environmental**perspectives**

65 Maygrove Road, West Hampstead REP Maygrove Road Developments

Energy Statement, November 2011

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65 Maygrove Road, West Hampstead NW6 2EH

Energy Statement

Issue/Revision:	Draft 01	Final 01
Date:	18 October 2011	30 November 2011
Comments:		
Prepared by:	Jane Wakiwaka	Jane Wakiwaka
Signature:		
Authorised by:	Iain Fraser	Iain Fraser
Signature:		
File Reference:	550275if18Oct11DR01_Energy	550275if30Nov11FD01_Energy

CONTENTS

1.0 EXECUTIVE SUMMARY

1.1 This report considers the approach to the energy use for the application of a residential development situated on Maygrove Road within the London Borough of Camden.

1.2 This report sets out how the proposal responds, in terms of energy, to the replacement London Plan, the Mayor's Energy Strategy; Camden Council's Unitary Development Plan; and the Sustainability Checklist issued by Camden as Supplementary Planning Guidance.

1.3 In accordance with best practice, the design of the buildings at the Maygrove Road development will conform to the principles of the Energy Hierarchy that provides a set of guiding principles to reduce energy consumption and associated carbon emissions to a minimum. Consequently, energy efficiency will be incorporated into the design of the dwellings before the application of low or zero carbon technologies.

1.4 Taking into account best practice guidance for passive energy efficient design published by the Energy Savings Trust (EST), the dwellings will exceed the 2010 Building Regulations Part L1A Target Emission Rating (TER). The proposed development as a whole will achieve a 5-10% reduction against the TER through the use of energy efficiency measures alone.

1.5 In response to the second tier of the Energy Hierarchy, a preliminary investigation into the appropriateness of connection to existing or proposed district heating schemes has been undertaken. Unfortunately, due to the distance between the proposed development and other schemes, installation costs are prohibitive to connection. Additionally, as part of the second tier of the Energy Hierarchy, a stand-alone communal heating scheme incorporating a Combined Heat and Power (CHP) engine for the proposed development has been undertaken.

1.6 In response to the third tier of the Energy Hierarchy, this study has considered a number of renewable technologies.

1.7 As the proposed development is seeking to achieve a Level 4 under the Code for Sustainable Homes (CSH) it must demonstrate that it has met the mandatory requirement under 'Ene1', which is equivalent to a 25% improvement against the baseline 2010 Building Regulations. However, the CSH does not require unregulated emissions be included as part of the assessment method. Consequently, when these are removed from the energy calculations using the building compliance SAP (Standard Assessment Procedure), the proposed development meets the 25% target for emissions reduction.

2.0 BACKGROUND

INTRODUCTION

2.1 Environmental Perspectives LLP were commissioned by REP Maygrove Road Developments to coordinate the production of an Energy Statement for the redevelopment of a brownfield site situated within the administrative boundaries of the London Borough of Camden (LB Camden). Within the Borough, the site is located on Maygrove Road, and is for a new, high quality, residential development comprising 68 units in two new buildings, with associated soft and hard landscaping.

THE PROPOSED DEVELOPMENT

2.2 The application site is located at 65 Maygrove Road within the LB Camden, and covers an area of approximately 0.3 hectares (ha) and is located in Camden, centred on Ordnance Survey Reference 525042,184693.

2.3 The application site is in an area of dense urban development surrounded by residential housing. There is a small area of amenity grassland to the north and east of the site with some areas of scattered woodland containing mature Sycamore and Cherry trees along the eastern and north eastern site borders and an area of Laurel with a ground covering of mulch.

2.4 The assessment site is dominated by buildings and hardstanding. There are ornamental shrub planters along the south of the site containing *Miscanthus* grass species and Privet hedge species. The site currently comprises a three storey office building and existing car park, which will be demolished for the construction of two interconnected buildings, comprised of 56 market and 12 affordable/intermediate units consisting of one to three bedroom flats and 4 bedroom houses. The proposed development will also incorporate soft landscaping, basement parking and provision of safe and secure cycle spaces.

3.0 PLANNING POLICY & LEGISLATIVE CONTEXT

3.1 There are a number of international and national policy drivers for energy efficiency and reduced carbon dioxide (CO_2) emissions, which have been introduced to address the issue of global warming and the implications of climate change. This includes the Kyoto Protocol on an international level, and in response to the UK Government's commitment, national policies have been developed including the *Energy White Paper* and *Planning Policy Statement 22: Renewable Energ*y (PPS22) and *Planning Policy Statement: Planning and Climate Change - Supplement to Planning Policy Statement 1*. On a regional level, the replacement *London Plan* and the Mayor's *Energy Strategy* provides the policy drivers for major developments within Greater London and at the local level; the Unitary Development Plan outlines the approach for projects located in the LB Camden.

International Policy Drivers

Kyoto Protocol (1997)

3.2 The Kyoto Protocol was agreed at the 1997 UN Convention on Climate Change. The UK's target is to cut its emissions by 12.5% below 1990 levels by 2008-2012. The UK Government has committed to a more challenging target to cut the UK's CO_2 emissions to 20% below 1990 levels by 2010.

National Policy Drivers

Energy White Paper

3.3 The *Energy White Paper: Our Energy Future – Creating a Low Carbon Economy*[1] is a change in direction for energy policy in response to the increasing challenges faced by the UK, including climate change, decreasing domestic supplies of fossil fuel and escalating energy prices. The *Energy White Paper* sets four priorities:

- Cutting the UK's carbon dioxide emissions - the main contributor to global warming - by some 60% by about 2050, with real progress by 2020;
- Security of supply;
- A competitive market for the benefit of businesses, industries and households; and
- Affordable energy for the poor.

3.4 *Meeting the Challenge - A White Paper on Energy*[2] published in 2007 sets out the Government's international and domestic energy strategy to respond to changing circumstances; address long-term energy challenges; and how to deliver on the four energy policy goals set in the *Energy White Paper*[1].

Climate Change Act 2008

3.5 On 26th November 2008, the UK Government published the Climate Change Act 2008[3], the world's first long-term legally binding framework to mitigate against climate change. Within this framework, the Act sets legally binding targets to increase greenhouse gas emission reductions through action in the UK and abroad from the 60% target to 80% by 2050. In addition, there is an interim target that the carbon budget (i.e. the CO_2 emissions) must be at least 26% lower than the 1990 baseline.

Planning Policy Statement: Planning and Climate Change - Supplement to Planning Policy Statement 1

3.6 *Policy Statement: Planning and Climate Change - Supplement to Planning Policy Statement 1*[4] strengthens the drivers for energy efficiency, low and zero carbon (LZC) technologies and the setting of specific carbon reduction targets. *Planning and Climate Change - Supplement to PPS1* specifically requires planning authorities to '*expect a proportion of the energy supply of new development to be secured from decentralised and renewable or low-carbon energy sources'* and to *'set out a target percentage of the energy to be used in new development to come from decentralised and renewable or low-carbon energy sources where it is viable*' within Local Development Documents.

Planning Policy Statement 22: Renewable Energy (PPS22)

3.7 PPS22[5] seeks to deliver the Government's vision for a low carbon economy as detailed in the *Energy White Paper*[1] and promotes the generation of renewable energy.

Regional Policy Drivers

The Replacement London Plan: Spatial Development Strategy for Greater London

3.8 Following the election of Boris Johnson as the Mayor in May 2008, a consultation document for the draft replacement London Plan was published in October 2009. The consultation document was open for public comment between 12 October 2009 to 12 January 2010, which was followed by the Examination in Public in summer and autumn of 2010. In May 2011, the inspectorate declared the document to be 'sound', and has been sent to the Secretary of State for consideration. Following his approval, the replacement London Plan[6] was formally published and adopted in July 2011.

3.9 The replacement London Plan is comprised of separate chapters relating to a number of areas, including London's Places, People, Economy and Transport. Chapter 5 relates specifically to how the Mayor seeks to tackle climate change by reducing London's carbon dioxide emissions, managing resources more effectively, and helping the city to cope with the effects of a changing climate. This chapter includes the following policies that are relevant to this Energy Strategy report, which provides guidance on the Mayor's expectations of how developments can make the fullest contribution to the mitigation of climate change.

Policy 5.2 Minimising Carbon Dioxide Emissions

'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 Emissions 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	Non-domestic buildings
• 2010-2013 25% improvement on 2010 Building Regulations (Code for Sustainable Homes Level 4) • 2013-2016 40% improvement on 2010 Building Regulations • 2016-2031 Zero carbon	• 2010-2013 25% improvement on 2010 Building Regulations • 2013-2016 40% improvement on 2010 Building Regulations • 2016-2019 As building regulations requirements • 2019-2031 Zero carbon

C - Major developments 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 the 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… 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

'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.

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 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 the buildings…'

Policy 5.5 Decentralised Energy Networks

'A – The Mayor expects 25 per cent of the heat and power used in London to be generated through the use of localised decentralised energy systems by 2025. In order to achieve this target the Mayor prioritises the development of decentralised heating and cooling networks at the development and area wide levels, including larger scale heat transmission networks.

B – Within LDFs boroughs should develop policies and proposals to identify and establish decentralised energy network opportunities. Boroughs may choose to develop this as a supplementary planning document and work jointly with neighbouring boroughs to realise wider decentralised energy network opportunities. As a minimum boroughs should:

a identify and safeguard existing heating and cooling networks

b identify opportunities for expanding existing networks and establishing new networks. Boroughs should use the London Heat Map tool and consider any new developments, planned major infrastructure works and energy supply opportunities which may arise

c develop energy master plans for specific decentralised energy opportunities which identify:

- *Major heat loads (including anchor heat loads, with particular reference to sites such as universities, hospitals and social housing)*
- *Major heat supply plant*
- *Possible opportunities to utilise energy from waste*
- *Possible heating and cooling network routes*
- *Implementation options for delivering feasible projects, considering issues of procurement, funding and risk and the role of the public sector*

d require developers to prioritise connection to existing or planned decentralised energy networks where feasible.'

Policy 5.6 Decentralised Energy in Development Proposals

'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

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

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

Policy 5.9 Overheating and Cooling

'…B - Major development proposals should reduce potential overheating and reliance on air conditioning systems and demonstrate this in accordance with the following cooling hierarchy:

- *Minimise internal heat generation through energy efficient design*
- *Reduce the amount of heat entering a building in summer through shading, albedo, fenestration, insulation and green roofs and walls*
- *Manage the heat within the building through exposed internal thermal mass and high ceilings*
- *Passive ventilation*
- *Mechanical ventilation*
- *Active cooling systems (ensuring they are the lowest carbon options).*

…D - Major development proposals should demonstrate how the design, materials, construction and operation of the development would minimise overheating and also meet its cooling needs. New development in London should also be designed to avoid the need for energy intensive air conditioning systems as much as possible. Further details and guidance regarding overheating and cooling are outlined in the London Climate Change Adaptation Strategy.'

Policy 5.10 Urban Greening

'A - The Mayor will promote and support urban greening, such as new planting in the public realm (including streets, squares and plazas) and green infrastructure, to contribute to the adaptation to, and mitigation of, the effects of climate change.

B - The Mayor seeks to increase the amount of surface area greened in the Central Activities Zone by at least five per cent by 2030, and a further five per cent by 2050.

C - Development proposals should integrate green infrastructure from the beginning of the design process to contribute to urban greening, including the public realm. Elements that can contribute to this include tree planting, green roofs and walls, and soft landscaping. Major development proposals within the Central Activities Zone should demonstrate how green infrastructure has been incorporated.'

GLA Energy Team Guidance on Planning Energy Assessments

3.10 The GLA Energy team published this guidance note which provides further detail on addressing the London Plan's energy hierarchy through the provision of an energy assessment. The most recent version 1.1 published in October 2010 describes the means by which development proposals can demonstrate that climate change mitigation measures are integral to the context of the development.

3.11 The document has provided a guide to the structure and content of the energy assessment which has been adopted by this report.

Local Policy Drivers

LB Camden Local Development Framework

3.12 Due to changes in national government planning legislation, all local authorities have updated and replaced their Unitary Development Plans with a new suite of documents called the Local Development Framework (LDF). Camden's LDF replaced the UDP in November 2010, and sets out their strategy for managing growth and development in the borough, including where new homes, jobs and infrastructure will be located.

3.13 Within the LDF, the Core Strategy[7] and Development Policies[8] documents have been identified as having particular relevance on how the sustainability objectives of the Council should be met in new developments, as outlined in the following policies:

Core Strategy Policy CS13 – Tackling climate change through promoting higher environmental standards

<u>Reducing the effects of and adapting to climate change</u>

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

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

b) Promoting the efficient use of land and building;

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

> *1. Ensuring developments use less energy,*
>
> *2. Making use of energy from efficient sources, such as the King's Cross, Gower Street, Bloomsbury and proposed Euston Road decentralised energy networks;*

3. Generating renewable energy on-site; and

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

The Council will have regard to the cost of installing measures to tackle climate change as well as the cumulative future costs of delaying reduction in carbon dioxide emissions.

Local energy generation

The Council will promote local energy generation and networks by:

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

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

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

Camden's carbon reduction measures

The Council will take a lead in tackling climate change by:

j) Taking measures to reduce its own carbon emissions;

k) Trialling new energy efficient technologies, where feasible; and

l) Raising awareness on mitigation and adaptation measures.'

Development Plan Policy DP22 – Promoting sustainable design and construction

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

a) Demonstrate how sustainable development principles…. Have been incorporated in the design and proposed implementation; and *b) Incorporate green or brown roofs and green walls wherever suitable.*

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

c) Expecting new build housing to meet Code for Sustainable Homes Level 3 by 2010 and Code level 4 by 2013 and encouraging Code Level 6 (zero carbon) by 2016;

d) Expecting developments (except new build) of 500 sq m of residential floorspace or above or 5 or more dwellings to achieve "very good" in EcoHomes assessment prior to 2013 and encouraging "excellent" from 2013;

e) Expecting non-domestic developments of 500 sqm of floorspace or above to achieve "very good" in BREEAM assessments and "excellent" from 2016 and encouraging zero carbon from 2019.

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

f) Summer shading and planting;

g) Limiting run-off;

h) Reducing water consumption;

i) Reducing air pollution; and

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

Camden Planning Guidance 3 - Sustainability

3.14 In addition to the adopted policy documents within the LDF, the LB of Camden has also provided a number of supplementary planning documents (SPDs) that provide information on how planning policies are to be applied in the Borough. The Camden Planning Guidance documents in particular, support the policies within the LDF, and form an additional 'material consideration' in planning guidance. The Guidance covers a range of topics, including sustainability.

3.15 In relation to energy the *Camden Planning Guidance on Sustainability*[9] provides information on how energy statements should be structured and information the council requires to evaluate applications. The document also highlights the Council's requirements and guidelines where technologies are to be included on development proposals.

BUILDING REGULATIONS

3.16 The Building Regulations 2000 (England & Wales) set out standards and requirements that individual aspects of building design and construction must achieve. The 'functional' requirements are also considered in a series of Approved Documents that provide general guidance in common building situations.

3.17 In total, there are 14 technical areas that each Approved Document provides practical guidance on, including fire safety, ventilation, hygiene, drainage and access. Approved Document Part L (Conservation of Fuel and Power) of the Building Regulations deals with the energy efficiency requirements:

Approved Document Part L – the Conservation of Fuel and Power

'Reasonable provision shall be made for the conservation of fuel and power in buildings by:

a. Limiting heat gains and losses:

i) through thermal elements and other parts of the building fabric; and

ii) From pipes, ducts and vessels used for space heating, space cooling and hot water services;

b. Providing and commissioning energy efficient fixed building services with effective controls; and

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

3.18 On 1st April 2002, Part L of the Building Regulations came into force, with a view of reducing heating costs, conserving fuel and protecting the environment from the effects of climate change. However, to ensure that Part L of the Building Regulations was in line with the commitments made in the Energy White Paper (2003) of reducing CO_2 emissions from buildings, and to implement the Energy Performance of Buildings Directive (EPBD), amendments to the Approved Document were made in 2006.

3.19 On 6th April 2006, the amends to the 2002 version of Part L of the Building Regulations were implemented, introducing new energy efficiency requirements and other relevant changes, which included:

- Introduction of a single calculation method (setting maximum CO_2 emissions for the whole building), that replaced the previous three methods of demonstrating compliance;
- An increase in the CO_2 emissions standards for new buildings by between 20% and 28% compared to 2002 standards (dependant on the type and size of building); and
- Higher standards for work on the existing buildings than were generally required in 2002.

3.20 More recently, with the introduction of new planning policy and legislative drivers, identified above, a need to reconsider and revise the 2006 editions of the Approved

Documents L was identified. The latest revision to the document, the 2010 version of Part L, has been adopted from October 2010.

3.21 Within the updated 2010 version of Part L, a number of changes have been made, including the following:

- The Target Emissions Rate (TER) is no longer based on a 2002 notional building and an improvement factor but will take an 'aggregate approach' for the non-dwellings sector. The TER will be based on a building of the same size and shape as the actual building, constructed to a concurrent specification, provided in the 2010 NCM modelling guide. This approach has been adopted, as the level of improvement that can be reasonably expected is considered to vary significantly across the building sector; a blanket improvement factor is therefore inequitable. Therefore, some buildings (e.g. those buildings that use a higher load of lighting versus, say, hot water) will be expected to exceed the 25% reductions target, while other buildings will be allowed to achieve less than 25%;
- In order to assist Building Control Officers to enforce regulations, design-stage submissions must be accompanied by a copy of the design specifications. This will also increase the emphasis on commissioning to ensure that systems perform as intended. This is also to enable the Building Controls Officer to be able to check that the relevant elements are in place. Should any changes be made to the building to the design stage list of specifications, a list of these changes must be provided to the Building Control Officers, as well as a certificate signed off by a suitably accredited energy assessor; and
- Accredited construction details that cover building elements, such as thermal bridging will no longer make assumptions. Under the 2010 Building Regulations, each of the junctions will need to be measured, multiplied by the appropriate psi value (values supplied by the SAP 2009 document), and added up to produce an 'effective' y value.

3.22 In addition to the revisions that have been implemented from October 2010, the Government have also announced further revisions to Part L that will be used as a catalyst of achieving the target for zero carbon dwellings by 2016 and zero carbon non-domestic buildings by 2019. It is expected that amendments to the Part L documents will expect a 44% improvement of the Target Emission Rate (TER) or the CO_2 emissions of a new building in the 2013 revision (relative to the 2006 requirements) for domestic buildings and an aggregated 44% improvement of the TER for non-domestic buildings.

CODE FOR SUSTAINABLE HOMES

3.23 The proposed development is being assessed under the UK Government's Code for Sustainable Homes (CSH), which aims to encourage and reward best practice through the recognition of improvements made to the design of residential buildings against a number of environmental criteria, including energy. The design team for the proposed development at Maygrove Road have committed to achieving a CSH rating of Level 4 for all the proposed residential dwellings on-site, which exceeds the minimum requirements as set by the Council. The scheme has been registered against the November 2010 version of the CSH.

3.24 Under the CSH, mandatory standards for energy (as well as other environmental categories) must be met, before even the lowest level of CSH can be achieved. In addition, the CSH demands incrementally higher standards for energy to be met at each performance level. For Credit Ene 1 (Dwelling emission rate as defined by 2010 Building Regulations), in order to secure a Level 4 rating, dwellings must achieve an improvement of the Dwelling Emissions Rate (DER) over the Target Emissions Rate (TER) greater than or equal to 25% demonstrated using SAP2009 software, which is equivalent to 3 credits.

3.25 In addition, other specific energy related CSH Credits have been targeted by the design team at the pre-assessment meeting (as detailed within the Sustainability Statement and accompanying CSH Pre-Certification Assessment Report submitted within this application), which include those that relate to building fabric, internal and external lighting, drying space, energy labelled white goods and LZC technologies.

3.26 As part of the credit requirements for Ene 7 Low and Zero Carbon Technologies, the CSH requires an energy feasibility study to be produced and provides clear guidance regarding the minimum content of the study. Credit compliant details for Ene 7 are set out within Appendix 1.0 of this document.

4.0 ENERGY ASSESSMENT METHODOLOGY

4.1 The application is for a proposed development encompassing two buildings with a total of 68 dwellings. The residential dwellings are comprised of a combination of one, two, three and four bed units.

4.2 The assessment methodology for this Energy Strategy Report has been informed by the following guidance:

- The replacement London Plan[6];
- The London Borough of Camden, *Camden Planning Guidance 3 - Sustainability*[9];
- The Mayor's *Sustainable Design and Construction Supplementary Planning Guidance*[10] (SPG);
- The Standard Assessment Procedure 2009;
- NHER v5.3;
- Energy Savings Trust Guidance on *Energy Efficiency and Code for Sustainable Homes*[11];
- The *London Renewables Toolkit for Planners, Developers and Consultants*[12].

BASELINE EMISSIONS – RESIDENTIAL ELEMENT

4.3 In forming the baseline standard for this assessment (a building compliant with Part L of the 2010 Building Regulations), initial energy demand SAP calculations using approved NHER calculation software and based upon a sample set of the proposed apartments have been undertaken. Using this baseline, further calculations to identify energy efficient measures with regard to the building fabric etc., efficient supply, and, renewable energy systems have then been progressed.

4.4 A sample set of eight apartments has been selected to give a representation of the development's performance. The selected apartments are a mixture of the size, aspect and various elevations (from ground, mid, and top floor levels) of the 68 dwellings proposed for the site as follows:

- Flat A, a four Bed duplex north-facing end terrace flat located on the ground/first floor;
- Flat 1, a two Bed duplex south-facing corner flat located on the basement/ground floor;
- Flat 5, a three Bed duplex south-facing mid-terrace flat located on the basement/ground floor;
- Flat 8, a one Bed west-facing corner flat located on the ground floor;

- Flat 17, a one Bed south-facing mid-terrace flat located on the first floor;
- Flat 28, a one Bed south-facing mid-terrace flat located on the second floor;
- Flat 47, a two Bed north-facing corner flat located on the third floor; and
- Flat 51, a two Bed south-facing corner flat located on the fourth floor.

4.5 From this, an average was estimated for one, two, three and four bed flats to calculate the baseline emissions for the residential element of the proposed development as built to meet the TER and comply with 2010 Building Regulations. Table 4.1 below shows the baseline TER that has been applied to each of the different dwelling types:

Table 4.1 Average residential Element Baseline SAP calculations Target Emission Ratings

Dwelling Type	Average TER ($kgCO_2/m^2/yr$)	Baseline CO_2 Emissions ($kgCO_2/yr$)
One Bed	13.7	19,800
Two Bed	22.8	47,200
Three Bed	9.7	7,800
Four Bed	23.6	9,300
Note: SAP 2009 calculations undertaken using approved NHER calculation software 'NHER Plan Assessor Version 5.3' in November 2011		

BASELINE EMISSIONS – ANCILLIARY AREAS

4.6 In forming the baseline standard for this assessment (a building compliant with Part L of the 2010 Building Regulations), initial energy demand iSBEM calculations using approved NCM calculation software and based upon the geometry/servicing of the car parking area at 65 Maygrove Road. Using this baseline, further calculations to identify energy efficient measures with regard to the ventilation and lighting systems have been progressed. The area is not expected to generate any unregulated emissions.

Table 4.2 Ancillary Element Baseline iSBEM calculation Target Emission Ratings

Area	TER ($kgCO_2/m^2/yr$)	Baseline CO_2 Emissions ($kgCO_2/yr$)
Car Parking/Lifts/Communal Areas	9.15	18,400
Note: iSBEM calculations undertaken using approved NCM calculation software 'iSBEM v4.1.c' in November 2011		

UNREGULATED EMISSIONS

4.7 Part L1A regulates the emissions relating to the provision of heat and light to dwellings. Small power loads, i.e. electrical energy for domestic appliances such as televisions, refrigerators and washing machines, are not considered within the regulations yet the associated emissions with these appliances can be significant compared to the overall emissions from a dwelling.

4.8 As stated within GLA Energy Team Guidance[13], the baseline energy consumption and CO_2 emissions should include both regulated and unregulated energy use. Therefore, in order to demonstrate compliance with London policy, unregulated emissions have been included within the calculations to ensure that the overall total emissions of the proposed development have been considered.

4.9 However, it should be noted that the CSH assessment process does not require unregulated emissions to be included and therefore, for the CSH Ene 1 calculation only, unregulated emissions have been excluded.

4.10 Within the current version of the NHER SAP software (version 5.3), there is at present no procedure available to calculate unregulated emissions. The NHER has advised that unregulated emissions relating to cooking and appliances should in the interim be based on the previous NHER SAP software (version 4.5 which used the BREDEM12 calculation method), which has been used for this assessment.

4.11 Given the basic function of the communal and car parking areas, the only additional, unregulated energy uses or emissions associated with these areas is the use of the lifts serving the upper floors of the proposed development.

4.12 Based on these outputs, Table 4.3 below shows the baseline for regulated and unregulated emissions for the residential element of the proposed development.

Table 4.3 Annual Carbon Dioxide Emissions

Dwelling Type/Area	Regulated emissions ($kgCO_2/yr$)	Unregulated emissions ($kgCO_2/yr$)	Total annual emissions ($kgCO_2/yr$)
One Bed	19,800	14,900	34,700
Two Bed	47,200	17,900	65,100
Three Bed	7,800	7,900	15,700
Four Bed	9,300	3,900	13,200
Car Parking/Lifts/Communal Areas	18,400	17,000	35,400
Total	**102,500**	**61,600**	**164,100**

BASELINE SUMMARY

4.13 This section has described a baseline of Part L 2010 compliant buildings, for both residential and communal areas, for the application site (as summarised in Table 4.4 below). From this platform, energy efficiency measures and LZC technologies considered for incorporation into the proposed development have been assessed. Analysis has been carried out in accordance with the methods contained within the *London Renewables Toolkit for Planners, Developers and Consultants* with the selected energy efficiency measures and LZC technologies discussed in Section 5.0 and Section 6.0.

Table 4.4 Summary of Baseline Energy Demand

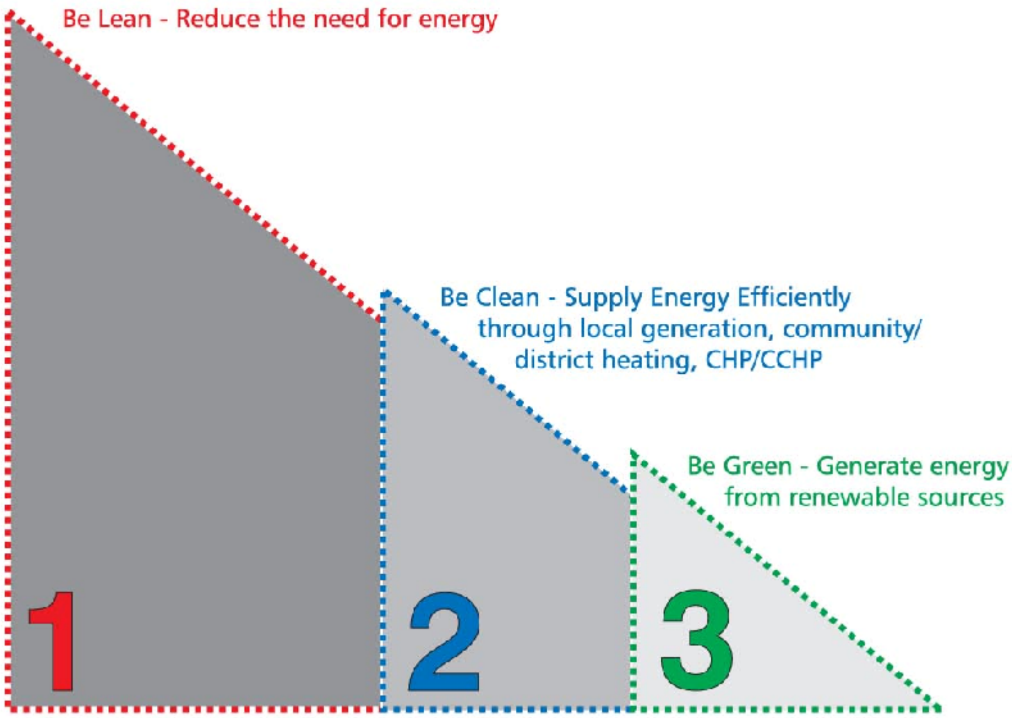
Type of Emissions	Annual CO_2 Emissions ($tonneCO_2/yr$)
Regulated Emissions	102
Unregulated Emissions	62
TOTAL	**164**

5.0 ENERGY EFFICIENCY MEASURES – BE LEAN

THE MAYOR'S ENERGY HIERARCHY

5.1 The *Mayor's Energy Strategy* adopts a set of principles to guide design development and decisions regarding energy, balanced with the need to optimise environmental and economic benefits. These guiding principles have been reordered since the publication of the Mayor's *Energy Strategy* in Feb 2004 and the recently published London Plan[6] states that '*The following hierarchy should be used to assess applications:*

- *Using less energy, in particular by adopting sustainable design and construction measures;*
- *Supplying energy efficiency, in particular by prioritising decentralised energy generation; and*
- *Using renewable energy.'*



5.2 It is considered that the above principles for carbon reduction form the most appropriate approach from both a practical and financial perspective. The industry is broadly in agreement that energy efficiency and low carbon technologies have the greatest impact in offsetting CO_2 emissions. Therefore, it is logical to encourage enhanced mitigation through energy efficiency and low carbon technologies in the first instance, as opposed to applying renewables as a first option at a significantly greater cost.

5.3 Consequently, as a result of the above principles, the first stage in the energy strategy for the proposed development is the consideration of energy efficiency measures to ensure that the base energy demand is minimised.

ENERGY EFFICIENCY MEASURES

5.4 In order to achieve a building that complies with 2010 Building Regulations Part L1A and Part L2A, and exceeds the TER, measures to make the building energy efficient must be incorporated within the scheme design.

5.5 The TER will be calculated using the Standard Assessment Procedure (SAP) approved for the task by the DCLG and will be a function of the form and fuel selected for use within the dwellings. It is estimated that passive energy efficient design measures, including those set out within the best practice guidance document produced by the EST, will improve upon the TER by **5-10%** as a result of energy efficiency measures for the proposed development.

5.6 The following key passive energy efficient design measures to improve upon the TER have been included based on discussions between the design team as follows:

- U values of:
  - Floors: 0.13 W/m^2K;
  - Roof: 0.13 W/m^2K;
  - External walls: 0.2 W/m^2K;
  - Windows: 1.5 W/m^2K;
  - Doors: 1.0 W/m^2K (solid);
  - Doors: 1.5 W/m^2K (glazed);
- 100% of all fixed internal lighting have dedicated low energy fittings with suitable lighting controls;
- Air permeability of $3m^3/m^2hr$ @ 50Pa or less;
- Energy metering.

Passive Solar Design

5.7 Passive design measures manage internal heating through solar gain and as such reduce the need for cooling. Where feasible, passive design measures have been considered such as building orientation and solar shading. However, due to the constrained nature of the application site, including the relative locations of the nearby listed buildings, the ability to orientate buildings to reduce solar gains is limited.

5.8 Where possible, layouts of dwellings and window design have been configured to maximise the available daylight to the dwellings, which will seek to passively reduce energy demand from lighting and will also allow for solar gain from low winter sun, while balancing the need to reduce the risk of overheating especially in summer.

5.9 The building fabric will be designed to have low U-values, improving upon maximum Building Regulation values, to help retain heat in winter months and exclude heat during summer months.

5.10 The need for heating and cooling will further be reduced by constructing a more airtight building and reducing the air permeability to well below the maximum values described in the Building Regulations.

5.11 The residential flats will be provided with mechanical extract ventilation, in order to remove both cooking odours from kitchens and reduce indoor humidity in bath and shower rooms. Living spaces will be ventilated by trickle vents with the specification of openable windows to additionally help to manage solar gain and minimise cooling loads.

Energy Efficient Systems Design

5.12 A number of measures are proposed to be included in the design of the dwellings to limit the use of energy. The heating system will include the use of a programmer to allow occupants to match the supply of heat for their house to their demand and the use of thermostatic radiator valves for the isolation of rooms that do not require heat.

5.13 The common areas will also include measures to reduce their use of power. Energy efficient lifts will be assessed for installation while operation of the car park ventilation system will be demand-led, based on readings from gas monitors, rather than a permanently operating system.

5.14 The lighting systems for the proposed development will also be designed to provide adequate lighting while minimising the use of energy for this building service.

Energy Efficiency Measures Summary

5.15 The incorporation of energy efficiency measures proposed for the whole development is expected to exceed 2010 Building Regulations compared with the baseline building by up to 10% for the residential element. Whilst there will be measures included to reduce unregulated emissions (e.g. provision of Home User Guide and display energy metering, which will encourage occupants to utilise buildings in a sustainable and energy efficient manner), at this stage, no quantitative assessment has been made on the reduction of unregulated emissions. Therefore, this assessment has taken a conservative approach, and at this stage, has assumed that the unregulated emissions have not changed from the baseline scenario.

5.16 Therefore, when taking into account of total site emissions, the specification of energy efficient measures will result in a **3.1-6.2%** reduction against the baseline building.

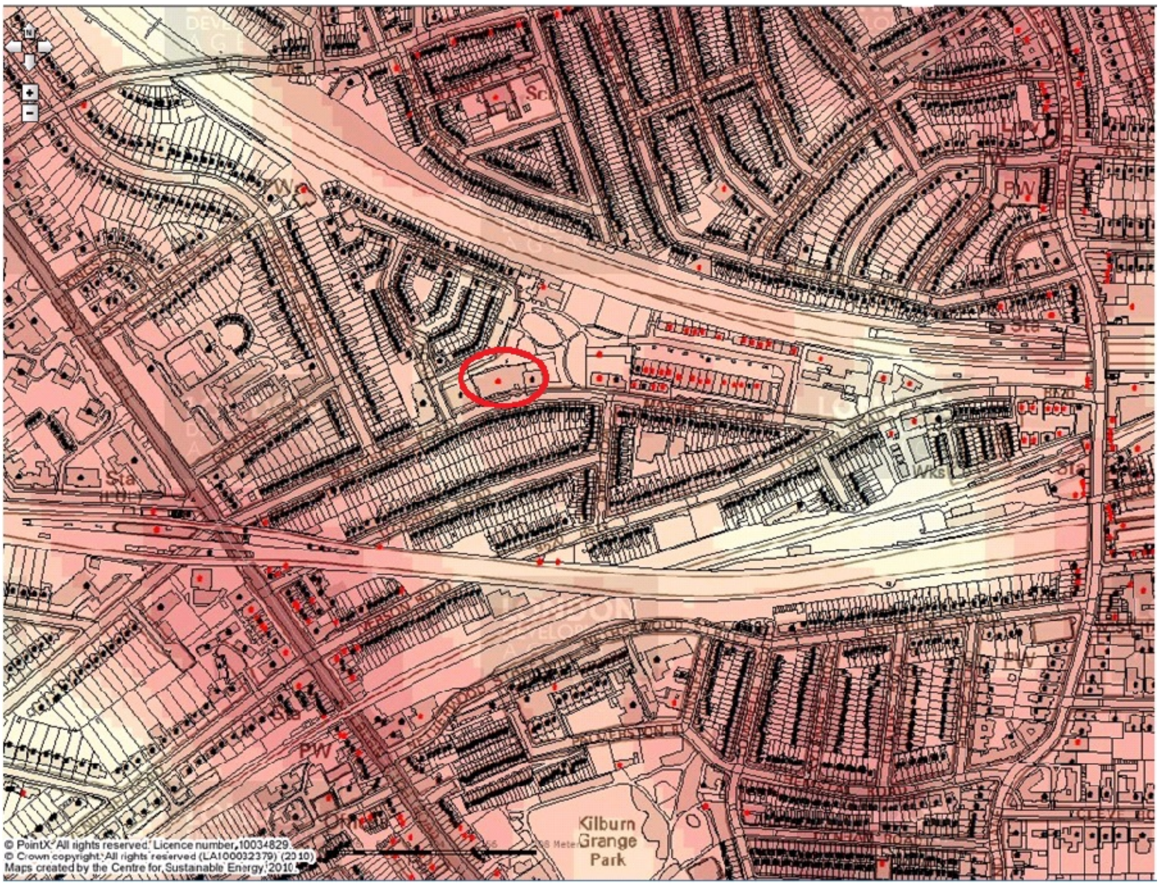
5.17 The approaches to be adopted will ensure that the proposed development is a carbon efficient development.

6.0 SUPPLYING LOW CARBON ENERGY – BE CLEAN

6.1 In response to the second tier of the Energy Hierarchy and Camden's requirement that developments seek to connect to optimise energy supply, a preliminary investigation into the adjacent heat loads and infrastructure has been undertaken.

6.2 Using the mapping system developed by the LDA[14], an investigation into the potential for connection to an existing or proposed scheme was undertaken, as shown in the figure below.

Figure 6.1 London Heat Map for the Application Site (circled in red) and Surrounding Areas



6.3 From the heat map shown above the predominant characteristic of the area is of a residential area which are likely to have individual heat generating equipment. The Sidings Community Centre could be a potential supplier/user of heat in the vicinity of the site however the distance from the site to the Community Centre is likely to make the installation of such a connection uneconomic.

Communal Gas Boiler System

6.4 In accordance with the second principle of the Energy Hierarchy, a number of different options were considered to develop the energy study during the feasibility stage, which included:

- Individual condensing gas boiler systems;
- An electrically based system; and
- A communal gas boiler system.

6.5 The electrically based system was immediately ruled out; based on concerns relating to fuel poverty, and the associated higher carbon intensity of an all-electric system, this approach was not favourable. On this basis, this option was not considered further as part of the energy strategy for the development.

6.6 Whilst highly efficient condensing gas boilers serving individual dwellings can provide CO_2 savings compared to other systems, the communal gas boiler system was identified as being the more favourable option. The communal system would enable future connection to a decentralised heat network and would be more efficient over time given the superior maintenance of a single centralised boiler versus 68 individual boilers. In terms of CO_2 savings between the centralised or individual boiler options, the communal system significantly outperformed the individual systems based on the SAP calculation procedure.

6.7 A communal gas boiler system provides an opportunity for the proposed development to be 'future-proofed' so that it makes the best use of efficient distribution, with current and future technologies. In particular, such a system enables the necessary infrastructure to be brought forward to link with other potential decentralised energy generation schemes coming forward in the vicinity, following completion of the proposed development. This ability to link with wider decentralised infrastructure is consistent with the requirements of the Mayor's London Plan. It should be noted, however, that permission to connect to decentralised schemes in the vicinity is subject to agreement with third parties and not guaranteed.

6.8 Subject to discussions and agreements with third parties, the proposed development could therefore, benefit from this potential network as it comes online. The integration of the proposed development into the energy from a district heating infrastructure would result in significant carbon reductions. As a result of this potential, the development at Maygrove Road will include for a future connection to a district heating system within the incoming utility meter plant-room/boiler-room.

