	19.6612	19.9915	20.3353	20.4906	20.5315	20.5353	20.5358	20.5123	20.2693	19.7975	19.4153	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9915	0.9804	0.9448	0.8381	0.6551	0.4556	0.3180	0.3615	0.6189	0.9034	0.9813	0.9935	(94)
Useful gains	414.0041	477.4977	539.1750	556.2271	475.3035	327.6379	218.4965	228.9147	347.7535	427.2332	404.8835	393.0160	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W	870.7044	846.0190	771.0478	644.7722	494.3952	329.6390	218.6996	229.3299	358.0034	543.8133	717.8048	864.7512	(97)
Month fracti	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000	(97a)
Space heating kWh	339.7851	247.6463	172.5134	63.7525	14.2042	0.0000	0.0000	0.0000	0.0000	86.7356	225.3033	350.9710	(98)
Space heating												1500.9114	(98)
Space heating per m2											(98) / (4) =	26.2443	(99)

8c. Space cooling requirement

Not applicable

CALCULATION OF TARGET EMISSIONS 09 Jan 2014

9a. Energy requirements - Individual heating systems, including micro-CHP

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(201)
Fraction of space heat from main system(s)	1.0000	(202)
Efficiency of main space heating system 1 (in %)	93.5000	(206)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)
Space heating requirement	1605.2528	(211)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	339.7851	247.6463	172.5134	63.7525	14.2042	0.0000	0.0000	0.0000	0.0000	86.7356	225.3033	350.9710	(98)
Space heating efficiency (main heating system 1)	93.5000	93.5000	93.5000	93.5000	93.5000	0.0000	0.0000	0.0000	0.0000	93.5000	93.5000	93.5000	(210)
Space heating fuel (main heating system)	363.4065	264.8624	184.5063	68.1845	15.1917	0.0000	0.0000	0.0000	0.0000	92.7654	240.9661	375.3700	(211)
Water heating requirement	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water heating requirement	176.0408	155.2999	163.4218	146.9444	144.3248	129.4254	124.7423	136.2702	135.8381	152.3509	160.5328	171.9563	(64)
Efficiency of water heater												79.8000	(216)
(217)m	86.5399	86.0530	84.9583	82.7607	80.6544	79.8000	79.8000	79.8000	79.8000	83.3762	85.7180	86.6782	(217)
Fuel for water heating, kWh/month	203.4216	180.4702	192.3553	177.5533	178.9423	162.1872	156.3187	170.7646	170.2232	182.7272	187.2803	198.3848	(219)

Water heating fuel used	2160.6285	(219)
Annual totals kWh/year		
Space heating fuel - main system	1605.2528	(211)
Space heating fuel - secondary	0.0000	(215)
Electricity for pumps and fans:		
central heating pump	30.0000	(230c)
main heating flue fan	45.0000	(230e)
Total electricity for the above, kWh/year	75.0000	(231)
Electricity for lighting (calculated in Appendix L)	261.2799	(232)
Total delivered energy for all uses	4102.1612	(238)

12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	1605.2528	0.2160	346.7346	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	2160.6285	0.2160	466.6958	(264)
Space and water heating			813.4304	(265)
Pumps and fans	75.0000	0.5190	38.9250	(267)
Energy for lighting	261.2799	0.5190	135.6043	(268)
Total CO2, kg/m2/year			987.9596	(272)
Emissions per m2 for space and water heating			14.2233	(272a)
Fuel factor (mains gas)			1.0000	
Emissions per m2 for lighting			2.3711	(272b)
Emissions per m2 for pumps and fans			0.6806	(272c)
Target Carbon Dioxide Emission Rate (TER) = (14.2233 * 1.00) + 2.3711 + 0.6806, rounded to 2 d.p.			17.2800	(273)

APPENDIX D

BE GREEN DER WORKSHEET

FULL SAP CALCULATION PRINTOUT
Calculation Type: New Build (As Designed)

Design SAP
elmhurst energy

Property Reference	02 S	Issued on Date	19/02/2021
Assessment Reference	02 S Be Green	Prop Type Ref	2B4P
Property			

SAP Rating	85 B	DER	7.64	TER	25.10
Environmental	95 A	% DER<TER	69.56		
CO_2 Emissions (t/year)	0.34	DFEE	40.17	TFEE	40.31
General Requirements Compliance	Fail	% DFEE<TFEE	0.36		

Assessor Details	Mr. Jacob Cox, Jacob Cox, Tel: 02031165949, jacob.cox@wsp.com	Assessor ID	T241-0001
Client			

REGULATIONS COMPLIANCE REPORT - Approved Document L1A, 2013 Edition, England

REGULATIONS COMPLIANCE REPORT - Approved Document L1A, 2013 Edition, England

DWELLING AS DESIGNED

Mid-floor flat, total floor area 57 m^2

This report covers items included within the SAP calculations.
It is not a complete report of regulations compliance.

