Energy & Sustainability Report
66 Fitzjohns Avenue, NW3 5LT

July 2020

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About *MES Building Solutions*

***MES Building Solutions* is an established consultancy practice specialising in providing building solutions throughout the UK.**

We offer a full range of services for both residential and commercial buildings from small individual properties through to highly complex mixed use developments.

We are an industry leader in delivering a professional, accredited and certified service to a wide range of clients including architects, developers, builders, housing associations, the public sector and private householders.

Employing highly qualified staff, our team comes from a variety of backgrounds within the construction industry with combined knowledge of building design, engineering, assessment, construction, development, research and surveying.

We are renowned for our creative thinking and provide a high quality, honest and diligent service.

MES Building Solutions maintains its position at the forefront of changes in planning, building regulations and neighbourly matters, as well as technological advances. Our clients, large or small are therefore assured of a cost effective, cohesive and fully integrated professional service.

List of contents

Section 1: Introduction

1.1 Executive Summary

This report is produced in support of a full planning application to the London Borough of Camden Council for construction of two new dwellings at 66 Fitzjohns Avenue, NW3 5LT.

Local planning policy requires that the development follows the hierarchy of energy efficiency, decentralised energy and renewable energy technologies set out in the London Plan (2016) Chapter 5.

The application is for the demolition of two existing dwellings and the construction of two new dwellings in their place. Accommodation will comprise of two, 3 bedroom houses with green roofs and off street parking.

Investigation confirms that connection to district heating and CHP are not feasible. After a review of available renewable technologies photovoltaic panels are considered most appropriate.

The building fabric combined with the energy produced by the proposed 3.0kWp photovoltaic installation will offset 52.38% of the developments regulated carbon emissions and reduce the energy demand by 79.22%. The developments regulated carbon emissions is further reduced to 76.96% if assessed under SAP10 emission factors

This is in line with London Plan and London Borough of Camden Council policy.

Table 1a: Total anticipated reduction in regulated emissions & energy use		
	kWh/year	**Tonnes CO_2 per year**
Total Part L1A 'Baseline' annual figures	36,249	8.21
Total 'be lean, be clean' annual figures	9,816	5.09
Total 'be lean, be clean & be green' annual figures	7,534	3.91
Contribution from renewables	**23.24%**	**23.18%**
Total reduction over Baseline	**79.22%**	**52.38%**

1.2 Introduction

MES Building Solutions has been retained Webb Architects to provide an energy statement in order to address the requirements of Camden Council. The purpose of this Energy & Sustainability Statement is to establish the predicted energy requirements for the proposed development illustrating how energy efficiency measures in conjunction with renewable generation can be used to reduce the predicted energy consumption and associated carbon dioxide emissions.

This is achieved by following the energy hierarchy which includes:

- Calculation of baseline energy consumption & CO_2 emissions using sample SAP calculations
- Implementation of the energy hierarchy (be lean, be clean, be green)
- Calculation of energy consumption & CO_2 emissions at each stage of energy hierarchy
- Calculation of final energy consumption & CO_2 emissions
- Calculation of reduction in emissions achieved
- Calculation of contribution from renewable generation

The report also addresses wider sustainability principles, looking at the following areas:

- Energy use
- Water conservation
- Materials selection
- Flood risk & surface water management
- Waste management
- Pollution mitigation
- Health & Wellbeing
- Construction & building management
- Site ecology

1.3 Planning Policy

National Policy

In February 2019, the Government published the National Planning Policy Framework (NPPF) which superseded a number of planning policies including the Planning Policy Statement (PPS) suite.

The NPPF outlines the Government's planning policies for England. It provides a framework within which local people and accountable councils can produce their own distinctive local plan which reflect the needs and priorities of their neighbourhoods and communities. The purpose of the NPPF is to contribute to the achievement of sustainable development.

The NPPF aims to strengthen local decision making as a way to foster the delivery of sustainable developments. However, the NPPF also outlines that sustainable developments require careful attention to viability and costs in plan-making and decision-taking processes. Over everything else, plans should be deliverable. Therefore, the size and scale of development within the plan should not be subjected to large scale obligations and burdens, so that their ability to be developed viably is threatened.

The NPPF guidance promotes planning for climate change. Chapter 14 of the NPPF, Meeting the Challenge of Climate Change, Flooding and Coastal Change (paragraphs 149 to 154) state that:

Plans should take a proactive approach to mitigating and adapting to climate change, taking into account the long-term implications for flood risk, coastal change, water supply, biodiversity and landscapes, and the risk of overheating from rising temperatures. Policies should support appropriate measures to ensure the future resilience of communities and infrastructure to climate change impacts, such as providing space for physical protection measures, or making provision for the possible future relocation of vulnerable development and infrastructure.

- New development should be planned for in ways that:
  - o Avoid increased vulnerability to the range of impacts arising from climate change. When new development is brought forward in areas which are vulnerable, care should be taken to ensure that risks can be managed through suitable adaptation measures, including through the planning of green infrastructure; and

- Can help to reduce greenhouse gas emissions, such as through its location, orientation and design. Any local requirements for the sustainability of buildings should reflect the Government's policy for national technical standards.

- To help increase the use and supply of renewable and low carbon energy and heat, plans should:
  - Provide a positive strategy for energy from these sources, that maximises the potential for suitable development, while ensuring that adverse impacts are addressed satisfactorily (including cumulative landscape and visual impacts);
  - Consider identifying suitable areas for renewable and low carbon energy sources, and supporting infrastructure, where this would help secure their development; and
  - Identify opportunities for development to draw its energy supply from decentralised, renewable or low carbon energy supply systems and for co-locating potential heat customers and suppliers.

- Local planning authorities should support community-led initiatives for renewable and low carbon energy, including developments outside areas identified in local plans or other strategic policies that are being taken forward through neighbourhood planning.

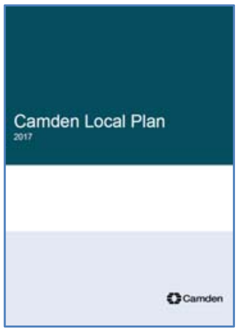
- In determining planning applications, local planning authorities should expect new development to:
  - Comply with any development plan policies on local requirements for decentralised energy supply unless it can be demonstrated by the applicant, having regard to the type of development involved and its design, that this is not feasible or viable; and
  - Take account of landform, layout, building orientation, massing and landscaping to minimise energy consumption.

- When determining planning applications for renewable and low carbon development, local planning authorities should:
  - Not require applicants to demonstrate the overall need for renewable or low carbon energy, and recognise that even small-scale projects provide a valuable contribution to cutting greenhouse gas emissions; and

Approve the application if its impacts are (or can be made) acceptable. Once suitable areas for renewable and low carbon energy have been identified in plans, local planning authorities should expect subsequent applications for commercial scale projects outside these areas to demonstrate that the proposed location meets the criteria used in identifying suitable areas.

Camden Local Plan 2017

Policy CC1 Climate change mitigation



The Council will require all development to minimise the effects of climate change and encourage all developments to meet the highest feasible environmental standards that are financially viable during construction and occupation.

We will:
a. promote zero carbon development and require all development to reduce carbon dioxide emissions through following the steps in the energy hierarchy;

b. require all major development to demonstrate how London Plan targets for carbon dioxide emissions have been met;

c. ensure that the location of development and mix of land uses minimise the need to travel by car and help to support decentralised energy networks;

d. support and encourage sensitive energy efficiency improvements to existing buildings;

e. require all proposals that involve substantial demolition to demonstrate that it is not possible to retain and improve the existing building; and

f. expect all developments to optimise resource efficiency. For decentralised energy networks, we will promote decentralised energy by:

g. working with local organisations and developers to implement decentralised energy networks in the parts of Camden most likely to support them;

h. protecting existing decentralised energy networks (e.g. at Gower Street, Bloomsbury, King's Cross, Gospel Oak and Somers Town) and safeguarding potential network routes; and

i. requiring all major developments to assess the feasibility of connecting to an existing decentralised energy network, or where this is not possible establishing a new network.

To ensure that the Council can monitor the effectiveness of renewable and low carbon technologies, major developments will be required to install appropriate monitoring equipment.

Policy CC2 Adapting to climate change

The Council will require development to be resilient to climate change.

All development should adopt appropriate climate change adaptation measures such as:

a. the protection of existing green spaces and promoting new appropriate green infrastructure;

b. not increasing, and wherever possible reducing, surface water runoff through increasing permeable surfaces and use of Sustainable Drainage Systems;

c. incorporating bio-diverse roofs, combination green and blue roofs and green walls where appropriate; and

d. measures to reduce the impact of urban and dwelling overheating, including application of the cooling hierarchy.

Any development involving 5 or more residential units or 500 sqm or more of any additional floorspace is required to demonstrate the above in a Sustainability Statement.

Sustainable design and construction measures

The Council will promote and measure sustainable design and construction by:

e. ensuring development schemes demonstrate how adaptation measures and sustainable development principles have been incorporated into the design and proposed implementation;

f. encourage new build residential development to use the Home Quality Mark and Passivhaus design standards;

g. encouraging conversions and extensions of 500 sqm of residential floorspace or above or five or more dwellings to achieve “excellent” in BREEAM domestic refurbishment; and

h. expecting non-domestic developments of 500 sqm of floorspace or above to achieve “excellent” in BREEAM assessments and encouraging zero carbon in new development from 2019.

London Plan (2016)

Policy 5.2 Minimising Carbon Dioxide Emissions
Planning decisions

A Development proposals should make the fullest contribution to minimising carbon dioxide emissions in accordance with the following energy hierarchy:

1 Be lean: use less energy
2 Be clean: supply energy efficiently
3 Be green: use renewable energy

B The Mayor will work with boroughs and developers to ensure that major developments meet the following targets for carbon dioxide emissions reduction in buildings. These targets are expressed as minimum improvements over the Target Emission Rate (TER) outlined in the national Building Regulations leading to zero carbon residential buildings from 2016 and zero carbon non-domestic buildings from 2019.

Residential buildings:

Year	Improvement on 2010 Building Regulations
2010 – 2013	25 per cent (Code for Sustainable Homes level 4)
2013 - 2016	40 per cent
2016 - 2031	Zero Carbon

Non-domestic buildings:

Year	Improvement on 2010 Building Regulations
2010 – 2013	25 per cent
2013 - 2016	40 per cent
2016 - 2019	As per building regulations requirements
2019 - 2031	Zero Carbon

C Major development proposals should include a detailed energy assessment to demonstrate how the targets for carbon dioxide emissions reduction outlined above are to be met within the framework of the energy hierarchy.

D As a minimum, energy assessments should include the following details:

a calculation of the energy demand and carbon dioxide emissions covered by Building Regulations and, separately, the energy demand and carbon dioxide emissions from any other part of the development, including plant or equipment, that are not covered by the Building Regulations (see paragraph 5.22) at each stage of the energy hierarchy
b proposals to reduce carbon dioxide emissions through the energy efficient design of the site, buildings and services
c 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)
d proposals to further reduce carbon dioxide emissions through the use of on-site renewable energy technologies.

E The carbon dioxide reduction targets should be met on-site. Where it is clearly demonstrated that the specific targets cannot be fully achieved on-site, any shortfall may be provided off-site or through a cash in lieu contribution to the relevant borough to be ring fenced to secure delivery of carbon dioxide savings elsewhere.

Policy 5.3 Sustainable Design and Construction

Strategic
A The highest standards of sustainable design and construction should be achieved in London to improve the environmental performance of new developments and to adapt to the effects of climate change over their lifetime.

Planning decisions
B Development proposals should demonstrate that sustainable design standards are integral to the proposal, including its construction and operation, and ensure that they are considered at the beginning of the design process.

C Major development proposals should meet the minimum standards outlined in the Mayor's supplementary planning guidance and this should be clearly demonstrated within a design and access statement. The standards include measures to achieve other policies in this Plan and the following sustainable design principles:

- a minimising carbon dioxide emissions across the site, including the building and services (such as heating and cooling systems)
- b avoiding internal overheating and contributing to the urban heat island effect
- c efficient use of natural resources (including water), including making the most of natural systems both within and around buildings
- d minimising pollution (including noise, air and urban runoff)
- e minimising the generation of waste and maximising reuse or recycling
- f avoiding impacts from natural hazards (including flooding)
- g ensuring developments are comfortable and secure for users, including avoiding the creation of adverse local climatic conditions
- h securing sustainable procurement of materials, using local supplies where feasible, and
- i promoting and protecting biodiversity and green infrastructure.

LDF preparation

D Within LDFs boroughs should consider the need to develop more detailed policies and proposals based on the sustainable design principles outlined above and those which are outlined in the Mayor's supplementary planning guidance that are specific to their local circumstances.

Policy 5.6 Decentralised Energy in Development Proposals

Planning decisions

A Development proposals should evaluate the feasibility of Combined Heat and Power (CHP) systems, and where a new CHP system is appropriate also examine opportunities to extend the system beyond the site boundary to adjacent sites.

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

1 Connection to existing heating or cooling networks;
2 Site wide CHP network;
3 Communal heating and cooling;

C Potential opportunities to meet the first priority in this hierarchy are outlined in the London Heat Map tool. Where future network opportunities are identified, proposals should be designed to connect to these networks.

Policy 5.7 Renewable Energy

Strategic

A The Mayor seeks to increase the proportion of energy generated from renewable sources, and expects that the projections for installed renewable energy capacity outlined in the Climate Change Mitigation and Energy Strategy and in supplementary planning guidance will be achieved in London.

Planning decisions

B Within the framework of the energy hierarchy (see Policy 5.2), major development proposals should provide a reduction in expected carbon dioxide emissions through the use of on-site renewable energy generation, where feasible.

LDF preparation

C Within LDFs boroughs should, and other agencies may wish to, develop more detailed policies and proposals to support the development of renewable energy in London – in particular, to identify broad areas where specific renewable energy technologies, including large scale systems and the large scale deployment of small scale systems, are appropriate. The identification of areas should be consistent with any guidelines and criteria outlined by the Mayor.

D All renewable energy systems should be located and designed to minimise any potential adverse impacts on biodiversity, the natural environment and historical assets, and to avoid any adverse impacts on air quality.

London Plan (December 2019) - Intend to publish version

A draft new London Plan was published by the Mayor for consultation in December 2017, although the current 2016 Plan is still the adopted Development Plan, the proposed document is given significant weight.

Policy SI 2 Minimising greenhouse gas emissions

A Major development should be net zero-carbon. This means reducing greenhouse gas emissions in operation and minimising both annual and peak energy demand in accordance with the following energy hierarchy:

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

B Major development proposals should include a detailed energy strategy to demonstrate how the zero-carbon target will be met within the framework of the energy hierarchy.

C A minimum on-site reduction of at least 35 per cent beyond Building Regulations156 is required for major development. Residential development should achieve 10 per cent, and non-residential development should achieve 15 per cent through energy efficiency measures. Where it is clearly demonstrated that the zero-carbon target cannot be fully achieved on-site, any shortfall should be provided, in agreement with the borough, either:

1) through a cash in lieu contribution to the borough's carbon offset fund, or
2) off-site provided that an alternative proposal is identified and delivery is certain.

D Boroughs must establish and administer a carbon offset fund. Offset fund payments must be ring-fenced to implement projects that deliver carbon reductions. The operation of offset funds should be monitored and reported on annually.

E Major development proposals should calculate and minimise carbon emissions from any other part of the development, including plant or equipment, that are not covered by Building Regulations, i.e. unregulated emissions.

F Development proposals referable to the Mayor should calculate whole life-cycle carbon emissions through a nationally recognised Whole Life-Cycle Carbon Assessment and demonstrate actions taken to reduce life-cycle carbon emissions.

Policy SI 3 Energy infrastructure

A Boroughs and developers should engage at an early stage with relevant energy companies and bodies to establish the future energy and infrastructure requirements arising from large-scale development proposals such as Opportunity Areas, Town Centres, other growth areas or clusters of significant new development.

B Energy masterplans should be developed for large-scale development locations (such as those outlined in Part A and other opportunities) which establish the most effective energy supply options. Energy masterplans should identify:

1) major heat loads (including anchor heat loads, with particular reference to sites such as universities, hospitals and social housing)
2) heat loads from existing buildings that can be connected to future phases of a heat network
3) major heat supply plant including opportunities to utilise heat from energy from waste plants
4) secondary heat sources, including both environmental and waste heat
5) opportunities for low and ambient temperature heat networks
6) possible land for energy centres and/or energy storage
7) possible heating and cooling network routes
8) opportunities for futureproofing utility infrastructure networks to minimise the impact from road works
9) infrastructure and land requirements for electricity and gas supplies
10) implementation options for delivering feasible projects, considering issues of procurement, funding and risk, and the role of the public sector
11) opportunities to maximise renewable electricity generation and incorporate demand-side response measures.

C Development Plans should:
1) identify the need for, and suitable sites for, any necessary energy infrastructure requirements including energy centres, energy storage and upgrades to existing infrastructure
2) identify existing heating and cooling networks, identify proposed locations for future heating and cooling networks and identify opportunities for expanding and inter-connecting existing networks as well as establishing new networks.

D Major development proposals within Heat Network Priority Areas should have a communal low-temperature heating system:
1) the heat source for the communal heating system should be selected in accordance with the following heating hierarchy:

a) connect to local existing or planned heat networks
b) use zero-emission or local secondary heat sources (in conjunction with heat pump, if required)
c) use low-emission combined heat and power (CHP) (only where there is a case for CHP to enable the delivery of an area-wide heat network, meet the development's electricity demand and provide demand response to the local electricity network)
d) use ultra-low NOx gas boilers

2) CHP and ultra-low NOx gas boiler communal or district heating systems should be designed to ensure that they meet the requirements in Part B of Policy SI 1 Improving air quality 3) where a heat network is planned but not yet in existence the development should be designed to allow for the cost-effective connection at a later date.