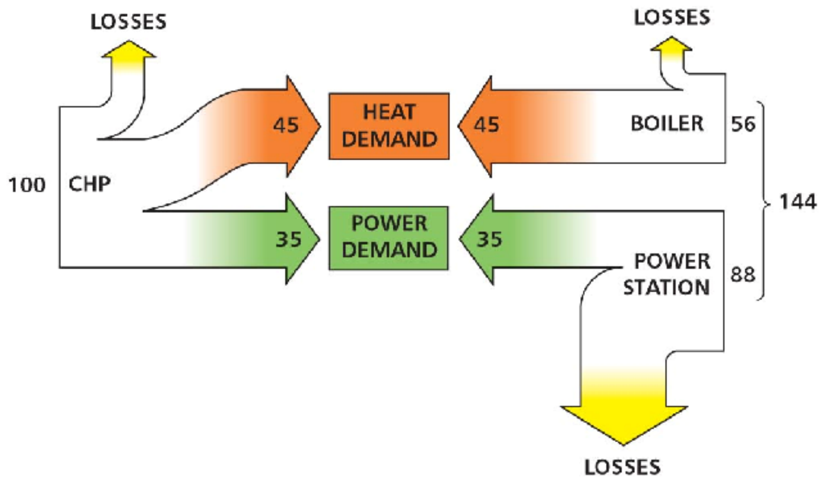
6.9 Finally, the provision of the communal heating system and the accessibility of the central plant for the proposed development (in addition to the ability to connect to potential energy distribution networks in the vicinity) also facilitates the adoption of emerging, and as yet undeveloped technologies, such as fuel cells and 'the hydrogen economy', once these become commercially and practically viable.

COMBINED HEAT & POWER OPTION

6.10 CHP is only a renewable source when it is powered by biofuel. However, even when it is used in combination with fossil fuels such as gas and diesel, it is still more energy efficient than obtaining energy from the National Grid (the Grid).

6.11 Power stations that generate electricity for the Grid are only 35%-45% efficient. This is reduced by a further 5% due to the transmission losses arising from the long distances between the power stations and the buildings that are served. This is a poor use of fossil fuel and has high carbon emissions per unit of electricity produced. CHP can increase the efficiency of power generation and the fuel use up to 75-80% (see Figure 6.2) by making use of the waste heat created as a by product of producing electricity, and using this heat buildings. Transmission losses are minimised by on-site generation and, as such, a gas-fired CHP can be seen as a relatively carbon efficient means of energy supply.

Figure 6.2 Sankey Diagram of Gas fired CHP versus Grid Electricity and Gas Fired Heating



6.12 Although the use of CHP results in an overall net reduction in emissions, as identified in Figure 6.2, the increase in fuel combustion from the proposed development would result in higher localised emissions and an impact upon local air quality. Increased emissions locally from a CHP do have minor air quality implications locally but crucially result in a net reduction of overall emissions.

6.13 CHP is effectively a mini power station with heat reclaim and minimal distribution losses due to its close proximity to the load. The power and heat produced serves a building, or buildings, where they are in close proximity.

6.14 As CHP incurs a significantly higher capital cost compared to conventional gas fired boilers, to maximise efficiency, it is important that the CHP plant operates for as many hours as possible and matches closely the base heat and power loads so that neither heat nor electricity is generated but not utilised (resulting in 'dumping'). For example, although it would be more cost-effective to size the CHP to match electricity demand, this would require an unacceptable amount of heat dumping. In terms of running hours, as a 'rule of thumb', CHP should be running for approximately 5,000 hours per year.

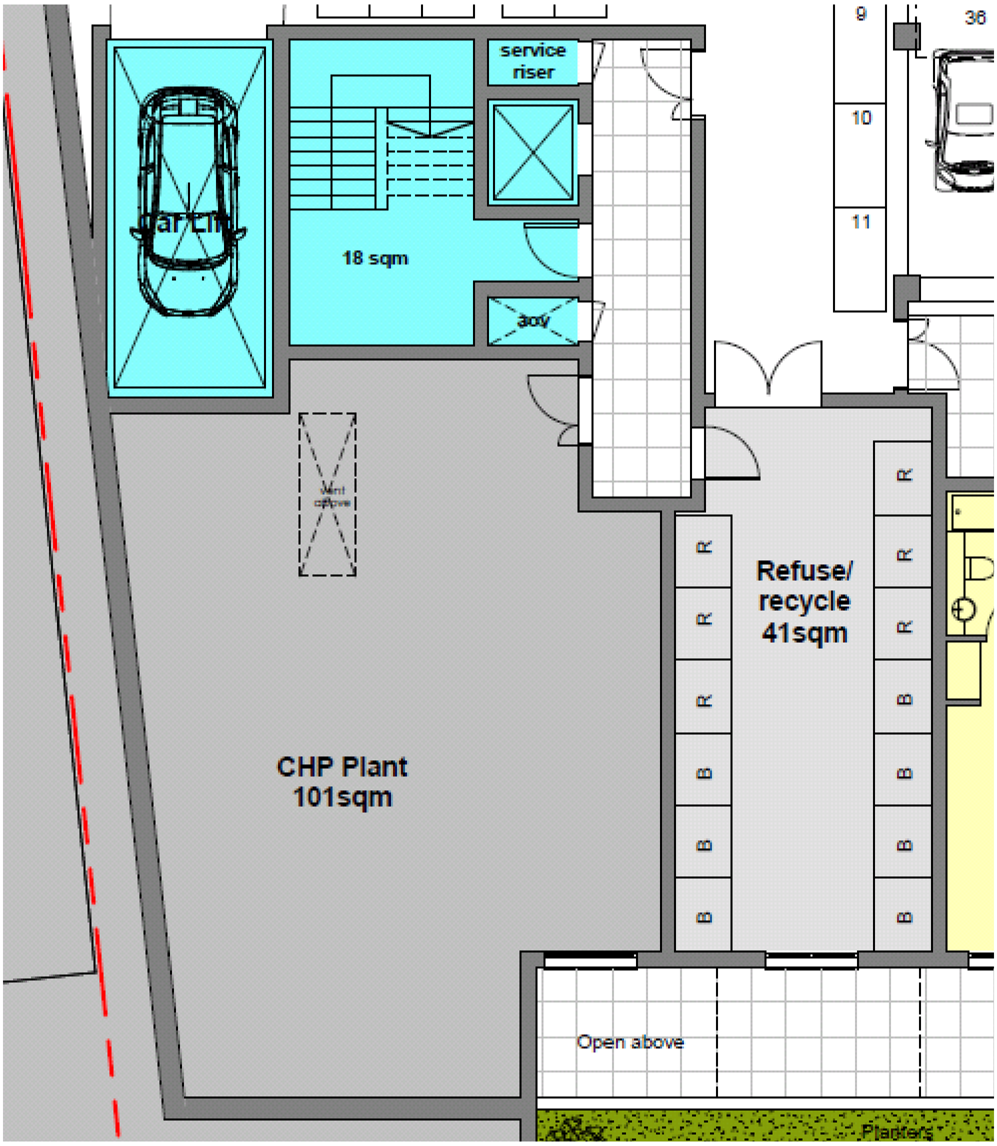
6.15 Therefore, as the thermal demand is usually the limiting factor and to ensure the CHP system operates for as many hours as possible, the summer thermal demand (principally hot water) is generally a key factor used for sizing a gas-fired CHP. It should be noted that if a CHP system is sized to provide the majority of the site's thermal demand, a significant proportion of the generated electricity would be dumped. Excess electricity can be exported to the Grid but as gas and diesel CHP is not considered a renewable technology, the electricity does not attract Renewable Obligation Certificates (ROCs) and, as such, the financial gains are minimal when compared to the capital cost of a large CHP system.

6.16 It is assumed that conventional gas fired boilers will provide the top up heat for the site's peak winter requirements. It will be necessary, however, to balance the summertime thermal demand with the site's electrical demand for optimum efficiency.

6.17 As this is a predominantly residential development of 68 dwellings in total with a comparatively minor communal area element, the load profiles and running hours are not ideal for large-scale CHP which would generate improved electricity to heat ratios. The small heat loads generated from 68 dwellings would enable a micro, sub-25kWe, CHP plant to operate for the 5,000 running hours necessary to deliver a good quality CHP.

6.18 One micro CHP unit could be incorporated within the proposed development to provide heat for the base thermal load. To house the CHP, an extra spatial requirement on top of the space required for the communal boilers will be allocated. A plantroom has been allocated in the basement of the proposed development for the installation of the CHP, back-up boilers, pumps and pressurisation vessels and is shown in :

Figure 6.3 Basement plant area for CHP at Maygrove Road (Smith Lam Architects Ltd drawing 20045/A102rev.B)



6.19 In the operation of a communal heating system the developer would be required to create a management, maintenance and billing system that would operate the communal heating system and provide their customers with competitively priced low carbon heat.

6.20 Involvement of an ESCo (Energy Services Company) or MUSCo (Multi-Utility Services Company) may help to raise initial capital to contribute towards the costs of constructing an energy centre and a district heating network. ESCos may reach an agreement with a developer, usually prior to the design and construction of a project, to supply the energy services for the owners/tenants for a set period, usually 20-30 years. For this exclusivity of supply, the ESCo will make a capital contribution towards the central plant, which contains a CHP, and will oversee the management and operation of the equipment and billing arrangements (further information on ESCos can be found in Appendix 2.0).

6.21 Unfortunately, due to the relatively small heating loads of the proposed development, the likely revenues to be generated from the sale of heating and power to the residents (or management company) is likely to be so small that the business case for an ESCo to get involved is poor. Most ESCos do not entertain proposals from developers unless they can provide their services to 250 homes, thus the 68 residential dwellings of the proposed development are not likely to generate interest. Therefore the operation of the communal heating system is likely to be overlooked by a contracted facilities management company.

CALCULATION OF EMISSIONS SAVINGS FROM CHP

6.22 There are two means by which the emissions savings from CHP can be accounted for in the assessment of the technology. The first uses the SAP calculation spreadsheet to estimate emissions reductions based on the improved DER (Dwelling Emission Rate) from the inclusion of the technology. The second is based on the selection of a CHP and using an estimation of its annual running hours the calculation of the additional local emissions offset against the emissions reductions from the cogeneration of heat and power.

6.23 The more accurate means of calculation is based on the selection of a CHP to estimate emissions reductions rather than the use of SAP. SAP after all is a Building Regulations compliance tool and is not geared towards calculating emissions reducing potential of communal heating schemes.

6.24 Based on the selection of a 10kWe machine running for 17 hours per day, the use of CHP at 65 Maygrove Road is estimated to reduce emissions by 12.8tonnes of CO_2 per annum, equating to an emissions reduction of **7.8%** from the overall emissions baseline.

6.25 Using the SAP calculation results for the sample dwellings indicates that the 25% emissions reduction target has been met through the use of CHP within a communal heating system as described by Table 6.1:

Table 6.1 Dwelling Emission Ratings (DERs) from SAP calculations for sample apartments using CHP within communal heating system

Dwelling Type	Average TER ($kgCO_2/m^2/yr$)	Average DER ($kgCO_2/m^2/yr$)	Percentage Improvement (%)
One Bed	13.7	5.2	62
Two Bed	22.8	8.2	64
Three Bed	9.7	4.0	59
Four Bed	23.6	11.4	52
Note: SAP 2009 calculations undertaken using approved NHER calculation software 'NHER Plan Assessor Version 5.3' in November 2011			

6.26 Table 6.1 is based on the assumption that around 60% of the dwellings heat demand is met by heat from the CHP with the other 40% being met by communal boilers and an allowance for heat losses from the distribution network. Note that as the communal spaces are not to be heated, no emissions reduction benefit can be associated to these spaces from the CHP.

6.27 Using the SAP output figures, the use of CHP at 65 Maygrove Road is estimated to reduce emissions by 43tonnes of CO_2 per annum, equating to an emissions reduction of **26.2%** from the overall emissions baseline.

7.0 LOW & ZERO CARBON TECHNOLOGIES – BE GREEN

7.1 This section describes the low and zero carbon (LZC) technologies which have been considered for the development. Readers familiar with these technologies may prefer to proceed to Section 8.0 of this report where the technologies that are appropriate for the proposed development are considered for this planning application.

7.2 When addressing the third tier of the Energy Hierarchy, the aim is to integrate renewable energy technologies that are appropriate to the design of the buildings at the development. Furthermore the integration of renewables must not compromise or detract from the adoption of energy efficiency measures and decentralised energy infrastructure.

7.3 From the suggested renewable energy systems listed in the *London Renewables Toolkit*[12], a number of potential technologies were identified; in each case the site location and/or development design provided, in principle, is a key determinant for the selection of each technology.

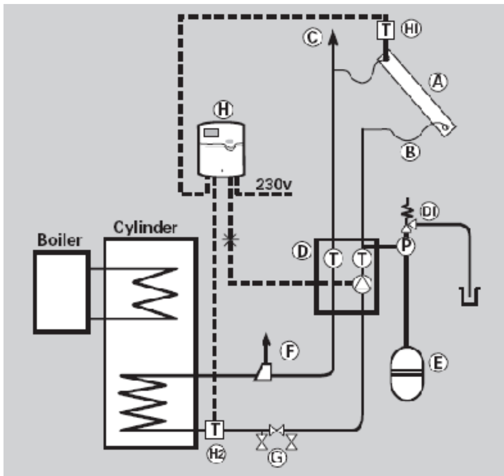
Solar Hot Water

7.4 Solar thermal panels are used to produce hot water and consist of roof mounted collector panels that make use of heat energy from the sun to heat water circulating in a closed loop. Usually this heat is then transferred via a heat exchanger into a hot water storage tank that is also heated by a gas or other boiler.

7.5 Two main types of solar water heating system are used in the UK; flat plate collectors and evacuated glass heat tubes. Flat plate collectors circulate water around a black coloured receiver plate that is heated by direct sunlight and to some extent by indirect light, heat being retained by a thermally glazed panel above. Evacuated glass heat tubes are more efficient, particularly in the UK, as they can work more effectively at low solar radiation levels. These consist of rows of parallel transparent glass tubes, each containing an absorber tube which converts the sunlight into heat energy. They are, however, more expensive than flat plate collectors.

Figure 7.1 Solar Thermal Evacuated Tube Panels

Figure 7.2 Typical schematic of Solar Thermal Installation



Ground Source Heat Pumps

7.6 Ground source heat pumps (GSHPs) extract heat from the ground. GSHPs work on the principle that the below ground temperature is more constant compared to that above ground. In the winter months, the below ground temperature is warmer than above and the heat carrier fluid circulating within the absorber pipes absorbs the heat. This heat energy is then raised by a compressor (using the compression cycle) and through a heat exchanger, distributed via a low temperature distribution system such as under floor heating to satisfy a proportion of the space heating requirements. GSHP systems are not suitable for satisfying high temperature hot water demands.

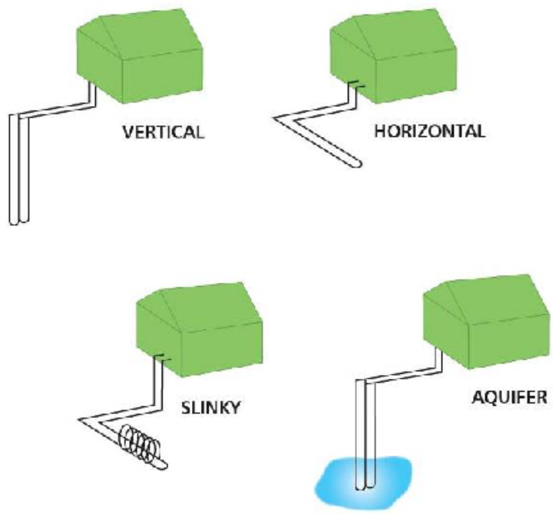
7.7 As Figure 7.3 shows, there are a number of configurations for GSHP systems. A vertical collector system is considered to be the most appropriate in the context of the proposed development given the large scale of the system and limited area available for horizontal collectors. Vertical collectors can be between 15–180m deep and minimum spacing between adjacent boreholes should be maintained at 5-15m to prevent thermal interference.

7.8 A key component of this technology is the heat exchanger. Larger heat exchangers deliver greater heat transfer and are, therefore, more efficient but have a higher capital cost.

7.9 It is important to establish ground conditions (depth of soil cover, the type of soil or rock and the ground temperature) at the application site and the presence of underlying London Clay is considered appropriate. This would, however, be subject to a ground survey.

7.10 'Reversible' heat pump systems are also available that give the potential for provision of space cooling, if required. These systems extract coolth from the ground during the summer months and heat during the winter months. Groundwater can also be used to cool buildings where a suitable source exists, abstraction and discharge permissions can be obtained and test bores are favourable.

Figure 7.3 Diagram showing ground coupling options



7.11 Under this feasibility study, the GSHP system has been assessed for use with the proposed development, and has been sized based on the available site footprint. As horizontal collectors require a relatively large area, and given the small size of the application site in relation to the density of the buildings, it is considered that the most appropriate option for the scheme would be to incorporate closed loop vertical heat pumps, which provide better efficiencies due to the larger heat transfer surface area found at depth.

Air Source Heat Pump

7.12 Air source heat pumps (ASHPs) absorb heat from the outside air; the heat is then used to warm water for radiators or underfloor heating systems, or to warm the air within a dwelling. ASHPs work on a similar principle to a fridge, which extracts heat from its inside. An evaporator coil, mounted outside absorbs the heat; a compressor unit then drives refrigerant through the heat pump and compresses it to the right level to suit the heat distribution system. Finally, a heat exchanger transfers the heat from the refrigerant for use, depending on which of the two main types of systems (identified below) is installed:

- Air to air systems - produce warm air which is circulated by fans to heat a home; and
- Air to water systems - use heat to warm water. Heat pumps heat water to a lower temperature than a standard boiler system; therefore, these systems are more suitable for underfloor heating than radiator systems, requiring less space to incorporate, compared with an air to air system.

7.13 The efficiency of ASHPs is measured by a coefficient of performance (CoP) - the amount of heat produced compared to the amount of electricity needed to run them. As ASHPs produce less heat than traditional boilers, buildings must be well insulated and draught-proofed to ensure that the heating system is effective.

7.14 Using air instead of the earth as a heat source mean that ASHPs have a lower CoP than GSHPs, resulting in less carbon savings for a similar sized heat pump. However, the key issue when considering the potential carbon savings of ASHPs is the carbon content of grid electricity. The cleaner the grid electricity, the better the carbon savings from ASHPs; given the legally binding UK carbon reduction targets, it is likely that ASHPs installed with an estimated operational period of 25 years will be better in carbon terms compared with traditional condensing gas fired boilers.

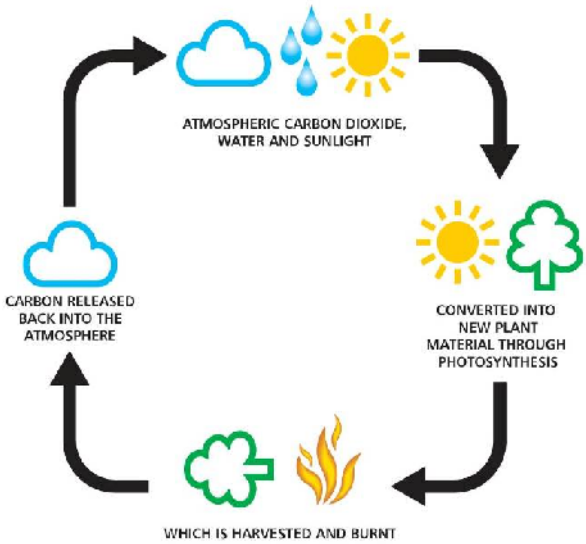
7.15 In addition, ASHPs are becoming increasingly popular in the UK, largely due to the fact that there is no need for extensive excavation, requiring far less space and are more easily installed than GSHPs. Buildings do not have to be re-engineered to obtain heat from a different fuel source should gas become scarce, expensive or a 'dirty' fuel, compared to electricity.

Biofuelled Heating

7.16 Biomass boilers replace conventionally powered boilers with an almost carbon neutral fuel such as wood pellets. The fuel is classed as almost carbon neutral because the CO_2 released during the burning of biomass is balanced by that absorbed by the plants during their growth, see Figure 7.4.

7.17 The proposed development could allocate space for these boilers and storage of the fuel and it may be possible to source the fuel from within the south of England. It should be noted, however, that fossil fuels are utilised in the production, processing and transportation of biomass fuels and therefore, care should be taken when choosing the fuel supplier and the distance and method for transportation.

Figure 7.4 Biomass Life Cycle



ELECTRICAL PROVISION

Photovoltaic Cells

7.18 Solar Photovoltaics (PVs) are solar panels which generate electricity through photon-to-electron energy transfer, which takes place in the dielectric materials that make up the cells. The cells are made up from layers of semi-conducting silicon material which, when illuminated by the sun, produce an electrical field that generates an electrical current. PVs can generate electricity even on overcast days, requiring daylight, rather than direct sunlight. This makes them viable even in the UK, although peak output is obtained at midday on a sunny summer's day. PVs offer a simple, proven solution to generating renewable electricity.

Figure 7.5 Photovoltaic (PV) Panels

Rooftop Building Integrated Wind Turbines

7.19 Wind turbines are an established means of capturing wind energy and converting it into usable electricity. Wind turbines come in various sizes depending on the location and the electrical requirements. A wind turbine usually consists of a nacelle containing a generator connected, sometimes via a gearbox, to a rotor consisting of three blades.

8.0 LOW AND ZERO CARBON TECHNOLOGY ASSESSMENT FOR MAYGROVE ROAD

HEATING AND HOT WATER PROVISION

Solar Hot Water

8.1 As part of the feasibility of appropriate low and zero carbon technologies, available roofspace was identified to accommodate solar technologies (i.e. solar thermal panels or photovoltaic panels). It is not considered appropriate to specify solar thermal heating to individual flats, as this would require a dedicated link between the panels to hot water cylinders in each flat, involving additional floorspace for risers between the roof and dwellings.

8.2 Further, as discussed in Section 6.0 of this report, the proposed development will benefit from a communal heating system with CHP, in accordance with the second principle of the Energy Hierarchy. The use of a renewable heating technology to compete with the supply of low carbon heating is unwise given that both technologies look to serve the base heat load, or that associated with domestic hot water demand for the proposed development.

8.3 Following discussions with the design team, it was considered that this approach was not considered cost-effective or favourable, and as such, alternative low and zero carbon technologies are considered more appropriate to the development.

Ground Source Heat Pumps

8.4 The use of GSHPs would not only be cost-prohibitive (these types of systems would require instruction of a specialist installer with groundworks which are likely to lengthen the construction programme) but also involve the additional project risk of buried systems which is not considered acceptable to the operation of the scheme. On this basis, GSHPs have not been considered appropriate for the proposed development at Maygrove Road.

Air Source Heat Pump

8.5 Though there will be future carbon benefits from the use of ASHPs (given the greening of electricity supplies in the UK) they only offer marginal carbon savings at the present time and many local authorities are set against their use due to fuel poverty concerns. In addition, the use of ASHPs requires that outdoor units are installed on the facade or roof of the building, which is unlikely to be possible without creating an unacceptable visual intrusion to the development. Therefore, ASHPs have not been selected for inclusion at the proposed development in favour of other heat generating technologies.

Biofuelled Heating

8.6 Although many biomass burners will meet Clean Air Act requirements, combustion of woody biomass releases higher quantities of NO_x compared to a comparable system fuelled by natural gas. As a consequence, many London boroughs have concerns about the potential impact on air quality that the widespread uptake of biomass boilers would have. In light of these concerns, London boroughs recently commissioned a report[15] to review the potential impacts of biomass use in London. The report, whilst acknowledging the problems widespread biomass combustion would cause, does not advocate the rejection of biomass as a renewable fuel for London but indicates a general approval of schemes that are linked to large-scale biomass CHP.

8.7 In addition, the ability of the application site to accommodate space required for deliveries and storage of biomass has been questioned within the design of the buildings. The management burden of checking fuel quality, scheduling fuel deliveries and disposal of ash from a biomass system further reduces its attractiveness. For these reasons and those highlighted above, the integration of biomass boilers is not preferred for the proposed development.

ELECTRICAL PROVISION

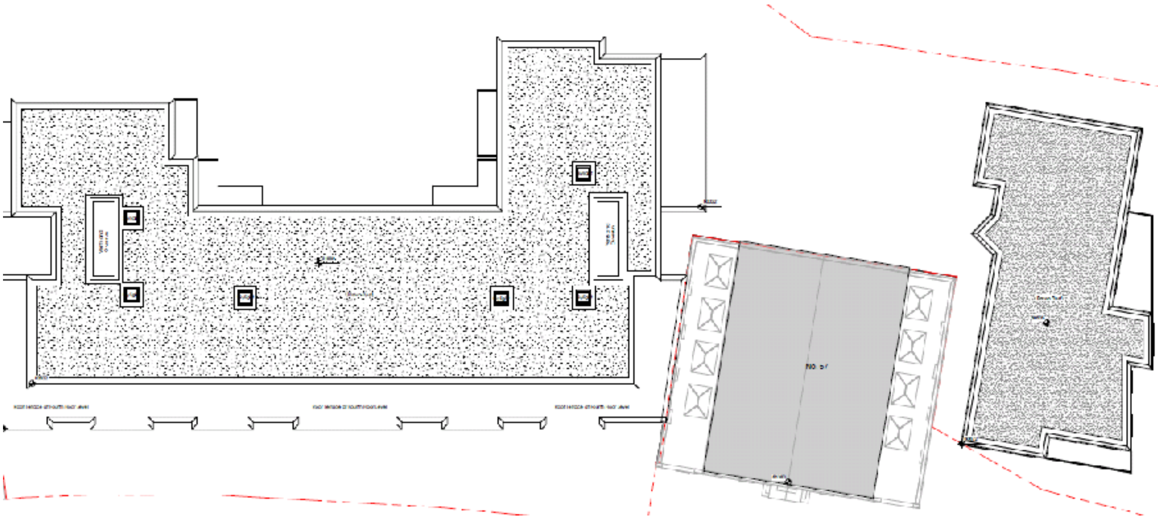
Rooftop Building Integrated Wind Turbines

8.8 Owing to site constraints, micro-wind turbines have not been considered as part of this feasibility study. Constraints include low wind speeds in this area, averaging 2.5 m/s assuming a mid-rotor height above the landscape (high height and density)[16]. Wind turbines are also likely to have an impact on the landscape and sensitive local environment, as well as health and safety implications for occupiers or users on-site and on adjacent areas as a result of noise and light flicker associated with the wind turbines. Finally, it should also be noted that the rated power and energy output of micro-wind turbines is also the subject of further independent investigation into whether these devices meet their rated power outputs and therefore deliver the anticipated energy yields.

Photovoltaic Cells

8.9 It is considered technically feasible to utilise the roofspace on the buildings of the proposed development to accommodate photovoltaic panels including spacing required for access and to prevent overshadowing. The roofspace shown on Figure 8.1 below indicates that there is free space upon which PV panels could be located.

Figure 8.1 Roof space at 65 Maygrove Road



8.10 Though there is space for the inclusion of PV panels at the development, from a cost analysis point of view it is preferred to invest capital into both passive design measures (improved U-values for building fabric and higher levels of airtightness) and the creation of a communal heating system powered by CHP. These measures will ensure the development can achieve greater carbon dioxide reductions rather than designing to a lower standard and then including renewable technologies.

8.11 The installation of PV panels is therefore technically feasible but has been ruled out on an economic basis.

9.0 CONCLUSION

9.1 The Energy Statement has shown how the proposed development will be designed using the Energy Hierarchy and will deliver significant carbon dioxide savings as compared to Part L 2010 compliant, 'business as usual' buildings.

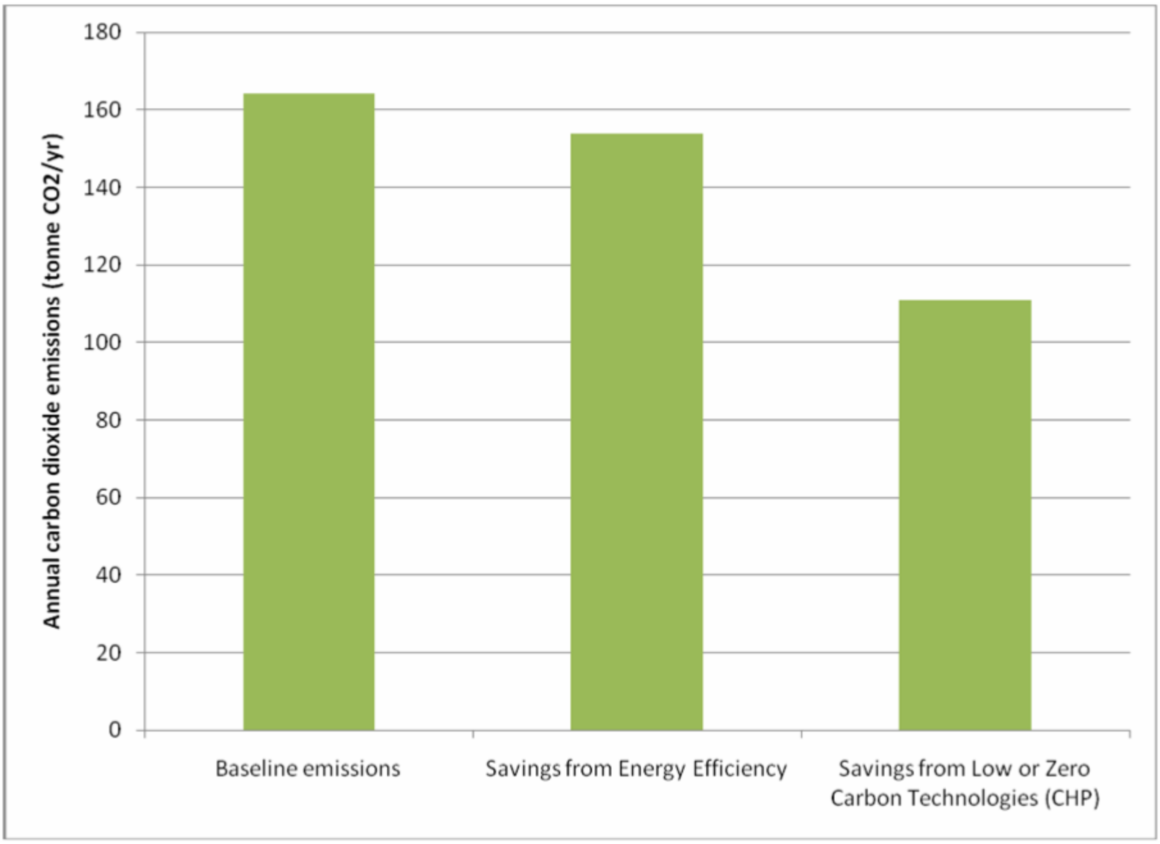
9.2 In response to the first tier of the Energy Hierarchy, it is estimated that passive energy efficient design measures are likely to exceed the TER as a result of energy efficiency measures alone.

9.3 The overall savings from applying the principles of the Energy Hierarchy are summarised in Table 9.1 below.

Table 9.1 Overall carbon dioxide emissions reductions

	Total CO_2 emissions (tonne CO_2/yr)	Total CO_2 saving (%)
Baseline emissions	164	-
Savings from Energy Efficiency	10	6.2
Savings from Low or Zero Carbon Technologies After Energy Efficiency Measures	43	26.2
Emissions savings	53	32.4

Figure 9.1 Calculation of Total Carbon Dioxide Savings



9.4 Of the technologies that can be practically applied at the development, photovoltaic systems are considered to be most appropriate when technical and spatial constraints have been taken into account.

9.5 Thus, the proposed development can achieve a **32.4%** carbon dioxide saving as a result of the inclusion of energy efficiency measures and CHP beyond the energy baseline demand of both regulated and unregulated emissions.

9.6 The target for the overall carbon dioxide saving (when using SAP and accounting for regulated emissions alone) exceeds the 25% improvement upon the TER and achieves the mandatory requirement under 'Ene1', for Level 4 of the Code for Sustainable Homes.

– END –

APPENDIX 1.0 – CODE FOR SUSTAINABLE HOMES ENE 7 LOW OR ZERO CARBON TECHNOLOGIES CREDIT COMPLIANCE

In order to meet the requirements of the Code for Sustainable Homes (Technical Guidance November 2010) Credit Ene 7 the following section details the additional features of the Low or Zero Carbon (LZC) feasibility study that are not considered within the main body of the Energy Strategy Report produced in support of the planning application. This Low or Zero Carbon feasibility study has been undertaken at the outline proposals stage, Royal Institute of British Architects (RIBA) stage C.

ACCREDITED ENERGY ASSESSOR

This section of the report has been undertaken by an accredited Low Carbon Consultant and Low Carbon Energy Assessor of a government recognised competent person's scheme run by the Chartered Institution of Building Services Engineers. Environmental Perspectives operate as independent energy specialists without any professional ties to a particular manufacturer or technology.

STANDARD CASE CO_2 EMISSIONS

The Standard Case CO_2 emissions are included in the SAP output documents listed in Appendix 1.2. The specification assumptions are described in the following table:

Table 9.2 Standard CO_2 emissions calculation – specification assumptions

Element or System		Value
[1]	Main heating fuel (space and water)	Mains gas
[2]	Main water heating system (and second main heating system where specified)	Communal Boiler Fully pumped circulation Water pump in heated space
[2a]	Boiler	SEDBUK (2011) Fanned flue On/off burner control
[2b]	Heating system controls	Charging system linked to use Programmer Room thermostats TRVs
[3]	Secondary heating fuel	Electricity
[3a]	Secondary heating system	Panel, convector or radiant heaters
[4]	Hot water system	From main
[4a]	Hot water storage	None
[4b]	Primary water heating losses	Primary pipework insulated Cylinder temperature controlled by thermostat
[4c]	Technologies covered by Appendix H of SAP	None specified
[5]	Technologies covered by Appendix M of SAP	None specified

ACTUAL CASE CO_2 EMISSIONS

The Actual Case CO_2 emissions are included in the SAP output documents listed in Appendix 1.3. The specification assumptions are described in the following table:

Table 9.3 Actual case CO_2 emissions calculation – specification assumptions

Element or System		Value
[1]	Main heating fuel (space and water)	Mains gas
[2]	Main water heating system (and second main heating system where specified)	Communal Boiler and CHP Fully pumped circulation Water pump in heated space
[2a]	Boiler	SEDBUK (2011) Fanned flue On/off burner control
[2b]	Heating system controls	Charging system linked to use Programmer Room thermostats TRVs
[3]	Secondary heating fuel	Electricity
[3a]	Secondary heating system	Panel, convector or radiant heaters
[4]	Hot water system	From main
[4a]	Hot water storage	None
[4b]	Primary water heating losses	Primary pipework insulated Cylinder temperature controlled by thermostat
[4c]	Technologies covered by Appendix H of SAP	None specified
[5]	Technologies covered by Appendix M of SAP	None specified

Following calculation of emissions using the Standard Assessment Procedure (SAP) for scenarios with and without low or zero carbon technologies the following summary table indicates the reduction in CO_2 emissions in percentage terms:

Table 9.4 Reduction in CO_2 emissions Flat A

Value Required		Data Source Guidance	Unit Required	Value
[1]	Standard case CO_2 emissions	SAP section 16 [SAP box ZC8]	+ $kgCO_2/m^2/yr$	13.55
[2]	Actual case CO_2 emissions	SAP section 16 [SAP box ZC8]	+/- $kgCO_2/m^2/yr$	11.35
[3]	Reduction in CO_2 emissions	100x(1-([2]/[1]))	+/- %	16.24

Table 9.5 Reduction in CO_2 emissions Flat 1

Value Required		Data Source Guidance	Unit Required	Value
[1]	Standard case CO_2 emissions	SAP section 16 [SAP box ZC8]	+ $kgCO_2/m^2/yr$	7.2
[2]	Actual case CO_2 emissions	SAP section 16 [SAP box ZC8]	+/- $kgCO_2/m^2/yr$	6.29
[3]	Reduction in CO_2 emissions	100x(1-([2]/[1]))	+/- %	12.64

Table 9.6 Reduction in CO_2 emissions Flat 5

Value Required		Data Source Guidance	Unit Required	Value
[1]	Standard case CO_2 emissions	SAP section 16 [SAP box ZC8]	+ $kgCO_2/m^2/yr$	4.54
[2]	Actual case CO_2 emissions	SAP section 16 [SAP box ZC8]	+/- $kgCO_2/m^2/yr$	4.00
[3]	Reduction in CO_2 emissions	100x(1-([2]/[1]))	+/- %	11.89

Table 9.7 Reduction in CO_2 emissions Flat 8

Value Required		Data Source Guidance	Unit Required	Value
[1]	Standard case CO_2 emissions	SAP section 16 [SAP box ZC8]	+ $kgCO_2/m^2/yr$	3.68
[2]	Actual case CO_2 emissions	SAP section 16 [SAP box ZC8]	+/- $kgCO_2/m^2/yr$	3.2
[3]	Reduction in CO_2 emissions	100x(1-([2]/[1]))	+/- %	13.04

Table 9.8 Reduction in CO_2 emissions Flat 17

Value Required		Data Source Guidance	Unit Required	Value
[1]	Standard case CO_2 emissions	SAP section 16 [SAP box ZC8]	+ $kgCO_2/m^2/yr$	7.04
[2]	Actual case CO_2 emissions	SAP section 16 [SAP box ZC8]	+/- $kgCO_2/m^2/yr$	6.13
[3]	Reduction in CO_2 emissions	100x(1-([2]/[1]))	+/- %	12.93

Table 9.9 Reduction in CO_2 emissions Flat 28

Value Required		Data Source Guidance	Unit Required	Value
[1]	Standard case CO_2 emissions	SAP section 16 [SAP box ZC8]	+ $kgCO_2/m^2/yr$	7.03
[2]	Actual case CO_2 emissions	SAP section 16 [SAP box ZC8]	+/- $kgCO_2/m^2/yr$	6.12
[3]	Reduction in CO_2 emissions	100x(1-([2]/[1]))	+/- %	12.94

Table 9.10 Reduction in CO_2 emissions Flat 47

Value Required		Data Source Guidance	Unit Required	Value
[1]	Standard case CO_2 emissions	SAP section 16 [SAP box ZC8]	+ $kgCO_2/m^2/yr$	7.72
[2]	Actual case CO_2 emissions	SAP section 16 [SAP box ZC8]	+/- $kgCO_2/m^2/yr$	6.63
[3]	Reduction in CO_2 emissions	100x(1-([2]/[1]))	+/- %	14.12

Table 9.11 Reduction in CO_2 emissions Flat 51

Value Required		Data Source Guidance	Unit Required	Value
[1]	Standard case CO_2 emissions	SAP section 16 [SAP box ZC8]	+ $kgCO_2/m^2/yr$	13.69
[2]	Actual case CO_2 emissions	SAP section 16 [SAP box ZC8]	+/- $kgCO_2/m^2/yr$	11.43
[3]	Reduction in CO_2 emissions	100x(1-([2]/[1]))	+/- %	16.5

We therefore recommend that at least one credit can be awarded under the Ene 7 section of the Code for Sustainable Homes given the performance described above on a sample set of SAP calculations undertaken for the proposed development. It is likely that dwellings with greater heat loss, namely the larger four bedroom dwellings and the top level apartments can achieve an additional credit given the emissions reducing ability of the communal heating system.