1a TER and DER

Fuel for main heating:Electricity
Fuel factor:1.55 (electricity)
Target Carbon Dioxide Emission Rate (TER) 25.10 kgCO□/m^2
Dwelling Carbon Dioxide Emission Rate (DER) 7.64 kgCO□/m^2OK

1b TFEE and DFEE

Target Fabric Energy Efficiency (TFEE)40.3 kWh/m^2/yr
Dwelling Fabric Energy Efficiency (DFEE)40.2 kWh/m^2/yrOK

2 Fabric U-values

Element	Average	Highest	
External wall	0.14 (max. 0.30)	0.21 (max. 0.70)	OK
Party wall	0.00 (max. 0.20)	-	OK
Floor	(no floor)		
Roof	(no roof)		
Openings	1.36 (max. 2.00)	1.40 (max. 3.30)	OK

2a Thermal bridging

Thermal bridging calculated using default y-value of 0.15

3 Air permeability

Air permeability at 50 pascals:	3.00 (design value)	
Maximum	10.0	OK

4 Heating efficiency

Main heating system:	Heat pump with radiators or underfloor - Electric
Daikin Altherma ERHQ006BV3 + EKHBH008B	
Secondary heating system:	None

5 Cylinder insulation

Hot water storage	Measured store loss: 1.03 kWh/day	
Permitted by DBSCG 2.10	OK	
Primary pipework insulated:	Yes	OK

6 Controls

Space heating controls:	Time and temperature zone control	OK
Hot water controls:	Cylinderstat	OK
	Independent timer for DHW	OK

7 Low energy lights

Percentage of fixed lights with low-energy fittings:	100%	
Minimum	75%	OK

8 Mechanical ventilation

Continuous supply and extract system

Specific fan power:	0.59	
Maximum	1.5	OK
MVHR efficiency:	89%	
Minimum:	70%	OK

9 Summertime temperature

Overheating risk (Thames Valley):	High	Fail
Based on:		
Overshading:	Average	
Windows facing East:	5.25 m^2, No overhang	
Windows facing West:	11.40 m^2, No overhang	
Air change rate:	0.10 ach	
Blinds/curtains:	Dark-coloured curtain or roller blind, closed 100% of daylight hours	

10 Key features

Party wall U-value	0.00 W/m^2K
Door U-value	1.00 W/m^2K
Air permeability	3.0 m^3/m^2h
Photovoltaic array	1216.00 kWh/Year

CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Designed) (Version 9.92, January 2014)
CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

1. Overall dwelling dimensions

		Area (m2)		Storey height (m)		Volume (m3)
Ground floor		57.1900 (1b)	x	2.6500 (2b)	=	151.5535 (1b) - (3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	57.1900					(4)
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	151.5535 (5)

2. Ventilation rate

	main heating		secondary heating		other		total	m3 per hour
Number of chimneys	0	+	0	+	0	=	0 * 40 =	0.0000 (6a)
Number of open flues	0	+	0	+	0	=	0 * 20 =	0.0000 (6b)
Number of intermittent fans							0 * 10 =	0.0000 (7a)
Number of passive vents							0 * 10 =	0.0000 (7b)
Number of flueless gas fires							0 * 40 =	0.0000 (7c)

		Air changes per hour
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	0.0000 / (5) =	0.0000 (8)
Pressure test		Yes
Measured/design AP50		3.0000
Infiltration rate		0.1500 (18)
Number of sides sheltered		2 (19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500 (20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.1275 (21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.1626	0.1594	0.1562	0.1403	0.1371	0.1211	0.1211	0.1179	0.1275	0.1371	0.1434	0.1498	(22b)

Balanced mechanical ventilation with heat recovery
If mechanical ventilation: 0.5000 (23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 62.3000 (23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Effective ac	0.3511	0.3479	0.3447	0.3288	0.3256	0.3096	0.3096	0.3064	0.3160	0.3256	0.3319	0.3383	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
Front Door			1.8900	1.0000	1.8900			(26)
Glazing (Uw = 1.40)			16.6500	1.3258	22.0739			(27)
External Wall 1	33.2000	16.6500	16.5500	0.1500	2.4825			(29a)
Common Area	8.9800	1.8900	7.0900	0.2075	1.4710			(29a)
Other Wall	11.8200		11.8200	0.0750	0.8865			(29a)
Total net area of external elements Aum(A, m2)			54.0000					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		28.8038			(33)
Party Wall 1			29.0700	0.0000	0.0000			(32)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		100.0000 (35)
Thermal bridges (Default value 0.150 * total exposed area)		8.1000 (36)
Total fabric heat loss	(33) + (36) =	36.9038 (37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	17.5576	17.3982	17.2387	16.4417	16.2822	15.4852	15.4852	15.3258	15.8040	16.2822	16.6011	16.9199	(38)
Heat transfer coeff	54.4614	54.3020	54.1426	53.3455	53.1861	52.3890	52.3890	52.2296	52.7078	53.1861	53.5049	53.8237	(39)
Average = Sum(39)m / 12 =												53.3056	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.9523	0.9495	0.9467	0.9328	0.9300	0.9161	0.9161	0.9133	0.9216	0.9300	0.9356	0.9411	(40)
HLP (average)												0.9321	(40)
Days in month	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy 1.9012 (42)
Average daily hot water use (litres/day) 79.3529 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	87.2882	84.1141	80.9400	77.7659	74.5917	71.4176	71.4176	74.5917	77.7659	80.9400	84.1141	87.2882	(44)
Energy conte	129.4459	113.2142	116.8269	101.8525	97.7299	84.3335	78.1474	89.6753	90.7463	105.7560	115.4410	125.3614	(45)
Energy content (annual)										Total = Sum(45)m =		1248.5305	(45)
Distribution loss (46)m = 0.15 x (45)m	19.4169	16.9821	17.5240	15.2779	14.6595	12.6500	11.7221	13.4513	13.6119	15.8634	17.3161	18.8042	(46)

