Energy and Sustainability Strategy Assessment Report

J3386 Smarts Place

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CONTENTS

REVISION HISTORY

Revision	Status	Date	Author	Reviewer	Approver
00	S9	25.09.2018	ES	PD	AL

1. SUMMARY

This report has been prepared by Webb Yates Engineers and sets the energy and sustainability strategy for the proposed development in 8 Smarts Place, a three storey, single family dwelling with roof terrace built as a vertical extension onto the roof of a Victorian warehouse with floors from basement to 3rd floor which is currently being used as office space.

Figure 1 Smart's Place 1:20 model - David Kohn Architects

The energy strategy proposed meets the Building Regulations Part L1A requirements and is aimed to achieve the best outcome in terms of sustainability and energy efficiency.

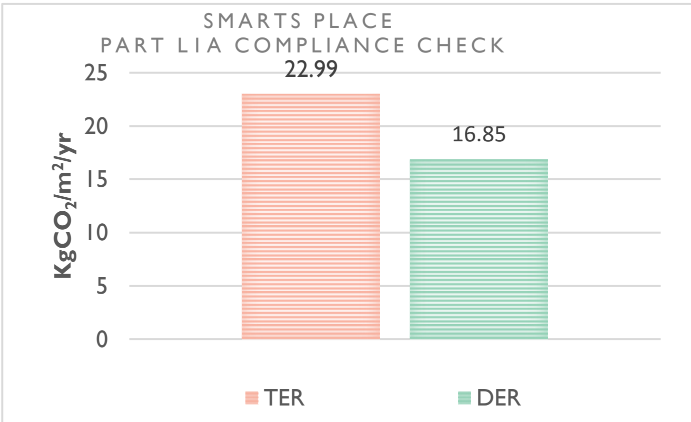
SAP2012 software in line with PartL1A 2013 edition and 2016 amendments has been utilised to calculate the energy and CO_2 emissions rating of the building and to make recommendations for the performance of the building and energy services. TAS by EDSL software has been utilised to complete a dynamic thermal modelling analysis to demonstrate that any risk of overheating has been mitigated and in line with the council's cooling hierarchy.

1.1. TARGET EMISSIONS RATING - DWELLINGS EMISSIONS RATING Part L1A

The annual Target CO_2 emissions for the site have been estimated for the scheme 7,207 $kgCO_2/yr$. This corresponds to a TER of 22.99 $kgCO_2/m^2/yr$.

The annual Dwellings CO_2 emissions for the site have been estimated for the scheme 5.28 tCO_2/yr.

This corresponds to a DER of 16.85 $kgCO_2/m^2/yr$, a 26.71% improvement on the TER against the council's requirement of 19% achieving a compliant development.

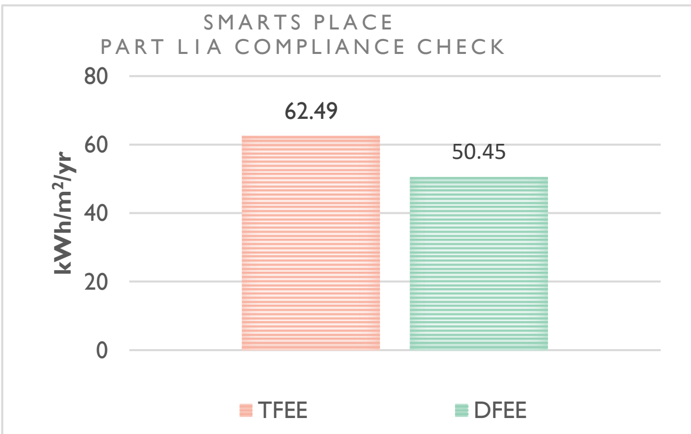


1.2. TARGET FABRIC ENERGY EFFICIENCY - DWELLING FABRIC ENERGY EFFICIENCY Part L1A

The Target energy efficiency for the site have been estimated for the scheme 62.49 $kWh/m^2/yr$.

The Dwelling energy efficiency for the site have been estimated for the scheme 50.45 $kWh/m^2/yr$.

This corresponds to a 19.27% improvement on the TFEE.



1.3. MODEL ASSUMPTIONS

U-Values:

- External Walls 0.13 W/m^{2}K
- Roof and Roof Terrace 0.12 W/m^{2}K and 0.11 W/m^{2}K
- Party Floor - 0.13 W/m^{2}K
- Windows and rooflights– 1.00 W/m^{2}K

Other model inputs:

- Thermal bridges – Y-Value 0.15 W/mK
- Pressure test – 3 m^3/(h.m^2)
- Heating and Cooling System – Air Source Heat Pump
- Heating and Distribution - Underfloor heating/Radiators
- Cooling Distribution – Fan coil units
- Ventilation – Balanced mechanical ventilation with heat recovery

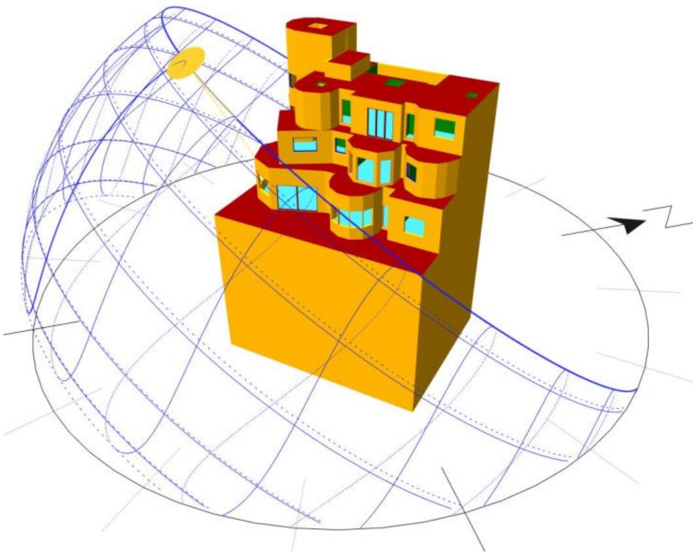


Figure 2 Thermal Model

2. INTRODUCTION

The development is the vertical extension on 8 Smarts Place. The building is located on a cul de sac in Covent Garden, south of High Holborn. The existing building is a former Victorian warehouse with floors from basement to 3rd floor and is currently being used as office space. The proposed scheme for the extension is to build a stepped 3-storey apartment onto the existing roof. Planning was granted in 2016 for a three-storey extension, and also in 2004 for a two-storey scheme.

Figure 3 Location plan

The dwelling is split into three storeys, with roof terrace. The internal floor area is 313.5 m^2 including the lobbies, staircase and lift. The development includes a Livingroom, dining/kitchen, a library, 3 bedrooms, 3 bathrooms, a changing room, storage room, plantroom and roof terrace.

This report sets out the energy strategy for the proposed development. In developing this strategy local and regional planning policies have been addressed.

This report follows the energy hierarchy set out in The London Plan policy 5.2 A to ensure that energy needs are met in the most efficient way:

I. Be lean – use less energy
II. Be clean – supply energy efficiently
III. Be green – use renewable energy

The energy consumption of the development has been assessed in line with this policy and the CO_2 emission savings have been estimated with SAP2012 software by Energy Design Tool.

This report identifies the proposed energy strategy to meet Building Regulations Part L1A requirements. The proposed Sustainability Principles and Engineering Concepts incorporate the requirements and guidelines of the relevant British Standards, CIBSE Guides and DfE Building Bulletins.

3. PLANNING POLICY BACKGROUND

The main planning documents which constitute the statutory development plan for Camden and form the basis on which decisions will be made for the Smarts Place proposed development are outlined below.

3.1. London Borough of Camden Planning Policy

The Council encourages development to be designed with high environmental standards and to minimise carbon emissions on-site, as detailed in the Policy CC.1 Climate change mitigation and Policy CC.2 Adapting to climate change.

Policy CC1 Climate change mitigation

The Borough requires all the development to minimise the effects on climate change and encourage all developments to meet the highest feasible environmental standards that are financially viable during construction and occupation. Paragraph 8.8 of the Camden Local Plan states that all new residential development will also be required to demonstrate a **19% CO_2** reduction below Part L 2013 Building Regulations (in addition to any requirements for renewable energy). This can be demonstrated through an energy statement or sustainability statement.

Policy CC2 Adapting to climate change

The Council will require development to be resilient to climate change, adopting appropriate climate change adaption measure and sustainable design and construction measures.

Paragraphs 8.41 to 8.43 of The Camden Local Plan require that all new developments are expected to submit a statement demonstrating how the London Plan's "Cooling hierarchy" has informed the building design. Any development that is likely to be at risk of overheating will be required to complete a dynamic thermal modelling to demonstrate that any risk of overheating has been mitigated. Active cooling is only permitted where dynamic modelling demonstrates there is a clear need for it after the preferred measures are incorporated in line with the cooling hierarchy.

The cooling hierarchy includes:

- Minimise the amount of heat generation through efficient design;
- Reduce the amount of heat entering a building in summer through orientation, shading, albedo, fenestration, insulation and green roofs and walls;
- Manage the heat within the building through exposed internal thermal mass and high ceilings;
- Passive ventilation;
- Mechanical ventilation and
- Active cooling.

3.2. The London Plan 2016

The updated London Plan, published in March 2016, for energy and sustainability constitutes the core document against which developments in Southwark are assessed. The following briefly summarizes the most significant policies affecting the energy strategy for this development.

Policy 5.2 Minimising Carbon dioxide emissions

Boroughs should encourage developments to make the fullest contribution to the mitigation of and adaptation to climate change and to minimise emissions of carbon dioxide. The following hierarchy will be used to assess applications:

- Using Less Energy: sustainable design and construction measures
- Supplying Energy Efficiently: prioritising decentralised energy generation
- Using Renewable Energy

These contributions should most effectively reflect the context of the development – for example, its nature, size, location, accessibility and operation.

An assessment of the energy demand and carbon dioxide emissions should be undertaken for proposed major developments, which should demonstrate the expected energy and carbon dioxide emission savings from the energy efficiency and renewable energy measures incorporated in the development, including the feasibility of CHP/CCHP and community heating systems. The assessment should include:

- calculation of baseline energy demand and carbon dioxide emissions
- proposals to reduce carbon dioxide emissions through the energy efficient design of the site, buildings and services
- proposals to further reduce carbon dioxide emissions through the use of decentralised energy where feasible, such as district heating and cooling and combined heat and power (CHP)
- proposals to further reduce carbon dioxide emissions through the
- use of on-site renewable energy technologies. This assessment should form part of the sustainable design and construction statement.

Policy 5.3 Sustainable design and construction

Developments should be encouraged to meet the highest standards of sustainable design and construction. These will include measures to:

- make most effective use of land and existing buildings
- reduce carbon dioxide and other emissions that contribute to climate change
- design new buildings for flexible use throughout their lifetime
- avoid internal overheating and excessive heat generation
- make most effective and sustainable use of water, aggregates and other resources
- minimise energy use, including by passive solar design, natural ventilation, and vegetation on buildings
- supply energy efficiently and incorporate decentralised energy systems and use renewable energy where feasible
- minimise light lost to the sky, particularly from street lights
- procure materials sustainably using local suppliers wherever possible
- ensure designs make the most of natural systems both within and around the building
- reduce air and water pollution
- manage flood risk, including through sustainable drainage systems (SUDS) and flood resilient design for infrastructure and property
- ensure developments are comfortable and secure for users
- conserve and enhance the natural environment, particularly in relation to biodiversity, and enable easy access to open spaces
- avoid creation of adverse local climatic conditions
- promote sustainable waste behaviour in new and existing developments, including support for local integrated recycling schemes, CHP and CCHP schemes and other treatment options
- encourage major developments to incorporate living roofs and walls where feasible
- reduce adverse noise impacts.

Policy 5.4 Retrofitting

The environmental impact of existing urban areas should be reduced through policies and programmes that bring existing buildings up to the Mayor's standards on sustainable design and construction.

Policy 5.5 Decentralised Energy Networks

It should be demonstrated that heating, cooling and power systems have been selected to minimise carbon dioxide emissions. The need for active cooling systems should be reduced as far as possible through passive design including ventilation, appropriate use of thermal mass, external summer shading and vegetation on and adjacent to developments. The heating and cooling infrastructure should be designed to allow the use of decentralised energy (including renewable generation) and for it to be maximised in the future.

Policy 5.6 Decentralised Energy in Development Proposals

Major development proposals should select energy systems in accordance with the following hierarchy:

- Connection to existing heating or cooling networks;
- Site wide CHP network;
- Communal heating and cooling;

Policy 5.7 Renewable Energy

Major developments should achieve a reduction in carbon dioxide emissions of 20% from on-site renewable energy generation (which can include sources of decentralised renewable energy) unless it can be demonstrated that such provision is not feasible. These can include biomass fuelled heating, cooling and electricity generating plant, biomass heating, renewable energy from waste, photovoltaics, solar water heating, wind, hydrogen fuel cells, and ground-coupled heating and cooling in new developments wherever feasible.

4. TARGET EMISSION RATE (TER) – TARGET FABRIC ENERGY EFFICIENCY RATE (TFEE)

The TER and the TFEE were calculated using SAP2012 software assuming a specification compliant with the current Building Regulations as in the Notional Building's values below.

Fabric U-values [W/m^{2}K]						Ventilation		Heating	Hot Water
Roof	External Walls	Party walls	Floor	Windows	Doors	Airtightness [m^3/hr/m^2]	Mechanical Ventilation		
0.13	0.18	0.0	0.13	1.40	1.00	5	Extract fans	89.5% Gas Boiler	From boiler

The TER site wide CO_2 emissions were calculated to be 7,207 kgCO_2/yr. This corresponds to a TER rating of 22.99 kgCO_2/m^2/yr.

The calculated TFEE rating for the site is 62.49 kWh/m^2/yr.

5. LOW ENERGY BUILDINGS SCENARIO (Be Lean)

It is proposed to use a number of energy efficiency measures to reduce the energy demand of the development, including the commitment to use improved thermal performance glass. SAP calculations were undertaken for an 'Energy Efficient' scenario incorporating these U-values and airtightness specifications.

The assumptions made are tabulated below.

Fabric average U-values [W/m²K]						Ventilation		Heating	Hot Water
Roof	External Walls	Party walls	Floor	Windows	Doors	Airtightness [m³/hr/m²]	Mechanical Ventilation		
0.11 0.12	0.13	-	0.13	1.00	1.00	3	MVHR	Air Source Heat Pump	Air Source Heat Pump

In addition to improved building fabric a number of other sustainable design and construction methods are to be incorporated into the design of the dwellings which comply with the Mayor's requirement to reduce energy demand (be lean). These include:

Passive Design Measures

Location of windows on south facing facades where possible to allow the utilisation of beneficial winter solar heat gains.

Open plan arrangement with windows on opposite sides of the larger living spaces to allow natural cross ventilation in the summer. The cooling hierarchy has been applied to the design as demonstrated through the Overheating Analysis of Appendix B.

Enhanced Building Fabric U-Values

Enhancements of the building fabric will be used, the table below demonstrates the limiting U-Values set by the Approved Document Part L and the proposed U- Value for the proposed development.

Element	Building Regulation Part L1A Limit U-Value [W/m²K]	U-Value [W/m²K] Indicative build-up
External Wall	0.30	0.13
Floor	0.25	0.13
Roof	0.20	0.12
Glazing	2.00	1.00

Enhanced Air Tightness

The proposed development will be designed to high performance with good air tightness. It is proposed that the scheme does not exceed an air permeability level of 3m³/hr/m² at 50Pa during testing.

This target will be achieve by ensuring that sensitive areas are accounted for in the design and construction phases to make certain that a tightly sealed building is constructed and all punctures through the seal are air-tight.
The Design Team must ensure that all openings, both major and minor, such as services, be accounted for and assessed to reduce air leakage.

High Performance Building Envelope

High thermal performance construction elements will be used to reduce thermal bridging.
Good building air tightness to limit unnecessary ventilation heat loss. Ventilation will be provided either by natural ventilation and by mechanical ventilation with heat recovery.

Efficient Systems

Insulation of pipework, ductwork and hot water systems to replace the existing have been selected to be in line with the future highest standards.
Use of efficient systems and equipment with suitable time and temperature controls which have been appropriately commissioned such that the systems can be operated efficiently.
Minimisation of lengths and diameters of 'dead legs'. Components i.e. fans, pumps, refrigeration equipment, should be efficient and appropriately sized to have no more capacity for demand and standby than is required for the task so to operate their optimum levels.

Energy Efficient Lighting and Appliances

Provision of the required lighting levels whilst minimising energy consumption by appropriate specification of light fittings and effective control of lighting systems by:

- Specifying 100% of the fixed internal light fittings as dedicated energy efficient fixtures.
- Having suitable energy consumption metering.
- Ensuring systems have been appropriately commissioned.
- Using lighting systems which are efficient and make use of daylight where possible/practical.
- Provision of low output or energy efficient external lighting.
- Avoiding the use of external lighting when spaces are unoccupied or during the day by means PIR, daylight sensors and time controls.

