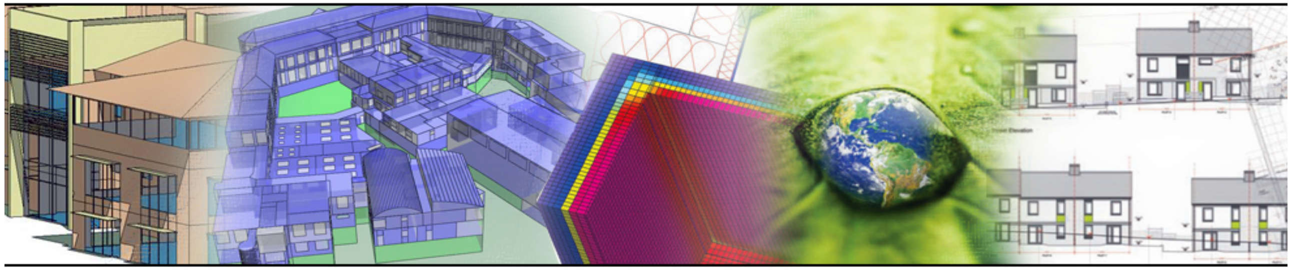

Energy and Sustainability Statement

61 Belmont Road
Twickenham

Prepared for: Hazam Smith & Partners

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ES1	Final	01/02/16	Issued to client for comment

CONTENTS

1. Executive Summary

This Energy Statement has been produced to demonstrate compliance with the London Borough of Richmond upon Thames Development Management Plan Policy DM SD1. This policy requires all developments to achieve a minimum 40 per cent improvement over a Part L1A 2010 compliant baseline, in line with requirements of The London Plan 2015.

This has been achieved using the energy hierarchy outlined within Policy 5.2 of the London Plan 2015[1]. The London Plan stipulates that new-build 'major' developments must achieve a 40% CO_2 saving against a 2010 Part L1a compliant baseline. This corresponds to 35% CO_2 savings against a 2013 Part L1a compliant baseline.

This site is not considered to be a major development under the definition in the London Plan; however Policy DM SD1 of the Local Development Plan stipulates that all developments should achieve a 40% saving in CO2 emissions.

SAP calculations have been carried out using Government approved FSAP software in accordance with the current Building Regulations. Results of this assessment demonstrate that the required CO2 savings can be achieved through a combination of passive design measures and renewable energy technology. Savings have been expressed against each stage of the hierarchy. The results of this assessment can be seen in Table 1 (figures have been calculated to 1 decimal place), all data produced has been based on assumptions and will require reassessment at detailed design stage.

	Predicted Annual CO_2 Emissions (kg.CO_2/year)	CO_2 Reduction (%)	Cumulative CO_2 Reduction (%)
Baseline	1,857	-	-
Be Lean	1,853	0.2%	0.2%
Be Clean	1,853	0.0%	0.2%
Be Green	1,193	35.6%	35.8%
Target	1,207	35.0%	**Target Achieved**