Water storage loss:

Store volume	150.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):	1.0300	(48)
Temperature factor from Table 2b	0.7209	(49)
Enter (49) or (54) in (55)	0.7425	(55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Total storage loss	23.0183	20.7908	23.0183	22.2758	23.0183	22.2758	23.0183	23.0183	22.2758	23.0183	22.2758	23.0183	(56)
If cylinder contains dedicated solar storage	23.0183	20.7908	23.0183	22.2758	23.0183	22.2758	23.0183	23.0183	22.2758	23.0183	22.2758	23.0183	(57)
Primary loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(59)
Total heat required for water heating calculated for each month	152.4642	134.0050	139.8453	124.1284	120.7483	106.6093	101.1657	112.6936	113.0221	128.7744	137.7168	148.3798	(62)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63)

Solar input (sum of months) = Sum(63)m = 0.0000 (63)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Output from w/h	152.4642	134.0050	139.8453	124.1284	120.7483	106.6093	101.1657	112.6936	113.0221	128.7744	137.7168	148.3798	(64)

Total per year (kWh/year) = Sum(64)m = 1519.5529 (64)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat gains from water heating, kWh/month	61.4554	54.2763	57.2596	51.6866	50.9099	45.8615	44.3987	48.2317	47.9938	53.5786	56.2048	60.0974	(65)

5. Internal gains (see Table 5 and 5a)

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	95.0588	95.0588	95.0588	95.0588	95.0588	95.0588	95.0588	95.0588	95.0588	95.0588	95.0588	95.0588	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	14.7820	13.1292	10.6774	8.0835	6.0425	5.1013	5.5122	7.1649	9.6167	12.2107	14.2516	15.1928	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	165.8087	167.5293	163.1935	153.9631	142.3114	131.3604	124.0445	122.3239	126.6597	135.8901	147.5418	158.4928	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	32.5059	32.5059	32.5059	32.5059	32.5059	32.5059	32.5059	32.5059	32.5059	32.5059	32.5059	32.5059	(69)
Pumps, fans	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)	-76.0470	-76.0470	-76.0470	-76.0470	-76.0470	-76.0470	-76.0470	-76.0470	-76.0470	-76.0470	-76.0470	-76.0470	(71)
Water heating gains (Table 5)	82.6014	80.7683	76.9619	71.7870	68.4273	63.6966	59.6756	64.8276	66.6580	72.0142	78.0622	80.7760	(72)
Total internal gains	314.7097	312.9445	302.3503	285.3512	268.2987	251.6759	240.7499	245.8340	254.4521	271.6326	291.3733	305.9792	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
East	5.2500	19.6403	0.5000	0.9000	0.7700	32.1553	(76)
West	11.4000	19.6403	0.5000	0.9000	0.7700	69.8229	(80)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	101.9782	199.4910	328.5332	479.1461	587.2115	601.1155	572.2865	491.5856	382.0977	236.7128	127.1548	83.8619	(83)
Total gains	416.6879	512.4354	630.8836	764.4973	855.5103	852.7914	813.0364	737.4196	636.5498	508.3454	418.5281	389.8411	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C) 21.0000 (85)

Utilisation factor for gains for living area, nil,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	29.1695	29.2551	29.3413	29.7797	29.8689	30.3234	30.3234	30.4159	30.1400	29.8689	29.6909	29.5151	
alpha	2.9446	2.9503	2.9561	2.9853	2.9913	3.0216	3.0216	3.0277	3.0093	2.9913	2.9794	2.9677	
util living area	0.9430	0.9026	0.8223	0.6826	0.5248	0.3786	0.2790	0.3184	0.5205	0.7802	0.9122	0.9514	(86)
Tweekday	17.8052	18.3048	18.9879	19.6402	19.9758	20.1163	20.1455	20.1431	20.0438	19.5138	18.5504	17.7200	
Tweekend	19.8800	20.1064	20.4214	20.7301	20.9002	20.9727	20.9919	20.9879	20.9290	20.6578	20.2104	19.8389	
24 / 16	9	8	9	8	9	9	9	9	8	9	8	9	
24 / 9	22	20	22	22	22	21	22	22	22	22	22	22	
16 / 9	0	0	0	0	0	0	0	0	0	0	0	0	
MIT	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	(87)
Th 2	20.1233	20.1256	20.1280	20.1397	20.1421	20.1539	20.1539	20.1562	20.1492	20.1421	20.1374	20.1327	(88)
util rest of house	0.9355	0.8908	0.8024	0.6522	0.4856	0.3323	0.2269	0.2625	0.4676	0.7488	0.8995	0.9450	(89)
Tweekday	17.8052	18.3048	18.9879	19.6402	19.9758	20.1163	20.1455	20.1431	20.0438	19.5138	18.5504	17.7200	
Tweekend	17.8052	18.3048	18.9879	19.6402	19.9758	20.1163	20.1455	20.1431	20.0438	19.5138	18.5504	17.7200	
MIT 2	20.1233	20.1256	20.1280	20.1397	20.1421	20.1539	20.1539	20.1562	20.1492	20.1421	20.1374	20.1327	(90)