APPENDIX 1.1 SAP CALCULATIONS STANDARD CASE

SAP 2009 Worksheet

NHER

This design submission has been carried out by an Authorised SAP Assessor. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Miss Olivia Finch	Assessor number	1422
Client		Last modified	14/12/2011
Address	1 65 Maygrove Road, West Hampstead, London, NW6 2EH		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		56.00	(1a)	x	2.85	(2a)	=	159.60	(3a)
+1		34.00	(1b)	x	2.85	(2b)	=	96.90	(3b)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	90.00	(4)						
Dwelling volume							(3a) + (3b) + (3c) + (3d)...(3n) =	256.50	(5)

2. Ventilation rate

				m³ per hour	
Number of chimneys		0	x 40 =	0	(6a)
Number of open flues		0	x 20 =	0	(6b)
Number of intermittent fans		0	x 10 =	0	(7a)
Number of passive vents		0	x 10 =	0	(7b)
Number of flueless gas fires		0	x 40 =	0	(7c)
				Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) =	0	÷ (5) =	0.00	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		3.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.15	(18)

Air permeability value applies if a pressurisation test has been done, or a design or specified air permeability is being used

Number of sides on which dwelling is sheltered		4	(19)
Shelter factor	1 - [0.075 x (19)] =	0.70	(20)
Adjusted infiltration rate	(18) x (20) =	0.10	(21)

Infiltration rate modified for monthly wind speed:

Monthly average wind speed from Table 7

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(22)m	5.40	5.10	5.10	4.50	4.10	3.90	3.70	3.70	4.20	4.50	4.80	5.10

∑(22)1...12 = 54.10 (22)

Wind Factor (22a)m = (22)m ÷ 4

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(22a)m	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.20	1.27

∑(22a)1...12 = 13.52 (22a)

Adjusted infiltration rate (allowing for shelter and wind speed) = (21) × (22a)m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(22b)m	0.14	0.13	0.13	0.12	0.11	0.10	0.10	0.10	0.11	0.12	0.13	0.13

∑(22b)1...12 = 1.42 (22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system 0.5 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)), otherwise (23b) = (23a) | 0.5 | (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = | N/A | (23c)

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 x (23b), then (24c) = (23b); otherwise (24c) = (22b)m + 0.5 x (23b)

(24c)m	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	(24c)

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in box (25)

(25)m	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	(25)

3. Heat losses and heat loss parameter

The κ-value is the heat capacity per unit area, see Table 1e.

Element	Gross Area, m²	Openings, m²	Net area A, m²		U-value, W/m²K		A x U, W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Window*			10.00	x	1.42	=	14.15	N/A	N/A	(27)
Basement floor			56.00	x	0.13	=	7.28	N/A	N/A	(28)
External wall			27.90	x	0.20	=	5.58	N/A	N/A	(29a)
Total area of external elements ∑A, m²			93.90 (31)							

** for windows and roof windows, effective window U-value is calculated using formula 1/[(1/UValue)+0.04] paragraph 3.2*

Fabric heat loss, W/K = ∑(A × U) (26)...(30) + (32) = | 27.01 | (33)

Heat capacity Cm = ∑(A x κ) (28)...(30) + (32) + (32a)...(32e) = | N/A | (34)

Thermal mass parameter (TMP) in kJ/m²K Calculated separately = | 100.00 | (35)

Thermal bridges: ∑(L x Ψ) calculated using Appendix K | 14.08 | (36)

if details of thermal bridging are not known then (36) = 0.15 x (31)

Total fabric heat loss (33) + (36) = | 41.10 | (37)

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

(38)m	42.32	42.32	42.32	42.32	42.32	42.32	42.32	42.32	42.32	42.32	42.32	42.32	(38)

Heat transfer coefficient, W/K (37)m + (38)m

(39)m	83.42	83.42	83.42	83.42	83.42	83.42	83.42	83.42	83.42	83.42	83.42	83.42

Average = ∑(39)1...12/12 = | 83.42 | (39)

Heat loss parameter (HLP), W/m²K (39)m ÷ (4)

(40)m	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93

Average = ∑(40)1...12/12 = | 0.93 | (40)

4. Water heating energy requirement

kWh/year

Assumed occupancy, N | 2.63 | (42)

If TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA - 13.9)²)] + 0.0013 x (TFA - 13.9)

If TFA ≤ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 96.56 | (43)

Annual average hot water usage has been reduced by 5% if the dwelling is designed to achieve a water use target of not more than 125 litres per person per day (all water use, hot and cold)

Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(44)m	106.22	102.35	98.49	94.63	90.77	86.90	86.90	90.77	94.63	98.49	102.35	106.22

∑(44)1...12 = | 1158.73 | (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)

(45)m	157.89	138.09	142.50	124.24	119.21	102.87	95.32	109.38	110.69	129.00	140.81	152.91

∑(45)1...12 = | 1522.91 | (45)

If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

For community heating include distribution loss whether or not hot water tank is present

Distribution loss 0.15 x (45)m

(46)m	23.68	20.71	21.38	18.64	17.88	15.43	14.30	16.41	16.60	19.35	21.12	22.94	(46)

Water storage loss:

b) If manufacturer's declared cylinder loss factor is not known:

Cylinder volume (litres) including any solar storage within same cylinder	110.00	(50)

If community heating and no tank in dwelling, enter 110 litres in box (50)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in box (50)

Hot water storage loss factor from Table 2 (kWh/litre/day)	0.02	(51)

If community heating see SAP 2009 section 4.3

Volume factor from Table 2a	1.03	(52)
Temperature factor from Table 2b	1.00	(53)
Energy lost from water storage, kWh/day (50) x (51) x (52) x (53)	1.72	(54)
Enter (49) or (54) in (55)	1.72	(55)

Water storage loss calculated for each month = (55) x (41)m

(56)m	53.36	48.19	53.36	51.64	53.36	51.64	53.36	53.36	51.64	53.36	51.64	53.36	(56)

If cylinder contains dedicated solar storage, = (56)m x [(50) - (H11)] ÷ (50), else = (56)m where (H11) is from Appendix H

(57)m	53.36	48.19	53.36	51.64	53.36	51.64	53.36	53.36	51.64	53.36	51.64	53.36	(57)

Primary circuit loss (annual) from Table 3	360.00	(58)

Primary circuit loss for each month (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58	(59)

Combi loss for each month from Table 3a, 3b or 3c (enter '0' if not a combi boiler)

(61)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)

Total heat required for water heating calculated for each month 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m	241.83	213.90	226.43	205.46	203.14	184.09	179.25	193.32	191.91	212.93	222.04	236.84	(62)

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRS and/or WWHRS applies, see Appendix G)

(63)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

∑(63)1...12 = 0.00 (63)

Output from water heater for each month, kWh/month (62)m + (63)m

(64)m	241.83	213.90	226.43	205.46	203.14	184.09	179.25	193.32	191.91	212.93	222.04	236.84

∑(64)1...12 = 2511.15 (64)

if (64)m < 0 then set to 0

Heat gains from water heating, kWh/month 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m]

(65)m	119.65	106.56	114.53	106.29	106.78	99.18	98.84	103.52	101.78	110.04	111.80	117.99	(65)

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5), Watts													
(66)m	157.54	157.54	157.54	157.54	157.54	157.54	157.54	157.54	157.54	157.54	157.54	157.54	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m	62.92	55.88	45.45	34.41	25.72	21.71	23.46	30.50	40.93	51.97	60.66	64.67	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m	356.83	360.54	351.20	331.34	306.26	282.70	266.95	263.25	272.58	292.45	317.52	341.09	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m	53.38	53.38	53.38	53.38	53.38	53.38	53.38	53.38	53.38	53.38	53.38	53.38	(69)
Pumps and fans gains (Table 5a)													
(70)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(70)
Losses e.g. evaporation (negative values) (Table 5)													
(71)m	-105.03	-105.03	-105.03	-105.03	-105.03	-105.03	-105.03	-105.03	-105.03	-105.03	-105.03	-105.03	(71)

Water heating gains (Table 5)

(72)m	160.81	158.58	153.94	147.62	143.53	137.75	132.85	139.13	141.37	147.90	155.28	158.59	(72)

Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

(73)m	686.46	680.89	656.48	619.26	581.40	548.06	529.16	538.78	560.77	598.21	639.35	670.24	(73)

6. Solar gains

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

Rows (74) to (82) are used 12 times, one for each month, repeating as needed if there is more than one window type.

Details for month of January and annual totals are shown below:

	Access factor Table 6d		Area m²		Solar flux W/m²		g Specific data or Table 6b		FF Specific data or Table 6c		Gains (W)	
South	0.54	x	10.00	x	47.32	x	0.53	x	1.00	=	135.44	(78)

Solar gains in watts, calculated for each month ∑(74)m...(82)m

(83)m	135.44	220.90	269.73	300.84	310.67	311.67	306.63	297.31	286.17	244.11	160.47	117.03	(83)

Total gains - internal and solar (73)m + (83)m

(84)m	821.90	901.79	926.21	920.10	892.07	859.73	835.79	836.09	846.95	842.32	799.82	787.26	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(˚C) | 21.00 | (85)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains for living area, η1,m (see Table 9a)													
(86)m	0.90	0.87	0.83	0.79	0.70	0.55	0.39	0.39	0.58	0.75	0.87	0.91	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)													
(87)m	19.63	19.82	20.11	20.35	20.67	20.88	20.97	20.97	20.85	20.54	19.98	19.64	(87)
Temperature during heating periods in the living area from Table 9, Th2(˚C)													
(88)m	20.15	20.15	20.15	20.15	20.15	20.15	20.15	20.15	20.15	20.15	20.15	20.15	(88)
Utilisation factor for gains for rest of dwelling η2,m (see Table 9a)													
(89)m	0.89	0.86	0.81	0.76	0.66	0.50	0.32	0.32	0.52	0.72	0.85	0.89	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)													
(90)m	18.34	18.61	19.01	19.35	19.77	20.03	20.13	20.13	20.01	19.60	18.84	18.36	(90)

Living area fraction | fLA 56.00 | ÷ (4) = | 0.62 | (91)

Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2													
(92)m	19.14	19.36	19.70	19.98	20.33	20.56	20.65	20.65	20.53	20.18	19.55	19.16	(92)
Apply adjustment to the mean internal temperature from Table 4e, where appropriate													
(93)m	19.14	19.36	19.70	19.98	20.33	20.56	20.65	20.65	20.53	20.18	19.55	19.16	(93)

8. Space heating requirement

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

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that tim = (93)m and recalculate the utilisation factor for gains using Table 9a)

Utilisation factor for gains, ⍰m													
(94)m	0.87	0.84	0.80	0.76	0.66	0.52	0.36	0.36	0.55	0.72	0.84	0.88	(94)
Useful gains, ⍰mGm, W = (94)m x (84)m													
(95)m	718.78	761.63	743.70	697.50	592.88	451.33	302.39	302.40	465.82	607.89	672.10	691.63	(95)
Monthly average external temperature from Table 8													
(96)m	4.50	5.00	6.80	8.70	11.70	14.60	16.90	16.90	14.30	10.80	7.00	4.90	(96)
Heat loss rate for mean internal temperature, Lm, W													
(97)m	1221.59	1198.19	1075.88	940.59	719.65	496.99	312.89	312.89	520.05	782.65	1047.13	1189.34	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m - (95)m] x (41)m													
(98)m	374.09	293.37	247.14	175.03	94.32	0.00	0.00	0.00	0.00	130.02	270.03	370.29	

Total per year (kWh/year) = ∑(98)1...5, 10...12 = | 1954.29 | (98)

Space heating requirement in kWh/m²/year | (98) ÷ (4) | 21.71 | (99)

9b. Energy requirements - Community heating scheme

Fraction of space heating from secondary/supplementary system (Table 11)	0.00	(301)		
Fraction of space heating from community system 1 - (301)	1.00	(302)		

Community scheme fractions obtained from plant design specification or operational records:

Fraction of community DHW from boilers	1.00	(303b)		
Fraction of total space heat from community boilers (302) x (303b) =	1.00	(304b)		
Factor for control and charging method (Table 4c(3)) for community space heating	1.00	(305)		
Factor for control and charging method (Table 4c(3)) for community water heating	1.00	(305a)		
Distribution loss factor (Table 12c) for community heating system	0.10	(306)		
Space heating:			**kWh/year**	
Annual space heating requirement			1954.29	
Space heat from community boilers (98) x (304b) x (305) x (306) =	195.43	(307b)		
Water heating:				
Annual water heating requirement			2511.15	
If DHW from community scheme:				
Community DHW: boilers fuel use (64) x (303b) x (305a) x (306) =	251.12	(310b)		
Electricity used for heat distribution	0.01 x [(307a)...(307e) + (310a)...(310e)] =		4.47	(313)

Electricity for pumps and fans within dwelling (Table 4f):

mechanical ventilation fans - balanced, extract or positive input from outside	74.48			(330a)
warm air heating system fans	0.00			(330b)
pump for solar water heating	0.00			(330g)
Total electricity for the above, kWh/year		(330a) + (330b) + (330g) =	74.48	(331)
Electricity for lighting (calculated in Appendix L):			444.45	(332)

10b. Fuel costs - Community heating scheme

	Heat or fuel kWh/year		Fuel price (Table 12)		Fuel cost £/year	
Space heating from community boilers	195.43	x	3.78	x 0.01 =	7.39	(340b)
Water heating from community boilers	251.12	x	3.78	x 0.01 =	9.49	(342b)
Pumps and fans	74.48	x	11.46	x 0.01 =	8.54	(349)
Electricity for lighting	444.45	x	11.46	x 0.01 =	50.93	(350)
Additional standing charges (Table 12)					106.00	(351)
Total energy cost			(340a)...(342e) + (345)...(354)		182.35	(355)

11b. SAP rating - Community heating scheme

Energy cost deflator (Table 12)		0.47	(356)
Energy cost factor (ECF)	[(355) x (356)] ÷ [(4) + 45.0] =	0.63	(357)
SAP value		91.14	
SAP rating		91	(358)
SAP band		B	

12b. Carbon dioxide emissions - Community heating scheme

Emissions from other community sources (not CHP)

Efficiency of boilers (%) 90.00 (367b)

	Energy used kWh/year		Emission Factor (kgCO2/kWh)		Emissions (kgCO2/year)	
Emissions from boilers (Mains gas)	496.16	x	0.198	=	98.24	(368)
Electrical energy for heat distribution	4.47	x	0.517	=	2.31	(372)

Total carbon dioxide from community systems				(363)...(366) + (368)...(372) =	100.55	(373)
Space and water heating				(373) + (374) + (375) =	100.55	(376)
Electricity for pumps and fans within dwelling	74.48	x	0.517	=	38.50	(378)
Electricity for lighting	444.45	x	0.517	=	229.78	(379)
Total carbon dioxide emissions				∑(376)...(382) =	368.84	(383)
Dwelling carbon dioxide emissions rate				(383) ÷ (4) =	4.10	(384)
EI value					96.34	
EI rating (see section 14)					96	(385)
EI band					A	

13b. Primary energy - Community heating scheme

Primary energy from other community sources (not CHP)

	Energy used kWh/year		Primary Energy Factor		Primary Energy	
Efficiency of boilers (%)			90.00	(367b*)		
Primary energy - boilers (Mains gas)	496.16	x	1.02	=	506.08	(368*)
Electrical energy for heat distribution	4.47	x	2.92	=	13.04	(372*)
Total primary energy from community systems				(363*)...(366*) + (368*)...(372*) =	519.12	(373*)
Space and water heating				(373*) + (374*) + (375*) =	519.12	(376*)
Electricity for pumps and fans within dwelling	74.48	x	2.92	=	217.47	(378*)
Electricity for lighting	444.45	x	2.92	=	1297.80	(379*)
Total primary energy kWh/year				∑(376*)...(382*) =	2034.40	(383*)
Primary energy kWh/m2/year				(383*) ÷ (4) =	22.60	(384*)

SAP 2009 Worksheet

This design submission has been carried out by an Authorised SAP Assessor. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Miss Olivia Finch	Assessor number	1422
Client		Last modified	14/12/2011
Address	5 65 Maygrove Road, West Hampstead, London, NW6 2EH		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		264.00	(1a)	x	2.80	(2a)	=	739.20	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	264.00	(4)						
Dwelling volume							(3a) + (3b) + (3c) + (3d)...(3n) =	739.20	(5)

2. Ventilation rate

				m³ per hour	
Number of chimneys		0	x 40 =	0	(6a)
Number of open flues		0	x 20 =	0	(6b)
Number of intermittent fans		2	x 10 =	20	(7a)
Number of passive vents		4	x 10 =	40	(7b)
Number of flueless gas fires		0	x 40 =	0	(7c)
				Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) =	60	÷ (5) =	0.08	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		3.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.23	(18)

Air permeability value applies if a pressurisation test has been done, or a design or specified air permeability is being used

Number of sides on which dwelling is sheltered		4	(19)
Shelter factor	1 - [0.075 x (19)] =	0.70	(20)
Adjusted infiltration rate	(18) x (20) =	0.16	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table 7												
(22)m	5.40	5.10	5.10	4.50	4.10	3.90	3.70	3.70	4.20	4.50	4.80	5.10
Wind Factor (22a)m = (22)m ÷ 4												
(22a)m	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.20	1.27
Adjusted infiltration rate (allowing for shelter and wind speed) = (21) × (22a)m												
(22b)m	0.22	0.21	0.21	0.18	0.17	0.16	0.15	0.15	0.17	0.18	0.19	0.21

∑(22)1...12 =	54.10	(22)
∑(22a)1...12 =	13.52	(22a)
∑(22b)1...12 =	2.19	(22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	N/A	(23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)), otherwise (23b) = (23a)	N/A	(23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = N/A (23c)

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m ≥ 1, then (24d)m = (22b)m; otherwise (24d)m = 0.5 + [(22b)m2 x 0.5]

(24d)m	0.52	0.52	0.52	0.52	0.51	0.51	0.51	0.51	0.51	0.52	0.52	0.52	(24d)

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in box (25)

(25)m	0.52	0.52	0.52	0.52	0.51	0.51	0.51	0.51	0.51	0.52	0.52	0.52	(25)

3. Heat losses and heat loss parameter

The κ-value is the heat capacity per unit area, see Table 1e.

Element	Gross Area, m²	Openings, m²	Net area A, m²		U-value, W/m²K		A x U, W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Window*			10.00	x	1.42	=	14.15	N/A	N/A	(27)
Basement floor			56.00	x	0.13	=	7.28	N/A	N/A	(28)
External wall			27.90	x	0.20	=	5.58	N/A	N/A	(29a)
Total area of external elements ∑A, m²			93.90	(31)						

** for windows and roof windows, effective window U-value is calculated using formula 1/[(1/UValue)+0.04] paragraph 3.2*

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	27.01	(33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K	Calculated separately =	100.00	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		14.08	(36)

if details of thermal bridging are not known then (36) = 0.15 x (31)

Total fabric heat loss (33) + (36) = 41.10 (37)

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

(38)m	127.79	127.16	127.16	126.01	125.32	125.00	124.70	124.70	125.49	126.01	126.57	127.16	(38)

Heat transfer coefficient, W/K (37)m + (38)m

(39)m	168.88	168.26	168.26	167.11	166.42	166.10	165.80	165.80	166.59	167.11	167.66	168.26

Average = ∑(39)1...12/12 = 167.19 (39)

Heat loss parameter (HLP), W/m²K (39)m ÷ (4)

(40)m	0.64	0.64	0.64	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.64	0.64

Average = ∑(40)1...12/12 = 0.63 (40)

4. Water heating energy requirement

kWh/year

Assumed occupancy, N 3.09 (42)

If TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA - 13.9)²)] + 0.0013 x (TFA - 13.9)

If TFA ≤ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 107.47 (43)

Annual average hot water usage has been reduced by 5% if the dwelling is designed to achieve a water use target of not more than 125 litres per person per day (all water use, hot and cold)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)												
(44)m	118.22	113.92	109.62	105.32	101.02	96.72	96.72	101.02	105.32	109.62	113.92	118.22

∑(44)1...12 = 1289.66 (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)

(45)m	175.73	153.70	158.60	138.27	132.68	114.49	106.09	121.74	123.20	143.57	156.72	170.19

∑(45)1...12 = 1695.00 (45)

If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

For community heating include distribution loss whether or not hot water tank is present

Distribution loss 0.15 x (45)m

(46)m	26.36	23.05	23.79	20.74	19.90	17.17	15.91	18.26	18.48	21.54	23.51	25.53	(46)

Water storage loss:

b) If manufacturer's declared cylinder loss factor is not known:

Cylinder volume (litres) including any solar storage within same cylinder	110.00	(50)
If community heating and no tank in dwelling, enter 110 litres in box (50)		
Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in box (50)		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.02	(51)
If community heating see SAP 2009 section 4.3		
Volume factor from Table 2a	1.03	(52)
Temperature factor from Table 2b	1.00	(53)
Energy lost from water storage, kWh/day (50) x (51) x (52) x (53)	1.72	(54)
Enter (49) or (54) in (55)	1.72	(55)

Water storage loss calculated for each month = (55) x (41)m

(56)m	53.36	48.19	53.36	51.64	53.36	51.64	53.36	53.36	51.64	53.36	51.64	53.36	(56)

If cylinder contains dedicated solar storage, = (56)m x [(50) - (H11)] ÷ (50), else = (56)m where (H11) is from Appendix H

(57)m	53.36	48.19	53.36	51.64	53.36	51.64	53.36	53.36	51.64	53.36	51.64	53.36	(57)

Primary circuit loss (annual) from Table 3 — 360.00 (58)

Primary circuit loss for each month (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58	(59)

Combi loss for each month from Table 3a, 3b or 3c (enter '0' if not a combi boiler)

(61)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)

Total heat required for water heating calculated for each month 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m	259.67	229.51	242.54	219.50	216.61	195.72	190.03	205.68	204.42	227.51	237.95	254.12	(62)

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRS and/or WWHRS applies, see Appendix G)

(63)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

∑(63)1...12 = 0.00 (63)

Output from water heater for each month, kWh/month (62)m + (63)m

(64)m	259.67	229.51	242.54	219.50	216.61	195.72	190.03	205.68	204.42	227.51	237.95	254.12

∑(64)1...12 = 2683.24 (64)

if (64)m < 0 then set to 0

Heat gains from water heating, kWh/month 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m]

(65)m	125.58	111.75	119.88	110.96	111.26	103.05	102.42	107.63	105.94	114.88	117.09	123.73	(65)

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5), Watts													
(66)m	185.11	185.11	185.11	185.11	185.11	185.11	185.11	185.11	185.11	185.11	185.11	185.11	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m	130.73	116.12	94.43	71.49	53.44	45.12	48.75	63.37	85.05	107.99	126.04	134.37	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m	639.42	646.06	629.34	593.74	548.81	506.58	478.36	471.73	488.45	524.05	568.98	611.21	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m	56.60	56.60	56.60	56.60	56.60	56.60	56.60	56.60	56.60	56.60	56.60	56.60	(69)
Pumps and fans gains (Table 5a)													
(70)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(70)
Losses e.g. evaporation (negative values) (Table 5)													
(71)m	-123.41	-123.41	-123.41	-123.41	-123.41	-123.41	-123.41	-123.41	-123.41	-123.41	-123.41	-123.41	(71)
Water heating gains (Table 5)													
(72)m	168.79	166.30	161.13	154.11	149.54	143.12	137.66	144.66	147.14	154.41	162.63	166.31	(72)

Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(73)m	1057.24	1046.77	1003.20	937.64	870.09	813.11	783.08	798.05	838.94	904.75	975.94	1030.18	(73)

6. Solar gains

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

Rows (74) to (82) are used 12 times, one for each month, repeating as needed if there is more than one window type.

Details for month of January and annual totals are shown below:

	Access factor Table 6d		Area m²		Solar flux W/m²		g Specific data or Table 6b		FF Specific data or Table 6c		Gains (W)	
South	0.54	x	10.00	x	47.32	x	0.53	x	1.00	=	135.44	(78)

Solar gains in watts, calculated for each month ∑(74)m...(82)m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(83)m	135.44	220.90	269.73	300.84	310.67	311.67	306.63	297.31	286.17	244.11	160.47	117.03	(83)

Total gains - internal and solar (73)m + (83)m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(84)m	1192.68	1267.67	1272.93	1238.47	1180.76	1124.78	1089.70	1095.36	1125.12	1148.86	1136.42	1147.21	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(˚C) | 21.00 | (85)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains for living area, η1,m (see Table 9a)													
(86)m	0.98	0.97	0.96	0.94	0.89	0.77	0.58	0.58	0.79	0.92	0.97	0.98	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)													
(87)m	19.67	19.80	20.04	20.27	20.59	20.84	20.96	20.96	20.82	20.47	19.97	19.70	(87)
Temperature during heating periods in the living area from Table 9, Th2(˚C)													
(88)m	20.40	20.40	20.40	20.40	20.40	20.40	20.41	20.41	20.40	20.40	20.40	20.40	(88)
Utilisation factor for gains for rest of dwelling η2,m (see Table 9a)													
(89)m	0.98	0.97	0.95	0.93	0.87	0.73	0.51	0.51	0.76	0.91	0.96	0.98	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)													
(90)m	18.56	18.75	19.10	19.43	19.89	20.23	20.38	20.38	20.20	19.72	19.01	18.61	(90)

Living area fraction fLA 34.00 ÷ (4) = 0.13 (91)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2													
(92)m	18.71	18.89	19.22	19.54	19.98	20.31	20.45	20.45	20.28	19.82	19.14	18.75	(92)
Apply adjustment to the mean internal temperature from Table 4e, where appropriate													
(93)m	18.71	18.89	19.22	19.54	19.98	20.31	20.45	20.45	20.28	19.82	19.14	18.75	(93)

8. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that tim = (93)m and recalculate the utilisation factor for gains using Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm													
(94)m	0.97	0.96	0.94	0.92	0.85	0.72	0.52	0.52	0.75	0.89	0.95	0.97	(94)
Useful gains, ηmGm, W = (94)m x (84)m													
(95)m	1151.93	1211.66	1194.26	1134.45	1008.53	815.40	563.95	564.40	839.58	1021.13	1082.03	1109.43	(95)
Monthly average external temperature from Table 8													
(96)m	4.50	5.00	6.80	8.70	11.70	14.60	16.90	16.90	14.30	10.80	7.00	4.90	(96)
Heat loss rate for mean internal temperature, Lm, W													
(97)m	2399.28	2336.71	2090.00	1811.54	1378.56	948.86	588.97	589.05	996.21	1506.55	2034.62	2329.61	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m - (95)m] x (41)m													
(98)m	928.03	756.03	666.43	487.50	275.30	0.00	0.00	0.00	0.00	361.15	685.86	907.81	

Total per year (kWh/year) = ∑(98)1...5, 10...12 = 5068.12 (98)

Space heating requirement in kWh/m²/year (98) ÷ (4) 19.20 (99)

9b. Energy requirements - Community heating scheme

Fraction of space heating from secondary/supplementary system (Table 11) 0.00 (301)

Fraction of space heating from community system 1 - (301)		1.00	(302)		
Community scheme fractions obtained from plant design specification or operational records:					
Fraction of community DHW from boilers		1.00	(303b)		
Fraction of total space heat from community boilers (302) x (303b) =		1.00	(304b)		
Factor for control and charging method (Table 4c(3)) for community space heating		1.00	(305)		
Factor for control and charging method (Table 4c(3)) for community water heating		1.00	(305a)		
Distribution loss factor (Table 12c) for community heating system		0.10	(306)		
Space heating:				**kWh/year**	
Annual space heating requirement				5068.12	
Space heat from community boilers (98) x (304b) x (305) x (306) =		506.81	(307b)		
Water heating:					
Annual water heating requirement				2683.24	
If DHW from community scheme:					
Community DHW: boilers fuel use (64) x (303b) x (305a) x (306) =		268.32	(310b)		
Electricity used for heat distribution	0.01 x [(307a)...(307e) + (310a)...(310e)] =			7.75	(313)
Electricity for pumps and fans within dwelling (Table 4f):					
mechanical ventilation fans - balanced, extract or positive input from outside			0.00		(330a)
warm air heating system fans			0.00		(330b)
pump for solar water heating			0.00		(330g)
Total electricity for the above, kWh/year	(330a) + (330b) + (330g) =			0.00	(331)
Electricity for lighting (calculated in Appendix L):				923.51	(332)

10b. Fuel costs - Community heating scheme

	Heat or fuel kWh/year		Fuel price (Table 12)		Fuel cost £/year	
Space heating from community boilers	506.81	x	3.78	x 0.01 =	19.16	(340b)
Water heating from community boilers	268.32	x	3.78	x 0.01 =	10.14	(342b)
Pumps and fans	0.00	x	11.46	x 0.01 =	0.00	(349)
Electricity for lighting	923.51	x	11.46	x 0.01 =	105.83	(350)
Additional standing charges (Table 12)					106.00	(351)
Total energy cost			(340a)...(342e) + (345)...(354)		241.13	(355)

11b. SAP rating - Community heating scheme

Energy cost deflator (Table 12)		0.47	(356)
Energy cost factor (ECF)	[(355) x (356)] ÷ [(4) + 45.0] =	0.37	(357)
SAP value		94.88	
SAP rating		95	(358)
SAP band		A	

12b. Carbon dioxide emissions - Community heating scheme

Emissions from other community sources (not CHP)

	Energy used kWh/year		Emission Factor (kgCO2/kWh)		Emissions (kgCO2/year)	
Efficiency of boilers (%)			75.00	(367b)		
Emissions from boilers (Mains gas)	1033.51	x	0.198	=	204.64	(368)
Electrical energy for heat distribution	7.75	x	0.517	=	4.01	(372)
Total carbon dioxide from community systems			(363)...(366) + (368)...(372) =		208.64	(373)
Space and water heating			(373) + (374) + (375) =		208.64	(376)

Electricity for pumps and fans within dwelling	0.00	x	0.000	=	0.00	(378)
Electricity for lighting	923.51	x	0.517	=	477.46	(379)
Total carbon dioxide emissions				∑(376)...(382) =	686.10	(383)
Dwelling carbon dioxide emissions rate				(383) ÷ (4) =	2.60	(384)
EI value					97.02	
EI rating (see section 14)					97	(385)
EI band					A	

13b. Primary energy - Community heating scheme

Primary energy from other community sources (not CHP)

	Energy used kWh/year		Primary Energy Factor		Primary Energy	
Efficiency of boilers (%)			75.00	(367b*)		
Primary energy - boilers (Mains gas)	1033.51	x	1.02	=	1054.18	(368*)
Electrical energy for heat distribution	7.75	x	2.92	=	22.63	(372*)
Total primary energy from community systems				(363*)...(366*) + (368*)...(372*) =	1076.82	(373*)
Space and water heating				(373*) + (374*) + (375*) =	1076.82	(376*)
Electricity for pumps and fans within dwelling	0.00	x	0.00	=	0.00	(378*)
Electricity for lighting	923.51	x	2.92	=	2696.65	(379*)
Total primary energy kWh/year				∑(376*)...(382*) =	3773.47	(383*)
Primary energy kWh/m2/year				(383*) ÷ (4) =	14.29	(384*)

SAP 2009 Worksheet

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This design submission has been carried out by an Authorised SAP Assessor. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Miss Olivia Finch	Assessor number	1422
Client		Last modified	14/12/2011
Address	8 65 Maygrove Road, West Hampstead, London, NW6 2EH		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		670.00	(1a)	x	2.85	(2a)	=	1909.50	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	670.00	(4)						
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =			1909.50	(5)

2. Ventilation rate

			m³ per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	2	x 10 =	20	(7a)
Number of passive vents	2	x 10 =	20	(7b)
Number of flueless gas fires	0	x 40 =	0	(7c)
			Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs (6a) + (6b) + (7a) + (7b) + (7c) =	40	÷ (5) =	0.02	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		3.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.17	(18)

Air permeability value applies if a pressurisation test has been done, or a design or specified air permeability is being used

Number of sides on which dwelling is sheltered		4	(19)
Shelter factor	1 - [0.075 x (19)] =	0.70	(20)
Adjusted infiltration rate	(18) x (20) =	0.12	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table 7												
(22)m	5.40	5.10	5.10	4.50	4.10	3.90	3.70	3.70	4.20	4.50	4.80	5.10
Wind Factor (22a)m = (22)m ÷ 4												
(22a)m	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.20	1.27
Adjusted infiltration rate (allowing for shelter and wind speed) = (21) × (22a)m												
(22b)m	0.16	0.15	0.15	0.13	0.12	0.12	0.11	0.11	0.13	0.13	0.14	0.15

∑(22)1...12 = 54.10 (22)

∑(22a)1...12 = 13.52 (22a)

∑(22b)1...12 = 1.62 (22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	N/A	(23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)), otherwise (23b) = (23a)	N/A	(23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = N/A (23c)

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m ≥ 1, then (24d)m = (22b)m; otherwise (24d)m = 0.5 + [(22b)m2 x 0.5]

(24d)m	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	(24d)

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in box (25)

(25)m	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	(25)

3. Heat losses and heat loss parameter

The κ-value is the heat capacity per unit area, see Table 1e.

Element	Gross Area, m²	Openings, m²	Net area A, m²		U-value, W/m²K		A x U, W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Window*			10.00	x	1.42	=	14.15	N/A	N/A	(27)
Ground floor			56.00	x	0.13	=	7.28	N/A	N/A	(28a)
External wall			38.16	x	0.20	=	7.63	N/A	N/A	(29a)
Total area of external elements ∑A, m²			104.16	(31)						

** for windows and roof windows, effective window U-value is calculated using formula 1/[(1/UValue)+0.04] paragraph 3.2*

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	29.06	(33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K	Calculated separately =	100.00	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		15.62	(36)

if details of thermal bridging are not known then (36) = 0.15 x (31)

Total fabric heat loss (33) + (36) = 44.69 (37)

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

(38)m	323.29	322.40	322.40	320.78	319.81	319.36	318.93	318.93	320.04	320.78	321.56	322.40	(38)

Heat transfer coefficient, W/K (37)m + (38)m

(39)m	367.98	367.09	367.09	365.46	364.49	364.04	363.61	363.61	364.73	365.46	366.25	367.09	

Average = ∑(39)1...12/12 = 365.58 (39)

Heat loss parameter (HLP), W/m²K (39)m ÷ (4)

(40)m	0.55	0.55	0.55	0.55	0.54	0.54	0.54	0.54	0.54	0.55	0.55	0.55

Average = ∑(40)1...12/12 = 0.55 (40)

4. Water heating energy requirement

kWh/year

Assumed occupancy, N 3.61 (42)

If TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA - 13.9)²)] + 0.0013 x (TFA - 13.9)

If TFA ≤ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 120.01 (43)

Annual average hot water usage has been reduced by 5% if the dwelling is designed to achieve a water use target of not more than 125 litres per person per day (all water use, hot and cold)

Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(44)m	132.01	127.21	122.41	117.61	112.81	108.01	108.01	112.81	117.61	122.41	127.21	132.01

∑(44)1...12 = 1440.09 (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)

(45)m	196.23	171.63	177.10	154.40	148.15	127.84	118.47	135.94	137.57	160.32	175.00	190.04

∑(45)1...12 = 1892.70 (45)

If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

For community heating include distribution loss whether or not hot water tank is present

Distribution loss 0.15 x (45)m

(46)m	29.43	25.74	26.57	23.16	22.22	19.18	17.77	20.39	20.63	24.05	26.25	28.51	(46)

Water storage loss:

b) If manufacturer's declared cylinder loss factor is not known:

Cylinder volume (litres) including any solar storage within same cylinder	110.00	(50)
If community heating and no tank in dwelling, enter 110 litres in box (50)		
Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in box (50)		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.02	(51)
If community heating see SAP 2009 section 4.3		
Volume factor from Table 2a	1.03	(52)
Temperature factor from Table 2b	1.00	(53)
Energy lost from water storage, kWh/day (50) x (51) x (52) x (53)	1.72	(54)
Enter (49) or (54) in (55)	1.72	(55)

Water storage loss calculated for each month = (55) x (41)m

(56)m	53.36	48.19	53.36	51.64	53.36	51.64	53.36	53.36	51.64	53.36	51.64	53.36	(56)

If cylinder contains dedicated solar storage, = (56)m x [(50) - (H11)] ÷ (50), else = (56)m where (H11) is from Appendix H

(57)m	53.36	48.19	53.36	51.64	53.36	51.64	53.36	53.36	51.64	53.36	51.64	53.36	(57)

Primary circuit loss (annual) from Table 3 — 360.00 (58)

Primary circuit loss for each month (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58	(59)

Combi loss for each month from Table 3a, 3b or 3c (enter '0' if not a combi boiler)

(61)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)

Total heat required for water heating calculated for each month 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m	280.16	247.44	261.04	235.63	232.09	209.07	202.40	219.87	218.79	244.25	256.23	273.97	(62)

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRS and/or WWHRS applies, see Appendix G)

(63)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

∑(63)1...12 = 0.00 (63)

Output from water heater for each month, kWh/month (62)m + (63)m

(64)m	280.16	247.44	261.04	235.63	232.09	209.07	202.40	219.87	218.79	244.25	256.23	273.97

∑(64)1...12 = 2880.94 (64)

if (64)m < 0 then set to 0

Heat gains from water heating, kWh/month 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m]

(65)m	132.39	117.71	126.03	116.32	116.41	107.49	106.54	112.35	110.72	120.45	123.17	130.33	(65)

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5), Watts													
(66)m	216.78	216.78	216.78	216.78	216.78	216.78	216.78	216.78	216.78	216.78	216.78	216.78	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m	228.20	202.69	164.84	124.79	93.28	78.75	85.10	110.61	148.46	188.51	220.01	234.54	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m	1068.53	1079.62	1051.68	992.19	917.11	846.53	799.39	788.30	816.24	875.73	950.81	1021.39	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m	60.29	60.29	60.29	60.29	60.29	60.29	60.29	60.29	60.29	60.29	60.29	60.29	(69)
Pumps and fans gains (Table 5a)													
(70)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(70)
Losses e.g. evaporation (negative values) (Table 5)													
(71)m	-144.52	-144.52	-144.52	-144.52	-144.52	-144.52	-144.52	-144.52	-144.52	-144.52	-144.52	-144.52	(71)
Water heating gains (Table 5)													
(72)m	177.95	175.17	169.40	161.55	156.46	149.29	143.19	151.00	153.78	161.90	171.07	175.18	(72)

Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

(73)m	1607.23	1590.02	1518.46	1411.09	1299.40	1207.13	1160.23	1182.46	1251.03	1358.68	1474.44	1563.66	(73)

6. Solar gains

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

Rows (74) to (82) are used 12 times, one for each month, repeating as needed if there is more than one window type.