Table 1. **CO_2 reduction summary**

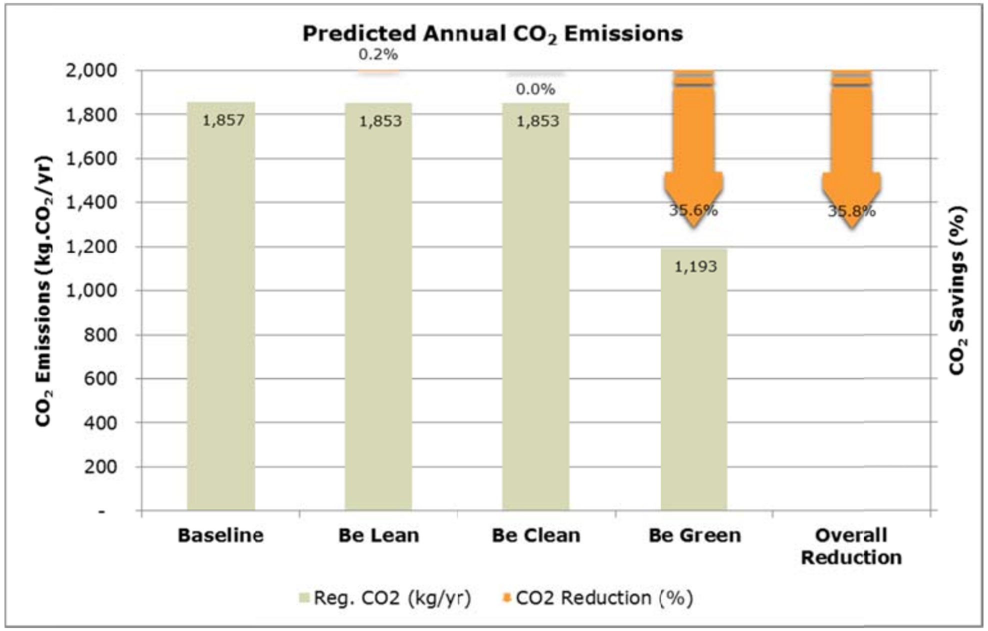


Figure 1. Predicted annual CO_2 emissions

[1] London Plan, March 2015

2. Introduction

Stroma Technology has been commissioned by Hazam Smith & Partners to prepare a Sustainability Statement in support of the planning application at 61 Belmont Road, Twickenham.

The proposed development is located within the London Borough of Richmond upon Thames and will need to meet the requirements of the Richmond Core Strategy (adopted April 2009) and the Development Management Plan (Adopted November 2011). A further Supplementary Planning Document entitled 'Sustainable Construction Checklist Guidance Document' (Adopted August 2011) sets out the requirements of the content for Energy Statements and this statement has been prepared in accordance with this SBD.

Policy 5.2 of the London Plan 2015 will be followed, which adopts a fabric first approach using the Energy Hierarchy shown in Figure 2. The hierarchy uses a tiered methodology which follows fabric first, then low and zero carbon technology and finally renewable energy generation.

The Energy Strategy for the proposed development will be as follows:

1. Incorporate passive features such as low U-values, low air permeability and correct orientation.
2. Install energy efficient building services such as high efficiency gas condensing boilers.
3. Research the possibility of decentralised energy and integrate where viable.
4. Use solar PV to reduce CO2 emissions towards the target DER.

Figure 2. Energy Hierarchy

3. **The Development Site**

The development site is located in Twickenham within the London Borough of Richmond upon Thames and is situated on the land behind between Belmont Road and the River Crane. The surrounding area is predominantly residential units comprising of both detached and semi-detached houses and flats.

Figure 3. Street view of access from Belmont Road

Figure 4. Aerial view of the development site

The proposed development consists of a single storey dwelling approximately 80m2 in floor area. The dwelling incorporates design features such as projecting roofs, to prevent light spillage from windows into the trees in order to minimise disruption to wildlife as well as nesting boxes in the sides of projecting roofs to provide habitats.