E) Heat networks should achieve good practice design and specification standards for primary, secondary and tertiary systems comparable to those set out in the CIBSE/ADE Code of Practice CP1 or equivalent.

Policy SI 4 Managing heat risk

A Development proposals should minimise adverse impacts on the urban heat island through design, layout, orientation, materials and the incorporation of green infrastructure.

B Major development proposals should demonstrate through an energy strategy how they will reduce the potential for internal overheating and reliance on air conditioning systems in accordance with the following cooling hierarchy:

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

Policy SI 12 Flood risk management

A Current and expected flood risk from all sources (as defined in paragraph 9.12.2) across London should be managed in a sustainable and cost-effective way in collaboration with the Environment Agency, the Lead Local Flood Authorities, developers and infrastructure providers.
B Development Plans should use the Mayor's Regional Flood Risk Appraisal and their Strategic Flood Risk Assessment as well as Local Flood Risk Management Strategies, where necessary, to identify areas where particular and cumulative flood risk issues exist and develop actions and policy approaches aimed at reducing these risks. Boroughs should co-operate and jointly address cross-boundary flood risk issues including with authorities outside London.

C Development proposals should ensure that flood risk is minimised and mitigated, and that residual risk is addressed. This should include, where possible, making space for water and aiming for development to be set back from the banks of watercourses.

D Developments Plans and development proposals should contribute to the delivery of the measures set out in Thames Estuary 2100 Plan. The Mayor will work with the Environment Agency and relevant local planning authorities, including authorities outside London, to safeguard an appropriate location for a new Thames Barrier.

E Development proposals for utility services should be designed to remain operational under flood conditions and buildings should be designed for quick recovery following a flood.

F Development proposals adjacent to flood defences will be required to protect the integrity of flood defences and allow access for future maintenance and upgrading. Unless exceptional circumstances are demonstrated for not doing so, development proposals should be set back from flood defences to allow for any foreseeable future maintenance and upgrades in a sustainable and cost-effective way.

G Natural flood management methods should be employed in development proposals due to their multiple benefits including increasing flood storage and creating recreational areas and habitat.

1.4 SAP 10

The following guidance was issued by the GLA, in October 2018, for all new developments.

'Grid electricity has been significantly decarbonised since the last update of Part L in April 2014 and in July 2018 the Government published updated carbon emission factors (SAP 10) demonstrating this. These new emission factors will however not be incorporated into Part L of the Building Regulations until the Government has consulted on new Building Regulations.

The impact of these new emission factors is significant in that technologies generating on-site electricity (such as gas-engine CHP and solar PV) will not achieve the carbon savings they have to date. It is therefore anticipated that developments will need to utilise alternative or additional technologies to meet the 35 per cent on-site carbon reduction target, including using zero emission or local secondary heat sources.

The GLA has decided that from January 2019 and until central Government updates Part L with the latest carbon emission factors, planning applicants are encouraged to use the SAP 10 emission factors for referable applications when estimating CO_2 emission performance against London Plan policies. This will ensure that the assessment of new developments better reflects the actual carbon emissions associated with their expected operation'.

As a result of the above guidance, MES have based the reduction targets on the proposed SAP 10 emission factors, as these are considered more accurate although it is acknowledged that the EPC certificates are currently assessed against SAP 2012.

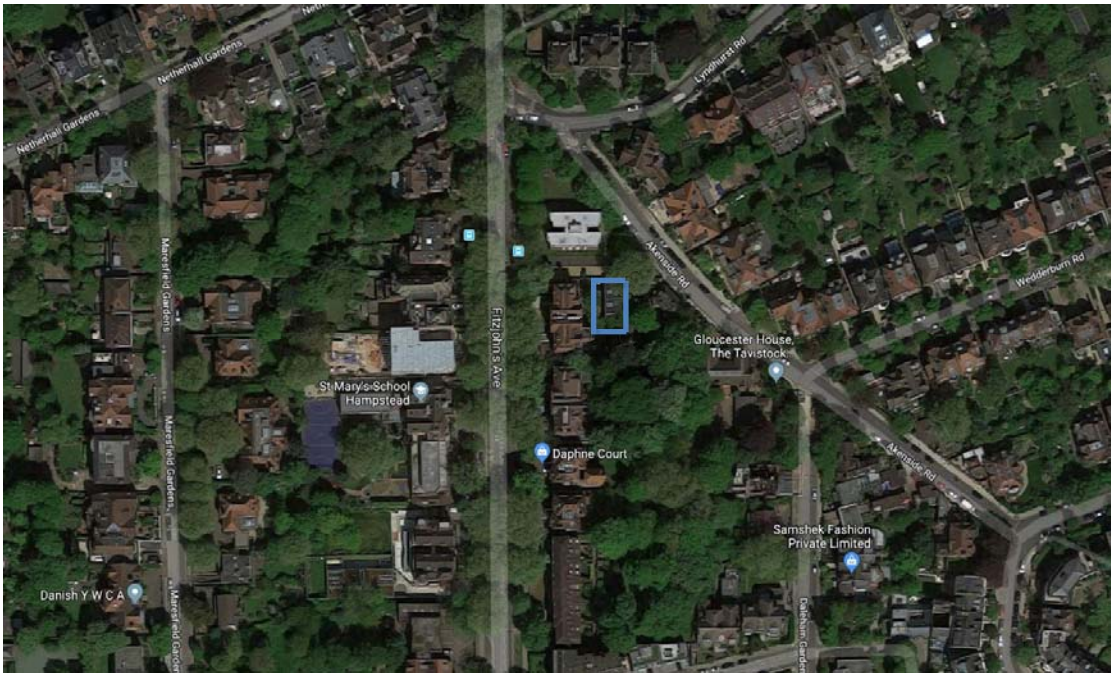
	Emissions kg CO_2 per kWh	
	SAP 2012	**SAP 10**
Mains Gas	0.216	0.210
Electricity	0.519	0.233

1c: SAP 2012 and SAP 10 emission factors

Section 2: Description of development

2.1 Location

The development site is to be located at 66 Fitzjohns Avenue, London, NW3 5LT. The surrounding area is a mix of four and five storey residential dwellings and a school to the west on Fitzjohns Avenue.

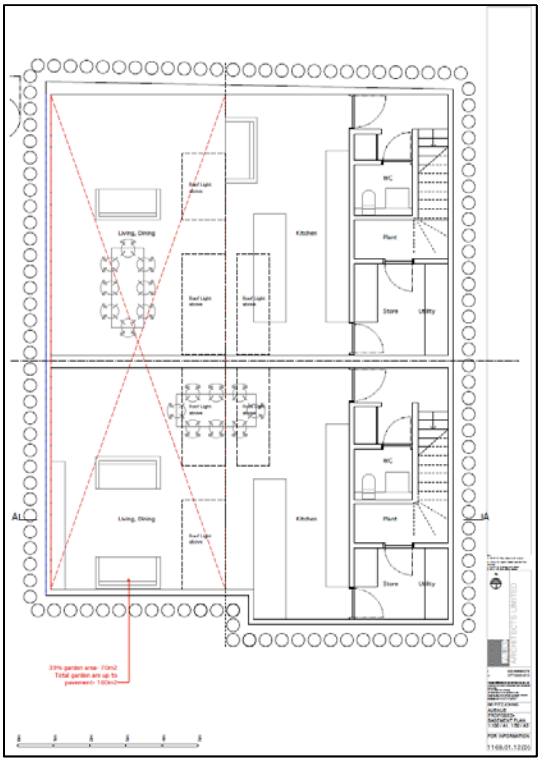


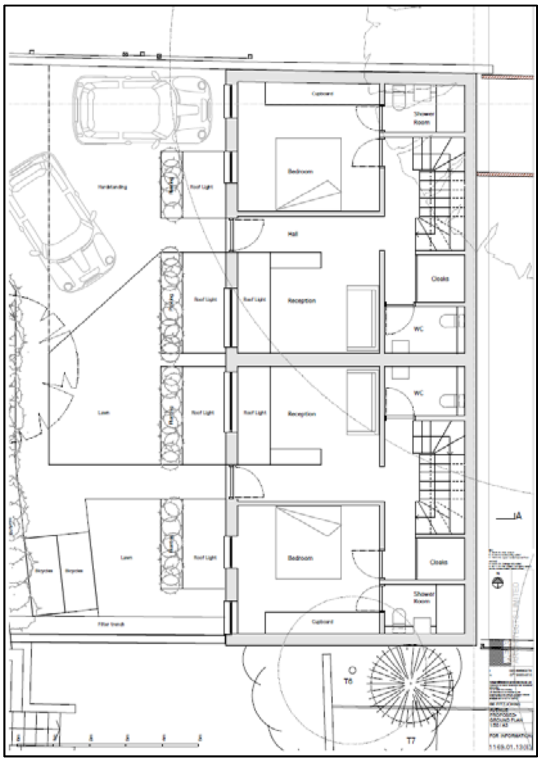
Site Location Plan (Google 2018)

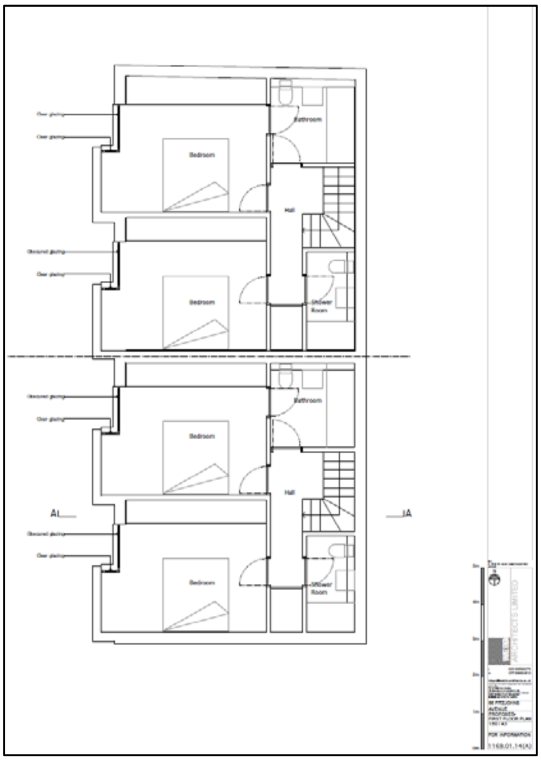
2.2 Details of development

The application is for the demolition of two existing dwellings and the construction of two replacement dwellings in their place. Accommodation will comprise of two, 3 bedroom houses with green roofs and off street parking.

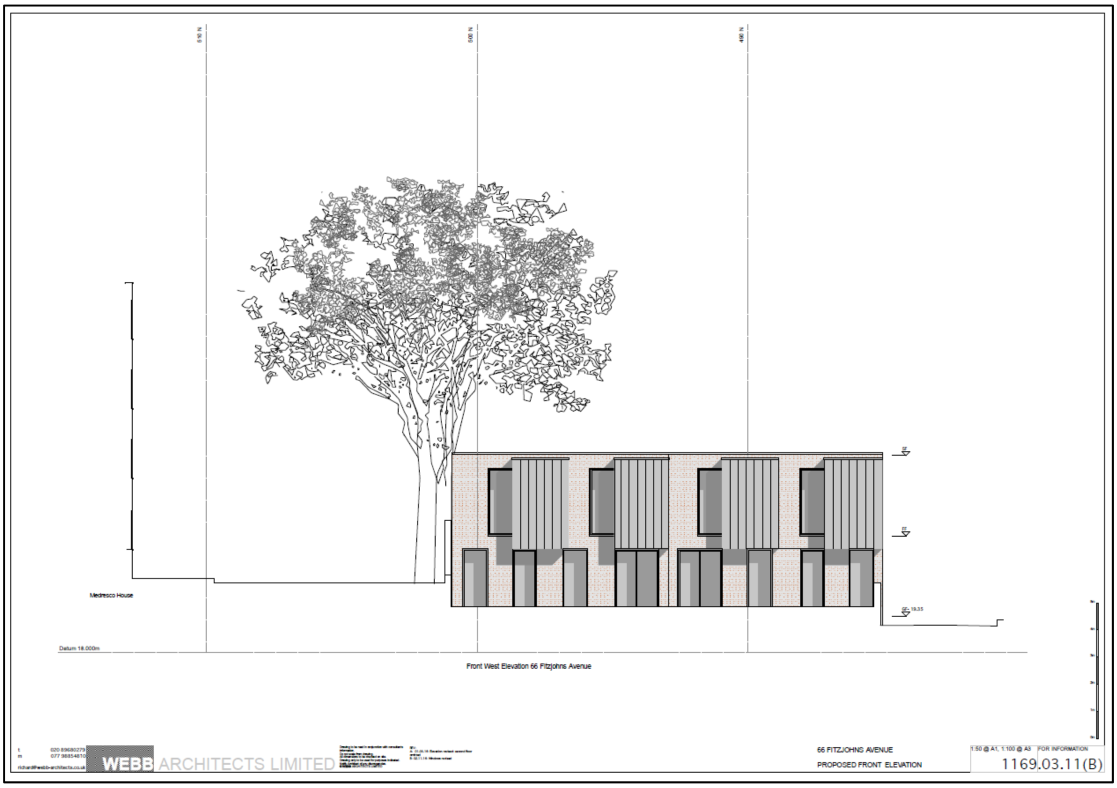
In line with the London Plan planning policy this is to be considered a minor development.

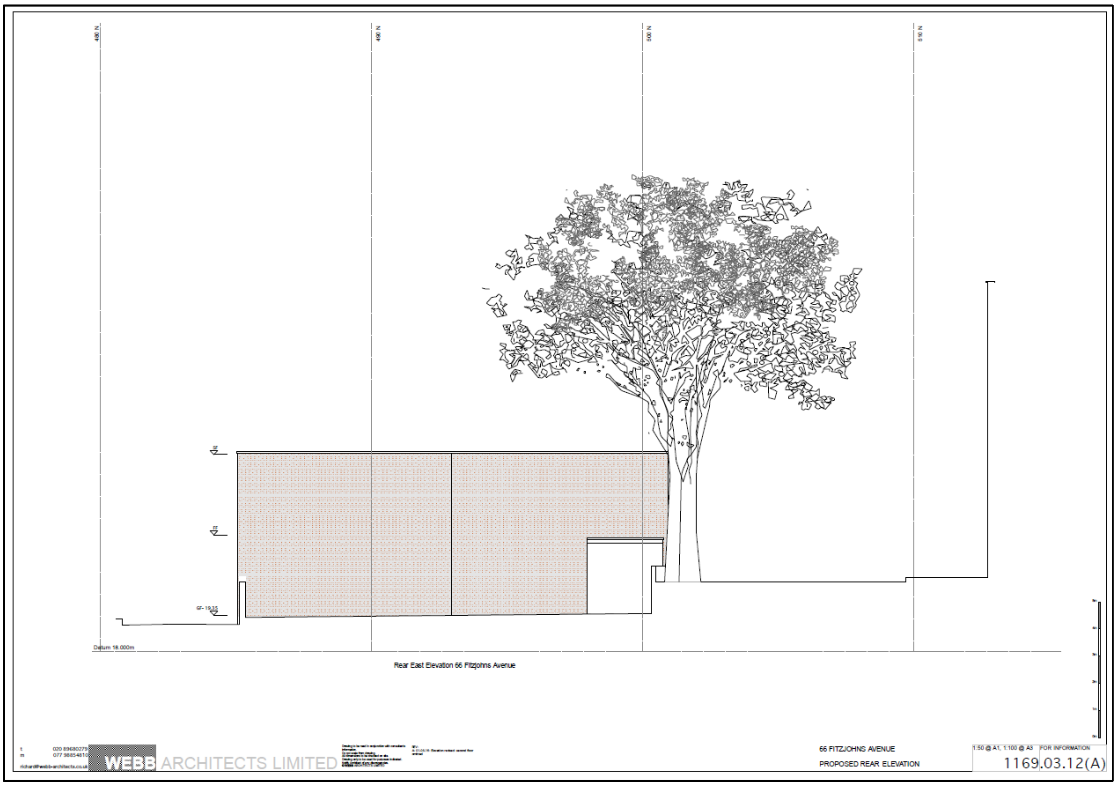






Proposed floor plans (2018)





Proposed elevation (2018)

Section 3: Energy

3.1 The Energy Hierarchy

The energy hierarchy is generally accepted as the most effective way of reducing building carbon emissions.