Details for month of January and annual totals are shown below:

	Access factor Table 6d		Area m²		Solar flux W/m²		g Specific data or Table 6b		FF Specific data or Table 6c		Gains (W)	
West	0.77	x	10.00	x	19.87	x	0.53	x	1.00	=	81.10	(80)

Solar gains in watts, calculated for each month ∑(74)m...(82)m

(83)m	81.10	157.19	251.25	373.04	453.89	473.61	459.69	400.08	300.38	191.43	100.83	66.90	(83)

Total gains - internal and solar (73)m + (83)m

(84)m	1688.33	1747.22	1769.71	1784.13	1753.29	1680.73	1619.92	1582.54	1551.41	1550.11	1575.27	1630.56	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(˚C) 21.00 (85)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains for living area, η1,m (see Table 9a)													
(86)m	1.00	1.00	0.99	0.99	0.97	0.92	0.78	0.79	0.95	0.99	1.00	1.00	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)													
(87)m	19.52	19.61	19.84	20.08	20.43	20.74	20.92	20.92	20.67	20.26	19.80	19.56	(87)
Temperature during heating periods in the living area from Table 9, Th2(˚C)													
(88)m	20.48	20.48	20.48	20.48	20.48	20.48	20.48	20.48	20.48	20.48	20.48	20.48	(88)
Utilisation factor for gains for rest of dwelling η2,m (see Table 9a)													
(89)m	1.00	1.00	0.99	0.99	0.97	0.90	0.72	0.73	0.93	0.98	1.00	1.00	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)													
(90)m	18.41	18.53	18.87	19.22	19.74	20.17	20.41	20.41	20.08	19.49	18.82	18.46	(90)

Living area fraction fLA 56.00 ÷ (4) = 0.08 (91)

Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2													
(92)m	18.50	18.62	18.95	19.30	19.79	20.22	20.46	20.45	20.13	19.55	18.90	18.55	(92)
Apply adjustment to the mean internal temperature from Table 4e, where appropriate													
(93)m	18.50	18.62	18.95	19.30	19.79	20.22	20.46	20.45	20.13	19.55	18.90	18.55	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that tim = (93)m and recalculate the utilisation factor for gains using Table 9a)													
Utilisation factor for gains, ηm													
(94)m	0.99	0.99	0.99	0.98	0.96	0.89	0.71	0.72	0.92	0.98	0.99	1.00	(94)
Useful gains, ηmGm, W = (94)m x (84)m													
(95)m	1679.66	1735.82	1750.95	1751.71	1676.81	1487.87	1155.92	1146.06	1423.32	1516.32	1563.64	1622.49	(95)
Monthly average external temperature from Table 8													
(96)m	4.50	5.00	6.80	8.70	11.70	14.60	16.90	16.90	14.30	10.80	7.00	4.90	(96)
Heat loss rate for mean internal temperature, Lm, W													
(97)m	5151.75	5000.62	4459.48	3872.12	2950.55	2044.88	1292.78	1291.15	2126.19	3198.15	4357.58	5010.66	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m - (95)m] x (41)m													
(98)m	2583.23	2193.95	2015.15	1526.69	947.66	0.00	0.00	0.00	0.00	1251.28	2011.63	2520.80	

Total per year (kWh/year) = ∑(98)1...5, 10...12 = 15050.39 (98)

Space heating requirement in kWh/m²/year (98) ÷ (4) 22.46 (99)

9b. Energy requirements - Community heating scheme

Fraction of space heating from secondary/supplementary system (Table 11) 0.00 (301)

Fraction of space heating from community system 1 - (301)		1.00	(302)		
Community scheme fractions obtained from plant design specification or operational records:					
Fraction of community DHW from boilers		1.00	(303b)		
Fraction of total space heat from community boilers (302) x (303b) =		1.00	(304b)		
Factor for control and charging method (Table 4c(3)) for community space heating		1.00	(305)		
Factor for control and charging method (Table 4c(3)) for community water heating		1.00	(305a)		
Distribution loss factor (Table 12c) for community heating system		0.10	(306)		
Space heating:				**kWh/year**	
Annual space heating requirement				15050.39	
Space heat from community boilers (98) x (304b) x (305) x (306) =		1505.04	(307b)		
Water heating:					
Annual water heating requirement				2880.94	
If DHW from community scheme:					
Community DHW: boilers fuel use (64) x (303b) x (305a) x (306) =		288.09	(310b)		
Electricity used for heat distribution	0.01 x [(307a)...(307e) + (310a)...(310e)] =			17.93	(313)
Electricity for pumps and fans within dwelling (Table 4f):					
mechanical ventilation fans - balanced, extract or positive input from outside			0.00		(330a)
warm air heating system fans			0.00		(330b)
pump for solar water heating			0.00		(330g)
Total electricity for the above, kWh/year	(330a) + (330b) + (330g) =			0.00	(331)
Electricity for lighting (calculated in Appendix L):				1612.04	(332)

10b. Fuel costs - Community heating scheme

	Heat or fuel kWh/year		Fuel price (Table 12)		Fuel cost £/year	
Space heating from community boilers	1505.04	x	3.78	x 0.01 =	56.89	(340b)
Water heating from community boilers	288.09	x	3.78	x 0.01 =	10.89	(342b)
Pumps and fans	0.00	x	11.46	x 0.01 =	0.00	(349)
Electricity for lighting	1612.04	x	11.46	x 0.01 =	184.74	(350)
Additional standing charges (Table 12)					106.00	(351)
Total energy cost				(340a)...(342e) + (345)...(354)	358.52	(355)

11b. SAP rating - Community heating scheme

Energy cost deflator (Table 12)		0.47	(356)
Energy cost factor (ECF)	[(355) x (356)] ÷ [(4) + 45.0] =	0.24	(357)
SAP value		96.71	
SAP rating		97	(358)
SAP band		A	

12b. Carbon dioxide emissions - Community heating scheme

Emissions from other community sources (not CHP)

Efficiency of boilers (%) 75.00 (367b)

	Energy used kWh/year		Emission Factor (kgCO2/kWh)		Emissions (kgCO2/year)	
Emissions from boilers (Mains gas)	2390.84	x	0.198	=	473.39	(368)
Electrical energy for heat distribution	17.93	x	0.517	=	9.27	(372)
Total carbon dioxide from community systems				(363)...(366) + (368)...(372) =	482.66	(373)
Space and water heating				(373) + (374) + (375) =	482.66	(376)

Electricity for pumps and fans within dwelling	0.00	x	0.000	=	0.00	(378)
Electricity for lighting	1612.04	x	0.517	=	833.43	(379)
Total carbon dioxide emissions				∑(376)...(382) =	1316.08	(383)
Dwelling carbon dioxide emissions rate				(383) ÷ (4) =	1.96	(384)
EI value					97.53	
EI rating (see section 14)					98	(385)
EI band					A	

13b. Primary energy - Community heating scheme

Primary energy from other community sources (not CHP)

Efficiency of boilers (%)			75.00	(367b*)		
	Energy used kWh/year		**Primary Energy Factor**		**Primary Energy**	
Primary energy - boilers (Mains gas)	2390.84	x	1.02	=	2438.66	(368*)
Electrical energy for heat distribution	17.93	x	2.92	=	52.36	(372*)
Total primary energy from community systems				(363*)...(366*) + (368*)...(372*) =	2491.02	(373*)
Space and water heating				(373*) + (374*) + (375*) =	2491.02	(376*)
Electricity for pumps and fans within dwelling	0.00	x	0.00	=	0.00	(378*)
Electricity for lighting	1612.04	x	2.92	=	4707.16	(379*)
Total primary energy kWh/year				∑(376*)...(382*) =	7198.18	(383*)
Primary energy kWh/m2/year				(383*) ÷ (4) =	10.74	(384*)

SAP 2009 Worksheet

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This design submission has been carried out by an Authorised SAP Assessor. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Miss Olivia Finch	Assessor number	1422
Client		Last modified	14/12/2011
Address	17 65 Maygrove Road, West Hampstead, London, NW6 2EH		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		54.00	(1a)	x	2.85	(2a)	=	153.90	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	54.00	(4)						
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =			153.90	(5)

2. Ventilation rate

				m³ per hour	
Number of chimneys		0	x 40 =	0	(6a)
Number of open flues		0	x 20 =	0	(6b)
Number of intermittent fans		2	x 10 =	20	(7a)
Number of passive vents		2	x 10 =	20	(7b)
Number of flueless gas fires		0	x 40 =	0	(7c)
				Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) =	40	÷ (5) =	0.26	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		3.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.41	(18)

Air permeability value applies if a pressurisation test has been done, or a design or specified air permeability is being used

Number of sides on which dwelling is sheltered		4	(19)
Shelter factor	1 - [0.075 x (19)] =	0.70	(20)
Adjusted infiltration rate	(18) x (20) =	0.29	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table 7												
(22)m	5.40	5.10	5.10	4.50	4.10	3.90	3.70	3.70	4.20	4.50	4.80	5.10

∑(22)1...12 = 54.10 (22)

Wind Factor (22a)m = (22)m ÷ 4

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(22a)m	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.20	1.27

∑(22a)1...12 = 13.52 (22a)

Adjusted infiltration rate (allowing for shelter and wind speed) = (21) × (22a)m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(22b)m	0.39	0.37	0.37	0.32	0.29	0.28	0.27	0.27	0.30	0.32	0.34	0.37

∑(22b)1...12 = 3.88 (22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	N/A	(23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)), otherwise (23b) = (23a)	N/A	(23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = N/A (23c)

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m ≥ 1, then (24d)m = (22b)m; otherwise (24d)m = 0.5 + [(22b)m2 x 0.5]

(24d)m	0.58	0.57	0.57	0.55	0.54	0.54	0.54	0.54	0.55	0.55	0.56	0.57	(24d)

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in box (25)

(25)m	0.58	0.57	0.57	0.55	0.54	0.54	0.54	0.54	0.55	0.55	0.56	0.57	(25)

3. Heat losses and heat loss parameter

The κ-value is the heat capacity per unit area, see Table 1e.

Element	Gross Area, m²	Openings, m²	Net area A, m²		U-value, W/m²K		A x U, W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Window*			10.00	x	1.42	=	14.15	N/A	N/A	(27)
External wall			10.52	x	0.20	=	2.10	N/A	N/A	(29a)
Total area of external elements ∑A, m²			20.52 (31)							

** for windows and roof windows, effective window U-value is calculated using formula 1/[(1/UValue)+0.04] paragraph 3.2*

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	16.25	(33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K	Calculated separately =	100.00	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		3.08	(36)

if details of thermal bridging are not known then (36) = 0.15 x (31)

Total fabric heat loss (33) + (36) = 19.33 (37)

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

(38)m	29.20	28.79	28.79	28.04	27.59	27.38	27.18	27.18	27.70	28.04	28.40	28.79	(38)

Heat transfer coefficient, W/K (37)m + (38)m

(39)m	48.54	48.13	48.13	47.37	46.92	46.71	46.52	46.52	47.03	47.37	47.74	48.13

Average = ∑(39)1...12/12 = 47.42 (39)

Heat loss parameter (HLP), W/m²K (39)m ÷ (4)

(40)m	0.90	0.89	0.89	0.88	0.87	0.87	0.86	0.86	0.87	0.88	0.88	0.89

Average = ∑(40)1...12/12 = 0.88 (40)

4. Water heating energy requirement

kWh/year

Assumed occupancy, N 1.81 (42)

If TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA - 13.9)²)] + 0.0013 x (TFA - 13.9)

If TFA ≤ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 77.14 (43)

Annual average hot water usage has been reduced by 5% if the dwelling is designed to achieve a water use target of not more than 125 litres per person per day (all water use, hot and cold)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)												
(44)m	84.85	81.77	78.68	75.60	72.51	69.43	69.43	72.51	75.60	78.68	81.77	84.85

∑(44)1...12 = 925.68 (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)

(45)m	126.14	110.32	113.84	99.25	95.23	82.18	76.15	87.38	88.43	103.05	112.49	122.16

∑(45)1...12 = 1216.62 (45)

If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

For community heating include distribution loss whether or not hot water tank is present

Distribution loss 0.15 x (45)m

(46)m	18.92	16.55	17.08	14.89	14.28	12.33	11.42	13.11	13.26	15.46	16.87	18.32	(46)

Water storage loss:

b) If manufacturer's declared cylinder loss factor is not known:

Cylinder volume (litres) including any solar storage within same cylinder — 110.00 (50)

If community heating and no tank in dwelling, enter 110 litres in box (50)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in box (50)

Hot water storage loss factor from Table 2 (kWh/litre/day) — 0.02 (51)

If community heating see SAP 2009 section 4.3

Volume factor from Table 2a — 1.03 (52)

Temperature factor from Table 2b — 1.00 (53)

Energy lost from water storage, kWh/day (50) x (51) x (52) x (53) — 1.72 (54)

Enter (49) or (54) in (55) — 1.72 (55)

Water storage loss calculated for each month = (55) x (41)m

(56)m	53.36	48.19	53.36	51.64	53.36	51.64	53.36	53.36	51.64	53.36	51.64	53.36	(56)

If cylinder contains dedicated solar storage, = (56)m x [(50) - (H11)] ÷ (50), else = (56)m where (H11) is from Appendix H

(57)m	53.36	48.19	53.36	51.64	53.36	51.64	53.36	53.36	51.64	53.36	51.64	53.36	(57)

Primary circuit loss (annual) from Table 3 — 360.00 (58)

Primary circuit loss for each month (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58	(59)

Combi loss for each month from Table 3a, 3b or 3c (enter '0' if not a combi boiler)

(61)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)

Total heat required for water heating calculated for each month 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m	210.07	186.13	197.77	180.47	179.16	163.40	160.08	171.32	169.65	186.99	193.72	206.09	(62)

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRS and/or WWHRS applies, see Appendix G)

(63)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

∑(63)1...12 = 0.00 (63)

Output from water heater for each month, kWh/month (62)m + (63)m

(64)m	210.07	186.13	197.77	180.47	179.16	163.40	160.08	171.32	169.65	186.99	193.72	206.09

∑(64)1...12 = 2204.86 (64)

if (64)m < 0 then set to 0

Heat gains from water heating, kWh/month 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m]

(65)m	109.09	97.33	105.00	97.98	98.81	92.30	92.47	96.20	94.38	101.41	102.38	107.76	(65)

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5), Watts													
(66)m	108.48	108.48	108.48	108.48	108.48	108.48	108.48	108.48	108.48	108.48	108.48	108.48	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m	35.72	31.73	25.80	19.53	14.60	12.33	13.32	17.31	23.24	29.51	34.44	36.71	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m	235.23	237.67	231.52	218.43	201.90	186.36	175.98	173.54	179.69	192.79	209.32	224.85	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m	47.66	47.66	47.66	47.66	47.66	47.66	47.66	47.66	47.66	47.66	47.66	47.66	(69)
Pumps and fans gains (Table 5a)													
(70)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(70)
Losses e.g. evaporation (negative values) (Table 5)													
(71)m	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	(71)
Water heating gains (Table 5)													
(72)m	146.62	144.84	141.13	136.08	132.81	128.20	124.28	129.30	131.09	136.31	142.20	144.84	(72)

Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

(73)m	501.39	498.05	482.27	457.86	433.12	410.70	397.40	403.97	417.83	442.41	469.77	490.22	(73)

6. Solar gains

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

Rows (74) to (82) are used 12 times, one for each month, repeating as needed if there is more than one window type.

Details for month of January and annual totals are shown below:

	Access factor Table 6d		Area m²		Solar flux W/m²		g Specific data or Table 6b		FF Specific data or Table 6c		Gains (W)	
South	0.77	x	10.00	x	47.32	x	0.53	x	1.00	=	193.13	(78)

Solar gains in watts, calculated for each month ∑(74)m...(82)m

(83)m	193.13	314.98	384.62	428.97	442.99	444.41	437.23	423.95	408.06	348.08	228.82	166.87	(83)

Total gains - internal and solar (73)m + (83)m

(84)m	694.52	813.04	866.88	886.83	876.12	855.12	834.63	827.92	825.90	790.49	698.59	657.10	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(˚C) 21.00 (85)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains for living area, η1,m (see Table 9a)													
(86)m	0.80	0.73	0.66	0.58	0.47	0.34	0.23	0.23	0.37	0.55	0.74	0.81	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)													
(87)m	20.12	20.37	20.59	20.76	20.90	20.97	20.99	20.99	20.96	20.83	20.45	20.13	(87)
Temperature during heating periods in the living area from Table 9, Th2(˚C)													
(88)m	20.17	20.18	20.18	20.19	20.20	20.20	20.20	20.20	20.19	20.19	20.18	20.18	(88)
Utilisation factor for gains for rest of dwelling η2,m (see Table 9a)													
(89)m	0.79	0.71	0.63	0.55	0.43	0.30	0.18	0.18	0.33	0.52	0.71	0.80	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)													
(90)m	19.03	19.37	19.67	19.90	20.09	20.17	20.20	20.20	20.16	20.00	19.49	19.04	(90)

Living area fraction fLA 54.00 ÷ (4) = 1.00 (91)

Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2													
(92)m	20.12	20.37	20.59	20.76	20.90	20.97	20.99	20.99	20.96	20.83	20.45	20.13	(92)
Apply adjustment to the mean internal temperature from Table 4e, where appropriate													
(93)m	20.12	20.37	20.59	20.76	20.90	20.97	20.99	20.99	20.96	20.83	20.45	20.13	(93)

8. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that tim = (93)m and recalculate the utilisation factor for gains using Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, □m													
(94)m	0.79	0.72	0.65	0.57	0.46	0.34	0.23	0.23	0.37	0.54	0.72	0.79	(94)
Useful gains, □mGm, W = (94)m x (84)m													
(95)m	545.72	583.77	560.69	509.38	406.61	290.57	189.07	189.03	303.85	430.73	505.00	521.88	(95)
Monthly average external temperature from Table 8													
(96)m	4.50	5.00	6.80	8.70	11.70	14.60	16.90	16.90	14.30	10.80	7.00	4.90	(96)
Heat loss rate for mean internal temperature, Lm, W													
(97)m	758.27	739.69	663.78	571.29	431.88	297.72	190.47	190.47	313.43	475.10	641.84	732.74	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m - (95)m] x (41)m													
(98)m	158.14	104.78	76.70	44.57	18.80	0.00	0.00	0.00	0.00	33.01	98.52	156.87	

Total per year (kWh/year) = ∑(98)1...5, 10...12 = 691.39 (98)

Space heating requirement in kWh/m²/year (98) ÷ (4) 12.80 (99)

9b. Energy requirements - Community heating scheme

Fraction of space heating from secondary/supplementary system (Table 11) 0.00 (301)

Fraction of space heating from community system 1 - (301)	1.00	(302)	
Community scheme fractions obtained from plant design specification or operational records:			
Fraction of community DHW from boilers	1.00	(303b)	
Fraction of total space heat from community boilers (302) x (303b) =	1.00	(304b)	
Factor for control and charging method (Table 4c(3)) for community space heating	1.00	(305)	
Factor for control and charging method (Table 4c(3)) for community water heating	1.00	(305a)	
Distribution loss factor (Table 12c) for community heating system	0.10	(306)	

Space heating: kWh/year

Annual space heating requirement			691.39	
Space heat from community boilers (98) x (304b) x (305) x (306) =	69.14	(307b)		

Water heating:

Annual water heating requirement			2204.86	
If DHW from community scheme:				
Community DHW: boilers fuel use (64) x (303b) x (305a) x (306) =	220.49	(310b)		
Electricity used for heat distribution	0.01 x [(307a)...(307e) + (310a)...(310e)] =		2.90	(313)

Electricity for pumps and fans within dwelling (Table 4f):

mechanical ventilation fans - balanced, extract or positive input from outside	0.00			(330a)
warm air heating system fans	0.00			(330b)
pump for solar water heating	0.00			(330g)
Total electricity for the above, kWh/year	(330a) + (330b) + (330g) =		0.00	(331)

Electricity for lighting (calculated in Appendix L):	252.33	(332)

10b. Fuel costs - Community heating scheme

	Heat or fuel kWh/year		Fuel price (Table 12)		Fuel cost £/year	
Space heating from community boilers	69.14	x	3.78	x 0.01 =	2.61	(340b)
Water heating from community boilers	220.49	x	3.78	x 0.01 =	8.33	(342b)
Pumps and fans	0.00	x	11.46	x 0.01 =	0.00	(349)
Electricity for lighting	252.33	x	11.46	x 0.01 =	28.92	(350)
Additional standing charges (Table 12)					106.00	(351)
Total energy cost			(340a)...(342e) + (345)...(354)		145.87	(355)

11b. SAP rating - Community heating scheme

Energy cost deflator (Table 12)		0.47	(356)
Energy cost factor (ECF)	[(355) x (356)] ÷ [(4) + 45.0] =	0.69	(357)
SAP value		90.34	
SAP rating		90	(358)
SAP band		B	

12b. Carbon dioxide emissions - Community heating scheme

Emissions from other community sources (not CHP)

Efficiency of boilers (%)			75.00	(367b)		
	Energy used kWh/year		Emission Factor (kgCO2/kWh)		Emissions (kgCO2/year)	
Emissions from boilers (Mains gas)	386.17	x	0.198	=	76.46	(368)
Electrical energy for heat distribution	2.90	x	0.517	=	1.50	(372)
Total carbon dioxide from community systems			(363)...(366) + (368)...(372) =		77.96	(373)
Space and water heating			(373) + (374) + (375) =		77.96	(376)

Electricity for pumps and fans within dwelling	0.00	x	0.000	=	0.00	(378)
Electricity for lighting	252.33	x	0.517	=	130.46	(379)
Total carbon dioxide emissions				∑(376)...(382) =	208.42	(383)
Dwelling carbon dioxide emissions rate				(383) ÷ (4) =	3.86	(384)
EI value					97.18	
EI rating (see section 14)					97	(385)
EI band					A	

13b. Primary energy - Community heating scheme

Primary energy from other community sources (not CHP)

Efficiency of boilers (%)			75.00	(367b*)		
	Energy used kWh/year		**Primary Energy Factor**		**Primary Energy**	
Primary energy - boilers (Mains gas)	386.17	x	1.02	=	393.89	(368*)
Electrical energy for heat distribution	2.90	x	2.92	=	8.46	(372*)
Total primary energy from community systems				(363*)...(366*) + (368*)...(372*) =	402.35	(373*)
Space and water heating				(373*) + (374*) + (375*) =	402.35	(376*)
Electricity for pumps and fans within dwelling	0.00	x	0.00	=	0.00	(378*)
Electricity for lighting	252.33	x	2.92	=	736.82	(379*)
Total primary energy kWh/year				∑(376*)...(382*) =	1139.17	(383*)
Primary energy kWh/m2/year				(383*) ÷ (4) =	21.10	(384*)

SAP 2009 Worksheet

NHER

This design submission has been carried out by an Authorised SAP Assessor. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Miss Olivia Finch	Assessor number	1422
Client		Last modified	14/12/2011
Address	28 65 Maygrove Road, West Hampstead, London, NW6 2EH		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		54.00	(1a)	x	2.85	(2a)	=	153.90	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	54.00	(4)						
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =			153.90	(5)

2. Ventilation rate

			m³ per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	2	x 10 =	20	(7a)
Number of passive vents	2	x 10 =	20	(7b)
Number of flueless gas fires	0	x 40 =	0	(7c)

				Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) =	40	÷ (5) =	0.26	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		3.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.41	(18)

Air permeability value applies if a pressurisation test has been done, or a design or specified air permeability is being used

Number of sides on which dwelling is sheltered		4	(19)
Shelter factor	1 - [0.075 x (19)] =	0.70	(20)
Adjusted infiltration rate	(18) x (20) =	0.29	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table 7 (22)m	5.40	5.10	5.10	4.50	4.10	3.90	3.70	3.70	4.20	4.50	4.80	5.10

∑(22)1...12 = 54.10 (22)

Wind Factor (22a)m = (22)m ÷ 4

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(22a)m	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.20	1.27

∑(22a)1...12 = 13.52 (22a)

Adjusted infiltration rate (allowing for shelter and wind speed) = (21) × (22a)m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(22b)m	0.39	0.37	0.37	0.32	0.29	0.28	0.27	0.27	0.30	0.32	0.34	0.37

∑(22b)1...12 = 3.88 (22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	N/A	(23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)), otherwise (23b) = (23a)	N/A	(23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = N/A (23c)

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m ≥ 1, then (24d)m = (22b)m; otherwise (24d)m = 0.5 + [(22b)m2 x 0.5]

(24d)m	0.58	0.57	0.57	0.55	0.54	0.54	0.54	0.54	0.55	0.55	0.56	0.57	(24d)

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in box (25)

(25)m	0.58	0.57	0.57	0.55	0.54	0.54	0.54	0.54	0.55	0.55	0.56	0.57	(25)

3. Heat losses and heat loss parameter

The κ-value is the heat capacity per unit area, see Table 1e.

Element	Gross Area, m²	Openings, m²	Net area A, m²		U-value, W/m²K		A x U, W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Window*			10.00	x	1.42	=	14.15	N/A	N/A	(27)
External wall			9.95	x	0.20	=	1.99	N/A	N/A	(29a)
Total area of external elements ∑A, m²			19.95	(31)						

** for windows and roof windows, effective window U-value is calculated using formula 1/[(1/UValue)+0.04] paragraph 3.2*

Fabric heat loss, W/K = ∑(A × U) (26)...(30) + (32) = 16.14 (33)

Heat capacity Cm = ∑(A x κ) (28)...(30) + (32) + (32a)...(32e) = N/A (34)

Thermal mass parameter (TMP) in kJ/m²K Calculated separately = 100.00 (35)

Thermal bridges: ∑(L x Ψ) calculated using Appendix K 2.99 (36)

if details of thermal bridging are not known then (36) = 0.15 x (31)

Total fabric heat loss (33) + (36) = 19.13 (37)

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

(38)m	29.20	28.79	28.79	28.04	27.59	27.38	27.18	27.18	27.70	28.04	28.40	28.79	(38)

Heat transfer coefficient, W/K (37)m + (38)m

(39)m	48.34	47.93	47.93	47.17	46.72	46.51	46.32	46.32	46.83	47.17	47.54	47.93

Average = ∑(39)1...12/12 = 47.22 (39)

Heat loss parameter (HLP), W/m²K (39)m ÷ (4)

(40)m	0.90	0.89	0.89	0.87	0.87	0.86	0.86	0.86	0.87	0.87	0.88	0.89

Average = ∑(40)1...12/12 = 0.87 (40)

4. Water heating energy requirement

kWh/year

Assumed occupancy, N 1.81 (42)

If TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA - 13.9)²)] + 0.0013 x (TFA - 13.9)

If TFA ≤ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 77.14 (43)

Annual average hot water usage has been reduced by 5% if the dwelling is designed to achieve a water use target of not more than 125 litres per person per day (all water use, hot and cold)

Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(44)m	84.85	81.77	78.68	75.60	72.51	69.43	69.43	72.51	75.60	78.68	81.77	84.85

∑(44)1...12 = 925.68 (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)

(45)m	126.14	110.32	113.84	99.25	95.23	82.18	76.15	87.38	88.43	103.05	112.49	122.16

∑(45)1...12 = 1216.62 (45)

If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

For community heating include distribution loss whether or not hot water tank is present

Distribution loss 0.15 x (45)m

(46)m	18.92	16.55	17.08	14.89	14.28	12.33	11.42	13.11	13.26	15.46	16.87	18.32	(46)

Water storage loss:

b) If manufacturer's declared cylinder loss factor is not known:

Cylinder volume (litres) including any solar storage within same cylinder	110.00	(50)
If community heating and no tank in dwelling, enter 110 litres in box (50)		
Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in box (50)		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.02	(51)
If community heating see SAP 2009 section 4.3		
Volume factor from Table 2a	1.03	(52)
Temperature factor from Table 2b	1.00	(53)
Energy lost from water storage, kWh/day (50) x (51) x (52) x (53)	1.72	(54)
Enter (49) or (54) in (55)	1.72	(55)

Water storage loss calculated for each month = (55) x (41)m													
(56)m	53.36	48.19	53.36	51.64	53.36	51.64	53.36	53.36	51.64	53.36	51.64	53.36	(56)
If cylinder contains dedicated solar storage, = (56)m x [(50) - (H11)] ÷ (50), else = (56)m where (H11) is from Appendix H													
(57)m	53.36	48.19	53.36	51.64	53.36	51.64	53.36	53.36	51.64	53.36	51.64	53.36	(57)
Primary circuit loss (annual) from Table 3									360.00	(58)			
Primary circuit loss for each month (58) ÷ 365 × (41)m (modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)													
(59)m	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58	(59)
Combi loss for each month from Table 3a, 3b or 3c (enter '0' if not a combi boiler)													
(61)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)
Total heat required for water heating calculated for each month 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m													
(62)m	210.07	186.13	197.77	180.47	179.16	163.40	160.08	171.32	169.65	186.99	193.72	206.09	(62)
Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating) (add additional lines if FGHRS and/or WWHRS applies, see Appendix G)													
(63)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
										∑(63)1...12 =		0.00	(63)
Output from water heater for each month, kWh/month (62)m + (63)m													
(64)m	210.07	186.13	197.77	180.47	179.16	163.40	160.08	171.32	169.65	186.99	193.72	206.09	
										∑(64)1...12 =		2204.86	(64)
if (64)m < 0 then set to 0													
Heat gains from water heating, kWh/month 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m]													
(65)m	109.09	97.33	105.00	97.98	98.81	92.30	92.47	96.20	94.38	101.41	102.38	107.76	(65)

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5), Watts													
(66)m	108.48	108.48	108.48	108.48	108.48	108.48	108.48	108.48	108.48	108.48	108.48	108.48	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m	35.72	31.73	25.80	19.53	14.60	12.33	13.32	17.31	23.24	29.51	34.44	36.71	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m	235.23	237.67	231.52	218.43	201.90	186.36	175.98	173.54	179.69	192.79	209.32	224.85	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m	47.66	47.66	47.66	47.66	47.66	47.66	47.66	47.66	47.66	47.66	47.66	47.66	(69)
Pumps and fans gains (Table 5a)													
(70)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(70)
Losses e.g. evaporation (negative values) (Table 5)													
(71)m	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	(71)
Water heating gains (Table 5)													
(72)m	146.62	144.84	141.13	136.08	132.81	128.20	124.28	129.30	131.09	136.31	142.20	144.84	(72)

Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

(73)m	501.39	498.05	482.27	457.86	433.12	410.70	397.40	403.97	417.83	442.41	469.77	490.22	(73)

6. Solar gains

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

Rows (74) to (82) are used 12 times, one for each month, repeating as needed if there is more than one window type.

Details for month of January and annual totals are shown below:

	Access factor Table 6d		Area m²		Solar flux W/m²		g Specific data or Table 6b		FF Specific data or Table 6c		Gains (W)	
South	0.77	x	10.00	x	47.32	x	0.53	x	1.00	=	193.13	(78)

Solar gains in watts, calculated for each month ∑(74)m...(82)m

(83)m	193.13	314.98	384.62	428.97	442.99	444.41	437.23	423.95	408.06	348.08	228.82	166.87	(83)

Total gains - internal and solar (73)m + (83)m

(84)m	694.52	813.04	866.88	886.83	876.12	855.12	834.63	827.92	825.90	790.49	698.59	657.10	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(˚C) 21.00 (85)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains for living area, η1,m (see Table 9a)													
(86)m	0.80	0.73	0.66	0.58	0.47	0.34	0.23	0.23	0.37	0.55	0.74	0.81	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)													
(87)m	20.13	20.38	20.60	20.76	20.91	20.97	20.99	20.99	20.97	20.83	20.45	20.13	(87)
Temperature during heating periods in the living area from Table 9, Th2(˚C)													
(88)m	20.17	20.18	20.18	20.19	20.20	20.20	20.20	20.20	20.20	20.19	20.19	20.18	(88)
Utilisation factor for gains for rest of dwelling η2,m (see Table 9a)													
(89)m	0.79	0.71	0.63	0.55	0.43	0.30	0.18	0.18	0.33	0.52	0.71	0.79	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)													
(90)m	19.05	19.39	19.68	19.91	20.10	20.18	20.20	20.20	20.16	20.00	19.50	19.06	(90)

Living area fraction fLA 54.00 ÷ (4) = 1.00 (91)

Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2													
(92)m	20.13	20.38	20.60	20.76	20.91	20.97	20.99	20.99	20.97	20.83	20.45	20.13	(92)
Apply adjustment to the mean internal temperature from Table 4e, where appropriate													
(93)m	20.13	20.38	20.60	20.76	20.91	20.97	20.99	20.99	20.97	20.83	20.45	20.13	(93)

8. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that tim = (93)m and recalculate the utilisation factor for gains using Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm													
(94)m	0.79	0.72	0.65	0.57	0.46	0.34	0.23	0.23	0.37	0.54	0.72	0.79	(94)
Useful gains, ηmGm, W = (94)m x (84)m													
(95)m	545.21	582.97	559.67	508.20	405.38	289.51	188.30	188.26	302.78	429.65	504.32	521.42	(95)
Monthly average external temperature from Table 8													
(96)m	4.50	5.00	6.80	8.70	11.70	14.60	16.90	16.90	14.30	10.80	7.00	4.90	(96)
Heat loss rate for mean internal temperature, Lm, W													
(97)m	755.57	736.98	661.30	569.07	430.13	296.48	189.66	189.66	312.14	473.23	639.47	730.11	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m - (95)m] x (41)m													
(98)m	156.51	103.49	75.61	43.83	18.42	0.00	0.00	0.00	0.00	32.43	97.31	155.26	

Total per year (kWh/year) = ∑(98)1...5, 10...12 = 682.85 (98)

Space heating requirement in kWh/m²/year (98) ÷ (4) 12.65 (99)

9b. Energy requirements - Community heating scheme

Fraction of space heating from secondary/supplementary system (Table 11) 0.00 (301)

Fraction of space heating from community system 1 - (301)			1.00	(302)		

Community scheme fractions obtained from plant design specification or operational records:

Fraction of community DHW from boilers			1.00	(303b)		
Fraction of total space heat from community boilers (302) x (303b) =			1.00	(304b)		
Factor for control and charging method (Table 4c(3)) for community space heating			1.00	(305)		
Factor for control and charging method (Table 4c(3)) for community water heating			1.00	(305a)		
Distribution loss factor (Table 12c) for community heating system			0.10	(306)		
Space heating:					**kWh/year**	
Annual space heating requirement					682.85	
Space heat from community boilers (98) x (304b) x (305) x (306) =			68.28	(307b)		
Water heating:						
Annual water heating requirement					2204.86	
If DHW from community scheme:						
Community DHW: boilers fuel use (64) x (303b) x (305a) x (306) =			220.49	(310b)		
Electricity used for heat distribution			0.01 x [(307a)...(307e) + (310a)...(310e)] =		2.89	(313)
Electricity for pumps and fans within dwelling (Table 4f):						
mechanical ventilation fans - balanced, extract or positive input from outside				0.00		(330a)
warm air heating system fans				0.00		(330b)
pump for solar water heating				0.00		(330g)
Total electricity for the above, kWh/year			(330a) + (330b) + (330g) =		0.00	(331)
Electricity for lighting (calculated in Appendix L):					252.33	(332)

10b. Fuel costs - Community heating scheme

	Heat or fuel kWh/year		Fuel price (Table 12)		Fuel cost £/year	
Space heating from community boilers	68.28	x	3.78	x 0.01 =	2.58	(340b)
Water heating from community boilers	220.49	x	3.78	x 0.01 =	8.33	(342b)
Pumps and fans	0.00	x	11.46	x 0.01 =	0.00	(349)
Electricity for lighting	252.33	x	11.46	x 0.01 =	28.92	(350)
Additional standing charges (Table 12)					106.00	(351)
Total energy cost			(340a)...(342e) + (345)...(354)		145.83	(355)

11b. SAP rating - Community heating scheme

Energy cost deflator (Table 12)		0.47	(356)
Energy cost factor (ECF)	[(355) x (356)] ÷ [(4) + 45.0] =	0.69	(357)
SAP value		90.34	
SAP rating		90	(358)
SAP band		B	

12b. Carbon dioxide emissions - Community heating scheme

Emissions from other community sources (not CHP)

	Energy used kWh/year		Emission Factor (kgCO2/kWh)		Emissions (kgCO2/year)	
Efficiency of boilers (%)			75.00	(367b)		
Emissions from boilers (Mains gas)	385.03	x	0.198	=	76.24	(368)
Electrical energy for heat distribution	2.89	x	0.517	=	1.49	(372)
Total carbon dioxide from community systems			(363)...(366) + (368)...(372) =		77.73	(373)
Space and water heating			(373) + (374) + (375) =		77.73	(376)

Electricity for pumps and fans within dwelling	0.00	x	0.000	=	0.00	(378)
Electricity for lighting	252.33	x	0.517	=	130.46	(379)
Total carbon dioxide emissions				∑(376)...(382) =	208.19	(383)
Dwelling carbon dioxide emissions rate				(383) ÷ (4) =	3.86	(384)
EI value					97.18	
EI rating (see section 14)					97	(385)
EI band					A	

13b. Primary energy - Community heating scheme

Primary energy from other community sources (not CHP)

	Energy used kWh/year		Primary Energy Factor		Primary Energy	
Efficiency of boilers (%)			75.00	(367b*)		
Primary energy - boilers (Mains gas)	385.03	x	1.02	=	392.73	(368*)
Electrical energy for heat distribution	2.89	x	2.92	=	8.43	(372*)
Total primary energy from community systems				(363*)...(366*) + (368*)...(372*) =	401.16	(373*)
Space and water heating				(373*) + (374*) + (375*) =	401.16	(376*)
Electricity for pumps and fans within dwelling	0.00	x	0.00	=	0.00	(378*)
Electricity for lighting	252.33	x	2.92	=	736.82	(379*)
Total primary energy kWh/year				∑(376*)...(382*) =	1137.98	(383*)
Primary energy kWh/m2/year				(383*) ÷ (4) =	21.07	(384*)

SAP 2009 Worksheet

This design submission has been carried out by an Authorised SAP Assessor. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Miss Olivia Finch	Assessor number	1422
Client		Last modified	14/12/2011
Address	47 65 Maygrove Road, West Hampstead, London, NW6 2EH		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		88.00	(1a)	x	2.85	(2a)	=	250.80	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	88.00	(4)						
Dwelling volume							(3a) + (3b) + (3c) + (3d)...(3n) =	250.80	(5)

2. Ventilation rate

			m³ per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	3	x 10 =	30	(7a)
Number of passive vents	4	x 10 =	40	(7b)
Number of flueless gas fires	0	x 40 =	0	(7c)

				Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) =	70	÷ (5) =	0.28	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		3.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.43	(18)

Air permeability value applies if a pressurisation test has been done, or a design or specified air permeability is being used

Number of sides on which dwelling is sheltered		4	(19)
Shelter factor	1 - [0.075 x (19)] =	0.70	(20)
Adjusted infiltration rate	(18) x (20) =	0.30	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table 7 (22)m	5.40	5.10	5.10	4.50	4.10	3.90	3.70	3.70	4.20	4.50	4.80	5.10

∑(22)1...12 = 54.10 (22)

Wind Factor (22a)m = (22)m ÷ 4

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(22a)m	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.20	1.27

∑(22a)1...12 = 13.52 (22a)

Adjusted infiltration rate (allowing for shelter and wind speed) = (21) × (22a)m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(22b)m	0.41	0.38	0.38	0.34	0.31	0.29	0.28	0.28	0.32	0.34	0.36	0.38

∑(22b)1...12 = 4.06 (22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	N/A	(23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)), otherwise (23b) = (23a)	N/A	(23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = N/A (23c)

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m ≥ 1, then (24d)m = (22b)m; otherwise (24d)m = 0.5 + [(22b)m2 x 0.5]

(24d)m	0.58	0.57	0.57	0.56	0.55	0.54	0.54	0.54	0.55	0.56	0.56	0.57	(24d)

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in box (25)

(25)m	0.58	0.57	0.57	0.56	0.55	0.54	0.54	0.54	0.55	0.56	0.56	0.57	(25)

3. Heat losses and heat loss parameter

The κ-value is the heat capacity per unit area, see Table 1e.

