PRICE&MYERS
Consulting Engineers

16A Lyndhurst Gardens
Energy Strategy Report

Project:	16A Lyndhurst Gardens
Project No:	20527
Version:	V2
Prepared by:	James Low
Checked by:	Jessica Gray
Date:	28 June 2013

Contents

EXECUTIVE SUMMARY

The proposed 16A Lyndhurst Gardens development consists of one new luxury dwelling, which will replace the existing building. The building has been designed to blend into its green surroundings and is located in the London Borough of Camden.

The proposed development addresses national planning policies on energy; in particular, mitigation of climate change and energy security through energy efficiency enhancements and use of alternative energy technologies. In order to reduce the carbon footprint of the building beyond the requirements of current regulatory and market standards, the development will benefit from the following integrated systems:

- Passive design features
- Energy efficiency measures
- Zero carbon energy systems

The building fabric U-values will meet or exceed the Part L 2010 requirements and robust detailing at joints and junctions will further reduce heat loss due to excessive infiltration. Energy efficient light fittings will minimise the electricity demand for lighting.

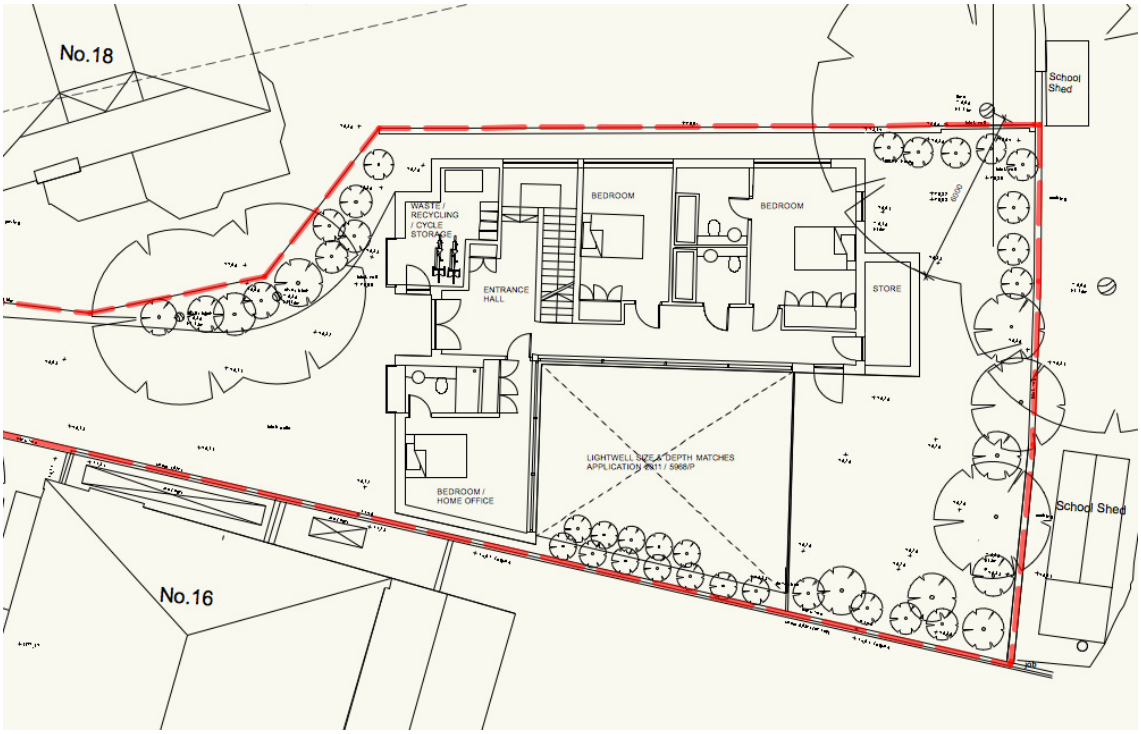
Following the Energy Hierarchy, an energy assessment has been carried out based on design information to identify the most appropriate strategy. A combination of passive and energy efficient design measures, incorporated with a GSHP have been demonstrated to achieve a 48.58% improvement over Part L 2010.

The London Plan also aims to encourage a 20% reduction of CO2 emissions through the use of renewable technologies, and through the use of GSHP a 17% reduction is achieved (for regulated and unregulated carbon emissions) which is considered the best possible given the limitations of the site in terms of appearance, practicality and financial viability of the systems.

1. INTRODUCTION

1.1. Site analysis

The 16A Lyndhurst Gardens development is located in Camden, London. The site is surrounded by existing trees and currently comprises an existing building. One new dwelling is proposed to replace the existing building.



The new design proposal aims to sit in harmony with the surrounding area and to maximise the natural feel of the site, whilst providing adequate amenity spaces for the dwelling. The South facing courtyard with a W - E orientation will provide adequate sunlight to the rooms and reduce glare and overheating. Access is from the West of the site from Lyndhurst Gardens as pictured above.

1.2. Objective

This report summarises the work undertaken to support the development of an energy strategy for the 16A Lyndhurst Gardens scheme. This work has resulted in a strategy, which requires design, technical and commercial decisions in order to continue the design development and ultimately select the final solution for ensuring a low carbon development.

This report outlines the energy strategy for the development, including passive design, energy and CO_2 footprint of the proposed scheme, and renewable energy options. The final proposed strategy will allow the scheme to achieve the minimum energy and CO2 targets for CSH Level 4.

2. POLICY

2.1. Camden Policies on Energy

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, including the relevant measures set out in (Camden Development Policies – Section 3, paragraph 22.5), have been incorporated into 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 4 by 2013 and encouraging Code Level 6 (zero carbon) by 2016.;

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

e) Expecting non-domestic developments of 500 sqm of floor space 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 include appropriate climate change adaptation 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.

Policy CS13 Reducing the effects of and adapting to climate change

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

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

b) Promoting the efficient use of land and buildings;

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

    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 are 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 reductions in carbon dioxide emissions

2.2. The London Plan Policies on Energy

Although it is not a major development, there is an aspiration to achieve a high level of environmental performance. The London Plan policies have therefore been adhered to.

Policy 5.2: Minimising Carbon Dioxide Emissions

Planning decisions

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

The mayor will work with boroughs and developers to ensure that major developments meet the following targets for carbon dioxide emission reductions in buildings:

2010 - 2013: 25% improvement over Part L 2010
2013 - 2016: 40% improvement over Part L 2010

Major development proposals should include a detailed energy assessment to demonstrate how the targets for carbon dioxide emissions reduction outlined above are to be met within the framework of the energy hierarchy. This report contains a detailed energy assessment in line with the requirements of Policy 5.2.

Policy 5.6: Decentralised Energy in Development Proposals

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.

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.

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

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

There is a presumption that all major development proposals will seek to reduce carbon dioxide emissions by at least 20% through the use of on-site renewable energy generation wherever feasible. Development proposals should seek to utilise renewable energy technologies such as: biomass heating; cooling and electricity; renewable energy from waste; photovoltaics; solar water heating; wind and heat pumps. The Mayor encourages the use of a full range of renewable energy technologies, which should be incorporated wherever site conditions make them feasible and where they contribute to the highest overall and most cost effective carbon dioxide emissions savings for a development proposal.

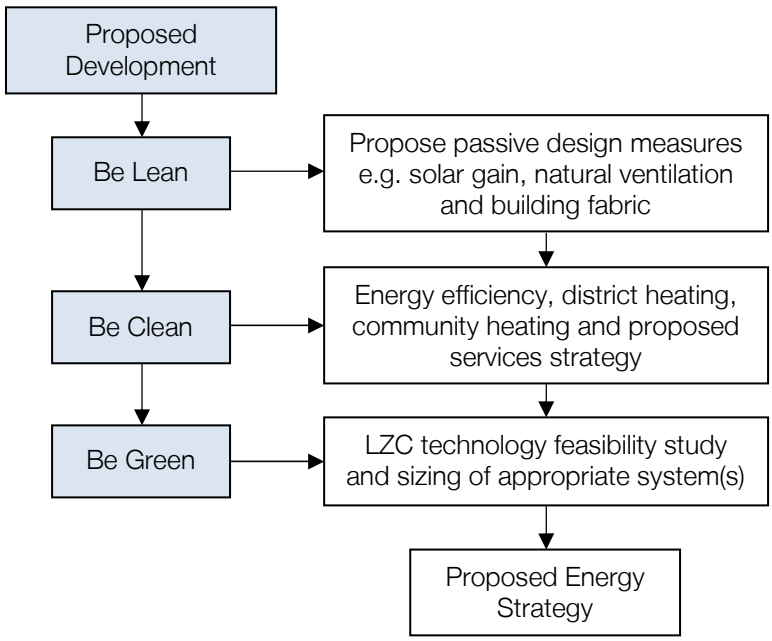
3. APPROACH

The approach to achieving the planning policy energy objectives has been to consider strategies and technologies to achieve a low energy and carbon footprint for the scheme.

The development will adopt the following energy hierarchy:

- Use less energy through passive design measures (Be Lean)
- Supply and consume energy efficiently (Be Clean)
- Utilise renewable energy sources to reduce carbon emissions (Be Green)

This energy strategy examines the energy performance of the proposed development based on the following methodology:



The performance of the development in terms of energy consumption and carbon emissions is calculated at each stage of the assessment, ensuring that both regulated and unregulated energy is considered when determining the performance of the proposed energy strategy.

Accredited Energy Assessor

This report has been checked and reviewed by Jessica Gray who is an On Construction Domestic Energy Assessor (OCDEA). The energy consumption and carbon emission figures within this report have been calculated using the approved Standard Assessment Procedure for the Energy Rating of Dwellings (SAP), current SAP 2009 version.

4. PASSIVE DESIGN

Passive design measures have been considered throughout the pre-planning stage to reduce energy demand. Risk of solar overheating has been considered in the Standard Assessment Procedure (SAP) analysis for compliance with Part L1A. Opportunities for day lighting, efficient ventilation and passive solar heating have been considered.

4.1. Solar Gain Control & Daylighting

The U-Values of all glazed elements will exceed Building Regulations standards, and incorporate low emissivity coating, resulting in an efficient balance between passive solar gain and the thermal losses from each room.

Daylight levels are good and are supplemented with low energy light fittings. The orientation of the buildings reduces peak solar gain while ensuring good levels of daylight both morning and evening.

4.2. Energy Efficiency

Studies have been carried out to determine the energy and carbon emissions benefits of various enhancements to the thermal performance of the new proposed building envelope by using lower U-Values for new elements and improving overall air tightness, resulting in a significant improvement over Building Regulations standards. The houses are designed to be naturally ventilated, reducing additional energy loads for the building.

Table 4-1 shows a summary of the proposed U-values, air tightness, heating and ventilation strategy for 16A Lyndhurst Gardens scheme. These measures will be considered for the development, and have been assumed for the analysis at this stage.

Element	Measure
Walls	0.15W/m^2K
Roof	0.16 W/m^2K
Ground Floor	0.15 W/m^2K
Windows	1.2 W/m^2K
External Doors	2 W/m^2K
Air tightness	4 $m^3/m^2/h$
Thermal Bridging	Y value = 0.066 (Default)

Table 4-1: Passive design measures

4.3. Energy Conservation Measures

Additional energy conservation measures which will help to reduce energy consumption in use have been identified, as follows:

- All new white goods selected for this development are rated A or A+ in the EU energy labelling scheme for domestic appliances;
- Water efficient fittings throughout, helping to reduce hot water demand;
- Movement and daylight sensors fitted to lighting for external area.

5. ESTIMATED ENERGY AND CARBON DIOXIDE FOOTPRINT

Calculations have been carried out to determine the estimated energy demand and carbon footprint of the proposed development, taking into account the passive design and energy efficiency measures identified in Section 4. This will form a base case for the development using mains gas as the baseline fuel.

The energy consumption includes regulated energy (space and water heating, lighting, pumps and fans) derived from outputs of the SAP modelling for the site and unregulated energy (household appliances and equipment) based on the BRE methodology. Full details of assumptions are included in Appendix A and Table 5-1 details the energy demand for the site taking into account the regulated and unregulated energy.

Energy & CO_2										
Gas Demand				Electricity Demand					Total Energy (kWh/yr)	Total CO_2 (kg/yr)
Space heating (kWh/yr)	Hot Water (kWh/yr)	Total (kWh/yr)	Gas CO_2 (kg/yr)	Pumps & Fans (kWh/yr)	Lighting (kWh/yr)	Appliances (kWh/yr)	Total (kWh/yr)	Electricity CO_2 ($kgCO_2$/yr)		
22,052	3,015	25,066	4,963	175	1,175	3,788	5,138	2,657	**30,205**	**7,620**

Table 5-1: Estimated energy demand and CO_2 emissions of the site by energy source

6. LOW AND ZERO CARBON ENERGY SYSTEMS

The following table outlines the low and zero carbon technologies that have been considered for the site. The technical feasibility for each has been discussed based on the energy demand and site constraints.

Technology	Description	Advantages	Disadvantages	Feasibility	
Solar thermal collectors	Solar collectors can be used to provide hot water. They can provide up to around 50% of the demand.	No noise issues associated with Solar thermal collectors No additional land use from the installation of solar thermal collectors Low maintenance and easy to manage Low capital cost	The hot water cylinder will need to be larger than a traditional cylinder. Consideration will need to be given to the space required. Needs unobstructed space on roof.	The building roof has areas of pitched roofs although it is potentially to be covered by a green roof, and it is one storey high and is shaded by surrounding large trees shade making it unfeasible to locate solar technologies. In addition it is not thought this would fit into building aesthetics.	✗
Photovoltaic Panels (PV)	Photovoltaics provide noiseless, low-maintenance, carbon free electricity.	Can have significant impact on carbon by offsetting electricity which has a high carbon footprint Low maintenance No noise issues No additional land use from the installation of PV panels Bolt on technology that does not need significant amounts of auxiliary equipment.	High capital investment required Needs unobstructed space on roof	The building roof has areas of pitched roofs although it is potentially to be covered by a green roof, and it is one storey high and is shaded by surrounding large trees shade making it unfeasible to locate solar technologies. In addition it is not thought this would fit into building aesthetics	✗

CHP [Combined Heat & Power]	CHP systems use an engine driven alternator to generate electricity while using the waste heat from the engine, jacket and exhaust to provide heating and hot water. Economic viability relies on at least 4000 hours running time per annum.	Mature technology High CO_2 savings	Cost of the system is relatively high for small schemes such as this. Only appropriate for large development with high heat loads.	Communal CHP is not viable for a single dwelling. Micro CHP would be technically feasible but is unlikely to save enough carbon to meet the targets.	✗
Biomass heating	Solid, liquid or gaseous fuels derived from plant material can provide boiler heat for space and water heating.	Potential to reduce large component of the total CO_2 A biomass boiler would replace a standard gas heating system so some of the cost may be offset through money saved on a traditional boiler.	Regular maintenance will be required Reliability of fuel may become a problem, therefore limited cost saving for residents The noise generated by a biomass boiler is similar to that of a gas boiler. It is advisable not to locate next to particularly sensitive areas such as bedrooms. A plant room and fuel store will be required which may take additional land from the proposed development or surroundings The fuel will need to be delivered, which can cause issues with access etc. Biomass is often not a favoured technology in new development due to the potential local impacts of NO_x emissions and delivery vehicles.	This is a small tight site in an urban area. Biomass is not considered feasible for such a development due to issues of fuel storages, access for delivery vehicles and local NO_x emissions.	✗

Wind turbines [Vertical axis]	Most small (1-25kW) wind turbines can be mounted on buildings, but larger machines require foundations at ground level in a suitable site.	Low noise Bolt on technology that does not need significant amounts of auxiliary equipment.	Low energy output particularly in urban environments, therefore not suitable here High visual impact Noise impact High capital cost	The development is not appropriate for this technology as wind speeds and profiles are inadequate in this urban area.	✗
Ground Source Heat Pumps (GSHP) – heating & cooling	A ground loop heat exchanger offer efficient heating of a space in winter, as the temperature of the ground (below approx 2m) remains almost constant all year round. The same loop of pipe and compressor allows heat from the building to be rejected (via a highly efficient compressor) into the soil, dissipating heat from the space.	Low maintenance and easy to manage Optimum efficiency with under-floor heating systems As heat pumps would replace standard heating systems, some of the cost may offset through money saved on a traditional boiler.	The heat pump has a noise level around 45-60dB so some attenuation may be required and it should be sensibly located (i.e. in a plant room) Relatively high capital cost Requires electricity to run the pump, therefore limited carbon savings in most cases	GSHP vertical boreholes could be used to provide space heating. Further investigation would be required at detailed design stage to check whether this is feasible given the proximity of the London Tube network.	✓
Air Source Heat Pump (ASHP) - heating	Air Source Heat Pumps extract latent energy from the air in a manner similar to ground source heat pumps.	ASHP systems are generally cheaper than ground source as there is no requirement for long lengths of buried piping. Low maintenance and easy to manage Optimum efficiency with under-floor heating systems As heat pumps would replace standard heating systems, some of the cost may offset money saved on a traditional boiler.	The heat pump has a noise level around 40-60dB so some attenuation may be required and it should be sensibly located. The potential noise from the external unit may mean there is local opposition to their installation. Requires electricity to run the pump, therefore limited carbon savings in most cases Potential noise issues	The use of ASHP would be technically feasible, however the requirement to have an outdoor unit would create some noise.	✓

Table 6-1: Feasibility of LZC technologies for the site

7. SUMMARY OF ESTIMATED CARBON DIOXIDE EMISSIONS REDUCTIONS

The energy demand and potential impact on CO_2 of the inclusion of renewable technologies has been considered for the development.