1. Be lean: use less energy
2. Be clean: supply energy efficiently
3. Be green: use renewable energy
4. Be seen: monitor, verify and report on energy performance

Development proposals should:

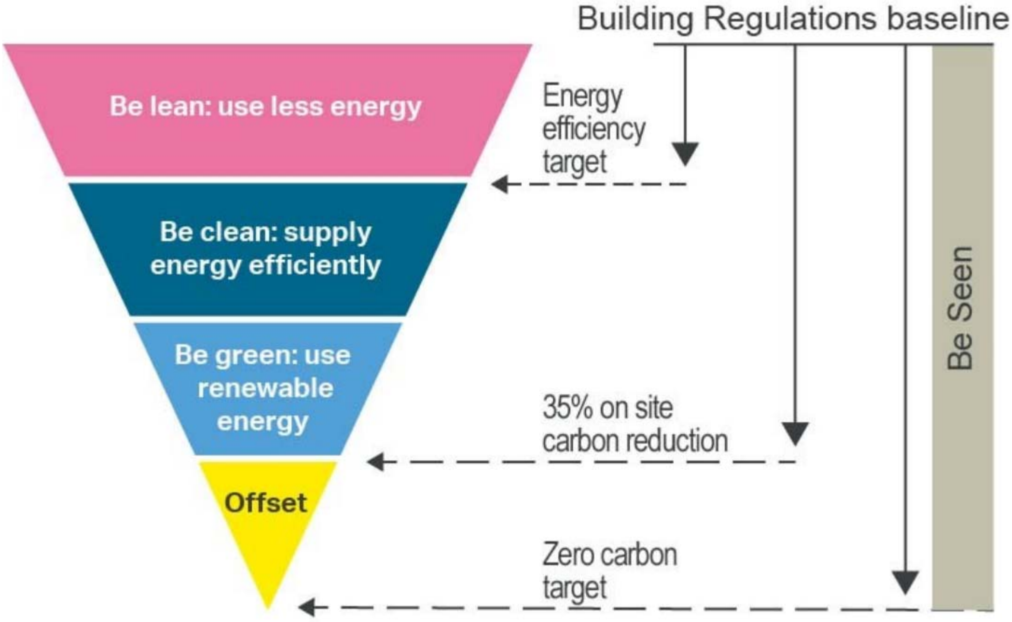


Figure 3.1: The Energy Hierarchy

- ***Reducing energy demand***

The first step in the process of reducing the overall energy used and CO_2 produced by the building is to minimise the energy required to heat it. A well-insulated building envelope and passive design will reduce the energy requirement for heating and ventilating the building.

- ***Energy efficient systems***

The second step is to specify services and controls, lighting and appliances that are energy efficient and which result in further reduction in energy requirements.

- ***Making use of Low or zero-carbon (LZC) technologies***

When the energy demand has been reduced by implementing the processes of improving the fabric and energy efficiency, then LZC technologies can be employed to reduce the environmental impact of the remaining energy consumption.

- ***Monitoring and reporting***

Ensure comprehensive monitoring and reporting of energy demand and carbon emissions. Major developments are required to undertake this process for at least five years.

3.2 Calculating Baseline Energy Demand

Energy used in a building is divided between that which is regulated (Heating, Cooling, Hot water, Ventilation & Lighting) and that which is said to be unregulated and associated with the building in use (Equipment and Appliances).

3a: Unregulated Energy Use and Emissions		
	Part L	**SAP 10**
Emissions (Tonnes CO_2 per year)	**4.38**	**2.16**
Energy (kWh per year)	**9,458**	**9,458**

The first step is to calculate a Building Regulations Part L1A 2013 compliant specification in order to establish baseline emissions for the development. In order to comply with Camden's planning requirements, we have been advised the development must achieve a 20% reduction in CO2 emissions from renewables technologies over a Part L compliant DER. Full SAP calculations have been undertaken on the government approved SAP2012 software and the current methodology has been used to establish baseline energy requirements which comply with the 2013 edition of Part L1A, along with applying the conversion factor to the SAP 10 emissions.

House Type	Carbon Emissions (tonnes CO_2 per year)								Total Emissions (tonnes CO_2 per year)
	Space Heating (Gas)	Space Heating (Electricity)	Secondary Heating	Water Heating (Gas)	Water Heating (Electricity)	Pumps & Fans	Lighting	Additional Allowable Generation	
House 1	2.93	0.00	0.00	0.90	0.00	0.04	0.29	0.00	4.16
House 2	2.84	0.00	0.00	0.90	0.00	0.04	0.29	0.00	4.06
Total:	**5.76**	**0.00**	**0.00**	**1.79**	**0.00**	**0.08**	**0.58**	**0.00**	**8.21**
								Total:	**8.21**

Table 3.b: Part L Baseline carbon dioxide (CO_2) emissions. (Tonnes CO_2 per year)

House Type	Carbon Emissions (tonnes CO_2 per year)								Total Emissions (tonnes CO_2 per year)
	Space Heating (Gas)	Space Heating (Electricity)	Secondary Heating	Water Heating (Gas)	Water Heating (Electricity)	Pumps & Fans	Lighting	Additional Allowable Generation	
House 1	2.85	0.00	0.00	0.87	0.00	0.02	0.13	0.00	3.87
House 2	2.76	0.00	0.00	0.87	0.00	0.02	0.13	0.00	3.77
Total:	**5.60**	**0.00**	**0.00**	**1.74**	**0.00**	**0.03**	**0.26**	**0.00**	**7.64**
								Total:	**7.64**

Table 3c: SAP 10 'Baseline' carbon dioxide (CO_2) emissions. (Tonnes CO_2 per year)

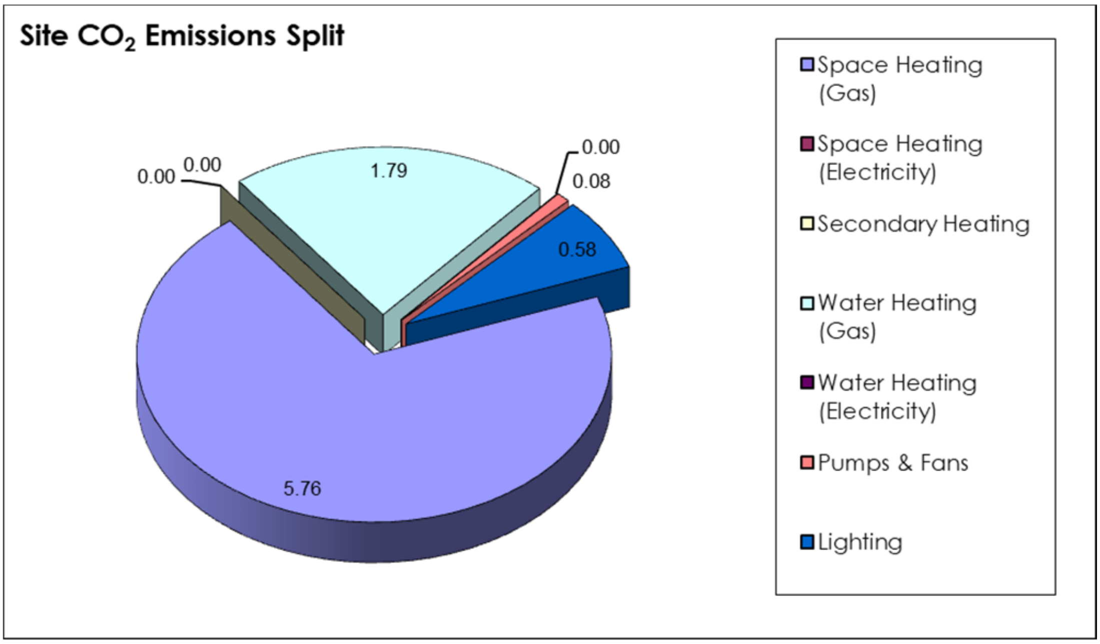


Figure 3.2: Part L Baseline carbon dioxide emissions (tonnes CO_2 per year) split.

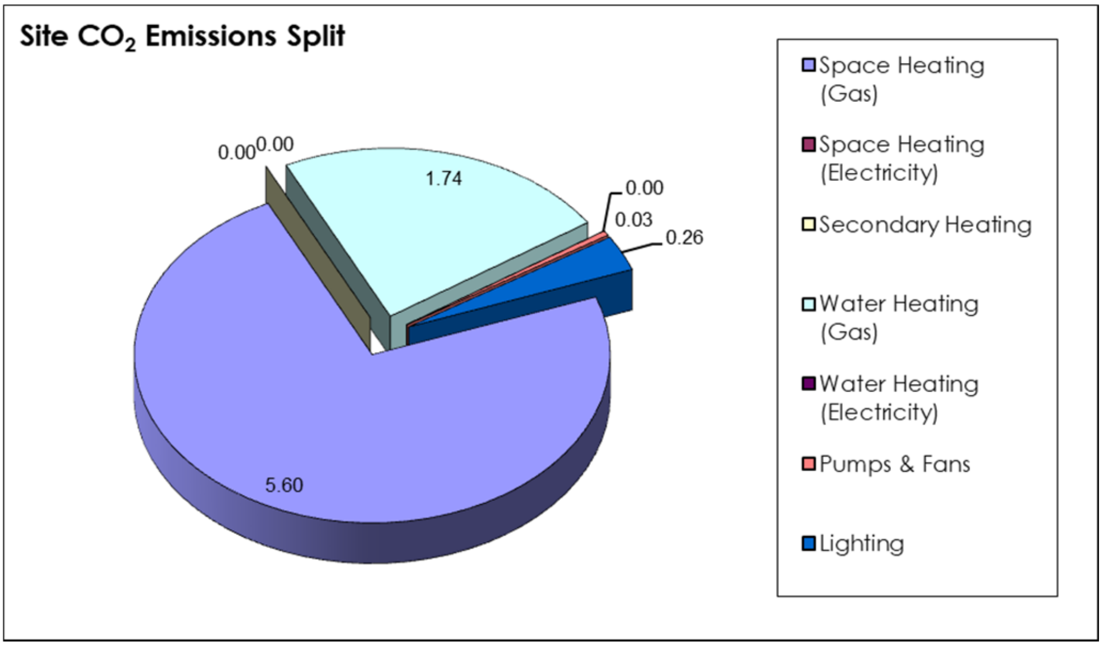


Figure 3.3: SAP 10 Baseline CO_2 emissions split

Figures 3.2 and 3.3 show how the CO_2 emissions are split between individual energy end uses.

3.3 Emission reduction targets

Camden Council policy requires the development to meet the carbon emission reduction requirements set out in the London Plan. The London Plan sets no fixed target for a minor development but rather states that efforts should be made to reduce emissions as far as is practical/feasible. Planning condition 7 requires this development to investigate the feasibility for appropriate renewable or low carbon sustainable energy sources with the aim of reducing the development's carbon emissions by at least 20%.

Both Part L of Building Regulations and London Plan policy 5.2 consider emissions from regulated energy (heating, cooling, lighting, ventilation) only when setting targets for reduction. The baseline emissions for the development are therefore derived from the total regulated energy uses for the dwellings.

3d: Total Annual Part L Baseline Regulated Emissions & Fabric Energy Efficiency	
Emissions	**8.21 Tonnes CO_2 per year**
Energy	**36,249 kWh/year**

3.4 Energy Efficiency Measures (Be lean and Be Clean)

The first two steps of the Mayor's energy hierarchy require the reduction of energy consumption in the building through improvements to its fabric and by increasing the efficiency of the building services. This reduces the energy required to run the building and thus the emissions associated with that energy use. As the new 2013 Part L1A is already very stringent in terms of fabric performance targets, the reduction possible from further improvement to the building fabric and services is limited when compared those which may be expected from buildings constructed to earlier versions of Building Regulations.

The increase in Building Regulation targets has meant that we have combined stages one and two of the hierarchy to try and achieve a Part L compliant specification. As this is the case, the specification below achieves a 38% improvement over Part L 2013, with an improvement of 17.9% over Part L minimum fabric standards. A summary of the specification assumed in the compliant model is shown in table 3e, below.

3e: Be Lean and Be Clean Specification	
Element	**Specification**
Basement Walls	$0.14W/m^2K$
Ground & 1st Floor Walls	$0.17W/m^2K$
Oriel Window Walls	$0.14W/m^2K$
Roof Light Upstand	$0.32W/m^2K$
Flat Roof to Basement	$0.27W/m^2K$
Flat Roof to Main House	$0.13W/m^2K$
Flat Roof to Window	$0.18W/m^2K$
Basement Floor	$0.09W/m^2K$
Exposed Floor of Window	$0.13W/m^2K$
Doors	$1.80W/m^2K$
Windows	$1.60W/m^2K$
Air Permeability	$3.0m^3/m^2/hr$
Ventilation	Mechanical Ventilation with Heat Recovery
Thermal Bridging	Calculated Y-Value
Lighting	100% low energy lamps
Space Heating	Low temp Air source heat pump
Heating Controls	Time and temperature zone control & Delayed start stat
DHW	250l cylinder via main heating
Renewable technology	N/A

House Type	Carbon Emissions (tonnes CO_2 per year)								Total Emissions (tonnes CO_2 per year)
	Space Heating (Gas)	Space Heating (Electricity)	Space Cooling	Water Heating (Gas)	Water Heating (Electricity)	Pumps & Fans	Lighting	Additional Allowable Generation	
House 1	0.00	1.21	0.02	0.00	0.70	0.35	0.29	0.00	2.58
House 2	0.00	1.17	0.02	0.00	0.70	0.34	0.29	0.00	2.52
Total:	**0.00**	**2.39**	**0.04**	**0.00**	**1.40**	**0.69**	**0.58**	**0.00**	**5.09**
								Total:	**5.09**

Table 3f: Part L 'Lean & Clean' carbon dioxide (CO_2) emissions. (Tonnes CO_2 per year)

House Type	Carbon Emissions (tonnes CO_2 per year)								Total Emissions (tonnes CO_2 per year)
	Space Heating (Gas)	Space Heating (Electricity)	Space Cooling	Water Heating (Gas)	Water Heating (Electricity)	Pumps & Fans	Lighting	Additional Allowable Generation	
House 1	0.00	0.54	0.01	0.00	0.31	0.16	0.13	0.00	1.16
House 2	0.00	0.53	0.01	0.00	0.31	0.15	0.13	0.00	1.13
Total:	**0.00**	**1.07**	**0.02**	**0.00**	**0.63**	**0.31**	**0.26**	**0.00**	**2.29**
								Total:	**2.29**

Table 3g: SAP 10 'Lean & Clean' carbon dioxide (CO_2) emissions. (Tonnes CO_2 per year)

3h: Regulated Baseline & Target Emissions. (Tonnes CO_2 per year)	
Part L Compliant DER	**8.21**
20% LZC Reduction Target	**6.57**

3.5 Be Clean (District Heating & CHP)

District heating

It is a requirement of the London Plan (Policy 5.6) to consider the application of both a district heating scheme and/or CHP technology on all new developments unless it is not possible on the application site.

As can be seen from the London Heat Map extract in Figure 3.3 below, there are no existing, or proposed heating networks within a feasible distance of the site. It is also not practical for this development of two houses to be connected, in the future, to a district heat network. Space would be required for incoming pipework, and may need to be laid during the project for future use, with no guarantee it will be suitable or compatible at such time a connection may be available. Space would also be required for a plant room, to fit the heat exchangers, pump controls and ancillaries as well as riser space for the distribution pipework.

As such, connection to a district heating network is not a viable option on this occasion.

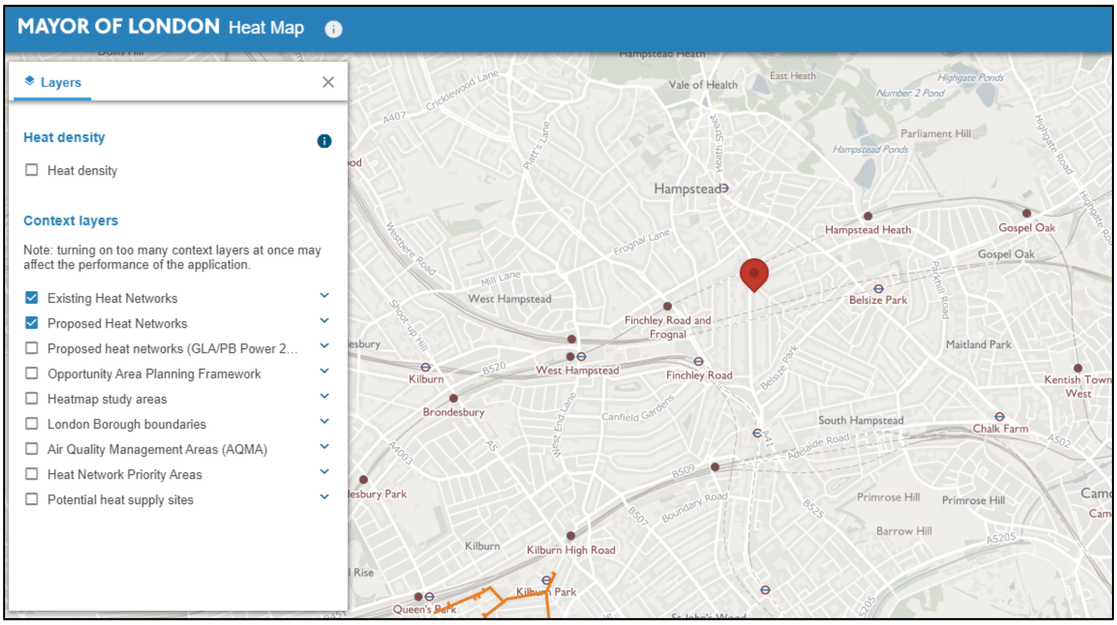
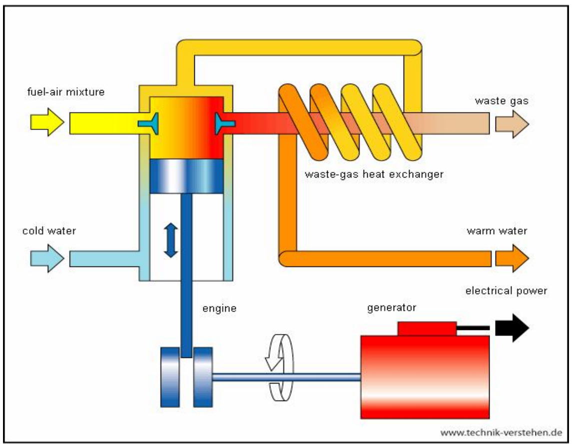


Figure 3.4: London Heat map showing the lack of a potential district heating network within the site boundary.