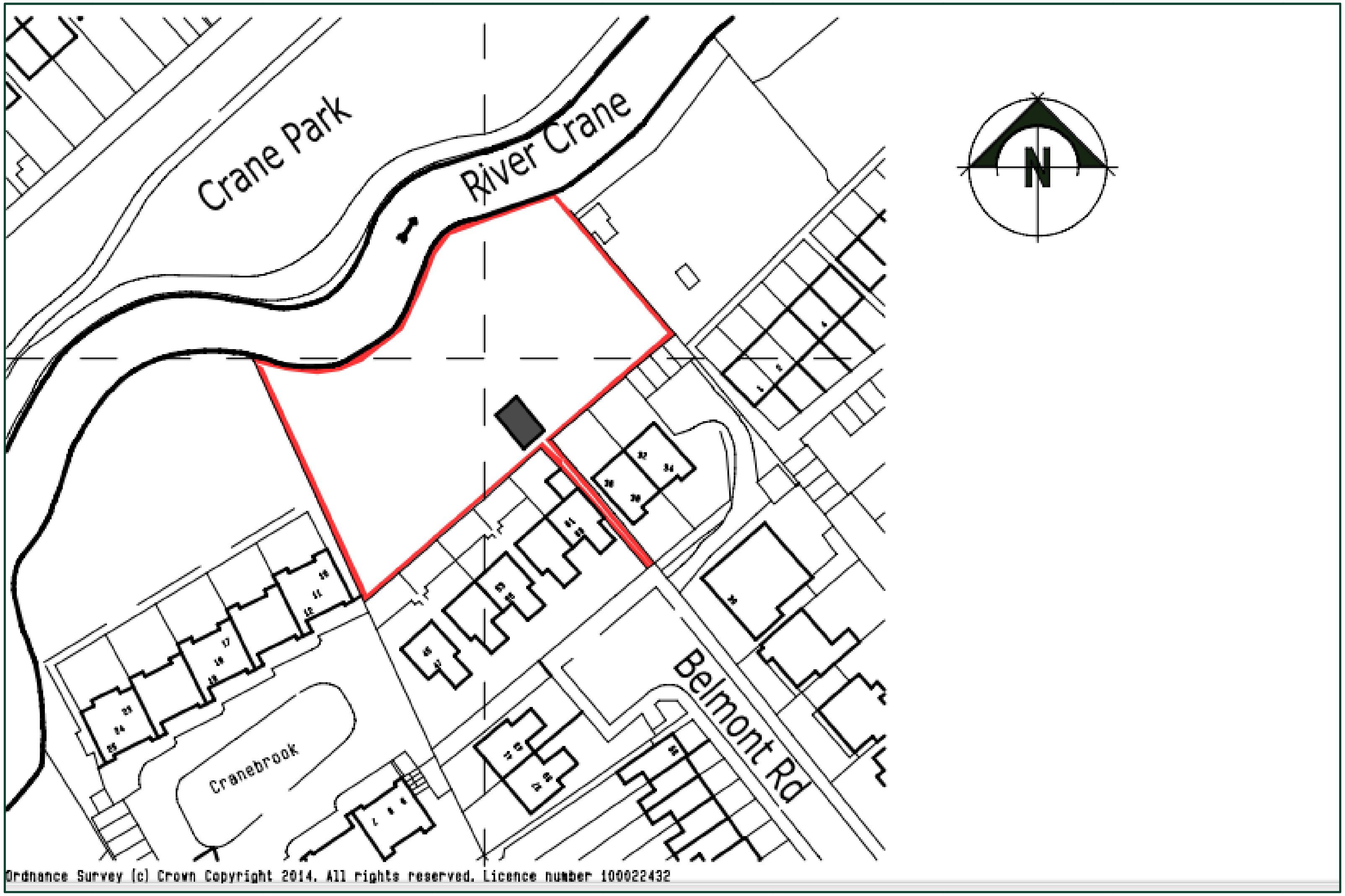


Figure 5. Site location

4. Planning Policy

4.1. National Policy - England

The Department for Communities and Local Government (DCLG) released the National Planning Policy Framework (NPPF) in March 2012. In revising this framework, the Government's objective is to streamline the process encouraging sustainable development and promoting the needs and priorities of local communities.

This framework is to be used as the base by councils to develop their own local planning policy. Section 10 of the framework addresses climate change, flooding and costal change. Considerations include;

- Minimising CO_2 emissions
- Vulnerability of fuel supply
- A promotion of decentralised, low carbon and renewable energy sources wherever viable
- Convergence towards existing 'zero carbon' policy targets (postponed)

4.2. Regional Policy – London Plan

The spatial development strategy plan for London was revised on 10th March 2015, and replaced the London Plan (July 2011) first published in February 2008.

Policy 5.2-Minimising Carbon Dioxide Emissions

This states that development proposals must follow the energy hierarchy to make the fullest contribution to minimising CO_2 emissions:

Be Lean: use less energy

Be Clean: supply energy efficiency

Be Green: use renewable energy

Developers are to ensure that major developments meet minimum targets for CO_2 emissions, which are outlined as improvements over the Target Emission Rate (TER) which is benchmarked in Building Regulations, Approved Document L1A. Table 1 shows the following targets have been introduced with a move towards residential development being Zero Carbon by 2016.