Element	Gross Area, m²	Openings, m²	Net area A, m²		U-value, W/m²K		A x U, W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Window*			18.00	x	1.42	=	25.47	N/A	N/A	(27)
External wall			73.05	x	0.20	=	14.61	N/A	N/A	(29a)
Total area of external elements ∑A, m²			91.05 (31)							

** for windows and roof windows, effective window U-value is calculated using formula 1/[(1/UValue)+0.04] paragraph 3.2*

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	40.08	(33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K	Calculated separately =	100.00	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		13.66	(36)

if details of thermal bridging are not known then (36) = 0.15 x (31)

Total fabric heat loss (33) + (36) = 53.74 (37)

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

(38)m	48.19	47.45	47.45	46.11	45.30	44.93	44.58	44.58	45.50	46.11	46.76	47.45	(38)

Heat transfer coefficient, W/K (37)m + (38)m

(39)m	101.93	101.19	101.19	99.85	99.04	98.67	98.32	98.32	99.24	99.85	100.50	101.19

Average = ∑(39)1...12/12 = 99.94 (39)

Heat loss parameter (HLP), W/m²K (39)m ÷ (4)

(40)m	1.16	1.15	1.15	1.13	1.13	1.12	1.12	1.12	1.13	1.13	1.14	1.15

Average = ∑(40)1...12/12 = 1.14 (40)

4. Water heating energy requirement

kWh/year

Assumed occupancy, N 2.60 (42)

If TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA - 13.9)²)] + 0.0013 x (TFA - 13.9)

If TFA ≤ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 95.89 (43)

Annual average hot water usage has been reduced by 5% if the dwelling is designed to achieve a water use target of not more than 125 litres per person per day (all water use, hot and cold)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)												
(44)m	105.48	101.64	97.80	93.97	90.13	86.30	86.30	90.13	93.97	97.80	101.64	105.48

∑(44)1...12 = 1150.64 (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)

(45)m	156.79	137.13	141.51	123.37	118.38	102.15	94.66	108.62	109.92	128.10	139.83	151.84

∑(45)1...12 = 1512.28 (45)

If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

For community heating include distribution loss whether or not hot water tank is present

Distribution loss 0.15 x (45)m

(46)m	23.52	20.57	21.23	18.51	17.76	15.32	14.20	16.29	16.49	19.21	20.97	22.78	(46)

Water storage loss:

b) If manufacturer's declared cylinder loss factor is not known:

Cylinder volume (litres) including any solar storage within same cylinder	110.00	(50)
If community heating and no tank in dwelling, enter 110 litres in box (50)		
Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in box (50)		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.02	(51)
If community heating see SAP 2009 section 4.3		
Volume factor from Table 2a	1.03	(52)
Temperature factor from Table 2b	1.00	(53)
Energy lost from water storage, kWh/day (50) x (51) x (52) x (53)	1.72	(54)
Enter (49) or (54) in (55)	1.72	(55)

Water storage loss calculated for each month = (55) x (41)m

(56)m	53.36	48.19	53.36	51.64	53.36	51.64	53.36	53.36	51.64	53.36	51.64	53.36	(56)

If cylinder contains dedicated solar storage, = (56)m x [(50) - (H11)] ÷ (50), else = (56)m where (H11) is from Appendix H

(57)m	53.36	48.19	53.36	51.64	53.36	51.64	53.36	53.36	51.64	53.36	51.64	53.36	(57)

Primary circuit loss (annual) from Table 3	360.00	(58)

Primary circuit loss for each month (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58	(59)

Combi loss for each month from Table 3a, 3b or 3c (enter '0' if not a combi boiler)

(61)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)

Total heat required for water heating calculated for each month 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m	240.72	212.94	225.44	204.59	202.31	183.37	178.59	192.55	191.14	212.03	221.05	235.78	(62)

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRS and/or WWHRS applies, see Appendix G)

(63)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

∑(63)1...12 = 0.00 (63)

Output from water heater for each month, kWh/month (62)m + (63)m

(64)m	240.72	212.94	225.44	204.59	202.31	183.37	178.59	192.55	191.14	212.03	221.05	235.78

∑(64)1...12 = 2500.52 (64)

if (64)m < 0 then set to 0

Heat gains from water heating, kWh/month 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m]

(65)m	119.28	106.24	114.20	106.00	106.51	98.94	98.62	103.26	101.53	109.74	111.47	117.63	(65)

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5), Watts													
(66)m	155.84	155.84	155.84	155.84	155.84	155.84	155.84	155.84	155.84	155.84	155.84	155.84	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m	52.71	46.82	38.07	28.82	21.55	18.19	19.65	25.55	34.29	43.54	50.82	54.17	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m	351.27	354.91	345.73	326.17	301.49	278.29	262.79	259.15	268.33	287.89	312.57	335.77	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m	53.18	53.18	53.18	53.18	53.18	53.18	53.18	53.18	53.18	53.18	53.18	53.18	(69)
Pumps and fans gains (Table 5a)													
(70)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(70)
Losses e.g. evaporation (negative values) (Table 5)													
(71)m	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	(71)
Water heating gains (Table 5)													
(72)m	160.32	158.10	153.49	147.22	143.15	137.42	132.55	138.79	141.01	147.50	154.82	158.11	(72)

Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

(73)m	669.43	664.96	642.42	607.35	571.32	539.03	520.13	528.61	548.76	584.05	623.34	653.18	(73)

6. Solar gains

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

Rows (74) to (82) are used 12 times, one for each month, repeating as needed if there is more than one window type.

Details for month of January and annual totals are shown below:

	Access factor Table 6d		Area m²		Solar flux W/m²		g Specific data or Table 6b		FF Specific data or Table 6c		Gains (W)	
North	0.77	x	12.00	x	10.73	x	0.53	x	1.00	=	52.53	(74)
East	0.77	x	6.00	x	19.87	x	0.53	x	1.00	=	48.66	(76)

Solar gains in watts, calculated for each month ∑(74)m...(82)m

(83)m	101.19	194.02	313.87	491.41	640.68	695.97	663.28	541.54	381.43	236.38	125.23	83.94	(83)

Total gains - internal and solar (73)m + (83)m

(84)m	770.62	858.98	956.29	1098.75	1212.00	1235.00	1183.40	1070.16	930.19	820.43	748.57	737.12	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(˚C) 21.00 (85)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains for living area, η1,m (see Table 9a)													
(86)m	0.92	0.90	0.85	0.76	0.62	0.47	0.33	0.36	0.60	0.80	0.90	0.93	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)													
(87)m	19.04	19.28	19.73	20.21	20.65	20.88	20.97	20.96	20.77	20.26	19.51	19.08	(87)
Temperature during heating periods in the living area from Table 9, Th2(˚C)													
(88)m	19.96	19.96	19.96	19.97	19.98	19.99	19.99	19.99	19.98	19.97	19.97	19.96	(88)
Utilisation factor for gains for rest of dwelling η2,m (see Table 9a)													
(89)m	0.91	0.89	0.83	0.73	0.57	0.40	0.25	0.28	0.53	0.76	0.89	0.92	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)													
(90)m	17.37	17.73	18.36	19.02	19.61	19.88	19.97	19.97	19.77	19.11	18.06	17.44	(90)

Living area fraction fLA 88.00 ÷ (4) = 1.00 (91)

Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2													
(92)m	19.04	19.28	19.73	20.21	20.65	20.88	20.97	20.96	20.77	20.26	19.51	19.08	(92)
Apply adjustment to the mean internal temperature from Table 4e, where appropriate													
(93)m	19.04	19.28	19.73	20.21	20.65	20.88	20.97	20.96	20.77	20.26	19.51	19.08	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that tim = (93)m and recalculate the utilisation factor for gains using Table 9a)													
Utilisation factor for gains, ηm													
(94)m	0.90	0.88	0.82	0.74	0.61	0.46	0.33	0.36	0.58	0.77	0.88	0.91	(94)
Useful gains, ηmGm, W = (94)m x (84)m													
(95)m	695.88	753.22	788.79	813.77	733.63	565.93	384.86	380.48	541.46	634.57	656.71	667.87	(95)
Monthly average external temperature from Table 8													
(96)m	4.50	5.00	6.80	8.70	11.70	14.60	16.90	16.90	14.30	10.80	7.00	4.90	(96)
Heat loss rate for mean internal temperature, Lm, W													
(97)m	1481.71	1445.27	1308.69	1148.84	886.80	619.95	399.97	399.20	642.42	944.26	1257.00	1434.81	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m - (95)m] x (41)m													
(98)m	584.65	465.06	386.80	241.25	113.96	0.00	0.00	0.00	0.00	230.41	432.21	570.60	

Total per year (kWh/year) = ∑(98)1...5, 10...12 = 3024.95 (98)

Space heating requirement in kWh/m²/year (98) ÷ (4) 34.37 (99)

9b. Energy requirements - Community heating scheme

Fraction of space heating from secondary/supplementary system (Table 11)			0.00	(301)		
Fraction of space heating from community system 1 - (301)			1.00	(302)		
Community scheme fractions obtained from plant design specification or operational records:						
Fraction of community DHW from boilers			1.00	(303b)		
Fraction of total space heat from community boilers (302) x (303b) =			1.00	(304b)		
Factor for control and charging method (Table 4c(3)) for community space heating			1.00	(305)		
Factor for control and charging method (Table 4c(3)) for community water heating			1.00	(305a)		
Distribution loss factor (Table 12c) for community heating system			0.10	(306)		
Space heating:					**kWh/year**	
Annual space heating requirement					3024.95	
Space heat from community boilers (98) x (304b) x (305) x (306) =			302.49	(307b)		
Water heating:						
Annual water heating requirement					2500.52	
If DHW from community scheme:						
Community DHW: boilers fuel use (64) x (303b) x (305a) x (306) =			250.05	(310b)		
Electricity used for heat distribution				0.01 x [(307a)...(307e) + (310a)...(310e)] =	5.53	(313)
Electricity for pumps and fans within dwelling (Table 4f):						
mechanical ventilation fans - balanced, extract or positive input from outside				0.00		(330a)
warm air heating system fans				0.00		(330b)
pump for solar water heating				0.00		(330g)
Total electricity for the above, kWh/year				(330a) + (330b) + (330g) =	0.00	(331)
Electricity for lighting (calculated in Appendix L):					372.34	(332)

10b. Fuel costs - Community heating scheme

	Heat or fuel kWh/year		Fuel price (Table 12)		Fuel cost £/year	
Space heating from community boilers	302.49	x	3.78	x 0.01 =	11.43	(340b)
Water heating from community boilers	250.05	x	3.78	x 0.01 =	9.45	(342b)
Pumps and fans	0.00	x	11.46	x 0.01 =	0.00	(349)
Electricity for lighting	372.34	x	11.46	x 0.01 =	42.67	(350)
Additional standing charges (Table 12)					106.00	(351)
Total energy cost				(340a)...(342e) + (345)...(354)	169.56	(355)

11b. SAP rating - Community heating scheme

Energy cost deflator (Table 12)		0.47	(356)
Energy cost factor (ECF)	[(355) x (356)] ÷ [(4) + 45.0] =	0.60	(357)
SAP value		91.64	
SAP rating		92	(358)
SAP band		A	

12b. Carbon dioxide emissions - Community heating scheme

Emissions from other community sources (not CHP)

	Energy used kWh/year		Emission Factor (kgCO2/kWh)		Emissions (kgCO2/year)	
Efficiency of boilers (%)			75.00	(367b)		
Emissions from boilers (Mains gas)	736.73	x	0.198	=	145.87	(368)
Electrical energy for heat distribution	5.53	x	0.517	=	2.86	(372)
Total carbon dioxide from community systems				(363)...(366) + (368)...(372) =	148.73	(373)

Space and water heating				(373) + (374) + (375) =	148.73	(376)
Electricity for pumps and fans within dwelling	0.00	x	0.000	=	0.00	(378)
Electricity for lighting	372.34	x	0.517	=	192.50	(379)
Total carbon dioxide emissions				∑(376)...(382) =	341.23	(383)
Dwelling carbon dioxide emissions rate				(383) ÷ (4) =	3.88	(384)
EI value					96.56	
EI rating (see section 14)					97	(385)
EI band					A	

13b. Primary energy - Community heating scheme

Primary energy from other community sources (not CHP)

	Energy used kWh/year		Primary Energy Factor		Primary Energy	
Efficiency of boilers (%)			75.00 (367b*)			
Primary energy - boilers (Mains gas)	736.73	x	1.02	=	751.46	(368*)
Electrical energy for heat distribution	5.53	x	2.92	=	16.13	(372*)
Total primary energy from community systems				(363*)...(366*) + (368*)...(372*) =	767.60	(373*)
Space and water heating				(373*) + (374*) + (375*) =	767.60	(376*)
Electricity for pumps and fans within dwelling	0.00	x	0.00	=	0.00	(378*)
Electricity for lighting	372.34	x	2.92	=	1087.23	(379*)
Total primary energy kWh/year				∑(376*)...(382*) =	1854.83	(383*)
Primary energy kWh/m2/year				(383*) ÷ (4) =	21.08	(384*)

SAP 2009 Worksheet

NHER

This design submission has been carried out by an Authorised SAP Assessor. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Miss Olivia Finch	Assessor number	1422
Client		Last modified	14/12/2011
Address	51 65 Maygrove Road, West Hampstead, London, NW6 2EH		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		84.00	(1a)	x	11.40	(2a)	=	957.60	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	84.00	(4)						
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =			957.60	(5)

2. Ventilation rate

				m³ per hour	
Number of chimneys		0	x 40 =	0	(6a)
Number of open flues		0	x 20 =	0	(6b)
Number of intermittent fans		3	x 10 =	30	(7a)
Number of passive vents		4	x 10 =	40	(7b)
Number of flueless gas fires		0	x 40 =	0	(7c)
				Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) =	70	÷ (5) =	0.07	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		3.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.22	(18)

Air permeability value applies if a pressurisation test has been done, or a design or specified air permeability is being used

Number of sides on which dwelling is sheltered		2	(19)
Shelter factor	1 - [0.075 x (19)] =	0.85	(20)
Adjusted infiltration rate	(18) x (20) =	0.19	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table 7												
(22)m	5.40	5.10	5.10	4.50	4.10	3.90	3.70	3.70	4.20	4.50	4.80	5.10

∑(22)1...12 = 54.10 (22)

Wind Factor (22a)m = (22)m ÷ 4

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(22a)m	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.20	1.27

∑(22a)1...12 = 13.52 (22a)

Adjusted infiltration rate (allowing for shelter and wind speed) = (21) × (22a)m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(22b)m	0.26	0.24	0.24	0.21	0.19	0.18	0.18	0.18	0.20	0.21	0.23	0.24

∑(22b)1...12 = 2.56 (22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	N/A	(23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)), otherwise (23b) = (23a)	N/A	(23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =	N/A	(23c)

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m ≥ 1, then (24d)m = (22b)m; otherwise (24d)m = 0.5 + [(22b)m2 x 0.5]

(24d)m	0.53	0.53	0.53	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.53	0.53	(24d)

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in box (25)

(25)m	0.53	0.53	0.53	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.53	0.53	(25)

3. Heat losses and heat loss parameter

The κ-value is the heat capacity per unit area, see Table 1e.

Element	Gross Area, m²	Openings, m²	Net area A, m²		U-value, W/m²K		A x U, W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Window*			17.63	x	1.42	=	24.94	N/A	N/A	(27)
External wall			45.93	x	0.20	=	9.19	N/A	N/A	(29a)
Roof			84.00	x	0.13	=	10.92	N/A	N/A	(30)
Total area of external elements ∑A, m²			147.55	(31)						

** for windows and roof windows, effective window U-value is calculated using formula 1/[(1/UValue)+0.04] paragraph 3.2*

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	45.05	(33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K	Calculated separately =	100.00	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		22.13	(36)

if details of thermal bridging are not known then (36) = 0.15 x (31)

Total fabric heat loss	(33) + (36) =	67.18	(37)

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

(38)m	168.36	167.24	167.24	165.20	163.97	163.41	162.87	162.87	164.27	165.20	166.19	167.24	(38)

Heat transfer coefficient, W/K (37)m + (38)m

(39)m	235.54	234.42	234.42	232.37	231.15	230.58	230.04	230.04	231.45	232.37	233.36	234.42	

Average = ∑(39)1...12/12 = 232.52 (39)

Heat loss parameter (HLP), W/m²K (39)m ÷ (4)

(40)m	2.80	2.79	2.79	2.77	2.75	2.75	2.74	2.74	2.76	2.77	2.78	2.79

Average = ∑(40)1...12/12 = 2.77 (40)

4. Water heating energy requirement

kWh/year

Assumed occupancy, N 2.53 (42)

If TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA - 13.9)²)] + 0.0013 x (TFA - 13.9)

If TFA ≤ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 94.39 (43)

Annual average hot water usage has been reduced by 5% if the dwelling is designed to achieve a water use target of not more than 125 litres per person per day (all water use, hot and cold)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)												
(44)m	103.83	100.06	96.28	92.50	88.73	84.95	84.95	88.73	92.50	96.28	100.06	103.83

∑(44)1...12 = 1132.70 (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)

(45)m	154.35	134.99	139.30	121.45	116.53	100.56	93.18	106.93	108.20	126.10	137.65	149.48

∑(45)1...12 = 1488.70 (45)

If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

For community heating include distribution loss whether or not hot water tank is present

Distribution loss 0.15 x (45)m

(46)m	23.15	20.25	20.90	18.22	17.48	15.08	13.98	16.04	16.23	18.91	20.65	22.42	(46)

Water storage loss:

b) If manufacturer's declared cylinder loss factor is not known:

Cylinder volume (litres) including any solar storage within same cylinder	110.00	(50)
If community heating and no tank in dwelling, enter 110 litres in box (50)		
Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in box (50)		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.02	(51)
If community heating see SAP 2009 section 4.3		
Volume factor from Table 2a	1.03	(52)
Temperature factor from Table 2b	1.00	(53)
Energy lost from water storage, kWh/day (50) x (51) x (52) x (53)	1.72	(54)
Enter (49) or (54) in (55)	1.72	(55)

Water storage loss calculated for each month = (55) x (41)m

(56)m	53.36	48.19	53.36	51.64	53.36	51.64	53.36	53.36	51.64	53.36	51.64	53.36	(56)

If cylinder contains dedicated solar storage, = (56)m x [(50) - (H11)] ÷ (50), else = (56)m where (H11) is from Appendix H

(57)m	53.36	48.19	53.36	51.64	53.36	51.64	53.36	53.36	51.64	53.36	51.64	53.36	(57)

Primary circuit loss (annual) from Table 3	360.00	(58)

Primary circuit loss for each month (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58	(59)

Combi loss for each month from Table 3a, 3b or 3c (enter '0' if not a combi boiler)

(61)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)

Total heat required for water heating calculated for each month 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m	238.28	210.80	223.23	202.67	200.46	181.78	177.11	190.86	189.43	210.03	218.87	233.41	(62)

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRS and/or WWHRS applies, see Appendix G)

(63)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
											∑(63)1...12 =	0.00	(63)

Output from water heater for each month, kWh/month (62)m + (63)m

(64)m	238.28	210.80	223.23	202.67	200.46	181.78	177.11	190.86	189.43	210.03	218.87	233.41	
											∑(64)1...12 =	2476.94	(64)

if (64)m < 0 then set to 0

Heat gains from water heating, kWh/month 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m]

(65)m	118.47	105.53	113.46	105.36	105.89	98.42	98.13	102.70	100.96	109.07	110.75	116.85	(65)

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5), Watts													
(66)m	152.06	152.06	152.06	152.06	152.06	152.06	152.06	152.06	152.06	152.06	152.06	152.06	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m	50.73	45.05	36.64	27.74	20.74	17.51	18.92	24.59	33.00	41.90	48.91	52.14	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m	339.70	343.22	334.34	315.43	291.56	269.12	254.13	250.61	259.49	278.40	302.27	324.71	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m	52.74	52.74	52.74	52.74	52.74	52.74	52.74	52.74	52.74	52.74	52.74	52.74	(69)
Pumps and fans gains (Table 5a)													
(70)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(70)
Losses e.g. evaporation (negative values) (Table 5)													
(71)m	-101.38	-101.38	-101.38	-101.38	-101.38	-101.38	-101.38	-101.38	-101.38	-101.38	-101.38	-101.38	(71)
Water heating gains (Table 5)													
(72)m	159.23	157.04	152.50	146.33	142.33	136.69	131.89	138.04	140.22	146.61	153.82	157.05	(72)

Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

(73)m	653.08	648.75	626.91	592.93	558.05	526.74	508.37	516.66	536.14	570.34	608.42	637.33	(73)

6. Solar gains

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

Rows (74) to (82) are used 12 times, one for each month, repeating as needed if there is more than one window type.

Details for month of January and annual totals are shown below:

	Access factor Table 6d		Area m²		Solar flux W/m²		g Specific data or Table 6b		FF Specific data or Table 6c		Gains (W)	
South	1.00	x	17.63	x	47.32	x	0.53	x	1.00	=	442.06	(78)

Solar gains in watts, calculated for each month ∑(74)m...(82)m

(83)m	442.06	720.99	880.38	981.90	1013.99	1017.24	1000.80	970.39	934.04	796.73	523.76	381.97	(83)

Total gains - internal and solar (73)m + (83)m

(84)m	1095.14	1369.74	1507.29	1574.83	1572.04	1543.99	1509.17	1487.05	1470.18	1367.07	1132.18	1019.29	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(˚C) 21.00 (85)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains for living area, η1,m (see Table 9a)													
(86)m	0.91	0.87	0.83	0.79	0.72	0.61	0.48	0.48	0.64	0.78	0.88	0.91	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)													
(87)m	17.19	17.62	18.26	18.86	19.64	20.29	20.70	20.69	20.19	19.27	17.99	17.24	(87)
Temperature during heating periods in the living area from Table 9, Th2(˚C)													
(88)m	18.86	18.87	18.87	18.88	18.89	18.90	18.90	18.90	18.89	18.88	18.88	18.87	(88)
Utilisation factor for gains for rest of dwelling η2,m (see Table 9a)													
(89)m	0.89	0.85	0.80	0.74	0.64	0.48	0.27	0.28	0.52	0.72	0.85	0.90	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)													
(90)m	14.38	14.96	15.83	16.64	17.66	18.44	18.81	18.81	18.33	17.20	15.49	14.46	(90)

Living area fraction fLA 84.00 ÷ (4) = 1.00 (91)

Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2													
(92)m	17.19	17.62	18.26	18.86	19.64	20.29	20.70	20.69	20.19	19.27	17.99	17.24	(92)
Apply adjustment to the mean internal temperature from Table 4e, where appropriate													
(93)m	17.19	17.62	18.26	18.86	19.64	20.29	20.70	20.69	20.19	19.27	17.99	17.24	(93)

8. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that tim = (93)m and recalculate the utilisation factor for gains using Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, □m													
(94)m	0.87	0.83	0.79	0.74	0.67	0.57	0.45	0.46	0.60	0.73	0.84	0.88	(94)
Useful gains, □mGm, W = (94)m x (84)m													
(95)m	954.43	1135.30	1185.22	1170.96	1058.46	886.85	682.28	678.54	885.05	1001.60	949.70	895.20	(95)
Monthly average external temperature from Table 8													
(96)m	4.50	5.00	6.80	8.70	11.70	14.60	16.90	16.90	14.30	10.80	7.00	4.90	(96)
Heat loss rate for mean internal temperature, Lm, W													
(97)m	2989.23	2958.62	2686.36	2359.94	1835.11	1311.95	873.90	872.80	1363.46	1967.37	2564.65	2893.37	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m - (95)m] x (41)m													
(98)m	1513.89	1225.27	1116.85	856.07	577.82	0.00	0.00	0.00	0.00	718.53	1162.76	1486.64	

Total per year (kWh/year) = ∑(98)1...5, 10...12 = 8657.83 (98)

Space heating requirement in kWh/m²/year (98) ÷ (4) 103.07 (99)

9b. Energy requirements - Community heating scheme

Fraction of space heating from secondary/supplementary system (Table 11) 0.00 (301)

Fraction of space heating from community system 1 - (301)	1.00	(302)		
Community scheme fractions obtained from plant design specification or operational records:				
Fraction of community DHW from boilers	1.00	(303b)		
Fraction of total space heat from community boilers (302) x (303b) =	1.00	(304b)		
Factor for control and charging method (Table 4c(3)) for community space heating	1.00	(305)		
Factor for control and charging method (Table 4c(3)) for community water heating	1.00	(305a)		
Distribution loss factor (Table 12c) for community heating system	0.10	(306)		
Space heating:			**kWh/year**	
Annual space heating requirement			8657.83	
Space heat from community boilers (98) x (304b) x (305) x (306) =	865.78	(307b)		
Water heating:				
Annual water heating requirement			2476.94	
If DHW from community scheme:				
Community DHW: boilers fuel use (64) x (303b) x (305a) x (306) =	247.69	(310b)		
Electricity used for heat distribution		0.01 x [(307a)...(307e) + (310a)...(310e)] =	11.13	(313)
Electricity for pumps and fans within dwelling (Table 4f):				
mechanical ventilation fans - balanced, extract or positive input from outside		0.00		(330a)
warm air heating system fans		0.00		(330b)
pump for solar water heating		0.00		(330g)
Total electricity for the above, kWh/year		(330a) + (330b) + (330g) =	0.00	(331)
Electricity for lighting (calculated in Appendix L):			358.34	(332)

10b. Fuel costs - Community heating scheme

	Heat or fuel kWh/year		Fuel price (Table 12)		Fuel cost £/year	
Space heating from community boilers	865.78	x	3.78	x 0.01 =	32.73	(340b)
Water heating from community boilers	247.69	x	3.78	x 0.01 =	9.36	(342b)
Pumps and fans	0.00	x	11.46	x 0.01 =	0.00	(349)
Electricity for lighting	358.34	x	11.46	x 0.01 =	41.07	(350)
Additional standing charges (Table 12)					106.00	(351)
Total energy cost				(340a)...(342e) + (345)...(354)	189.15	(355)

11b. SAP rating - Community heating scheme

Energy cost deflator (Table 12)		0.47	(356)
Energy cost factor (ECF)	[(355) x (356)] ÷ [(4) + 45.0] =	0.69	(357)
SAP value		90.39	
SAP rating		90	(358)
SAP band		B	

12b. Carbon dioxide emissions - Community heating scheme

Emissions from other community sources (not CHP)

	Energy used kWh/year		Emission Factor (kgCO2/kWh)		Emissions (kgCO2/year)	
Efficiency of boilers (%)			75.00 (367b)			
Emissions from boilers (Mains gas)	1484.64	x	0.198	=	293.96	(368)
Electrical energy for heat distribution	11.13	x	0.517	=	5.76	(372)
Total carbon dioxide from community systems				(363)...(366) + (368)...(372) =	299.71	(373)
Space and water heating				(373) + (374) + (375) =	299.71	(376)

Electricity for pumps and fans within dwelling	0.00	x	0.000	=	0.00	(378)
Electricity for lighting	358.34	x	0.517	=	185.26	(379)
Total carbon dioxide emissions				∑(376)...(382) =	484.97	(383)
Dwelling carbon dioxide emissions rate				(383) ÷ (4) =	5.77	(384)
EI value					94.96	
EI rating (see section 14)					95	(385)
EI band					A	

13b. Primary energy - Community heating scheme

Primary energy from other community sources (not CHP)

Efficiency of boilers (%)			75.00	(367b*)		
	Energy used kWh/year		**Primary Energy Factor**		**Primary Energy**	
Primary energy - boilers (Mains gas)	1484.64	x	1.02	=	1514.33	(368*)
Electrical energy for heat distribution	11.13	x	2.92	=	32.51	(372*)
Total primary energy from community systems				(363*)...(366*) + (368*)...(372*) =	1546.84	(373*)
Space and water heating				(373*) + (374*) + (375*) =	1546.84	(376*)
Electricity for pumps and fans within dwelling	0.00	x	0.00	=	0.00	(378*)
Electricity for lighting	358.34	x	2.92	=	1046.34	(379*)
Total primary energy kWh/year				∑(376*)...(382*) =	2593.18	(383*)
Primary energy kWh/m2/year				(383*) ÷ (4) =	30.87	(384*)

APPENDIX 1.2 SAP CALCULATIONS ACTUAL CASE

SAP 2009 Worksheet

NHER

This design submission has been carried out by an Authorised SAP Assessor. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Miss Olivia Finch	Assessor number	1422
Client		Last modified	16/11/2011
Address	1 65 Maygrove Road, West Hampstead, London, NW6 2EH		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		56.00	(1a)	x	2.85	(2a)	=	159.60	(3a)
+1		34.00	(1b)	x	2.85	(2b)	=	96.90	(3b)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	90.00	(4)						
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =			256.50	(5)

2. Ventilation rate

			m³ per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	0	x 10 =	0	(7a)
Number of passive vents	0	x 10 =	0	(7b)
Number of flueless gas fires	0	x 40 =	0	(7c)

				Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) =	0	÷ (5) =	0.00	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		3.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.15	(18)

Air permeability value applies if a pressurisation test has been done, or a design or specified air permeability is being used

Number of sides on which dwelling is sheltered		4	(19)
Shelter factor	1 - [0.075 x (19)] =	0.70	(20)
Adjusted infiltration rate	(18) x (20) =	0.10	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table 7 (22)m	5.40	5.10	5.10	4.50	4.10	3.90	3.70	3.70	4.20	4.50	4.80	5.10
Wind Factor (22a)m = (22)m ÷ 4 (22a)m	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.20	1.27
Adjusted infiltration rate (allowing for shelter and wind speed) = (21) × (22a)m (22b)m	0.14	0.13	0.13	0.12	0.11	0.10	0.10	0.10	0.11	0.12	0.13	0.13

∑(22)1...12 =	54.10	(22)
∑(22a)1...12 =	13.52	(22a)
∑(22b)1...12 =	1.42	(22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	0.5	(23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)), otherwise (23b) = (23a)	0.5	(23b)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =	N/A	(23c)

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 x (23b), then (24c) = (23b); otherwise (24c) = (22b)m + 0.5 x (23b)

(24c)m	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	(24c)

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in box (25)

(25)m	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	(25)

3. Heat losses and heat loss parameter

The κ-value is the heat capacity per unit area, see Table 1e.

Element	Gross Area, m²	Openings, m²	Net area A, m²		U-value, W/m²K		A x U, W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Window*			10.00	x	1.42	=	14.15	N/A	N/A	(27)
Basement floor			56.00	x	0.13	=	7.28	N/A	N/A	(28)
External wall			27.90	x	0.20	=	5.58	N/A	N/A	(29a)
Total area of external elements ∑A, m²			93.90 (31)							

** for windows and roof windows, effective window U-value is calculated using formula 1/[(1/UValue)+0.04] paragraph 3.2*

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	27.01	(33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K	Calculated separately =	100.00	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		14.08	(36)
if details of thermal bridging are not known then (36) = 0.15 x (31)			
Total fabric heat loss	(33) + (36) =	41.10	(37)

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

(38)m	42.32	42.32	42.32	42.32	42.32	42.32	42.32	42.32	42.32	42.32	42.32	42.32	(38)

Heat transfer coefficient, W/K (37)m + (38)m

(39)m	83.42	83.42	83.42	83.42	83.42	83.42	83.42	83.42	83.42	83.42	83.42	83.42

Average = ∑(39)1...12/12 = 83.42 (39)

Heat loss parameter (HLP), W/m²K (39)m ÷ (4)

(40)m	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93

Average = ∑(40)1...12/12 = 0.93 (40)

4. Water heating energy requirement

	kWh/year	
Assumed occupancy, N	2.63	(42)

If TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA - 13.9)²)] + 0.0013 x (TFA - 13.9)

If TFA ≤ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 — 96.56 (43)

Annual average hot water usage has been reduced by 5% if the dwelling is designed to achieve a water use target of not more than 125 litres per person per day (all water use, hot and cold)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)												
(44)m	106.22	102.35	98.49	94.63	90.77	86.90	86.90	90.77	94.63	98.49	102.35	106.22

∑(44)1...12 = 1158.73 (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)

(45)m	157.89	138.09	142.50	124.24	119.21	102.87	95.32	109.38	110.69	129.00	140.81	152.91

∑(45)1...12 = 1522.91 (45)

If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

For community heating include distribution loss whether or not hot water tank is present

Distribution loss 0.15 x (45)m

(46)m	23.68	20.71	21.38	18.64	17.88	15.43	14.30	16.41	16.60	19.35	21.12	22.94	(46)

Water storage loss:

b) If manufacturer's declared cylinder loss factor is not known:

Cylinder volume (litres) including any solar storage within same cylinder	110.00	(50)
If community heating and no tank in dwelling, enter 110 litres in box (50)		
Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in box (50)		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.02	(51)
If community heating see SAP 2009 section 4.3		
Volume factor from Table 2a	1.03	(52)
Temperature factor from Table 2b	1.00	(53)
Energy lost from water storage, kWh/day (50) x (51) x (52) x (53)	1.72	(54)
Enter (49) or (54) in (55)	1.72	(55)

Water storage loss calculated for each month = (55) x (41)m

(56)m	53.36	48.19	53.36	51.64	53.36	51.64	53.36	53.36	51.64	53.36	51.64	53.36	(56)

If cylinder contains dedicated solar storage, = (56)m x [(50) - (H11)] ÷ (50), else = (56)m where (H11) is from Appendix H

(57)m	53.36	48.19	53.36	51.64	53.36	51.64	53.36	53.36	51.64	53.36	51.64	53.36	(57)

Primary circuit loss (annual) from Table 3 — 360.00 (58)

Primary circuit loss for each month (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58	(59)

Combi loss for each month from Table 3a, 3b or 3c (enter '0' if not a combi boiler)

(61)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)

Total heat required for water heating calculated for each month 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m	241.83	213.90	226.43	205.46	203.14	184.09	179.25	193.32	191.91	212.93	222.04	236.84	(62)

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRS and/or WWHRS applies, see Appendix G)

(63)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	

∑(63)1...12 = 0.00 (63)

Output from water heater for each month, kWh/month (62)m + (63)m

(64)m	241.83	213.90	226.43	205.46	203.14	184.09	179.25	193.32	191.91	212.93	222.04	236.84

∑(64)1...12 = 2511.15 (64)

if (64)m < 0 then set to 0

Heat gains from water heating, kWh/month 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m]

(65)m	119.65	106.56	114.53	106.29	106.78	99.18	98.84	103.52	101.78	110.04	111.80	117.99	(65)

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5), Watts													
(66)m	157.54	157.54	157.54	157.54	157.54	157.54	157.54	157.54	157.54	157.54	157.54	157.54	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m	62.92	55.88	45.45	34.41	25.72	21.71	23.46	30.50	40.93	51.97	60.66	64.67	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m	356.83	360.54	351.20	331.34	306.26	282.70	266.95	263.25	272.58	292.45	317.52	341.09	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m	53.38	53.38	53.38	53.38	53.38	53.38	53.38	53.38	53.38	53.38	53.38	53.38	(69)
Pumps and fans gains (Table 5a)													
(70)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(70)
Losses e.g. evaporation (negative values) (Table 5)													
(71)m	-105.03	-105.03	-105.03	-105.03	-105.03	-105.03	-105.03	-105.03	-105.03	-105.03	-105.03	-105.03	(71)

Water heating gains (Table 5)

(72)m	160.81	158.58	153.94	147.62	143.53	137.75	132.85	139.13	141.37	147.90	155.28	158.59	(72)

Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

(73)m	686.46	680.89	656.48	619.26	581.40	548.06	529.16	538.78	560.77	598.21	639.35	670.24	(73)

6. Solar gains

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

Rows (74) to (82) are used 12 times, one for each month, repeating as needed if there is more than one window type.