The carbon reduction target for the site is to ensure that the CO_2 emissions meet the requirements of the Building Regulations Part L 2010, and a total CO_2 saving of at least 20% of the site's overall CO_2 emissions through the use of renewable technologies. The passive design measures identified in section 4 have been incorporated into energy demand calculations to give a baseline for the development of 7,620 $kgCO_2/yr$. The feasibility of renewable energy systems to further reduce this has been analysed above.

GSHP have been chosen over ASHP due to greater carbon savings and the issue of locating an external ASHP unit on the development. Calculations have been undertaken to estimate the energy each would generate and the associated CO_2 savings. These calculations are based on the energy demands and CO_2 emissions for the site calculated in section 5. The energy produced by the various technologies and the associated CO_2 emissions have been calculated based on the emission factors and efficiencies detailed in Appendix B.

Table 7-1 and Figure 7-1 show the overall impacts in terms of carbon of combining passive design with the incorporation of a GSHP.

	Energy & CO2				Life Cycle Carbon and Cost Analysis		
Proposed LZC Technologies	**Energy Generated (kWh/yr)**	**% site energy demand met**	**CO2 saved by system (kgCO2/yr)**	**% reduction in site CO2 emissions**	**25 year CO2 saving (kgCO2)**	**Estimated capital cost**	**Payback period**
Ground Source Heat Pump (GSHP) Boiler = 90% efficient GSHP COP = 3.5 (Space heating only) (Efficiencies may vary on specification at tender stage)	17,862	59.1%	1,291	16.9%	32,279	£40-60k	N/A

Table 7-1: CO_2 saving from Renewable Technologies

The provision for GSHP system (for space heating) will be combined with a gas boiler for hot water.

Table 7-1 shows the CO_2 savings from a GSHP that can be installed on the site. The system will contribute to generating 59% of the development's energy demands. This in turn achieves a 17% saving in carbon emissions and results in a 48.58% improvement over Part L 2010. This is illustrated in Fig 7-1 below.

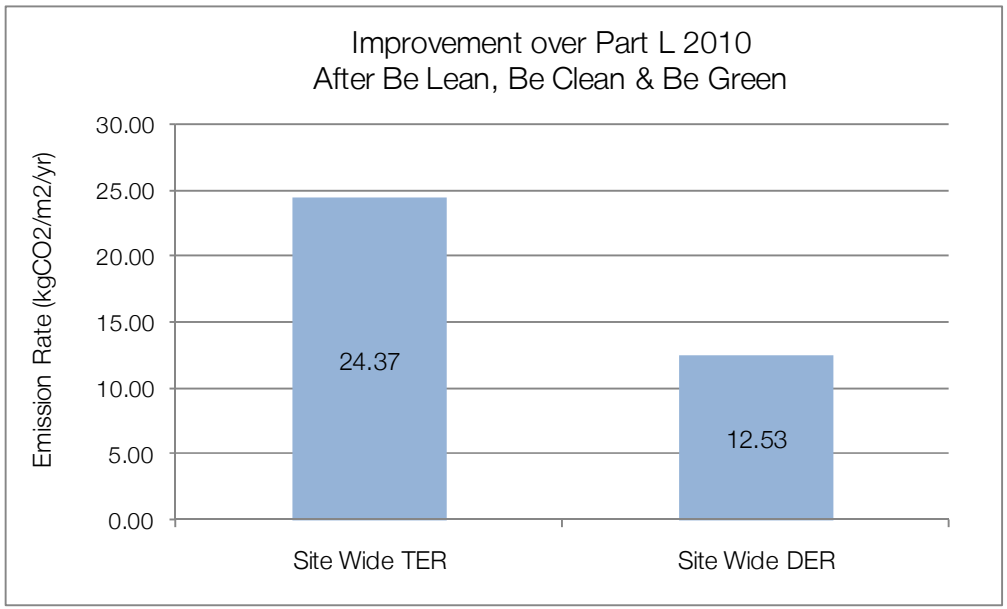


Figure 7-1 Improvement over Part L 2010.

8. CONCLUSION

For the 16A Lyndhurst Gardens development, passive design measures have been identified to help to reduce the energy load. After reducing demand, options for further reducing the CO_2 emissions through renewable technologies have been identified.

The proposed strategy combines GSHP for space heating with a gas boiler for hot water.

The energy strategy demonstrates that the development achieves a 48.58%% improvement in the DER over the TER for Part L 2010, which is well in excess of the 25% planning target. The London Plan also aims to encourage a 20% reduction of CO2 emissions through the use of renewable technologies, and through the use of GSHP a 17% reduction is achieved (for regulated and unregulated carbon emissions) which is considered the best possible for this site.

The advised option will be considered at the detailed design and construction stages and adequate provisions made to ensure that the various carbon reduction targets are met. Further investigation into the use of GSHP should form part of the detailed design stages.

The figures in this report are based on preliminary analysis only, and further detailed studies will be required before specifying any of the potential systems. Further investigation into fuel suppliers will be required.

APPENDIX A

The following table shows the energy assumptions used for the energy and CO_2 calculations within this report. Calculations for residential areas are based on Standard Assessment Procedure (SAP) results with an inclusion for unregulated energy appliance use not covered by SAP (based on BRE methodology).

The appliances figure is based on the BRE calculation formula for appliances and cooking, taken from the Code for Sustainable Homes in Ene 7 table 1.4, as below.
$kgCO_2$/year from appliances and cooking. See Ene 1:

$$99.9 \times (TFA \times N)^{0.4714} - (3.267 \times TFA) + (32.23 \times N) + 72.6$$

Where:

TFA = Total Floor Area

N = Number of Occupants

For TFA < $43m^2$; N = 1.46

For TFA ≥ $43m^2$; N = $2.844 \times (1 - \exp(-0.000391 \times TFA^2))$

Residential		
Energy Demands		**Source**
Use Type	**Demand (kWh/m^2)**	SAP Calculations
Space Heating	69.13	
DHW	9.45	
Fans/Pumps/Controls	0.55	
Lighting	3.68	
Appliances	11.88	BRE Methodology

APPENDIX B

The following tables show figures used in the energy and CO_2 calculations to estimate energy produced and CO_2 savings from LZC technologies. These figures can be used to validate the results.

CO_2 Intensity Values	
Gas Intensity	0.198 $kgCO_2/kWh$
Electricity Intensity	0.517 $kgCO_2/kWh$
Grid Displaced Electricity Intensity	0.529 $kgCO_2/kWh$
Biodiesel Intensity	0.025 $kgCO_2/kWh$

Energy & Renewable Technology Outputs	
PV energy produced per kWp	858.4 kWh/kWp
PV kWp per m^2 panel	0.167 kWp/m^2
Efficiency of solar thermal collectors	600 kWh/m^2
COP of ASHP	2.5
COP of GSHP	3.5
Electricity efficiency	100%
Gas boiler efficiency	90%

Fuel Prices (as of Feb 2012)	
Natural Gas	4.37 p/kWh
Electricity (Grid)	13.7 p/kWh

APPENDIX C

The following grants may be available with the use of renewable technologies on this development.

Grants (as of 1st March 2013)	
Feed-in Tariff	By generating your own renewable electricity your energy supplier may pay you money, called a 'Feed-in Tariff' (FIT). Using an MCS certified installer, the system could entitle you to a rate for each unit (kilowatt hour or kWh) of electricity you generate. As well as the FIT, you can sell any excess electricity back to your electricity supplier through an 'Export Tariff'. To qualify, the installation must be less than 5 MW, with the following technologies covered: • Solar photovoltaic (PV) panels • Wind turbines • Water (Hydro) turbines • Anaerobic digestion (biogas energy) • Micro combined heat and power (micro-CHP) **https://www.gov.uk/feed-in-tariffs**
Renewable Heat Incentive (RHI)	The RHI is a scheme for the non-domestic sector that provides payments to industry, business and public sector organisations that use renewable energy to heat their buildings. Payments are made to the owner of the heat installation over a 20-year period, for the following technologies: • Biomass boilers (including CHP biomass boilers) • Ground source heat pumps (GSHP) • Water source heat pumps • Deep geothermal heat pumps • All solar thermal collectors • Biomethane and biogas There are plans to extend support to the following in 2013: • Air source heat pumps (ASHP) • Biomass direct air heating • Biomass combustion over 200kW There are also plans to launch a domestic RHI scheme in summer 2013. **http://www.ofgem.gov.uk/e-serve/RHI/Pages/RHI.aspx**
Green Deal	The Green Deal is a Government backed initiative to promote the installation of energy efficiency measures in households in order to reduce energy consumption and bills. There will be no upfront costs, instead consumers will pay through their household energy bills. Consumers can see the Green Deal charge alongside the reductions in energy use which generate savings on their bill. It also means that if they move out (and cease to be the bill payer) the financial obligation remains at the property for the next bill payer: the charge is only paid where/whilst the benefits are enjoyed. **https://www.gov.uk/green-deal-energy-saving-measures/how-the-green-deal-works**

APPENDIX D

SAP Calculations

Price & Myers LLP
30 Newman Street
London W1T 1LT

Full SAP Calculation Printout

Property Reference: 20527_Lyndhurst Gardens
Survey Reference: 20527_16A Lyndhurst Gardens_v2
Property: Camden, London

Issued on Date: 12.Jun.2013
Prop Type Ref:

SAP Rating:	84 B	**CO2 Emissions (t/year):**	5.71	**DER:** 12.53 Pass	**Reduction:** 48.6%	**FEE:** 45.9	**ZC8:**	0.00
Environmental:	86 B	**General Requirements Compliance:**	Pass	**TER:** 24.37		**HLP:** 1.13	**Energy cost:**	£ 1513

CfSH Results	**Version:** CfSH November 2010	**ENE1 Credits:** 5.1	**ENE2 Credits:** 7.0	**ENE7 Credits:** 0	**CfSH Level:** 4

Surveyor: Jessica James, Tel: 02076315128, Fax: 02074621390 Surveyor ID: admin
Address: 30 Newman Street, London, W1T 1LT
Client:

Software Version: Elmhurst Energy Systems SAP2009 Calculator (Design System) version 3.08r12
SAP version: SAP 2009, Regs Region: England and Wales (Part L1A 2010), Calculation Type: New Dwelling As Designed

CALCULATION DETAILS for survey reference no '20527_16A Lyndhurst Gardens_v2'
SAP2009 - 9.81 input data (DesignData) -

SAP2009 Input Data

FullRefNo:	20527_16A Lyndhurst Gardens_v2
Sap Version:	SAP 2009
Regs Region:	England & Wales
Region:	Thames Valley
Calculation Type:	New Build (As Designed)
DwellingOrientation:	South East
Property Type:	House, Detached
Storeys:	3
Date Built:	2012
Sheltered Sides:	4
Sunlight Shade:	Average or unknown
Measurements	Perimeter, Floor Area, Storey Height
Basement:	59.18, 169, 3.25
1st Storey:	83.51, 193, 3.38
2nd Storey:	60.71, 126, 2.93
3rd Storey:	0, 0, 0
Living Area:	58 m2, fraction: 11.9%
Thermal Mass:	Simple calculation
Thermal Mass Simple:	Medium
Thermal MassValue:	250
External Walls	Nett Area, Gross Area, Kappa, Element, Construction, Type, ShelterFactor, UValueFinal
Basement Walls	203.69, 203.69, 9, , Other, , Cavity, 0.9, 0.13215859030837, Gross
Exposed External Walls	152.22, 256.33, 0, , Other, , Cavity, 0, 0.15, Gross
External Roofs	Nett Area, Gross Area, Kappa, Construction, Element, UValueFinal
Main Roof	114.15, 118.4, 9, Other, , , 0.16
GF Flat Roof	30, 30, 0, Other, , , 0.16
Exposed Basement Roof	25.4, 25.4, 0, Other, , , 0.16
Heat Loss Floors	Area, Kappa, Construction, Element, Type, UValueFinal, ShelterFactor
Basement Floor	145, 110, Other, , Basement, 0, 0.15
Exposed LG Floor	24, 0, Other, , GroundSolid, 0, 0.15
Description	Data Source, Type, Glazing, Glazing Gap, Argon Filled, Solar Trans, Frame Type, Frame Factor, U Value
Window	Manufacturer, Window, Double Low-E Hard 0.15, , , 0.72, , 0.8,
External Door	Manufacturer, Solid Door, , , , , , ,
Rooflight	Manufacturer, Roof Window, Double Low-E Soft 0.05, , , 0.63, , 0.8,
Openings	Opening Type, Location, Orientation, Curtain Type, Overhang Ratio, Wide Overhang, Width, Height, Count, Area, Curtain Closed
Window - N	Window, Exposed External Walls, North, None, 0, , 0, 0, 0, 18.70,
Window - S	Window, Exposed External Walls, South, None, 0, , 0, 0, 0, 47.13,
Window - E	Window, Exposed External Walls, East, None, 0, , 0, 0, 0, 27.18,
Window - W	Window, Exposed External Walls, West, None, 0, , 0, 0, 0, 6.94,
Rooflight - N	Roof Window, Main Roof, North, None, , , 0, 0, 0, 2.55,
Rooflight - S	Roof Window, Main Roof, South, None, , , 0, 0, 0, 1.70,
External Door - S	Solid Door, Exposed External Walls, South, , , , 0, 0, 0, 2.08,
External Door - W	Solid Door, Exposed External Walls, West, , , , 0, 0, 0, 2.08,
Conservatory:	None
Draught Proofing:	100
Draught Lobby:	No
Thermal Bridges	Junction with, Bridge Type, Source Type, Imported, Length, Psi, Adjusted, Result, Reference
0.	External wall, E1 Steel lintel with perforated steel base plate, , No, 0, 0, , ,
1.	External wall, E2 Other lintels (including other steel lintels), , No, 0, 0, , ,
2.	External wall, E3 Sill, Table K1 - Default, No, 40.38, 0.08, 0.08, 3.23,
3.	External wall, E4 Jamb, Table K1 - Default, No, 39.68, 0.1, 0.1, 3.97,
4.	External wall, E5 Ground floor, Table K1 - Default, Yes, 59.18, 0.32, 0.32, 18.94,
5.	External wall, E6 Intermediate floor within a dwelling, Table K1 - Default, Yes, 144.22, 0.14, 0.14, 20.19,
6.	External wall, E7 Intermediate floor between dwellings (in blocks of flats), , No, 0, 0, , ,
7.	External wall, E8 Balcony within a dwelling, , No, 0, 0, , ,
8.	External wall, E9 Balcony between dwellings, , No, 0, 0, , ,
9.	External wall, E10 Eaves (insulation at ceiling level), , No, 0, 0, , ,
10.	External wall, E11 Eaves (insulation at rafter level), , No, 0, 0, , ,
11.	External wall, E12 Gable (insulation at ceiling level), , No, 0, 0, , ,
12.	External wall, E13 Gable (insulation at rafter level), , No, 0, 0, , ,
13.	External wall, E14 Flat roof, , No, 0, 0, , ,
14.	External wall, E15 Flat roof with parapet, , No, 0, 0, , ,
15.	External wall, E16 Corner (normal), Table K1 - Default, Yes, 38.24, 0.18, 0.18, 6.88,
16.	External wall, E17 Corner (inverted - internal area greater than external area), , No, 0, 0, , ,
17.	Party wall, E18 Party wall between dwellings, , No, 0, 0, , ,
18.	Party wall, P1 Party wall - Ground floor, , No, 0, 0, , ,
19.	Party wall, P2 Party wall - Intermediate floor within a dwelling, , No, 0, 0, , ,
20.	Party wall, P3 Party wall - Intermediate floor between dwellings (in blocks of flats), , No, 0, 0, , ,
21.	Party wall, P4 Party wall - Roof (insulation at ceiling level), , No, 0, 0, , ,
22.	Party wall, P5 Party wall - Roof (insulation at rafter level), , No, 0, 0, , ,
Pressure Test:	True
Designed q50:	4
AsBuilt q50:	15
Property Tested:	False
Mechanical Ventilation	None

```
Chimneys MHS:                 0
Chimneys SHS:                 0
Chimneys Other:               0
Chimneys Total:               0
Open Flues MHS:               0
Open Flues SHS:               0
Open Flues Other:             0
Open Flues Total:             0
Intermittent Fans:            8
Passive Vents:                0
Flueless Gas Fires:           0
Cooling System                None
Light Fittings:               80
LEL Fittings:                 60
Percentage of LEL Fittings:   75
External Lights Fitted:       Yes
External LELs Fitted:         Yes
Electricity Tariff:           Standard
Main Heating 1
    Description               Central Heating
    Percentage                100
    MHS                       Electricity PEA Heat pump ground-to-water
    SAP Code                  201
    Boiler Efficiency Type    SAP Table
    Efficiency                320
    MHS Controls              CHD Time and temperature zone control
    Delayed Start Stat        No
    Ctrl SAP Code             2207
    Boiler Compensator        None
    Pumped                    Pump in heated space
    Heat Emitter              Radiators and Underfloor
    Under Floor Heating       Yes - Pipes in thin screed
Main Heating 2                None
Smoke Control Area            Unknown
Community Heating             None
Secondary Heating             None
Water Heating
    Type                      Independent
    WHS                       HGB Gas Boiler/circulator for water heating only
    Low Water Usage           Yes
    SAP Code                  911
    Hot Water Cylinder
    Cylinder Type             HotWaterCylinder
    Cylinder Insulation Type  Foam
    Insulation Thickness      100 mm
    Cylinder Volume           300.00
    Cylinder Stat             Yes
    Pipes Insulated           Yes
    Cylinder in Heated Space  Yes
Flue Gas Heat Recovery System None
Waste Water Heat Recovery     none
PV Unit                       None
Wind Turbine                  None
Terrain Type:                 Urban
Small Scale Hydro             None
Special Features              None
```