Year	L1A:2010 Limits
2010-2013	25% (Code for Sustainable Homes Level 4)
2013-2016	**40%**
2016-2031	Zero Carbon

Table 2. **London Plan 2015 limits**

4.3. Local Policy- London Borough of Richmond

The Richmond Local Development Management Plan (Adopted November 2011) and Core Strategy (adopted April 2009) contains the following policies that this Energy Strategy must address[2:]

Policy DM SD1: Sustainable Construction

All development in terms of materials, design, landscaping, standard of construction and operation should include measures capable of mitigating and adapting to climate change to meet future needs.

New buildings should be flexible to respond to future social, technological and economic needs by conforming to the Borough's Sustainable Construction Checklist SPD. New homes will be required to meet or exceed requirements of the Code for Sustainable Homes Level 3.

They also must achieve a minimum 25 per cent reduction in carbon dioxide emissions over Building Regulations (2010) in line with best practice from 2010 to 2013, 40 percent improvement from 2013 to 2016, and 'zero carbon' standards **(2)** from 2016. It is expected that efficiency measures will be prioritised as a means towards meeting these targets. These requirements may be adjusted in future years to take into account the then prevailing standards and any other national guidance to ensure the standards are met or exceeded.

Policy DM SD 2: Renewable Energy and Decentralised Energy Networks

New development will be required to conform with the Sustainable Construction Checklist SPD and:

(a) Maximise opportunities for the micro-generation of renewable energy. Some form of low carbon renewable and/or de-centralised energy will be expected in all new development, and

(b) Developments of 1 dwelling unit or more, or 100sqm of non-residential floor space or more will be required to reduce their total carbon dioxide emissions by following a hierarchy that first requires an efficient design to minimise the amount of energy used, secondly, by using low carbon technologies and finally, where feasible and viable, including a contribution from renewable sources.

(c) Local opportunities to contribute towards decentralised energy supply from renewable and low-carbon technologies will be encouraged where there is no over-riding adverse local impact.

(d) All new development will be required to connect to existing or planned decentralised energy networks where one exists. In all major developments and large Proposals Sites identified in the (forthcoming) Site Allocations DPD, provision should be made for future connection to a local energy network should one become available.

[2] Richmond Local Development Management Plan, November 2011

5. Regulations and Local Policy

5.1. Building Regualtions

Approved document L1A – Conservation of fuel and Power sets the standard for carbon emissions for new dwellings and was last revised in April 2014 (Part L: 2013). The properties will need to comply with the criteria set out in the document, as follows:

1. The predicted Dwelling Emission Rate of CO_2 emissions from dwellings (DER) are not greater than the Target Emission Rate (TER).
2. The performance of the building fabric and fixed building services should be no worse than the design limits set out in Table 2 of the Approved Document.
3. The dwellings will have appropriate passive control measures to limit the effect of solar gains on indoor temperatures in summer.
4. That the performance of dwellings as-built comply with the DER values achieved, including site testing of a representative sample of dwellings demonstrating that the 'air permeability' rate achieved is as per that specified, or better.
5. The necessary provisions for energy efficient operation of dwellings are put in place, including operation and maintenance instructions aimed at achieving economy in the use of fuel and power in a way that householders can understand.

Compliance with the Approved Document Part L1a should be demonstrated at detailed design stage, prior to construction.

5.2. Methodology

The Standard Assessment Procedure (SAP) is the Government's approved methodology for assessing the predicted energy consumption and carbon dioxide emissions of new buildings. Results are derived in respect of floor area and consider energy use ($kWh/m^2/yr$) and associated CO_2 emissions ($kg.CO_2/m^2/yr$) from the following:

- Space heating
- Domestic hot water
- Ventilation
- Lighting
- Ancillary pumps and fans
- Energy generating technology

SAP is compliant with the EU Energy Performance of Buildings Directive and is carried out using approved software. For the purposes of this report FSAP 2012 version 1.0.1.24 has been used to generate the data.

BE LEAN

USE LESS ENERGY

6. Be Lean – Use Less Energy

This section outlines the proposals for specifying building fabric and services beyond the requirements of Building Regulations (the baseline).