Living area fraction — fLA = Living area / (4) = 0.4802 (91)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
MIT	20.5442	20.5455	20.5467	20.5528	20.5540	20.5601	20.5601	20.5614	20.5577	20.5540	20.5516	20.5491	(92)
Temperature adjustment												-0.1000	
adjusted MIT	20.4442	20.4455	20.4467	20.4528	20.4540	20.4601	20.4601	20.4614	20.4577	20.4540	20.4516	20.4491	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9384	0.8953	0.8100	0.6636	0.5001	0.3493	0.2459	0.2829	0.4873	0.7608	0.9044	0.9475	(94)
Useful gains	391.0202	458.7932	510.9943	507.3470	427.8780	297.8897	199.9518	208.6262	310.1844	386.7333	378.5218	369.3691	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W	879.2378	844.1492	755.1090	616.2892	465.5916	307.0071	202.2292	212.1239	335.1001	524.0963	714.3742	874.5883	(97)
Month fracti	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000	(97a)

Space heating kWh

CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

	363.2339	258.9592	181.6213	78.4384	28.0590	0.0000	0.0000	0.0000	0.0000	102.1981	241.8137	375.8831	(98)
Space heating												1630.2067	(98)
Space heating per m2											(98) / (4) =	28.5051	(99)

8c. Space cooling requirement

Not applicable

9a. Energy requirements - Individual heating systems, including micro-CHP

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(201)
Fraction of space heat from main system(s)	1.0000	(202)
Efficiency of main space heating system 1 (in %)	320.4220	(206)
Efficiency of secondary/supplementary heating system, %	100.0000	(208)
Space heating requirement	508.7686	(211)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	363.2339	258.9592	181.6213	78.4384	28.0590	0.0000	0.0000	0.0000	0.0000	102.1981	241.8137	375.8831	(98)
Space heating efficiency (main heating system 1)	320.4220	320.4220	320.4220	320.4220	320.4220	0.0000	0.0000	0.0000	0.0000	320.4220	320.4220	320.4220	(210)
Space heating fuel (main heating system)	113.3611	80.8182	56.6819	24.4797	8.7569	0.0000	0.0000	0.0000	0.0000	31.8948	75.4673	117.3088	(211)
Water heating requirement	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)

Water heating

Water heating requirement	152.4642	134.0050	139.8453	124.1284	120.7483	106.6093	101.1657	112.6936	113.0221	128.7744	137.7168	148.3798	(64)
Efficiency of water heater												133.8550	(216)
(217)m	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	133.8550	(217)
Fuel for water heating, kWh/month	113.9025	100.1120	104.4752	92.7334	90.2083	79.6454	75.5786	84.1908	84.4362	96.2044	102.8851	110.8511	(219)
Water heating fuel used												1135.2231	(219)

Annual totals kWh/year		
Space heating fuel - main system	508.7686	(211)
Space heating fuel - secondary	0.0000	(215)
Electricity for pumps and fans:		
(BalancedWithHeatRecovery, Database: in-use factor = 1.4000, SFP = 0.8260)		
mechanical ventilation fans (SFP = 0.8260)	152.7235	(230a)
Total electricity for the above, kWh/year	152.7235	(231)
Electricity for lighting (calculated in Appendix L)	261.0541	(232)
Energy saving/generation technologies (Appendices M ,N and Q)		
Total delivered energy for all uses	2057.7693	(238)

12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	508.7686	0.5190	264.0509	(261)
Space heating - secondary	0.0000	0.5190	0.0000	(263)
Water heating (other fuel)	1135.2231	0.5190	589.1808	(264)
Space and water heating			853.2317	(265)
Pumps and fans	152.7235	0.5190	79.2635	(267)
Energy for lighting	261.0541	0.5190	135.4871	(268)
Energy saving/generation technologies				
PV Unit	-1216.0000	0.5190	-631.1040	(269)
Total CO2, kg/year			436.8783	(272)
Dwelling Carbon Dioxide Emission Rate (DER)			7.6400	(273)