SAP 2009 WORKSHEET FOR New Build (As Designed) BRE SAP Worksheet 9.90
CALCULATION OF FABRIC ENERGY EFFICIENCY
Calculated by program Elmhurst Energy Systems SAP2009 Calculator (Design System) version 3.08r12

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	169.0000 (1a)	x	3.2500 (2a)	=	549.2500 (1a) - (3a)	
Ground floor	193.0000 (1b)	x	3.3800 (2b)	=	652.3400 (1b) - (3b)	
First floor	126.0000 (1c)	x	2.9300 (2c)	=	369.1800 (1c) - (3c)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	488.0000					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =		1570.7700	(5)

2. Ventilation rate

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

	Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	40.0000 / (5) =	0.0255 (8)
Pressure test		Yes
Measured/design q50		4.0000
If based on air permeability value, then (18) = [(17)/20]+(8), otherwise (18) = (16)		0.2255 (18)
Number of sides on which dwelling is sheltered		2 (19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500 (20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.1916 (21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.4000	5.1000	5.1000	4.5000	4.1000	3.9000	3.7000	3.7000	4.2000	4.5000	4.8000	5.1000	(22)
Wind factor	1.3500	1.2750	1.2750	1.1250	1.0250	0.9750	0.9250	0.9250	1.0500	1.1250	1.2000	1.2750	(22a)
(22b)m	0.2587	0.2443	0.2443	0.2156	0.1964	0.1869	0.1773	0.1773	0.2012	0.2156	0.2300	0.2443	(22b)
Effective ach	0.5335	0.5299	0.5299	0.5232	0.5193	0.5175	0.5157	0.5157	0.5202	0.5232	0.5264	0.5299	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
External Door			4.1600	2.0000	8.3200			(26)
Window (Uw = 1.20)			99.9500	1.1450	114.4466			(27)
Rooflight (Uw = 1.20)			4.2500	1.1450	4.8664			(27a)
Basement Floor			145.0000	0.1500	21.7500			(28)
Exposed LG Floor			24.0000	0.1500	3.6000			(28a)
Basement Walls	203.6900		203.6900	0.1322	26.9194			(29a)
Exposed External Walls	256.3300	104.1100	152.2200	0.1500	22.8330			(29a)
Main Roof	118.4000	4.2500	114.1500	0.1600	18.2640			(30)
GF Flat Roof	30.0000		30.0000	0.1600	4.8000			(30)
Exposed Basement Roof	25.4000		25.4000	0.1600	4.0640			(30)
Total net area of external elements Aum(A, m2)			802.8200					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		229.8634			(33)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K							250.0000	(35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)							53.2100	(36)
Total fabric heat loss					(33) + (36) =		283.0734	(37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	276.5255	274.6515	274.6515	271.2246	269.1780	268.2261	267.3218	267.3218	269.6718	271.2246	272.8845	274.6515	(38)
(39)m	559.5989	557.7248	557.7248	554.2980	552.2514	551.2995	550.3951	550.3951	552.7452	554.2980	555.9578	557.7248	(39)
									Average = Sum(39)m / 12 =			554.5344	(39)
(40)m	1.1467	1.1429	1.1429	1.1359	1.1317	1.1297	1.1279	1.1279	1.1327	1.1359	1.1393	1.1429	(40)
									Average = Sum(40)m / 12 =			1.1363	(40)
(41)m	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy, N		3.3763 (42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36		114.3878 (43)

Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more that 125 litres per person per day (all water use, hot and cold)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(44)m	125.8266	121.2511	116.6756	112.1001	107.5246	102.9491	102.9491	107.5246	112.1001	116.6756	121.2511	125.8266	(44)
(45)m	187.0436	163.5896	168.8098	147.1725	141.2155	121.8582	112.9196	129.5768	131.1244	152.8128	166.8072	181.1418	(45)
Energy content (annual)										Total = Sum(45)m =		1804.0718	(45)
(46)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(46)
Water storage loss:													
(57)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(57)
Primary circuit loss (annual) from Table 3												0.0000	(58)
(59)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(59)
(65)m	39.7468	34.7628	35.8721	31.2741	30.0083	25.8949	23.9954	27.5351	27.8639	32.4727	35.4465	38.4926	(65)

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	168.8165	168.8165	168.8165	168.8165	168.8165	168.8165	168.8165	168.8165	168.8165	168.8165	168.8165	168.8165	(66)
(67)m	53.2391	47.2865	38.4559	29.1136	21.7628	18.3730	19.8527	25.8053	34.6359	43.9782	51.3290	54.7187	(67)
(68)m	597.1803	603.3772	587.7613	554.5169	512.5518	473.1106	446.7614	440.5645	456.1804	489.4248	531.3899	570.8312	(68)
(69)m	39.8817	39.8817	39.8817	39.8817	39.8817	39.8817	39.8817	39.8817	39.8817	39.8817	39.8817	39.8817	(69)
(70)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(70)

(71)m	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	(71)
(72)m	53.4231	51.7303	48.2152	43.4363	40.3337	35.9651	32.2519	37.0095	38.6999	43.6461	49.2313	51.7374	(72)
(73)m	777.4874	776.0389	748.0773	700.7118	648.2933	601.0937	572.5110	577.0243	603.1611	650.6941	705.5952	750.9322	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	18.7000	10.7264	0.7200	0.8000	0.7700	80.0667	(74)
East	27.1800	19.8726	0.7200	0.8000	0.7700	215.6051	(76)
South	47.1300	47.3233	0.7200	0.8000	0.7700	890.2836	(78)
West	6.9400	19.8726	0.7200	0.8000	0.7700	55.0515	(80)
Horizontal	4.2500	26.0000	0.6300	0.8000	1.0000	32.4562	(82)

(83)m	1273.4630	2193.7968	2971.1697	3809.1824	4351.8547	4509.1955	4381.3850	3946.7366	3327.2139	2509.8165	1530.7180	1085.8326	(83)
(84)m	2050.9505	2969.8358	3719.2470	4509.8942	5000.1480	5110.2892	4953.8960	4523.7610	3930.3750	3160.5106	2236.3131	1836.7649	(84)

7. Mean internal temperature (heating season)

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

Utilisation factor for gains for living area, ni1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	60.5593	60.7627	60.7627	61.1384	61.3650	61.4709	61.5719	61.5719	61.3102	61.1384	60.9559	60.7627	
alpha	5.0373	5.0508	5.0508	5.0759	5.0910	5.0981	5.1048	5.1048	5.0873	5.0759	5.0637	5.0508	
(86)m	0.9996	0.9974	0.9882	0.9548	0.8468	0.6543	0.4510	0.4916	0.8099	0.9763	0.9987	0.9997	(86)
(87)m	19.6168	19.8512	20.1821	20.5153	20.8259	20.9644	20.9957	20.9936	20.8996	20.5044	19.9298	19.6235	(87)
(88)m	19.9651	19.9681	19.9681	19.9738	19.9772	19.9788	19.9803	19.9803	19.9764	19.9738	19.9711	19.9681	(88)
(89)m	0.9995	0.9965	0.9839	0.9383	0.7962	0.5645	0.3413	0.3732	0.7297	0.9641	0.9982	0.9996	(89)
(90)m	18.6933	18.9298	19.2580	19.5846	19.8633	19.9632	19.9794	19.9789	19.9243	19.5806	19.0109	18.7025	(90)
Living area fraction									fLA = Living area / (4) =			0.1189	(91)
(92)m	18.8030	19.0393	19.3679	19.6952	19.9777	20.0822	20.1002	20.0995	20.0402	19.6904	19.1202	18.8120	(92)
Temperature adjustment												0.0000	
(93)m	18.8030	19.0393	19.3679	19.6952	19.9777	20.0822	20.1002	20.0995	20.0402	19.6904	19.1202	18.8120	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(94)m	0.9992	0.9953	0.9805	0.9328	0.7962	0.5741	0.3544	0.3873	0.7354	0.9597	0.9975	0.9995	(94)
(95)m	2049.3483	2956.0228	3646.5778	4206.9870	3981.1487	2933.8723	1755.5509	1752.2536	2890.3775	3033.0125	2230.6985	1835.7962	(95)
(96)m	4.5000	5.0000	6.8000	8.7000	11.7000	14.6000	16.9000	16.9000	14.3000	10.8000	7.0000	4.9000	(96)
(97)m	8003.9601	7830.0501	7009.4148	6094.6249	4571.3506	3022.3341	1761.3486	1760.9898	3172.8895	4927.9383	6738.2932	7759.0632	(97)
(98)m	4430.2312	3275.3463	2501.9507	1359.0993	439.1102	0.0000	0.0000	0.0000	0.0000	1409.8248	3245.4681	4406.9107	(98)
Space heating (October to May) (kWh/year)												21067.9414	(98)
Space heating requirement in kWh/m2/year											(98) / (4) =	43.1720	(99)

8c. Space cooling requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ext. temp.	0.0000	0.0000	0.0000	0.0000	0.0000	15.4000	17.8000	17.8000	0.0000	0.0000	0.0000	0.0000	
(100)m	0.0000	0.0000	0.0000	0.0000	0.0000	4741.1753	3412.4499	3412.4499	0.0000	0.0000	0.0000	0.0000	(100)
(101)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.9354	0.9778	0.9699	0.0000	0.0000	0.0000	0.0000	(101)
(102)m	0.0000	0.0000	0.0000	0.0000	0.0000	4434.7752	3336.7604	3309.6719	0.0000	0.0000	0.0000	0.0000	(102)
(103)m	0.0000	0.0000	0.0000	0.0000	0.0000	6464.7595	6180.7801	5722.4314	0.0000	0.0000	0.0000	0.0000	(103)
(104)m	0.0000	0.0000	0.0000	0.0000	0.0000	1461.5887	2115.9507	1795.0931	0.0000	0.0000	0.0000	0.0000	(104)
(98)m	0.0000	0.0000	0.0000	0.0000	0.0000	10.5756	0.2294	0.3329	0.0000	0.0000	0.0000	0.0000	(98)
(104)m	0.0000	0.0000	0.0000	0.0000	0.0000	1461.5887	2115.9507	1795.0931	0.0000	0.0000	0.0000	0.0000	(104)
Cooled fraction									fC = cooled area / (4) =			1.0000	(105)
(106)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.2500	0.2500	0.2500	0.0000	0.0000	0.0000	0.0000	(106)
(107)m	0.0000	0.0000	0.0000	0.0000	0.0000	365.3972	528.9877	448.7733	0.0000	0.0000	0.0000	0.0000	(107)
									Total = Sum(107)6..8 =			1343.1581	(107)
Space cooling requirement in kWh/m2/year											(107) / (4) =	2.7524	(108)

8f. Fabric Energy Efficiency

Fabric Energy Efficiency (99) + (108) = 45.9244

Fabric Energy Efficiency rounded 45.9 (109)

SAP 2009 WORKSHEET FOR New Build (As Designed) BRE SAP Worksheet 9.90
CALCULATION OF DATA FOR RENEWABLE HEAT INCENTIVE (RHI)
Calculated by program Elmhurst Energy Systems SAP2009 Calculator (Design System) version 3.08r12

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	169.0000 (1a)	x	3.2500 (2a)	=	549.2500 (1a) - (3a)	
Ground floor	193.0000 (1b)	x	3.3800 (2b)	=	652.3400 (1b) - (3b)	
First floor	126.0000 (1c)	x	2.9300 (2c)	=	369.1800 (1c) - (3c)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	488.0000					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =		1570.7700	(5)

2. Ventilation rate

	main heating		secondary heating		other		total	m3 per hour	
Number of chimneys	0	+	0	+	0	=	0 * 40 =	0.0000	(6a)
Number of open flues	0	+	0	+	0	=	0 * 20 =	0.0000	(6b)
Number of intermittent fans							8 * 10 =	80.0000	(7a)
Number of passive vents							0 * 10 =	0.0000	(7b)
Number of flueless gas fires							0 * 40 =	0.0000	(7c)

	Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	80.0000 / (5) =	0.0509 (8)
Pressure test		Yes
Measured/design q50		4.0000
If based on air permeability value, then (18) = [(17)/20]+(8), otherwise (18) = (16)		0.2509 (18)
Number of sides on which dwelling is sheltered		4 (19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7000 (20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.1757 (21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.4000	5.1000	5.1000	4.5000	4.1000	3.9000	3.7000	3.7000	4.2000	4.5000	4.8000	5.1000	(22)
Wind factor	1.3500	1.2750	1.2750	1.1250	1.0250	0.9750	0.9250	0.9250	1.0500	1.1250	1.2000	1.2750	(22a)
(22b)m	0.2371	0.2240	0.2240	0.1976	0.1800	0.1713	0.1625	0.1625	0.1844	0.1976	0.2108	0.2240	(22b)
Effective ach	0.5281	0.5251	0.5251	0.5195	0.5162	0.5147	0.5132	0.5132	0.5170	0.5195	0.5222	0.5251	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
External Door			4.1600	2.0000	8.3200			(26)
Window (Uw = 1.20)			99.9500	1.1450	114.4466			(27)
Rooflight (Uw = 1.20)			4.2500	1.1450	4.8664			(27a)
Basement Floor			145.0000	0.1500	21.7500			(28)
Exposed LG Floor			24.0000	0.1500	3.6000			(28a)
Basement Walls	203.6900		203.6900	0.1322	26.9194			(29a)
Exposed External Walls	256.3300	104.1100	152.2200	0.1500	22.8330			(29a)
Main Roof	118.4000	4.2500	114.1500	0.1600	18.2640			(30)
GF Flat Roof	30.0000		30.0000	0.1600	4.8000			(30)
Exposed Basement Roof	25.4000		25.4000	0.1600	4.0640			(30)
Total net area of external elements Aum(A, m2)			802.8200					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	229.8634			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		250.0000 (35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)		53.2100 (36)
Total fabric heat loss	(33) + (36) =	283.0734 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	273.7506	272.1763	272.1763	269.2976	267.5784	266.7787	266.0190	266.0190	267.9932	269.2976	270.6920	272.1763	(38)
(39)m	556.8240	555.2497	555.2497	552.3710	550.6517	549.8521	549.0924	549.0924	551.0665	552.3710	553.7654	555.2497	(39)
									Average = Sum(39)m / 12 =			552.5696	(39)
(40)m	1.1410	1.1378	1.1378	1.1319	1.1284	1.1267	1.1252	1.1252	1.1292	1.1319	1.1348	1.1378	(40)
									Average = Sum(40)m / 12 =			1.1323	(40)
(41)m	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy, N		3.3763 (42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36		114.3878 (43)
Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more that 125 litres per person per day (all water use, hot and cold)		