Details for month of January and annual totals are shown below:

	Access factor Table 6d		Area m²		Solar flux W/m²		g Specific data or Table 6b		FF Specific data or Table 6c		Gains (W)	
South	0.54	x	10.00	x	47.32	x	0.53	x	1.00	=	135.44	(78)

Solar gains in watts, calculated for each month ∑(74)m...(82)m

(83)m	135.44	220.90	269.73	300.84	310.67	311.67	306.63	297.31	286.17	244.11	160.47	117.03	(83)

Total gains - internal and solar (73)m + (83)m

(84)m	821.90	901.79	926.21	920.10	892.07	859.73	835.79	836.09	846.95	842.32	799.82	787.26	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(˚C) 21.00 (85)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains for living area, η1,m (see Table 9a)													
(86)m	0.90	0.87	0.83	0.79	0.70	0.55	0.39	0.39	0.58	0.75	0.87	0.91	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)													
(87)m	19.63	19.82	20.11	20.35	20.67	20.88	20.97	20.97	20.85	20.54	19.98	19.64	(87)
Temperature during heating periods in the living area from Table 9, Th2(˚C)													
(88)m	20.15	20.15	20.15	20.15	20.15	20.15	20.15	20.15	20.15	20.15	20.15	20.15	(88)
Utilisation factor for gains for rest of dwelling η2,m (see Table 9a)													
(89)m	0.89	0.86	0.81	0.76	0.66	0.50	0.32	0.32	0.52	0.72	0.85	0.89	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)													
(90)m	18.34	18.61	19.01	19.35	19.77	20.03	20.13	20.13	20.01	19.60	18.84	18.36	(90)

Living area fraction fLA 56.00 ÷ (4) = 0.62 (91)

Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2													
(92)m	19.14	19.36	19.70	19.98	20.33	20.56	20.65	20.65	20.53	20.18	19.55	19.16	(92)
Apply adjustment to the mean internal temperature from Table 4e, where appropriate													
(93)m	19.14	19.36	19.70	19.98	20.33	20.56	20.65	20.65	20.53	20.18	19.55	19.16	(93)

8. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that tim = (93)m and recalculate the utilisation factor for gains using Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm													
(94)m	0.87	0.84	0.80	0.76	0.66	0.52	0.36	0.36	0.55	0.72	0.84	0.88	(94)
Useful gains, ηmGm, W = (94)m x (84)m													
(95)m	718.78	761.63	743.70	697.50	592.88	451.33	302.39	302.40	465.82	607.89	672.10	691.63	(95)
Monthly average external temperature from Table 8													
(96)m	4.50	5.00	6.80	8.70	11.70	14.60	16.90	16.90	14.30	10.80	7.00	4.90	(96)
Heat loss rate for mean internal temperature, Lm, W													
(97)m	1221.59	1198.19	1075.88	940.59	719.65	496.99	312.89	312.89	520.05	782.65	1047.13	1189.34	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m - (95)m] x (41)m													
(98)m	374.09	293.37	247.14	175.03	94.32	0.00	0.00	0.00	0.00	130.02	270.03	370.29	

Total per year (kWh/year) = ∑(98)1...5, 10...12 = 1954.29 (98)

Space heating requirement in kWh/m²/year (98) ÷ (4) 21.71 (99)

9b. Energy requirements - Community heating scheme

Fraction of space heating from secondary/supplementary system (Table 11)	0.00	(301)		
Fraction of space heating from community system 1 - (301)	1.00	(302)		
Community scheme fractions obtained from plant design specification or operational records:				
Fraction of community DHW from CHP	0.60	(303a)		
Fraction of community DHW from boilers	0.40	(303b)		
Fraction of total space heat from community CHP (302) x (303a) =	0.60	(304a)		
Fraction of total space heat from community boilers (302) x (303b) =	0.40	(304b)		
Factor for control and charging method (Table 4c(3)) for community space heating	1.00	(305)		
Factor for control and charging method (Table 4c(3)) for community water heating	1.00	(305a)		
Distribution loss factor (Table 12c) for community heating system	0.10	(306)		
Space heating:			**kWh/year**	
Annual space heating requirement			1954.29	
Space heat from community CHP (98) x (304a) x (305) x (306) =	117.26	(307a)		
Space heat from community boilers (98) x (304b) x (305) x (306) =	78.17	(307b)		
Water heating:				
Annual water heating requirement			2511.15	
If DHW from community scheme:				
Community DHW: CHP fuel use (64) x (303a) x (305a) x (306) =	150.67	(310a)		
Community DHW: boilers fuel use (64) x (303b) x (305a) x (306) =	100.45	(310b)		
Electricity used for heat distribution		0.01 x [(307a)...(307e) + (310a)...(310e)] =	4.47	(313)
Electricity for pumps and fans within dwelling (Table 4f):				
mechanical ventilation fans - balanced, extract or positive input from outside		74.48		(330a)
warm air heating system fans		0.00		(330b)
pump for solar water heating		0.00		(330g)
Total electricity for the above, kWh/year		(330a) + (330b) + (330g) =	74.48	(331)
Electricity for lighting (calculated in Appendix L):			444.45	(332)

10b. Fuel costs - Community heating scheme

	Heat or fuel kWh/year		Fuel price (Table 12)		Fuel cost £/year	
Space heating from community CHP	117.26	x	2.65	x 0.01 =	3.11	(340a)
Space heating from community boilers	78.17	x	3.78	x 0.01 =	2.95	(340b)
Water heating from community CHP	150.67	x	2.65	x 0.01 =	3.99	(342a)
Water heating from community boilers	100.45	x	3.78	x 0.01 =	3.80	(342b)
Pumps and fans	74.48	x	11.46	x 0.01 =	8.54	(349)
Electricity for lighting	444.45	x	11.46	x 0.01 =	50.93	(350)
Additional standing charges (Table 12)					106.00	(351)
Total energy cost				(340a)...(342e) + (345)...(354)	179.32	(355)

11b. SAP rating - Community heating scheme

Energy cost deflator (Table 12)		0.47	(356)
Energy cost factor (ECF)	[(355) x (356)] ÷ [(4) + 45.0] =	0.62	(357)
SAP value		91.29	
SAP rating		91	(358)
SAP band		B	

12b. Carbon dioxide emissions - Community heating scheme

Emissions from community CHP (Mains gas)

Efficiency of CHP (%)				78.00		(359)
Heat to power ratio				3.00		(360)
	Energy kWh/year		**Emissions Factor**		**Emissions (kgCO2/year)**	
Space heating from CHP (Mains gas)	200.44	x	0.198	=	39.69	(363)
less credit emissions for electricity	-39.09	x	0.529	=	-20.68	(364)
Water heating from CHP (Mains gas)	257.55	x	0.198	=	51.00	(365)
less credit emissions for electricity	-50.22	x	0.529	=	-26.57	(366)

Emissions from other community sources (not CHP)

Efficiency of boilers (%)			90.00 (367b)			
	Energy used kWh/year		**Emission Factor (kgCO2/kWh)**		**Emissions (kgCO2/year)**	
Emissions from boilers (Mains gas)	198.46	x	0.198	=	39.30	(368)
Electrical energy for heat distribution	4.47	x	0.517	=	2.31	(372)
Total carbon dioxide from community systems			(363)...(366) + (368)...(372) =		85.04	(373)
Space and water heating			(373) + (374) + (375) =		85.04	(376)
Electricity for pumps and fans within dwelling	74.48	x	0.517	=	38.50	(378)
Electricity for lighting	444.45	x	0.517	=	229.78	(379)
Total carbon dioxide emissions			∑(376)...(382) =		353.33	(383)
Dwelling carbon dioxide emissions rate			(383) ÷ (4) =		3.93	(384)
EI value					96.49	
EI rating (see section 14)					96	(385)
EI band					A	

13b. Primary energy - Community heating scheme

Primary energy from community CHP (Mains gas)

Efficiency of CHP (%)				78.00		(359*)
Heat to power ratio				3.00		(360*)
	Energy kWh/year		**Primary Energy Factor**		**Primary Energy**	
Space heating from CHP (Mains gas)	200.44	x	1.02	=	204.45	(363*)
less credit emissions for electricity	-39.09	x	2.92	=	-114.13	(364*)
Water heating from CHP (Mains gas)	257.55	x	1.02	=	262.71	(365*)
less credit emissions for electricity	-50.22	x	2.92	=	-146.65	(366*)

Primary energy from other community sources (not CHP)

Efficiency of boilers (%)			90.00 (367b*)			
	Energy used kWh/year		**Primary Energy Factor**		**Primary Energy**	
Primary energy - boilers (Mains gas)	198.46	x	1.02	=	202.43	(368*)
Electrical energy for heat distribution	4.47	x	2.92	=	13.04	(372*)
Total primary energy from community systems			(363*)...(366*) + (368*)...(372*) =		421.84	(373*)
Space and water heating			(373*) + (374*) + (375*) =		421.84	(376*)
Electricity for pumps and fans within dwelling	74.48	x	2.92	=	217.47	(378*)
Electricity for lighting	444.45	x	2.92	=	1297.80	(379*)
Total primary energy kWh/year			∑(376*)...(382*) =		1937.12	(383*)
Primary energy kWh/m2/year			(383*) ÷ (4) =		21.52	(384*)

SAP 2009 Worksheet

This design submission has been carried out by an Authorised SAP Assessor. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name		Assessor number	
Client		Last modified	15/11/2011
Address	5 65 Maygrove Road, West Hampstead, London, NW6 2EH		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		264.00	(1a)	x	2.80	(2a)	=	739.20	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	264.00	(4)						
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =			739.20	(5)

2. Ventilation rate

			m³ per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	2	x 10 =	20	(7a)
Number of passive vents	4	x 10 =	40	(7b)
Number of flueless gas fires	0	x 40 =	0	(7c)

			Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs (6a) + (6b) + (7a) + (7b) + (7c) =	60	÷ (5) =	0.08	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area	3.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.23	(18)

Air permeability value applies if a pressurisation test has been done, or a design or specified air permeability is being used

Number of sides on which dwelling is sheltered		4	(19)
Shelter factor	1 - [0.075 x (19)] =	0.70	(20)
Adjusted infiltration rate	(18) x (20) =	0.16	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table 7												
(22)m	5.40	5.10	5.10	4.50	4.10	3.90	3.70	3.70	4.20	4.50	4.80	5.10

∑(22)1...12 = 54.10 (22)

Wind Factor (22a)m = (22)m ÷ 4

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(22a)m	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.20	1.27

∑(22a)1...12 = 13.52 (22a)

Adjusted infiltration rate (allowing for shelter and wind speed) = (21) × (22a)m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(22b)m	0.22	0.21	0.21	0.18	0.17	0.16	0.15	0.15	0.17	0.18	0.19	0.21

∑(22b)1...12 = 2.19 (22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	N/A	(23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)), otherwise (23b) = (23a)	N/A	(23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = N/A (23c)

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m ≥ 1, then (24d)m = (22b)m; otherwise (24d)m = 0.5 + [(22b)m2 x 0.5]

(24d)m	0.52	0.52	0.52	0.52	0.51	0.51	0.51	0.51	0.51	0.52	0.52	0.52	(24d)

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in box (25)

(25)m	0.52	0.52	0.52	0.52	0.51	0.51	0.51	0.51	0.51	0.52	0.52	0.52	(25)

3. Heat losses and heat loss parameter

The κ-value is the heat capacity per unit area, see Table 1e.

Element	Gross Area, m²	Openings, m²	Net area A, m²		U-value, W/m²K		A x U, W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Window*			10.00	x	1.42	=	14.15	N/A	N/A	(27)
Basement floor			56.00	x	0.13	=	7.28	N/A	N/A	(28)
External wall			27.90	x	0.20	=	5.58	N/A	N/A	(29a)
Total area of external elements ∑A, m²			93.90	(31)						

** for windows and roof windows, effective window U-value is calculated using formula 1/[(1/UValue)+0.04] paragraph 3.2*

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	27.01	(33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K	Calculated separately =	100.00	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		14.08	(36)

if details of thermal bridging are not known then (36) = 0.15 x (31)

Total fabric heat loss (33) + (36) = 41.10 (37)

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

(38)m	127.79	127.16	127.16	126.01	125.32	125.00	124.70	124.70	125.49	126.01	126.57	127.16	(38)

Heat transfer coefficient, W/K (37)m + (38)m

(39)m	168.88	168.26	168.26	167.11	166.42	166.10	165.80	165.80	166.59	167.11	167.66	168.26

Average = ∑(39)1...12/12 = 167.19 (39)

Heat loss parameter (HLP), W/m²K (39)m ÷ (4)

(40)m	0.64	0.64	0.64	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.64	0.64

Average = ∑(40)1...12/12 = 0.63 (40)

4. Water heating energy requirement

kWh/year

Assumed occupancy, N 3.09 (42)

If TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA - 13.9)²)] + 0.0013 x (TFA - 13.9)

If TFA ≤ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 107.47 (43)

Annual average hot water usage has been reduced by 5% if the dwelling is designed to achieve a water use target of not more than 125 litres per person per day (all water use, hot and cold)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)												
(44)m	118.22	113.92	109.62	105.32	101.02	96.72	96.72	101.02	105.32	109.62	113.92	118.22

∑(44)1...12 = 1289.66 (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)

(45)m	175.73	153.70	158.60	138.27	132.68	114.49	106.09	121.74	123.20	143.57	156.72	170.19

∑(45)1...12 = 1695.00 (45)

If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

For community heating include distribution loss whether or not hot water tank is present

Distribution loss 0.15 x (45)m

(46)m	26.36	23.05	23.79	20.74	19.90	17.17	15.91	18.26	18.48	21.54	23.51	25.53	(46)

Water storage loss:

b) If manufacturer's declared cylinder loss factor is not known:

Cylinder volume (litres) including any solar storage within same cylinder	110.00	(50)
If community heating and no tank in dwelling, enter 110 litres in box (50)		
Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in box (50)		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.02	(51)
If community heating see SAP 2009 section 4.3		
Volume factor from Table 2a	1.03	(52)
Temperature factor from Table 2b	1.00	(53)
Energy lost from water storage, kWh/day (50) x (51) x (52) x (53)	1.72	(54)
Enter (49) or (54) in (55)	1.72	(55)

Water storage loss calculated for each month = (55) x (41)m													
(56)m	53.36	48.19	53.36	51.64	53.36	51.64	53.36	53.36	51.64	53.36	51.64	53.36	(56)
If cylinder contains dedicated solar storage, = (56)m x [(50) - (H11)] ÷ (50), else = (56)m where (H11) is from Appendix H													
(57)m	53.36	48.19	53.36	51.64	53.36	51.64	53.36	53.36	51.64	53.36	51.64	53.36	(57)

Primary circuit loss (annual) from Table 3	360.00	(58)

Primary circuit loss for each month (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58	(59)
Combi loss for each month from Table 3a, 3b or 3c (enter '0' if not a combi boiler)													
(61)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)
Total heat required for water heating calculated for each month 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m													
(62)m	259.67	229.51	242.54	219.50	216.61	195.72	190.03	205.68	204.42	227.51	237.95	254.12	(62)

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRS and/or WWHRS applies, see Appendix G)

(63)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
											∑(63)1...12 =	0.00	(63)
Output from water heater for each month, kWh/month (62)m + (63)m													
(64)m	259.67	229.51	242.54	219.50	216.61	195.72	190.03	205.68	204.42	227.51	237.95	254.12	
											∑(64)1...12 =	2683.24	(64)

if (64)m < 0 then set to 0

Heat gains from water heating, kWh/month 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m]

(65)m	125.58	111.75	119.88	110.96	111.26	103.05	102.42	107.63	105.94	114.88	117.09	123.73	(65)

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5), Watts													
(66)m	185.11	185.11	185.11	185.11	185.11	185.11	185.11	185.11	185.11	185.11	185.11	185.11	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m	130.73	116.12	94.43	71.49	53.44	45.12	48.75	63.37	85.05	107.99	126.04	134.37	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m	639.42	646.06	629.34	593.74	548.81	506.58	478.36	471.73	488.45	524.05	568.98	611.21	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m	56.60	56.60	56.60	56.60	56.60	56.60	56.60	56.60	56.60	56.60	56.60	56.60	(69)
Pumps and fans gains (Table 5a)													
(70)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(70)
Losses e.g. evaporation (negative values) (Table 5)													
(71)m	-123.41	-123.41	-123.41	-123.41	-123.41	-123.41	-123.41	-123.41	-123.41	-123.41	-123.41	-123.41	(71)
Water heating gains (Table 5)													
(72)m	168.79	166.30	161.13	154.11	149.54	143.12	137.66	144.66	147.14	154.41	162.63	166.31	(72)

Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

(73)m	1057.24	1046.77	1003.20	937.64	870.09	813.11	783.08	798.05	838.94	904.75	975.94	1030.18	(73)

6. Solar gains

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

Rows (74) to (82) are used 12 times, one for each month, repeating as needed if there is more than one window type.

Details for month of January and annual totals are shown below:

	Access factor Table 6d		Area m²		Solar flux W/m²		g Specific data or Table 6b		FF Specific data or Table 6c		Gains (W)	
South	0.54	x	10.00	x	47.32	x	0.53	x	1.00	=	135.44	(78)

Solar gains in watts, calculated for each month ∑(74)m...(82)m

(83)m	135.44	220.90	269.73	300.84	310.67	311.67	306.63	297.31	286.17	244.11	160.47	117.03	(83)

Total gains - internal and solar (73)m + (83)m

(84)m	1192.68	1267.67	1272.93	1238.47	1180.76	1124.78	1089.70	1095.36	1125.12	1148.86	1136.42	1147.21	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(˚C) 21.00 (85)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains for living area, η1,m (see Table 9a)													
(86)m	0.98	0.97	0.96	0.94	0.89	0.77	0.58	0.58	0.79	0.92	0.97	0.98	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)													
(87)m	19.67	19.80	20.04	20.27	20.59	20.84	20.96	20.96	20.82	20.47	19.97	19.70	(87)
Temperature during heating periods in the living area from Table 9, Th2(˚C)													
(88)m	20.40	20.40	20.40	20.40	20.40	20.40	20.41	20.41	20.40	20.40	20.40	20.40	(88)
Utilisation factor for gains for rest of dwelling η2,m (see Table 9a)													
(89)m	0.98	0.97	0.95	0.93	0.87	0.73	0.51	0.51	0.76	0.91	0.96	0.98	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)													
(90)m	18.56	18.75	19.10	19.43	19.89	20.23	20.38	20.38	20.20	19.72	19.01	18.61	(90)

Living area fraction fLA 34.00 ÷ (4) = 0.13 (91)

Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2													
(92)m	18.71	18.89	19.22	19.54	19.98	20.31	20.45	20.45	20.28	19.82	19.14	18.75	(92)
Apply adjustment to the mean internal temperature from Table 4e, where appropriate													
(93)m	18.71	18.89	19.22	19.54	19.98	20.31	20.45	20.45	20.28	19.82	19.14	18.75	(93)

8. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that tim = (93)m and recalculate the utilisation factor for gains using Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ▯m													
(94)m	0.97	0.96	0.94	0.92	0.85	0.72	0.52	0.52	0.75	0.89	0.95	0.97	(94)
Useful gains, ▯mGm, W = (94)m x (84)m													
(95)m	1151.93	1211.66	1194.26	1134.45	1008.53	815.40	563.95	564.40	839.58	1021.13	1082.03	1109.43	(95)
Monthly average external temperature from Table 8													
(96)m	4.50	5.00	6.80	8.70	11.70	14.60	16.90	16.90	14.30	10.80	7.00	4.90	(96)
Heat loss rate for mean internal temperature, Lm, W													
(97)m	2399.28	2336.71	2090.00	1811.54	1378.56	948.86	588.97	589.05	996.21	1506.55	2034.62	2329.61	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m - (95)m] x (41)m													
(98)m	928.03	756.03	666.43	487.50	275.30	0.00	0.00	0.00	0.00	361.15	685.86	907.81	

Total per year (kWh/year) = ∑(98)1...5, 10...12 = 5068.12 (98)

Space heating requirement in kWh/m²/year (98) ÷ (4) 19.20 (99)

9b. Energy requirements - Community heating scheme

Fraction of space heating from secondary/supplementary system (Table 11) 0.00 (301)

Fraction of space heating from community system 1 - (301)	1.00	(302)
Community scheme fractions obtained from plant design specification or operational records:		
Fraction of community DHW from CHP	0.60	(303a)
Fraction of community DHW from boilers	0.40	(303b)
Fraction of total space heat from community CHP (302) x (303a) =	0.60	(304a)
Fraction of total space heat from community boilers (302) x (303b) =	0.40	(304b)
Factor for control and charging method (Table 4c(3)) for community space heating	1.00	(305)
Factor for control and charging method (Table 4c(3)) for community water heating	1.00	(305a)
Distribution loss factor (Table 12c) for community heating system	0.10	(306)

Space heating: kWh/year

Annual space heating requirement			5068.12	
Space heat from community CHP (98) x (304a) x (305) x (306) =	304.09	(307a)		
Space heat from community boilers (98) x (304b) x (305) x (306) =	202.72	(307b)		

Water heating:

Annual water heating requirement			2683.24	
If DHW from community scheme:				
Community DHW: CHP fuel use (64) x (303a) x (305a) x (306) =	160.99	(310a)		
Community DHW: boilers fuel use (64) x (303b) x (305a) x (306) =	107.33	(310b)		
Electricity used for heat distribution		0.01 x [(307a)...(307e) + (310a)...(310e)] =	7.75	(313)

Electricity for pumps and fans within dwelling (Table 4f):

mechanical ventilation fans - balanced, extract or positive input from outside	0.00			(330a)
warm air heating system fans	0.00			(330b)
pump for solar water heating	0.00			(330g)
Total electricity for the above, kWh/year		(330a) + (330b) + (330g) =	0.00	(331)
Electricity for lighting (calculated in Appendix L):			923.51	(332)

10b. Fuel costs - Community heating scheme

	Heat or fuel kWh/year		Fuel price (Table 12)		Fuel cost £/year	
Space heating from community CHP	304.09	x	2.65	x 0.01 =	8.06	(340a)
Space heating from community boilers	202.72	x	3.78	x 0.01 =	7.66	(340b)
Water heating from community CHP	160.99	x	2.65	x 0.01 =	4.27	(342a)
Water heating from community boilers	107.33	x	3.78	x 0.01 =	4.06	(342b)
Pumps and fans	0.00	x	11.46	x 0.01 =	0.00	(349)
Electricity for lighting	923.51	x	11.46	x 0.01 =	105.83	(350)
Additional standing charges (Table 12)					106.00	(351)
Total energy cost				(340a)...(342e) + (345)...(354)	235.88	(355)

11b. SAP rating - Community heating scheme

Energy cost deflator (Table 12)		0.47	(356)
Energy cost factor (ECF)	[(355) x (356)] ÷ [(4) + 45.0] =	0.36	(357)
SAP value		95.00	
SAP rating		95	(358)
SAP band		A	

12b. Carbon dioxide emissions - Community heating scheme

Emissions from community CHP (Mains gas)

Efficiency of CHP (%)	75.00	(359)

	Energy kWh/year		Emissions Factor		Emissions (kgCO2/year)	
Heat to power ratio				3.00		(360)
Space heating from CHP (Mains gas)	540.60	x	0.198	=	107.04	(363)
less credit emissions for electricity	-101.36	x	0.529	=	-53.62	(364)
Water heating from CHP (Mains gas)	286.21	x	0.198	=	56.67	(365)
less credit emissions for electricity	-53.66	x	0.529	=	-28.39	(366)

Emissions from other community sources (not CHP)

	Energy used kWh/year		Emission Factor (kgCO2/kWh)		Emissions (kgCO2/year)	
Efficiency of boilers (%)			75.00 (367b)			
Emissions from boilers (Mains gas)	413.41	x	0.198	=	81.85	(368)
Electrical energy for heat distribution	7.75	x	0.517	=	4.01	(372)
Total carbon dioxide from community systems			(363)...(366) + (368)...(372) =		167.56	(373)
Space and water heating			(373) + (374) + (375) =		167.56	(376)
Electricity for pumps and fans within dwelling	0.00	x	0.000	=	0.00	(378)
Electricity for lighting	923.51	x	0.517	=	477.46	(379)
Total carbon dioxide emissions			∑(376)...(382) =		645.02	(383)
Dwelling carbon dioxide emissions rate			(383) ÷ (4) =		2.44	(384)
EI value					97.20	
EI rating (see section 14)					97	(385)
EI band					A	

13b. Primary energy - Community heating scheme

Primary energy from community CHP (Mains gas)

	Energy kWh/year		Primary Energy Factor		Primary Energy	
Efficiency of CHP (%)				75.00		(359*)
Heat to power ratio				3.00		(360*)
Space heating from CHP (Mains gas)	540.60	x	1.02	=	551.41	(363*)
less credit emissions for electricity	-101.36	x	2.92	=	-295.98	(364*)
Water heating from CHP (Mains gas)	286.21	x	1.02	=	291.94	(365*)
less credit emissions for electricity	-53.66	x	2.92	=	-156.70	(366*)

Primary energy from other community sources (not CHP)

	Energy used kWh/year		Primary Energy Factor		Primary Energy	
Efficiency of boilers (%)			75.00 (367b*)			
Primary energy - boilers (Mains gas)	413.41	x	1.02	=	421.67	(368*)
Electrical energy for heat distribution	7.75	x	2.92	=	22.63	(372*)
Total primary energy from community systems			(363*)...(366*) + (368*)...(372*) =		834.98	(373*)
Space and water heating			(373*) + (374*) + (375*) =		834.98	(376*)
Electricity for pumps and fans within dwelling	0.00	x	0.00	=	0.00	(378*)
Electricity for lighting	923.51	x	2.92	=	2696.65	(379*)
Total primary energy kWh/year			∑(376*)...(382*) =		3531.63	(383*)
Primary energy kWh/m2/year			(383*) ÷ (4) =		13.38	(384*)

SAP 2009 Worksheet

NHER

This design submission has been carried out by an Authorised SAP Assessor. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name		Assessor number	
Client		Last modified	14/11/2011
Address	8 65 Maygrove Road, West Hampstead, London, NW6 2EH		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		670.00	(1a)	x	2.85	(2a)	=	1909.50	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	670.00	(4)						
Dwelling volume							(3a) + (3b) + (3c) + (3d)...(3n) =	1909.50	(5)

2. Ventilation rate

				m³ per hour	
Number of chimneys		0	x 40 =	0	(6a)
Number of open flues		0	x 20 =	0	(6b)
Number of intermittent fans		2	x 10 =	20	(7a)
Number of passive vents		2	x 10 =	20	(7b)
Number of flueless gas fires		0	x 40 =	0	(7c)
				Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) =	40	÷ (5) =	0.02	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		3.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.17	(18)

Air permeability value applies if a pressurisation test has been done, or a design or specified air permeability is being used

Number of sides on which dwelling is sheltered		4	(19)
Shelter factor	1 - [0.075 x (19)] =	0.70	(20)
Adjusted infiltration rate	(18) x (20) =	0.12	(21)

Infiltration rate modified for monthly wind speed:

Monthly average wind speed from Table 7

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(22)m	5.40	5.10	5.10	4.50	4.10	3.90	3.70	3.70	4.20	4.50	4.80	5.10

∑(22)1...12 = 54.10 (22)

Wind Factor (22a)m = (22)m ÷ 4

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(22a)m	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.20	1.27

∑(22a)1...12 = 13.52 (22a)

Adjusted infiltration rate (allowing for shelter and wind speed) = (21) × (22a)m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(22b)m	0.16	0.15	0.15	0.13	0.12	0.12	0.11	0.11	0.13	0.13	0.14	0.15

∑(22b)1...12 = 1.62 (22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	N/A	(23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)), otherwise (23b) = (23a)	N/A	(23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = N/A (23c)

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m ≥ 1, then (24d)m = (22b)m; otherwise (24d)m = 0.5 + [(22b)m2 x 0.5]

(24d)m	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	(24d)

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in box (25)

(25)m	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	(25)

3. Heat losses and heat loss parameter

The κ-value is the heat capacity per unit area, see Table 1e.

Element	Gross Area, m²	Openings, m²	Net area A, m²		U-value, W/m²K		A x U, W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Window*			10.00	x	1.42	=	14.15	N/A	N/A	(27)
Ground floor			56.00	x	0.13	=	7.28	N/A	N/A	(28a)
External wall			38.16	x	0.20	=	7.63	N/A	N/A	(29a)
Total area of external elements ∑A, m²			104.16	(31)						

** for windows and roof windows, effective window U-value is calculated using formula 1/[(1/UValue)+0.04] paragraph 3.2*

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	29.06	(33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K	Calculated separately =	100.00	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		15.62	(36)

if details of thermal bridging are not known then (36) = 0.15 x (31)

Total fabric heat loss (33) + (36) = 44.69 (37)

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

(38)m	323.29	322.40	322.40	320.78	319.81	319.36	318.93	318.93	320.04	320.78	321.56	322.40	(38)

Heat transfer coefficient, W/K (37)m + (38)m

(39)m	367.98	367.09	367.09	365.46	364.49	364.04	363.61	363.61	364.73	365.46	366.25	367.09	

Average = ∑(39)1...12/12 = 365.58 (39)

Heat loss parameter (HLP), W/m²K (39)m ÷ (4)

(40)m	0.55	0.55	0.55	0.55	0.54	0.54	0.54	0.54	0.54	0.55	0.55	0.55	

Average = ∑(40)1...12/12 = 0.55 (40)

4. Water heating energy requirement

kWh/year

Assumed occupancy, N 3.61 (42)

If TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA - 13.9)²)] + 0.0013 x (TFA - 13.9)

If TFA ≤ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 120.01 (43)

Annual average hot water usage has been reduced by 5% if the dwelling is designed to achieve a water use target of not more than 125 litres per person per day (all water use, hot and cold)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)													
(44)m	132.01	127.21	122.41	117.61	112.81	108.01	108.01	112.81	117.61	122.41	127.21	132.01	

∑(44)1...12 = 1440.09 (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)

(45)m	196.23	171.63	177.10	154.40	148.15	127.84	118.47	135.94	137.57	160.32	175.00	190.04	

∑(45)1...12 = 1892.70 (45)

If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

For community heating include distribution loss whether or not hot water tank is present

Distribution loss 0.15 x (45)m

(46)m	29.43	25.74	26.57	23.16	22.22	19.18	17.77	20.39	20.63	24.05	26.25	28.51	(46)

Water storage loss:

b) If manufacturer's declared cylinder loss factor is not known:

Cylinder volume (litres) including any solar storage within same cylinder	110.00	(50)
If community heating and no tank in dwelling, enter 110 litres in box (50)		
Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in box (50)		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.02	(51)
If community heating see SAP 2009 section 4.3		
Volume factor from Table 2a	1.03	(52)
Temperature factor from Table 2b	1.00	(53)
Energy lost from water storage, kWh/day (50) x (51) x (52) x (53)	1.72	(54)
Enter (49) or (54) in (55)	1.72	(55)

Water storage loss calculated for each month = (55) x (41)m

(56)m	53.36	48.19	53.36	51.64	53.36	51.64	53.36	53.36	51.64	53.36	51.64	53.36	(56)

If cylinder contains dedicated solar storage, = (56)m x [(50) - (H11)] ÷ (50), else = (56)m where (H11) is from Appendix H

(57)m	53.36	48.19	53.36	51.64	53.36	51.64	53.36	53.36	51.64	53.36	51.64	53.36	(57)

Primary circuit loss (annual) from Table 3 — 360.00 (58)

Primary circuit loss for each month (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58	(59)

Combi loss for each month from Table 3a, 3b or 3c (enter '0' if not a combi boiler)

(61)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)

Total heat required for water heating calculated for each month 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m	280.16	247.44	261.04	235.63	232.09	209.07	202.40	219.87	218.79	244.25	256.23	273.97	(62)

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRS and/or WWHRS applies, see Appendix G)

(63)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

∑(63)1...12 = 0.00 (63)

Output from water heater for each month, kWh/month (62)m + (63)m

(64)m	280.16	247.44	261.04	235.63	232.09	209.07	202.40	219.87	218.79	244.25	256.23	273.97

∑(64)1...12 = 2880.94 (64)

if (64)m < 0 then set to 0

Heat gains from water heating, kWh/month 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m]

(65)m	132.39	117.71	126.03	116.32	116.41	107.49	106.54	112.35	110.72	120.45	123.17	130.33	(65)

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5), Watts													
(66)m	216.78	216.78	216.78	216.78	216.78	216.78	216.78	216.78	216.78	216.78	216.78	216.78	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m	228.20	202.69	164.84	124.79	93.28	78.75	85.10	110.61	148.46	188.51	220.01	234.54	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m	1068.53	1079.62	1051.68	992.19	917.11	846.53	799.39	788.30	816.24	875.73	950.81	1021.39	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m	60.29	60.29	60.29	60.29	60.29	60.29	60.29	60.29	60.29	60.29	60.29	60.29	(69)
Pumps and fans gains (Table 5a)													
(70)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(70)
Losses e.g. evaporation (negative values) (Table 5)													
(71)m	-144.52	-144.52	-144.52	-144.52	-144.52	-144.52	-144.52	-144.52	-144.52	-144.52	-144.52	-144.52	(71)
Water heating gains (Table 5)													
(72)m	177.95	175.17	169.40	161.55	156.46	149.29	143.19	151.00	153.78	161.90	171.07	175.18	(72)

Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

(73)m	1607.23	1590.02	1518.46	1411.09	1299.40	1207.13	1160.23	1182.46	1251.03	1358.68	1474.44	1563.66	(73)

6. Solar gains

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

Rows (74) to (82) are used 12 times, one for each month, repeating as needed if there is more than one window type.

Details for month of January and annual totals are shown below:

	Access factor Table 6d		Area m²		Solar flux W/m²		g Specific data or Table 6b		FF Specific data or Table 6c		Gains (W)	
West	0.77	x	10.00	x	19.87	x	0.53	x	1.00	=	81.10	(80)

Solar gains in watts, calculated for each month ∑(74)m...(82)m

(83)m	81.10	157.19	251.25	373.04	453.89	473.61	459.69	400.08	300.38	191.43	100.83	66.90	(83)

Total gains - internal and solar (73)m + (83)m

(84)m	1688.33	1747.22	1769.71	1784.13	1753.29	1680.73	1619.92	1582.54	1551.41	1550.11	1575.27	1630.56	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(˚C) 21.00 (85)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains for living area, η1,m (see Table 9a)													
(86)m	1.00	1.00	0.99	0.99	0.97	0.92	0.78	0.79	0.95	0.99	1.00	1.00	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)													
(87)m	19.52	19.61	19.84	20.08	20.43	20.74	20.92	20.92	20.67	20.26	19.80	19.56	(87)
Temperature during heating periods in the living area from Table 9, Th2(˚C)													
(88)m	20.48	20.48	20.48	20.48	20.48	20.48	20.48	20.48	20.48	20.48	20.48	20.48	(88)
Utilisation factor for gains for rest of dwelling η2,m (see Table 9a)													
(89)m	1.00	1.00	0.99	0.99	0.97	0.90	0.72	0.73	0.93	0.98	1.00	1.00	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)													
(90)m	18.41	18.53	18.87	19.22	19.74	20.17	20.41	20.41	20.08	19.49	18.82	18.46	(90)

Living area fraction fLA 56.00 ÷ (4) = 0.08 (91)

Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2

(92)m	18.50	18.62	18.95	19.30	19.79	20.22	20.46	20.45	20.13	19.55	18.90	18.55	(92)

Apply adjustment to the mean internal temperature from Table 4e, where appropriate

(93)m	18.50	18.62	18.95	19.30	19.79	20.22	20.46	20.45	20.13	19.55	18.90	18.55	(93)

8. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that tim = (93)m and recalculate the utilisation factor for gains using Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ?m													
(94)m	0.99	0.99	0.99	0.98	0.96	0.89	0.71	0.72	0.92	0.98	0.99	1.00	(94)
Useful gains, ?mGm, W = (94)m x (84)m													
(95)m	1679.66	1735.82	1750.95	1751.71	1676.81	1487.87	1155.92	1146.06	1423.32	1516.32	1563.64	1622.49	(95)
Monthly average external temperature from Table 8													
(96)m	4.50	5.00	6.80	8.70	11.70	14.60	16.90	16.90	14.30	10.80	7.00	4.90	(96)
Heat loss rate for mean internal temperature, Lm, W													
(97)m	5151.75	5000.62	4459.48	3872.12	2950.55	2044.88	1292.78	1291.15	2126.19	3198.15	4357.58	5010.66	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m - (95)m] x (41)m													
(98)m	2583.23	2193.95	2015.15	1526.69	947.66	0.00	0.00	0.00	0.00	1251.28	2011.63	2520.80	

Total per year (kWh/year) = ∑(98)1...5, 10...12 = 15050.39 (98)

Space heating requirement in kWh/m²/year (98) ÷ (4) 22.46 (99)

9b. Energy requirements - Community heating scheme

Fraction of space heating from secondary/supplementary system (Table 11) 0.00 (301)

Fraction of space heating from community system 1 - (301)	1.00	(302)
Community scheme fractions obtained from plant design specification or operational records:		
Fraction of community DHW from CHP	0.60	(303a)
Fraction of community DHW from boilers	0.40	(303b)
Fraction of total space heat from community CHP (302) x (303a) =	0.60	(304a)
Fraction of total space heat from community boilers (302) x (303b) =	0.40	(304b)
Factor for control and charging method (Table 4c(3)) for community space heating	1.00	(305)
Factor for control and charging method (Table 4c(3)) for community water heating	1.00	(305a)
Distribution loss factor (Table 12c) for community heating system	0.10	(306)

Space heating:			**kWh/year**	
Annual space heating requirement			15050.39	
Space heat from community CHP (98) x (304a) x (305) x (306) =	903.02	(307a)		
Space heat from community boilers (98) x (304b) x (305) x (306) =	602.02	(307b)		
Water heating:				
Annual water heating requirement			2880.94	
If DHW from community scheme:				
Community DHW: CHP fuel use (64) x (303a) x (305a) x (306) =	172.86	(310a)		
Community DHW: boilers fuel use (64) x (303b) x (305a) x (306) =	115.24	(310b)		
Electricity used for heat distribution		0.01 x [(307a)...(307e) + (310a)...(310e)] =	17.93	(313)
Electricity for pumps and fans within dwelling (Table 4f):				
mechanical ventilation fans - balanced, extract or positive input from outside	0.00			(330a)
warm air heating system fans	0.00			(330b)
pump for solar water heating	0.00			(330g)
Total electricity for the above, kWh/year		(330a) + (330b) + (330g) =	0.00	(331)
Electricity for lighting (calculated in Appendix L):			1612.04	(332)

10b. Fuel costs - Community heating scheme

	Heat or fuel kWh/year		Fuel price (Table 12)		Fuel cost £/year	
Space heating from community CHP	903.02	x	2.65	x 0.01 =	23.93	(340a)
Space heating from community boilers	602.02	x	3.78	x 0.01 =	22.76	(340b)
Water heating from community CHP	172.86	x	2.65	x 0.01 =	4.58	(342a)
Water heating from community boilers	115.24	x	3.78	x 0.01 =	4.36	(342b)
Pumps and fans	0.00	x	11.46	x 0.01 =	0.00	(349)
Electricity for lighting	1612.04	x	11.46	x 0.01 =	184.74	(350)
Additional standing charges (Table 12)					106.00	(351)
Total energy cost				(340a)...(342e) + (345)...(354)	346.36	(355)

11b. SAP rating - Community heating scheme

Energy cost deflator (Table 12)		0.47	(356)
Energy cost factor (ECF)	[(355) x (356)] ÷ [(4) + 45.0] =	0.23	(357)
SAP value		96.82	
SAP rating		97	(358)
SAP band		A	

12b. Carbon dioxide emissions - Community heating scheme

Emissions from community CHP (Mains gas)

Efficiency of CHP (%)	75.00	(359)

Heat to power ratio			3.00			(360)
	Energy kWh/year		Emissions Factor		Emissions (kgCO2/year)	
Space heating from CHP (Mains gas)	1605.38	x	0.198	=	317.86	(363)
less credit emissions for electricity	-301.01	x	0.529	=	-159.23	(364)
Water heating from CHP (Mains gas)	307.30	x	0.198	=	60.85	(365)
less credit emissions for electricity	-57.62	x	0.529	=	-30.48	(366)

Emissions from other community sources (not CHP)

Efficiency of boilers (%)			75.00 (367b)			
	Energy used kWh/year		Emission Factor (kgCO2/kWh)		Emissions (kgCO2/year)	
Emissions from boilers (Mains gas)	956.34	x	0.198	=	189.35	(368)
Electrical energy for heat distribution	17.93	x	0.517	=	9.27	(372)
Total carbon dioxide from community systems			(363)...(366) + (368)...(372) =		387.62	(373)
Space and water heating			(373) + (374) + (375) =		387.62	(376)
Electricity for pumps and fans within dwelling	0.00	x	0.000	=	0.00	(378)
Electricity for lighting	1612.04	x	0.517	=	833.43	(379)
Total carbon dioxide emissions			∑(376)...(382) =		1221.05	(383)
Dwelling carbon dioxide emissions rate			(383) ÷ (4) =		1.82	(384)
EI value					97.71	
EI rating (see section 14)					98	(385)
EI band					A	

13b. Primary energy - Community heating scheme

Primary energy from community CHP (Mains gas)

Efficiency of CHP (%)			75.00			(359*)
Heat to power ratio			3.00			(360*)
	Energy kWh/year		Primary Energy Factor		Primary Energy	
Space heating from CHP (Mains gas)	1605.38	x	1.02	=	1637.48	(363*)
less credit emissions for electricity	-301.01	x	2.92	=	-878.94	(364*)
Water heating from CHP (Mains gas)	307.30	x	1.02	=	313.45	(365*)
less credit emissions for electricity	-57.62	x	2.92	=	-168.25	(366*)

Primary energy from other community sources (not CHP)

Efficiency of boilers (%)			75.00 (367b*)			
	Energy used kWh/year		Primary Energy Factor		Primary Energy	
Primary energy - boilers (Mains gas)	956.34	x	1.02	=	975.46	(368*)
Electrical energy for heat distribution	17.93	x	2.92	=	52.36	(372*)
Total primary energy from community systems			(363*)...(366*) + (368*)...(372*) =		1931.56	(373*)
Space and water heating			(373*) + (374*) + (375*) =		1931.56	(376*)
Electricity for pumps and fans within dwelling	0.00	x	0.00	=	0.00	(378*)
Electricity for lighting	1612.04	x	2.92	=	4707.16	(379*)
Total primary energy kWh/year			∑(376*)...(382*) =		6638.73	(383*)
Primary energy kWh/m2/year			(383*) ÷ (4) =		9.91	(384*)

SAP 2009 Worksheet

This design submission has been carried out by an Authorised SAP Assessor. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name		Assessor number	
Client		Last modified	14/11/2011
Address	17 65 Maygrove Road, West Hampstead, London, NW6 2EH		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		54.00	(1a)	x	2.85	(2a)	=	153.90	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	54.00	(4)						
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =			153.90	(5)

2. Ventilation rate

			m³ per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	2	x 10 =	20	(7a)
Number of passive vents	2	x 10 =	20	(7b)
Number of flueless gas fires	0	x 40 =	0	(7c)

				Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) =	40	÷ (5) =	0.26	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		3.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.41	(18)

Air permeability value applies if a pressurisation test has been done, or a design or specified air permeability is being used

Number of sides on which dwelling is sheltered		4	(19)
Shelter factor	1 - [0.075 x (19)] =	0.70	(20)
Adjusted infiltration rate	(18) x (20) =	0.29	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table 7 (22)m	5.40	5.10	5.10	4.50	4.10	3.90	3.70	3.70	4.20	4.50	4.80	5.10
Wind Factor (22a)m = (22)m ÷ 4 (22a)m	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.20	1.27
Adjusted infiltration rate (allowing for shelter and wind speed) = (21) × (22a)m (22b)m	0.39	0.37	0.37	0.32	0.29	0.28	0.27	0.27	0.30	0.32	0.34	0.37

∑(22)1...12 =	54.10	(22)
∑(22a)1...12 =	13.52	(22a)
∑(22b)1...12 =	3.88	(22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	N/A	(23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)), otherwise (23b) = (23a)	N/A	(23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = N/A (23c)

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m ≥ 1, then (24d)m = (22b)m; otherwise (24d)m = 0.5 + [(22b)m2 x 0.5]

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(24d)m	0.58	0.57	0.57	0.55	0.54	0.54	0.54	0.54	0.55	0.55	0.56	0.57	(24d)

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in box (25)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(25)m	0.58	0.57	0.57	0.55	0.54	0.54	0.54	0.54	0.55	0.55	0.56	0.57	(25)

3. Heat losses and heat loss parameter

The κ-value is the heat capacity per unit area, see Table 1e.