Where white goods are to be provided fridges and freezers will be A+ rated under the EU Energy Efficiency Rating Scheme, washing machines and dishwashers will be A rated and tumble dryers will be B rated. Information on the labelling scheme will be supplied to all dwellings in which appliances are not provided. The use of tumble dryers will be discouraged by the provision of suitable and sufficiently sized drying space either internally or externally.

Behaviour Change

Sufficient information about the building, the fixed building services and their maintenance requirements will be provided to the owner so that the building can be operated in such a manner as to use no more fuel and power than is reasonable in the circumstances.

A home user guide will be provided to each dwelling to inform residents of the most efficient way in which to operate their home and to encourage more sustainable ways of living.

Appropriate cycle storage will be made easily accessible to encourage low carbon modes of travel.

Information of the EU Energy Efficiency Rating Scheme will be provided to each dwelling.

A home office is designed as a part of the development.

5.1. LOW ENERGY BUILDINGS SCENARIO RESULTS (Be Lean)

	TOT REGULATED EMISSIONS (Tonnes CO2/year)	CO2 savings (Tonnes CO2/year)	PERCENTAGE SAVING (%)	TOTAL SAVINGS (%)
PART L 2013 BASELINE	7.208			
BE LEAN	5.708	1.500	20.81%	20.81%

6. ENERGY EFFICIENT TECHNOLOGY ASSESSMENT (Be Clean)

A number of low energy methods of supply have been investigated, to provide the heating, cooling and power as efficiently as possible. The following technologies will be considered for further analysis for the building.

Air source heat pump

High efficiency air source heat pump and incorporating underfloor heating is proposed; this allows a lower flow temperature. The heating and cooling controls will incorporate external temperature compensation allowing fast response to external temperature change, which saves energy by reducing the need for sudden demands of duty.

Distribution

The heating system will be designed to be as efficient as possible, with an inverter driven pump to adjust the pumping power required dependent on the heating demand.

New Community heat network / Connection to Existing Low Carbon Heating Infrastructure

Not applicable since the property is composed by one dwelling only and is not located near an existing communal heating network.

Combined Heat and Power (CHP) Systems

The most efficient form of decentralised energy systems are combined heat and power (CHP) systems. These are efficient because they make use of the waste heat left over from creating electricity. This means that much more of the energy that goes into the systems makes it to end uses compared to energy from the national grid.

However to make CHP systems viable there needs to be a relatively even and constant demand for energy. This is not the case for this development, the demand fluctuates daily, weekly, and seasonally. Also, there is not physical space to install a centralised system such as this and so CHP is considered to be unviable for this development.

Mechanical Ventilation Heat Recovery (MVHR)

MVHR units will provide controlled ventilation to the dwelling in an energy efficient manner. An MVHR unit consists of two fans, one to supply fresh air from outside into the building and one to extract stale air. It also contains a heat recovery device which extracts most of the heat from the outgoing air and transfers it to the fresh incoming air. Filters within the unit clean the air before it enters the living spaces. In this way fresh air at a comfortable temperature is provided to the dwelling using only a very small amount of energy to run the fans and this is reflected favourably in the SAP calculations.

6.1. ENERGY EFFICIENT SCENARIO RESULTS (Be Clean)

	TOT REGULATED EMISSIONS (Tonnes CO2/year)	CO2 savings (Tonnes CO2/year)	PERCENTAGE SAVING (%)	TOTAL SAVINGS (%)
PART L 2013 BASELINE	7.208			
BE LEAN	5.708	1.500	20.81%	20.81%
BE CLEAN	5.708	0.000	0.00%	20.81%

7. RENEWABLE ENERGY SCENARIO (Be Green)

The following types of green/renewable energy technologies have been considered:

- Air Source Heat Pump.

Other renewable technology options were investigated and discounted. The justification for discounting these technologies can be found in the following paragraphs.

The following renewable energy sources have been investigated to establish their feasibility for use within the proposed development:

- Ground Source Heating and Cooling
- Air Source Heating (Compact)
- Wind Turbines (Stand Alone and Roof Mounted)
- Biomass Heating
- Solar Photovoltaic (PV) panels
- Solar Thermal Systems

There are various location and physical factors particular to the site at Hand-in-Hand which will influence the choice of renewable technologies which need to be considered, these include, but are not limited to:

- The high-density nature of the scheme
- The extremely limited space of the site
- Character of the surrounding area
- The slope roof orientation
- Feasibility limitations

Feasibility of Ground Source Heating and Cooling Systems

A Ground Source Heat Pump (GSHP) is a system that extracts heat from the ground, upgrades it to a higher temperature and releases it where required for use for space and water heating. Most systems are 'closed loop' and comprise of plastic piping buried in the ground and connected to a heat pump. A water or water-antifreeze mixture is passed around the looped pipe where it absorbs heat from the ground. The fluid flows into an electrically powered heat pump, comprising a compressor and a pair of heat exchangers before discharging back to the underground loop. Pipes can either be buried in trenches, usually in a slinky arrangement to reduce the amount of surface area that is required, or in a borehole, in a vertical loop system. Vertical loop systems require less surface space but are considerably more expensive.

GSHP systems are not considered to be suitable for the site because there is no available space to locate the centralised equipment.

Feasibility of Air Source Heating and cooling (Compact Unit)

Compact units work on the same principle as ground source heating but they extract heat from the air instead of the ground. Compact units consist of a combined mechanical ventilation heat recovery and heat pump box above a secondary hot water tank.

These units can fit into a cupboard sized space and will meet all the heating, hot water and ventilation requirements of the dwelling.

An air to water heat pump uses the air as a heat sink and transfers the heat in the external space into the heating system. A maximum coefficient of performance (COP) of approximately 5 could be achieved by the heat pump in heating mode, but an average winter design period would give a seasonal COP of around 3. The temperature of the Low Temperature Hot Water (LTHW) providing the heating also affects the COP of the units, with the ideal flow and return temperatures being 45°C/35°C. This development incorporates this system.

Feasibility of Stand Alone and Roof Mounted Wind Turbines

Wind turbines are not ideally suited to urban areas as wind speeds are generally low and highly variable. This greatly affects the output of the turbine. Some turbines have been developed for use in urban environments and these can be mounted on the building to provide some of the electrical demand of the dwelling. Furthermore, the unit has 2 floors and the average wind speed on that position would be less than the cut in speed of standard turbines. A large standalone wind turbine could also be installed but this is likely to be met with opposition due to concerns over issues such as noise, flicker and birds and may lead to delays. Therefore, this technology is not proposed for this development.

Feasibility of Solar Photovoltaic (PV) Panels

Photovoltaic (PV) Panels are a renewable technology which will decrease the amount of electricity used in the building, particularly during the summer months when the solar irradiance is at its peak. Panels can be integrated within the building roof or stand alone; most efficient when south facing and angled at 30° from the horizontal. Such panels would reduce carbon emissions from the electrical uses within the building.

However PV is regarded as unviable for this development.

Feasibility of Solar Thermal Systems

Similarly to PV panels, solar thermal panels can either be integrated into the sloped roof structure. Either flat plate or evacuated tube type panels could be used. The solar thermal panels will be used to heat water which can be used for the domestic hot water supply to the dwellings.

It has already been identified that there is no available space for such a system and therefore ST panels are not recommended for this site.

Feasibility of Biomass Combined Heat and Power (CHP)

Micro scale biomass CHP suitable for use in single dwellings are not yet commercially available. As a district heating system is not proposed for this site as there is limited available space for a centralised system. Biomass CHP is also still an emerging technology which has yet to be proven reliable in the UK. Biomass CHP is therefore not proposed for this development.

The sitewide CO_2 emissions for the 'Be Green' scenario were calculated to be 5,282 $kgCO_2/yr$.

This corresponds to a DER rating of 16.85 $kg/CO_2/m^2/yr$ – a 26.71% reduction in CO_2 emissions per year over the TER.

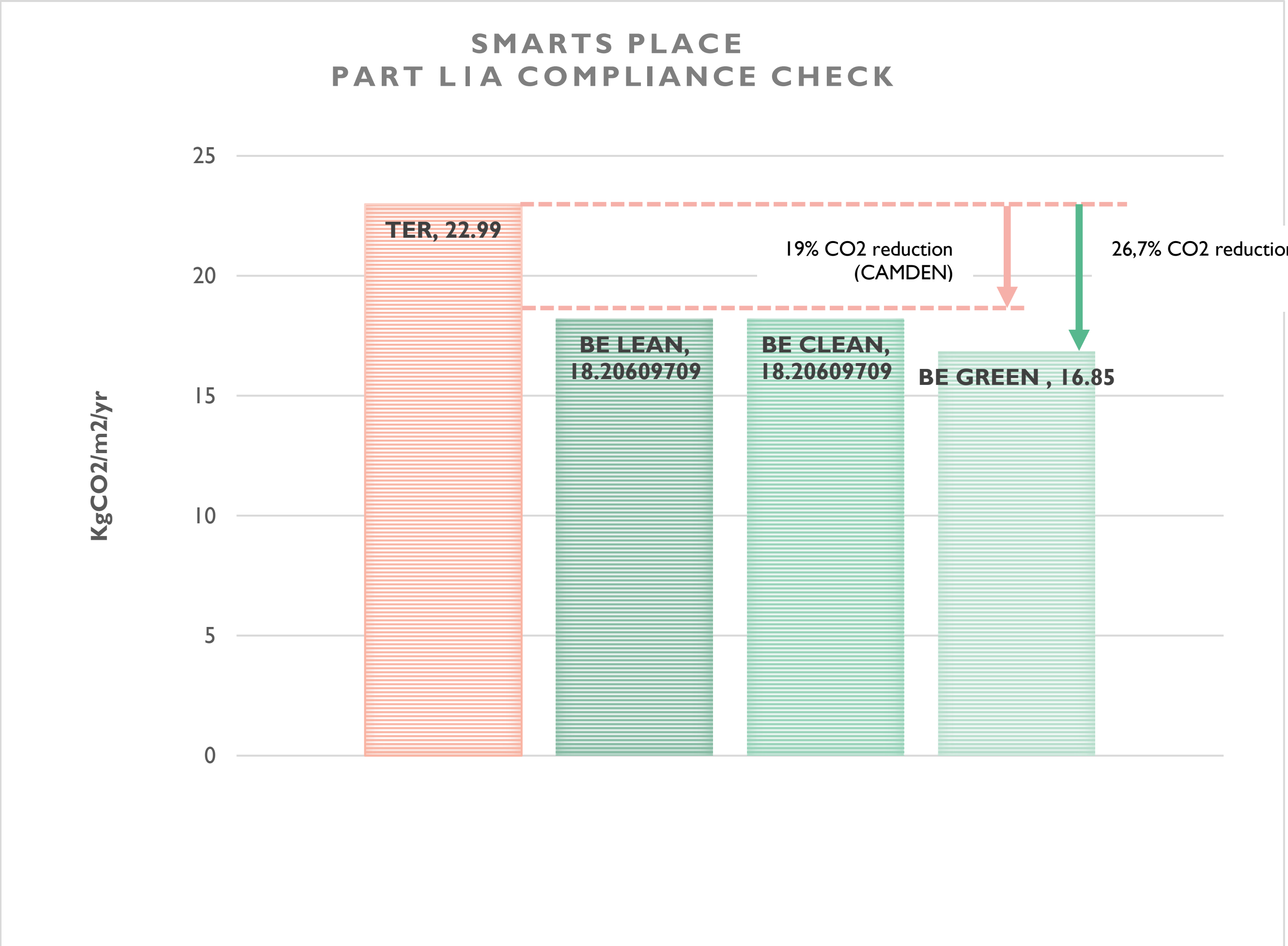
For details of the outputs refer to Appendix A showing results of the SAP Building Regulation Compliance information.

7.1. RENEWABLE ENERGY SCENARIO RESULTS (Be Green)

	TOT REGULATED EMISSIONS (Tonnes CO2/year)	CO2 savings (Tonnes CO2/year)	PERCENTAGE SAVING (%)	TOTAL SAVINGS (%)
PART L 2013 BASELINE	7.208			
BE LEAN	5.708	1.500	20.81%	20.81%
BE CLEAN	5.708	0.000	0.00%	20.81%
BE GREEN	5.283	0.425	7.45%	26.71%

8. ENERGY STRATEGY CONCLUSION

The baseline carbon emission calculations undertaken indicate that the proposals to develop the site to energy efficiency standards go beyond Part L1A Building Regulations. In summary, through the inclusion of MVHR and many 'Be Lean' energy efficient measures the following reduction in CO_2 emission will be achieved.



Calculated TER for the site of 22.99 kgCO2/m2/yr
Calculated DER rating of 16.85 kgCO2/m2/yr

Calculated TFEE for the site of 62.49 kWh/m2/yr
Calculated DFEE rating of 50.45 kWh/m2/yr

This corresponds to a **26.71%** improvement on Carbon Emission Part L1A, a 19.27% improvement on Energy Efficiency Part L1A and a comfortably predicted B Energy Efficiency Rating and B Environmental Impact Rating.
The result of 26.71% improvement on Carbon Emission Part L1A is comfortably compliant with the Borough Camden requirement of 19% of CO2 reduction below Part L2013 Building Regulation.

An Overheating analysis to assess the Thermal comfort of the development has been run as shown in **Appendix A**.

9. SUSTAINABILITY

9.1. SUMMARY

This chapter outlines the sustainability measures for the proposed development at 8 Smarts Place, London in line with the requirements set out by the London Plan (2015) and the relevant London Borough of Camden Planning Policy. The report is updated in line with the design development of the project.

The report provides an overview of the site and Planning Policies currently applicable to this development as set out in the Camden Core Strategy Policy CS13, Camden Development Policies DP22 and DP23, as well as the London Plan 2015, including the Greater London Authorities housing Standards Policy Transition Statement (May 2015) relating to water and materials and demonstrates how these Policies have been met, in accordance with Sections 5.2 to 5.7 of the London Plan 2015, the requirements of the Sustainable Design and Construction SPD.

The body of this report outlines the measures that are to be adopted to achieve high standards of sustainability. The proposed Finchley Road Development will aim to meet the targets set out by Camden Council and the Greater London Authority (GLA). The average CO2 savings being achieved at the design stage are as indicated under section 3.0 for improvements upon Part L Building Regulations (2013) and the contribution made by renewable technologies. These figures reflect regulated energy use only in accordance with Part L Building Regulations. The site also includes measures to promote health and wellbeing of the future occupants, maximising the benefit of daylighting and biodiversity.

This sustainability report should be read in conjunction with the energy statement, which provides details of the energy strategy and targets.

9.2. SITE

The proposed development at 8 Smarts Place within the London Borough of Camden. The Local Planning Authority for the area is the London Borough of Camden.

9.3. PLANNING POLICES

The proposed development at Smarts Place, London is in line with the requirements set out by the London Plan, and the London Borough of Camden Core Strategy and the Development Management Local Plan.

9.3.1. The London Plan 2015 (Regional Policy)

The London Plan 2015 requires compliance with the following policies relating to climate change:

- Policy 5.2 Minimising Carbon Dioxide Emissions (refer to the supplementary energy report).
- Policy 5.3 Sustainable Design and Construction.
- Policy 5.5 Decentralised Energy Networks (refer to the supplementary energy report).
- Policy 5.6 Decentralised Energy in Development Proposals (refer to the supplementary energy report).
- Policy 5.7 Renewable Energy (refer to the supplementary energy report for more details).
- Policy 5.12 Flood Risk Management.
- Policy 5.13 Sustainable Drainage.

- Policy 5.15 Water Use and Supplies.
- Policy 5.18 Construction, Excavation and Demolition Waste.

9.3.2. London Borough of Camden Core Strategy - 2010

London Borough of Camden' Local Development Framework Core Strategy sets out recommendations for the following spatial policies:

Core Strategy Policy 13 – Tackling climate change through promoting higher environmental standards

Reducing the Effects of and Adapting to Climate Change:

The Council will require all development to take measures to minimise the effects of, and adapt to, climate change and encourage all development to meet the highest feasible environmental standards that are financially viable during construction and occupation by:

a) Ensuring patterns of land use that minimise the need to travel by car and help support local energy networks.

b) Promoting the efficient use of land and buildings.

c) Minimising carbon emissions from the redevelopment, construction and occupation of buildings by implementing, in order, all of the elements of the following energy hierarchy:

- ensuring developments use less energy,
- making use of energy from efficient sources, such as the King's Cross, Gower Street, Bloomsbury and proposed Euston Road decentralised energy networks;
- generating renewable energy on-site; and

d) Ensuring buildings and spaces are designed to cope with, and minimise the effects of, climate change.