16 CO2 EMISSIONS ASSOCIATED WITH APPLIANCES AND COOKING AND SITE-WIDE ELECTRICITY GENERATION TECHNOLOGIES

DER		7.6400	ZC1
Total Floor Area	TFA	57.1900	
Assumed number of occupants	N	1.9012	
CO2 emission factor in Table 12 for electricity displaced from grid	EF	0.5190	
CO2 emissions from appliances, equation (L14)		17.1804	ZC2
CO2 emissions from cooking, equation (L16)		2.8786	ZC3
Total CO2 emissions		27.6990	ZC4
Residual CO2 emissions offset from biofuel CHP		0.0000	ZC5
Additional allowable electricity generation, kWh/m²/year		0.0000	ZC6
Resulting CO2 emissions offset from additional allowable electricity generation		0.0000	ZC7
Net CO2 emissions		27.6990	ZC8

FULL SAP CALCULATION PRINTOUT
Calculation Type: New Build (As Designed)

CALCULATION OF TARGET EMISSIONS 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Designed) (Version 9.92, January 2014)
CALCULATION OF TARGET EMISSIONS 09 Jan 2014

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)			Volume (m3)	
Ground floor	57.1900 (1b)	x	2.6500 (2b)		=	151.5535	(1b) - (3b)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 57.1900							(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)		=	151.5535	(5)

2. Ventilation rate

	main heating		secondary heating		other		total	m3 per hour	
Number of chimneys	0	+	0	+	0	=	0 * 40 =	0.0000	(6a)
Number of open flues	0	+	0	+	0	=	0 * 20 =	0.0000	(6b)
Number of intermittent fans							2 * 10 =	20.0000	(7a)
Number of passive vents							0 * 10 =	0.0000	(7b)
Number of flueless gas fires							0 * 40 =	0.0000	(7c)

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	20.0000 / (5) =	0.1320	(8)
Pressure test		Yes	
Measured/design AP50		5.0000	
Infiltration rate		0.3820	(18)
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.3247	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.4140	0.4058	0.3977	0.3571	0.3490	0.3084	0.3084	0.3003	0.3247	0.3490	0.3653	0.3815	(22b)
Effective ac	0.5857	0.5824	0.5791	0.5638	0.5609	0.5476	0.5476	0.5451	0.5527	0.5609	0.5667	0.5728	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
TER Opaque door			1.8900	1.0000	1.8900			(26)
TER Opening Type (Uw = 1.40)			12.4100	1.3258	16.4527			(27)
External Wall 1	33.2000	12.4100	20.7900	0.1800	3.7422			(29a)
Common Area	8.9800	1.8900	7.0900	0.1800	1.2762			(29a)
Other Wall	11.8200		11.8200	0.1800	2.1276			(29a)
Total net area of external elements Aum(A, m2)			54.0000					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		25.4887			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		250.0000	(35)
Thermal bridges (User defined value 0.050 * total exposed area)		2.7000	(36)
Total fabric heat loss	(33) + (36) =	28.1887	(37)

Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	29.2914	29.1250	28.9619	28.1958	28.0525	27.3853	27.3853	27.2617	27.6423	28.0525	28.3425	28.6456	(38)
Heat transfer coeff	57.4801	57.3137	57.1506	56.3845	56.2412	55.5739	55.5739	55.4504	55.8309	56.2412	56.5311	56.8342	(39)
Average = Sum(39)m / 12 =												56.3838	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.0051	1.0022	0.9993	0.9859	0.9834	0.9717	0.9717	0.9696	0.9762	0.9834	0.9885	0.9938	(40)
HLP (average)												0.9859	(40)
Days in month	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy	1.9012	(42)
Average daily hot water use (litres/day)	79.3529	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	87.2882	84.1141	80.9400	77.7659	74.5917	71.4176	71.4176	74.5917	77.7659	80.9400	84.1141	87.2882	(44)
Energy conte	129.4459	113.2142	116.8269	101.8525	97.7299	84.3335	78.1474	89.6753	90.7463	105.7560	115.4410	125.3614	(45)
Energy content (annual)										Total = Sum(45)m =		1248.5305	(45)
Distribution loss (46)m = 0.15 x (45)m	19.4169	16.9821	17.5240	15.2779	14.6595	12.6500	11.7221	13.4513	13.6119	15.8634	17.3161	18.8042	(46)

Water storage loss:		
Store volume	150.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):	1.3938	(48)
Temperature factor from Table 2b	0.5400	(49)
Enter (49) or (54) in (55)	0.7527	(55)

Regs Region: England
Elmhurst Energy Systems
SAP2012 Calculator (Design System) version 4.14r10