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(44)m	125.8266	121.2511	116.6756	112.1001	107.5246	102.9491	102.9491	107.5246	112.1001	116.6756	121.2511	125.8266	(44)
(45)m	187.0436	163.5896	168.8098	147.1725	141.2155	121.8582	112.9196	129.5768	131.1244	152.8128	166.8072	181.1418	(45)
Energy content (annual)										Total = Sum(45)m =		1804.0718	(45)
(46)m	28.0565	24.5384	25.3215	22.0759	21.1823	18.2787	16.9379	19.4365	19.6687	22.9219	25.0211	27.1713	(46)

Water storage loss:		
b) If manufacturer declared cylinder loss factor is not known :		
Cylinder volume (litres) including any solar storage within same cylinder		300.0000 (50)
Hot water storage loss factor from Table 2 (kWh/litre/day)		0.0103 (51)
Volume factor from Table 2a		0.7368 (52)
Temperature factor from Table 2b		0.6000 (53)
Enter (49) or (54) in (55)		1.3645 (55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(57)m	42.2998	38.2062	42.2998	40.9353	42.2998	40.9353	42.2998	42.2998	40.9353	42.2998	40.9353	42.2998	(57)
Primary circuit loss (annual) from Table 3												360.0000	(58)
(59)m	30.5753	27.6164	30.5753	29.5890	30.5753	29.5890	30.5753	30.5753	29.5890	30.5753	29.5890	30.5753	(59)
(62)m	259.9188	229.4122	241.6849	217.6968	214.0906	192.3825	185.7947	202.4519	201.6487	225.6880	237.3315	254.0169	(62)
(63)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63)
									Solar input (sum of months) = Sum(63)m =			0.0000	(63)
Water heat.	259.9188	229.4122	241.6849	217.6968	214.0906	192.3825	185.7947	202.4519	201.6487	225.6880	237.3315	254.0169	(64)
									Total per year (kWh/year) = Sum(64)m =			2662.1174	(64)
RHI water heating demand												2662	(64)
(65)m	120.4921	107.0517	114.4293	105.3543	105.2542	96.9373	95.8458	101.3844	100.0183	109.1104	111.8828	118.5297	(65)

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	202.5798	202.5798	202.5798	202.5798	202.5798	202.5798	202.5798	202.5798	202.5798	202.5798	202.5798	202.5798	(66)
(67)m	166.3721	147.7702	120.1748	90.9801	68.0087	57.4158	62.0398	80.6416	108.2370	137.4318	160.4032	170.9961	(67)
(68)m	891.3139	900.5630	877.2557	827.6372	765.0027	706.1352	666.8081	657.5590	680.8663	730.4848	793.1193	851.9868	(68)
(69)m	58.6343	58.6343	58.6343	58.6343	58.6343	58.6343	58.6343	58.6343	58.6343	58.6343	58.6343	58.6343	(69)
(70)m	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	(70)
(71)m	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	(71)
(72)m	161.9517	159.3031	153.8029	146.3254	141.4707	134.6351	128.8251	136.2693	138.9143	146.6537	155.3928	159.3142	(72)
(73)m	1355.7987	1343.7972	1287.3943	1201.1035	1110.6430	1034.3470	993.8338	1010.6309	1064.1786	1150.7312	1245.0762	1318.4579	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	18.7000	11.6736	0.7200	0.8000	0.7700	87.1366	(74)
East	27.1800	21.7895	0.7200	0.8000	0.7700	236.4031	(76)
South	47.1300	49.8711	0.7200	0.8000	0.7700	938.2152	(78)
West	6.9400	21.7895	0.7200	0.8000	0.7700	60.3619	(80)
Horizontal	4.2500	29.0000	0.6300	0.8000	1.0000	35.8650	(82)

(83)m	1357.9819	2136.7993	3005.5145	3778.9889	4346.7245	4788.0208	4576.4969	4169.5024	3429.5872	2579.0877	1729.3725	1137.2131	(83)
(84)m	2713.7805	3480.5964	4292.9088	4980.0924	5457.3676	5822.3679	5570.3307	5180.1333	4493.7657	3729.8189	2974.4487	2455.6710	(84)

7. Mean internal temperature (heating season)

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

Utilisation factor for gains for living area, ni1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	60.8610	61.0336	61.0336	61.3517	61.5432	61.6327	61.7180	61.7180	61.4969	61.3517	61.1972	61.0336	
alpha	5.0574	5.0689	5.0689	5.0901	5.1029	5.1088	5.1145	5.1145	5.0998	5.0901	5.0798	5.0689	
(86)m	0.9982	0.9939	0.9745	0.9235	0.7601	0.5190	0.3148	0.3383	0.6789	0.9397	0.9942	0.9988	(86)
(87)m	20.0580	20.2019	20.4593	20.6768	20.8777	20.9386	20.9464	20.9463	20.9177	20.7023	20.3006	20.0563	(87)
(88)m	19.9696	19.9722	19.9722	19.9770	19.9798	19.9812	19.9824	19.9824	19.9792	19.9770	19.9747	19.9722	(88)
(89)m	0.9976	0.9918	0.9654	0.8977	0.6940	0.4292	0.2151	0.2312	0.5800	0.9115	0.9918	0.9983	(89)
(90)m	18.7111	18.9226	19.2929	19.5962	19.8433	19.8991	19.9046	19.9046	19.8837	19.6385	19.0691	18.7106	(90)
Living area fraction									fLA = Living area / (4) =			0.1189	(91)
(92)m	18.8711	19.0747	19.4315	19.7246	19.9663	20.0227	20.0284	20.0284	20.0066	19.7649	19.2155	18.8706	(92)
Temperature adjustment												0.0000	
(93)m	18.8711	19.0747	19.4315	19.7246	19.9663	20.0227	20.0284	20.0284	20.0066	19.7649	19.2155	18.8706	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(94)m	0.9966	0.9892	0.9592	0.8900	0.6931	0.4330	0.2196	0.2361	0.5829	0.9040	0.9892	0.9975	(94)
(95)m	2704.5926	3442.9538	4117.8810	4432.4942	3782.3295	2520.8989	1223.2058	1223.0056	2619.3299	3371.8824	2942.3607	2449.6340	(95)
(96)m	5.1000	5.5000	7.4000	9.3000	12.6000	15.4000	17.8000	17.8000	15.1000	11.6000	7.6000	5.5000	(96)
(97)m	7668.1038	7537.3382	6680.4970	5758.2576	4056.2413	2541.7801	1223.6163	1223.5882	2703.8804	4510.0737	6432.2378	7424.0091	(97)
(98)m	3692.8523	2751.4263	1906.5862	954.5496	203.7904	0.0000	0.0000	0.0000	0.0000	846.8143	2512.7115	3700.9350	(98)
Space heating (October to May) (kWh/year)												16569.6657	(98)
RHI space heating demand												16570	(98)

SAP 2009 WORKSHEET FOR New Build (As Designed) BRE SAP Worksheet 9.90
CALCULATION OF ENERGY RATINGS
Calculated by program Elmhurst Energy Systems SAP2009 Calculator (Design System) version 3.08r12

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	169.0000 (1a)	x	3.2500 (2a)	=	549.2500 (1a) - (3a)	
Ground floor	193.0000 (1b)	x	3.3800 (2b)	=	652.3400 (1b) - (3b)	
First floor	126.0000 (1c)	x	2.9300 (2c)	=	369.1800 (1c) - (3c)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	488.0000					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	1570.7700	(5)

2. Ventilation rate

	main heating		secondary heating		other		total	m3 per hour	
Number of chimneys	0	+	0	+	0	=	0 * 40 =	0.0000	(6a)
Number of open flues	0	+	0	+	0	=	0 * 20 =	0.0000	(6b)
Number of intermittent fans							8 * 10 =	80.0000	(7a)
Number of passive vents							0 * 10 =	0.0000	(7b)
Number of flueless gas fires							0 * 40 =	0.0000	(7c)

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	80.0000 / (5) =	0.0509	(8)
Pressure test		Yes	
Measured/design q50		4.0000	
If based on air permeability value, then (18) = [(17)/20]+(8), otherwise (18) = (16)		0.2509	(18)
Number of sides on which dwelling is sheltered		4	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7000	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.1757	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.4000	5.1000	5.1000	4.5000	4.1000	3.9000	3.7000	3.7000	4.2000	4.5000	4.8000	5.1000	(22)
Wind factor	1.3500	1.2750	1.2750	1.1250	1.0250	0.9750	0.9250	0.9250	1.0500	1.1250	1.2000	1.2750	(22a)
(22b)m	0.2371	0.2240	0.2240	0.1976	0.1800	0.1713	0.1625	0.1625	0.1844	0.1976	0.2108	0.2240	(22b)
Effective ach	0.5281	0.5251	0.5251	0.5195	0.5162	0.5147	0.5132	0.5132	0.5170	0.5195	0.5222	0.5251	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
External Door			4.1600	2.0000	8.3200			(26)
Window (Uw = 1.20)			99.9500	1.1450	114.4466			(27)
Rooflight (Uw = 1.20)			4.2500	1.1450	4.8664			(27a)
Basement Floor			145.0000	0.1500	21.7500			(28)
Exposed LG Floor			24.0000	0.1500	3.6000			(28a)
Basement Walls	203.6900		203.6900	0.1322	26.9194			(29a)
Exposed External Walls	256.3300	104.1100	152.2200	0.1500	22.8330			(29a)
Main Roof	118.4000	4.2500	114.1500	0.1600	18.2640			(30)
GF Flat Roof	30.0000		30.0000	0.1600	4.8000			(30)
Exposed Basement Roof	25.4000		25.4000	0.1600	4.0640			(30)
Total net area of external elements Aum(A, m2)			802.8200					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		229.8634			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		250.0000 (35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)		53.2100 (36)
Total fabric heat loss	(33) + (36) =	283.0734 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	273.7506	272.1763	272.1763	269.2976	267.5784	266.7787	266.0190	266.0190	267.9932	269.2976	270.6920	272.1763	(38)
(39)m	556.8240	555.2497	555.2497	552.3710	550.6517	549.8521	549.0924	549.0924	551.0665	552.3710	553.7654	555.2497	(39)
									Average = Sum(39)m / 12 =			552.5696	(39)
(40)m	1.1410	1.1378	1.1378	1.1319	1.1284	1.1267	1.1252	1.1252	1.1292	1.1319	1.1348	1.1378	(40)
									Average = Sum(40)m / 12 =			1.1323	(40)
(41)m	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy, N		3.3763 (42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36		114.3878 (43)

Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more that 125 litres per person per day (all water use, hot and cold)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(44)m	125.8266	121.2511	116.6756	112.1001	107.5246	102.9491	102.9491	107.5246	112.1001	116.6756	121.2511	125.8266	(44)
(45)m	187.0436	163.5896	168.8098	147.1725	141.2155	121.8582	112.9196	129.5768	131.1244	152.8128	166.8072	181.1418	(45)
Energy content (annual)										Total = Sum(45)m =		1804.0718	(45)
(46)m	28.0565	24.5384	25.3215	22.0759	21.1823	18.2787	16.9379	19.4365	19.6687	22.9219	25.0211	27.1713	(46)

Water storage loss:		
b) If manufacturer declared cylinder loss factor is not known :		
Cylinder volume (litres) including any solar storage within same cylinder		300.0000 (50)
Hot water storage loss factor from Table 2 (kWh/litre/day)		0.0103 (51)
Volume factor from Table 2a		0.7368 (52)
Temperature factor from Table 2b		0.6000 (53)
Enter (49) or (54) in (55)		1.3645 (55)

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(57)m		42.2998	38.2062	42.2998	40.9353	42.2998	40.9353	42.2998	42.2998	40.9353	42.2998	40.9353	42.2998	(57)
Primary circuit loss (annual) from Table 3													360.0000	(58)
(59)m		30.5753	27.6164	30.5753	29.5890	30.5753	29.5890	30.5753	30.5753	29.5890	30.5753	29.5890	30.5753	(59)
(62)m		259.9188	229.4122	241.6849	217.6968	214.0906	192.3825	185.7947	202.4519	201.6487	225.6880	237.3315	254.0169	(62)
(63)m		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63)
									Solar input (sum of months) = Sum(63)m =				0.0000	(63)
Water heat.		259.9188	229.4122	241.6849	217.6968	214.0906	192.3825	185.7947	202.4519	201.6487	225.6880	237.3315	254.0169	(64)
									Total per year (kWh/year) = Sum(64)m =				2662.1174	(64)
(65)m		120.4921	107.0517	114.4293	105.3543	105.2542	96.9373	95.8458	101.3844	100.0183	109.1104	111.8828	118.5297	(65)

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	202.5798	202.5798	202.5798	202.5798	202.5798	202.5798	202.5798	202.5798	202.5798	202.5798	202.5798	202.5798	(66)
(67)m	166.3721	147.7702	120.1748	90.9801	68.0087	57.4158	62.0398	80.6416	108.2370	137.4318	160.4032	170.9961	(67)
(68)m	891.3139	900.5630	877.2557	827.6372	765.0027	706.1352	666.8081	657.5590	680.8663	730.4848	793.1193	851.9868	(68)
(69)m	58.6343	58.6343	58.6343	58.6343	58.6343	58.6343	58.6343	58.6343	58.6343	58.6343	58.6343	58.6343	(69)
(70)m	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	(70)
(71)m	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	(71)
(72)m	161.9517	159.3031	153.8029	146.3254	141.4707	134.6351	128.8251	136.2693	138.9143	146.6537	155.3928	159.3142	(72)
(73)m	1355.7987	1343.7972	1287.3943	1201.1035	1110.6430	1034.3470	993.8338	1010.6309	1064.1786	1150.7312	1245.0762	1318.4579	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	18.7000	10.7264	0.7200	0.8000	0.7700	80.0667	(74)
East	27.1800	19.8726	0.7200	0.8000	0.7700	215.6051	(76)
South	47.1300	47.3233	0.7200	0.8000	0.7700	890.2836	(78)
West	6.9400	19.8726	0.7200	0.8000	0.7700	55.0515	(80)
Horizontal	4.2500	26.0000	0.6300	0.8000	1.0000	32.4562	(82)

(83)m	1273.4630	2193.7968	2971.1697	3809.1824	4351.8547	4509.1955	4381.3850	3946.7366	3327.2139	2509.8165	1530.7180	1085.8326	(83)
(84)m	2629.2617	3537.5940	4258.5639	5010.2859	5462.4977	5543.5425	5375.2188	4957.3675	4391.3925	3660.5477	2775.7941	2404.2906	(84)

7. Mean internal temperature (heating season)

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

Utilisation factor for gains for living area, ni1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	60.8610	61.0336	61.0336	61.3517	61.5432	61.6327	61.7180	61.7180	61.4969	61.3517	61.1972	61.0336	
alpha	5.0574	5.0689	5.0689	5.0901	5.1029	5.1088	5.1145	5.1145	5.0998	5.0901	5.0798	5.0689	
(86)m	0.9987	0.9943	0.9792	0.9340	0.8080	0.6105	0.4160	0.4497	0.7561	0.9580	0.9965	0.9991	(86)
(87)m	19.9977	20.1701	20.4091	20.6404	20.8443	20.9274	20.9447	20.9438	20.8929	20.6386	20.2248	20.0007	(87)
(88)m	19.9696	19.9722	19.9722	19.9770	19.9798	19.9812	19.9824	19.9824	19.9792	19.9770	19.9747	19.9722	(88)
(89)m	0.9983	0.9924	0.9720	0.9121	0.7525	0.5235	0.3143	0.3405	0.6710	0.9386	0.9951	0.9987	(89)
(90)m	18.6228	18.8763	19.2212	19.5469	19.8067	19.8912	19.9040	19.9037	19.8624	19.5524	18.9588	18.6294	(90)
Living area fraction										fLA = Living area / (4) =		0.1189	(91)
(92)m	18.7862	19.0300	19.3624	19.6769	19.9300	20.0144	20.0277	20.0273	19.9848	19.6815	19.1093	18.7924	(92)
Temperature adjustment												0.0000	
(93)m	18.7862	19.0300	19.3624	19.6769	19.9300	20.0144	20.0277	20.0273	19.9848	19.6815	19.1093	18.7924	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(94)m	0.9975	0.9899	0.9664	0.9043	0.7495	0.5264	0.3189	0.3454	0.6715	0.9313	0.9933	0.9981	(94)
(95)m	2622.7380	3501.9804	4115.4141	4530.6749	4094.1986	2918.2462	1713.9819	1712.2259	2948.9057	3408.9445	2757.2798	2399.7942	(95)
(96)m	4.5000	5.0000	6.8000	8.7000	11.7000	14.6000	16.9000	16.9000	14.3000	10.8000	7.0000	4.9000	(96)
(97)m	7954.9182	7790.1716	6975.2681	6063.3130	4531.8816	2977.1080	1717.3996	1717.1907	3132.7270	4905.8885	6705.7084	7713.7499	(97)
(98)m	3967.1421	2881.6645	2127.7314	1103.4994	325.6362	0.0000	0.0000	0.0000	0.0000	1113.7264	2842.8686	3953.5830	(98)
Space heating (October to May) (kWh/year)												18315.8516	(98)
Space heating requirement in kWh/m2/year											(98) / (4) =	37.5325	(99)