Local Energy Generation

The Council will promote local energy generation and networks by:

e) Working with our partners and developers to implement local energy networks in the parts of Camden most likely to support them, i.e. in the vicinity of:

- Housing estates with community heating or the potential for community heating and other uses with large heating loads;
- The growth areas of King's Cross, Euston; Tottenham Court Road; West Hampstead Interchange and Holborn;
- Schools to be redeveloped as part of Building Schools for the Future programme;
- Existing or approved combined heat and power/local energy networks; and other locations where land ownership would facilitate their implementation.

f) Protecting existing local energy networks where possible (e.g. at Gower Street and Bloomsbury) and safeguarding potential network routes (e.g. Euston Road).

Water and Surface Water Flooding

We will make Camden a water efficient borough and minimise the potential for surface water flooding by:

g) Protecting our existing drinking water and foul water infrastructure, including Barrow Hill Reservoir, Hampstead Heath Reservoir, Highgate Reservoir and Kidderpore Reservoir.

h) Making sure development incorporates efficient water and foul water infrastructure.

i) requiring development to avoid harm to the water environment, water quality or drainage systems and prevents or mitigates local surface water and down- stream flooding, especially in areas up-hill from, and in, areas known to be at risk from surface water flooding such as South and West Hampstead, Gospel Oak and King's Cross (see Map 5).

Waste

New development in Camden must support the objectives of sustainable waste management. This includes:

- Aiming for at least 10% of the total value of materials used to be derived from recycled and reused sources.
- Major developments are anticipated to be able to achieve 15-20% of the total value of materials used to be derived from recycled and reused sources.

Development Policy 22 – Promoting sustainable design and construction

The Council will require development to incorporate sustainable design and construction measures. Schemes must:

a) Demonstrate how sustainable development principles, including the relevant measures set out in paragraph 22.5 below, have been incorporated into the design and proposed implementation; and

b) Incorporate green or brown roofs and green walls wherever suitable.

The Council will require development to be resilient to climate change by ensuring schemes include appropriate climate change adaptation measures, such as:

a) Summer shading and planting;

b) Limiting run-off;

c) Reducing water consumption;

d) Reducing air pollution; and

e) Not locating vulnerable uses in basements in flood-prone areas.

Development Policy 23 – Water

The Council will require developments to reduce their water consumption, the pressure on the combined sewer network and the risk of flooding by:

a) Incorporating water efficient features and equipment and capturing, retaining and re-using surface water and grey water on-site;

b) Limiting the amount and rate of run-off and waste water entering the combined storm water and sewer network through the methods outlined in part

a) and other sustainable urban drainage methods to reduce the risk of flooding;

c) Reducing the pressure placed on the combined storm water and sewer network from foul water and surface water run-off and ensuring developments in the areas identified by the north London strategic flood risk assessment and shown on map 2 as being at risk of surface water flooding are designed to cope with the potential flooding;

d) Ensuring that developments are assessed for upstream and downstream groundwater flood risks in areas where historic underground streams are known to have been present;

e) Encouraging the provision of attractive and efficient water features.

9.4. PROPOSED SUSTAINABILITY MEASURES

The Sustainable Design and Construction SPD provides additional information to support the implementation of the Mayor's London Plan. The SPD does not set new policies, however it can be taken into account as a further material consideration. It is applicable to all development types, with specific information on different building types where applicable.

This section addresses issues which are relevant to the proposed development.

9.4.1. Reducing the Effects of and Adapting to Climate Change

This section respond to the Camden Core Strategy policy 13 and Camden Development Policies DP22 and DP23.

9.4.2. Minimising the Need to Travel by Car

The proposed development is located in a highly sustainable location and will not have a detrimental impact on the local public transport network and will have no impact on the local highway network.

The proposed development will not include car parking spaces.

Additionally the proposed development is adequately located, according to the TfL Planning Information Database, the site has a PTAI (Public Transport Accessibility Index) of 35.2, which translates into a PTAL (Public Transport Accessibility Levels) of 6a.

The design team has also provided a Residential and Commercial Travel Plans to ensure that the need to travel by car is minimised.

9.4.3. Re-use Land and Buildings

The site is currently occupied by office spaces, the building will be maintained. 100% of the proposed development will be constructed on previously developed land. The proposed development has been design to ensure that the scheme will benefit from internal daylight, Windows have been positioned to allow sufficient daylight to enter the rooms. Solar gains will be utilised on facades and shading strategies will be incorporated into the building design where overheating is an issue.

9.4.4. Minimising Carbon Emissions

An energy assessment has been carried out for this development. Further details are provided in this report. The energy efficiency measures include:

Enhancements of the building fabric will be used in order to exceed Building Regulation Part L1A.

The proposed development will be designed to high performance with good air tightness. The air tightness level will be achieved by ensuring that sensitive areas are accounted for in the design and construction phases to make certain that a tightly sealed building is constructed and all punctures through the seal are air- tight. The Design Team must ensure that all opening both major and minor, such as services, be accounted for and assessed to reduce air leakage.

All lighting will be dedicated low energy fittings. Lighting systems to a number of spaces may include LED technology where viable and subject to the performance of each product being able to deliver to the performance requirements of the space served.

A feasibility study has been carried out in the energy statement to establish the most appropriate local low or zero carbon energy source for the development. In line with the site strategy this will be a connection to an energy centre (including a combine heat and power unit for the residential units) and the installation of an air source heat pump system for the commercial unit.

All major mechanical and electrical plant will be kept in dedicated plant rooms/spaces with easy access for maintenance.

The proposed development will be design to ensure that all timber specified will be sourced responsibly such as FSC or similar. All insulation materials will have a Global Warming Potential of less than five. The use of new aggregates will be minimised on-site, on-site demolition waste will be used as aggregate where possible.

The proposed building has been designed to ensure that the effect of climate change are mitigated and to mitigate the heat island effect. The materials of the building will be defined to ensure that the thermal mass will mitigate any overheating risk due to variation of temperatures as a result of climate change.

9.4.5. Local Energy Generation

The Combined heat and power Network Map from the Camden Core Strategy Section 3 – Tackling Climate Change and improving and protecting Camden's environment and quality of life did not identify the proposed development as located in a zone of opportunity to connect to an existing or proposed district heating network.

9.4.6. Water and Surface Water

Sufficient drainage will be incorporated to ensure water does not collect during wet weather. Sustainable Drainage Systems (Suds) will be incorporated where possible.

Existing Site Drainage

The existing building footprint currently occupies the entire site area and is all hardstanding. The existing drainage system currently drains into the basement level where it is picked up by an existing combined sewer connects to the existing Thames Water main sewer (as seen in figure 3 below). There are no flow controls on either the surface water or foul drainage.

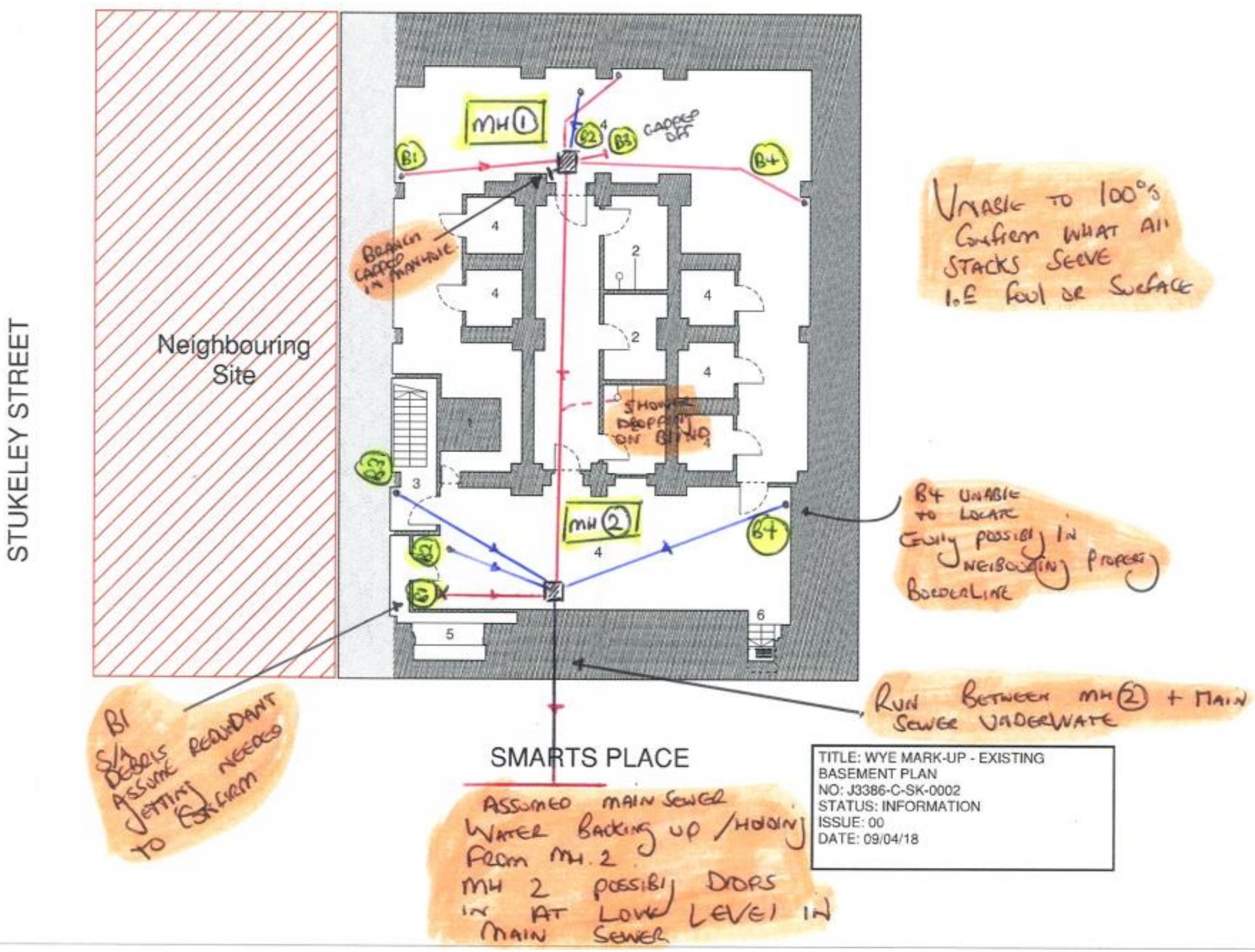


Fig. 3 Existing drainage layout at basement level

Proposed Site Drainage

Generally, the aim should be to discharge surface run off as high up the following hierarchy of drainage options as reasonably practicable:

- Into the ground (infiltration);
- To a surface water body;
- To a surface water sewer, highway drain, or another drainage system;
- To a combined sewer.

Building Regulations require soakaways to be installed 5m away from any adjacent buildings which due to the limited space on site this cannot be achieved.

Also based on the fact the underlying bedrock is understood to be London Clays the site is not deemed to be suitable for infiltration.

There are also no surface water bodies within the vicinity of the site and due to the spatial constraints of the site above ground drainage storage options such as swales, ponds detention basins etc are not considered a viable solution.

As the existing drainage and building is to remain in use, it is proposed to reuse the existing rainwater and soil vent down pipes as well as the sewer connection within the basement. The drainage from the new extension above what was formerly the roof of the building will reuse the existing foul stacks and rainwater pipes.

The drainage design has been done in consultation with The London Plan, Policy 5.13, Sustainable Drainage and Camden's planning guidance and in particular CPG3, Sustainability.

However, since this is an extension on the roof of an existing building and the existing building from roof level below is to remain the same there is limited practical scope to introduce any new SuDS measures below ground and the existing structure is unable to take the extra weight of a green or blue roof as well as the new lightweight extension.

As the existing building footprint will remain the same there will be no increase in surface water flows and the increase in foul flows will be negligible in comparison to the existing foul flows form the building (and as a result will not have an impact on the capacity of the existing drainage system).

9.4.7. Internal Water Usage

The proposed development will be deigned to meet the requirements of Building Regulation Part G 2015. The following flow rate and capacity for the sanitaryware will be used as a guidance.

- 6/3litre dual flush WCs.
- Taps with a flow rate of no more than 4litres per minute.
- Baths with an average capacity of no more than 140litres to overflow.
- Showers with a flow rate of no more than 9litres per minute.
- Washing machines will have a consumption figure of no more than 17.16 litres per kilogram of dry load.
- Dishwashers will have a consumption figure of no more than 4.5 litres per place setting.
- Waste disposal units will not be supplied.
- Water softeners will not be supplied.

The above will result in a calculated daily consumption of less than 110litres per person, per day.

Additionally all water systems in the building will be designed in compliance with the measures outlined in the Health and Safety Executive's 'Legionnaires Disease, The Control of Legionella Bacteria in Water Systems'. Approved Code of Practice and Guidance, 200054 and, where relevant, other Industry/Best Practice Guidance.

9.4.8. Waste

Construction Waste Management

To promote resource efficiency via the effective management and reduction of construction waste. The proposed development will implement a Site Waste Management Plan.

Demolition waste will be minimised, reused and recycled, where practicable. The specification will include a Site Waste Management Plan (SWMP).

The proposed development will include a compliant Site Waste Management Plan (SWMP) that contains:

a) Target benchmarks for resource efficiency, i.e. m^3 of waste per $100m^2$ or tonnes of waste per $100m^2$ set in accordance with best practice.

b) Procedures and commitments to minimize non-hazardous construction waste at Design Stage. Specify waste minimisation actions relating to at least three waste groups and support them by appropriate monitoring of waste.

c) Procedures for minimising hazardous waste

d) Monitoring, measuring and reporting of hazardous and non-hazardous site waste production according to the defined waste groups (according to the waste streams generated by the scope of the works).

Diverting Waste from Landfill

The proposed development will include a compliant Site Waste Management Plan (SWMP) including procedures and commitments to sort and divert waste from landfill for at least 10% of the total value of the material used, through either:

a) Re-use on-site (in situ or for new applications).

b) Re-use on other sites.

c) Salvage/reclaim for re-use.

d) Return to the supplier via a 'take-back' scheme.

e) Recovery and recycling using an approved Waste Management Contractor.

f) Compost according to the defined waste groups (in line with the waste streams generated by the scope of the works).

The proposed development will ensure that at least 85% by weight or by volume of non-hazardous construction waste generated by the project has been diverted from landfill.

Operational Waste

To recognise and encourage the provision of dedicated storage facilities for a building's operational-related recyclable waste streams, so that this waste is diverted from landfill or incineration.

There is to be dedicated space for the segregation and storage of operational recyclable waste.

Individual recycling facilities will be provided to the dwelling.

A waste and recycling scheme will be established in line with the requirements set out by the Local Authorities.

9.4.9. Air Quality

Potential construction phase air quality impacts have been assessed as a result of fugitive dust emissions from demolition, earthworks, construction and track out activities. It is considered that the use of good practice control measures would provide suitable mitigation for a development of this size and nature and reduce potential impacts to an acceptable level.

Potential impacts during the operational phase of the development may occur due to road traffic exhaust emissions associated with vehicles travelling to and from the site. A screening assessment was therefore undertaken to determine the potential for trips generated by the development to affect local air quality. This indicated that impacts were not anticipated to be significant.

Dispersion modelling was undertaken in order to quantify pollutant concentrations at the site and assess the potential for future site users to be exposed to poor air quality. The results indicated high pollutant concentrations at the ground, first and second floor of the development. In order to reduce future exposure of residents to poor air quality, suitable mitigation for inclusion within the development was identified. This included a mechanical ventilation system to supply clean air to specified areas. Mitigation measures are detailed in the air quality report.

9.5. CONCLUSION

The proposed development at Smart Place has been designed in line with the Local and Regional Planning Policies and achieves a high standard of sustainability with the adoption of the energy efficient measures, energy centre, as well as water savings measures and waste management.

APPENDIX A - OVERHEATING ANALYSIS

Overheating Assessment Report

J3386 Smarts Place

Ref: J3386-M-RP-0002

Revision: 00

Status: S9

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CONTENTS

REVISION HISTORY

Revision	Status	Date	Author	Reviewer	Approver
00	S9	01.10.2018	ES	PD	AL

1. SUMMARY

This report has been prepared by Webb Yates Engineers and sets thermal comfort strategy for the proposed development in 8 Smarts Place, a three storey, single family dwelling with roof terrace built as vertical extension onto the roof of a Victorian warehouse with floors from basement to 3rd floor which is currently being used as office space.

In compliance with London Plan and Camden Local Policy requirements a dynamic thermal analysis has been completed to determine the potential for overheating within the planned development.

TAS by EDSL software has been utilised to complete a dynamic thermal modelling and to demonstrate that any risk of overheating has been mitigated, in line with the London Plan cooling hierarchy.