Communal heating scheme

The benefit of communal heating systems becomes questionable for small scale residential installation when compared to more traditional self-contained individual boilers. Additional space is required for centralised plant rooms and ducting/pipework. The increased cost and complexity of such systems is not offset by the minimal performance improvement that may be achieved and given this; communal heating is not proposed for the development.

Combined heat & power (CHP)



Combined heat and power uses an electricity generator, generally a gas powered internal combustion engine, with heat recovery on the exhaust used to heat water for heating and domestic hot water supply.

The proportions of heat and electricity produced are normally in the region of 65:35. This requires a constant heat load throughout the year for the system to perform efficiently.

For CHP to be viable on residential developments a minimum of 100 units is usually required in order to generate sufficient heating baseload. As this is not the case on this occasion CHP is not viable for consideration.

3.6 The Cooling Hierarchy

Overheating within dwellings has become a more prevalent issue and steps to mitigate this risk are included within the steps over the cooling hierarchy listed below.

1. Minimising internal heat generation through energy efficient design: For example, heat distribution infrastructure within buildings should be designed to minimise pipe lengths, particularly lateral pipework in corridors of apartment blocks, and adopting pipe configurations which minimise heat loss e.g. twin pipes.
2. Reducing the amount of heat entering the building in summer: For example, through use of carefully designed shading measures, including balconies, louvres, internal or external blinds, shutters, trees and vegetation.
3. Use of thermal mass and high ceilings to manage the heat within the building: Increasing the amount of exposed thermal mass can help to absorb excess heat within the building.
4. Passive ventilation: For example, through the use of openable windows, shallow floorplates, dual aspect units, designing in the 'stack effect'
5. Mechanical ventilation: Mechanical ventilation can be used to make use of 'free cooling' where the outside air temperature is below that in the building during summer months. This will require a by-pass on the heat recovery system for summer mode operation.

For this development the risk of over overheating has been assessed by the SAP software as being 'not significant'. This is a result of the high standard of insulation specification, the use of mechanical ventilation and the inclusion of the split comfort cooling system.

3.7 CO_2 reduction through the use of renewable or low carbon technology (Be green)

Energy resources accepted as renewable or low carbon technologies are defined by the Department of Energy & Climate Change Low Carbon Buildings Program as:

- Solar photovoltaics
- Wind turbines
- Small hydro
- Solar thermal hot water
- Ground source heat pumps
- Air source heat pumps
- Bio-energy
- Renewable CHP
- Micro CHP (Combined heat and power)

Given the nature of the site, all but solar photovoltaics and solar thermal have been discounted as impractical. Photovoltaic panels, when compared to solar water panels, by unit of area, are more efficient in terms of carbon offset. As this is the case PV is the chosen renewable technology for the development.

The proposal is to install 3.0kWp of PV (1.5kWp per dwelling) on the roof, angled above 10degrees and facing south, this will require 12 x 250W panels in total. This number could be reduced should more efficient panels be specified. An array of this size will produce approximately 2,281 kWh/yr of electricity offsetting 1.18 Tonnes of CO_2.

House Type	Carbon Emissions (tonnes CO_2 per year)								Total Emissions (tonnes CO_2 per year)
	Space Heating (Gas)	Space Heating (Electricity)	Space Cooling	Water Heating (Gas)	Water Heating (Electricity)	Pumps & Fans	Lighting	Additional Allowable Generation	
House 1	0.00	1.21	0.02	0.00	0.70	0.35	0.29	-0.59	1.98
House 2	0.00	1.17	0.02	0.00	0.70	0.34	0.29	-0.59	1.93
Total:	**0.00**	**2.39**	**0.04**	**0.00**	**1.40**	**0.69**	**0.58**	**-1.18**	**3.91**
								Total:	**3.91**

Table 3i: Part L 'Be lean be clean & be green' carbon dioxide (CO_2) emissions. (Tonnes CO_2 per year)

House Type	Carbon Emissions (tonnes CO_2 per year)								Total Emissions (tonnes CO_2 per year)
	Space Heating (Gas)	Space Heating (Electricity)	Space Cooling	Water Heating (Gas)	Water Heating (Electricity)	Pumps & Fans	Lighting	Additional Allowable Generation	
House 1	0.00	0.54	0.01	0.00	0.31	0.16	0.13	-0.27	0.89
House 2	0.00	0.53	0.01	0.00	0.31	0.15	0.13	-0.27	0.86
Total:	**0.00**	**1.07**	**0.02**	**0.00**	**0.63**	**0.31**	**0.26**	**-0.53**	**1.76**
								Total:	**1.76**

Table 3j: SAP 10 'Be lean be clean & be green' carbon dioxide (CO_2) emissions. (Tonnes CO_2 per year)

House Type	Energy (kWh per year)								Total Energy (kWh per year)
	Space Heating (1) *SAP (261)*	Space Heating (2) *SAP (262)*	Secondary Heating *SAP (263)*	Water Heating *SAP (264)*	Space Cooling *SAP (266)*	Pumps & Fans *SAP (267)*	Lighting *SAP (268)*	Additional Allowable Generation	
House 1	0	2,335	38	0	1,350	674	566	-1,141	3,822
Total:	**0**	**4,599**	**78**	**0**	**2,698**	**1,326**	**1,115**	**-2,281**	**7,534**
								Total:	**7,534**

Table 3k: 'Be lean be clean & be green' Energy demand (kWh per year)

Table 3l: Total anticipated reduction in regulated emissions & energy use		
	kWh/year/m²	**Tonnes CO_2 per year**
Total Part L1A 'Baseline' annual figures	36,249	8.21
Total 'be lean, be clean' annual figures	9,816	5.09
Total 'be lean, be clean & be green' annual figures	7,534	3.91
Contribution from renewables	**23.24%**	**23.18%**
Total reduction over Baseline	**79.22%**	**52.38%**

Solar Photovoltaics

Solar panel electricity systems, also known as solar photovoltaics (PV), capture the sun's energy using photovoltaic cells. These cells do not need direct sunlight to work – they can still generate some electricity on a cloudy day. The cells convert the sunlight into electricity, which can be used to run household appliances and lighting. When excess power is generated this can be sold back to the grid.

This is one of the chosen renewable technology on the site.

Wind Turbines

Wind turbines harness the power of the wind and use it to generate electricity. Forty percent of all the wind energy in Europe blows over the UK, making it an ideal country for domestic turbines. Urban sites such as the location of this development are generally unsuitable for wind turbine installations due to the interrupted turbulent wind flows caused by surrounding buildings and large obstacles. There are also possible issues with noise and 'flicker' for the neighbouring buildings.

The urban nature of the site and lack of space mean that a wind turbine cannot be recommended as a viable option for this development. There are also general issues surrounding the use of building mounted turbines with the potential for excessive noise and vibration within the building and the effect of flicker on surrounding buildings and amenity spaces.

Table 3m: Average wind speeds for the site	
45m above ground level	6.7m/s
25m above ground level	6.3m/s
10m above ground level	5.6m/s

Small Hydro Generation

Hydroelectricity generation uses running water to generate electricity, whether it is a small stream or a larger river. All streams and rivers flow downhill. Before the water flows down the hill, it has potential energy because of its height. Hydro power systems convert this potential energy into kinetic energy in a turbine, which drives a generator to produce electricity. Small, or 'micro' hydro generation requires a reliable source of flowing water with a reasonably constant flow velocity. Systems of this nature are normally installed in locations with a natural moving water source such as a river, stream or spring where part of the flow can be diverted through a generator.

There is no such source of flowing water in this case and small hydro generation is not an option for this development.

Solar Water heating

Solar water heating systems use free heat from the sun to warm domestic hot water. Solar hot water heating can generate a large proportion of a dwelling's annual DHW requirement. The displaced fuel would be mains gas meaning that the CO_2 savings of this type of system would be relatively low due to the low carbon intensity of the displaced fuel. Add to this the fact that only a small proportion of the development could benefit from solar thermal and consequently it is not considered to be a suitable system for this development as the roof space would be better used for PV.

Heat Pumps

Heat pumps use similar technology as refrigerators but reversed. A refrigerant liquid is used as a medium to extract heat from a source and convert it into useful heat energy. The heat source used can be generally one of three types; the ground, the air or a body of water. Both ground and water sourced heat pumps use a long circuitous pipe through which a refrigerant is pumped. In ground sourced heat pumps this can be either a coiled pipe or 'slinky' that is buried in a series of horizontal trenches or a loop inside a vertical bore hole to depths that can be up to 200m or deeper. Water sourced heat pumps generally use a similar system to the 'slinky' used for ground sourced systems but either floated on or submerged in a body of water (either a large pool or running water source). Air source heat pumps have a refrigerant coil mounted outside the building through which is passed air so that heat can be extracted. All three types of heat pump generally use the collected heat from the source to heat water. The heated water can then be used for space heating and DHW. Heat pumps require an input of energy to drive pumps, this is usually electricity and so they cannot be considered to be zero carbon unless the supplied electricity is from renewable sources; they do however have very good efficiencies; energy produced by heat pumps is typically in the region of 2.5 times that which is required to run them, giving efficiencies of 250%.

Air source heat pumps are specified for this project, this meets the Future Homes standard of ensuring new dwellings are not installed with fossil fuel systems.

Bio Energy

The Low Carbon Buildings Program (LCBP) defines biomass as follows:

"Biomass is often called 'bioenergy' or 'biofuels'. These biofuels are produced from organic materials, either directly from plants or indirectly from industrial, commercial, domestic or agricultural products. Biofuels fall into two main categories:

- *Woody biomass includes forest products, untreated wood products, energy crops, short rotation coppice (SRC), e.g. willow.*
- *Non-woody biomass includes animal waste, industrial and biodegradable municipal products from food processing and high energy crops, e.g. rape, sugar cane, maize."*

For small-scale domestic [and small scale commercial] applications of biomass the fuel usually takes the form of wood pellets, wood chips and logs. The LCBP goes on to state:

"There are two main ways of using biomass to heat a domestic property:

- *Stand-alone stoves providing space heating for a single room. These can be fuelled by logs or pellets but only pellets are suitable for automatic feed. Generally they are 5-11 kW in output, and some models can be fitted with a back boiler to provide water heating.*
- *Boilers connected to central heating and hot water systems. These are suitable for pellets, logs or chips, and are generally larger than 15 kW"*

(http://www.lowcarbonbuildings.org.uk/micro/biomass)

This technology is dismissed as the space requirements needed for the boiler and pellet store make this impractical along with complying with the clean air zone requirements.

Section 4: Sustainability

London Plan Policy 5.3 -Sustainable Design and Construction requires minor development to demonstrate that sustainable design standards are integral to the proposal, including its construction and operation, and ensure that they are considered at the beginning of the design process.

The design addresses issues regarding sustainability in a number of areas:

4.1 Management

Sustainability Objective:
To use sustainable construction methods and encourage best practice in building delivery.

Best practice will be used during construction so as to reduce the impact of works on the surrounding environment and a commitment can be made to register the site with the Considerate Contractors Scheme.

The construction site will be managed so as to reduce resource use, energy for site operations, water consumption, waste and pollution.

A system of monitoring, target setting and reporting can be put in place to ensure standards are met.

A system of commissioning will be instigated by the design team to ensure that all installed M&E systems are fully commissioned upon installation.

Home user guides will be provided to end users if requested to ensure they are provided with adequate information to enable effective use of the building and its systems. These will be tailored to ensure all building users fully understand the buildings operation so as to encourage efficient use. A programme of aftercare support will be implemented upon handover.

4.2 Health & Wellbeing

> ***Sustainability Objective:***
>
> *To provide comfortable working and living spaces that promotes a healthy environment and which is adaptable to changing needs.*

Health and wellbeing considers the environment provided for building users and how this promotes healthy happy lives.

Dwellings are designed and orientated wherever possible in such a way as to provide natural daylight, sunlight and external views to occupied spaces thus adding to the internal environment.

Each dwelling is provided with private outdoor space.

Finishing elements will be chosen which do not contain harmful chemicals such as VOCs and formaldehyde.

Every practical effort will be made to minimise sound transmission both from the external environment and between individual units. The measures employed will aim to go beyond current Building Regulation standards for minimising sound transmission wherever practical.

Dwellings have been designed to be adaptable and accessible in order to accommodate occupiers changing needs over time.

4.3 Energy

> ***Sustainability Objective:***
>
> *To ensure that the development is energy efficient in order to reduce running costs while maximising internal comfort for the building occupiers and ensure the emission of climate change gasses is minimised.*

Section 3 details the energy strategy proposed for the dwellings. A number of other areas are addressed below with an aim to reducing energy consumption with an aim to reduce running costs and lifecycle carbon emissions.

It is suggested that smart meters are requested from the energy supplier so that gas and electricity use can be monitored by occupants. Visual displays providing this information encourage energy efficiency and reduce running costs.

Space for a drying line can be provided as a retractable line on terrace space, or over the baths. This gives occupiers the opportunity to dry washing without the need for a tumble dryer when weather permits.

Information on the EU Energy Rating Scheme will be included as part of the welcome pack provided with the finished homes.

External lighting will use low energy fittings where appropriate with adequate controls such as timers, daylight sensors and, movement sensors.

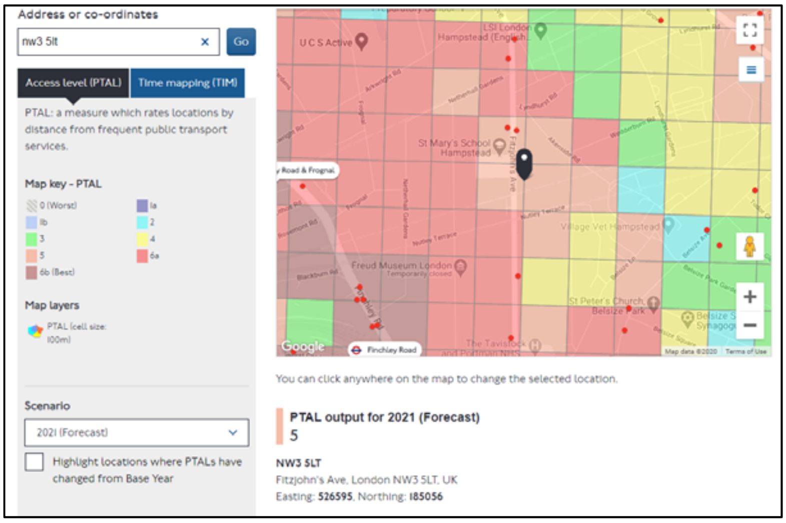
4.4 Transport

Sustainability Objective:

To reduce pollution and congestion levels. To encourage walking, cycling and the use of public transport.

As around 30% of UK energy use is associated with transport. Developments of this nature that can encourage a reduction in car use have a positive impact on the environment both through a reduced reliance on precious fossil fuel resources and a reduction in harmful emissions.

The location of the development means that it is close to local amenities and has excellent public transport links, with regular local bus services on Fitzjohns Avenue itself and the Finchley Road railway station within walking distance to the site whilst achieving a PTAL rating of 5.



4.5 Water Use

Sustainability Objective: *Conserve water through efficiency measures and recycling. Mitigating against increases in flood risk due to reduction in permeable areas and climate change.*

Clean water is a precious resource and efforts to be efficient in its use and minimise waste are of ever growing in importance. Building regulations allow for a daily potable water consumption of 125 litres/person/day in new dwellings.

The following example specification demonstrates how the higher target of 105 litres per person per day, set by Camden Council and the London Plan, can be achieved without requiring rainwater or greywater harvesting:

Maximum design flow rates & capacities:

***Taps** (other than kitchen taps)*		***5.00**(litres/min)*
Kitchen and Utility Taps		***7.00**(litres/min)*
Showers		***7.00**(litres/min)*
***Baths** (with shower over)*		***170**(litres to overflow)*
***WCs** (Flush Volume)*	***Full Flush:***	***6.00**(litres)*
	Part Flush:	***4.00**(litres)*
***Washing Machine** (Where specified)*		***8.17**(litres/kg dry load)*
***Dishwasher** (Where Specified)*		***1.25**(litres/place setting)*

It is proposed that rainwater harvesting will be supplied to provide grey water to the toilets, which could further reduce the water consumption of this development.

4.6 Materials

Sustainability Objective:
To reduce the impact of construction on natural resources by using sustainable, legally sourced product.

Building materials have a significant impact when the embodied energy and resources used in their manufacture, transport and disposal are considered. Responsible sourcing of materials can have a real beneficial effect on the embodied impact of the final development, with at least three of the key elements of the building envelope (external walls, windows roof, upper floor slabs, internal walls, floor finishes/coverings) are to achieve a rating of A+ to D in the Building Research Establishment (BRE) The Green Guide of specification.

All relevant materials in basic and finishing elements will be responsibly and legally sourced from certified suppliers using sustainable raw materials where possible and at least 50% of timber and timber products are to be sourced from accredited Forest Stewardship Council (FSC) or Programme for the Endorsement of Forestry Certification (PEFC) scheme.

All materials will be sourced from local suppliers where possible to reduce transport miles and support the local supply chain.

No construction or insulation materials are to be used which will release toxins into the internal and external environment, including those that deplete stratospheric ozone.

4.7 Waste management

Sustainability Objective:
To reduce waste going to landfill through material efficiency, recycling and sustainable construction methods.

A key part of sustainability is to manage resources efficiently. Reducing the amount of waste created and maximising resource efficiency during demolition, construction and during the building's lifetime is fundamental to providing sustainable developments.