8c. Space cooling requirement

Not applicable

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

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000 (201)
Fraction of space heat from main system(s)	1.0000 (202)
Efficiency of main space heating system 1 (in %)	224.0000 (206)
Efficiency of secondary/supplementary heating system, %	0.0000 (208)

Space heating:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(98)m	3967.1421	2881.6645	2127.7314	1103.4994	325.6362	0.0000	0.0000	0.0000	0.0000	1113.7264	2842.8686	3953.5830	(98)
(211)m	1771.0456	1286.4574	949.8801	492.6337	145.3733	0.0000	0.0000	0.0000	0.0000	497.1993	1269.1378	1764.9924	(211)
(215)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)

Annual totals kWh/year

Space heating fuel used, main system 1	8176.7195 (211)
Space heating fuel used, secondary	0.0000 (215)

Water heating

(64)m	259.9188	229.4122	241.6849	217.6968	214.0906	192.3825	185.7947	202.4519	201.6487	225.6880	237.3315	254.0169	(64)
Efficiency of water heater												65.0000	(216)
(217)m	65.0000	65.0000	65.0000	65.0000	65.0000	65.0000	65.0000	65.0000	65.0000	65.0000	65.0000	65.0000	(217)
(219)m	399.8750	352.9419	371.8229	334.9181	329.3701	295.9731	285.8379	311.4645	310.2288	347.2122	365.1253	390.7952	(219)

Water heating fuel used	4095.5652 (219)
Electricity for pumps, fans and electric keep-hot (Table 4f):	
central heating pump	130.0000 (230c)
Total electricity for the above, kWh/year	130.0000 (231)
Electricity for lighting (calculated in Appendix L)	1175.2731 (232)

10a. Fuel costs - using Table 12 prices

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating - main system 1	8176.7195	11.4600	937.0520	(240)

Space heating - secondary	0.0000	0.0000	0.0000 (242)
Water heating cost (other fuel)	4095.5652	3.1000	126.9625 (247)
Pumps and fans for heating	130.0000	11.4600	14.8980 (249)
Energy for lighting	1175.2731	11.4600	134.6863 (250)
Additional standing charges			106.0000 (251)
Total energy cost			1319.5989 (255)

11a. SAP rating - Individual heating systems

Energy cost deflator (Table 12):		0.4700 (256)
Energy cost factor (ECF)	[(255) x (256)] / [(4) + 45.0] =	1.1636 (257)
SAP value		83.7674
SAP rating (Section 12)		84 (258)
SAP band		B

10a. Fuel costs - using BEDF prices (333)

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year
Space heating - main system 1	8176.7195	13.1900	1078.5093 (240)
Space heating - secondary	0.0000	0.0000	0.0000 (242)
Water heating cost (other fuel)	4095.5652	3.4800	142.5257 (247)
Pumps and fans for heating	130.0000	13.1900	17.1470 (249)
Energy for lighting	1175.2731	13.1900	155.0185 (250)
Additional standing charges			120.0000 (251)
Total energy cost			1513.2005 (255)

12a. CO2 emissions - Individual heating systems including micro-CHP

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year
Space heating - main system 1	8176.7195	0.5170	4227.3640 (261)
Space heating - secondary	0.0000	0.0000	0.0000 (263)
Water heating cost (other fuel)	4095.5652	0.1980	810.9219 (264)
Space and water heating			5038.2859 (265)
Pumps and fans	130.0000	0.5170	67.2100 (267)
Energy for lighting	1175.2731	0.5170	607.6162 (268)
Total CO2, kg/year			5713.1121 (272)
CO2 emissions per m2			11.7100 (273)
EI value			85.6368
EI rating			86 (274)
EI band			B

13a. Primary energy - Individual heating systems including micro-CHP

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year
Space heating - main system 1	8176.7195	2.9200	23876.0208 (261)
Space heating - secondary	0.0000	0.0000	0.0000 (263)
Water heating cost (other fuel)	4095.5652	1.0200	4177.4765 (264)
Space and water heating			28053.4973 (265)
Pumps and fans	130.0000	2.9200	379.6000 (267)
Energy for lighting	1175.2731	2.9200	3431.7974 (268)
Primary energy kWh/year			31864.8947 (272)
Primary energy kWh/m2/year			65.2969 (273)

SAP 2009 WORKSHEET FOR New Build (As Designed) BRE SAP Worksheet 9.90
CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE
Calculated by program Elmhurst Energy Systems SAP2009 Calculator (Design System) version 3.08r12

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	169.0000 (1a)	x	3.2500 (2a)	=	549.2500 (1a) - (3a)	
Ground floor	193.0000 (1b)	x	3.3800 (2b)	=	652.3400 (1b) - (3b)	
First floor	126.0000 (1c)	x	2.9300 (2c)	=	369.1800 (1c) - (3c)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	488.0000					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =		1570.7700	(5)

2. Ventilation rate

	main heating		secondary heating		other		total	m3 per hour	
Number of chimneys	0	+	0	+	0	=	0 * 40 =	0.0000	(6a)
Number of open flues	0	+	0	+	0	=	0 * 20 =	0.0000	(6b)
Number of intermittent fans							8 * 10 =	80.0000	(7a)
Number of passive vents							0 * 10 =	0.0000	(7b)
Number of flueless gas fires							0 * 40 =	0.0000	(7c)

	Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	80.0000 / (5) =	0.0509 (8)
Pressure test		Yes
Measured/design q50		4.0000
If based on air permeability value, then (18) = [(17)/20]+(8), otherwise (18) = (16)		0.2509 (18)
Number of sides on which dwelling is sheltered		4 (19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7000 (20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.1757 (21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.4000	5.1000	5.1000	4.5000	4.1000	3.9000	3.7000	3.7000	4.2000	4.5000	4.8000	5.1000	(22)
Wind factor	1.3500	1.2750	1.2750	1.1250	1.0250	0.9750	0.9250	0.9250	1.0500	1.1250	1.2000	1.2750	(22a)
(22b)m	0.2371	0.2240	0.2240	0.1976	0.1800	0.1713	0.1625	0.1625	0.1844	0.1976	0.2108	0.2240	(22b)
Effective ach	0.5281	0.5251	0.5251	0.5195	0.5162	0.5147	0.5132	0.5132	0.5170	0.5195	0.5222	0.5251	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
External Door			4.1600	2.0000	8.3200			(26)
Window (Uw = 1.20)			99.9500	1.1450	114.4466			(27)
Rooflight (Uw = 1.20)			4.2500	1.1450	4.8664			(27a)
Basement Floor			145.0000	0.1500	21.7500			(28)
Exposed LG Floor			24.0000	0.1500	3.6000			(28a)
Basement Walls	203.6900		203.6900	0.1322	26.9194			(29a)
Exposed External Walls	256.3300	104.1100	152.2200	0.1500	22.8330			(29a)
Main Roof	118.4000	4.2500	114.1500	0.1600	18.2640			(30)
GF Flat Roof	30.0000		30.0000	0.1600	4.8000			(30)
Exposed Basement Roof	25.4000		25.4000	0.1600	4.0640			(30)
Total net area of external elements Aum(A, m2)			802.8200					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		229.8634			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		250.0000 (35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)		53.2100 (36)
Total fabric heat loss	(33) + (36) =	283.0734 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	273.7506	272.1763	272.1763	269.2976	267.5784	266.7787	266.0190	266.0190	267.9932	269.2976	270.6920	272.1763	(38)
(39)m	556.8240	555.2497	555.2497	552.3710	550.6517	549.8521	549.0924	549.0924	551.0665	552.3710	553.7654	555.2497	(39)
									Average = Sum(39)m / 12 =			552.5696	(39)
(40)m	1.1410	1.1378	1.1378	1.1319	1.1284	1.1267	1.1252	1.1252	1.1292	1.1319	1.1348	1.1378	(40)
									Average = Sum(40)m / 12 =			1.1323	(40)
(41)m	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy, N		3.3763 (42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36		114.3878 (43)

Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more that 125 litres per person per day (all water use, hot and cold)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(44)m	125.8266	121.2511	116.6756	112.1001	107.5246	102.9491	102.9491	107.5246	112.1001	116.6756	121.2511	125.8266	(44)
(45)m	187.0436	163.5896	168.8098	147.1725	141.2155	121.8582	112.9196	129.5768	131.1244	152.8128	166.8072	181.1418	(45)
Energy content (annual)										Total = Sum(45)m =		1804.0718	(45)
(46)m	28.0565	24.5384	25.3215	22.0759	21.1823	18.2787	16.9379	19.4365	19.6687	22.9219	25.0211	27.1713	(46)

Water storage loss:		
b) If manufacturer declared cylinder loss factor is not known :		
Cylinder volume (litres) including any solar storage within same cylinder		300.0000 (50)
Hot water storage loss factor from Table 2 (kWh/litre/day)		0.0103 (51)
Volume factor from Table 2a		0.7368 (52)
Temperature factor from Table 2b		0.6000 (53)
Enter (49) or (54) in (55)		1.3645 (55)

(57)m	42.2998	38.2062	42.2998	40.9353	42.2998	40.9353	42.2998	42.2998	40.9353	42.2998	40.9353	42.2998	(57)
Primary circuit loss (annual) from Table 3												360.0000	(58)
(59)m	30.5753	27.6164	30.5753	29.5890	30.5753	29.5890	30.5753	30.5753	29.5890	30.5753	29.5890	30.5753	(59)
(62)m	259.9188	229.4122	241.6849	217.6968	214.0906	192.3825	185.7947	202.4519	201.6487	225.6880	237.3315	254.0169	(62)
(63)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63)
								Solar input (sum of months) = Sum(63)m =				0.0000	(63)
Water heat.	259.9188	229.4122	241.6849	217.6968	214.0906	192.3825	185.7947	202.4519	201.6487	225.6880	237.3315	254.0169	(64)
								Total per year (kWh/year) = Sum(64)m =				2662.1174	(64)
(65)m	120.4921	107.0517	114.4293	105.3543	105.2542	96.9373	95.8458	101.3844	100.0183	109.1104	111.8828	118.5297	(65)

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	168.8165	168.8165	168.8165	168.8165	168.8165	168.8165	168.8165	168.8165	168.8165	168.8165	168.8165	168.8165	(66)
(67)m	66.5488	59.1081	48.0699	36.3920	27.2035	22.9663	24.8159	32.2567	43.2948	54.9727	64.1613	68.3984	(67)
(68)m	597.1803	603.3772	587.7613	554.5169	512.5518	473.1106	446.7614	440.5645	456.1804	489.4248	531.3899	570.8312	(68)
(69)m	39.8817	39.8817	39.8817	39.8817	39.8817	39.8817	39.8817	39.8817	39.8817	39.8817	39.8817	39.8817	(69)
(70)m	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	(70)
(71)m	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	(71)
(72)m	161.9517	159.3031	153.8029	146.3254	141.4707	134.6351	128.8251	136.2693	138.9143	146.6537	155.3928	159.3142	(72)
(73)m	909.3259	905.4333	873.2790	820.8793	764.8710	714.3570	684.0473	692.7355	722.0345	774.6962	834.5889	882.1887	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	18.7000	10.7264	0.7200	0.8000	0.7700	80.0667	(74)
East	27.1800	19.8726	0.7200	0.8000	0.7700	215.6051	(76)
South	47.1300	47.3233	0.7200	0.8000	0.7700	890.2836	(78)
West	6.9400	19.8726	0.7200	0.8000	0.7700	55.0515	(80)
Horizontal	4.2500	26.0000	0.6300	0.8000	1.0000	32.4562	(82)

(83)m	1273.4630	2193.7968	2971.1697	3809.1824	4351.8547	4509.1955	4381.3850	3946.7366	3327.2139	2509.8165	1530.7180	1085.8326	(83)
(84)m	2182.7889	3099.2302	3844.4487	4630.0617	5116.7257	5223.5525	5065.4323	4639.4721	4049.2484	3284.5127	2365.3069	1968.0213	(84)

7. Mean internal temperature (heating season)

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

Utilisation factor for gains for living area, ni1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	60.8610	61.0336	61.0336	61.3517	61.5432	61.6327	61.7180	61.7180	61.4969	61.3517	61.1972	61.0336	
alpha	5.0574	5.0689	5.0689	5.0901	5.1029	5.1088	5.1145	5.1145	5.0998	5.0901	5.0798	5.0689	
(86)m	0.9995	0.9969	0.9864	0.9499	0.8365	0.6416	0.4405	0.4790	0.7952	0.9722	0.9983	0.9996	(86)
(87)m	19.9334	20.1082	20.3544	20.5997	20.8249	20.9226	20.9440	20.9427	20.8784	20.5932	20.1662	19.9379	(87)
(88)m	19.9696	19.9722	19.9722	19.9770	19.9798	19.9812	19.9824	19.9824	19.9792	19.9770	19.9747	19.9722	(88)
(89)m	0.9993	0.9958	0.9814	0.9322	0.7844	0.5525	0.3333	0.3635	0.7133	0.9584	0.9976	0.9995	(89)
(90)m	18.5289	18.7863	19.1436	19.4931	19.7861	19.8879	19.9038	19.9034	19.8500	19.4914	18.8735	18.5374	(90)
Living area fraction										fLA = Living area / (4) =		0.1189	(91)
(92)m	18.6958	18.9434	19.2875	19.6246	19.9096	20.0109	20.0274	20.0269	19.9722	19.6223	19.0272	18.7039	(92)
Temperature adjustment												0.0000	
(93)m	18.6958	18.9434	19.2875	19.6246	19.9096	20.0109	20.0274	20.0269	19.9722	19.6223	19.0272	18.7039	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(94)m	0.9989	0.9942	0.9769	0.9245	0.7804	0.5553	0.3381	0.3686	0.7127	0.9519	0.9966	0.9992	(94)
(95)m	2180.4315	3081.2229	3755.7920	4280.6796	3992.9139	2900.5976	1712.7571	1710.2408	2885.9011	3126.4889	2357.3587	1966.5344	(95)
(96)m	4.5000	5.0000	6.8000	8.7000	11.7000	14.6000	16.9000	16.9000	14.3000	10.8000	7.0000	4.9000	(96)
(97)m	7904.5881	7742.0723	6933.6786	6034.4453	4520.6292	2975.1962	1717.2538	1716.9559	3125.7830	4873.1959	6660.2197	7664.5932	(97)
(98)m	4258.7725	3132.0908	2364.3476	1262.7113	392.6202	0.0000	0.0000	0.0000	0.0000	1299.5500	3098.0599	4239.3557	(98)
Space heating (October to May) (kWh/year)												20047.5080	(98)
Space heating requirement in kWh/m2/year											(98) / (4) =	41.0810	(99)

8c. Space cooling requirement

Not applicable

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

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000 (201)
Fraction of space heat from main system(s)	1.0000 (202)
Efficiency of main space heating system 1 (in %)	224.0000 (206)
Efficiency of secondary/supplementary heating system, %	0.0000 (208)

Space heating:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(98)m	4258.7725	3132.0908	2364.3476	1262.7113	392.6202	0.0000	0.0000	0.0000	0.0000	1299.5500	3098.0599	4239.3557	(98)
(211)m	1901.2377	1398.2548	1055.5123	563.7104	175.2769	0.0000	0.0000	0.0000	0.0000	580.1562	1383.0624	1892.5695	(211)
(215)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)