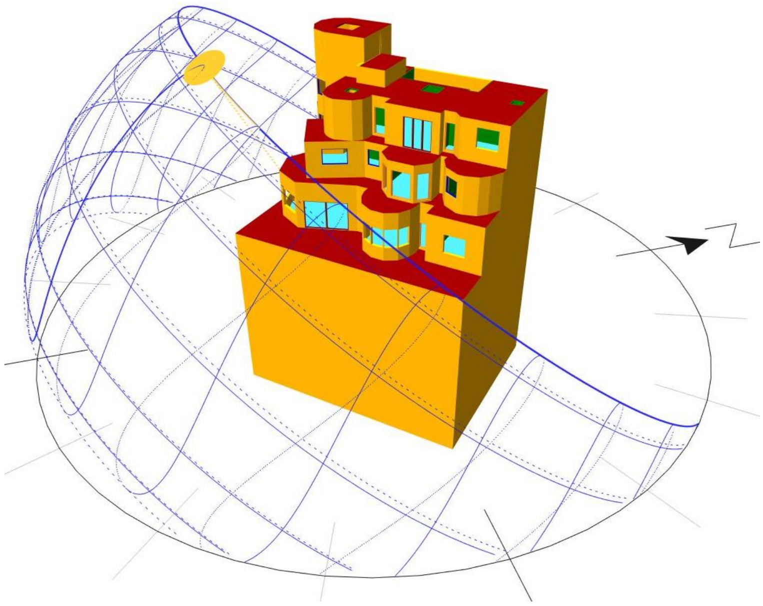


Figure 1 Thermal Model

2. INTRODUCTION

Refer to the introduction, Planning Policy background and model assumption of the document J3386-M-RP-0001.

Due to the nature of the design, its orientation and boundary, the large expanses of glazed surfaces on the south façade, a high risk of overheating has been identified.

Before selecting active cooling as a strategy to mitigate the risk of overheating the cooling hierarchy has been followed as shown in this report.

The cooling hierarchy includes:

- Minimise the amount of heat generation through efficient design;
- Reduce the amount of heat entering a building in summer through orientation, shading, albedo, fenestration, insulation and green roofs and walls;
- Manage the heat within the building through exposed internal thermal mass and high ceilings;
- Passive ventilation;
- Mechanical ventilation and
- Active cooling.

3. METHODOLOGY

A dynamic thermal simulation (DSM) of the building has been carried out to appraise the thermal comfort likely to be experienced based on scheme design and the passive and active measures introduced to help regulate temperatures in the warmer months. The predicted internal temperature was simulated considering all aspects of occupancy, solar gain, and predicted internal heat gains and making allowance for global warming.
Overheating has been assessed using the CIBSE TM52 Method.
Should a risk of overheating be identified, different conditions are simulated following the cooling hierarchy as explained below.

MODEL 1 – As designed
MODEL 2 – Openable windows and additional curtains/blinds
MODEL 3 – Mechanical Ventilation with heat recovery system in addition to model 2 provisions
MODEL 4 – Mechanical Ventilation with heat recovery system and active cooling system in addition to model 3 provisions

The results of the analysis have been outlined for all the occupied rooms, including Living rooms, Kitchen, Bedrooms, Common spaces.

4. CIBSE TM52

The models have been assessed following the Design methodology for the assessment of overheating risk in homes according to CIBSE TM52 requirements.

The following three criteria, taken together, provide a robust yet balanced assessment of the risk of overheating of buildings in the UK and Europe. A room or building that fails any two of the three criteria is classed as overheating.

CIBSE recommends that new buildings, major refurbishments and adaptation strategies should conform to Category II in BS EN 15251 (BSI, 2007), which sets a maximum acceptable temperature of 3 °C above the comfort temperature for buildings in free-running mode. For such buildings the maximum acceptable temperature (T_{max}) can be calculated from the running mean of the outdoor temperature (T_{rm}) using the formula:

$T_{max} = 0.33\ T_{rm} + 21.8$

The criteria are all defined in terms of ΔT the difference between the actual operative temperature in the room at any time (T_{op}) and T_{max} the limiting maximum acceptable temperature. ΔT is calculated as:

$\Delta T = T_{op} - T_{max}$

- Criterion 1: Hours of Exceedance (H_e):

  The first criterion sets a limit for the number of hours that the operative temperature can exceed the threshold comfort temperature (upper limit of the range of comfort temperature) by 1 K or more during the occupied hours of a typical non-heating season (1 May to 30 September).

  The number of hours (H_e) during which ΔT is greater than or equal to one degree (K) during the period May to September inclusive shall not be more than 3 per cent of occupied hours.

- Criterion 2: Daily Weighted Exceedance (W_e):

  The second criterion deals with the severity of overheating within any one day, which can be as important as its frequency, the level of which is a function of both temperature rise and its duration. This criterion sets a daily limit for acceptability.

  The weighted exceedance (W_e) shall be less than or equal to 6 in any one day where:

  $W_e = (\Sigma\ he) \times WF = (he0 \times 0) + (he1 \times 1) + (he2 \times 2) + (he3 \times 3)$

  where the weighting factor wf = 0 if $\Delta T \leq 0$, otherwise

  WF = ΔT, and hey is the time (h) when WF = y

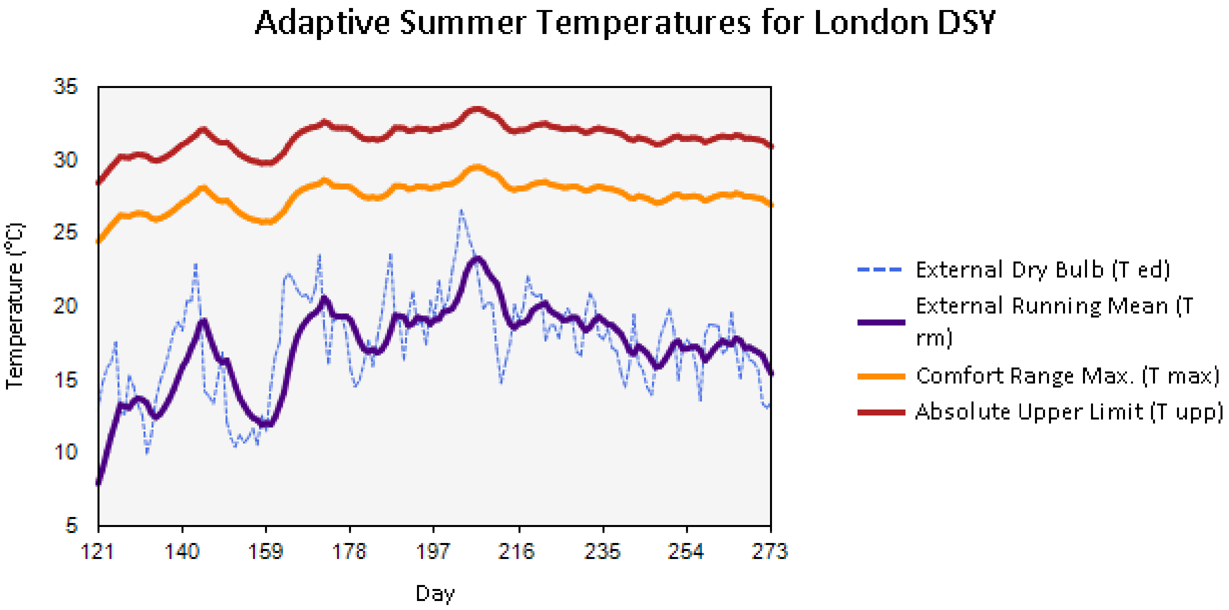
- Criterion 3: Upper Limit Temperature (T_{upp})

  The third criterion sets an absolute maximum daily temperature for a room, beyond which the level of overheating is unacceptable.

  To set an absolute maximum value for the indoor operative temperature the value of ΔT shall not exceed 4 K. The absolute maximum value of the indoor operative temperature is expressed as T_{upp}

  $T_{upp} = T_{max} + 4$

In order to demonstrate that the proposed office space is not at risk of overheating, two of the three criteria must be met. CIBSE London Design Summer weather data has been used in the calculations.



5. THE COOLING HIERARCHY

The Cooling Hierarchy has been followed to ensure that suitable passive design measures have been incorporated into the design prior to the inclusion of any active cooling. The DSM has included the measures which are discussed below, however the results show that the office space would be subject to overheating without the inclusion of comfort cooling.

The building represented in MODEL 1 as designed and with the inclusion of first stages of the cooling hierarchy.
Stage one of the Cooling Hierarchy is to minimise internal heat generation through energy efficient design. Low energy lighting has been specified with occupancy controls to be provided for the luminaire.

The modelling accounts for CIBSE 59 residential internal gains. These internal gains cannot be controlled through the design as they relate to occupancy levels and also equipment which may be used in the space. Energy efficient equipment such as mechanical ventilation supply and extract fans with highly efficient heat recovery system has been specified.

Stage two of the hierarchy is to reduce the amount of heat entering the building in summer, this has been achieved through specifying a low g-value for the windows. In addition, high performance windows with U-values of 1.0 W/m^2K have been specified thought the development.
In considering the opportunity for external shading to the facades it is important to bear in mind both the sensitive context of the elevations in the locality and also the lengthy discussions that have taken place in respect of the design approach to the scheme. Internal blinds have been included in MODEL 2.
Medium thermal mass is expected and is included in the modelling. The design process has established the building and floor heights based on a range of design and urban planning factors.

The next stage is to consider passive and active ventilation methods. Passive ventilation through openable windows has been included in MODEL 2.

Highly efficient mechanical ventilation with heat recovery (MVHR), has been included in MODEL 3 to ensure good levels of ventilation are achieved.

As a last step MODEL 4 includes the Active cooling system to mitigate the overheating risk in the remaining rooms.

The effect of each appropriate feature to reduce overheating has been assessed. All the measures explained in this report has been applied, in order to mitigate the overheating risk as a first instance with passive measures, then with mechanical ventilation with heat recovery and as last with active cooling.

6. INPUT DATA OF OVERHEATING ANALYSIS

The 3D Thermal model has been designed according to the Stage 3 Architectural drawings.

6.1. MODEL 1

The Model 1 Scenario includes the energy efficiency build ups and materials selected during the building design. Model 1 assumes that all the windows are fully closed and have no blinds.

The following Fabric is included in the model.

Figure 2 3D TAS Model

Fabric average U-values [W/m²K]					
Roof	External Walls	Party walls	Floor	Windows	Doors
0.11 0.12	0.13	-	0.13	1.00	1.00

6.2. MODEL 2

The Model 2 Scenario includes Model 1 assumptions and to reduce the overheating issues, internal curtains have been added to each window. Where it was possible, due to the design openable windows have been provided to reduce the overheating hours.

6.3. MODEL 3

The Model 3 Scenario includes Model 2 assumptions and mechanical Ventilation with heat recovery, to reduce the overheating hours.

6.4. MODEL 4

The Model 4 Scenario includes Model 3 provisions and active cooling to mitigate the risk of overheating where it has been assessed in Model 3.

6.5. OCCUPANCY AND EQUIPMENT

The internal gains and variation profiles for occupancy and equipment are based on CIBSE TM59 5.1, which is shown below.

Number of people	Description	Peak load (W) Sensible	Peak load (W) Latent	Period 00–01	01–02	02–03	03–04	04–05	05–06	06–07	07–08	08–09	09–10	10–11	11–12	12–13	13–14	14–15	15–16	16–17	17–18	18–19	19–20	20–21	21–22	22–23	23–24
				Hour ending 1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00	18.00	19.00	20.00	21.00	22.00	23.00	24.00
1	Single bedroom occupancy	75	55	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.7
2	Double bedroom cccupancy	150	110	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.7
2	Studio occupancy	150	110	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.7
1	1-bedroom living/kitchen occupancy	75	55	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
1	1-bedroom living occupancy	75	55	0	0	0	0	0	0	0	0	0	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0	0
1	1-bedroom kitchen occupancy	75	55	0	0	0	0	0	0	0	0	0	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0	0
2	2-bedroom living/kitchen occupancy	150	110	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
2	2-bedroom living occupancy	150	110	0	0	0	0	0	0	0	0	0	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0	0
2	2-bedroom kitchen occupancy	150	110	0	0	0	0	0	0	0	0	0	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0	0
3	3-bedroom living/kitchen occupancy	225	165	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
3	3-bedroom living occupancy	225	165	0	0	0	0	0	0	0	0	0	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0	0
3	3-bedroom kitchen occupancy	225	165	0	0	0	0	0	0	0	0	0	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0	0
	Single bedroom equipment	80		0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.13
	Double bedroom equipment	80		0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.13
	Studio equipment	450		0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	1	1	0.44	0.44	0.24	0.24
	Living/litchen equipment	450		0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	1	1	0.44	0.44	0.24	0.24
	Living equipment	150		0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	1	1	1	1	0.4	0.4
	Kitchen equipment	300		0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	1	1	0.17	0.17	0.17	0.17
	Lighting profile	2 (W/m2)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0

Figure 3 Internal gains

7. RESULTS OF OVERHEATING ANALYSIS

The results of the overheating calculations are set out in the following tables and images.

As an example, the following images compare the 4 models dry bulbs temperature of the zones at the same hour and day.

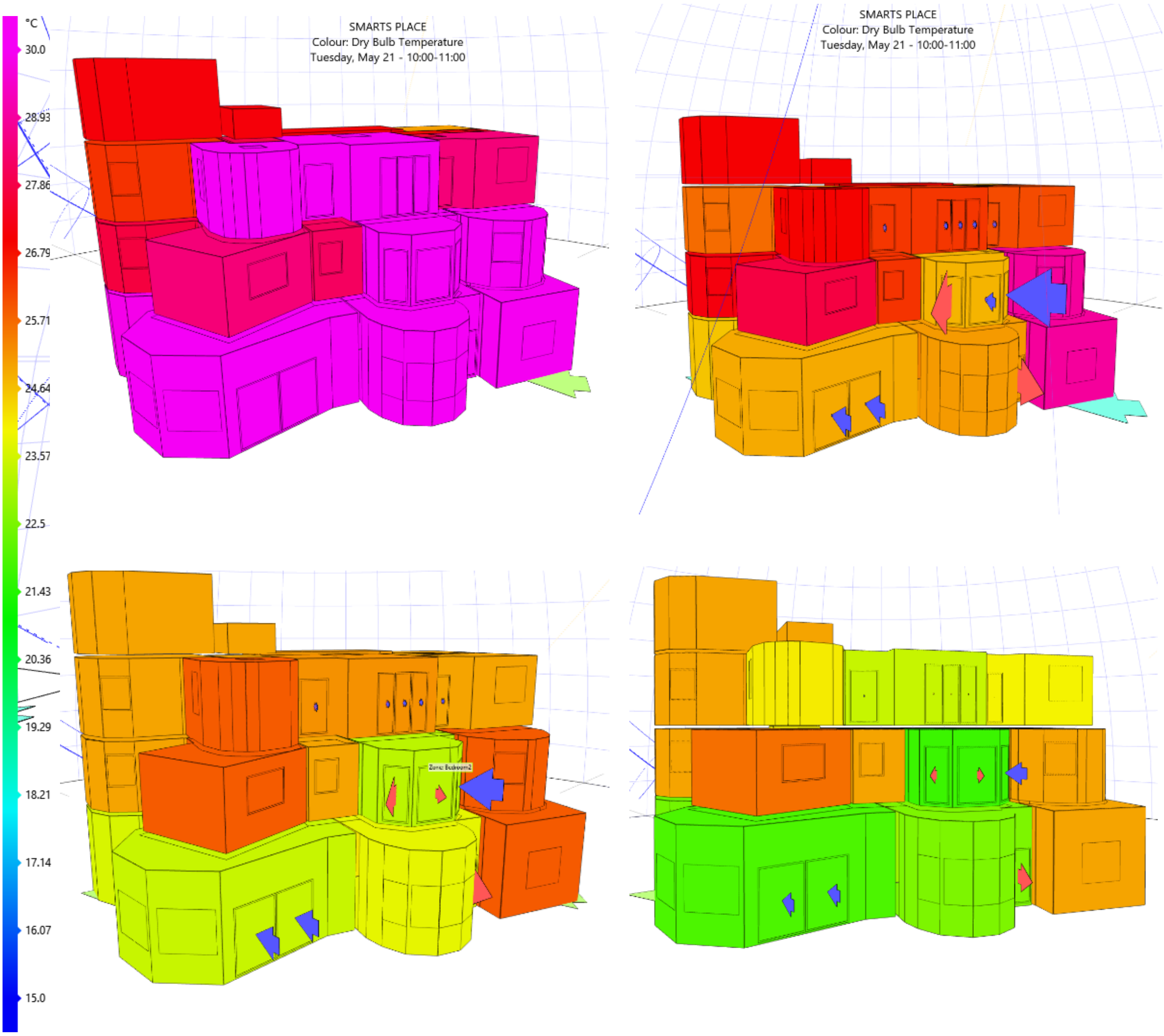


Figure 4 Dry bulb internal temperatures at the same hour and day in order in Model 1 (Performing materials only), Model 2 (Openable windows and Blinds), Model 3 (Mechanical Ventilation) and Model 4 (Active Cooling)

In the following tables the results of the 4 Models analysis are presented according to TM52 Method.