CALCULATION OF TARGET EMISSIONS 09 Jan 2014

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Total storage loss
                23.3325    21.0745    23.3325    22.5798    23.3325    22.5798    23.3325    23.3325    22.5798    23.3325    22.5798    23.3325 (56)
If cylinder contains dedicated solar storage
                23.3325    21.0745    23.3325    22.5798    23.3325    22.5798    23.3325    23.3325    22.5798    23.3325    22.5798    23.3325 (57)
Primary loss    23.2624    21.0112    23.2624    22.5120    23.2624    22.5120    23.2624    23.2624    22.5120    23.2624    22.5120    23.2624 (59)
Total heat required for water heating calculated for each month
               176.0408   155.2999   163.4218   146.9444   144.3248   129.4254   124.7423   136.2702   135.8381   152.3509   160.5328   171.9563 (62)
Solar input      0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000 (63)
                                                                                         Solar input (sum of months) = Sum(63)m =     0.0000 (63)
Output from w/h
               176.0408   155.2999   163.4218   146.9444   144.3248   129.4254   124.7423   136.2702   135.8381   152.3509   160.5328   171.9563 (64)
                                                                                           Total per year (kWh/year) = Sum(64)m =  1797.1479 (64)
Heat gains from water heating, kWh/month
                80.3167    71.3123    76.1209    69.9394    69.7711    64.1144    63.2599    67.0930    66.2466    72.4398    74.4576    78.9586 (65)
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5. Internal gains (see Table 5 and 5a)
----------------------------------------------------------------------------------------------------
Metabolic gains (Table 5), Watts
                  Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
(66)m           95.0588    95.0588    95.0588    95.0588    95.0588    95.0588    95.0588    95.0588    95.0588    95.0588    95.0588    95.0588 (66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
                14.7947    13.1406    10.6866     8.0905     6.0477     5.1057     5.5169     7.1711     9.6251    12.2212    14.2640    15.2059 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
               165.8087   167.5293   163.1935   153.9631   142.3114   131.3604   124.0445   122.3239   126.6597   135.8901   147.5418   158.4928 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
                32.5059    32.5059    32.5059    32.5059    32.5059    32.5059    32.5059    32.5059    32.5059    32.5059    32.5059    32.5059 (69)
Pumps, fans      3.0000     3.0000     3.0000     3.0000     3.0000     3.0000     3.0000     3.0000     3.0000     3.0000     3.0000     3.0000 (70)
Losses e.g. evaporation (negative values) (Table 5)
               -76.0470   -76.0470   -76.0470   -76.0470   -76.0470   -76.0470   -76.0470   -76.0470   -76.0470   -76.0470   -76.0470   -76.0470 (71)
Water heating gains (Table 5)
               107.9525   106.1195   102.3130    97.1381    93.7784    89.0477    85.0268    90.1787    92.0092    97.3653   103.4133   106.1272 (72)
Total internal gains
               343.0736   341.3070   330.7107   313.7093   296.6551   280.0315   269.1058   274.1913   282.8116   299.9943   319.7367   334.3435 (73)
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6. Solar gains
----------------------------------------------------------------------------------------------------
[Jan]                                        Area        Solar flux                g               FF            Access              Gains
                                               m2          Table 6a    Specific data   Specific data           factor                  W
                                                               W/m2      or Table 6b     or Table 6c         Table 6d
----------------------------------------------------------------------------------------------------
East                                       3.9100           19.6403           0.6300          0.7000           0.7700            23.4691 (76)
West                                       8.5000           19.6403           0.6300          0.7000           0.7700            51.0197 (80)
----------------------------------------------------------------------------------------------------

Solar gains     74.4888   145.7159   239.9733   349.9867   428.9219   439.0779   418.0200   359.0730   279.0989   172.9042    92.8788    61.2560 (83)
Total gains    417.5624   487.0228   570.6840   663.6960   725.5770   719.1094   687.1259   633.2644   561.9104   472.8984   412.6155   395.5995 (84)
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7. Mean internal temperature (heating season)
----------------------------------------------------------------------------------------------------
Temperature during heating periods in the living area from Table 9, Th1 (C)                                                           21.0000 (85)
Utilisation factor for gains for living area, nil,m (see Table 9a)
                  Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
tau             69.0940    69.2946    69.4924    70.4365    70.6160    71.4639    71.4639    71.6231    71.1349    70.6160    70.2538    69.8791
alpha            5.6063     5.6196     5.6328     5.6958     5.7077     5.7643     5.7643     5.7749     5.7423     5.7077     5.6836     5.6586
util living area
                 0.9947     0.9868     0.9584     0.8621     0.6859     0.4902     0.3553     0.4015     0.6588     0.9251     0.9876     0.9960 (86)