Annual totals kWh/year	
Space heating fuel used, main system 1	8949.7804 (211)
Space heating fuel used, secondary	0.0000 (215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(64)m	259.9188	229.4122	241.6849	217.6968	214.0906	192.3825	185.7947	202.4519	201.6487	225.6880	237.3315	254.0169	(64)
Efficiency of water heater												65.0000	(216)
(217)m	65.0000	65.0000	65.0000	65.0000	65.0000	65.0000	65.0000	65.0000	65.0000	65.0000	65.0000	65.0000	(217)
(219)m	399.8750	352.9419	371.8229	334.9181	329.3701	295.9731	285.8379	311.4645	310.2288	347.2122	365.1253	390.7952	(219)

Water heating fuel used	4095.5652 (219)
Electricity for pumps, fans and electric keep-hot (Table 4f):	
central heating pump	130.0000 (230c)
Total electricity for the above, kWh/year	130.0000 (231)
Electricity for lighting (calculated in Appendix L)	1175.2731 (232)

12a. CO2 emissions - Individual heating systems including micro-CHP

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	8949.7804	0.5170	4627.0364	(261)

Space heating - secondary	0.0000	0.0000		0.0000 (263)
Water heating cost (other fuel)	4095.5652	0.1980		810.9219 (264)
Space and water heating				5437.9584 (265)
Pumps and fans	130.0000	0.5170		67.2100 (267)
Energy for lighting	1175.2731	0.5170		607.6162 (268)
Total CO2, kg/year				6112.7845 (272)
Dwelling Carbon Dioxide Emission Rate (DER)				12.5300 (273)

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

DER		12.5300	ZC1
Total Floor Area	TFA	488.0000	
Assumed number of occupants	N	3.3763	
CO2 emission factor in Table 12 for electricity displaced from grid	EF	0.5290	
CO2 emissions from appliances, equation (L14)		7.3913	ZC2
CO2 emissions from cooking, equation (L16)		0.4099	ZC3
Total CO2 emissions		20.3312	ZC4
Residual CO2 emissions offset from biofuel CHP		0.0000	ZC5
Additional allowable electricity generation, kWh/m²/year		0.0000	ZC6
Resulting CO2 emissions offset from additional allowable electricity generation		0.0000	ZC7
Net CO2 emissions		20.3312	ZC8

SAP 2009 WORKSHEET FOR New Build (As Designed) BRE SAP Worksheet 9.90
CALCULATION OF TARGET EMISSIONS
Calculated by program Elmhurst Energy Systems SAP2009 Calculator (Design System) version 3.08r12

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	169.0000 (1a)	x	3.2500 (2a)	=	549.2500 (1a) - (3a)	
Ground floor	193.0000 (1b)	x	3.3800 (2b)	=	652.3400 (1b) - (3b)	
First floor	126.0000 (1c)	x	2.9300 (2c)	=	369.1800 (1c) - (3c)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	488.0000					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =		1570.7700	(5)

2. Ventilation rate

	main heating		secondary heating		other		total	m3 per hour	
Number of chimneys	0	+	0	+	0	=	0 * 40 =	0.0000	(6a)
Number of open flues	0	+	0	+	0	=	0 * 20 =	0.0000	(6b)
Number of intermittent fans							3 * 10 =	30.0000	(7a)
Number of passive vents							0 * 10 =	0.0000	(7b)
Number of flueless gas fires							0 * 40 =	0.0000	(7c)

	Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	30.0000 / (5) =	0.0191 (8)
Pressure test		Yes
Measured/design q50		10.0000
If based on air permeability value, then (18) = [(17)/20]+(8), otherwise (18) = (16)		0.5191 (18)
Number of sides on which dwelling is sheltered		2 (19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500 (20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.4412 (21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.4000	5.1000	5.1000	4.5000	4.1000	3.9000	3.7000	3.7000	4.2000	4.5000	4.8000	5.1000	(22)
Wind factor	1.3500	1.2750	1.2750	1.1250	1.0250	0.9750	0.9250	0.9250	1.0500	1.1250	1.2000	1.2750	(22a)
(22b)m	0.5957	0.5626	0.5626	0.4964	0.4523	0.4302	0.4081	0.4081	0.4633	0.4964	0.5295	0.5626	(22b)
Effective ach	0.6774	0.6582	0.6582	0.6232	0.6023	0.5925	0.5833	0.5833	0.6073	0.6232	0.6402	0.6582	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
Doors			1.8500	2.0000	3.7000			(26)
Windows (Uw = 2.00)			120.1500	1.8519	222.5000			(27)
Basement Floor			145.0000	0.2500	36.2500			(28)
Exposed LG Floor			24.0000	0.2500	6.0000			(28a)
Basement Walls	460.0200	122.0000	338.0200	0.3500	118.3070			(29a)
Main Roof	173.8000		173.8000	0.1600	27.8080			(30)
Total net area of external elements Aum(A, m2)			802.8200					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		414.5650			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		250.0000 (35)
Thermal bridges (User defined value 0.110 * total exposed area)		88.3102 (36)
Total fabric heat loss	(33) + (36) =	502.8752 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	351.1377	341.2037	341.2037	323.0386	312.1900	307.1442	302.3506	302.3506	314.8076	323.0386	331.8373	341.2037	(38)
(39)m	854.0129	844.0789	844.0789	825.9138	815.0652	810.0194	805.2258	805.2258	817.6828	825.9138	834.7125	844.0789	(39)
									Average = Sum(39)m / 12 =			827.1674	(39)
(40)m	1.7500	1.7297	1.7297	1.6924	1.6702	1.6599	1.6501	1.6501	1.6756	1.6924	1.7105	1.7297	(40)
									Average = Sum(40)m / 12 =			1.6950	(40)
(41)m	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy, N	3.3763 (42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	120.4083 (43)

Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more that 125 litres per person per day (all water use, hot and cold)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(44)m	132.4491	127.6327	122.8164	118.0001	113.1838	108.3674	108.3674	113.1838	118.0001	122.8164	127.6327	132.4491	(44)
(45)m	196.8881	172.1995	177.6945	154.9184	148.6479	128.2718	118.8627	136.3967	138.0257	160.8556	175.5865	190.6756	(45)
Energy content (annual)										Total = Sum(45)m =		1899.0229	(45)
(46)m	29.5332	25.8299	26.6542	23.2378	22.2972	19.2408	17.8294	20.4595	20.7039	24.1283	26.3380	28.6013	(46)

Water storage loss:	
b) If manufacturer declared cylinder loss factor is not known :	
Cylinder volume (litres) including any solar storage within same cylinder	150.0000 (50)
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.0191 (51)
Volume factor from Table 2a	0.9283 (52)
Temperature factor from Table 2b	0.5400 (53)
Enter (49) or (54) in (55)	1.4364 (55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(57)m	44.5282	40.2190	44.5282	43.0918	44.5282	43.0918	44.5282	44.5282	43.0918	44.5282	43.0918	44.5282	(57)
Primary circuit loss (annual) from Table 3												610.0000	(58)
(59)m	51.8082	46.7945	51.8082	50.1370	51.8082	50.1370	51.8082	51.8082	50.1370	51.8082	50.1370	51.8082	(59)
(62)m	293.2245	259.2131	274.0309	248.1472	244.9843	221.5006	215.1991	232.7331	231.2545	257.1920	268.8153	287.0120	(62)
(63)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63)
								Solar input (sum of months) = Sum(63)m =				0.0000	(63)
Water heat.	293.2245	259.2131	274.0309	248.1472	244.9843	221.5006	215.1991	232.7331	231.2545	257.1920	268.8153	287.0120	(64)
								Total per year (kWh/year) = Sum(64)m =				3033.3064	(64)
(65)m	142.5344	126.8672	136.1526	126.0934	126.4945	117.2334	116.5910	122.4210	120.4766	130.5536	132.9655	140.4688	(65)

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	168.8165	168.8165	168.8165	168.8165	168.8165	168.8165	168.8165	168.8165	168.8165	168.8165	168.8165	168.8165	(66)
(67)m	90.5064	80.3870	65.3751	49.4931	36.9967	31.2342	33.7496	43.8691	58.8809	74.7629	87.2593	93.0219	(67)
(68)m	597.1803	603.3772	587.7613	554.5169	512.5518	473.1106	446.7614	440.5645	456.1804	489.4248	531.3899	570.8312	(68)
(69)m	39.8817	39.8817	39.8817	39.8817	39.8817	39.8817	39.8817	39.8817	39.8817	39.8817	39.8817	39.8817	(69)
(70)m	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	(70)
(71)m	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	(71)
(72)m	191.5785	188.7904	183.0007	175.1297	170.0195	162.8242	156.7083	164.5444	167.3286	175.4753	184.6744	188.8021	(72)
(73)m	962.9102	956.1996	919.7821	862.7847	803.2130	750.8139	720.8643	732.6229	766.0349	823.3080	886.9685	936.3000	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
East	120.1500	19.8726	0.7200	0.7000	0.7700	833.9528	(76)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(83)m	833.9528	1616.4375	2583.5875	3836.0144	4667.3375	4870.1288	4727.0118	4114.0218	3088.7844	1968.5170	1036.8199	687.9288	(83)
(84)m	1796.8630	2572.6370	3503.3696	4698.7991	5470.5505	5620.9426	5447.8760	4846.6448	3854.8193	2791.8250	1923.7884	1624.2288	(84)

7. Mean internal temperature (heating season)

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

Utilisation factor for gains for living area, ni1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	39.6819	40.1490	40.1490	41.0320	41.5781	41.8371	42.0862	42.0862	41.4450	41.0320	40.5995	40.1490	
alpha	3.6455	3.6766	3.6766	3.7355	3.7719	3.7891	3.8057	3.8057	3.7630	3.7355	3.7066	3.6766	
(86)m	0.9995	0.9982	0.9923	0.9690	0.8969	0.7581	0.5670	0.6213	0.9028	0.9891	0.9990	0.9996	(86)
(87)m	18.8669	19.0961	19.5187	20.0182	20.5300	20.8374	20.9625	20.9489	20.6490	20.0082	19.2949	18.9170	(87)
(88)m	19.5103	19.5246	19.5246	19.5510	19.5669	19.5743	19.5814	19.5814	19.5631	19.5510	19.5382	19.5246	(88)
(89)m	0.9993	0.9975	0.9890	0.9553	0.8482	0.6447	0.3892	0.4339	0.8312	0.9822	0.9985	0.9995	(89)
(90)m	17.5979	17.8372	18.2581	18.7675	19.2554	19.5029	19.5745	19.5714	19.3700	18.7654	18.0461	17.6584	(90)
Living area fraction									fLA = Living area / (4) =			0.1189	(91)
(92)m	17.7487	17.9868	18.4079	18.9162	19.4069	19.6615	19.7395	19.7351	19.5220	18.9131	18.1945	17.8080	(92)
Temperature adjustment												0.0000	
(93)m	17.7487	17.9868	18.4079	18.9162	19.4069	19.6615	19.7395	19.7351	19.5220	18.9131	18.1945	17.8080	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(94)m	0.9990	0.9963	0.9852	0.9469	0.8413	0.6528	0.4106	0.4564	0.8284	0.9775	0.9977	0.9992	(94)
(95)m	1795.0166	2563.0813	3451.6431	4449.4215	4602.3703	3669.2652	2236.9270	2212.2279	3193.4291	2728.9619	1919.4220	1622.9654	(95)
(96)m	4.5000	5.0000	6.8000	8.7000	11.7000	14.6000	16.9000	16.9000	14.3000	10.8000	7.0000	4.9000	(96)
(97)m	11314.5477	10961.9083	9798.0166	8437.6726	6281.6060	4099.9291	2286.4176	2282.9338	4269.9258	6700.7488	9344.1776	10895.3763	(97)
(98)m	7082.5311	5644.0118	4721.7019	2871.5409	1249.3514	0.0000	0.0000	0.0000	0.0000	2955.0094	5345.8240	6898.6737	(98)
Space heating (October to May) (kWh/year)												36768.6442	(98)
Space heating requirement in kWh/m2/year											(98) / (4) =	75.3456	(99)

8c. Space cooling requirement

Not applicable

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

Fraction of space heat from secondary/supplementary system (Table 11) 0.1000 (201)
Fraction of space heat from main system(s) 0.9000 (202)
Efficiency of main space heating system 1 (in %) 78.9000 (206)
Efficiency of secondary/supplementary heating system, % 100.0000 (208)
Space heating:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(98)m	7082.5311	5644.0118	4721.7019	2871.5409	1249.3514	0.0000	0.0000	0.0000	0.0000	2955.0094	5345.8240	6898.6737	(98)
(211)m	8078.9328	6438.0362	5385.9718	3275.5219	1425.1156	0.0000	0.0000	0.0000	0.0000	3370.7331	6097.8981	7869.2095	(211)
(215)m	708.2531	564.4012	472.1702	287.1541	124.9351	0.0000	0.0000	0.0000	0.0000	295.5009	534.5824	689.8674	(215)

Annual totals kWh/year
Space heating fuel used, main system 1 41941.4192 (211)
Space heating fuel used, secondary 3676.8644 (215)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water heating													
(64)m	293.2245	259.2131	274.0309	248.1472	244.9843	221.5006	215.1991	232.7331	231.2545	257.1920	268.8153	287.0120	(64)
Efficiency of water heater												68.8000	(216)
(217)m	78.3939	78.3416	78.2045	77.8982	76.8809	68.8000	68.8000	68.8000	68.8000	77.8917	78.2918	78.3915	(217)
(219)m	374.0400	330.8753	350.4029	318.5533	318.6543	321.9485	312.7894	338.2748	336.1257	330.1918	343.3504	366.1263	(219)

Water heating fuel used 4041.3328 (219)

Electricity for pumps, fans and electric keep-hot (Table 4f):
central heating pump 130.0000 (230c)
boiler with a fan-assisted flue 45.0000 (230e)
Total electricity for the above, kWh/year 175.0000 (231)
Electricity for lighting (calculated in Appendix L) 1598.3714 (232)