7.1. MODEL 1 – Building as designed

High performing Materials	Openable windows	Blinds	Mechanical Ventilation	Active Cooling	TM52
✓	✗	✗	✗	✗	FAIL

Building Designer File (.tbd): Model 1 SMARTS PLACE.tbd
Simulation Results File (.tsd): Model 1 SMARTS PLACE.tsd
Building Category: Category II
Report Criteria: TM52

Results

Zone Name	Occupied Summer Hours	Max. Exceedable Hours	Criterion 1: #Hours Exceeding Comfort Range	Criterion 2: Peak Daily Weighted Exceedance	Criterion 3: #Hours Exceeding Absolute Limit	Result
Bedroom1	3672	110	713	21.0	19	Fail
Bedroom2	3672	110	3651	46.0	2514	Fail
Cloackroom	2142	64	2045	36.0	3	Fail
Diningroom	2142	64	2090	40.0	596	Fail
Dressingroom	2142	64	2142	11.0	2136	Fail
Kitchen	2142	64	2099	42.0	471	Fail
Library	2142	64	1091	32.0	196	Fail
Livingroom	2142	64	1944	39.0	580	Fail
Lobby	2142	64	2142	35.0	859	Fail
Master bedroom	3672	110	3661	33.0	3392	Fail
Mezzanine	2142	64	903	26.0	151	Fail

7.2. MODEL 2 – Openable windows and blinds

High performing Materials	Openable windows	Blinds	Mechanical Ventilation	Active Cooling	TM52
✓	✓	✓	✗	✗	FAIL

Building Designer File (.tbd): 2 SMARTS PLACE blinds.tbd
Simulation Results File (.tsd): 2 SMARTS PLACE blinds.tsd
Building Category: Category II
Report Criteria: TM52

Results

Zone Name	Occupied Summer Hours	Max. Exceedable Hours	Criterion 1: #Hours Exceeding Comfort Range	Criterion 2: Peak Daily Weighted Exceedance	Criterion 3: #Hours Exceeding Absolute Limit	Result
Bedroom1	3672	110	327	10.0	0	Fail
Bedroom2	3672	110	54	19.0	1	Fail
Cloackroom	2142	64	270	7.0	0	Fail
Diningroom	2142	64	84	13.0	0	Fail
Dressingroom	2142	64	194	26.0	7	Fail
Kitchen	2142	64	40	9.0	0	Pass
Library	2142	64	616	25.0	0	Fail
Livingroom	2142	64	121	17.0	0	Fail
Lobby	2142	64	1122	26.0	0	Fail
Master bedroom	3672	110	203	23.0	13	Fail
Mezzanine	2142	64	526	16.0	0	Fail

7.3. MODEL 3 – Mechanical Ventilation

High performing Materials	Openable windows	Blinds	Mechanical Ventilation	Active Cooling	TM52
✓	✓	✓	✓	✗	FAIL

Building Designer File (.tbd): SMARTS PLACE3 VENT.tbd
Simulation Results File (.tsd): 3 SMARTS PLACE VENT .tsd
Building Category: Category II
Report Criteria: TM52

Results

Zone Name	Occupied Summer Hours	Max. Exceedable Hours	Criterion 1: #Hours Exceeding Comfort Range	Criterion 2: Peak Daily Weighted Exceedance	Criterion 3: #Hours Exceeding Absolute Limit	Result
Bedroom1	3672	110	53	6.0	0	Pass
Bedroom2	3672	110	38	18.0	1	Fail
Cloackroom	2142	64	8	4.0	0	Pass
Diningroom	2142	64	54	13.0	0	Pass
Dressingroom	2142	64	144	25.0	5	Fail
Kitchen	2142	64	27	8.0	0	Pass
Library	2142	64	107	10.0	0	Fail
Livingroom	2142	64	70	14.0	0	Fail
Lobby	2142	64	97	16.0	0	Fail
Master bedroom	3672	110	148	26.0	5	Fail
Mezzanine	2142	64	78	9.0	0	Fail

7.4. MODEL 4 – Active cooling

High performing Materials	Openable windows	Blinds	Mechanical Ventilation	Active Cooling	TM52
✓	✓	✓	✓	✓	PASS

Building Designer File (.tbd): SMARTS PLACE COOL.tbd
Simulation Results File (.tsd): 4 SMARTS PLACE blinds VENT COOL.tsd
Building Category: Category II
Report Criteria: TM52

Results

Zone Name	Occupied Summer Hours	Max. Exceedable Hours	Criterion 1: #Hours Exceeding Comfort Range	Criterion 2: Peak Daily Weighted Exceedance	Criterion 3: #Hours Exceeding Absolute Limit	Result
Bedroom1	3672	110	49	5.0	0	Pass
Bedroom2	3672	110	38	21.0	0	Pass
Cloackroom	2142	64	0	0.0	0	Pass
Diningroom	2142	64	11	2.0	0	Pass
Dressingroom	2142	64	48	7.0	0	Pass
Kitchen	2142	64	2	1.0	0	Pass
Library	2142	64	34	3.0	0	Pass
Livingroom	2142	64	23	5.0	0	Pass
Lobby	2142	64	0	0.0	0	Pass
Master bedroom	3672	110	71	12.0	0	Pass
Mezzanine	2142	64	21	3.0	0	Pass

8. CONCLUSIONS

The results of Model 1, 2 and 3 have shown that even after following the Cooling Hierarchy and including all suitable passive design measures the spaces will experience some periods of overheating during the summer.

Therefore, due to the nature of the analysed space and in order to maintain specific internal conditions within the proposed space, comfort cooling is recommended and has been included in the form of highly efficient Air Source Heat Pumps (ASHP), with varied Seasonal Energy Efficiency Ratio (SEER) for each floor.

As the multi-split system will provide both heating and cooling to the dwelling it is considered a renewable energy technology and is therefore the most efficient and low carbon method of providing cooling.

APPENDIX B – SAP CALCULATION

SAP 2012 input data (new dwelling as designed)
Generated by Energy Design Tools SAP 2012 calculator v5.2

File name: J3386
Printed on: 26 September 2018

Listing of input data

Located In:	England
Region:	Thames
Postcode:	WC2B 5LW
UPRN:	0000000000
RRN:	(not assigned)
Date of assessment:	17 September 2018
Tenure:	Owner-occupied
Date of certificate:	26 September 2018
Assessment type:	New dwelling as designed
Transaction type:	New dwelling
Year completed:	2018
Related Party Discosure:	No related party
PCDF revision number:	430

Property description

Dwelling type:	Flat
Detachment:	End-terrace
Number of dwellings above:	0
Number of dwellings below:	5

Storey number	Area (m^2)	Height (m)	Volume (m^3)	Basement?
1	143.20	3.30	472.56	-
2	100.25	2.78	278.70	-
3	70.06	2.78	194.77	-

Living area:	100.00 %
Front of dwelling faces:	South East

Opening types

Name	Source	Type	Glazing	Argon	Gap	Frame	FF	g value	U-Value
Smart window	Manufacturer	Window	Double low E, soft	-	-	-	0.85	0.88	1.00
Smart rooflight	Manufacturer	Roof window	Double, low E, hard	-	-	-	0.80	0.85	1.00

Openings

Type-name	Location	Orientation	Width (m)	Height (m)
Smart rooflight	Roof	Horizontal	6.32	1.00
Smart window	External Wall	South East	25.45	1.00
Smart window	External Wall	Unknown or unspecified	15.85	1.00
Smart window	External Wall	East	6.23	1.00
Smart window	External Wall	South West	3.75	1.00

Overshading:	Very little

Exposed Elements

Element name	Type	Gross area (m^2)	Openings (m^2)	Net area (m^2)	U-Value	K-value
Internal floor	internalfloor	100.25	-	100.25	-	
Internal floor	internalfloor	70.06	-	70.06	0.18	
Party floor	partyfloor	143.20	-	143.20	0.13	
Party wall	party wall	82.44	-	82.44	0.13	
Roof	roof	70.06	6.32	63.74	0.12	
Terrace	roof	73.14	-	73.14	0.11	
External Wall	wall	409.43	51.28	358.15	0.13	

Thermal bridges:

Default (y = 0.15)

Thermal mass

TMP = 250kJ/m^2K

Ventilation

Pressure test:	Yes (design value)
Ventilation:	Balanced with heat recovery (MVHR) (Appendix Q datasheet)
Brand/Model:	Nuaire
Approved installation scheme?	Yes
Duct type:	Rigid
SFP:	0.59
Wet rooms:	Kitchen + 6
Duct insulation:	Not insulated
Efficiency (%):	90
Number of chimneys:	0
Number of open flues:	0
Number of intermittent fans:	0
Number of passive stacks:	0
Number of sides sheltered:	0
q50:	3.00

Main heating system

Heat pump with radiators or underfloor
Electric heat pumps
Air source heat pump, in other cases
Fraction of primary space heating provided: 1
Main fuel: Electricity
SAP tables
(224) Air source heat pump, in other cases

Radiators and underfloor heating (pipes in screed above insulation)
Design temperature: unknown

Main heating controls

Programmer, TRVs and bypass
Delayed start thermostat

Secondary heating

None

Space cooling system:

Split or multi-split
Compressor control: On/off control
Percentage of floor area cooled: 90%
Energy label class: A

Water heating

(941) - Electric heat pump for water heating only

Cylinder volume: 500l
Cylinder heat exchanger area: 2.00
Insulation: 150mm factory insulated
Cylinder in heated space
Water separately timed
Primary pipework: Fully insulated
Cylinderstat

Solar panel:	No

Other information

Water use <= 125 litres/person/day	Yes
Electricity tariff:	Standard tariff
Conservatory:	No conservatory
Photovoltaics:	None
Terrain type:	Dense urban
Wind turbine?	No
Special feature (App. Q)	No
Total fixed lighting outlets:	60
Low energy fixed lighting outlets:	60 (= 100% of total outlets)

Results summary

Results summary - New dwelling as built - Worksheet version 9.92 - Energy Design Tools SAP 2012 v5.2
Regulations: Approved Document L1A, 2013 Edition, England
SAP 2012 = B 81 | EI 2012 = B 83| DFEE = 50.45 | TFEE = 62.49 | DER = 16.85 | TER = 22.99
Heat demand kWh: space 6080 water space 2422
Weather data for: postcode WC2B
PCDF revision number: 430 (6 September 2018)
External Definitions revision number: 5.0 (11 June 2014)
Applicable recommendations: None

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SAP 2012 OVERHEATING ASSESSMENT FOR NEW DWELLING AS DESIGNED (version 9.92, October 2012)
Calculated by Energy Design Tools SAP 2012 calculator v5.2, printed on 26 September 2018

J3386

Dwelling type:	End-terrace Flat Top-floor
Window setup and cross ventilation:	Dwelling of two or more storeys, windows open upstairs and downstairs. Cross ventilation possible.
Region:	Thames
Front of dwelling faces:	South East
Overshading:	Very little
Overhangs:	see below
Thermal mass parameter:	250.0 (global variable applied)
Blinds, curtains, shutters:	Net curtain (covering whole window), closed for 50% of daylight hours
Ventilation rate during hot weather:	8 (Windows fully open)

Summer ventilation heat loss coefficient:	2,497.50 (P1)
Transmission heat loss coefficient:	211.25 (37)
Summer heat loss coefficient:	2,708.75 (P2)

<u>Overhangs</u>

Orientation	Ratio	Z-overhangs	Overhang type
Unknown or unspecified	-	1.00	None
East	-	1.00	None
South East	-	1.00	None
South West	-	1.00	None

<u>Solar shading</u>

Orientation	Z-blinds	Solar access	Overhangs	Z-summer	
Unknown or unspecified	0.90	1.00	1.00	0.90	(P8)
East	0.90	1.00	1.00	0.90	(P8)
South East	0.90	1.00	1.00	0.90	(P8)
South West	0.90	1.00	1.00	0.90	(P8)

Monthly calculations

	June	July	August	
External temperature:	16	17.9	17.8	
Solar gains:	3,208	3,042	2,769	(P3)
Internal gains:	837	804	815	
Total summer gains:	4,046	3,846	3,584	(P5)
Solar gain/loss ratio:	1.49	1.42	1.32	(P6)
Threshold temperature:	17.74	19.57	19.37	
Likelihood of high internal temperature	Not significant	Not significant	Not significant	(P7)

Assessment of likelihood of high internal temperature: Not significant

Regulations Compliance Report - Approved Document L1A, 2013 Edition, England
generated by Energy Design Tools SAP 2012 calculator, v5.2

File name: J3386
Printed on: 26 September 2018

Dwelling as Designed
Top-floor flat , total floor area 314m^2

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

---

1 TER and DER
Fuel for main heating: Electricity
Fuel factor: 1.550 (electricity)
Target Carbon Dioxide Emission Rate (TER): 22.99kg/m^2
Dwelling Carbon Dioxide Emission Rate (DER): 16.85kg/m^2

Result: OK

1b TFEE and DFEE
Target Fabric Energy Efficiency (TFEE) 62.5kWh/m^2
Dwelling Fabric Energy Efficiency (DFEE) 50.5kWh/m^2

Result: OK

---

2 Fabric U-values

Element	Average	Highest	Pass/Fail
External wall	0.13 (max 0.30)	0.13 (max 0.70)	OK
Party wall	0.13 (max 0.20)	0.13 (no max)	OK
Floor	(no floor)		
Roof	0.11 (max 0.20)	0.12 (max 0.35)	OK
Openings	1.00 (max 2.00)	1.00 (max 3.30)	OK

2a Thermal bridging
Default y-value of 0.15
Note: Thermal bridging calculated from linear thermal transmittances for each junction

---

3 Air permeability
Air permeability at 50 pascals: 3.00 (design value)
Maximum: 10.00
OK

---

4 Heating efficiency

Main heating system : Heat pump with radiators or underfloor
Electric heat pumps

Air source heat pump, in other cases- electric
Efficiency: 170%
Data from SAP tables. Minumum: 170%
OK

Secondary heating
No secondary system specified

---

5 Cylinder insulation

Hot water storage:
Nominal cylinder loss: 2.66kWh/day
Permitted by DBSCG: 3.93kWh/day - OK

Primary pipework insulated: Yes - OK

Solar hot water cylinder: No solar water heating

---

6 Controls
Space heating controls : Programmer, TRVs and bypass   Fail

Hot water controls:
Cylinderstat: Yes
Water separately timed: Yes

---

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

---

8 Mechanical ventilation
Continuous supply and extract system: SFP = 0.59 W/(l/s)
Maximum: 1.5 W/(l/s)
Efficiency: 90% Minimum: 70% OK

---

9 Summertime temperature
Overheating risk (Thames): Not significant - OK
Based on:
Overshading: Very little
Air change rate: 8
Blinds/curtains: Net curtain (covering whole window), closed 50% of daylight hours

---

10 Key features
External wall U-value: 0.13W/m^{2}K
Roof U-value: 0.11W/m^{2}K
Opening U-value: 1.00W/m^{2}K
Party wall U-value: 0.13W/m^{2}K
Design air permeability is 3.00m^3/h.m^2

SAP 2012 worksheet for new dwelling as designed (Version 9.92, October 2013)
Calculation of Dwelling Emissions for regulations compliance
Approved Document L1A, 2013 Edition, England
Generated by the Energy Design Tools SAP 2012 calculator v5.2

File name: J3386
Using weather data for: UK average

1. Overall dwelling dimensions

	Area (m^2)	Av. storey height (m)	Volume (m^3)	
Storey 1	143.20	3.30	472.56	
Storey 2	100.25	2.78	278.70	
Storey 3	70.06	2.78	194.77	
Total floor area	313.51			(4)
Dwelling volume			946.02	(5)

2. Ventilation rate

		m^3/hr	
Number of chimneys	0	0	(6a)
Number of open flues	0	0	(6b)
Number of intermittent fans	0	0	(7a)
Number of passive vents	0	0	(7b)
Number of flueless gas fires	0	0	(7c)
Infiltration due to chimneys, flues and fans		0.00	(8)
Pressure test	Yes		
q50	3.00		
Infiltration rate		0.15	(18)
Sides sheltered		0	(19)
Shelter factor		1	(20)
Infiltration rate incorporating shelter factor		0.15	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	(22)
Wind factor	1.275	1.25	1.225	1.1	1.075	0.95	0.95	0.925	1	1.075	1.125	1.175	(22a)
Adj infilt rate	0.19	0.19	0.18	0.17	0.16	0.14	0.14	0.14	0.15	0.16	0.17	0.18	(22b)
Effective ach	0.38	0.37	0.37	0.35	0.35	0.33	0.33	0.32	0.34	0.35	0.35	0.36	(25)