Efforts to reduce construction waste will generally concentrate on reducing site waste together with increasing reuse and recycling of waste that cannot be avoided in an effort to reduce volumes going to landfill. This will be implemented through a Site Waste Management Plan.

Adequate facilities will be provided for the storage and recycling of household waste and recycling. Hounslow Council operates a waste & recycling collection scheme with recycling sorted prior to collection. Green waste is collected as part of the local authority scheme.

4.8 Land Use & Ecology

Sustainability Objective:

To protect, maintain and enhance existing biodiversity and habitats. To create new habitats to add value to the landscape in order to improve the urban environment.

This site is assumed to have low ecological value given that it is currently occupied by two dwellings. The nature of the development means there is opportunity to improve the ecology of the site by incorporating areas of planting. Efforts will be made to protect any existing urban habitats while encouraging new ones.

As the current site has low ecological value any undertaking to improve upon this will have a positive ecological impact.

4.9 Pollution

Sustainability Objective:

To reduce the environmental impact of atmospheric, watercourse, noise and sound pollution.

There are a variety of forms of environmental pollution that can potentially arise from the construction and use of buildings. A significant proportion is airborne in the form of dust, fumes and chemicals. Other forms of pollution include unwanted noise or light.

Best practice will be used during the construction phase to ensure that environmental pollution due to construction work will be minimised.

Efforts will be made to ensure the environmental impact of the materials used for the build will be reduced through responsible sourcing and reduced wastage.

The use of materials whose manufacture or installation requires the use of harmful global warming chemicals will be avoided.

Development of previously open land and climate change increases the chance of flash flooding and the management of surface water run-off is to be considered seriously in order to mitigate these effects.

Initial investigations of the Environment Agency Flood Map suggest that the site is inside Flood Zone 1.

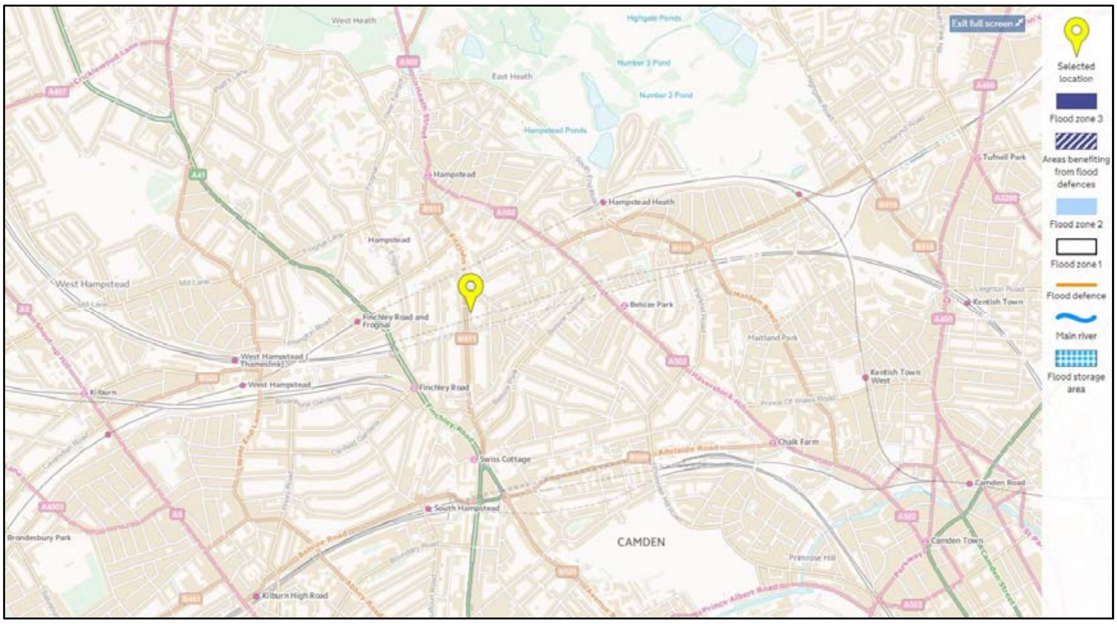


Figure 4: Environment Agency Flood Map

Section 5: Summary

This report is produced in support of a full planning application to the London Borough of Camden Council for construction of two new dwellings at 66 Fitzjohns Avenue, NW3 5LT.

Local planning policy requires that the development follows the hierarchy of energy efficiency, decentralised energy and renewable energy technologies set out in the London Plan (2016) Chapter 5.

The application is for the demolition of two existing dwellings and the construction of two new dwellings in their place. Accommodation will comprise of two, 3 bedroom houses with green roofs and off street parking.

Investigation confirms that connection to district heating and CHP are not feasible. After a review of available renewable technologies photovoltaic panels and air source heat pumps are considered most appropriate.

The building fabric combined with the energy produced by the proposed 3.0kWp photovoltaic installation will offset 52.38% of the developments regulated carbon emissions and reduce the energy demand by 79.22%. This is in line with London Plan and London Borough of Camden Council policy.

These reductions are further enhanced when assessed using the proposed SAP 10 emission factors, with a total reduction in tonnes of CO_2 of 76.96%.

Table 5a: Total anticipated reduction in regulated emissions & energy use				
	Part L		SAP 10	
	kWh/year	Tonnes CO_2 per year	kWh/year	Tonnes CO_2 per year
Total Part L1A 'Baseline' annual figures	36,249	8.21	36,249	7.64
Total 'be lean, be clean' annual figures	9,816	5.09	9,816	2.29
Total 'be lean, be clean & be green' annual figures	7,534	3.91	7,534	1.76
Contribution from PV	**23.24%**	**23.18%**	**23.24%**	**23.14%**
Total reduction over Baseline	**79.22%**	**52.38%**	**79.22%**	**76.96%**

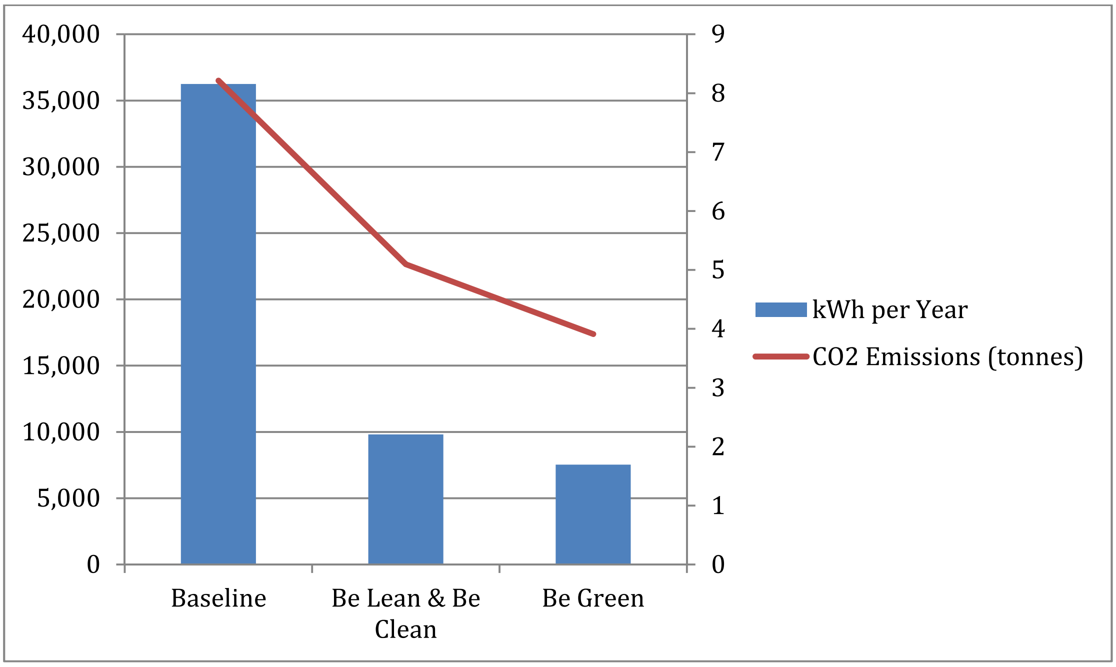


Figure 5.1: Part L Reduction through each stage of the Energy Hierarchy

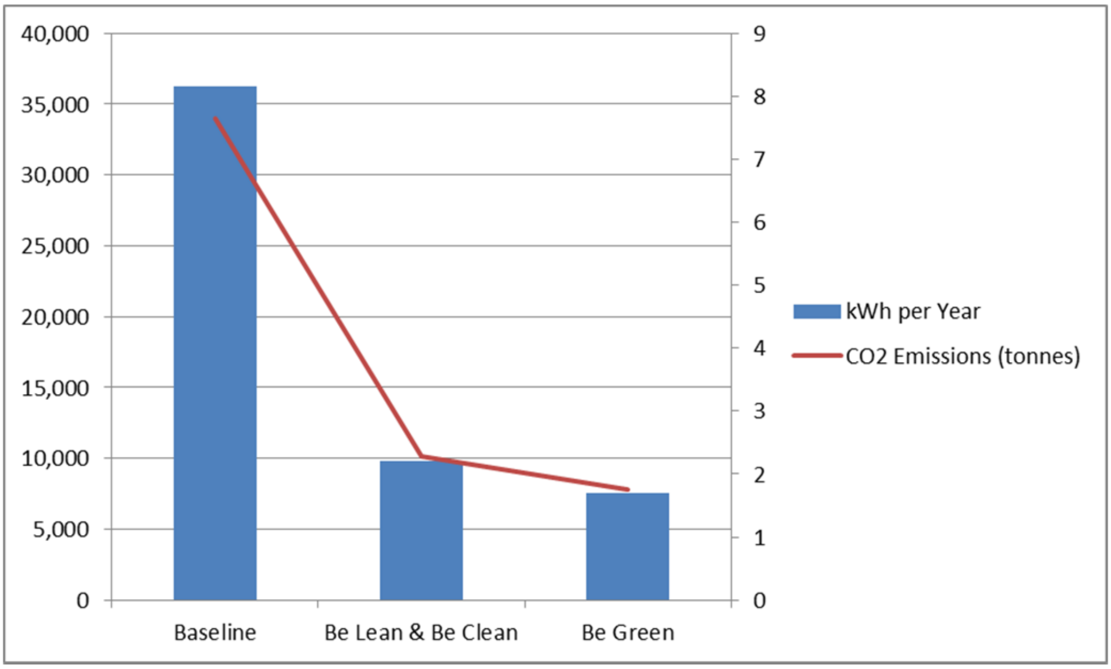


Figure 5.2: SAP 10 Reduction through each stage of the Energy Hierarchy

Appendices

SAP Calculations

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

Property Reference	0009-Webb-66-Fitzjohns-Ave-1	Issued on Date	21/07/2020
Assessment Reference	ASHP + PV	Prop Type Ref	66 Fitzjohns Avenue - 1
Property	1, Fitzjohns Avenue, London, NW3 5LT		

SAP Rating	87 B	DER	11.73	TER	24.57
Environmental	89 B	% DER<TER	52.26		
CO_2 Emissions (t/year)	1.60	DFEE	50.89	TFEE	61.98
General Requirements Compliance	Pass	% DFEE<TFEE	17.89		

Assessor Details	Mr. Andrew Gwynne, Andrew Gwynne, Tel: 01636 653055, andrew.gwynne@mesenergyservices.co.uk	Assessor ID	P742-0001
Client			

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

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

DWELLING AS DESIGNED

Semi-Detached House, total floor area 169 m²

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

1a TER and DER
Fuel for main heating:Electricity
Fuel factor:1.55 (electricity)
Target Carbon Dioxide Emission Rate (TER) 24.57 kgCO_2/m²
Dwelling Carbon Dioxide Emission Rate (DER) 11.73 kgCO_2/m²OK

1b TFEE and DFEE
Target Fabric Energy Efficiency (TFEE)62.0 kWh/m²/yr
Dwelling Fabric Energy Efficiency (DFEE)50.9 kWh/m²/yrOK

2 Fabric U-values

Element	Average	Highest	
External wall	0.16 (max. 0.30)	0.32 (max. 0.70)	OK
Party wall	0.00 (max. 0.20)	-	OK
Floor	0.09 (max. 0.25)	0.13 (max. 0.70)	OK
Roof	0.20 (max. 0.20)	0.27 (max. 0.35)	OK
Openings	1.55 (max. 2.00)	1.80 (max. 3.30)	OK

2a Thermal bridging
Thermal bridging calculated using user-specified y-value of 0.061

3 Air permeability

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

4 Heating efficiency

Main heating system:	Heat pump with radiators or underfloor - Electric
Air-to-water heat pump	
Secondary heating system:	None

5 Cylinder insulation

Hot water storage	Nominal cylinder loss: 2.26 kWh/day	
Permitted by DBSCG 2.56	OK	
Primary pipework insulated:	Yes	OK

6 Controls

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

7 Low energy lights

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

8 Mechanical ventilation

Continuous supply and extract system		
Specific fan power:	0.85	
Maximum	1.5	OK
MVHR efficiency:	85%	
Minimum:	70%	OK

9 Summertime temperature

Overheating risk (Thames Valley):	Not significant	OK
Based on:		
Overshading:	Average	
Windows facing North:	1.95 m², No overhang	
Windows facing West:	13.07 m², No overhang	
Air change rate:	8.00 ach	
Blinds/curtains:	None	

10 Key features

External wall U-value	0.14 W/m²K
External wall U-value	0.14 W/m²K
Party wall U-value	0.00 W/m²K
Floor U-value	0.09 W/m²K
Air permeability	3.0 m³/m²h
Photovoltaic array	1.50 kW

CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

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

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)
Ground floor	78.2500 (1b)	x	2.6600 (2b)	=	208.1450 (1b) - (3b)
First floor	44.2900 (1c)	x	3.3400 (2c)	=	147.9286 (1c) - (3c)
Second floor	46.6400 (1d)	x	3.0200 (2d)	=	140.8528 (1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 169.1800					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	496.9264 (5)

2. Ventilation rate

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

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

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

Balanced mechanical ventilation with heat recovery

If mechanical ventilation:	0.5000 (23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =	72.2500 (23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Effective ac	0.3013	0.2981	0.2949	0.2790	0.2758	0.2599	0.2599	0.2567	0.2663	0.2758	0.2822	0.2886	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
Window (Uw = 1.60)			7.7100	1.5038	11.5940			(27)
Fully Glazed Door (Uw = 1.60)			7.3100	1.5038	10.9925			(27)
Solid Door			1.8900	1.8000	3.4020			(26)
Roof Light (Uw = 1.40)			8.8400	1.3258	11.7197			(27a)
Basement Floor			75.9100	0.0900	6.8319	110.0000	8350.1000	(28)
Exposed Floor to Window			2.3400	0.1300	0.3042	20.0000	46.8000	(28b)
Basement Wall	65.6000		65.6000	0.1400	9.1840	9.0000	590.4000	(29a)
External Wall GF	70.3400	10.5600	59.7800	0.1700	10.1626	9.0000	538.0200	(29a)
External Wall 1st F	55.8300		55.8300	0.1700	9.4911	9.0000	502.4700	(29a)
External Wall to Window	20.3500	6.3500	14.0000	0.1400	1.9600	9.0000	126.0000	(29a)
Roof Light Upstand	6.3400		6.3400	0.3200	2.0288	9.0000	57.0600	(29a)
Flat Roof to Basement	38.1600	3.3100	34.8500	0.2700	9.4095	9.0000	313.6500	(30)
Main Flat Roof	43.2100	5.5300	37.6800	0.1300	4.8984	9.0000	339.1200	(30)
Flat Roof to Window	2.3400		2.3400	0.1800	0.4212	9.0000	21.0600	(30)
Total net area of external elements Aum(A, m2)			380.4200					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		92.3999			(33)
Party Wall			67.1600	0.0000	0.0000	110.0000	7387.6000	(32)
Internal Wall			227.1200			9.0000	2044.0800	(32c)
Internal Floor 1			37.3300			18.0000	671.9400	(32d)
Internal Floor 2			44.2900			18.0000	797.2200	(32d)
Internal Ceiling 1			37.3300			18.0000	671.9400	(32e)
Internal Ceiling 2			44.2900			18.0000	797.2200	(32e)

Heat capacity Cm = Sum(A x k)	(28)...(30) + (32) + (32a)...(32e) =	23254.6800 (34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		137.4553 (35)
Thermal bridges (User defined value 0.061 * total exposed area)		23.2056 (36)
Total fabric heat loss	(33) + (36) =	115.6055 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	49.4109	48.8882	48.3655	45.7520	45.2293	42.6158	42.6158	42.0931	43.6612	45.2293	46.2747	47.3201	(38)
Heat transfer coeff	165.0164	164.4937	163.9710	161.3575	160.8348	158.2213	158.2213	157.6986	159.2667	160.8348	161.8802	162.9256	(39)
Average = Sum(39)m / 12 =												161.2268	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.9754	0.9723	0.9692	0.9538	0.9507	0.9352	0.9352	0.9321	0.9414	0.9507	0.9569	0.9630	(40)
HLP (average)												0.9530	(40)
Days in month	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy	2.9615	(42)
Average daily hot water use (litres/day)	104.5350	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	114.9885	110.8071	106.6257	102.4443	98.2629	94.0815	94.0815	98.2629	102.4443	106.6257	110.8071	114.9885	(44)
Energy conte	170.5246	149.1419	153.9011	134.1747	128.7438	111.0962	102.9469	118.1331	119.5440	139.3170	152.0754	165.1440	(45)
Energy content (annual)										Total = Sum(45)m =		1644.7428	(45)
Distribution loss (46)m = 0.15 x (45)m	25.5787	22.3713	23.0852	20.1262	19.3116	16.6644	15.4420	17.7200	17.9316	20.8975	22.8113	24.7716	(46)