12a. CO2 emissions - Individual heating systems including micro-CHP

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	41941.4192	0.1940	8136.6353	(261)
Space heating - secondary	3676.8644	0.4220	1551.6368	(263)
Water heating cost (other fuel)	4041.3328	0.1940	784.0186	(264)
Space and water heating			10472.2907	(265)
Pumps and fans	175.0000	0.4220	73.8500	(267)
Energy for lighting	1598.3714	0.4220	674.5127	(268)
Total CO2, kg/year			11220.6534	(272)
Emissions per m2 for space and water heating			21.6109	(272a)

```
Emissions per m2 for lighting                                                                                    1.3822 (272b)
Target Carbon Dioxide Emission Rate (TER)                                                                       24.3700 (273)
 = [(21.6109 * 1.47 * 1.2251) + (1.3822 * 1.2251)] * 0.60
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SAP 2009 WORKSHEET FOR New Build (As Designed) BRE SAP Worksheet 9.90
CALCULATION OF STANDARD ENE7 CO2
Calculated by program Elmhurst Energy Systems SAP2009 Calculator (Design System) version 3.08r12

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	169.0000 (1a)	x	3.2500 (2a)	=	549.2500 (1a) - (3a)	
Ground floor	193.0000 (1b)	x	3.3800 (2b)	=	652.3400 (1b) - (3b)	
First floor	126.0000 (1c)	x	2.9300 (2c)	=	369.1800 (1c) - (3c)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	488.0000					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	1570.7700	(5)

2. Ventilation rate

	main heating		secondary heating		other		total	m3 per hour	
Number of chimneys	0	+	0	+	0	=	0 * 40 =	0.0000	(6a)
Number of open flues	0	+	0	+	0	=	0 * 20 =	0.0000	(6b)
Number of intermittent fans							8 * 10 =	80.0000	(7a)
Number of passive vents							0 * 10 =	0.0000	(7b)
Number of flueless gas fires							0 * 40 =	0.0000	(7c)

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	80.0000 / (5) =	0.0509	(8)
Pressure test		Yes	
Measured/design q50		4.0000	
If based on air permeability value, then (18) = [(17)/20]+(8), otherwise (18) = (16)		0.2509	(18)
Number of sides on which dwelling is sheltered		4	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7000	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.1757	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.4000	5.1000	5.1000	4.5000	4.1000	3.9000	3.7000	3.7000	4.2000	4.5000	4.8000	5.1000	(22)
Wind factor	1.3500	1.2750	1.2750	1.1250	1.0250	0.9750	0.9250	0.9250	1.0500	1.1250	1.2000	1.2750	(22a)
(22b)m	0.2371	0.2240	0.2240	0.1976	0.1800	0.1713	0.1625	0.1625	0.1844	0.1976	0.2108	0.2240	(22b)
Effective ach	0.5281	0.5251	0.5251	0.5195	0.5162	0.5147	0.5132	0.5132	0.5170	0.5195	0.5222	0.5251	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
External Door			4.1600	2.0000	8.3200			(26)
Window (Uw = 1.20)			99.9500	1.1450	114.4466			(27)
Rooflight (Uw = 1.20)			4.2500	1.1450	4.8664			(27a)
Basement Floor			145.0000	0.1500	21.7500			(28)
Exposed LG Floor			24.0000	0.1500	3.6000			(28a)
Basement Walls	203.6900		203.6900	0.1322	26.9194			(29a)
Exposed External Walls	256.3300	104.1100	152.2200	0.1500	22.8330			(29a)
Main Roof	118.4000	4.2500	114.1500	0.1600	18.2640			(30)
GF Flat Roof	30.0000		30.0000	0.1600	4.8000			(30)
Exposed Basement Roof	25.4000		25.4000	0.1600	4.0640			(30)
Total net area of external elements Aum(A, m2)			802.8200					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		229.8634			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		250.0000 (35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)		53.2100 (36)
Total fabric heat loss	(33) + (36) =	283.0734 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	273.7506	272.1763	272.1763	269.2976	267.5784	266.7787	266.0190	266.0190	267.9932	269.2976	270.6920	272.1763	(38)
(39)m	556.8240	555.2497	555.2497	552.3710	550.6517	549.8521	549.0924	549.0924	551.0665	552.3710	553.7654	555.2497	(39)
									Average = Sum(39)m / 12 =			552.5696	(39)
(40)m	1.1410	1.1378	1.1378	1.1319	1.1284	1.1267	1.1252	1.1252	1.1292	1.1319	1.1348	1.1378	(40)
									Average = Sum(40)m / 12 =			1.1323	(40)
(41)m	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy, N		3.3763 (42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36		114.3878 (43)
Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more that 125 litres per person per day (all water use, hot and cold)		

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(44)m	125.8266	121.2511	116.6756	112.1001	107.5246	102.9491	102.9491	107.5246	112.1001	116.6756	121.2511	125.8266	(44)
(45)m	187.0436	163.5896	168.8098	147.1725	141.2155	121.8582	112.9196	129.5768	131.1244	152.8128	166.8072	181.1418	(45)
Energy content (annual)										Total = Sum(45)m =		1804.0718	(45)
(46)m	28.0565	24.5384	25.3215	22.0759	21.1823	18.2787	16.9379	19.4365	19.6687	22.9219	25.0211	27.1713	(46)

Water storage loss:		
b) If manufacturer declared cylinder loss factor is not known :		
Cylinder volume (litres) including any solar storage within same cylinder		150.0000 (50)
Hot water storage loss factor from Table 2 (kWh/litre/day)		0.0191 (51)
Volume factor from Table 2a		0.9283 (52)
Temperature factor from Table 2b		0.5400 (53)
Enter (49) or (54) in (55)		1.4364 (55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(57)m	44.5282	40.2190	44.5282	43.0918	44.5282	43.0918	44.5282	44.5282	43.0918	44.5282	43.0918	44.5282	(57)
Primary circuit loss (annual) from Table 3												360.0000	(58)
(59)m	30.5753	27.6164	30.5753	29.5890	30.5753	29.5890	30.5753	30.5753	29.5890	30.5753	29.5890	30.5753	(59)
(62)m	262.1472	231.4250	243.9133	219.8533	216.3190	194.5391	188.0231	204.6804	203.8052	227.9164	239.4880	256.2453	(62)
(63)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63)
									Solar input (sum of months) = Sum(63)m =			0.0000	(63)
Water heat.	262.1472	231.4250	243.9133	219.8533	216.3190	194.5391	188.0231	204.6804	203.8052	227.9164	239.4880	256.2453	(64)
									Total per year (kWh/year) = Sum(64)m =			2688.3553	(64)
(65)m	122.2748	108.6619	116.2121	107.0795	107.0370	98.6625	97.6286	103.1671	101.7435	110.8931	113.6081	120.3125	(65)

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	168.8165	168.8165	168.8165	168.8165	168.8165	168.8165	168.8165	168.8165	168.8165	168.8165	168.8165	168.8165	(66)
(67)m	66.5488	59.1081	48.0699	36.3920	27.2035	22.9663	24.8159	32.2567	43.2948	54.9727	64.1613	68.3984	(67)
(68)m	597.1803	603.3772	587.7613	554.5169	512.5518	473.1106	446.7614	440.5645	456.1804	489.4248	531.3899	570.8312	(68)
(69)m	39.8817	39.8817	39.8817	39.8817	39.8817	39.8817	39.8817	39.8817	39.8817	39.8817	39.8817	39.8817	(69)
(70)m	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	(70)
(71)m	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	(71)
(72)m	164.3479	161.6992	156.1990	148.7215	143.8669	137.0313	131.2212	138.6655	141.3105	149.0499	157.7890	161.7103	(72)
(73)m	911.7220	907.8295	875.6752	823.2754	767.2671	716.7531	686.4435	695.1316	724.4307	777.0923	836.9851	884.5848	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	18.7000	10.7264	0.7200	0.8000	0.7700	80.0667	(74)
East	27.1800	19.8726	0.7200	0.8000	0.7700	215.6051	(76)
South	47.1300	47.3233	0.7200	0.8000	0.7700	890.2836	(78)
West	6.9400	19.8726	0.7200	0.8000	0.7700	55.0515	(80)
Horizontal	4.2500	26.0000	0.6300	0.8000	1.0000	32.4562	(82)

(83)m	1273.4630	2193.7968	2971.1697	3809.1824	4351.8547	4509.1955	4381.3850	3946.7366	3327.2139	2509.8165	1530.7180	1085.8326	(83)
(84)m	2185.1851	3101.6263	3846.8449	4632.4578	5119.1218	5225.9486	5067.8285	4641.8683	4051.6446	3286.9089	2367.7030	1970.4175	(84)

7. Mean internal temperature (heating season)

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

Utilisation factor for gains for living area, ni1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	60.8610	61.0336	61.0336	61.3517	61.5432	61.6327	61.7180	61.7180	61.4969	61.3517	61.1972	61.0336	
alpha	5.0574	5.0689	5.0689	5.0901	5.1029	5.1088	5.1145	5.1145	5.0998	5.0901	5.0798	5.0689	
(86)m	0.9995	0.9969	0.9864	0.9498	0.8363	0.6414	0.4403	0.4788	0.7949	0.9721	0.9983	0.9996	(86)
(87)m	19.6500	19.8828	20.2111	20.5377	20.8377	20.9677	20.9962	20.9944	20.9089	20.5291	19.9600	19.6557	(87)
(88)m	19.9696	19.9722	19.9722	19.9770	19.9798	19.9812	19.9824	19.9824	19.9792	19.9770	19.9747	19.9722	(88)
(89)m	0.9993	0.9958	0.9814	0.9320	0.7842	0.5523	0.3332	0.3633	0.7130	0.9583	0.9976	0.9995	(89)
(90)m	18.7301	18.9645	19.2897	19.6079	19.8746	19.9672	19.9816	19.9812	19.9327	19.6064	19.0439	18.7379	(90)
Living area fraction										fLA = Living area / (4) =		0.1189	(91)
(92)m	18.8394	19.0736	19.3992	19.7184	19.9890	20.0861	20.1022	20.1016	20.0487	19.7161	19.1528	18.8470	(92)
Temperature adjustment												0.0000	
(93)m	18.8394	19.0736	19.3992	19.7184	19.9890	20.0861	20.1022	20.1016	20.0487	19.7161	19.1528	18.8470	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(94)m	0.9990	0.9944	0.9777	0.9265	0.7847	0.5620	0.3459	0.3771	0.7193	0.9536	0.9968	0.9993	(94)
(95)m	2182.9221	3084.2727	3761.0278	4292.0905	4017.1637	2936.7754	1753.1849	1750.3651	2914.3686	3134.3323	2360.0789	1968.9914	(95)
(96)m	4.5000	5.0000	6.8000	8.7000	11.7000	14.6000	16.9000	16.9000	14.3000	10.8000	7.0000	4.9000	(96)
(97)m	7984.5367	7814.3703	6995.7027	6086.2582	4564.3757	3016.5301	1758.3066	1757.9996	3167.9124	4924.9674	6729.8074	7744.0651	(97)
(98)m	4316.4013	3178.6256	2406.5981	1291.8007	407.1257	0.0000	0.0000	0.0000	0.0000	1332.2325	3146.2046	4296.6548	(98)
Space heating (October to May) (kWh/year)												20375.6433	(98)
Space heating requirement in kWh/m2/year											(98) / (4) =	41.7534	(99)

8c. Space cooling requirement

Not applicable

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

Fraction of space heat from secondary/supplementary system (Table 11)	0.1000 (201)
Fraction of space heat from main system(s)	0.9000 (202)
Efficiency of main space heating system 1 (in %)	88.9000 (206)
Efficiency of secondary/supplementary heating system, %	100.0000 (208)
Space heating:	

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(98)m	4316.4013	3178.6256	2406.5981	1291.8007	407.1257	0.0000	0.0000	0.0000	0.0000	1332.2325	3146.2046	4296.6548	(98)
(211)m	4369.8101	3217.9562	2436.3760	1307.7848	412.1633	0.0000	0.0000	0.0000	0.0000	1348.7168	3185.1340	4349.8192	(211)
(215)m	431.6401	317.8626	240.6598	129.1801	40.7126	0.0000	0.0000	0.0000	0.0000	133.2232	314.6205	429.6655	(215)

Annual totals kWh/year	
Space heating fuel used, main system 1	20627.7604 (211)
Space heating fuel used, secondary	2037.5643 (215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(64)m	262.1472	231.4250	243.9133	219.8533	216.3190	194.5391	188.0231	204.6804	203.8052	227.9164	239.4880	256.2453	(64)
Efficiency of water heater												78.8000	(216)
(217)m	88.1855	88.0553	87.7615	87.1241	84.8623	78.8000	78.8000	78.8000	78.8000	87.1165	88.0202	88.1975	(217)
(219)m	297.2680	262.8178	277.9276	252.3449	254.9059	246.8770	238.6080	259.7467	258.6361	261.6225	272.0829	290.5359	(219)

Water heating fuel used	3173.3732 (219)
Electricity for pumps, fans and electric keep-hot (Table 4f):	
central heating pump	130.0000 (230c)
boiler with a fan-assisted flue	45.0000 (230e)
Total electricity for the above, kWh/year	175.0000 (231)
Electricity for lighting (calculated in Appendix L)	1175.2731 (232)

12a. CO2 emissions - Individual heating systems including micro-CHP

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	

Space heating - main system 1	20627.7604	0.1980	4084.2966 (261)
Space heating - secondary	2037.5643	0.5170	1053.4208 (263)
Water heating cost (other fuel)	3173.3732	0.1980	628.3279 (264)
Space and water heating			5766.0452 (265)
Pumps and fans	175.0000	0.5170	90.4750 (267)
Energy for lighting	1175.2731	0.5170	607.6162 (268)
Total CO2, kg/year			6464.1364 (272)
Dwelling Carbon Dioxide Emission Rate (DER)			13.2500 (273)

SAP 2009 WORKSHEET FOR New Build (As Designed) BRE SAP Worksheet 9.90
CALCULATION OF ENERGY RATINGS FOR IMPROVED DWELLING
Calculated by program Elmhurst Energy Systems SAP2009 Calculator (Design System) version 3.08r12

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Basement floor	169.0000 (1a)	x	3.2500 (2a)	=	549.2500 (1a) - (3a)	
Ground floor	193.0000 (1b)	x	3.3800 (2b)	=	652.3400 (1b) - (3b)	
First floor	126.0000 (1c)	x	2.9300 (2c)	=	369.1800 (1c) - (3c)	
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	488.0000					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n) =		1570.7700	(5)

2. Ventilation rate

	main heating		secondary heating		other		total	m3 per hour	
Number of chimneys	0	+	0	+	0	=	0 * 40 =	0.0000	(6a)
Number of open flues	0	+	0	+	0	=	0 * 20 =	0.0000	(6b)
Number of intermittent fans							8 * 10 =	80.0000	(7a)
Number of passive vents							0 * 10 =	0.0000	(7b)
Number of flueless gas fires							0 * 40 =	0.0000	(7c)

	Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	80.0000 / (5) =	0.0509 (8)
Pressure test		Yes
Measured/design q50		4.0000
If based on air permeability value, then (18) = [(17)/20]+(8), otherwise (18) = (16)		0.2509 (18)
Number of sides on which dwelling is sheltered		4 (19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7000 (20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.1757 (21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.4000	5.1000	5.1000	4.5000	4.1000	3.9000	3.7000	3.7000	4.2000	4.5000	4.8000	5.1000	(22)
Wind factor	1.3500	1.2750	1.2750	1.1250	1.0250	0.9750	0.9250	0.9250	1.0500	1.1250	1.2000	1.2750	(22a)
(22b)m	0.2371	0.2240	0.2240	0.1976	0.1800	0.1713	0.1625	0.1625	0.1844	0.1976	0.2108	0.2240	(22b)
Effective ach	0.5281	0.5251	0.5251	0.5195	0.5162	0.5147	0.5132	0.5132	0.5170	0.5195	0.5222	0.5251	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
External Door			4.1600	2.0000	8.3200			(26)
Window (Uw = 1.20)			99.9500	1.1450	114.4466			(27)
Rooflight (Uw = 1.20)			4.2500	1.1450	4.8664			(27a)
Basement Floor			145.0000	0.1500	21.7500			(28)
Exposed LG Floor			24.0000	0.1500	3.6000			(28a)
Basement Walls	203.6900		203.6900	0.1322	26.9194			(29a)
Exposed External Walls	256.3300	104.1100	152.2200	0.1500	22.8330			(29a)
Main Roof	118.4000	4.2500	114.1500	0.1600	18.2640			(30)
GF Flat Roof	30.0000		30.0000	0.1600	4.8000			(30)
Exposed Basement Roof	25.4000		25.4000	0.1600	4.0640			(30)
Total net area of external elements Aum(A, m2)			802.8200					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		229.8634			(33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		250.0000 (35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)		53.2100 (36)
Total fabric heat loss	(33) + (36) =	283.0734 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	273.7506	272.1763	272.1763	269.2976	267.5784	266.7787	266.0190	266.0190	267.9932	269.2976	270.6920	272.1763	(38)
(39)m	556.8240	555.2497	555.2497	552.3710	550.6517	549.8521	549.0924	549.0924	551.0665	552.3710	553.7654	555.2497	(39)
									Average = Sum(39)m / 12 =			552.5696	(39)
(40)m	1.1410	1.1378	1.1378	1.1319	1.1284	1.1267	1.1252	1.1252	1.1292	1.1319	1.1348	1.1378	(40)
									Average = Sum(40)m / 12 =			1.1323	(40)
(41)m	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy, N		3.3763 (42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36		114.3878 (43)

Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more that 125 litres per person per day (all water use, hot and cold)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(44)m	125.8266	121.2511	116.6756	112.1001	107.5246	102.9491	102.9491	107.5246	112.1001	116.6756	121.2511	125.8266	(44)
(45)m	187.0436	163.5896	168.8098	147.1725	141.2155	121.8582	112.9196	129.5768	131.1244	152.8128	166.8072	181.1418	(45)
Energy content (annual)										Total = Sum(45)m =		1804.0718	(45)
(46)m	28.0565	24.5384	25.3215	22.0759	21.1823	18.2787	16.9379	19.4365	19.6687	22.9219	25.0211	27.1713	(46)

Water storage loss:		
b) If manufacturer declared cylinder loss factor is not known :		
Cylinder volume (litres) including any solar storage within same cylinder		300.0000 (50)
Hot water storage loss factor from Table 2 (kWh/litre/day)		0.0103 (51)
Volume factor from Table 2a		0.7368 (52)
Temperature factor from Table 2b		0.6000 (53)
Enter (49) or (54) in (55)		1.3645 (55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(57)m	42.2998	38.2062	42.2998	40.9353	42.2998	40.9353	42.2998	42.2998	40.9353	42.2998	40.9353	42.2998	(57)
Primary circuit loss (annual) from Table 3												360.0000	(58)
(59)m	30.5753	27.6164	30.5753	29.5890	30.5753	29.5890	30.5753	30.5753	29.5890	30.5753	29.5890	30.5753	(59)
(62)m	259.9188	229.4122	241.6849	217.6968	214.0906	192.3825	185.7947	202.4519	201.6487	225.6880	237.3315	254.0169	(62)
(63)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63)
								Solar input (sum of months) = Sum(63)m =				0.0000	(63)
Water heat.	259.9188	229.4122	241.6849	217.6968	214.0906	192.3825	185.7947	202.4519	201.6487	225.6880	237.3315	254.0169	(64)
								Total per year (kWh/year) = Sum(64)m =				2662.1174	(64)
(65)m	120.4921	107.0517	114.4293	105.3543	105.2542	96.9373	95.8458	101.3844	100.0183	109.1104	111.8828	118.5297	(65)

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	202.5798	202.5798	202.5798	202.5798	202.5798	202.5798	202.5798	202.5798	202.5798	202.5798	202.5798	202.5798	(66)
(67)m	166.3721	147.7702	120.1748	90.9801	68.0087	57.4158	62.0398	80.6416	108.2370	137.4318	160.4032	170.9961	(67)
(68)m	891.3139	900.5630	877.2557	827.6372	765.0027	706.1352	666.8081	657.5590	680.8663	730.4848	793.1193	851.9868	(68)
(69)m	58.6343	58.6343	58.6343	58.6343	58.6343	58.6343	58.6343	58.6343	58.6343	58.6343	58.6343	58.6343	(69)
(70)m	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	10.0000	(70)
(71)m	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	-135.0532	(71)
(72)m	161.9517	159.3031	153.8029	146.3254	141.4707	134.6351	128.8251	136.2693	138.9143	146.6537	155.3928	159.3142	(72)
(73)m	1355.7987	1343.7972	1287.3943	1201.1035	1110.6430	1034.3470	993.8338	1010.6309	1064.1786	1150.7312	1245.0762	1318.4579	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	18.7000	10.7264	0.7200	0.8000	0.7700	80.0667	(74)
East	27.1800	19.8726	0.7200	0.8000	0.7700	215.6051	(76)
South	47.1300	47.3233	0.7200	0.8000	0.7700	890.2836	(78)
West	6.9400	19.8726	0.7200	0.8000	0.7700	55.0515	(80)
Horizontal	4.2500	26.0000	0.6300	0.8000	1.0000	32.4562	(82)

(83)m	1273.4630	2193.7968	2971.1697	3809.1824	4351.8547	4509.1955	4381.3850	3946.7366	3327.2139	2509.8165	1530.7180	1085.8326	(83)
(84)m	2629.2617	3537.5940	4258.5639	5010.2859	5462.4977	5543.5425	5375.2188	4957.3675	4391.3925	3660.5477	2775.7941	2404.2906	(84)

7. Mean internal temperature (heating season)

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

Utilisation factor for gains for living area, ni1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	60.8610	61.0336	61.0336	61.3517	61.5432	61.6327	61.7180	61.7180	61.4969	61.3517	61.1972	61.0336	
alpha	5.0574	5.0689	5.0689	5.0901	5.1029	5.1088	5.1145	5.1145	5.0998	5.0901	5.0798	5.0689	
(86)m	0.9987	0.9943	0.9792	0.9340	0.8080	0.6105	0.4160	0.4497	0.7561	0.9580	0.9965	0.9991	(86)
(87)m	19.9977	20.1701	20.4091	20.6404	20.8443	20.9274	20.9447	20.9438	20.8929	20.6386	20.2248	20.0007	(87)
(88)m	19.9696	19.9722	19.9722	19.9770	19.9798	19.9812	19.9824	19.9824	19.9792	19.9770	19.9747	19.9722	(88)
(89)m	0.9983	0.9924	0.9720	0.9121	0.7525	0.5235	0.3143	0.3405	0.6710	0.9386	0.9951	0.9987	(89)
(90)m	18.6228	18.8763	19.2212	19.5469	19.8067	19.8912	19.9040	19.9037	19.8624	19.5524	18.9588	18.6294	(90)
Living area fraction										fLA = Living area / (4) =		0.1189	(91)
(92)m	18.7862	19.0300	19.3624	19.6769	19.9300	20.0144	20.0277	20.0273	19.9848	19.6815	19.1093	18.7924	(92)
Temperature adjustment												0.0000	
(93)m	18.7862	19.0300	19.3624	19.6769	19.9300	20.0144	20.0277	20.0273	19.9848	19.6815	19.1093	18.7924	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(94)m	0.9975	0.9899	0.9664	0.9043	0.7495	0.5264	0.3189	0.3454	0.6715	0.9313	0.9933	0.9981	(94)
(95)m	2622.7380	3501.9804	4115.4141	4530.6749	4094.1986	2918.2462	1713.9819	1712.2259	2948.9057	3408.9445	2757.2798	2399.7942	(95)
(96)m	4.5000	5.0000	6.8000	8.7000	11.7000	14.6000	16.9000	16.9000	14.3000	10.8000	7.0000	4.9000	(96)
(97)m	7954.9182	7790.1716	6975.2681	6063.3130	4531.8816	2977.1080	1717.3996	1717.1907	3132.7270	4905.8885	6705.7084	7713.7499	(97)
(98)m	3967.1421	2881.6645	2127.7314	1103.4994	325.6362	0.0000	0.0000	0.0000	0.0000	1113.7264	2842.8686	3953.5830	(98)
Space heating (October to May) (kWh/year)												18315.8516	(98)
Space heating requirement in kWh/m2/year											(98) / (4) =	37.5325	(99)

8c. Space cooling requirement

Not applicable

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

Fraction of space heat from secondary/supplementary system (Table 11) 0.0000 (201)
Fraction of space heat from main system(s) 1.0000 (202)
Efficiency of main space heating system 1 (in %) 224.0000 (206)
Efficiency of secondary/supplementary heating system, % 0.0000 (208)
Space heating:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(98)m	3967.1421	2881.6645	2127.7314	1103.4994	325.6362	0.0000	0.0000	0.0000	0.0000	1113.7264	2842.8686	3953.5830	(98)
(211)m	1771.0456	1286.4574	949.8801	492.6337	145.3733	0.0000	0.0000	0.0000	0.0000	497.1993	1269.1378	1764.9924	(211)
(215)m	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)

Annual totals kWh/year
Space heating fuel used, main system 1 8176.7195 (211)
Space heating fuel used, secondary 0.0000 (215)

Water heating

(64)m	259.9188	229.4122	241.6849	217.6968	214.0906	192.3825	185.7947	202.4519	201.6487	225.6880	237.3315	254.0169	(64)
Efficiency of water heater												65.0000	(216)
(217)m	65.0000	65.0000	65.0000	65.0000	65.0000	65.0000	65.0000	65.0000	65.0000	65.0000	65.0000	65.0000	(217)
(219)m	399.8750	352.9419	371.8229	334.9181	329.3701	295.9731	285.8379	311.4645	310.2288	347.2122	365.1253	390.7952	(219)

Water heating fuel used 4095.5652 (219)

Electricity for pumps, fans and electric keep-hot (Table 4f):
central heating pump 130.0000 (230c)
Total electricity for the above, kWh/year 130.0000 (231)
Electricity for lighting (calculated in Appendix L) 1175.2731 (232)

Energy saving/generation technologies (Appendices M ,N and Q)
PV Unit 0 (0.80 * 2.50 * 1073 * 0.80) -1716.8000 (233)

10a. Fuel costs - using Table 12 prices

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating - main system 1	8176.7195	11.4600	937.0520	(240)
Space heating - secondary	0.0000	0.0000	0.0000	(242)
Water heating cost (other fuel)	4095.5652	3.1000	126.9625	(247)
Pumps and fans for heating	130.0000	11.4600	14.8980	(249)
Energy for lighting	1175.2731	11.4600	134.6863	(250)
Additional standing charges			106.0000	(251)
Energy saving/generation technologies				
PV Unit	-1716.8000	11.4600	-196.7453	(252)
Total energy cost			1122.8536	(255)

11a. SAP rating - Individual heating systems

Energy cost deflator (Table 12):		0.4700	(256)
Energy cost factor (ECF)	[(255) x (256)] / [(4) + 45.0] =	0.9901	(257)
SAP value		86.1876	
SAP rating (Section 12)		86	(258)
SAP band		B	

10a. Fuel costs - using BEDF prices (333)

	Fuel kWh/year	Fuel price p/kWh	Fuel cost £/year	
Space heating - main system 1	8176.7195	13.1900	1078.5093	(240)
Space heating - secondary	0.0000	0.0000	0.0000	(242)
Water heating cost (other fuel)	4095.5652	3.4800	142.5257	(247)
Pumps and fans for heating	130.0000	13.1900	17.1470	(249)
Energy for lighting	1175.2731	13.1900	155.0185	(250)
Additional standing charges			120.0000	(251)
Energy saving/generation technologies				
PV Unit	-1716.8000	13.1900	-226.4459	(252)
Total energy cost			1286.7546	(255)

12a. CO2 emissions - Individual heating systems including micro-CHP

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	8176.7195	0.5170	4227.3640	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating cost (other fuel)	4095.5652	0.1980	810.9219	(264)
Space and water heating			5038.2859	(265)
Pumps and fans	130.0000	0.5170	67.2100	(267)
Energy for lighting	1175.2731	0.5170	607.6162	(268)
Energy saving/generation technologies				
PV Unit	-1716.8000	0.5290	-908.1872	(269)
Total CO2, kg/year			4804.9249	(272)
CO2 emissions per m2			9.8500	(273)
EI value			87.9201	
EI rating			88	(274)
EI band			B	

13a. Primary energy - Individual heating systems including micro-CHP

	Energy kWh/year	Primary energy factor kg CO2/kWh	Primary energy kWh/year	
Space heating - main system 1	8176.7195	2.9200	23876.0208	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating cost (other fuel)	4095.5652	1.0200	4177.4765	(264)
Space and water heating			28053.4973	(265)
Pumps and fans	130.0000	2.9200	379.6000	(267)
Energy for lighting	1175.2731	2.9200	3431.7974	(268)
Energy saving/generation technologies				
PV Unit	-1716.8000	2.9200	-5013.0560	(269)
Primary energy kWh/year			26851.8387	(272)
Primary energy kWh/m2/year			55.0243	(273)

REGULATIONS COMPLIANCE REPORT - Approved Document L1A, 2010 Edition
Calculated by program Elmhurst Energy Systems SAP2009 Calculator (Design System) version 3.08r12

New Build (As Designed)

1 TER and DER
Fuel for main heating:Electricity
Fuel factor:1.47 (electricity)
Target Carbon Dioxide Emission Rate (TER) 24.37 kg/m²
Dwelling Carbon Dioxide Emission Rate (DER) 12.53 kg/m²OK

2 Fabric U-values

Element	Average	Highest	
External wall	0.15 (max. 0.30)	0.15 (max. 0.70)	OK
Floor	0.15 (max. 0.25)	0.15 (max. 0.70)	OK
Roof	0.16 (max. 0.20)	0.16 (max. 0.35)	OK
Openings	1.23 (max. 2.00)	2.00 (max. 3.30)	OK

2a Thermal bridging
Thermal bridging calculated from linear thermal transmittances for each junction

3 Air permeability
Air permeability at 50 pascals: 4.00 (design value)
Maximum 10.0 OK

4 Heating efficiency
Main heating system: Heat pump with radiators or underfloor - Electric
Ground-to-water heat pump

Secondary heating system: None

5 Cylinder insulation
Hot water storage Nominal cylinder loss: 2.27 kWh/day
Permitted by DBSCG 2.86 OK
Primary pipework insulated: Yes OK

6 Controls
Space heating controls: Time and temperature zone control OK

Hot water controls: Cylinderstat OK

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

8 Mechanical ventilation
Not applicable

9 Summertime temperature
Overheating risk (Thames Valley): Slight OK
Based on:
Overshading: Average
Windows facing North: 21.25 m², No overhang
Windows facing East: 27.18 m², No overhang
Windows facing South: 48.83 m², No overhang
Windows facing West: 6.94 m², No overhang
Ventilation rate: 4.00
Blinds/curtains: None

10 Key features
External wall U-value 0.15 W/m²K
External wall U-value 0.15 W/m²K
Floor U-value 0.15 W/m²K
Floor U-value 0.15 W/m²K
Window U-value 1.20 W/m²K
Roof window U-value 1.20 W/m²K
Air permeability 4.0 m³/m²h

SAP 2009 OVERHEATING ASSESSMENT FOR New Build (As Designed) BRE SAP Worksheet 9.90
Calculated by program Elmhurst Energy Systems SAP2009 Calculator (Design System) version 3.08r12

Overheating Calculation Input Data

Dwelling type	Detached House
Number of storeys	3
Cross ventilation possible	Yes
Region	Thames Valley
Front of dwelling faces	South East
Overshading	Average or unknown
Thermal mass parameter	250.0
Night ventilation	No
Ventilation rate during hot weather (ach)	4.00 (Windows half open)

Overheating Calculation

Summer ventilation heat loss coefficient	2073.42 (P1)
Transmission heat loss coefficient	283.07 (37)
Summer heat loss coefficient	2356.49 (P2)

Overhangs

Orientation	Ratio	Z_overhangs	Overhang type
North	0.000	1.000	None
East	0.000	1.000	None
South	0.000	1.000	None
West	0.000	1.000	None

Solar shading

Orientation	Z blinds	Solar access	Z overhangs	Z summer
North	1.000	0.90	1.000	0.900 (P8)
North	1.000	1.00	1.000	1.000 (P8)
East	1.000	0.90	1.000	0.900 (P8)
South	1.000	0.90	1.000	0.900 (P8)
South	1.000	1.00	1.000	1.000 (P8)
West	1.000	0.90	1.000	0.900 (P8)

[Jul]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Shading	Gains W
North	18.7000	85.3441	0.7200	0.8000	0.9000	744.5996
East	27.1800	117.7842	0.7200	0.8000	0.9000	1493.6332
South	47.1300	110.5233	0.7200	0.8000	0.9000	2430.2937
West	6.9400	117.7842	0.7200	0.8000	0.9000	381.3765
					total:	5305.9274

	Jun	Jul	Aug	
Solar gains	5551	5306	4837	(P3)
Internal gains	1024	984	1001	
Total summer gains	6575	6290	5838	(P5)
Summer gain/loss ratio	2.79	2.67	2.48	(P6)
Summer external temperature	15.40	17.80	17.80	
Thermal mass temperature increment (TMP = 250.0)	0.25	0.25	0.25	
Threshold temperature	18.44	20.72	20.53	(P7)
Likelihood of high internal temperature	Not significant	Slight	Not significant	

Assessment of likelihood of high internal temperature: Slight

SAP 2009 IMPROVEMENTS
Calculated by program Elmhurst Energy Systems SAP2009 Calculator (Design System) version 3.08r12

20527_Lyndhurst Gardens

Current energy efficiency rating: B 84
Current environmental impact rating: B 86

(For testing purposes):

A	Not considered
B	Not considered
C	Not considered
D	Not considered
E Low energy lighting	Already installed
F	Not considered
G	Not considered
H	Not considered
I	Not considered
J	Not considered
K	Not considered
L	Not considered
M	Not considered
N Solar water heating	SAP increase too small
O	Not considered
P	Not considered
Q	Not considered
R	Not considered
S	Not considered
T	Not considered
U Solar photovoltaic (PV) panels	Recommended
V Wind turbine	SAP increase too small

Recommended measures:	SAP change	Cost change	CO2 change
U Solar photovoltaic (PV) panels	+ 2.4	-£ 226	-908 kg (15.9%)

Measures omitted - SAP change or cost saving too small:

N Solar water heating	+ 0.6	-£ 52	-319 kg (5.6%)
V Wind turbine	+ 0.1	-£ 8	-33 kg (0.7%)

	Typical annual savings		Energy efficiency	Environmental impact
Lower cost measures				
(none)				
Sub Total	£0	0.00 kg/m²		
Higher cost measures				
(none)				
Sub Total	£0	0.00 kg/m²		

Potential energy efficiency rating: B 84
Potential environmental impact rating: B 86

Further improvements to achieve even higher standards

Solar photovoltaic	£226	1.86 kg/m²	B 86	B 88
Total Savings	£226	1.86 kg/m²		

Enhanced energy efficiency rating: B 86
Enhanced environmental impact rating: B 88

Fuel prices for cost data on this page from database revision number 333 TEST (21 Dec 2012)
Recommendation texts revision number 3.9c (09 Jan 2012)

Typical heating and lighting costs of this home (per year):

	Current	Potential	Enhanced
Electricity	£1251	£1251	£1251
Mains gas	£263	£263	£263
Space heating	£1216	£1216	£1216
Water heating	£143	£143	£143
Lighting	£155	£155	£155
Generated (PV)	-£0	-£0	-£226
Total cost	£1514	£1514	£1288
Carbon dioxide emissions	5.7 tonnes	5.7 tonnes	4.8 tonnes
Primary energy	65 kWh/m²	65 kWh/m²	55 kWh/m²