3. Heat losses and heat loss parameter

Element	gross area (m^2)	Openings (m^2)	Net area (m^2)	U-Value (W/m^2K)	A*U (W/K)	**κ (kJ/m^2K)**	**A*κ (kJ/K)**	
Smart window (Uw=1.00)	-	-	51.28	0.96	49.31	-	-	
Smart rooflight (Uw=1.00)	-	-	6.32	0.96	6.08	-	-	
Party floor	143.20	0.00	143.20	0.13	18.616	-	-	(26-33)
Internal floor from below	100.25	0.00	100.25	-	-			(26-33)
Internal floor from above	100.25	0.00	100.25	-	-			(26-33)
Internal floor from below	70.06	0.00	70.06	-	-			(26-33)
Internal floor from above	70.06	0.00	70.06	-	-			(26-33)
Roof	70.06	6.32	63.74	0.12	7.6488	-	-	(26-33)
Terrace	73.14	0.00	73.14	0.11	8.0454	-	-	(26-33)
Party wall	82.44	0.00	82.44	0.13	10.71759	-	-	(26-33)
External Wall	409.43	51.28	358.15	0.13	46.5595	-	-	(26-33)

TMP	250.00	(35)
Thermal bridges	82.89	(36)
Total fabric heat loss	211.25	(37)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat transfer	328.71	327.54	326.37	320.52	319.35	313.49	313.49	312.32	315.83	319.35	321.69	324.03	(39)
HLP	1.05	1.04	1.04	1.02	1.02	1.00	1.00	1.00	1.01	1.02	1.03	1.03	(40)
HLP (average)												1.02	(40)

4. Water heating energy requirements

Assumed occupancy:	3.15	(42)
Average daily water use (litres/day)	109.00	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily water use	119.90	115.54	111.18	106.82	102.46	98.10	98.10	102.46	106.82	111.18	115.54	119.90	(44)
Energy content	177.81	155.51	160.48	139.91	134.24	115.84	107.34	123.18	124.65	145.27	158.57	172.20	(45)
Distribution loss	26.67	23.33	24.07	20.99	20.14	17.38	16.10	18.48	18.70	21.79	23.79	25.83	(46)
Store volume										500.00			(50)
Store loss factor (kWh/litre/day)										0.01			(51)
Volume factor										0.62			(52)
Temperature factor										0.54			(53)
Energy lost from store in kWh/day										1.44			(55)
Storage loss	44.58	40.27	44.58	43.15	44.58	43.15	44.58	44.58	43.15	44.58	43.15	44.58	(57)
Storage loss (solar store)	44.58	40.27	44.58	43.15	44.58	43.15	44.58	44.58	43.15	44.58	43.15	44.58	(58)
Primary loss	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)
Combi loss	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)
Total	245.66	216.79	228.32	205.56	202.09	158.99	151.93	167.76	167.80	213.11	224.23	240.05	(62)
WWHR input	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Solar input	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Output from w/h	245.66	216.79	228.32	205.56	202.09	158.99	151.93	167.76	167.80	213.11	224.23	240.05	(64)
Total water output												2,422.29	(64)
Heat gains (kWh)	113.40	100.73	107.64	99.05	98.91	91.04	89.97	95.23	93.97	102.58	105.25	111.53	(65)

5. Internal gains / 6. Solar gains (in watts)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic	157.47	157.47	157.47	157.47	157.47	157.47	157.47	157.47	157.47	157.47	157.47	157.47	(66)
Lighting	41.81	37.14	30.20	22.87	17.09	14.43	15.59	20.27	27.20	34.54	40.31	42.98	(67)
Appliances	469.11	473.98	461.72	435.60	402.64	371.66	350.96	346.08	358.35	384.46	417.42	448.41	(68)
Cooking	38.75	38.75	38.75	38.75	38.75	38.75	38.75	38.75	38.75	38.75	38.75	38.75	(69)
Pumps, fans	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
Losses	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	(71)
Water heating	152.42	149.90	144.67	137.56	132.95	126.45	120.93	128.00	130.52	137.88	146.18	149.91	(72)
Total internal	736.59	734.26	709.83	669.27	625.92	585.78	560.72	567.60	589.31	630.12	677.16	714.54	(73)
Solar gains	882.28	1,597.25	2,393.48	3,244.61	3,838.40	3,886.96	3,716.68	3,270.94	2,692.49	1,825.52	1,074.99	742.69	(83)
Total gains	1,618.87	2,331.51	3,103.31	3,913.89	4,464.32	4,472.74	4,277.40	3,838.54	3,281.80	2,455.63	1,752.15	1,457.23	(84)

7. Mean internal temperature / 8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Util living area	1.00	0.99	0.96	0.84	0.64	0.45	0.32	0.37	0.64	0.94	1.00	1.00	(86)
Util elsewhere	1.00	0.99	0.95	0.81	0.58	0.38	0.26	0.30	0.56	0.92	1.00	1.00	(89)
Living area fraction												1.00	(91)
Util overall	1.00	0.99	0.96	0.83	0.63	0.43	0.31	0.36	0.62	0.93	1.00	1.00	(94)
Space heating kWh	2,615.61	1,797.35	1,167.33	374.64	73.25	0.00	0.00	0.00	0.00	662.88	1,772.55	2,697.98	(98)
Total space heating requirement kWh												11,161.60	(98)
Space heating requirement per m^2												35.60	(99)

8c. Space cooling requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Ext temp	-	-	-	-	-	14.60	16.60	16.40	-	-	-	-	
Heat loss rate W	-	-	-	-	-	2,946.82	2,319.84	2,373.64	-	-	-	-	(100)
Utilisation	-	-	-	-	-	0.98	0.99	0.99	-	-	-	-	(101)
Useful loss W	-	-	-	-	-	2,895.64	2,303.64	2,344.04	-	-	-	-	(102)
Gains W	-	-	-	-	-	5,249.87	5,024.51	4,535.90	-	-	-	-	(103)
Space heating kWh	-	-	-	-	-	0.00	0.00	0.00	-	-	-	-	(103)
Space cooling kWh	-	-	-	-	-	1,525.54	1,821.89	1,467.67	-	-	-	-	(103)
Cooled fraction												0.9	(105)
Intermittency factor												0.25	(106)
Space cooling	-	-	-	-	-	95.35	113.87	91.73	-	-	-	-	(100)

9a. Energy requirements

Fraction of space heat from secondary	0	(201)
Fraction of space heat from main systems	1	(202)
Fraction of main heating from main system 2	0	(203)
Fraction of total heating from main system 1	1	(204)
Fraction of total heating from main system 2	0	(205)
Efficiency of main system 1 (%)	170.0	(206)
Efficiency of main system 2 (%)		(207)
Efficiency of secondary system (%)	0	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	2,615.61	1,797.35	1,167.33	374.64	73.25	0.00	0.00	0.00	0.00	662.88	1,772.55	2,697.98	(98)
Space heating (main system 1)	1,538.59	1,057.27	686.67	220.38	43.09	0.00	0.00	0.00	0.00	389.93	1,042.68	1,587.05	(210)
Space heating (main system 2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(212)
Space heating (secondary)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(215)
Flue gas heat rec.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	eq.(G6)
Water heating requirement	245.66	216.79	228.32	205.56	202.09	158.99	151.93	167.76	167.80	213.11	224.23	240.05	(64)
Efficiency of water heater (%)	170.00	170.00	170.00	170.00	170.00	100.00	100.00	100.00	100.00	170.00	170.00	170.00	(217)
Water heating fuel	144.50	127.53	134.31	120.92	118.88	158.99	151.93	167.76	167.80	125.36	131.90	141.20	(219)

Annual totals (kWh/year):		
Space heating fuel used, main system 1	6,565.65	(211)
Space heating fuel used, main system 2	0.00	(212)
Space heating fuel used, secondary system	0.00	(215)
Water heating fuel	1,044.60	(219)
Cooling energy	300.94	(221)
Electricity for pumps and fans	30.00	(231)
Electricity for ventilation	851.18	(231)
Electricity for lighting	738.44	(232)
Energy saving / generation technologies		
Energy generated by PVs	0.00	(233)
Energy generated by wind turbine	0.00	(234)
mCHP	0.00	(235)
Hydroenergy	0.00	(235a)
Total delivered energy for all uses	10,177.29	(238)

12a. Carbon dioxide emissions

	kWh/year	Emission factor	Emissions kg/year	
Space heating - main system 1	6,565.65	0.519	3,407.57	(261)
Space heating - main system 2	0.00		0.00	(262)
Space heating - secondary system	0.00	0	0.00	(263)
Water heating	1,044.60	0.519	542.15	(264)
Space cooling	300.94	0.519	156.18996672136	(266)
Pumps and fans	30.00	0.519	15.57	(267)

Mechanical ventilation	851.18	0.519	441.763977	(267)
Energy for lighting	738.44	0.519	383.25	(268)
Photovoltaics	0.00	0.529	0.00	
Micro wind turbines	0.00	0.529	0.00	
Hydroelectric energy	0.00	0.529	0.00	
mCHP	0.00	0.529	0.00	(269)
Total kg/year			5,282.01	(272)
Dwelling Carbon Dioxide Emission Rate (DER)			16.85	(273)

SAP 2012 worksheet for Notional Dwelling (Version 9.92, October 2013)
Calculation of Target Emissions
Approved Document L1A, 2013 Edition, England
Generated by the Energy Design Tools SAP 2012 calculator v5.2

File name: J3386
Using weather data for: UK average

1. Overall dwelling dimensions

	Area (m^2)	Av. storey height (m)	Volume (m^3)	
Storey 1	143.20	3.30	472.56	
Storey 2	100.25	2.78	278.70	
Storey 3	70.06	2.78	194.77	
Total floor area	313.51			(4)
Dwelling volume			946.02	(5)

2. Ventilation rate

		m^3/hr	
Number of chimneys	0	0	(6a)
Number of open flues	0	0	(6b)
Number of intermittent fans	4	40	(7a)
Number of passive vents	0	0	(7b)
Number of flueless gas fires	0	0	(7c)
Infiltration due to chimneys, flues and fans		0.04	(8)
q50	5		
Infiltration rate		0.29	(18)
Sides sheltered		2	(19)
Shelter factor		0.85	(20)
Infiltration rate incorporating shelter factor		0.25	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	(22)
Wind factor	1.275	1.25	1.225	1.1	1.075	0.95	0.95	0.925	1	1.075	1.125	1.175	(22a)
Adj infilt rate	0.32	0.31	0.30	0.27	0.27	0.24	0.24	0.23	0.25	0.27	0.28	0.29	(22b)
Effective ach	0.55	0.55	0.55	0.54	0.54	0.53	0.53	0.53	0.53	0.54	0.54	0.54	(25)

3. Heat losses and heat loss parameter

Element	gross area (m^2)	Openings (m^2)	Net area (m^2)	U-Value (W/m^2K)	A*U (W/K)	**κ (kJ/m^2K)**	**A*κ (kJ/K)**	
Door	-	-	0.00		0.00	-	-	(26)
Windows	-	-	51.28	1.33	67.98	-	-	(27)
Ground floor	-	-	0.00	0.13	0.00	-	-	(28a)
Walls	409.43	51.28	358.15	0.18	64.47	-	-	(29a)
Roof	-	-	136.88	0.13	17.79	-	-	(30)
Total area of external elements			552.63					(31)
Fabric heat loss					160.31			(33)
TMP							250.00	(35)
Thermal bridges				27.6315				(36)
Total fabric heat loss					187.94			(37)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss	171.76	171.15	170.55	167.75	167.23	164.79	164.79	164.34	165.73	167.23	168.29	169.40	(38)
Heat transfer	359.69	359.09	358.49	355.69	355.17	352.73	352.73	352.27	353.67	355.17	356.22	357.33	(39)
HLP	1.15	1.15	1.14	1.13	1.13	1.13	1.13	1.12	1.13	1.13	1.14	1.14	(40)

4. Water heating energy requirements

Assumed occupancy:												3.15	(42)
Average daily water use (litres/day)												109.00	(43)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily water use	119.90	115.54	111.18	106.82	102.46	98.10	98.10	102.46	106.82	111.18	115.54	119.90	(44)
Energy content	177.81	155.51	160.48	139.91	134.24	115.84	107.34	123.18	124.65	145.27	158.57	172.20	(45)
Distribution loss	26.67	23.33	24.07	20.99	20.14	17.38	16.10	18.48	18.70	21.79	23.79	25.83	(46)
Store volume										150.00			(50)
Store loss factor (kWh/litre/day)										0.02			(51)
Volume factor										0.93			(52)
Temperature factor										0.54			(53)
Energy lost from store in kWh/day										1.44			(55)
Storage loss	48.56	43.86	48.56	46.99	48.56	46.99	48.56	48.56	46.99	48.56	46.99	48.56	(57)
Storage loss (solar store)	48.56	43.86	48.56	46.99	48.56	46.99	48.56	48.56	46.99	48.56	46.99	48.56	(58)
Primary loss	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)
Combi loss	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)
Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(62)
WWHR input	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Solar input	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Output from w/h	249.63	220.39	232.30	209.41	206.07	185.35	179.17	195.00	194.16	217.09	228.08	244.02	(64)
Total water output												2,973.91	(64)
Heat gains (kWh)	116.58	103.61	110.82	102.12	102.09	94.12	93.15	98.42	97.05	105.76	108.33	114.71	(65)

5. Internal gains / 6. Solar gains (in watts)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic	157.47	157.47	157.47	157.47	157.47	157.47	157.47	157.47	157.47	157.47	157.47	157.47	(66)
Lighting	42.44	37.70	30.66	23.21	17.35	14.65	15.83	20.57	27.61	35.06	40.92	43.62	(67)
Appliances	469.11	473.98	461.72	435.60	402.64	371.66	350.96	346.08	358.35	384.46	417.42	448.41	(68)
Cooking	38.75	38.75	38.75	38.75	38.75	38.75	38.75	38.75	38.75	38.75	38.75	38.75	(69)
Pumps, fans	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
Losses	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	(71)
Water heating	156.69	154.18	148.95	141.84	137.22	130.73	125.20	132.28	134.79	142.15	150.46	154.19	(72)
Total internal	741.49	739.10	714.56	673.89	630.45	590.27	565.23	572.18	593.99	634.91	682.04	719.46	(73)
Solar gains	526.09	954.01	1,433.02	1,947.14	2,306.80	2,337.25	2,234.35	1,964.26	1,613.64	1,091.32	641.31	442.66	(83)
Total gains	1,267.59	1,693.10	2,147.58	2,621.03	2,937.25	2,927.52	2,799.58	2,536.43	2,207.64	1,726.23	1,323.35	1,162.12	(84)

7. Mean internal temperature / 8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Util living area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(86)
Util elsewhere	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(89)
Living area fraction												1.00	(91)
Util overall	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(94)
Space heating kWh	3,146.33	2,453.68	2,038.82	1,149.53	494.26	0.00	0.00	0.00	0.00	1,324.56	2,334.00	3,215.74	(98)
Total space heating requirement kWh												16,156.92	(98)
Space heating requirement per m^2												51.54	(99)

9a. Energy requirements

Fraction of space heat from secondary	0	(201)
Fraction of space heat from main systems	1	(202)
Fraction of main heating from main system 2	0	(203)
Fraction of total heating from main system 1	1	(204)
Fraction of total heating from main system 2	0	(205)
Efficiency of main system 1 (%)	93.5	(206)
Efficiency of main system 2 (%)	0.0	(207)
Efficiency of secondary system (%)	100	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	3,146.33	2,453.68	2,038.82	1,149.53	494.26	0.00	0.00	0.00	0.00	1,324.56	2,334.00	3,215.74	(98)

Space heating (main system 1)	3,365.06	2,624.25	2,180.56	1,229.44	528.63	0.00	0.00	0.00	0.00	1,416.64	2,496.25	3,439.30	(210)
Space heating (main system 2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(212)
Space heating (secondary)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(215)
Water heating requirement	249.63	220.39	232.30	209.41	206.07	185.35	179.17	195.00	194.16	217.09	228.08	244.02	(64)
Efficiency of water heater (%)	89.62	89.51	89.28	88.67	87.06	79.80	79.80	79.80	79.80	88.82	89.43	89.65	(217)
Water heating fuel	278.56	246.21	260.20	236.18	236.68	232.27	224.52	244.36	243.30	244.41	255.03	272.19	(219)

Annual totals (kWh/year):

Space heating fuel used, main system 1	17,280.13	(211)
Space heating fuel used, main system 2	0.00	(212)
Space heating fuel used, secondary system	0.00	(215)
Water heating fuel	2,973.91	(219)
Cooling energy	0.00	(221)
Electricity for pumps and fans	75.00	(231)
Electricity for ventilation	0.00	(231)
Electricity for lighting	749.53	(232)
Total delivered energy for all uses	21,003.56	(238)