Water storage loss:		
Store volume	250.0000	(47)
b) If manufacturer declared loss factor is not known :		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.0115	(51)
Volume factor from Table 2a	0.7830	(52)
Temperature factor from Table 2b	0.5400	(53)
Enter (49) or (54) in (55)	1.2206	(55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Total storage loss	37.8386	34.1768	37.8386	36.6180	37.8386	36.6180	37.8386	37.8386	36.6180	37.8386	36.6180	37.8386	(56)
If cylinder contains dedicated solar storage	37.8386	34.1768	37.8386	36.6180	37.8386	36.6180	37.8386	37.8386	36.6180	37.8386	36.6180	37.8386	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Total heat required for water heating calculated for each month	231.6256	204.3299	215.0021	193.3047	189.8448	170.2261	164.0479	179.2341	178.6740	200.4180	211.2054	226.2450	(62)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63)
								Solar input (sum of months) = Sum(63)m =				0.0000	(63)
Output from w/h	231.6256	204.3299	215.0021	193.3047	189.8448	170.2261	164.0479	179.2341	178.6740	200.4180	211.2054	226.2450	(64)
								Total per year (kWh/year) = Sum(64)m =				2364.1577	(64)
Heat gains from water heating, kWh/month	105.5802	93.7401	100.0529	91.9171	91.6881	84.2435	83.1106	88.1600	87.0524	95.2037	97.8691	103.7912	(65)

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	148.0737	148.0737	148.0737	148.0737	148.0737	148.0737	148.0737	148.0737	148.0737	148.0737	148.0737	148.0737	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	32.0321	28.4506	23.1376	17.5166	13.0939	11.0544	11.9447	15.5262	20.8392	26.4601	30.8829	32.9223	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	340.7125	344.2480	335.3386	316.3715	292.4289	269.9263	254.8932	251.3576	260.2671	279.2342	303.1767	325.6793	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	37.8074	37.8074	37.8074	37.8074	37.8074	37.8074	37.8074	37.8074	37.8074	37.8074	37.8074	37.8074	(69)
Pumps, fans	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)	-118.4590	-118.4590	-118.4590	-118.4590	-118.4590	-118.4590	-118.4590	-118.4590	-118.4590	-118.4590	-118.4590	-118.4590	(71)
Water heating gains (Table 5)	141.9089	139.4942	134.4797	127.6626	123.2367	117.0048	111.7079	118.4947	120.9061	127.9619	135.9292	139.5043	(72)
Total internal gains	585.0756	582.6149	563.3780	531.9729	499.1817	468.4076	448.9678	455.8006	472.4344	504.0783	540.4109	568.5281	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	1.9500	10.6334	0.6300	0.7000	0.7700	6.3369	(74)
West	5.7600	19.6403	0.6300	0.7000	0.7700	34.5734	(80)
West	7.3100	19.6403	0.6300	0.7000	0.7700	43.8770	(80)
Horizontal	8.8400	26.0000	0.6300	0.7000	1.0000	91.2235	(82)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	176.0107	355.0398	610.1391	927.9432	1169.9101	1211.8154	1147.8794	964.3267	722.1723	428.0826	221.4194	143.4770	(83)
Total gains	761.0863	937.6547	1173.5172	1459.9161	1669.0918	1680.2231	1596.8472	1420.1273	1194.6067	932.1610	761.8304	712.0051	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	39.1454	39.2698	39.3950	40.0331	40.1632	40.8266	40.8266	40.9619	40.5586	40.1632	39.9038	39.6477	
alpha	3.6097	3.6180	3.6263	3.6689	3.6775	3.7218	3.7218	3.7308	3.7039	3.6775	3.6603	3.6432	
util living area	0.9930	0.9848	0.9593	0.8831	0.7412	0.5626	0.4245	0.4895	0.7534	0.9449	0.9874	0.9945	(86)
MIT	19.5653	19.7514	20.0728	20.4725	20.7494	20.8811	20.9149	20.9068	20.7904	20.3841	19.9020	19.5411	(87)
Th 2	20.1039	20.1065	20.1091	20.1220	20.1246	20.1377	20.1377	20.1403	20.1324	20.1246	20.1194	20.1143	(88)
util rest of house	0.9917	0.9818	0.9514	0.8614	0.6979	0.4983	0.3459	0.4060	0.6947	0.9302	0.9845	0.9934	(89)
MIT 2	18.1488	18.4215	18.8875	19.4597	19.8263	19.9921	20.0239	20.0209	19.8939	19.3501	18.6519	18.1210	(90)
Living area fraction									fLA = Living area / (4) =			0.2660	(91)
MIT	18.5256	18.7752	19.2028	19.7291	20.0718	20.2286	20.2609	20.2565	20.1324	19.6251	18.9844	18.4987	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.5256	18.7752	19.2028	19.7291	20.0718	20.2286	20.2609	20.2565	20.1324	19.6251	18.9844	18.4987	(93)

CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9883	0.9760	0.9414	0.8502	0.6951	0.5053	0.3574	0.4177	0.6947	0.9197	0.9794	0.9907	(94)
Useful gains	752.2161	915.1801	1104.7085	1241.2151	1160.1070	849.0745	570.6841	593.2019	829.8515	857.2942	746.1207	705.3933	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W	2347.4517	2282.3870	2082.8927	1747.3528	1346.4789	890.5565	579.2286	608.1676	960.7573	1451.5508	1923.8478	2329.6305	(97)
Month fracti	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000	(97a)
Space heating kWh	1186.8553	918.7630	727.7690	364.4191	138.6607	0.0000	0.0000	0.0000	0.0000	442.1269	847.9635	1208.4325	(98)
Space heating												5834.9900	(98)
Space heating per m2											(98) / (4) =	34.4898	(99)

8c. Space cooling requirement

Calculated for June, July and August. See Table 10b

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ext. temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	
Heat loss rate W	0.0000	0.0000	0.0000	0.0000	0.0000	1487.2799	1170.8374	1198.5091	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.8815	0.9261	0.8983	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	1311.0450	1084.3661	1076.6263	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	1960.4113	1866.6880	1681.5651	0.0000	0.0000	0.0000	0.0000	(103)
Month fracti	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	(103a)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	467.5438	582.0475	450.0745	0.0000	0.0000	0.0000	0.0000	(104)
Space cooling												1499.6658	(104)
Cooled fraction										fC = cooled area / (4) =		0.4378	(105)
Intermittency factor (Table 10b)	0.0000	0.0000	0.0000	0.0000	0.0000	0.2500	0.2500	0.2500	0.0000	0.0000	0.0000	0.0000	(106)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	51.1747	63.7077	49.2626	0.0000	0.0000	0.0000	0.0000	(107)
Space cooling												164.1451	(107)
Space cooling per m2												0.9702	(108)

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

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(201)
Fraction of space heat from main system(s)	1.0000	(202)
Efficiency of main space heating system 1 (in %)	249.9000	(206)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)
Space heating requirement	2334.9300	(211)
Cooling System Energy Efficiency Ratio (see Table 10c)	4.3200	(209)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	1186.8553	918.7630	727.7690	364.4191	138.6607	0.0000	0.0000	0.0000	0.0000	442.1269	847.9635	1208.4325	(98)
Space heating efficiency (main heating system 1)	249.9000	249.9000	249.9000	249.9000	249.9000	0.0000	0.0000	0.0000	0.0000	249.9000	249.9000	249.9000	(210)
Space heating fuel (main heating system)	474.9321	367.6523	291.2241	145.8260	55.4865	0.0000	0.0000	0.0000	0.0000	176.9215	339.3211	483.5664	(211)
Water heating requirement	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water heating requirement	231.6256	204.3299	215.0021	193.3047	189.8448	170.2261	164.0479	179.2341	178.6740	200.4180	211.2054	226.2450	(64)
Efficiency of water heater												175.1000	(216)
(217)m	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	(217)
Fuel for water heating, kWh/month	132.2819	116.6933	122.7882	110.3968	108.4208	97.2165	93.6881	102.3610	102.0411	114.4591	120.6199	129.2090	(219)
Water heating fuel used												1350.1757	(219)
Space cooling fuel requirement (221)m	0.0000	0.0000	0.0000	0.0000	0.0000	11.8460	14.7471	11.4034	0.0000	0.0000	0.0000	0.0000	(221)
Cooling												37.9965	(221)

Annual totals kWh/year

Space heating fuel - main system	2334.9300	(211)
Space heating fuel - secondary	0.0000	(215)

Electricity for pumps and fans:
(BalancedWithHeatRecovery, DataSheet: in-use factor = 1.2500, SFP = 1.0625)

mechanical ventilation fans (SFP = 1.0625)	644.1408	(230a)
central heating pump	30.0000	(230c)
Total electricity for the above, kWh/year	674.1408	(231)
Electricity for lighting (calculated in Appendix L)	565.6965	(232)

Energy saving/generation technologies (Appendices M ,N and Q)

PV Unit 0 (0.80 * 1.50 * 951 * 1.00) =	-1140.7392	-1140.7392	(233)
Total delivered energy for all uses		3822.2004	(238)

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	2334.9300	0.5190	1211.8287	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	1350.1757	0.5190	700.7412	(264)
Space and water heating			1912.5699	(265)
Space cooling	37.9965	0.5190	19.7202	(266)

CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

Pumps and fans	674.1408	0.5190	349.8791 (267)
Energy for lighting	565.6965	0.5190	293.5965 (268)
Energy saving/generation technologies			
PV Unit	-1140.7392	0.5190	-592.0436 (269)
Total CO2, kg/year			1983.7220 (272)
Dwelling Carbon Dioxide Emission Rate (DER)			11.7300 (273)

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

DER		11.7300	ZC1
Total Floor Area	TFA	169.1800	
Assumed number of occupants	N	2.9615	
CO2 emission factor in Table 12 for electricity displaced from grid	EF	0.5190	
CO2 emissions from appliances, equation (L14)		11.9340	ZC2
CO2 emissions from cooking, equation (L16)		1.1235	ZC3
Total CO2 emissions		24.7875	ZC4
Residual CO2 emissions offset from biofuel CHP		0.0000	ZC5
Additional allowable electricity generation, kWh/m²/year		0.0000	ZC6
Resulting CO2 emissions offset from additional allowable electricity generation		0.0000	ZC7
Net CO2 emissions		24.7875	ZC8

CALCULATION OF TARGET EMISSIONS 09 Jan 2014

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

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	78.2500 (1b)	x	2.6600 (2b)	=	208.1450	(1b) - (3b)
First floor	44.2900 (1c)	x	3.3400 (2c)	=	147.9286	(1c) - (3c)
Second floor	46.6400 (1d)	x	3.0200 (2d)	=	140.8528	(1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 169.1800						(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	496.9264	(5)

2. Ventilation rate

	main heating		secondary heating		other		total	m3 per hour	
Number of chimneys	0	+	0	+	0	=	0 * 40 =	0.0000	(6a)
Number of open flues	0	+	0	+	0	=	0 * 20 =	0.0000	(6b)
Number of intermittent fans							4 * 10 =	40.0000	(7a)
Number of passive vents							0 * 10 =	0.0000	(7b)
Number of flueless gas fires							0 * 40 =	0.0000	(7c)

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	40.0000 / (5) =	0.0805	(8)
Pressure test		Yes	
Measured/design AP50		5.0000	
Infiltration rate		0.3305	(18)
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.2809	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.3582	0.3512	0.3441	0.3090	0.3020	0.2669	0.2669	0.2599	0.2809	0.3020	0.3160	0.3301	(22b)
Effective ac	0.5641	0.5617	0.5592	0.5477	0.5456	0.5356	0.5356	0.5338	0.5395	0.5456	0.5499	0.5545	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
TER Opaque door			1.8900	1.0000	1.8900			(26)
TER Opening Type (Uw = 1.40)			15.0200	1.3258	19.9129			(27)
TER Room Window (Uw = 1.70)			8.8400	1.5918	14.0712			(27a)
Basement Floor			75.9100	0.1300	9.8683			(28)
Exposed Floor to Window			2.3400	0.1300	0.3042			(28b)
Basement Wall	65.6000		65.6000	0.1800	11.8080			(29a)
External Wall GF	70.3400	10.5600	59.7800	0.1800	10.7604			(29a)
External Wall 1st F	55.8300		55.8300	0.1800	10.0494			(29a)
External Wall to Window	20.3500	6.3500	14.0000	0.1800	2.5200			(29a)
Roof Light Upstand	6.3400		6.3400	0.1800	1.1412			(29a)
Flat Roof to Basement	38.1600	3.3100	34.8500	0.1300	4.5305			(30)
Main Flat Roof	43.2100	5.5300	37.6800	0.1300	4.8984			(30)
Flat Roof to Window	2.3400		2.3400	0.1300	0.3042			(30)
Total net area of external elements Aum(A, m2)			380.4200					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		92.0586			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		250.0000	(35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)		21.8244	(36)
Total fabric heat loss	(33) + (36) =	113.8830	(37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	92.5116	92.1031	91.7028	89.8223	89.4704	87.8326	87.8326	87.5292	88.4634	89.4704	90.1822	90.9263	(38)
Heat transfer coeff	206.3946	205.9862	205.5858	203.7053	203.3535	201.7156	201.7156	201.4123	202.3465	203.3535	204.0652	204.8093	(39)
Average = Sum(39)m / 12 =												203.7036	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.2200	1.2176	1.2152	1.2041	1.2020	1.1923	1.1923	1.1905	1.1960	1.2020	1.2062	1.2106	(40)
HLP (average)												1.2041	(40)
Days in month	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy	2.9615	(42)
Average daily hot water use (litres/day)	104.5350	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daily hot water use												

CALCULATION OF TARGET EMISSIONS 09 Jan 2014

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	114.9885	110.8071	106.6257	102.4443	98.2629	94.0815	94.0815	98.2629	102.4443	106.6257	110.8071	114.9885	(44)
Energy conte	170.5246	149.1419	153.9011	134.1747	128.7438	111.0962	102.9469	118.1331	119.5440	139.3170	152.0754	165.1440	(45)

Energy content (annual) Total = Sum(45)m = 1644.7428 (45)

Distribution loss (46)m = 0.15 x (45)m

	25.5787	22.3713	23.0852	20.1262	19.3116	16.6644	15.4420	17.7200	17.9316	20.8975	22.8113	24.7716	(46)

Water storage loss:

Store volume 250.0000 (47)

a) If manufacturer declared loss factor is known (kWh/day): 1.8903 (48)

Temperature factor from Table 2b 0.5400 (49)

Enter (49) or (54) in (55) 1.0208 (55)

Total storage loss	31.6444	28.5820	31.6444	30.6236	31.6444	30.6236	31.6444	31.6444	30.6236	31.6444	30.6236	31.6444	(56)
If cylinder contains dedicated solar storage	31.6444	28.5820	31.6444	30.6236	31.6444	30.6236	31.6444	31.6444	30.6236	31.6444	30.6236	31.6444	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Total heat required for water heating calculated for each month	225.4314	198.7352	208.8079	187.3103	183.6506	164.2318	157.8537	173.0399	172.6796	194.2238	205.2110	220.0508	(62)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63)

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

Output from w/h	225.4314	198.7352	208.8079	187.3103	183.6506	164.2318	157.8537	173.0399	172.6796	194.2238	205.2110	220.0508	(64)

Total per year (kWh/year) = Sum(64)m = 2291.2259 (64)

Heat gains from water heating, kWh/month	100.6249	89.2643	95.0976	87.1216	86.7328	79.4480	78.1553	83.2047	82.2569	90.2483	93.0735	98.8358	(65)

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	148.0737	148.0737	148.0737	148.0737	148.0737	148.0737	148.0737	148.0737	148.0737	148.0737	148.0737	148.0737	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	32.0321	28.4506	23.1376	17.5166	13.0939	11.0544	11.9447	15.5262	20.8392	26.4601	30.8829	32.9223	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	340.7125	344.2480	335.3386	316.3715	292.4289	269.9263	254.8932	251.3576	260.2671	279.2342	303.1767	325.6793	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	37.8074	37.8074	37.8074	37.8074	37.8074	37.8074	37.8074	37.8074	37.8074	37.8074	37.8074	37.8074	(69)
Pumps, fans	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)	-118.4590	-118.4590	-118.4590	-118.4590	-118.4590	-118.4590	-118.4590	-118.4590	-118.4590	-118.4590	-118.4590	-118.4590	(71)
Water heating gains (Table 5)	135.2485	132.8337	127.8193	121.0022	116.5763	110.3444	105.0474	111.8343	114.2456	121.3015	129.2688	132.8438	(72)
Total internal gains	578.4152	575.9545	556.7176	525.3124	492.5212	461.7472	442.3074	449.1402	465.7740	497.4179	533.7505	561.8676	(73)

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6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	1.9500	10.6334	0.6300	0.7000	0.7700	6.3369	(74)
West	13.0700	19.6403	0.6300	0.7000	0.7700	78.4503	(80)
Horizontal	8.8400	26.0000	0.6300	0.7000	1.0000	91.2235	(82)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	176.0107	355.0398	610.1391	927.9432	1169.9101	1211.8154	1147.8794	964.3267	722.1723	428.0826	221.4194	143.4770	(83)
Total gains	754.4259	930.9943	1166.8567	1453.2557	1662.4314	1673.5627	1590.1868	1413.4669	1187.9463	925.5005	755.1699	705.3447	(84)