MIT             20.0815    20.2538    20.5243    20.8137    20.9570    20.9947    20.9993    20.9986    20.9745    20.7503    20.3600    20.0521 (87)
Th 2            20.0791    20.0815    20.0839    20.0951    20.0972    20.1069    20.1069    20.1088    20.1032    20.0972    20.0929    20.0885 (88)
util rest of house
                 0.9930     0.9827     0.9462     0.8285     0.6301     0.4238     0.2835     0.3244     0.5837     0.8975     0.9831     0.9947 (89)
MIT 2           18.8628    19.1139    19.4994    19.8934    20.0598    20.1038    20.1067    20.1082    20.0854    19.8250    19.2780    18.8272 (90)
Living area fraction                                                                                 fLA = Living area / (4) =     0.4802 (91)
MIT             19.4479    19.6612    19.9915    20.3353    20.4906    20.5315    20.5353    20.5358    20.5123    20.2693    19.7975    19.4153 (92)
Temperature adjustment                                                                                                             0.0000
adjusted MIT    19.4479    19.6612    19.9915    20.3353    20.4906    20.5315    20.5353    20.5358    20.5123    20.2693    19.7975    19.4153 (93)
```

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----------------------------------------------------------------------------------------------------
8. Space heating requirement
----------------------------------------------------------------------------------------------------
                  Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Utilisation      0.9915     0.9804     0.9448     0.8381     0.6551     0.4556     0.3180     0.3615     0.6189     0.9034     0.9813     0.9935 (94)
Useful gains   414.0041   477.4977   539.1750   556.2271   475.3035   327.6379   218.4965   228.9147   347.7535   427.2332   404.8835   393.0160 (95)
Ext temp.        4.3000     4.9000     6.5000     8.9000    11.7000    14.6000    16.6000    16.4000    14.1000    10.6000     7.1000     4.2000 (96)
Heat loss rate W
               870.7044   846.0190   771.0478   644.7722   494.3952   329.6390   218.6996   229.3299   358.0034   543.8133   717.8048   864.7512 (97)
Month fracti     1.0000     1.0000     1.0000     1.0000     1.0000     0.0000     0.0000     0.0000     0.0000     1.0000     1.0000     1.0000 (97a)
Space heating kWh
               339.7851   247.6463   172.5134    63.7525    14.2042     0.0000     0.0000     0.0000     0.0000    86.7356   225.3033   350.9710 (98)
Space heating                                                                                                                   1500.9114 (98)
Space heating per m2                                                                                            (98) / (4) =    26.2443 (99)
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8c. Space cooling requirement
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Not applicable
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CALCULATION OF TARGET EMISSIONS 09 Jan 2014

9a. Energy requirements - Individual heating systems, including micro-CHP

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(201)
Fraction of space heat from main system(s)	1.0000	(202)
Efficiency of main space heating system 1 (in %)	93.5000	(206)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)
Space heating requirement	1605.2528	(211)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	339.7851	247.6463	172.5134	63.7525	14.2042	0.0000	0.0000	0.0000	0.0000	86.7356	225.3033	350.9710	(98)
Space heating efficiency (main heating system 1)	93.5000	93.5000	93.5000	93.5000	93.5000	0.0000	0.0000	0.0000	0.0000	93.5000	93.5000	93.5000	(210)
Space heating fuel (main heating system)	363.4065	264.8624	184.5063	68.1845	15.1917	0.0000	0.0000	0.0000	0.0000	92.7654	240.9661	375.3700	(211)
Water heating requirement	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water heating requirement	176.0408	155.2999	163.4218	146.9444	144.3248	129.4254	124.7423	136.2702	135.8381	152.3509	160.5328	171.9563	(64)
Efficiency of water heater												79.8000	(216)
(217)m	86.5399	86.0530	84.9583	82.7607	80.6544	79.8000	79.8000	79.8000	79.8000	83.3762	85.7180	86.6782	(217)
Fuel for water heating, kWh/month	203.4216	180.4702	192.3553	177.5533	178.9423	162.1872	156.3187	170.7646	170.2232	182.7272	187.2803	198.3848	(219)

Water heating fuel used	2160.6285	(219)
Annual totals kWh/year		
Space heating fuel - main system	1605.2528	(211)
Space heating fuel - secondary	0.0000	(215)
Electricity for pumps and fans:		
central heating pump	30.0000	(230c)
main heating flue fan	45.0000	(230e)
Total electricity for the above, kWh/year	75.0000	(231)
Electricity for lighting (calculated in Appendix L)	261.2799	(232)
Total delivered energy for all uses	4102.1612	(238)

12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	1605.2528	0.2160	346.7346	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	2160.6285	0.2160	466.6958	(264)
Space and water heating			813.4304	(265)
Pumps and fans	75.0000	0.5190	38.9250	(267)
Energy for lighting	261.2799	0.5190	135.6043	(268)
Total CO2, kg/m2/year			987.9596	(272)