12a. Carbon dioxide emissions

	kWh/year	Emission factor	Emissions kg/year	
Space heating - main system 1	17,280.13	0.216	3,732.51	(261)
Space heating - main system 2	0.00	0	0.00	(262)
Space heating - secondary system	0.00		0.00	(263)
Water heating	2,973.91	0.216	642.36	(264)
Space cooling	0.00	0.519	0	(266)
Pumps and fans	75.00	0.519	38.93	(267)
Mechanical ventilation	0.00	0.519	0	(267)
Energy for lighting	749.53	0.519	389.01	(268)
Photovoltaics	0.00	0.529	0.00	
Total kg/year			4,802.80	(272)
Emissions per m^2 for space and water heating			13.95	(272a)
Emissions per m^2 for lighting			1.24	(272b)
Emissions per m^2 for pumps and fans			0.12	(272c)
Target Carbon Dioxide Emission Rate (TER)			22.99	(273)

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SAP 2012 worksheet for new dwelling as designed (Version 9.92, October 2013)
Calculation of Fabric Energy Efficiency
Generated by the Energy Design Tools SAP 2012 calculator v5.2

File name: J3386
Using weather data for: UK average

1. Overall dwelling dimensions

	Area (m^2)	Av. storey height (m)	Volume (m^3)	
Storey 1	143.20	3.30	472.56	
Storey 2	100.25	2.78	278.70	
Storey 3	70.06	2.78	194.77	
Total floor area	313.51			(4)
Dwelling volume			946.02	(5)

2. Ventilation rate

		m^3/hr	
Number of chimneys	0	0	(6a)
Number of open flues	0	0	(6b)
Number of intermittent fans	4	40	(7a)
Number of passive vents	0	0	(7b)
Number of flueless gas fires	0	0	(7c)
Infiltration due to chimneys, flues and fans		0.04	(8)
Pressure test	Yes		
q50	3.00		
Infiltration rate		0.15	(18)
Sides sheltered		0	(19)
Shelter factor		1	(20)
Infiltration rate incorporating shelter factor		0.19	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	(22)
Wind factor	1.275	1.25	1.225	1.1	1.075	0.95	0.95	0.925	1	1.075	1.125	1.175	(22a)
Adj infilt rate	0.25	0.24	0.24	0.21	0.21	0.18	0.18	0.18	0.19	0.21	0.22	0.23	(22b)
Effective ach	0.53	0.53	0.53	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.53	(25)

3. Heat losses and heat loss parameter

Element	gross area (m^2)	Openings (m^2)	Net area (m^2)	U-Value (W/m^2K)	A*U (W/K)	**κ (kJ/m²K)**	**A*κ (kJ/K)**	
Smart window (Uw=1.00)	-	-	51.28	0.96	49.31	-	-	
Smart rooflight (Uw=1.00)	-	-	6.32	0.96	6.08	-	-	
Party floor	143.20	0.00	143.20	0.13	18.616	-	-	(26-33)
Internal floor from below	100.25	0.00	100.25	-	-			(26-33)
Internal floor from above	100.25	0.00	100.25	-	-			(26-33)
Internal floor from below	70.06	0.00	70.06	-	-			(26-33)
Internal floor from above	70.06	0.00	70.06	-	-			(26-33)
Roof	70.06	6.32	63.74	0.12	7.6488	-	-	(26-33)
Terrace	73.14	0.00	73.14	0.11	8.0454	-	-	(26-33)
Party wall	82.44	0.00	82.44	0.13	10.71759	-	-	(26-33)
External Wall	409.43	51.28	358.15	0.13	46.5595	-	-	(26-33)
TMP							250.00	(35)

Thermal bridges	82.89	(36)
Total fabric heat loss	211.25	(37)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat transfer	376.73	376.36	376.00	374.33	374.01	372.55	372.55	372.28	373.12	374.01	374.65	375.31	(39)
HLP	1.20	1.20	1.20	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.20	1.20	(40)
HLP (average)												1.19	(40)

4. Water heating energy requirements

Assumed occupancy:	3.15	(42)
Average daily water use (litres/day)	109.00	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily water use	119.90	115.54	111.18	106.82	102.46	98.10	98.10	102.46	106.82	111.18	115.54	119.90	(44)
Energy content	177.81	155.51	160.48	139.91	134.24	115.84	107.34	123.18	124.65	145.27	158.57	172.20	(45)
Distribution loss	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(46)
Storage loss	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(57)
Storage loss (solar store)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(58)
Primary loss	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(59)
Combi loss	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)
Total	151.14	132.19	136.40	118.92	114.11	98.47	91.24	104.70	105.95	123.48	134.79	146.37	(62)
WWHR input	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Solar input	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Output from w/h	151.14	132.19	136.40	118.92	114.11	98.47	91.24	104.70	105.95	123.48	134.79	146.37	(64)
Total water output												1,457.75	(64)
Heat gains (kWh)	37.78	33.05	34.10	29.73	28.53	24.62	22.81	26.18	26.49	30.87	33.70	36.59	(65)

5. Internal gains / 6. Solar gains (in watts)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic	157.47	157.47	157.47	157.47	157.47	157.47	157.47	157.47	157.47	157.47	157.47	157.47	(66)
Lighting	41.81	37.14	30.20	22.87	17.09	14.43	15.59	20.27	27.20	34.54	40.31	42.98	(67)
Appliances	469.11	473.98	461.72	435.60	402.64	371.66	350.96	346.08	358.35	384.46	417.42	448.41	(68)
Cooking	38.75	38.75	38.75	38.75	38.75	38.75	38.75	38.75	38.75	38.75	38.75	38.75	(69)
Pumps, fans	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(70)
Losses	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	(71)
Water heating	50.79	49.18	45.83	41.29	38.34	34.19	30.66	35.18	36.79	41.49	46.80	49.18	(72)
Total internal	631.96	630.54	608.00	570.00	528.32	490.52	467.45	471.78	492.58	530.73	574.78	610.81	(73)
Solar gains	882.28	1,597.25	2,393.48	3,244.61	3,838.40	3,886.96	3,716.68	3,270.94	2,692.49	1,825.52	1,074.99	742.69	(83)
Total gains	1,514.23	2,227.79	3,001.47	3,814.62	4,366.71	4,377.48	4,184.13	3,742.71	3,185.07	2,356.25	1,649.77	1,353.50	(84)

7. Mean internal temperature / 8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Util living area	1.00	1.00	0.97	0.89	0.72	0.53	0.39	0.45	0.73	0.96	1.00	1.00	(86)
Util elsewhere	1.00	0.99	0.97	0.86	0.66	0.45	0.30	0.35	0.65	0.95	1.00	1.00	(89)
Living area fraction												1.00	(91)
Util overall	1.00	0.99	0.97	0.88	0.72	0.53	0.39	0.45	0.73	0.96	1.00	1.00	(94)
Space heating kWh	3,157.97	2,296.45	1,682.88	744.36	225.69	0.00	0.00	0.00	0.00	1,082.04	2,280.40	3,274.04	(98)
Total space heating requirement kWh												14,743.83	(98)
Space heating requirement per m^2												47.03	(99)

8c. Space cooling requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ext temp	-	-	-	-	-	14.60	16.60	16.40	-	-	-	-	
Heat loss rate W	-	-	-	-	-	3,501.99	2,756.89	2,829.34	-	-	-	-	(100)
Utilisation	-	-	-	-	-	0.95	0.97	0.96	-	-	-	-	(101)
Useful loss W	-	-	-	-	-	3,313.89	2,684.16	2,708.25	-	-	-	-	(102)
Gains W	-	-	-	-	-	5,157.61	4,934.24	4,443.08	-	-	-	-	(103)

Space heating kWh	-	-	-	-	-	0.00	0.00	0.00	-	-	-	-	(103)
Space cooling kWh	-	-	-	-	-	1,327.48	1,674.06	1,290.71	-	-	-	-	(103)
Cooled fraction												1	(105)
Intermittency factor												0.25	(106)
Space cooling	-	-	-	-	-	331.87	418.51	322.68	-	-	-	-	(100)

Space cooling (June to August)	1,073.06	(107)
Space cooling per m^2	3.42	(108)
8f. Dwelling Fabric Energy Efficiency (kWh/m^2)	50.5	(109)

SAP 2012 worksheet
Calculation of Target Fabric Energy Efficiency
Approved Document L1A, 2013 Edition, England
Generated by the Energy Design Tools SAP 2012 calculator v5.2

File name: J3386
Using weather data for: UK average

1. Overall dwelling dimensions

	Area (m^2)	Av. storey height (m)	Volume (m^3)	
Storey 1	143.20	3.30	472.56	
Storey 2	100.25	2.78	278.70	
Storey 3	70.06	2.78	194.77	
Total floor area	313.51			(4)
Dwelling volume			946.02	(5)

8c. Space cooling requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ext temp	-	-	-	-	-	14.60	16.60	16.40	-	-	-	-	
Heat loss rate W	-	-	-	-	-	3,315.63	2,610.18	2,677.29	-	-	-	-	(100)
Utilisation	-	-	-	-	-	0.85	0.91	0.87	-	-	-	-	(101)
Useful loss W	-	-	-	-	-	2,804.77	2,382.42	2,341.70	-	-	-	-	(102)
Gains W	-	-	-	-	-	3,392.71	3,245.61	2,952.58	-	-	-	-	(103)
Space heating kWh	-	-	-	-	-	0.00	0.00	0.00	-	-	-	-	(103)
Space cooling kWh	-	-	-	-	-	423.32	642.22	454.50	-	-	-	-	(103)
Cooled fraction												1	(105)
Intermittency factor												0.25	(106)
Space cooling	-	-	-	-	-	105.83	160.55	113.62	-	-	-	-	(100)

2. Ventilation rate

		m^3/hr	
Number of chimneys	0	0	(6a)
Number of open flues	0	0	(6b)
Number of intermittent fans	4	40	(7a)
Number of passive vents	0	0	(7b)
Number of flueless gas fires	0	0	(7c)
Infiltration due to chimneys, flues and fans		0.04	(8)
q50	5		
Infiltration rate		0.29	(18)
Sides sheltered		2	(19)
Shelter factor		0.85	(20)
Infiltration rate incorporating shelter factor		0.25	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	(22)
Wind factor	1.275	1.25	1.225	1.1	1.075	0.95	0.95	0.925	1	1.075	1.125	1.175	(22a)
Adj infilt rate	0.32	0.31	0.30	0.27	0.27	0.24	0.24	0.23	0.25	0.27	0.28	0.29	(22b)
Effective ach	0.55	0.55	0.55	0.54	0.54	0.53	0.53	0.53	0.53	0.54	0.54	0.54	(25)

3. Heat losses and heat loss parameter

Element	gross area (m^2)	Openings (m^2)	Net area (m^2)	U-Value (W/m^2K)	A*U (W/K)	**κ (kJ/m^2K)**	**A*κ (kJ/K)**	
Door	-	-	0.00		0.00	-	-	(26)

Windows	-	-	51.28	1.33	67.98	-	-	(27)
Ground floor	-	-	0.00	0.13	0.00	-	-	(28a)
Walls	409.43	51.28	358.15	0.18	64.47	-	-	(29a)
Roof	-	-	136.88	0.13	17.79	-	-	(30)
Total area of external elements			552.63					(31)
Fabric heat loss					160.31			(33)
TMP							250.00	(35)
Thermal bridges				27.6315				(36)
Total fabric heat loss					187.94			(37)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss	171.76	171.15	170.55	167.75	167.23	164.79	164.79	164.34	165.73	167.23	168.29	169.40	(38)
Heat transfer	359.69	359.09	358.49	355.69	355.17	352.73	352.73	352.27	353.67	355.17	356.22	357.33	(39)
HLP	1.15	1.15	1.14	1.13	1.13	1.13	1.13	1.12	1.13	1.13	1.14	1.14	(40)

4. Water heating energy requirements

Assumed occupancy:	3.15	(42)
Average daily water use (litres/day)	109.00	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily water use	119.90	115.54	111.18	106.82	102.46	98.10	98.10	102.46	106.82	111.18	115.54	119.90	(44)
Energy content	177.81	155.51	160.48	139.91	134.24	115.84	107.34	123.18	124.65	145.27	158.57	172.20	(45)
Distribution loss	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(46)
Storage loss	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(57)
Storage loss (solar store)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(58)
Primary loss	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(59)
Heat gains (kWh)	37.78	33.05	34.10	29.73	28.53	24.62	22.81	26.18	26.49	30.87	33.70	36.59	(65)

5. Internal gains / 6. Solar gains (in watts)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic	157.47	157.47	157.47	157.47	157.47	157.47	157.47	157.47	157.47	157.47	157.47	157.47	(66)
Lighting	42.44	37.70	30.66	23.21	17.35	14.65	15.83	20.57	27.61	35.06	40.92	43.62	(67)
Appliances	469.11	473.98	461.72	435.60	402.64	371.66	350.96	346.08	358.35	384.46	417.42	448.41	(68)
Cooking	38.75	38.75	38.75	38.75	38.75	38.75	38.75	38.75	38.75	38.75	38.75	38.75	(69)
Pumps, fans	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(70)
Losses	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	(71)
Water heating	50.79	49.18	45.83	41.29	38.34	34.19	30.66	35.18	36.79	41.49	46.80	49.18	(72)
Total internal	632.58	631.10	608.45	570.35	528.57	490.73	467.68	472.08	492.99	531.25	575.38	611.45	(73)
Solar gains	526.09	954.01	1,433.02	1,947.14	2,306.80	2,337.25	2,234.35	1,964.26	1,613.64	1,091.32	641.31	442.66	(83)
Total gains	1,158.68	1,585.10	2,041.47	2,517.49	2,835.37	2,827.99	2,702.03	2,436.34	2,106.63	1,622.58	1,216.69	1,054.11	(84)

7. Mean internal temperature / 8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Util living area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(86)
Util elsewhere	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(89)
Living area fraction												1.00	(91)
Util overall	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(94)
Space heating kWh	3,218.46	2,517.78	2,106.26	1,204.85	531.25	0.00	0.00	0.00	0.00	1,388.93	2,402.14	3,287.37	(98)
Total space heating requirement kWh												16,657.03	(98)
Space heating requirement per m^2												53.13	(99)

Space cooling (June to August)	380.01	(107)
Space cooling per m^2	1.21	(108)
Target Fabric Energy Efficiency (TFEE) (kWh/m^2)	62.5	(109)

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SAP 2012 worksheet (Version 9.92, October 2013)
Calculation of Heat Demand
Generated by the Energy Design Tools SAP 2012 calculator v5.2

File name: J3386
Using weather data for: WC2B

1. Overall dwelling dimensions

	Area (m^2)	Av. storey height (m)	Volume (m^3)	
Storey 1	143.20	3.30	472.56	
Storey 2	100.25	2.78	278.70	
Storey 3	70.06	2.78	194.77	
Total floor area	313.51			(4)
Dwelling volume			946.02	(5)

2. Ventilation rate

		m^3/hr	
Number of chimneys	0	0	(6a)
Number of open flues	0	0	(6b)
Number of intermittent fans	0	0	(7a)
Number of passive vents	0	0	(7b)
Number of flueless gas fires	0	0	(7c)
Infiltration due to chimneys, flues and fans		0.00	(8)
Pressure test	Yes		
q50	3.00		
Infiltration rate		0.15	(18)
Sides sheltered		0	(19)
Shelter factor		1	(20)
Infiltration rate incorporating shelter factor		0.15	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	4.1	3.9	3.9	3.6	3.7	3.2	3.4	3.2	3.2	3.4	3.4	3.8	(22)
Wind factor	1.025	0.975	0.975	0.9	0.925	0.8	0.85	0.8	0.8	0.85	0.85	0.95	(22a)
Adj infilt rate	0.15	0.15	0.15	0.14	0.14	0.12	0.13	0.12	0.12	0.13	0.13	0.14	(22b)
Effective ach	0.34	0.33	0.33	0.32	0.32	0.31	0.31	0.31	0.31	0.31	0.31	0.33	(25)

3. Heat losses and heat loss parameter

Element	gross area (m^2)	Openings (m^2)	Net area (m^2)	U-Value (W/m^2K)	A*U (W/K)	**κ (kJ/m^2K)**	**A*κ (kJ/K)**	
Smart window (Uw=1.00)	-	-	51.28	0.96	49.31	-	-	
Smart rooflight (Uw=1.00)	-	-	6.32	0.96	6.08	-	-	
Party floor	143.20	0.00	143.20	0.13	18.616	-	-	(26-33)
Internal floor from below	100.25	0.00	100.25	-	-			(26-33)
Internal floor from above	100.25	0.00	100.25	-	-			(26-33)
Internal floor from below	70.06	0.00	70.06	-	-			(26-33)
Internal floor from above	70.06	0.00	70.06	-	-			(26-33)
Roof	70.06	6.32	63.74	0.12	7.6488	-	-	(26-33)
Terrace	73.14	0.00	73.14	0.11	8.0454	-	-	(26-33)
Party wall	82.44	0.00	82.44	0.13	10.71759	-	-	(26-33)
External Wall	409.43	51.28	358.15	0.13	46.5595	-	-	(26-33)
TMP							250.00	(35)