Element	Gross Area, m²	Openings, m²	Net area A, m²		U-value, W/m²K		A x U, W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Window*			10.00	x	1.42	=	14.15	N/A	N/A	(27)
External wall			10.52	x	0.20	=	2.10	N/A	N/A	(29a)
Total area of external elements ∑A, m²			20.52 (31)							

** for windows and roof windows, effective window U-value is calculated using formula 1/[(1/UValue)+0.04] paragraph 3.2*

Fabric heat loss, W/K = ∑(A × U) (26)...(30) + (32) = 16.25 (33)

Heat capacity Cm = ∑(A x κ) (28)...(30) + (32) + (32a)...(32e) = N/A (34)

Thermal mass parameter (TMP) in kJ/m²K Calculated separately = 100.00 (35)

Thermal bridges: ∑(L x Ψ) calculated using Appendix K 3.08 (36)

if details of thermal bridging are not known then (36) = 0.15 x (31)

Total fabric heat loss (33) + (36) = 19.33 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	29.20	28.79	28.79	28.04	27.59	27.38	27.18	27.18	27.70	28.04	28.40	28.79	(38)

Heat transfer coefficient, W/K (37)m + (38)m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(39)m	48.54	48.13	48.13	47.37	46.92	46.71	46.52	46.52	47.03	47.37	47.74	48.13

Average = ∑(39)1...12/12 = 47.42 (39)

Heat loss parameter (HLP), W/m²K (39)m ÷ (4)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(40)m	0.90	0.89	0.89	0.88	0.87	0.87	0.86	0.86	0.87	0.88	0.88	0.89

Average = ∑(40)1...12/12 = 0.88 (40)

4. Water heating energy requirement

kWh/year

Assumed occupancy, N 1.81 (42)

If TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA - 13.9)²)] + 0.0013 x (TFA - 13.9)

If TFA ≤ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 77.14 (43)

Annual average hot water usage has been reduced by 5% if the dwelling is designed to achieve a water use target of not more than 125 litres per person per day (all water use, hot and cold)

Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(44)m	84.85	81.77	78.68	75.60	72.51	69.43	69.43	72.51	75.60	78.68	81.77	84.85

∑(44)1...12 = 925.68 (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(45)m	126.14	110.32	113.84	99.25	95.23	82.18	76.15	87.38	88.43	103.05	112.49	122.16

∑(45)1...12 = 1216.62 (45)

If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

For community heating include distribution loss whether or not hot water tank is present

Distribution loss 0.15 x (45)m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(46)m	18.92	16.55	17.08	14.89	14.28	12.33	11.42	13.11	13.26	15.46	16.87	18.32	(46)

Water storage loss:

b) If manufacturer's declared cylinder loss factor is not known:

Cylinder volume (litres) including any solar storage within same cylinder	110.00	(50)
If community heating and no tank in dwelling, enter 110 litres in box (50)		
Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in box (50)		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.02	(51)
If community heating see SAP 2009 section 4.3		
Volume factor from Table 2a	1.03	(52)
Temperature factor from Table 2b	1.00	(53)
Energy lost from water storage, kWh/day (50) x (51) x (52) x (53)	1.72	(54)
Enter (49) or (54) in (55)	1.72	(55)

Water storage loss calculated for each month = (55) x (41)m

(56)m	53.36	48.19	53.36	51.64	53.36	51.64	53.36	53.36	51.64	53.36	51.64	53.36	(56)

If cylinder contains dedicated solar storage, = (56)m x [(50) - (H11)] ÷ (50), else = (56)m where (H11) is from Appendix H

(57)m	53.36	48.19	53.36	51.64	53.36	51.64	53.36	53.36	51.64	53.36	51.64	53.36	(57)

Primary circuit loss (annual) from Table 3 — 360.00 (58)

Primary circuit loss for each month (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58	(59)

Combi loss for each month from Table 3a, 3b or 3c (enter '0' if not a combi boiler)

(61)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)

Total heat required for water heating calculated for each month 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m	210.07	186.13	197.77	180.47	179.16	163.40	160.08	171.32	169.65	186.99	193.72	206.09	(62)

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRS and/or WWHRS applies, see Appendix G)

(63)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	

∑(63)1...12 = 0.00 (63)

Output from water heater for each month, kWh/month (62)m + (63)m

(64)m	210.07	186.13	197.77	180.47	179.16	163.40	160.08	171.32	169.65	186.99	193.72	206.09	

∑(64)1...12 = 2204.86 (64)

if (64)m < 0 then set to 0

Heat gains from water heating, kWh/month 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m]

(65)m	109.09	97.33	105.00	97.98	98.81	92.30	92.47	96.20	94.38	101.41	102.38	107.76	(65)

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5), Watts													
(66)m	108.48	108.48	108.48	108.48	108.48	108.48	108.48	108.48	108.48	108.48	108.48	108.48	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m	35.72	31.73	25.80	19.53	14.60	12.33	13.32	17.31	23.24	29.51	34.44	36.71	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m	235.23	237.67	231.52	218.43	201.90	186.36	175.98	173.54	179.69	192.79	209.32	224.85	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m	47.66	47.66	47.66	47.66	47.66	47.66	47.66	47.66	47.66	47.66	47.66	47.66	(69)
Pumps and fans gains (Table 5a)													
(70)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(70)
Losses e.g. evaporation (negative values) (Table 5)													
(71)m	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	(71)
Water heating gains (Table 5)													
(72)m	146.62	144.84	141.13	136.08	132.81	128.20	124.28	129.30	131.09	136.31	142.20	144.84	(72)

Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

(73)m	501.39	498.05	482.27	457.86	433.12	410.70	397.40	403.97	417.83	442.41	469.77	490.22	(73)

6. Solar gains

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

Rows (74) to (82) are used 12 times, one for each month, repeating as needed if there is more than one window type.

Details for month of January and annual totals are shown below:

	Access factor Table 6d		Area m²		Solar flux W/m²		g Specific data or Table 6b		FF Specific data or Table 6c		Gains (W)	
South	0.77	x	10.00	x	47.32	x	0.53	x	1.00	=	193.13	(78)

Solar gains in watts, calculated for each month ∑(74)m...(82)m

(83)m	193.13	314.98	384.62	428.97	442.99	444.41	437.23	423.95	408.06	348.08	228.82	166.87	(83)

Total gains - internal and solar (73)m + (83)m

(84)m	694.52	813.04	866.88	886.83	876.12	855.12	834.63	827.92	825.90	790.49	698.59	657.10	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(˚C) 21.00 (85)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains for living area, η1,m (see Table 9a)													
(86)m	0.80	0.73	0.66	0.58	0.47	0.34	0.23	0.23	0.37	0.55	0.74	0.81	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)													
(87)m	20.12	20.37	20.59	20.76	20.90	20.97	20.99	20.99	20.96	20.83	20.45	20.13	(87)
Temperature during heating periods in the living area from Table 9, Th2(˚C)													
(88)m	20.17	20.18	20.18	20.19	20.20	20.20	20.20	20.20	20.19	20.19	20.18	20.18	(88)
Utilisation factor for gains for rest of dwelling η2,m (see Table 9a)													
(89)m	0.79	0.71	0.63	0.55	0.43	0.30	0.18	0.18	0.33	0.52	0.71	0.80	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)													
(90)m	19.03	19.37	19.67	19.90	20.09	20.17	20.20	20.20	20.16	20.00	19.49	19.04	(90)

Living area fraction fLA 54.00 ÷ (4) = 1.00 (91)

Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2													
(92)m	20.12	20.37	20.59	20.76	20.90	20.97	20.99	20.99	20.96	20.83	20.45	20.13	(92)
Apply adjustment to the mean internal temperature from Table 4e, where appropriate													
(93)m	20.12	20.37	20.59	20.76	20.90	20.97	20.99	20.99	20.96	20.83	20.45	20.13	(93)

8. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that tim = (93)m and recalculate the utilisation factor for gains using Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, □m													
(94)m	0.79	0.72	0.65	0.57	0.46	0.34	0.23	0.23	0.37	0.54	0.72	0.79	(94)
Useful gains, □mGm, W = (94)m x (84)m													
(95)m	545.72	583.77	560.69	509.38	406.61	290.57	189.07	189.03	303.85	430.73	505.00	521.88	(95)
Monthly average external temperature from Table 8													
(96)m	4.50	5.00	6.80	8.70	11.70	14.60	16.90	16.90	14.30	10.80	7.00	4.90	(96)
Heat loss rate for mean internal temperature, Lm, W													
(97)m	758.27	739.69	663.78	571.29	431.88	297.72	190.47	190.47	313.43	475.10	641.84	732.74	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m - (95)m] x (41)m													
(98)m	158.14	104.78	76.70	44.57	18.80	0.00	0.00	0.00	0.00	33.01	98.52	156.87	

Total per year (kWh/year) = ∑(98)1...5, 10...12 = 691.39 (98)

Space heating requirement in kWh/m²/year (98) ÷ (4) 12.80 (99)

9b. Energy requirements - Community heating scheme

Fraction of space heating from secondary/supplementary system (Table 11) 0.00 (301)

Fraction of space heating from community system 1 - (301)	1.00	(302)		
Community scheme fractions obtained from plant design specification or operational records:				
Fraction of community DHW from CHP	0.60	(303a)		
Fraction of community DHW from boilers	0.40	(303b)		
Fraction of total space heat from community CHP (302) x (303a) =	0.60	(304a)		
Fraction of total space heat from community boilers (302) x (303b) =	0.40	(304b)		
Factor for control and charging method (Table 4c(3)) for community space heating	1.00	(305)		
Factor for control and charging method (Table 4c(3)) for community water heating	1.00	(305a)		
Distribution loss factor (Table 12c) for community heating system	0.10	(306)		
Space heating:			**kWh/year**	
Annual space heating requirement			691.39	
Space heat from community CHP (98) x (304a) x (305) x (306) =	41.48	(307a)		
Space heat from community boilers (98) x (304b) x (305) x (306) =	27.66	(307b)		
Water heating:				
Annual water heating requirement			2204.86	
If DHW from community scheme:				
Community DHW: CHP fuel use (64) x (303a) x (305a) x (306) =	132.29	(310a)		
Community DHW: boilers fuel use (64) x (303b) x (305a) x (306) =	88.19	(310b)		
Electricity used for heat distribution	0.01 x [(307a)...(307e) + (310a)...(310e)] =		2.90	(313)
Electricity for pumps and fans within dwelling (Table 4f):				
mechanical ventilation fans - balanced, extract or positive input from outside	0.00			(330a)
warm air heating system fans	0.00			(330b)
pump for solar water heating	0.00			(330g)
Total electricity for the above, kWh/year	(330a) + (330b) + (330g) =		0.00	(331)
Electricity for lighting (calculated in Appendix L):			252.33	(332)

10b. Fuel costs - Community heating scheme

	Heat or fuel kWh/year		Fuel price (Table 12)		Fuel cost £/year	
Space heating from community CHP	41.48	x	2.65	x 0.01 =	1.10	(340a)
Space heating from community boilers	27.66	x	3.78	x 0.01 =	1.05	(340b)
Water heating from community CHP	132.29	x	2.65	x 0.01 =	3.51	(342a)
Water heating from community boilers	88.19	x	3.78	x 0.01 =	3.33	(342b)
Pumps and fans	0.00	x	11.46	x 0.01 =	0.00	(349)
Electricity for lighting	252.33	x	11.46	x 0.01 =	28.92	(350)
Additional standing charges (Table 12)					106.00	(351)
Total energy cost				(340a)...(342e) + (345)...(354)	143.90	(355)

11b. SAP rating - Community heating scheme

Energy cost deflator (Table 12)		0.47	(356)
Energy cost factor (ECF)	[(355) x (356)] ÷ [(4) + 45.0] =	0.68	(357)
SAP value		90.47	
SAP rating		90	(358)
SAP band		B	

12b. Carbon dioxide emissions - Community heating scheme

Emissions from community CHP (Mains gas)

Efficiency of CHP (%)	75.00	(359)

Heat to power ratio				3.00		(360)
	Energy kWh/year		**Emissions Factor**		**Emissions (kgCO2/year)**	
Space heating from CHP (Mains gas)	73.75	x	0.198	=	14.60	(363)
less credit emissions for electricity	-13.83	x	0.529	=	-7.31	(364)
Water heating from CHP (Mains gas)	235.18	x	0.198	=	46.57	(365)
less credit emissions for electricity	-44.10	x	0.529	=	-23.33	(366)
Emissions from other community sources (not CHP)						
Efficiency of boilers (%)			75.00	(367b)		
	Energy used kWh/year		**Emission Factor (kgCO2/kWh)**		**Emissions (kgCO2/year)**	
Emissions from boilers (Mains gas)	154.47	x	0.198	=	30.58	(368)
Electrical energy for heat distribution	2.90	x	0.517	=	1.50	(372)
Total carbon dioxide from community systems			(363)...(366) + (368)...(372) =		62.61	(373)
Space and water heating			(373) + (374) + (375) =		62.61	(376)
Electricity for pumps and fans within dwelling	0.00	x	0.000	=	0.00	(378)
Electricity for lighting	252.33	x	0.517	=	130.46	(379)
Total carbon dioxide emissions			∑(376)...(382) =		193.07	(383)
Dwelling carbon dioxide emissions rate			(383) ÷ (4) =		3.58	(384)
EI value					97.39	
EI rating (see section 14)					97	(385)
EI band					A	

13b. Primary energy - Community heating scheme

Primary energy from community CHP (Mains gas)						
Efficiency of CHP (%)				75.00		(359*)
Heat to power ratio				3.00		(360*)
	Energy kWh/year		**Primary Energy Factor**		**Primary Energy**	
Space heating from CHP (Mains gas)	73.75	x	1.02	=	75.22	(363*)
less credit emissions for electricity	-13.83	x	2.92	=	-40.38	(364*)
Water heating from CHP (Mains gas)	235.18	x	1.02	=	239.89	(365*)
less credit emissions for electricity	-44.10	x	2.92	=	-128.76	(366*)
Primary energy from other community sources (not CHP)						
Efficiency of boilers (%)			75.00	(367b*)		
	Energy used kWh/year		**Primary Energy Factor**		**Primary Energy**	
Primary energy - boilers (Mains gas)	154.47	x	1.02	=	157.56	(368*)
Electrical energy for heat distribution	2.90	x	2.92	=	8.46	(372*)
Total primary energy from community systems			(363*)...(366*) + (368*)...(372*) =		311.98	(373*)
Space and water heating			(373*) + (374*) + (375*) =		311.98	(376*)
Electricity for pumps and fans within dwelling	0.00	x	0.00	=	0.00	(378*)
Electricity for lighting	252.33	x	2.92	=	736.82	(379*)
Total primary energy kWh/year			∑(376*)...(382*) =		1048.80	(383*)
Primary energy kWh/m2/year			(383*) ÷ (4) =		19.42	(384*)

SAP 2009 Worksheet

NHER

This design submission has been carried out by an Authorised SAP Assessor. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name		Assessor number	
Client		Last modified	15/11/2011
Address	28 65 Maygrove Road, West Hampstead, London, NW6 2EH		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		54.00	(1a)	x	2.85	(2a)	=	153.90	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	54.00	(4)						
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =			153.90	(5)

2. Ventilation rate

			m³ per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	2	x 10 =	20	(7a)
Number of passive vents	2	x 10 =	20	(7b)
Number of flueless gas fires	0	x 40 =	0	(7c)
			Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs (6a) + (6b) + (7a) + (7b) + (7c) =	40	÷ (5) =	0.26	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		3.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.41	(18)

Air permeability value applies if a pressurisation test has been done, or a design or specified air permeability is being used

Number of sides on which dwelling is sheltered		4	(19)
Shelter factor	1 - [0.075 x (19)] =	0.70	(20)
Adjusted infiltration rate	(18) x (20) =	0.29	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table 7 (22)m	5.40	5.10	5.10	4.50	4.10	3.90	3.70	3.70	4.20	4.50	4.80	5.10

∑(22)1...12 = 54.10 (22)

Wind Factor (22a)m = (22)m ÷ 4

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(22a)m	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.20	1.27

∑(22a)1...12 = 13.52 (22a)

Adjusted infiltration rate (allowing for shelter and wind speed) = (21) × (22a)m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(22b)m	0.39	0.37	0.37	0.32	0.29	0.28	0.27	0.27	0.30	0.32	0.34	0.37

∑(22b)1...12 = 3.88 (22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	N/A	(23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)), otherwise (23b) = (23a)	N/A	(23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = N/A (23c)

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m ≥ 1, then (24d)m = (22b)m; otherwise (24d)m = 0.5 + [(22b)m2 x 0.5]

(24d)m	0.58	0.57	0.57	0.55	0.54	0.54	0.54	0.54	0.55	0.55	0.56	0.57	(24d)

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in box (25)

(25)m	0.58	0.57	0.57	0.55	0.54	0.54	0.54	0.54	0.55	0.55	0.56	0.57	(25)

3. Heat losses and heat loss parameter

The κ-value is the heat capacity per unit area, see Table 1e.

Element	Gross Area, m²	Openings, m²	Net area A, m²		U-value, W/m²K		A x U, W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Window*			10.00	x	1.42	=	14.15	N/A	N/A	(27)
External wall			9.95	x	0.20	=	1.99	N/A	N/A	(29a)
Total area of external elements ∑A, m²			19.95 (31)							

** for windows and roof windows, effective window U-value is calculated using formula 1/[(1/UValue)+0.04] paragraph 3.2*

Fabric heat loss, W/K = ∑(A × U) (26)...(30) + (32) = 16.14 (33)

Heat capacity Cm = ∑(A x κ) (28)...(30) + (32) + (32a)...(32e) = N/A (34)

Thermal mass parameter (TMP) in kJ/m²K Calculated separately = 100.00 (35)

Thermal bridges: ∑(L x Ψ) calculated using Appendix K 2.99 (36)

if details of thermal bridging are not known then (36) = 0.15 x (31)

Total fabric heat loss (33) + (36) = 19.13 (37)

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

(38)m	29.20	28.79	28.79	28.04	27.59	27.38	27.18	27.18	27.70	28.04	28.40	28.79	(38)

Heat transfer coefficient, W/K (37)m + (38)m

(39)m	48.34	47.93	47.93	47.17	46.72	46.51	46.32	46.32	46.83	47.17	47.54	47.93

Average = ∑(39)1...12/12 = 47.22 (39)

Heat loss parameter (HLP), W/m²K (39)m ÷ (4)

(40)m	0.90	0.89	0.89	0.87	0.87	0.86	0.86	0.86	0.87	0.87	0.88	0.89

Average = ∑(40)1...12/12 = 0.87 (40)

4. Water heating energy requirement

kWh/year

Assumed occupancy, N 1.81 (42)

If TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA - 13.9)²)] + 0.0013 x (TFA - 13.9)

If TFA ≤ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 77.14 (43)

Annual average hot water usage has been reduced by 5% if the dwelling is designed to achieve a water use target of not more than 125 litres per person per day (all water use, hot and cold)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)													
(44)m	84.85	81.77	78.68	75.60	72.51	69.43	69.43	72.51	75.60	78.68	81.77	84.85	
											∑(44)1...12 =	925.68	(44)
Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)													
(45)m	126.14	110.32	113.84	99.25	95.23	82.18	76.15	87.38	88.43	103.05	112.49	122.16	
											∑(45)1...12 =	1216.62	(45)

If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

For community heating include distribution loss whether or not hot water tank is present

Distribution loss 0.15 x (45)m

(46)m	18.92	16.55	17.08	14.89	14.28	12.33	11.42	13.11	13.26	15.46	16.87	18.32	(46)

Water storage loss:

b) If manufacturer's declared cylinder loss factor is not known:

Cylinder volume (litres) including any solar storage within same cylinder | 110.00 | (50)

If community heating and no tank in dwelling, enter 110 litres in box (50)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in box (50)

Hot water storage loss factor from Table 2 (kWh/litre/day) | 0.02 | (51)

If community heating see SAP 2009 section 4.3

Volume factor from Table 2a | 1.03 | (52)

Temperature factor from Table 2b | 1.00 | (53)

Energy lost from water storage, kWh/day (50) x (51) x (52) x (53) | 1.72 | (54)

Enter (49) or (54) in (55) | 1.72 | (55)

Water storage loss calculated for each month = (55) x (41)m

(56)m	53.36	48.19	53.36	51.64	53.36	51.64	53.36	53.36	51.64	53.36	51.64	53.36	(56)

If cylinder contains dedicated solar storage, = (56)m x [(50) - (H11)] ÷ (50), else = (56)m where (H11) is from Appendix H

(57)m	53.36	48.19	53.36	51.64	53.36	51.64	53.36	53.36	51.64	53.36	51.64	53.36	(57)

Primary circuit loss (annual) from Table 3 | 360.00 | (58)

Primary circuit loss for each month (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58	(59)

Combi loss for each month from Table 3a, 3b or 3c (enter '0' if not a combi boiler)

(61)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)

Total heat required for water heating calculated for each month 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m	210.07	186.13	197.77	180.47	179.16	163.40	160.08	171.32	169.65	186.99	193.72	206.09	(62)

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRS and/or WWHRS applies, see Appendix G)

(63)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	

∑(63)1...12 = | 0.00 | (63)

Output from water heater for each month, kWh/month (62)m + (63)m

(64)m	210.07	186.13	197.77	180.47	179.16	163.40	160.08	171.32	169.65	186.99	193.72	206.09	

∑(64)1...12 = | 2204.86 | (64)

if (64)m < 0 then set to 0

Heat gains from water heating, kWh/month 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m]

(65)m	109.09	97.33	105.00	97.98	98.81	92.30	92.47	96.20	94.38	101.41	102.38	107.76	(65)

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5), Watts													
(66)m	108.48	108.48	108.48	108.48	108.48	108.48	108.48	108.48	108.48	108.48	108.48	108.48	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m	35.72	31.73	25.80	19.53	14.60	12.33	13.32	17.31	23.24	29.51	34.44	36.71	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m	235.23	237.67	231.52	218.43	201.90	186.36	175.98	173.54	179.69	192.79	209.32	224.85	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m	47.66	47.66	47.66	47.66	47.66	47.66	47.66	47.66	47.66	47.66	47.66	47.66	(69)
Pumps and fans gains (Table 5a)													
(70)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(70)
Losses e.g. evaporation (negative values) (Table 5)													
(71)m	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	(71)
Water heating gains (Table 5)													
(72)m	146.62	144.84	141.13	136.08	132.81	128.20	124.28	129.30	131.09	136.31	142.20	144.84	(72)

Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

(73)m	501.39	498.05	482.27	457.86	433.12	410.70	397.40	403.97	417.83	442.41	469.77	490.22	(73)

6. Solar gains

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

Rows (74) to (82) are used 12 times, one for each month, repeating as needed if there is more than one window type.

Details for month of January and annual totals are shown below:

	Access factor Table 6d		Area m²		Solar flux W/m²		g Specific data or Table 6b		FF Specific data or Table 6c		Gains (W)	
South	0.77	x	10.00	x	47.32	x	0.53	x	1.00	=	193.13	(78)

Solar gains in watts, calculated for each month ∑(74)m...(82)m

(83)m	193.13	314.98	384.62	428.97	442.99	444.41	437.23	423.95	408.06	348.08	228.82	166.87	(83)

Total gains - internal and solar (73)m + (83)m

(84)m	694.52	813.04	866.88	886.83	876.12	855.12	834.63	827.92	825.90	790.49	698.59	657.10	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(˚C) 21.00 (85)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains for living area, η1,m (see Table 9a)													
(86)m	0.80	0.73	0.66	0.58	0.47	0.34	0.23	0.23	0.37	0.55	0.74	0.81	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)													
(87)m	20.13	20.38	20.60	20.76	20.91	20.97	20.99	20.99	20.97	20.83	20.45	20.13	(87)
Temperature during heating periods in the living area from Table 9, Th2(˚C)													
(88)m	20.17	20.18	20.18	20.19	20.20	20.20	20.20	20.20	20.20	20.19	20.19	20.18	(88)
Utilisation factor for gains for rest of dwelling η2,m (see Table 9a)													
(89)m	0.79	0.71	0.63	0.55	0.43	0.30	0.18	0.18	0.33	0.52	0.71	0.79	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)													
(90)m	19.05	19.39	19.68	19.91	20.10	20.18	20.20	20.20	20.16	20.00	19.50	19.06	(90)

Living area fraction fLA 54.00 ÷ (4) = 1.00 (91)

Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2													
(92)m	20.13	20.38	20.60	20.76	20.91	20.97	20.99	20.99	20.97	20.83	20.45	20.13	(92)
Apply adjustment to the mean internal temperature from Table 4e, where appropriate													
(93)m	20.13	20.38	20.60	20.76	20.91	20.97	20.99	20.99	20.97	20.83	20.45	20.13	(93)

8. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that tim = (93)m and recalculate the utilisation factor for gains using Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm													
(94)m	0.79	0.72	0.65	0.57	0.46	0.34	0.23	0.23	0.37	0.54	0.72	0.79	(94)
Useful gains, ηmGm, W = (94)m x (84)m													
(95)m	545.21	582.97	559.67	508.20	405.38	289.51	188.30	188.26	302.78	429.65	504.32	521.42	(95)
Monthly average external temperature from Table 8													
(96)m	4.50	5.00	6.80	8.70	11.70	14.60	16.90	16.90	14.30	10.80	7.00	4.90	(96)
Heat loss rate for mean internal temperature, Lm, W													
(97)m	755.57	736.98	661.30	569.07	430.13	296.48	189.66	189.66	312.14	473.23	639.47	730.11	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m - (95)m] x (41)m													
(98)m	156.51	103.49	75.61	43.83	18.42	0.00	0.00	0.00	0.00	32.43	97.31	155.26	

Total per year (kWh/year) = ∑(98)1...5, 10...12 = 682.85 (98)

Space heating requirement in kWh/m²/year (98) ÷ (4) 12.65 (99)

9b. Energy requirements - Community heating scheme

Fraction of space heating from secondary/supplementary system (Table 11) 0.00 (301)

Fraction of space heating from community system 1 - (301)	1.00	(302)		
Community scheme fractions obtained from plant design specification or operational records:				
Fraction of community DHW from CHP	0.60	(303a)		
Fraction of community DHW from boilers	0.40	(303b)		
Fraction of total space heat from community CHP (302) x (303a) =	0.60	(304a)		
Fraction of total space heat from community boilers (302) x (303b) =	0.40	(304b)		
Factor for control and charging method (Table 4c(3)) for community space heating	1.00	(305)		
Factor for control and charging method (Table 4c(3)) for community water heating	1.00	(305a)		
Distribution loss factor (Table 12c) for community heating system	0.10	(306)		
Space heating:			**kWh/year**	
Annual space heating requirement			682.85	
Space heat from community CHP (98) x (304a) x (305) x (306) =	40.97	(307a)		
Space heat from community boilers (98) x (304b) x (305) x (306) =	27.31	(307b)		
Water heating:				
Annual water heating requirement			2204.86	
If DHW from community scheme:				
Community DHW: CHP fuel use (64) x (303a) x (305a) x (306) =	132.29	(310a)		
Community DHW: boilers fuel use (64) x (303b) x (305a) x (306) =	88.19	(310b)		
Electricity used for heat distribution	0.01 x [(307a)...(307e) + (310a)...(310e)] =		2.89	(313)
Electricity for pumps and fans within dwelling (Table 4f):				
mechanical ventilation fans - balanced, extract or positive input from outside	0.00			(330a)
warm air heating system fans	0.00			(330b)
pump for solar water heating	0.00			(330g)
Total electricity for the above, kWh/year	(330a) + (330b) + (330g) =		0.00	(331)
Electricity for lighting (calculated in Appendix L):			252.33	(332)

10b. Fuel costs - Community heating scheme

	Heat or fuel kWh/year		Fuel price (Table 12)		Fuel cost £/year	
Space heating from community CHP	40.97	x	2.65	x 0.01 =	1.09	(340a)
Space heating from community boilers	27.31	x	3.78	x 0.01 =	1.03	(340b)
Water heating from community CHP	132.29	x	2.65	x 0.01 =	3.51	(342a)
Water heating from community boilers	88.19	x	3.78	x 0.01 =	3.33	(342b)
Pumps and fans	0.00	x	11.46	x 0.01 =	0.00	(349)
Electricity for lighting	252.33	x	11.46	x 0.01 =	28.92	(350)
Additional standing charges (Table 12)					106.00	(351)
Total energy cost				(340a)...(342e) + (345)...(354)	143.88	(355)

11b. SAP rating - Community heating scheme

Energy cost deflator (Table 12)		0.47	(356)
Energy cost factor (ECF)	[(355) x (356)] ÷ [(4) + 45.0] =	0.68	(357)
SAP value		90.47	
SAP rating		90	(358)
SAP band		B	

12b. Carbon dioxide emissions - Community heating scheme

Emissions from community CHP (Mains gas)

Efficiency of CHP (%)	75.00	(359)

Heat to power ratio					3.00	(360)

	Energy kWh/year		Emissions Factor		Emissions (kgCO2/year)	
Space heating from CHP (Mains gas)	72.84	x	0.198	=	14.42	(363)
less credit emissions for electricity	-13.66	x	0.529	=	-7.22	(364)
Water heating from CHP (Mains gas)	235.18	x	0.198	=	46.57	(365)
less credit emissions for electricity	-44.10	x	0.529	=	-23.33	(366)

Emissions from other community sources (not CHP)

Efficiency of boilers (%)			75.00	(367b)		

	Energy used kWh/year		Emission Factor (kgCO2/kWh)		Emissions (kgCO2/year)	
Emissions from boilers (Mains gas)	154.01	x	0.198	=	30.49	(368)
Electrical energy for heat distribution	2.89	x	0.517	=	1.49	(372)
Total carbon dioxide from community systems			(363)...(366) + (368)...(372) =		62.42	(373)
Space and water heating			(373) + (374) + (375) =		62.42	(376)
Electricity for pumps and fans within dwelling	0.00	x	0.000	=	0.00	(378)
Electricity for lighting	252.33	x	0.517	=	130.46	(379)
Total carbon dioxide emissions			∑(376)...(382) =		192.88	(383)
Dwelling carbon dioxide emissions rate			(383) ÷ (4) =		3.57	(384)
EI value					97.39	
EI rating (see section 14)					97	(385)
EI band					A	

13b. Primary energy - Community heating scheme

Primary energy from community CHP (Mains gas)

Efficiency of CHP (%)					75.00	(359*)
Heat to power ratio					3.00	(360*)

	Energy kWh/year		Primary Energy Factor		Primary Energy	
Space heating from CHP (Mains gas)	72.84	x	1.02	=	74.29	(363*)
less credit emissions for electricity	-13.66	x	2.92	=	-39.88	(364*)
Water heating from CHP (Mains gas)	235.18	x	1.02	=	239.89	(365*)
less credit emissions for electricity	-44.10	x	2.92	=	-128.76	(366*)

Primary energy from other community sources (not CHP)

Efficiency of boilers (%)			75.00	(367b*)		

	Energy used kWh/year		Primary Energy Factor		Primary Energy	
Primary energy - boilers (Mains gas)	154.01	x	1.02	=	157.09	(368*)
Electrical energy for heat distribution	2.89	x	2.92	=	8.43	(372*)
Total primary energy from community systems			(363*)...(366*) + (368*)...(372*) =		311.06	(373*)
Space and water heating			(373*) + (374*) + (375*) =		311.06	(376*)
Electricity for pumps and fans within dwelling	0.00	x	0.00	=	0.00	(378*)
Electricity for lighting	252.33	x	2.92	=	736.82	(379*)
Total primary energy kWh/year			∑(376*)...(382*) =		1047.88	(383*)
Primary energy kWh/m2/year			(383*) ÷ (4) =		19.41	(384*)

SAP 2009 Worksheet

NHER

This design submission has been carried out by an Authorised SAP Assessor. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name		Assessor number	
Client		Last modified	15/11/2011
Address	47 65 Maygrove Road, West Hampstead, London, NW6 2EH		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		88.00	(1a)	x	2.85	(2a)	=	250.80	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	88.00	(4)						
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =			250.80	(5)

2. Ventilation rate

			m³ per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	3	x 10 =	30	(7a)
Number of passive vents	4	x 10 =	40	(7b)
Number of flueless gas fires	0	x 40 =	0	(7c)

				Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) =	70	÷ (5) =	0.28	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		3.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.43	(18)

Air permeability value applies if a pressurisation test has been done, or a design or specified air permeability is being used

Number of sides on which dwelling is sheltered		4	(19)
Shelter factor	1 - [0.075 x (19)] =	0.70	(20)
Adjusted infiltration rate	(18) x (20) =	0.30	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table 7												
(22)m	5.40	5.10	5.10	4.50	4.10	3.90	3.70	3.70	4.20	4.50	4.80	5.10

∑(22)1...12 = 54.10 (22)

Wind Factor (22a)m = (22)m ÷ 4

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(22a)m	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.20	1.27

∑(22a)1...12 = 13.52 (22a)

Adjusted infiltration rate (allowing for shelter and wind speed) = (21) × (22a)m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(22b)m	0.41	0.38	0.38	0.34	0.31	0.29	0.28	0.28	0.32	0.34	0.36	0.38

∑(22b)1...12 = 4.06 (22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	N/A	(23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)), otherwise (23b) = (23a)	N/A	(23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =	N/A	(23c)

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m ≥ 1, then (24d)m = (22b)m; otherwise (24d)m = 0.5 + [(22b)m2 x 0.5]

(24d)m	0.58	0.57	0.57	0.56	0.55	0.54	0.54	0.54	0.55	0.56	0.56	0.57	(24d)

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in box (25)

(25)m	0.58	0.57	0.57	0.56	0.55	0.54	0.54	0.54	0.55	0.56	0.56	0.57	(25)

3. Heat losses and heat loss parameter

The κ-value is the heat capacity per unit area, see Table 1e.