Emissions per m2 for space and water heating			14.2233	(272a)
Fuel factor (electricity)			1.5500	
Emissions per m2 for lighting			2.3711	(272b)
Emissions per m2 for pumps and fans			0.6806	(272c)
Target Carbon Dioxide Emission Rate (TER) = (14.2233 * 1.55) + 2.3711 + 0.6806, rounded to 2 d.p.			25.1000	(273)

BLOCK COMPLIANCE
Calculation Type: New Build (As Designed)

Design SAP
elmhurst energy

Block Reference	GUH	**Issued on Date**	19/02/2021
Block Name	GUH		

Assessor Details	Mr. Jacob Cox, Jacob Cox, Tel: 02031165949, jacob.cox@wsp.com	**Assessor ID**	T241-0001
Client			

Block Compliance Report - DER

Block Reference: GUH		**Block Name: GUH**			
Property-Assessment Reference	**Multiplier**	**Floor Area (m^2)**	**DER ($kgCO_2/m^2$)**	**TER ($kgCO_2/m^2$)**	**% DER/TER**
01 N-01 N Be Green	1	72.37	11.91	29.47	59.58 %
01 S-01 S Be Green	1	57.19	9.69	28.59	66.10 %
02 N-02 N Be Green	1	72.37	9.98	25.96	61.55 %
02 S-02 S Be Green	1	57.19	7.64	25.10	69.56 %
03 N-03 N Be Green	1	72.37	12.66	29.47	57.04 %
03 S-03 S Be Green	1	57.19	10.31	28.59	63.93 %
Totals:	6	388.68	62.19	167.16	
Average DER = 10.50 $kgCO_2/m^2$		**% DER/TER**	PASS		
Average TER = 27.91 $kgCO_2/m^2$		62.38 %			

Block Compliance Report - DFEE

Block Reference: GUH		**Block Name: GUH**			
Property-Assessment Reference	**Multiplier**	**Floor Area (m^2)**	**DFEE ($kWh/m^2/yr$)**	**TFEE ($kWh/m^2/yr$)**	**% DFEE/TFEE**
01 N-01 N Be Green	1	72.37	57.26	60.58	5.48 %
01 S-01 S Be Green	1	57.19	50.30	51.85	2.98 %
02 N-02 N Be Green	1	72.37	47.83	49.03	2.44 %
02 S-02 S Be Green	1	57.19	40.17	40.31	0.36 %
03 N-03 N Be Green	1	72.37	60.86	60.58	-0.46 %
03 S-03 S Be Green	1	57.19	53.33	51.85	-2.85 %
Totals:	6	388.68	309.74	314.20	
Average DFEE = 52.06 $kWh/m^2/yr$		**% DFEE/TFEE**	PASS		
Average TFEE = 52.88 $kWh/m^2/yr$		1.55 %			

APPENDIX E

OVERHEATING CHECKLIST

SECTION 1 – SITE FEATURES AFFECTING VULNERABILITY TO OVERHEATING		RESPONSE
Site Location	Urban – within central London or in a high-density conurbation	Yes
	Peri-urban – on the suburban fringes of London	No
Air quality and/or Noise sensitivity – are any of the following in vicinity of buildings?	Busy road / A roads	A400 to the West of the development
	Railways / Overground DLR	No
	Airport / Flight path	No
	Industrial uses / waste facility	No
Proposed building use	Will any buildings be occupied by vulnerable people (e.g. elderly, disabled, young children)?	Yes
	Are residents likely to be at home during the day (e.g. students)?	Yes
Dwelling Aspect	Are there any single aspect units	No single aspect units
Glazing ratio	Is the glazing ratio (glazing: internal floor area) greater than 25%?	No
	If yes, is this to allow acceptable levels of daylighting?	N/A
Security – Are there any security issues that could limit opening of windows for ventilation?	Single storey ground floor units	No ground floor units
	Vulnerable areas identified by the Police Architectural Liaison Officer	No
	Other	No

SECTION 2 – DESIGN FEATURES IMPLEMENTED TO MITIGATE OVERHEATING RISK		RESPONSE
Landscaping	Will deciduous trees be provided for summer shading (to windows and pedestrian routes)?	No
	Will green roofs be provided?	Yes
	Will other green or blue infrastructure be provided around buildings for evaporative cooling?	No
Materials	Have high albedo (light colour) materials been specified?	Yes – This will be determined as the design progresses
Dwelling aspect	% of total units that are single aspect	0%
	% single aspect with N/NE/NW orientation	N/A
	% single aspect with E orientation	N/A
	% single aspect with S/SE/SW orientation	N/A
	% single aspect with W orientation	N/A
Glazing ratio – What is the glazing ratio (glazing; internal floor area) on each façade?	N/NE/NW	0%
	E	9.9%
	S/SE/SW	0%
	W	18.5%
Daylighting	What is the average daylight factor range?	To be confirmed
Window opening	Are windows openable?	Yes
	What is the average percentage of openable area for the windows?	To be confirmed
Window opening – what is the extent of the opening?	Fully openable	East facing glazing is fully openable
	Limited (e.g. for security, safety, wind loading reasons)	West facing glazing is openable but cannot be used to comply with TM59
Security	Where there are security issues (e.g. ground floor flats) has an alternative night time natural ventilation method been provided (e.g. ventilation grates)?	To be confirmed
Shading	Is there any external shading	Balconies provide to the East facing façade
	Is there any internal shading?	Occupants to install blinds or curtains (these have not been considered
Glazing specification	Is there any solar control glazing?	Glazing with a g-value of 0.5 has been specified
Ventilation – What is the ventilation strategy	Natural – background	No
	Natural – purge	No
	Mechanical – background (e.g. MVHR)	Yes
	Mechanical – purge	No
	What is the average design air change rate	0.3l/s/m^2
Heating system	Is communal heating present?	No
	What is the flow/return temperature?	N/A
	Have horizontal pipe runs been minimised	N/A
	Do the specification include insulation levels in line with the London Heat Network	N/A

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