Thermal bridges	82.89	(36)
Total fabric heat loss	211.25	(37)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat transfer	317.00	314.66	314.66	311.15	312.32	306.47	308.81	306.47	306.47	308.81	308.81	313.49	(39)
HLP	1.01	1.00	1.00	0.99	1.00	0.98	0.99	0.98	0.98	0.99	0.99	1.00	(40)
HLP (average)												0.99	(40)

4. Water heating energy requirements

Assumed occupancy:	3.15	(42)
Average daily water use (litres/day)	109.00	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily water use	119.90	115.54	111.18	106.82	102.46	98.10	98.10	102.46	106.82	111.18	115.54	119.90	(44)
Energy content	177.81	155.51	160.48	139.91	134.24	115.84	107.34	123.18	124.65	145.27	158.57	172.20	(45)
Distribution loss	26.67	23.33	24.07	20.99	20.14	17.38	16.10	18.48	18.70	21.79	23.79	25.83	(46)
Store volume									500.00				(50)
Store loss factor (kWh/litre/day)									0.01				(51)
Volume factor									0.62				(52)
Temperature factor									0.54				(53)
Energy lost from store in kWh/day									1.44				(55)
Storage loss	44.58	40.27	44.58	43.15	44.58	43.15	44.58	44.58	43.15	44.58	43.15	44.58	(57)
Storage loss (solar store)	44.58	40.27	44.58	43.15	44.58	43.15	44.58	44.58	43.15	44.58	43.15	44.58	(58)
Primary loss	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)
Combi loss	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)
Total	245.66	216.79	228.32	205.56	202.09	158.99	151.93	167.76	167.80	213.11	224.23	240.05	(62)
WWHR input	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Solar input	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Output from w/h	245.66	216.79	228.32	205.56	202.09	158.99	151.93	167.76	167.80	213.11	224.23	240.05	(64)
Total water output												2,422.29	(64)
Water heating demand												2,422	(64)
Heat gains (kWh)	113.40	100.73	107.64	99.05	98.91	91.04	89.97	95.23	93.97	102.58	105.25	111.53	(65)

5. Internal gains / 6. Solar gains (in watts)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic	188.97	188.97	188.97	188.97	188.97	188.97	188.97	188.97	188.97	188.97	188.97	188.97	(66)
Lighting	104.55	92.87	75.52	57.18	42.74	36.08	38.99	50.67	68.02	86.36	100.80	107.46	(67)
Appliances	700.17	707.44	689.13	650.15	600.95	554.71	523.81	516.54	534.85	573.82	623.02	669.27	(68)
Cooking	57.05	57.05	57.05	57.05	57.05	57.05	57.05	57.05	57.05	57.05	57.05	57.05	(69)
Pumps, fans	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
Losses	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	(71)
Water heating	152.42	149.90	144.67	137.56	132.95	126.45	120.93	128.00	130.52	137.88	146.18	149.91	(72)
Total internal	1,080.18	1,073.24	1,032.36	967.93	899.68	840.28	806.76	818.26	856.42	921.09	993.04	1,049.67	(73)
Solar gains	1,199.88	1,944.29	2,912.91	4,089.37	4,670.06	5,046.20	4,838.03	4,375.64	3,621.05	2,423.28	1,508.41	1,035.64	(83)
Total gains	2,280.06	3,017.53	3,945.27	5,057.30	5,569.74	5,886.47	5,644.80	5,193.90	4,477.47	3,344.38	2,501.45	2,085.31	(84)

7. Mean internal temperature / 8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Util living area	0.99	0.97	0.86	0.62	0.40	0.22	0.12	0.14	0.34	0.74	0.97	0.99	(86)
Util elsewhere	0.99	0.96	0.82	0.57	0.35	0.17	0.07	0.09	0.28	0.68	0.95	0.99	(89)
Living area fraction												1.00	(91)
Util overall	0.99	0.96	0.85	0.60	0.39	0.21	0.11	0.13	0.33	0.72	0.96	0.99	(94)
Space heating kWh	1,720.47	1,035.88	432.45	59.77	5.04	0.00	0.00	0.00	0.00	121.57	891.06	1,813.45	(98)
Total space heating requirement kWh												6,079.70	(98)
Space heating demand												6,080	(98)

8c. Space cooling requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ext temp	-	-	-	-	-	14.60	16.60	16.40	-	-	-	-

Heat loss rate W	-	-	-	-	-	2,880.79	2,285.19	2,329.15	-	-	-	-	(100)
Utilisation	-	-	-	-	-	0.99	1.00	0.99	-	-	-	-	(101)
Useful loss W	-	-	-	-	-	2,856.13	2,277.29	2,316.15	-	-	-	-	(102)
Gains W	-	-	-	-	-	5,883.47	5,641.80	5,190.90	-	-	-	-	(103)
Space heating kWh	-	-	-	-	-	0.00	0.00	0.00	-	-	-	-	(103)
Space cooling kWh	-	-	-	-	-	1,961.72	2,252.87	1,924.94	-	-	-	-	(103)
Cooled fraction												0.9	(105)
Intermittency factor												0.25	(106)
Space cooling	-	-	-	-	-	122.61	140.80	120.31	-	-	-	-	(100)

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SAP 2012 worksheet for new dwelling as designed (Version 9.92, October 2013)
Calculation of Energy Ratings
Generated by the Energy Design Tools SAP 2012 calculator v5.2

File name: J3386
Using weather data for: UK average

1. Overall dwelling dimensions

	Area (m^2)	Av. storey height (m)	Volume (m^3)	
Storey 1	143.20	3.30	472.56	
Storey 2	100.25	2.78	278.70	
Storey 3	70.06	2.78	194.77	
Total floor area	313.51			(4)
Dwelling volume			946.02	(5)

2. Ventilation rate

		m^3/hr	
Number of chimneys	0	0	(6a)
Number of open flues	0	0	(6b)
Number of intermittent fans	0	0	(7a)
Number of passive vents	0	0	(7b)
Number of flueless gas fires	0	0	(7c)
Infiltration due to chimneys, flues and fans		0.00	(8)
Pressure test	Yes		
q50	3.00		
Infiltration rate		0.15	(18)
Sides sheltered		0	(19)
Shelter factor		1	(20)
Infiltration rate incorporating shelter factor		0.15	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	(22)
Wind factor	1.275	1.25	1.225	1.1	1.075	0.95	0.95	0.925	1	1.075	1.125	1.175	(22a)
Adj infilt rate	0.19	0.19	0.18	0.17	0.16	0.14	0.14	0.14	0.15	0.16	0.17	0.18	(22b)
Effective ach	0.38	0.37	0.37	0.35	0.35	0.33	0.33	0.32	0.34	0.35	0.35	0.36	(25)

3. Heat losses and heat loss parameter

Element	gross area (m^2)	Openings (m^2)	Net area (m^2)	U-Value (W/m^2K)	A*U (W/K)	**κ (kJ/m²K)**	**A*κ (kJ/K)**	
Smart window (Uw=1.00)	-	-	51.28	0.96	49.31	-	-	
Smart rooflight (Uw=1.00)	-	-	6.32	0.96	6.08	-	-	
Party floor	143.20	0.00	143.20	0.13	18.616	-	-	(26-33)
Internal floor from below	100.25	0.00	100.25	-	-			(26-33)
Internal floor from above	100.25	0.00	100.25	-	-			(26-33)
Internal floor from below	70.06	0.00	70.06	-	-			(26-33)
Internal floor from above	70.06	0.00	70.06	-	-			(26-33)
Roof	70.06	6.32	63.74	0.12	7.6488	-	-	(26-33)
Terrace	73.14	0.00	73.14	0.11	8.0454	-	-	(26-33)
Party wall	82.44	0.00	82.44	0.13	10.71759	-	-	(26-33)
External Wall	409.43	51.28	358.15	0.13	46.5595	-	-	(26-33)
TMP							250.00	(35)

Thermal bridges	82.89	(36)
Total fabric heat loss	211.25	(37)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat transfer	328.71	327.54	326.37	320.52	319.35	313.49	313.49	312.32	315.83	319.35	321.69	324.03	(39)
HLP	1.05	1.04	1.04	1.02	1.02	1.00	1.00	1.00	1.01	1.02	1.03	1.03	(40)
HLP (average)												1.02	(40)

4. Water heating energy requirements

Assumed occupancy:	3.15	(42)
Average daily water use (litres/day)	109.00	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily water use	119.90	115.54	111.18	106.82	102.46	98.10	98.10	102.46	106.82	111.18	115.54	119.90	(44)
Energy content	177.81	155.51	160.48	139.91	134.24	115.84	107.34	123.18	124.65	145.27	158.57	172.20	(45)
Distribution loss	26.67	23.33	24.07	20.99	20.14	17.38	16.10	18.48	18.70	21.79	23.79	25.83	(46)
Store volume										500.00			(50)
Store loss factor (kWh/litre/day)										0.01			(51)
Volume factor										0.62			(52)
Temperature factor										0.54			(53)
Energy lost from store in kWh/day										1.44			(55)
Storage loss	44.58	40.27	44.58	43.15	44.58	43.15	44.58	44.58	43.15	44.58	43.15	44.58	(57)
Storage loss (solar store)	44.58	40.27	44.58	43.15	44.58	43.15	44.58	44.58	43.15	44.58	43.15	44.58	(58)
Primary loss	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)
Combi loss	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)
Total	245.66	216.79	228.32	205.56	202.09	158.99	151.93	167.76	167.80	213.11	224.23	240.05	(62)
WWHR input	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Solar input	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Output from w/h	245.66	216.79	228.32	205.56	202.09	158.99	151.93	167.76	167.80	213.11	224.23	240.05	(64)
Total water output												2,422.29	(64)
Heat gains (kWh)	113.40	100.73	107.64	99.05	98.91	91.04	89.97	95.23	93.97	102.58	105.25	111.53	(65)

5. Internal gains / 6. Solar gains (in watts)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic	188.97	188.97	188.97	188.97	188.97	188.97	188.97	188.97	188.97	188.97	188.97	188.97	(66)
Lighting	104.55	92.87	75.52	57.18	42.74	36.08	38.99	50.67	68.02	86.36	100.80	107.46	(67)
Appliances	700.17	707.44	689.13	650.15	600.95	554.71	523.81	516.54	534.85	573.82	623.02	669.27	(68)
Cooking	57.05	57.05	57.05	57.05	57.05	57.05	57.05	57.05	57.05	57.05	57.05	57.05	(69)
Pumps, fans	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
Losses	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	-125.98	(71)
Water heating	152.42	149.90	144.67	137.56	132.95	126.45	120.93	128.00	130.52	137.88	146.18	149.91	(72)
Total internal	1,080.18	1,073.24	1,032.36	967.93	899.68	840.28	806.76	818.26	856.42	921.09	993.04	1,049.67	(73)
Solar gains	1,115.77	2,011.96	2,997.50	4,040.49	4,763.11	4,816.94	4,608.50	4,066.59	3,363.88	2,294.55	1,357.96	940.27	(83)
Total gains	2,195.95	3,085.19	4,029.86	5,008.42	5,662.79	5,657.22	5,415.26	4,884.84	4,220.30	3,215.64	2,351.00	1,989.94	(84)

7. Mean internal temperature / 8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Util living area	1.00	0.98	0.90	0.72	0.52	0.35	0.25	0.29	0.51	0.86	0.99	1.00	(86)
Util elsewhere	0.99	0.97	0.88	0.68	0.47	0.30	0.20	0.24	0.44	0.82	0.98	1.00	(89)
Living area fraction												1.00	(91)
Util overall	0.99	0.97	0.89	0.71	0.51	0.34	0.24	0.28	0.50	0.85	0.98	1.00	(94)
Space heating kWh	2,225.63	1,370.99	731.56	170.72	26.25	0.00	0.00	0.00	0.00	366.08	1,395.54	2,335.16	(98)
Total space heating requirement kWh												8,621.93	(98)
Space heating requirement per m^2												27.50	(99)

8c. Space cooling requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ext temp	-	-	-	-	-	14.60	16.60	16.40	-	-	-	-

Heat loss rate W	-	-	-	-	-	2,946.82	2,319.84	2,373.64	-	-	-	-	(100)
Utilisation	-	-	-	-	-	0.99	1.00	0.99	-	-	-	-	(101)
Useful loss W	-	-	-	-	-	2,910.35	2,308.55	2,352.69	-	-	-	-	(102)
Gains W	-	-	-	-	-	5,654.22	5,412.26	4,881.84	-	-	-	-	(103)
Space heating kWh	-	-	-	-	-	0.00	0.00	0.00	-	-	-	-	(103)
Space cooling kWh	-	-	-	-	-	1,778.03	2,078.25	1,693.52	-	-	-	-	(103)
Cooled fraction												0.9	(105)
Intermittency factor												0.25	(106)
Space cooling	-	-	-	-	-	111.13	129.89	105.85	-	-	-	-	(100)

9a. Energy requirements

Fraction of space heat from secondary	0	(201)
Fraction of space heat from main systems	1	(202)
Fraction of main heating from main system 2	0	(203)
Fraction of total heating from main system 1	1	(204)
Fraction of total heating from main system 2	0	(205)
Efficiency of main system 1 (%)	170.0	(206)
Efficiency of main system 2 (%)		(207)
Efficiency of secondary system (%)	0	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	2,225.63	1,370.99	731.56	170.72	26.25	0.00	0.00	0.00	0.00	366.08	1,395.54	2,335.16	(98)
Space heating (main system 1)	1,309.19	806.47	430.33	100.43	15.44	0.00	0.00	0.00	0.00	215.34	820.91	1,373.63	(210)
Space heating (main system 2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(212)
Space heating (secondary)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(215)
Flue gas heat rec.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	eq.(G6)
Water heating requirement	245.66	216.79	228.32	205.56	202.09	158.99	151.93	167.76	167.80	213.11	224.23	240.05	(64)
Efficiency of water heater (%)	170.00	170.00	170.00	170.00	170.00	100.00	100.00	100.00	100.00	170.00	170.00	170.00	(217)
Water heating fuel	144.50	127.53	134.31	120.92	118.88	158.99	151.93	167.76	167.80	125.36	131.90	141.20	(219)

Annual totals (kWh/year):		
Space heating fuel used, main system 1	5,071.73	(211)
Space heating fuel used, main system 2	0.00	(212)
Space heating fuel used, secondary system	0.00	(215)
Water heating fuel	1,044.60	(219)
Cooling energy	346.86	(221)
Electricity for pumps and fans	30.00	(231)
Electricity for ventilation	851.18	(231)
Electricity for lighting	738.58	(232)
<u>Energy saving / generation technologies</u>		
Energy generated by PVs	0.00	(233)
Energy generated by wind turbine	0.00	(234)
mCHP	0.00	(235)
Hydroenergy	0.00	(235a)
Total delivered energy for all uses	8,729.42	(238)

10a. Fuel costs using Table 12 prices

	kWh/year	£/kWh	£/year	
Space heating - main system 1	5,071.73	13.19	668.96	(240)
Space heating - main system 2	0.00	-	0.00	(241)
Space heating - secondary system	0.00	-	0.00	(242)
Water heating	1,044.60	13.19	137.78	(247)
Space cooling	346.86	13.19	45.75	(248)
Pumps and fans	30.00	13.19	3.96	(249)
Mechanical ventilation	851.18	13.19	112.27	(249)

Energy for lighting	738.58	13.19	97.42	(250)
Additional standing charges			0	(251)
Photovoltaics	0.00	-	0.00	(252)
Micro wind turbines	0.00	-	0.00	(252)
Hydroelectric energy	0.00	-	0.00	(252)
mCHP	0.00	-	0.00	(252)
Total energy cost			1,151.41	(255)

11a. SAP Rating

Energy cost deflator	0.42	(256)
Energy cost factor (ECF)	1.35	(257)
SAP value	81.18	
SAP rating	81	(258)
SAP band	B	

12a. Carbon dioxide emissions

	kWh/year	Emission factor	Emissions kg/year	
Space heating - main system 1	5,071.73	0.519	2,632.23	(261)
Space heating - main system 2	0.00		0.00	(262)
Space heating - secondary system	0.00	0	0.00	(263)
Water heating	1,044.60	0.519	542.15	(264)
Space cooling	346.86	0.519	180.021534982086	(266)
Pumps and fans	30.00	0.519	15.57	(267)
Mechanical ventilation	851.18	0.519	441.763977	(267)
Energy for lighting	738.58	0.519	383.32	(268)
Photovoltaics	0.00	0.529	0.00	
Micro wind turbines	0.00	0.529	0.00	
Hydroelectric energy	0.00	0.529	0.00	
mCHP	0.00	0.529	0.00	(269)
Total kg/year			4,530.57	(272)
CO2 emissions per m²			14.45	(273)
EI value			83.07	(274)
EI rating			83	(274)
EI band			B	