Element	Gross Area, m²	Openings, m²	Net area A, m²		U-value, W/m²K		A x U, W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Window*			18.00	x	1.42	=	25.47	N/A	N/A	(27)
External wall			73.05	x	0.20	=	14.61	N/A	N/A	(29a)
Total area of external elements ∑A, m²			91.05	(31)						

** for windows and roof windows, effective window U-value is calculated using formula 1/[(1/UValue)+0.04] paragraph 3.2*

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	40.08	(33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K	Calculated separately =	100.00	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		13.66	(36)

if details of thermal bridging are not known then (36) = 0.15 x (31)

Total fabric heat loss	(33) + (36) =	53.74	(37)

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

(38)m	48.19	47.45	47.45	46.11	45.30	44.93	44.58	44.58	45.50	46.11	46.76	47.45	(38)

Heat transfer coefficient, W/K (37)m + (38)m

(39)m	101.93	101.19	101.19	99.85	99.04	98.67	98.32	98.32	99.24	99.85	100.50	101.19	

Average = ∑(39)1...12/12 =	99.94	(39)

Heat loss parameter (HLP), W/m²K (39)m ÷ (4)

(40)m	1.16	1.15	1.15	1.13	1.13	1.12	1.12	1.12	1.13	1.13	1.14	1.15	

Average = ∑(40)1...12/12 =	1.14	(40)

4. Water heating energy requirement

	kWh/year	
Assumed occupancy, N	2.60	(42)

If TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA - 13.9)²)] + 0.0013 x (TFA - 13.9)

If TFA ≤ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	95.89	(43)

Annual average hot water usage has been reduced by 5% if the dwelling is designed to achieve a water use target of not more than 125 litres per person per day (all water use, hot and cold)

Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(44)m	105.48	101.64	97.80	93.97	90.13	86.30	86.30	90.13	93.97	97.80	101.64	105.48	

∑(44)1...12 =	1150.64	(44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)

(45)m	156.79	137.13	141.51	123.37	118.38	102.15	94.66	108.62	109.92	128.10	139.83	151.84	

∑(45)1...12 =	1512.28	(45)

If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

For community heating include distribution loss whether or not hot water tank is present

Distribution loss 0.15 x (45)m

(46)m	23.52	20.57	21.23	18.51	17.76	15.32	14.20	16.29	16.49	19.21	20.97	22.78	(46)

Water storage loss:

b) If manufacturer's declared cylinder loss factor is not known:

Cylinder volume (litres) including any solar storage within same cylinder	110.00	(50)
If community heating and no tank in dwelling, enter 110 litres in box (50)		
Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in box (50)		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.02	(51)
If community heating see SAP 2009 section 4.3		
Volume factor from Table 2a	1.03	(52)
Temperature factor from Table 2b	1.00	(53)
Energy lost from water storage, kWh/day (50) x (51) x (52) x (53)	1.72	(54)
Enter (49) or (54) in (55)	1.72	(55)

Water storage loss calculated for each month = (55) x (41)m

(56)m	53.36	48.19	53.36	51.64	53.36	51.64	53.36	53.36	51.64	53.36	51.64	53.36	(56)

If cylinder contains dedicated solar storage, = (56)m x [(50) - (H11)] ÷ (50), else = (56)m where (H11) is from Appendix H

(57)m	53.36	48.19	53.36	51.64	53.36	51.64	53.36	53.36	51.64	53.36	51.64	53.36	(57)

Primary circuit loss (annual) from Table 3 — 360.00 (58)

Primary circuit loss for each month (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58	(59)

Combi loss for each month from Table 3a, 3b or 3c (enter '0' if not a combi boiler)

(61)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)

Total heat required for water heating calculated for each month 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m	240.72	212.94	225.44	204.59	202.31	183.37	178.59	192.55	191.14	212.03	221.05	235.78	(62)

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRS and/or WWHRS applies, see Appendix G)

(63)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	

∑(63)1...12 = 0.00 (63)

Output from water heater for each month, kWh/month (62)m + (63)m

(64)m	240.72	212.94	225.44	204.59	202.31	183.37	178.59	192.55	191.14	212.03	221.05	235.78	

∑(64)1...12 = 2500.52 (64)

if (64)m < 0 then set to 0

Heat gains from water heating, kWh/month 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m]

(65)m	119.28	106.24	114.20	106.00	106.51	98.94	98.62	103.26	101.53	109.74	111.47	117.63	(65)

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5), Watts													
(66)m	155.84	155.84	155.84	155.84	155.84	155.84	155.84	155.84	155.84	155.84	155.84	155.84	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m	52.71	46.82	38.07	28.82	21.55	18.19	19.65	25.55	34.29	43.54	50.82	54.17	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m	351.27	354.91	345.73	326.17	301.49	278.29	262.79	259.15	268.33	287.89	312.57	335.77	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m	53.18	53.18	53.18	53.18	53.18	53.18	53.18	53.18	53.18	53.18	53.18	53.18	(69)
Pumps and fans gains (Table 5a)													
(70)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(70)
Losses e.g. evaporation (negative values) (Table 5)													
(71)m	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	-103.89	(71)
Water heating gains (Table 5)													
(72)m	160.32	158.10	153.49	147.22	143.15	137.42	132.55	138.79	141.01	147.50	154.82	158.11	(72)

Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

(73)m	669.43	664.96	642.42	607.35	571.32	539.03	520.13	528.61	548.76	584.05	623.34	653.18	(73)

6. Solar gains

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

Rows (74) to (82) are used 12 times, one for each month, repeating as needed if there is more than one window type.

Details for month of January and annual totals are shown below:

	Access factor Table 6d		Area m²		Solar flux W/m²		g Specific data or Table 6b		FF Specific data or Table 6c		Gains (W)	
North	0.77	x	12.00	x	10.73	x	0.53	x	1.00	=	52.53	(74)
East	0.77	x	6.00	x	19.87	x	0.53	x	1.00	=	48.66	(76)

Solar gains in watts, calculated for each month ∑(74)m...(82)m

(83)m	101.19	194.02	313.87	491.41	640.68	695.97	663.28	541.54	381.43	236.38	125.23	83.94	(83)

Total gains - internal and solar (73)m + (83)m

(84)m	770.62	858.98	956.29	1098.75	1212.00	1235.00	1183.40	1070.16	930.19	820.43	748.57	737.12	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(˚C) 21.00 (85)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains for living area, η1,m (see Table 9a)													
(86)m	0.92	0.90	0.85	0.76	0.62	0.47	0.33	0.36	0.60	0.80	0.90	0.93	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)													
(87)m	19.04	19.28	19.73	20.21	20.65	20.88	20.97	20.96	20.77	20.26	19.51	19.08	(87)
Temperature during heating periods in the living area from Table 9, Th2(˚C)													
(88)m	19.96	19.96	19.96	19.97	19.98	19.99	19.99	19.99	19.98	19.97	19.97	19.96	(88)
Utilisation factor for gains for rest of dwelling η2,m (see Table 9a)													
(89)m	0.91	0.89	0.83	0.73	0.57	0.40	0.25	0.28	0.53	0.76	0.89	0.92	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)													
(90)m	17.37	17.73	18.36	19.02	19.61	19.88	19.97	19.97	19.77	19.11	18.06	17.44	(90)

Living area fraction fLA 88.00 ÷ (4) = 1.00 (91)

Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2													
(92)m	19.04	19.28	19.73	20.21	20.65	20.88	20.97	20.96	20.77	20.26	19.51	19.08	(92)
Apply adjustment to the mean internal temperature from Table 4e, where appropriate													
(93)m	19.04	19.28	19.73	20.21	20.65	20.88	20.97	20.96	20.77	20.26	19.51	19.08	(93)

8. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that tim = (93)m and recalculate the utilisation factor for gains using Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm													
(94)m	0.90	0.88	0.82	0.74	0.61	0.46	0.33	0.36	0.58	0.77	0.88	0.91	(94)
Useful gains, ηmGm, W = (94)m x (84)m													
(95)m	695.88	753.22	788.79	813.77	733.63	565.93	384.86	380.48	541.46	634.57	656.71	667.87	(95)
Monthly average external temperature from Table 8													
(96)m	4.50	5.00	6.80	8.70	11.70	14.60	16.90	16.90	14.30	10.80	7.00	4.90	(96)
Heat loss rate for mean internal temperature, Lm, W													
(97)m	1481.71	1445.27	1308.69	1148.84	886.80	619.95	399.97	399.20	642.42	944.26	1257.00	1434.81	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m - (95)m] x (41)m													
(98)m	584.65	465.06	386.80	241.25	113.96	0.00	0.00	0.00	0.00	230.41	432.21	570.60	

Total per year (kWh/year) = ∑(98)1...5, 10...12 = 3024.95 (98)

Space heating requirement in kWh/m²/year (98) ÷ (4) 34.37 (99)

9b. Energy requirements - Community heating scheme

Fraction of space heating from secondary/supplementary system (Table 11)	0.00	(301)
Fraction of space heating from community system 1 - (301)	1.00	(302)

Community scheme fractions obtained from plant design specification or operational records:

Fraction of community DHW from CHP	0.60	(303a)
Fraction of community DHW from boilers	0.40	(303b)
Fraction of total space heat from community CHP (302) x (303a) =	0.60	(304a)
Fraction of total space heat from community boilers (302) x (303b) =	0.40	(304b)
Factor for control and charging method (Table 4c(3)) for community space heating	1.00	(305)
Factor for control and charging method (Table 4c(3)) for community water heating	1.00	(305a)
Distribution loss factor (Table 12c) for community heating system	0.10	(306)

Space heating:					
				kWh/year	
Annual space heating requirement				3024.95	
Space heat from community CHP (98) x (304a) x (305) x (306) =		181.50	(307a)		
Space heat from community boilers (98) x (304b) x (305) x (306) =		121.00	(307b)		

Water heating:					
Annual water heating requirement				2500.52	
If DHW from community scheme:					
Community DHW: CHP fuel use (64) x (303a) x (305a) x (306) =		150.03	(310a)		
Community DHW: boilers fuel use (64) x (303b) x (305a) x (306) =		100.02	(310b)		
Electricity used for heat distribution	0.01 x [(307a)...(307e) + (310a)...(310e)] =			5.53	(313)

Electricity for pumps and fans within dwelling (Table 4f):

mechanical ventilation fans - balanced, extract or positive input from outside		0.00		(330a)
warm air heating system fans		0.00		(330b)
pump for solar water heating		0.00		(330g)
Total electricity for the above, kWh/year	(330a) + (330b) + (330g) =		0.00	(331)

Electricity for lighting (calculated in Appendix L):	372.34	(332)

10b. Fuel costs - Community heating scheme

	Heat or fuel kWh/year		Fuel price (Table 12)		Fuel cost £/year	
Space heating from community CHP	181.50	x	2.65	x 0.01 =	4.81	(340a)
Space heating from community boilers	121.00	x	3.78	x 0.01 =	4.57	(340b)
Water heating from community CHP	150.03	x	2.65	x 0.01 =	3.98	(342a)
Water heating from community boilers	100.02	x	3.78	x 0.01 =	3.78	(342b)
Pumps and fans	0.00	x	11.46	x 0.01 =	0.00	(349)
Electricity for lighting	372.34	x	11.46	x 0.01 =	42.67	(350)
Additional standing charges (Table 12)					106.00	(351)
Total energy cost				(340a)...(342e) + (345)...(354)	165.81	(355)

11b. SAP rating - Community heating scheme

Energy cost deflator (Table 12)		0.47	(356)
Energy cost factor (ECF)	[(355) x (356)] ÷ [(4) + 45.0] =	0.59	(357)
SAP value		91.83	
SAP rating		92	(358)
SAP band		A	

12b. Carbon dioxide emissions - Community heating scheme

Emissions from community CHP (Mains gas)

Efficiency of CHP (%)			75.00		(359)
Heat to power ratio			3.00		(360)

	Energy kWh/year		Emissions Factor		Emissions (kgCO2/year)	
Space heating from CHP (Mains gas)	322.66	x	0.198	=	63.89	(363)
less credit emissions for electricity	-60.50	x	0.529	=	-32.00	(364)
Water heating from CHP (Mains gas)	266.72	x	0.198	=	52.81	(365)
less credit emissions for electricity	-50.01	x	0.529	=	-26.46	(366)

Emissions from other community sources (not CHP)

Efficiency of boilers (%)			75.00	(367b)		

	Energy used kWh/year		Emission Factor (kgCO2/kWh)		Emissions (kgCO2/year)	
Emissions from boilers (Mains gas)	294.69	x	0.198	=	58.35	(368)
Electrical energy for heat distribution	5.53	x	0.517	=	2.86	(372)
Total carbon dioxide from community systems			(363)...(366) + (368)...(372) =		119.44	(373)
Space and water heating			(373) + (374) + (375) =		119.44	(376)
Electricity for pumps and fans within dwelling	0.00	x	0.000	=	0.00	(378)
Electricity for lighting	372.34	x	0.517	=	192.50	(379)
Total carbon dioxide emissions			∑(376)...(382) =		311.94	(383)
Dwelling carbon dioxide emissions rate			(383) ÷ (4) =		3.54	(384)
EI value					96.86	
EI rating (see section 14)					97	(385)
EI band					A	

13b. Primary energy - Community heating scheme

Primary energy from community CHP (Mains gas)

Efficiency of CHP (%)			75.00		(359*)
Heat to power ratio			3.00		(360*)

	Energy kWh/year		Primary Energy Factor		Primary Energy	
Space heating from CHP (Mains gas)	322.66	x	1.02	=	329.11	(363*)
less credit emissions for electricity	-60.50	x	2.92	=	-176.66	(364*)
Water heating from CHP (Mains gas)	266.72	x	1.02	=	272.06	(365*)
less credit emissions for electricity	-50.01	x	2.92	=	-146.03	(366*)

Primary energy from other community sources (not CHP)

Efficiency of boilers (%)			75.00	(367b*)		

	Energy used kWh/year		Primary Energy Factor		Primary Energy	
Primary energy - boilers (Mains gas)	294.69	x	1.02	=	300.59	(368*)
Electrical energy for heat distribution	5.53	x	2.92	=	16.13	(372*)
Total primary energy from community systems			(363*)...(366*) + (368*)...(372*) =		595.20	(373*)
Space and water heating			(373*) + (374*) + (375*) =		595.20	(376*)
Electricity for pumps and fans within dwelling	0.00	x	0.00	=	0.00	(378*)
Electricity for lighting	372.34	x	2.92	=	1087.23	(379*)
Total primary energy kWh/year			∑(376*)...(382*) =		1682.44	(383*)
Primary energy kWh/m2/year			(383*) ÷ (4) =		19.12	(384*)

SAP 2009 Worksheet

NHER

This design submission has been carried out by an Authorised SAP Assessor. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name		Assessor number	
Client		Last modified	15/11/2011
Address	51 65 Maygrove Road, West Hampstead, London, NW6 2EH		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		84.00	(1a)	x	11.40	(2a)	=	957.60	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	84.00	(4)						
Dwelling volume							(3a) + (3b) + (3c) + (3d)...(3n) =	957.60	(5)

2. Ventilation rate

				m³ per hour	
Number of chimneys		0	x 40 =	0	(6a)
Number of open flues		0	x 20 =	0	(6b)
Number of intermittent fans		3	x 10 =	30	(7a)
Number of passive vents		4	x 10 =	40	(7b)
Number of flueless gas fires		0	x 40 =	0	(7c)
				Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) =	70	÷ (5) =	0.07	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		3.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.22	(18)

Air permeability value applies if a pressurisation test has been done, or a design or specified air permeability is being used

Number of sides on which dwelling is sheltered		2	(19)
Shelter factor	1 - [0.075 x (19)] =	0.85	(20)
Adjusted infiltration rate	(18) x (20) =	0.19	(21)

Infiltration rate modified for monthly wind speed:

Monthly average wind speed from Table 7

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(22)m	5.40	5.10	5.10	4.50	4.10	3.90	3.70	3.70	4.20	4.50	4.80	5.10

∑(22)1...12 = 54.10 (22)

Wind Factor (22a)m = (22)m ÷ 4

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(22a)m	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.20	1.27

∑(22a)1...12 = 13.52 (22a)

Adjusted infiltration rate (allowing for shelter and wind speed) = (21) × (22a)m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(22b)m	0.26	0.24	0.24	0.21	0.19	0.18	0.18	0.18	0.20	0.21	0.23	0.24

∑(22b)1...12 = 2.56 (22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	N/A	(23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)), otherwise (23b) = (23a)	N/A	(23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = N/A (23c)

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m ≥ 1, then (24d)m = (22b)m; otherwise (24d)m = 0.5 + [(22b)m2 x 0.5]

(24d)m	0.53	0.53	0.53	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.53	0.53	(24d)

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in box (25)

(25)m	0.53	0.53	0.53	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.53	0.53	(25)

3. Heat losses and heat loss parameter

The κ-value is the heat capacity per unit area, see Table 1e.

Element	Gross Area, m²	Openings, m²	Net area A, m²		U-value, W/m²K		A x U, W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Window*			17.63	x	1.42	=	24.94	N/A	N/A	(27)
External wall			45.93	x	0.20	=	9.19	N/A	N/A	(29a)
Roof			84.00	x	0.13	=	10.92	N/A	N/A	(30)
Total area of external elements ∑A, m²			147.55	(31)						

** for windows and roof windows, effective window U-value is calculated using formula 1/[(1/UValue)+0.04] paragraph 3.2*

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	45.05	(33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K	Calculated separately =	100.00	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		22.13	(36)

if details of thermal bridging are not known then (36) = 0.15 x (31)

Total fabric heat loss (33) + (36) = 67.18 (37)

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

(38)m	168.36	167.24	167.24	165.20	163.97	163.41	162.87	162.87	164.27	165.20	166.19	167.24	(38)

Heat transfer coefficient, W/K (37)m + (38)m

(39)m	235.54	234.42	234.42	232.37	231.15	230.58	230.04	230.04	231.45	232.37	233.36	234.42	

Average = ∑(39)1...12/12 = 232.52 (39)

Heat loss parameter (HLP), W/m²K (39)m ÷ (4)

(40)m	2.80	2.79	2.79	2.77	2.75	2.75	2.74	2.74	2.76	2.77	2.78	2.79

Average = ∑(40)1...12/12 = 2.77 (40)

4. Water heating energy requirement

kWh/year

Assumed occupancy, N 2.53 (42)

If TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA - 13.9)²)] + 0.0013 x (TFA - 13.9)

If TFA ≤ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 94.39 (43)

Annual average hot water usage has been reduced by 5% if the dwelling is designed to achieve a water use target of not more than 125 litres per person per day (all water use, hot and cold)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)												
(44)m	103.83	100.06	96.28	92.50	88.73	84.95	84.95	88.73	92.50	96.28	100.06	103.83

∑(44)1...12 = 1132.70 (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)

(45)m	154.35	134.99	139.30	121.45	116.53	100.56	93.18	106.93	108.20	126.10	137.65	149.48

∑(45)1...12 = 1488.70 (45)

If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

For community heating include distribution loss whether or not hot water tank is present

Distribution loss 0.15 x (45)m

(46)m	23.15	20.25	20.90	18.22	17.48	15.08	13.98	16.04	16.23	18.91	20.65	22.42	(46)

Water storage loss:

b) If manufacturer's declared cylinder loss factor is not known:

Cylinder volume (litres) including any solar storage within same cylinder | 110.00 | (50)

If community heating and no tank in dwelling, enter 110 litres in box (50)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in box (50)

Hot water storage loss factor from Table 2 (kWh/litre/day) | 0.02 | (51)

If community heating see SAP 2009 section 4.3

Volume factor from Table 2a | 1.03 | (52)

Temperature factor from Table 2b | 1.00 | (53)

Energy lost from water storage, kWh/day (50) x (51) x (52) x (53) | 1.72 | (54)

Enter (49) or (54) in (55) | 1.72 | (55)

Water storage loss calculated for each month = (55) x (41)m

(56)m	53.36	48.19	53.36	51.64	53.36	51.64	53.36	53.36	51.64	53.36	51.64	53.36	(56)

If cylinder contains dedicated solar storage, = (56)m x [(50) - (H11)] ÷ (50), else = (56)m where (H11) is from Appendix H

(57)m	53.36	48.19	53.36	51.64	53.36	51.64	53.36	53.36	51.64	53.36	51.64	53.36	(57)

Primary circuit loss (annual) from Table 3 | 360.00 | (58)

Primary circuit loss for each month (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58	(59)

Combi loss for each month from Table 3a, 3b or 3c (enter '0' if not a combi boiler)

(61)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)

Total heat required for water heating calculated for each month 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m	238.28	210.80	223.23	202.67	200.46	181.78	177.11	190.86	189.43	210.03	218.87	233.41	(62)

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRS and/or WWHRS applies, see Appendix G)

(63)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

∑(63)1...12 = | 0.00 | (63)

Output from water heater for each month, kWh/month (62)m + (63)m

(64)m	238.28	210.80	223.23	202.67	200.46	181.78	177.11	190.86	189.43	210.03	218.87	233.41

∑(64)1...12 = | 2476.94 | (64)

if (64)m < 0 then set to 0

Heat gains from water heating, kWh/month 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m]

(65)m	118.47	105.53	113.46	105.36	105.89	98.42	98.13	102.70	100.96	109.07	110.75	116.85	(65)

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5), Watts													
(66)m	152.06	152.06	152.06	152.06	152.06	152.06	152.06	152.06	152.06	152.06	152.06	152.06	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m	50.73	45.05	36.64	27.74	20.74	17.51	18.92	24.59	33.00	41.90	48.91	52.14	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m	339.70	343.22	334.34	315.43	291.56	269.12	254.13	250.61	259.49	278.40	302.27	324.71	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m	52.74	52.74	52.74	52.74	52.74	52.74	52.74	52.74	52.74	52.74	52.74	52.74	(69)
Pumps and fans gains (Table 5a)													
(70)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(70)
Losses e.g. evaporation (negative values) (Table 5)													
(71)m	-101.38	-101.38	-101.38	-101.38	-101.38	-101.38	-101.38	-101.38	-101.38	-101.38	-101.38	-101.38	(71)
Water heating gains (Table 5)													
(72)m	159.23	157.04	152.50	146.33	142.33	136.69	131.89	138.04	140.22	146.61	153.82	157.05	(72)

Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

(73)m	653.08	648.75	626.91	592.93	558.05	526.74	508.37	516.66	536.14	570.34	608.42	637.33	(73)

6. Solar gains

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

Rows (74) to (82) are used 12 times, one for each month, repeating as needed if there is more than one window type.

Details for month of January and annual totals are shown below:

	Access factor Table 6d		Area m²		Solar flux W/m²		g Specific data or Table 6b		FF Specific data or Table 6c		Gains (W)	
South	1.00	x	17.63	x	47.32	x	0.53	x	1.00	=	442.06	(78)

Solar gains in watts, calculated for each month ∑(74)m...(82)m

(83)m	442.06	720.99	880.38	981.90	1013.99	1017.24	1000.80	970.39	934.04	796.73	523.76	381.97	(83)

Total gains - internal and solar (73)m + (83)m

(84)m	1095.14	1369.74	1507.29	1574.83	1572.04	1543.99	1509.17	1487.05	1470.18	1367.07	1132.18	1019.29	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(˚C) 21.00 (85)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains for living area, η1,m (see Table 9a)													
(86)m	0.91	0.87	0.83	0.79	0.72	0.61	0.48	0.48	0.64	0.78	0.88	0.91	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)													
(87)m	17.19	17.62	18.26	18.86	19.64	20.29	20.70	20.69	20.19	19.27	17.99	17.24	(87)
Temperature during heating periods in the living area from Table 9, Th2(˚C)													
(88)m	18.86	18.87	18.87	18.88	18.89	18.90	18.90	18.90	18.89	18.88	18.88	18.87	(88)
Utilisation factor for gains for rest of dwelling η2,m (see Table 9a)													
(89)m	0.89	0.85	0.80	0.74	0.64	0.48	0.27	0.28	0.52	0.72	0.85	0.90	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)													
(90)m	14.38	14.96	15.83	16.64	17.66	18.44	18.81	18.81	18.33	17.20	15.49	14.46	(90)

Living area fraction fLA 84.00 ÷ (4) = 1.00 (91)

Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2

(92)m	17.19	17.62	18.26	18.86	19.64	20.29	20.70	20.69	20.19	19.27	17.99	17.24	(92)

Apply adjustment to the mean internal temperature from Table 4e, where appropriate

(93)m	17.19	17.62	18.26	18.86	19.64	20.29	20.70	20.69	20.19	19.27	17.99	17.24	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that tim = (93)m and recalculate the utilisation factor for gains using Table 9a)													
Utilisation factor for gains, ⍰m													
(94)m	0.87	0.83	0.79	0.74	0.67	0.57	0.45	0.46	0.60	0.73	0.84	0.88	(94)
Useful gains, ⍰mGm, W = (94)m x (84)m													
(95)m	954.43	1135.30	1185.22	1170.96	1058.46	886.85	682.28	678.54	885.05	1001.60	949.70	895.20	(95)
Monthly average external temperature from Table 8													
(96)m	4.50	5.00	6.80	8.70	11.70	14.60	16.90	16.90	14.30	10.80	7.00	4.90	(96)
Heat loss rate for mean internal temperature, Lm, W													
(97)m	2989.23	2958.62	2686.36	2359.94	1835.11	1311.95	873.90	872.80	1363.46	1967.37	2564.65	2893.37	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m - (95)m] x (41)m													
(98)m	1513.89	1225.27	1116.85	856.07	577.82	0.00	0.00	0.00	0.00	718.53	1162.76	1486.64	

Total per year (kWh/year) = ∑(98)1...5, 10...12 = 8657.83 (98)

Space heating requirement in kWh/m²/year (98) ÷ (4) 103.07 (99)

9b. Energy requirements - Community heating scheme

Fraction of space heating from secondary/supplementary system (Table 11) 0.00 (301)

Fraction of space heating from community system 1 - (301)	1.00	(302)
Community scheme fractions obtained from plant design specification or operational records:		
Fraction of community DHW from CHP	0.60	(303a)
Fraction of community DHW from boilers	0.40	(303b)
Fraction of total space heat from community CHP (302) x (303a) =	0.60	(304a)
Fraction of total space heat from community boilers (302) x (303b) =	0.40	(304b)
Factor for control and charging method (Table 4c(3)) for community space heating	1.00	(305)
Factor for control and charging method (Table 4c(3)) for community water heating	1.00	(305a)
Distribution loss factor (Table 12c) for community heating system	0.10	(306)

Space heating:			**kWh/year**	
Annual space heating requirement			8657.83	
Space heat from community CHP (98) x (304a) x (305) x (306) =	519.47	(307a)		
Space heat from community boilers (98) x (304b) x (305) x (306) =	346.31	(307b)		
Water heating:				
Annual water heating requirement			2476.94	
If DHW from community scheme:				
Community DHW: CHP fuel use (64) x (303a) x (305a) x (306) =	148.62	(310a)		
Community DHW: boilers fuel use (64) x (303b) x (305a) x (306) =	99.08	(310b)		
Electricity used for heat distribution	0.01 x [(307a)...(307e) + (310a)...(310e)] =		11.13	(313)
Electricity for pumps and fans within dwelling (Table 4f):				
mechanical ventilation fans - balanced, extract or positive input from outside	0.00			(330a)
warm air heating system fans	0.00			(330b)
pump for solar water heating	0.00			(330g)
Total electricity for the above, kWh/year	(330a) + (330b) + (330g) =		0.00	(331)
Electricity for lighting (calculated in Appendix L):			358.34	(332)

10b. Fuel costs - Community heating scheme

	Heat or fuel kWh/year		Fuel price (Table 12)		Fuel cost £/year	
Space heating from community CHP	519.47	x	2.65	x 0.01 =	13.77	(340a)
Space heating from community boilers	346.31	x	3.78	x 0.01 =	13.09	(340b)
Water heating from community CHP	148.62	x	2.65	x 0.01 =	3.94	(342a)
Water heating from community boilers	99.08	x	3.78	x 0.01 =	3.75	(342b)
Pumps and fans	0.00	x	11.46	x 0.01 =	0.00	(349)
Electricity for lighting	358.34	x	11.46	x 0.01 =	41.07	(350)
Additional standing charges (Table 12)					106.00	(351)
Total energy cost				(340a)...(342e) + (345)...(354)	181.61	(355)

11b. SAP rating - Community heating scheme

Energy cost deflator (Table 12)		0.47	(356)
Energy cost factor (ECF)	[(355) x (356)] ÷ [(4) + 45.0] =	0.66	(357)
SAP value		90.77	
SAP rating		91	(358)
SAP band		B	

12b. Carbon dioxide emissions - Community heating scheme

Emissions from community CHP (Mains gas)

Efficiency of CHP (%)	75.00	(359)

	Energy kWh/year		Emissions Factor		Emissions (kgCO2/year)	
Heat to power ratio				3.00		(360)
Space heating from CHP (Mains gas)	923.50	x	0.198	=	182.85	(363)
less credit emissions for electricity	-173.16	x	0.529	=	-91.60	(364)
Water heating from CHP (Mains gas)	264.21	x	0.198	=	52.31	(365)
less credit emissions for electricity	-49.54	x	0.529	=	-26.21	(366)

Emissions from other community sources (not CHP)

	Energy used kWh/year		Emission Factor (kgCO2/kWh)		Emissions (kgCO2/year)	
Efficiency of boilers (%)			75.00 (367b)			
Emissions from boilers (Mains gas)	593.85	x	0.198	=	117.58	(368)
Electrical energy for heat distribution	11.13	x	0.517	=	5.76	(372)
Total carbon dioxide from community systems			(363)...(366) + (368)...(372) =		240.70	(373)
Space and water heating			(373) + (374) + (375) =		240.70	(376)
Electricity for pumps and fans within dwelling	0.00	x	0.000	=	0.00	(378)
Electricity for lighting	358.34	x	0.517	=	185.26	(379)
Total carbon dioxide emissions			∑(376)...(382) =		425.96	(383)
Dwelling carbon dioxide emissions rate			(383) ÷ (4) =		5.07	(384)
EI value					95.58	
EI rating (see section 14)					96	(385)
EI band					A	

13b. Primary energy - Community heating scheme

Primary energy from community CHP (Mains gas)

	Energy kWh/year		Primary Energy Factor		Primary Energy	
Efficiency of CHP (%)				75.00		(359*)
Heat to power ratio				3.00		(360*)
Space heating from CHP (Mains gas)	923.50	x	1.02	=	941.97	(363*)
less credit emissions for electricity	-173.16	x	2.92	=	-505.62	(364*)
Water heating from CHP (Mains gas)	264.21	x	1.02	=	269.49	(365*)
less credit emissions for electricity	-49.54	x	2.92	=	-144.65	(366*)

Primary energy from other community sources (not CHP)

	Energy used kWh/year		Primary Energy Factor		Primary Energy	
Efficiency of boilers (%)			75.00 (367b*)			
Primary energy - boilers (Mains gas)	593.85	x	1.02	=	605.73	(368*)
Electrical energy for heat distribution	11.13	x	2.92	=	32.51	(372*)
Total primary energy from community systems			(363*)...(366*) + (368*)...(372*) =		1199.44	(373*)
Space and water heating			(373*) + (374*) + (375*) =		1199.44	(376*)
Electricity for pumps and fans within dwelling	0.00	x	0.00	=	0.00	(378*)
Electricity for lighting	358.34	x	2.92	=	1046.34	(379*)
Total primary energy kWh/year			∑(376*)...(382*) =		2245.78	(383*)
Primary energy kWh/m2/year			(383*) ÷ (4) =		26.74	(384*)

APPENDIX 2.0 – FINANCING OPTIONS

ENERGY SERVICES COMPANIES (ESCOS)

The incorporation of low-carbon and renewable technologies can provide a number of benefits to developers and end users and the technology options now available on the market present a commercially viable means of supplying a development's energy requirements

Low-carbon and renewable technologies still require a capital investment, in addition to long-term maintenance and the allocation of bills to end users. A proportion of the capital investment in renewable technologies may be sourced from a renewable grant funding scheme, however applications to these funding programmes are not guaranteed. These funding and maintenance issues present new risks for developers and building owners that can be managed by an Energy Supply Company (ESCo) that are specifically designed for the cost-effective supply and end-use of energy for their customers and should be distinguished from conventional energy supply companies that supply electricity or gas or heat.

The ESCo model can provide an additional source of private financial investment for low-carbon and renewable technologies and may finance the complete cost of the technologies, although it would be prudent for the developer to allocate a budget to account for any shortfall between the ESCo financial investment and the actual cost of the technology. In addition to financial leverage, an ESCo will take responsibility for competitive purchasing of various fuels; and energy consumption monitoring and management, including the sale of energy to end users that recoup the capital investment for the benefit of the developer/community.

Management models for ESCos can be based on community ownership through the establishment of a new not-for-profit company or third party private companies or joint venture partnerships involving a number of stakeholders.

Energy services are sub-contracted to a specialist ESCo for a fixed period for a set fee. The ESCo specifies, pays for, installs and runs power, heating, and cooling equipment over that time period. Once terms have been agreed, the ESCo:

- Organises and oversees all necessary works to the building(s) and the energy supply. Since the equipment remains the property of the ESCo there is no capital outlay for the customer;
- The capital, running and maintenance costs are subsumed into the customer's bills over the period of the contract;

- The customer pays a guaranteed amount for the energy services, leaving the ESCo to focus on delivering those services as efficiently as possible to maximise profits and/or environmental benefits. They can be a powerful mechanism for meeting the requirements of planning and other policy and legislative requirements profitably; and
- Assumes the risk that the project will save the amount of energy guaranteed.

ESCos are authorised to generate, distribute and supply electricity under the Electricity (Class Exemptions from the Requirement for a Licence) Order 2001. This is usually done through the establishment of a private wire network. They are increasingly being used by local authorities and are increasingly used by regeneration companies, developers and other organisations, to deliver sustainable energy and sustainable development objectives.

To ensure an ESCo is the appropriate solution for a given scheme, a feasibility study should be undertaken prior to implementation. Once decided upon, ESCos can be a useful mechanism for delivering one-off, as well as long-term projects, at small and community scales. They enable profits to be recycled to install more energy generation capacity or energy efficiency measures. They are particularly suited to delivering power and heat networks. While it is more expensive to produce and supply centrally generated energy due to the higher cost of the plant, it can usually be supplied cheaper to customers, since it is supplied direct avoiding distribution and other costs.

FEED IN TARIFFS

The Feed in Tariffs (FiT) is a policy mechanism designed to encourage the adoption of renewable energy sources and to help accelerate the move towards grid parity introduced on 1st of April 2010. Small-scale low-carbon electricity technologies that are eligible for FiTs include:

- Wind;
- Solar photovoltaics (PV);
- Hydro;
- Anaerobic digestion; and
- Domestic scale micro CHP (with a capacity or less).

The scheme will see the payment of cash rewards (feed in tariffs), by electricity suppliers, from April 2010, to owners of these small-scale electricity generating renewable technologies. In order to qualify, the technologies must use the Microgeneration Certification Scheme in order to confirm their eligibility (for more information please refers to http://www.microgenerationcertification.org/).

For developers who are required to install renewable technologies, such as PV or small-scale wind, as part of their planning application, there is now the opportunity to see a boosted revenue stream from the technologies in operation and a reduction in simple payback period. Tariffs will be fixed for a 20 or 25-year period, depending upon the technology: PV being given an extra 5 years compared to the other sources. It is anticipated that the tariff will result in a financial return of between 5-8% on the initial investment of the installation.

Costs for the FiT programme will be met by UK electricity suppliers who will pass the costs on to their customers. The scheme will undergo a review in 2013 to assess its cost and effectiveness in increasing small-scale renewable electricity generation. The rates payable to small-scale generators is shown below:

Complete listing of all Generation Tariff levels up to March 2012

Energy Source	Scale	Tariff (p/kWh)[A]	Duration (years)
Anaerobic digestion	≤500kW	12.1 [D]	20
Anaerobic digestion	>500kW	9.4	20
Hydro	≤15 kW	20.9	20
Hydro	>15 - 100kW	18.7	20
Hydro	>100kW - 2MW	11.5	20
Hydro	>2MW - 5MW	4.7	20
Micro-CHP [B]	<2 kW	10.5	10
Solar PV	≤4 kW new [C]	37.8	25
Solar PV	≤4 kW retrofit[C]	43.3	25
Solar PV	>4-10kW	37.8	25
Solar PV	>10 - 100kW [E]	32.9 [E]	25
Solar PV	>100kW - 5MW	30.7 [E]	25
Solar PV	Standalone [C]	30.7 [E]	25
Wind	≤1.5kW	36.2	20
Wind	>1.5 - 15kW	28.0	20
Wind	>15 - 100kW	25.3	20
Wind	>100 - 500kW	19.7	20
Wind	>500kW - 1.5MW	9.9	20
Wind	>1.5MW - 5MW	4.7	20
Existing generators transferred from RO		9.4	to 2027

RENEWABLE HEAT INCENTIVE

The Renewable Heat Incentive (RHI) is very similar to the Feed-in Tariffs, although this incentive relates to heat technologies (as opposed to technologies producing electricity). The RHI, which will be implemented in two separate phases, will operate based on the following three steps from July 2011:

- Installation of renewable heat systems such as solar thermal panels, heat pumps, or a biomass boiler;
- Estimate is made on how much heat the renewable energy system will produced;
- Receipt of a fixed amount based on this estimate.

Initially, the following heat and CHP technologies will be supported by the RHI:

- Biomass boilers;
- Biogas combustion (up to 200kWth)
- Deep geothermal;
- Ground source heat pumps;
- Energy from biomass proportion of municipal solid waste;
- Solar thermal (up to 200kWth);
- Water Source Heat Pumps;
- Renewable district heating where one of the eligible heat technologies above are utilised; and
- Feeding biomethane from anaerobic digestion back into the natural gas grid.
- For the second phase in 2012, other technologies that will also be considered for inclusion are air source heat pumps, hot air heating (e.g. kilns), bioliquids and landfill gas.
- Similar to the Feed-in-Tariffs above, the main benefit is the generation tariff, paid for every kilowatt-hour of energy produced. The level of payment depends on the technology and system size; as part of the scheme, the government have published tariffs for the initial scheme for non-residential installations. For residential installations, the tariffs have yet to be published, apart from indicative levels for the Premium payment; however, based on the original consultation, the second table indicates proposed tariff levels published on the RHI website.

Tariff name	Eligible technology	Eligible sizes	Tariff rate (p/kWh)
Small biomass	Solid biomass; Municipal Solid Waste (incl. CHP)	Less then 200 kWth	*Tier 1:* 7.6
			Tier 2: 1.9
Medium biomass		200 kWth and above; less than 1000 kWth	*Tier 1:* 4.7
			Tier 2: 1.9
Large biomass		1000 kWth and above	2.6
Small ground source	Ground-source heat pumps; Water-source heat pumps; Deep geothermal	Less than 100 kWth	4.3
Large ground source		100 kWth and above	3.0
Solar thermal	Solar thermal	Less than 200 kWth	8.5
Biomethane	Biomethane injection & biogas combustion, except landfill gas	Biomethane all scales; biogas < 200 kWth	6.5

Technology	Scale	Tariffs (pence/kWh)	Tariff lifetime (years)
Small installations			
Solid biomass	Up to 45kW	9	15
Biodiesel (restricted use)	Up to 45kW	6.5	15
Biogas on-site combustion	Up to 45kW	5.5	10
Ground source heat pumps	Up to 45kW	7	23
Air source heat pumps	Up to 45kW	7.5	18
Solar thermal	Up to 20kW	18	20
Medium installations			
Solid biomass	45kW-500kW	6.5	15
Biogas on-site combustion	45kW-200kW	5.5	10
Ground source heat pumps	45kW-350kW	5.5	20
Air source heat pumps	45kW-350kW	2	20
Solar thermal	20kW-100kW	17	20
Large installations			
Solid biomass	500kW and above	1.6-2.5	15
Ground source heat pumps	350kW and above	1.5	20
Biomethane injection	All scales	4	15

RENEWABLES OBLIGATION CERTIFICATES (ROCS)

The Renewables Obligation (RO) is designed to incentivise the generation of electricity from eligible renewable sources in the United Kingdom. The RO places an obligation on licensed electricity suppliers in the United Kingdom to source an increasing proportion of electricity from renewable sources. Suppliers meet their obligations by presenting Renewables Obligation Certificates (ROCs).

ROCs are green certificates issued for eligible renewable electricity generated within the UK and supplied to customers in the UK by a licensed supplier. ROCs are issued by Ofgem to accredited renewable generators. One ROC is issued for each megawatt-hour (MWh) of eligible renewable output. ROCs are traded separately to the actual electricity itself and work as a bonus premium on top of the price paid for the unit.

The following sources of electricity are able to attract ROCs:

- Biogas from anaerobic digestion;
- Biomass;
- Hydro electric;
- Tidal power;
- Wind power;
- Photovoltaic cells;
- Landfill gas;
- Sewage gas; and
- Wave power.

In 2009, a new order for the Renewables Obligation came into effect, whereby those licensed to supply electricity, are now required to submit a certain number of ROCs each year. In addition, the Renewables Obligation Is no longer 'technology neutral' as it intends to give increased incentives to developing technologies through a system of 'banding'. This will result in certain technologies benefiting from the introduction of banding as technologies in some bands receive more certificates per unit of generation(i.e. tidal, solar photovoltaics, geothermal, advanced gasification/pyrolosis), while those in others receive less (i.e. sewage gas, landfill gas).

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