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7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	56.9230	57.0359	57.1470	57.6745	57.7743	58.2434	58.2434	58.3312	58.0619	57.7743	57.5728	57.3636	
alpha	4.7949	4.8024	4.8098	4.8450	4.8516	4.8829	4.8829	4.8887	4.8708	4.8516	4.8382	4.8242	
util living area	0.9995	0.9984	0.9933	0.9667	0.8778	0.7080	0.5434	0.6242	0.8891	0.9897	0.9988	0.9996	(86)
MIT	19.5240	19.6911	20.0004	20.4174	20.7625	20.9415	20.9871	20.9757	20.8129	20.3407	19.8558	19.4979	(87)
Th 2	19.9041	19.9060	19.9079	19.9167	19.9184	19.9262	19.9262	19.9276	19.9232	19.9184	19.9150	19.9115	(88)
util rest of house	0.9993	0.9978	0.9907	0.9534	0.8313	0.6135	0.4183	0.4939	0.8263	0.9839	0.9983	0.9995	(89)
MIT 2	17.9237	18.1694	18.6219	19.2254	19.6854	19.8877	19.9215	19.9175	19.7645	19.1256	18.4171	17.8907	(90)

Living area fraction fLA = Living area / (4) = 0.2660 (91)

MIT	18.3494	18.5742	18.9886	19.5425	19.9719	20.1680	20.2049	20.1990	20.0434	19.4488	18.7998	18.3182	(92)

Temperature adjustment 0.0000

adjusted MIT	18.3494	18.5742	18.9886	19.5425	19.9719	20.1680	20.2049	20.1990	20.0434	19.4488	18.7998	18.3182	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9988	0.9967	0.9876	0.9475	0.8340	0.6363	0.4518	0.5286	0.8347	0.9803	0.9974	0.9992	(94)
Useful gains	753.5485	927.9293	1152.3689	1376.8876	1386.3867	1064.8792	718.4330	747.2111	991.5999	907.2730	753.1983	704.7543	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W	2899.7127	2816.6934	2567.4696	2167.9261	1682.1215	1123.1497	727.1690	765.1627	1202.6216	1799.4389	2387.5122	2891.5398	(97)
Month fracti	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000	(97a)
Space heating kWh	1596.7461	1269.2494	1052.8349	569.5477	220.0267	0.0000	0.0000	0.0000	0.0000	663.7714	1176.7060	1626.9684	(98)

CALCULATION OF TARGET EMISSIONS 09 Jan 2014

Space heating		8175.8507	(98)
Space heating per m2	(98) / (4) =	48.3263	(99)

8c. Space cooling requirement

Not applicable

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

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(201)
Fraction of space heat from main system(s)	1.0000	(202)
Efficiency of main space heating system 1 (in %)	93.5000	(206)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)
Space heating requirement	8744.2254	(211)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	1596.7461	1269.2494	1052.8349	569.5477	220.0267	0.0000	0.0000	0.0000	0.0000	663.7714	1176.7060	1626.9684	(98)
Space heating efficiency (main heating system 1)	93.5000	93.5000	93.5000	93.5000	93.5000	0.0000	0.0000	0.0000	0.0000	93.5000	93.5000	93.5000	(210)
Space heating fuel (main heating system)	1707.7499	1357.4860	1126.0266	609.1420	235.3226	0.0000	0.0000	0.0000	0.0000	709.9160	1258.5091	1740.0732	(211)
Water heating requirement	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water heating requirement	225.4314	198.7352	208.8079	187.3103	183.6506	164.2318	157.8537	173.0399	172.6796	194.2238	205.2110	220.0508	(64)
Efficiency of water heater												79.8000	(216)
(217)m	89.0232	88.8865	88.5352	87.5933	85.2968	79.8000	79.8000	79.8000	79.8000	87.8340	88.7332	89.0770	(217)
Fuel for water heating, kWh/month	253.2276	223.5831	235.8472	213.8409	215.3078	205.8042	197.8117	216.8420	216.3904	221.1260	231.2674	247.0343	(219)

Water heating fuel used	2678.0825	(219)
Annual totals kWh/year		
Space heating fuel - main system	8744.2254	(211)
Space heating fuel - secondary	0.0000	(215)
Electricity for pumps and fans:		
central heating pump	30.0000	(230c)
main heating flue fan	45.0000	(230e)
Total electricity for the above, kWh/year	75.0000	(231)
Electricity for lighting (calculated in Appendix L)	565.6965	(232)
Total delivered energy for all uses	12063.0044	(238)

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	8744.2254	0.2160	1888.7527	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	2678.0825	0.2160	578.4658	(264)
Space and water heating			2467.2185	(265)
Pumps and fans	75.0000	0.5190	38.9250	(267)
Energy for lighting	565.6965	0.5190	293.5965	(268)
Total CO2, kg/m2/year			2799.7400	(272)
Emissions per m2 for space and water heating			14.5834	(272a)
Fuel factor (electricity)			1.5500	
Emissions per m2 for lighting			1.7354	(272b)
Emissions per m2 for pumps and fans			0.2301	(272c)
Target Carbon Dioxide Emission Rate (TER) = (14.5834 * 1.55) + 1.7354 + 0.2301, rounded to 2 d.p.			24.5700	(273)

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

Property Reference	0009-Webb-66-Fitzjohns-Ave-2	**Issued on Date**	21/07/2020
Assessment Reference	ASHP + PV	**Prop Type Ref**	66 Fitzjohns Avenue - 2
Property	2, Fitzjohns Avenue, London, NW3 5LT		

SAP Rating	87 B	**DER**	11.87	**TER**	24.99
Environmental	89 B	**% DER<TER**	52.50		
CO_2 Emissions (t/year)	1.55	**DFEE**	51.49	**TFEE**	62.75
General Requirements Compliance	Pass	**% DFEE<TFEE**	17.93		

Assessor Details	Mr. Andrew Gwynne, Andrew Gwynne, Tel: 01636 653055, andrew.gwynne@mesenergyservices.co.uk	**Assessor ID**	P742-0001
Client			

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

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

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

DWELLING AS DESIGNED

Semi-Detached House, total floor area 162 m²

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

1a TER and DER
Fuel for main heating:Electricity
Fuel factor:1.55 (electricity)
Target Carbon Dioxide Emission Rate (TER) 24.99 kgCO_2/m²
Dwelling Carbon Dioxide Emission Rate (DER) 11.87 kgCO_2/m²OK

1b TFEE and DFEE
Target Fabric Energy Efficiency (TFEE)62.7 kWh/m²/yr
Dwelling Fabric Energy Efficiency (DFEE)51.5 kWh/m²/yrOK

2 Fabric U-values

Element	Average	Highest	
External wall	0.16 (max. 0.30)	0.32 (max. 0.70)	OK
Party wall	0.00 (max. 0.20)	-	OK
Floor	0.09 (max. 0.25)	0.13 (max. 0.70)	OK
Roof	0.19 (max. 0.20)	0.27 (max. 0.35)	OK
Openings	1.55 (max. 2.00)	1.80 (max. 3.30)	OK

2a Thermal bridging
Thermal bridging calculated using user-specified y-value of 0.063

3 Air permeability

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

4 Heating efficiency

Main heating system:	Heat pump with radiators or underfloor - Electric	
Air-to-water heat pump		
Secondary heating system:	None	

5 Cylinder insulation

Hot water storage	Nominal cylinder loss: 2.26 kWh/day	
Permitted by DBSCG 2.56	OK	
Primary pipework insulated:	Yes	OK

6 Controls

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

7 Low energy lights

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

8 Mechanical ventilation

Continuous supply and extract system		
Specific fan power:	0.85	
Maximum	1.5	OK
MVHR efficiency:	85%	
Minimum:	70%	OK

9 Summertime temperature

Overheating risk (Thames Valley):	Not significant	OK
Based on:		
Overshading:	Average	
Windows facing North:	1.95 m², No overhang	
Windows facing West:	13.07 m², No overhang	
Air change rate:	8.00 ach	
Blinds/curtains:	None	

10 Key features

External wall U-value	0.14 W/m²K
External wall U-value	0.14 W/m²K
Party wall U-value	0.00 W/m²K
Floor U-value	0.09 W/m²K
Air permeability	3.0 m³/m²h
Photovoltaic array	1.50 kW

CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

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

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)
Ground floor	71.3900 (1b)	x	2.6700 (2b)	=	190.6113 (1b) - (3b)
First floor	44.2900 (1c)	x	3.3400 (2c)	=	147.9286 (1c) - (3c)
Second floor	46.6400 (1d)	x	3.0200 (2d)	=	140.8528 (1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 162.3200					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	479.3927 (5)

2. Ventilation rate

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

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

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

Balanced mechanical ventilation with heat recovery
If mechanical ventilation: 0.5000 (23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 72.2500 (23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Effective ac	0.3013	0.2981	0.2949	0.2790	0.2758	0.2599	0.2599	0.2567	0.2663	0.2758	0.2822	0.2886	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
Window (Uw = 1.60)			7.7100	1.5038	11.5940			(27)
Fully Glazed Door (Uw = 1.60)			7.3100	1.5038	10.9925			(27)
Solid Door			1.8900	1.8000	3.4020			(26)
Roof Light (Uw = 1.40)			8.8400	1.3258	11.7197			(27a)
Basement Floor			71.3900	0.0900	6.4251	110.0000	7852.9000	(28)
Exposed Floor to Window			2.3400	0.1300	0.3042	20.0000	46.8000	(28b)
Basement Wall	64.5600		64.5600	0.1400	9.0384	9.0000	581.0400	(29a)
External Wall GF	70.3400	10.5600	59.7800	0.1700	10.1626	9.0000	538.0200	(29a)
External Wall 1st F	55.8300		55.8300	0.1700	9.4911	9.0000	502.4700	(29a)
External Wall to Window	20.3500	6.3500	14.0000	0.1400	1.9600	9.0000	126.0000	(29a)
Roof Light Upstand	6.3400		6.3400	0.3200	2.0288	9.0000	57.0600	(29a)
Flat Roof to Basement	32.6400	3.3100	29.3300	0.2700	7.9191	9.0000	263.9700	(30)
Main Flat Roof	43.2100	5.5300	37.6800	0.1300	4.8984	9.0000	339.1200	(30)
Flat Roof to Window	2.3400		2.3400	0.1800	0.4212	9.0000	21.0600	(30)
Total net area of external elements Aum(A, m2)			369.3400					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		90.3571			(33)
Party Wall			67.1600	0.0000	0.0000	110.0000	7387.6000	(32)
Internal Wall			227.1200			9.0000	2044.0800	(32c)
Internal Floor 1			38.7400			18.0000	697.3200	(32d)
Internal Floor 2			44.2900			18.0000	797.2200	(32d)
Internal Ceiling 1			38.7400			18.0000	697.3200	(32e)
Internal Ceiling 2			44.2900			18.0000	797.2200	(32e)

Heat capacity Cm = Sum(A x k)	(28)...(30) + (32) + (32a)...(32e) =	22749.2000 (34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		140.1503 (35)
Thermal bridges (User defined value 0.063 * total exposed area)		23.2684 (36)
Total fabric heat loss	(33) + (36) =	113.6255 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	47.6675	47.1633	46.6590	44.1377	43.6334	41.1121	41.1121	40.6079	42.1206	43.6334	44.6419	45.6505	(38)
Heat transfer coeff	161.2930	160.7887	160.2845	157.7632	157.2589	154.7376	154.7376	154.2333	155.7461	157.2589	158.2674	159.2760	(39)
Average = Sum(39)m / 12 =												157.6371	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	0.9937	0.9906	0.9875	0.9719	0.9688	0.9533	0.9533	0.9502	0.9595	0.9688	0.9750	0.9812	(40)
HLP (average)												0.9712	(40)
Days in month	31	28	31	30	31	30	31	31	30	31	30	31	(41)

CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

4. Water heating energy requirements (kWh/year)

Assumed occupancy	2.9521	(42)
Average daily hot water use (litres/day)	104.3133	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	114.7446	110.5721	106.3996	102.2270	98.0545	93.8820	93.8820	98.0545	102.2270	106.3996	110.5721	114.7446	(44)
Energy conte	170.1630	148.8256	153.5747	133.8902	128.4708	110.8605	102.7286	117.8825	119.2904	139.0215	151.7528	164.7938	(45)
Energy content (annual)										Total = Sum(45)m =		1641.2545	(45)
Distribution loss (46)m = 0.15 x (45)m	25.5244	22.3238	23.0362	20.0835	19.2706	16.6291	15.4093	17.6824	17.8936	20.8532	22.7629	24.7191	(46)

Water storage loss:

Store volume	250.0000	(47)
b) If manufacturer declared loss factor is not known :		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.0115	(51)
Volume factor from Table 2a	0.7830	(52)
Temperature factor from Table 2b	0.5400	(53)
Enter (49) or (54) in (55)	1.2206	(55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Total storage loss	37.8386	34.1768	37.8386	36.6180	37.8386	36.6180	37.8386	37.8386	36.6180	37.8386	36.6180	37.8386	(56)
If cylinder contains dedicated solar storage	37.8386	34.1768	37.8386	36.6180	37.8386	36.6180	37.8386	37.8386	36.6180	37.8386	36.6180	37.8386	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Total heat required for water heating calculated for each month	231.2640	204.0136	214.6757	193.0202	189.5718	169.9905	163.8296	178.9835	178.4204	200.1225	210.8828	225.8948	(62)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63)
								Solar input (sum of months) = Sum(63)m =				0.0000	(63)
Output from w/h	231.2640	204.0136	214.6757	193.0202	189.5718	169.9905	163.8296	178.9835	178.4204	200.1225	210.8828	225.8948	(64)
								Total per year (kWh/year) = Sum(64)m =				2360.6695	(64)
Heat gains from water heating, kWh/month	105.4600	93.6349	99.9444	91.8225	91.5973	84.1651	83.0380	88.0767	86.9681	95.1054	97.7618	103.6747	(65)

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	147.6070	147.6070	147.6070	147.6070	147.6070	147.6070	147.6070	147.6070	147.6070	147.6070	147.6070	147.6070	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	31.1026	27.6251	22.4662	17.0084	12.7140	10.7337	11.5981	15.0757	20.2345	25.6924	29.9868	31.9671	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	333.6317	337.0938	328.3695	309.7966	286.3516	264.3167	249.5959	246.1339	254.8581	273.4311	296.8760	318.9110	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	37.7607	37.7607	37.7607	37.7607	37.7607	37.7607	37.7607	37.7607	37.7607	37.7607	37.7607	37.7607	(69)
Pumps, fans	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)	-118.0856	-118.0856	-118.0856	-118.0856	-118.0856	-118.0856	-118.0856	-118.0856	-118.0856	-118.0856	-118.0856	-118.0856	(71)
Water heating gains (Table 5)	141.7473	139.3377	134.3339	127.5312	123.1147	116.8960	111.6103	118.3827	120.7890	127.8299	135.7803	139.3477	(72)
Total internal gains	576.7638	574.3387	555.4517	524.6183	492.4624	462.2284	443.0864	449.8743	466.1637	497.2354	532.9252	560.5079	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	1.9500	10.6334	0.6300	0.7000	0.7700	6.3369	(74)
West	5.7600	19.6403	0.6300	0.7000	0.7700	34.5734	(80)
West	7.3100	19.6403	0.6300	0.7000	0.7700	43.8770	(80)
Horizontal	8.8400	26.0000	0.6300	0.7000	1.0000	91.2235	(82)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains	176.0107	355.0398	610.1391	927.9432	1169.9101	1211.8154	1147.8794	964.3267	722.1723	428.0826	221.4194	143.4770	(83)
Total gains	752.7745	929.3785	1165.5909	1452.5615	1662.3725	1674.0439	1590.9658	1414.2011	1188.3360	925.3181	754.3446	703.9850	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C)	21.0000	(85)
Utilisation factor for gains for living area, nil,m (see Table 9a)		

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	39.1785	39.3014	39.4250	40.0551	40.1836	40.8383	40.8383	40.9718	40.5739	40.1836	39.9275	39.6747	
alpha	3.6119	3.6201	3.6283	3.6703	3.6789	3.7226	3.7226	3.7315	3.7049	3.6789	3.6618	3.6450	
util living area	0.9928	0.9841	0.9575	0.8783	0.7333	0.5542	0.4174	0.4819	0.7462	0.9426	0.9869	0.9943	(86)
MIT	19.5721	19.7605	20.0842	20.4834	20.7561	20.8834	20.9156	20.9079	20.7951	20.3920	19.9088	19.5472	(87)
Th 2	20.0886	20.0912	20.0938	20.1068	20.1094	20.1224	20.1224	20.1251	20.1172	20.1094	20.1042	20.0990	(88)
util rest of house	0.9913	0.9810	0.9491	0.8556	0.6888	0.4891	0.3384	0.3978	0.6858	0.9271	0.9838	0.9932	(89)
MIT 2	18.1459	18.4218	18.8906	19.4608	19.8199	19.9793	20.0093	20.0066	19.8848	19.3479	18.6488	18.1171	(90)
Living area fraction									fLA = Living area / (4) =			0.2772	(91)
MIT	18.5413	18.7929	19.2215	19.7443	20.0795	20.2300	20.2605	20.2565	20.1372	19.6374	18.9981	18.5135	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.5413	18.7929	19.2215	19.7443	20.0795	20.2300	20.2605	20.2565	20.1372	19.6374	18.9981	18.5135	(93)

CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9880	0.9752	0.9391	0.8451	0.6872	0.4974	0.3511	0.4108	0.6873	0.9169	0.9787	0.9904	(94)
Useful gains	743.7216	906.2867	1094.6297	1227.4902	1142.3995	832.6780	558.5549	580.9596	816.7925	848.4017	738.2531	697.2417	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W	2297.0201	2233.8208	2039.0621	1710.8315	1317.7439	871.1695	566.4196	594.7975	940.2653	1421.2044	1883.0811	2279.8032	(97)
Month fracti	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000	(97a)
Space heating kWh	1155.6541	892.1029	702.6577	348.0057	130.4562	0.0000	0.0000	0.0000	0.0000	426.1652	824.2762	1177.4258	(98)

Space heating 5656.7438 (98)
Space heating per m2 (98) / (4) = 34.8493 (99)

8c. Space cooling requirement

Calculated for June, July and August. See Table 10b

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ext. temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	
Heat loss rate W	0.0000	0.0000	0.0000	0.0000	0.0000	1454.5335	1145.0583	1172.1734	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.8863	0.9295	0.9024	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	1289.1336	1064.3114	1057.7874	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	1950.8760	1857.5656	1672.2782	0.0000	0.0000	0.0000	0.0000	(103)
Month fracti	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	(103a)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	476.4546	590.1811	457.1812	0.0000	0.0000	0.0000	0.0000	(104)

Space cooling 1523.8169 (104)
Cooled fraction fC = cooled area / (4) = 0.4563 (105)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Intermittency factor (Table 10b)	0.0000	0.0000	0.0000	0.0000	0.0000	0.2500	0.2500	0.2500	0.0000	0.0000	0.0000	0.0000	(106)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	54.3540	67.3280	52.1553	0.0000	0.0000	0.0000	0.0000	(107)

Space cooling 173.8374 (107)
Space cooling per m2 1.0710 (108)

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

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(201)
Fraction of space heat from main system(s)	1.0000	(202)
Efficiency of main space heating system 1 (in %)	249.9000	(206)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)
Space heating requirement	2263.6029	(211)
Cooling System Energy Efficiency Ratio (see Table 10c)	4.3200	(209)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	1155.6541	892.1029	702.6577	348.0057	130.4562	0.0000	0.0000	0.0000	0.0000	426.1652	824.2762	1177.4258	(98)
Space heating efficiency (main heating system 1)	249.9000	249.9000	249.9000	249.9000	249.9000	0.0000	0.0000	0.0000	0.0000	249.9000	249.9000	249.9000	(210)
Space heating fuel (main heating system)	462.4466	356.9839	281.1756	139.2580	52.2034	0.0000	0.0000	0.0000	0.0000	170.5343	329.8424	471.1588	(211)
Water heating requirement	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water heating requirement	231.2640	204.0136	214.6757	193.0202	189.5718	169.9905	163.8296	178.9835	178.4204	200.1225	210.8828	225.8948	(64)
Efficiency of water heater												175.1000	(216)
(217)m	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	175.1000	(217)
Fuel for water heating, kWh/month	132.0754	116.5126	122.6018	110.2342	108.2649	97.0820	93.5634	102.2179	101.8963	114.2904	120.4357	129.0090	(219)
Water heating fuel used												1348.1836	(219)
Space cooling fuel requirement (221)m	0.0000	0.0000	0.0000	0.0000	0.0000	12.5820	15.5852	12.0730	0.0000	0.0000	0.0000	0.0000	(221)
Cooling												40.2401	(221)

Annual totals kWh/year

Space heating fuel - main system	2263.6029	(211)
Space heating fuel - secondary	0.0000	(215)

Electricity for pumps and fans:

(BalancedWithHeatRecovery, DataSheet: in-use factor = 1.2500, SFP = 1.0625)		
mechanical ventilation fans (SFP = 1.0625)	621.4128	(230a)
central heating pump	30.0000	(230c)
Total electricity for the above, kWh/year	651.4128	(231)
Electricity for lighting (calculated in Appendix L)	549.2824	(232)

Energy saving/generation technologies (Appendices M ,N and Q)

PV Unit 0 (0.80 * 1.50 * 951 * 1.00) =	-1140.7392	-1140.7392	(233)
Total delivered energy for all uses		3711.9826	(238)

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	2263.6029	0.5190	1174.8099	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	1348.1836	0.5190	699.7073	(264)
Space and water heating			1874.5172	(265)
Space cooling	40.2401	0.5190	20.8846	(266)

CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

Pumps and fans	651.4128	0.5190	338.0832 (267)
Energy for lighting	549.2824	0.5190	285.0775 (268)
Energy saving/generation technologies			
PV Unit	-1140.7392	0.5190	-592.0436 (269)
Total CO2, kg/year			1926.5190 (272)
Dwelling Carbon Dioxide Emission Rate (DER)			11.8700 (273)

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

DER		11.8700	ZC1
Total Floor Area	TFA	162.3200	
Assumed number of occupants	N	2.9521	
CO2 emission factor in Table 12 for electricity displaced from grid	EF	0.5190	
CO2 emissions from appliances, equation (L14)		12.1798	ZC2
CO2 emissions from cooking, equation (L16)		1.1696	ZC3
Total CO2 emissions		25.2195	ZC4
Residual CO2 emissions offset from biofuel CHP		0.0000	ZC5
Additional allowable electricity generation, kWh/m²/year		0.0000	ZC6
Resulting CO2 emissions offset from additional allowable electricity generation		0.0000	ZC7
Net CO2 emissions		25.2195	ZC8

CALCULATION OF TARGET EMISSIONS 09 Jan 2014

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

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)
Ground floor	71.3900 (1b)	x	2.6700 (2b)	=	190.6113 (1b) - (3b)
First floor	44.2900 (1c)	x	3.3400 (2c)	=	147.9286 (1c) - (3c)
Second floor	46.6400 (1d)	x	3.0200 (2d)	=	140.8528 (1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) 162.3200					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	479.3927 (5)

2. Ventilation rate

	main heating		secondary heating		other		total	m3 per hour
Number of chimneys	0	+	0	+	0	=	0 * 40 =	0.0000 (6a)
Number of open flues	0	+	0	+	0	=	0 * 20 =	0.0000 (6b)
Number of intermittent fans							4 * 10 =	40.0000 (7a)
Number of passive vents							0 * 10 =	0.0000 (7b)
Number of flueless gas fires							0 * 40 =	0.0000 (7c)

		Air changes per hour
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	40.0000 / (5) =	0.0834 (8)
Pressure test		Yes
Measured/design AP50		5.0000
Infiltration rate		0.3334 (18)
Number of sides sheltered		2 (19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500 (20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.2834 (21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.3614	0.3543	0.3472	0.3118	0.3047	0.2693	0.2693	0.2622	0.2834	0.3047	0.3189	0.3330	(22b)
Effective ac	0.5653	0.5628	0.5603	0.5486	0.5464	0.5362	0.5362	0.5344	0.5402	0.5464	0.5508	0.5555	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K
TER Opaque door			1.8900	1.0000	1.8900		(26)
TER Opening Type (Uw = 1.40)			15.0200	1.3258	19.9129		(27)
TER Room Window (Uw = 1.70)			8.8400	1.5918	14.0712		(27a)
Basement Floor			71.3900	0.1300	9.2807		(28)
Exposed Floor to Window			2.3400	0.1300	0.3042		(28b)
Basement Wall	64.5600		64.5600	0.1800	11.6208		(29a)
External Wall GF	70.3400	10.5600	59.7800	0.1800	10.7604		(29a)
External Wall 1st F	55.8300		55.8300	0.1800	10.0494		(29a)
External Wall to Window	20.3500	6.3500	14.0000	0.1800	2.5200		(29a)
Roof Light Upstand	6.3400		6.3400	0.1800	1.1412		(29a)
Flat Roof to Basement	32.6400	3.3100	29.3300	0.1300	3.8129		(30)
Main Flat Roof	43.2100	5.5300	37.6800	0.1300	4.8984		(30)
Flat Roof to Window	2.3400		2.3400	0.1300	0.3042		(30)
Total net area of external elements Aum(A, m2)			369.3400				(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		90.5662		(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		250.0000 (35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)		21.7964 (36)
Total fabric heat loss	(33) + (36) =	112.3626 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	89.4290	89.0279	88.6347	86.7881	86.4426	84.8343	84.8343	84.5364	85.4538	86.4426	87.1415	87.8723	(38)
Heat transfer coeff	201.7916	201.3905	200.9974	199.1507	198.8053	197.1969	197.1969	196.8991	197.8164	198.8053	199.5042	200.2349	(39)
Average = Sum(39)m / 12 =												199.1491	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.2432	1.2407	1.2383	1.2269	1.2248	1.2149	1.2149	1.2130	1.2187	1.2248	1.2291	1.2336	(40)
HLP (average)												1.2269	(40)
Days in month	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy	2.9521 (42)
Average daily hot water use (litres/day)	104.3133 (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daily hot water use												

CALCULATION OF TARGET EMISSIONS 09 Jan 2014

	114.7446	110.5721	106.3996	102.2270	98.0545	93.8820	93.8820	98.0545	102.2270	106.3996	110.5721	114.7446	(44)
Energy conte	170.1630	148.8256	153.5747	133.8902	128.4708	110.8605	102.7286	117.8825	119.2904	139.0215	151.7528	164.7938	(45)
Energy content (annual)										Total = Sum(45)m =		1641.2545	(45)
Distribution loss (46)m = 0.15 x (45)m													
	25.5244	22.3238	23.0362	20.0835	19.2706	16.6291	15.4093	17.6824	17.8936	20.8532	22.7629	24.7191	(46)
Water storage loss:													
Store volume												250.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												1.8903	(48)
Temperature factor from Table 2b												0.5400	(49)
Enter (49) or (54) in (55)												1.0208	(55)
Total storage loss													
	31.6444	28.5820	31.6444	30.6236	31.6444	30.6236	31.6444	31.6444	30.6236	31.6444	30.6236	31.6444	(56)
If cylinder contains dedicated solar storage													
	31.6444	28.5820	31.6444	30.6236	31.6444	30.6236	31.6444	31.6444	30.6236	31.6444	30.6236	31.6444	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Total heat required for water heating calculated for each month													
	225.0698	198.4189	208.4815	187.0258	183.3776	163.9961	157.6354	172.7893	172.4260	193.9283	204.8885	219.7006	(62)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63)
								Solar input (sum of months) = Sum(63)m =				0.0000	(63)
Output from w/h													
	225.0698	198.4189	208.4815	187.0258	183.3776	163.9961	157.6354	172.7893	172.4260	193.9283	204.8885	219.7006	(64)
								Total per year (kWh/year) = Sum(64)m =				2287.7377	(64)
Heat gains from water heating, kWh/month													
	100.5046	89.1591	94.9890	87.0270	86.6420	79.3696	78.0827	83.1214	82.1726	90.1501	92.9663	98.7194	(65)

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

Metabolic gains (Table 5), Watts	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	147.6070	147.6070	147.6070	147.6070	147.6070	147.6070	147.6070	147.6070	147.6070	147.6070	147.6070	147.6070	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	31.1026	27.6251	22.4662	17.0084	12.7140	10.7337	11.5981	15.0757	20.2345	25.6924	29.9868	31.9671	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	333.6317	337.0938	328.3695	309.7966	286.3516	264.3167	249.5959	246.1339	254.8581	273.4311	296.8760	318.9110	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	37.7607	37.7607	37.7607	37.7607	37.7607	37.7607	37.7607	37.7607	37.7607	37.7607	37.7607	37.7607	(69)
Pumps, fans	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)													
	-118.0856	-118.0856	-118.0856	-118.0856	-118.0856	-118.0856	-118.0856	-118.0856	-118.0856	-118.0856	-118.0856	-118.0856	(71)
Water heating gains (Table 5)													
	135.0869	132.6772	127.6734	120.8708	116.4543	110.2356	104.9498	111.7223	114.1285	121.1695	129.1199	132.6873	(72)
Total internal gains													
	570.1033	567.6782	548.7913	517.9579	485.8020	455.5680	436.4260	443.2139	459.5033	490.5750	526.2648	553.8475	(73)

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6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	1.9500	10.6334	0.6300	0.7000	0.7700	6.3369	(74)
West	13.0700	19.6403	0.6300	0.7000	0.7700	78.4503	(80)
Horizontal	8.8400	26.0000	0.6300	0.7000	1.0000	91.2235	(82)

Solar gains	176.0107	355.0398	610.1391	927.9432	1169.9101	1211.8154	1147.8794	964.3267	722.1723	428.0826	221.4194	143.4770	(83)
Total gains	746.1141	922.7181	1158.9304	1445.9011	1655.7121	1667.3834	1584.3054	1407.5407	1181.6756	918.6576	747.6842	697.3245	(84)

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7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C)												21.0000	(85)
Utilisation factor for gains for living area, nil,m (see Table 9a)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	55.8607	55.9720	56.0814	56.6015	56.6998	57.1623	57.1623	57.2487	56.9833	56.6998	56.5012	56.2950	
alpha	4.7240	4.7315	4.7388	4.7734	4.7800	4.8108	4.8108	4.8166	4.7989	4.7800	4.7667	4.7530	
util living area													
	0.9994	0.9981	0.9923	0.9631	0.8693	0.6968	0.5336	0.6138	0.8814	0.9884	0.9986	0.9996	(86)
MIT	19.5070	19.6787	19.9953	20.4196	20.7662	20.9427	20.9872	20.9761	20.8152	20.3381	19.8442	19.4801	(87)
Th 2	19.8856	19.8876	19.8895	19.8985	19.9002	19.9081	19.9081	19.9096	19.9051	19.9002	19.8968	19.8932	(88)
util rest of house													
	0.9991	0.9974	0.9894	0.9485	0.8205	0.6011	0.4083	0.4827	0.8155	0.9819	0.9980	0.9994	(89)
MIT 2	17.8861	18.1386	18.6013	19.2142	19.6731	19.8709	19.9036	19.8999	19.7505	19.1086	18.3874	17.8520	(90)
Living area fraction									fLA = Living area / (4) =			0.2772	(91)
MIT	18.3355	18.5656	18.9877	19.5484	19.9761	20.1680	20.2040	20.1982	20.0457	19.4494	18.7912	18.3033	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.3355	18.5656	18.9877	19.5484	19.9761	20.1680	20.2040	20.1982	20.0457	19.4494	18.7912	18.3033	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9986	0.9962	0.9860	0.9426	0.8244	0.6255	0.4433	0.5192	0.8256	0.9781	0.9970	0.9990	(94)
Useful gains	745.1061	919.2267	1142.7186	1362.8660	1364.9347	1042.8851	702.3365	730.7649	975.6010	898.5278	745.4389	696.6433	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W													
	2832.2369	2752.1125	2510.0040	2120.6281	1645.3349	1097.9978	710.7003	747.8646	1176.1508	1759.3170	2332.4519	2823.9822	(97)
Month fracti	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000	(97a)
Space heating kWh													
	1552.8254	1231.6993	1017.2604	545.5887	208.6178	0.0000	0.0000	0.0000	0.0000	640.4272	1142.6493	1582.7402	(98)

CALCULATION OF TARGET EMISSIONS 09 Jan 2014

Space heating		7921.8082	(98)
Space heating per m2	(98) / (4) =	48.8036	(99)

8c. Space cooling requirement

Not applicable

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

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(201)
Fraction of space heat from main system(s)	1.0000	(202)
Efficiency of main space heating system 1 (in %)	93.5000	(206)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)
Space heating requirement	8472.5221	(211)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	1552.8254	1231.6993	1017.2604	545.5887	208.6178	0.0000	0.0000	0.0000	0.0000	640.4272	1142.6493	1582.7402	(98)
Space heating efficiency (main heating system 1)	93.5000	93.5000	93.5000	93.5000	93.5000	0.0000	0.0000	0.0000	0.0000	93.5000	93.5000	93.5000	(210)
Space heating fuel (main heating system)	1660.7758	1317.3254	1087.9790	583.5173	223.1206	0.0000	0.0000	0.0000	0.0000	684.9489	1222.0848	1692.7702	(211)
Water heating requirement	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water heating requirement	225.0698	198.4189	208.4815	187.0258	183.3776	163.9961	157.6354	172.7893	172.4260	193.9283	204.8885	219.7006	(64)
Efficiency of water heater												79.8000	(216)
(217)m	88.9895	88.8471	88.4821	87.5047	85.1584	79.8000	79.8000	79.8000	79.8000	87.7648	88.6918	89.0447	(217)
Fuel for water heating, kWh/month	252.9173	223.3261	235.6201	213.7322	215.3371	205.5089	197.5381	216.5280	216.0727	220.9637	231.0117	246.7307	(219)

Water heating fuel used	2675.2866	(219)
Annual totals kWh/year		
Space heating fuel - main system	8472.5221	(211)
Space heating fuel - secondary	0.0000	(215)
Electricity for pumps and fans:		
central heating pump	30.0000	(230c)
main heating flue fan	45.0000	(230e)
Total electricity for the above, kWh/year	75.0000	(231)
Electricity for lighting (calculated in Appendix L)	549.2824	(232)
Total delivered energy for all uses	11772.0911	(238)

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	8472.5221	0.2160	1830.0648	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	2675.2866	0.2160	577.8619	(264)
Space and water heating			2407.9267	(265)
Pumps and fans	75.0000	0.5190	38.9250	(267)
Energy for lighting	549.2824	0.5190	285.0775	(268)
Total CO2, kg/m2/year			2731.9292	(272)
Emissions per m2 for space and water heating			14.8344	(272a)
Fuel factor (electricity)			1.5500	
Emissions per m2 for lighting			1.7563	(272b)
Emissions per m2 for pumps and fans			0.2398	(272c)
Target Carbon Dioxide Emission Rate (TER) = (14.8344 * 1.55) + 1.7563 + 0.2398, rounded to 2 d.p.			24.9900	(273)