6.1. Building Fabric

Fundamental to achieving energy efficiency in any new building is the specification of a thermally efficient building envelope. Passive design features such as **high levels of insulation**, designing to maximise **solar gain** and limiting heat loss through **reduced air leakage and enhanced thermal bridging** are all proven techniques to increase energy consumption and reduce emissions.

Assumptions have been on this development in order to meet the fabric efficiency targets for Building Regulations 2013. This has been attained by targeting the notional u-values set out within *Table 4: Summary of concurrent notional dwelling specification, Approved Document L1A*. The Target Fabric Energy Efficiency (TFEE) has been achieved by incorporating Accredited Construction Details (ACDs) and Enhanced Construction Details (ECDs) into the calculation to reduce heat losses via thermal bridging.

Tables 3 shows the proposed building fabric specification applied to the SAP calculations with respect to the upper limits stipulated by Part L: 2010.

Building fabric			
Element	**L1A:2010 limiting[3] U-value ($W/m^2.K$)**	**Proposed U-value ($W/m^2.K$)**	**Improvement (%)**
Ground Floor	0.25	0.13	48%
External walls	0.30	0.20	33%
Party wall between dwelling	0.20	N/A	N/A
Roof	0.20	0.15	25%
Windows	2.00	1.20	40%
Doors	2.00	1.40	30%
y-value	0.15	0.034	77%
Air permeability ($m^3/h.m^2$ @ 50 Pa)			
Entire building	10.0	4.0	60%

Table 3. **Building fabric performance**

It can be seen that the values currently proposed for the development show a significant bettering of the mandatory requirements set out in the current Building Regulations.

[3] Building Regulations, Approved Document L1a

6.2. Building Services

Proposed space heating for the residential development will be provided by individual Potterton Promax Ultra 24 ErP condensing combi boilers (or a boiler of equivalent efficiency). Condensing boilers can increase efficiency by condensing water vapour produced from combustion in order to extract heat which would otherwise be lost. Weather compensators have also been assumed to further reduce the Dwelling Emission Rate.

The heating system will be equipped with two independent time and temperature controls. The efficiency of a heating system is greatly increased by dividing the home into distinct heating zones covering different heating needs. In most cases there is no need to heat bedrooms during the day, when they are not in use, or to run the whole system at the same temperature. This allows residents to make a more targeted and efficient use of heat generation.

Ventilation will be provided through natural ventilation utilising openable windows and trickle vents with intermittent extract fans in kitchens and wet rooms to minimise electrical consumption further reducing CO2 emissions over mechanical systems.

Low energy lighting will be specified throughout, i.e. having a luminous efficacy of greater than 45 lumens per circuit watt (residential). Typically this will be achieved with LEDs or compact fluorescent lights. Low voltage halogen spot lights will not be used as these are not low energy.

Element	Specification
Boilers	Potterton Promax Ultra 24 (or equivalent efficiency)
Heating emitter	Radiant – low surface temperature.
Heating control	Time and temperature zone control.
Domestic hot water	From main heating system.
Water consumption	≤125 litres/person/day
Internal fixed lighting	100% low energy.
Ventilation	Natural ventilation with intermittent extract fans
Thermal bridging	Accredited & Enhanced Construction Details incorporated into design.
Thermal mass parameter	Low

Table 4. **Building services specification (houses)**

	Predicted Annual CO_2 Emissions (kg.CO_2/year)	CO_2 Reduction (%)	Cumulative CO_2 Reduction (%)
Baseline	1,857	-	-
Be Lean	1,853	0.2%	0.2%
Be Clean			
Be Green			
Target	1,207	35.0%	**Insuffcient Reduction**

Table 5. **Whole site CO_2 emissions after 'Be Lean' measures**

6.3. Summertime Overheating

Effects of overheating have been well documented over recent years, often cited to result from climate change and modern construction techniques.

Although guidance exists across the industry to forecast the risk of overheating, design considerations are often required at concept stage to provide adequate mitigation.

6.3.1. Common Causes

The Zero Carbon Hub state three factors associated with overheating risk; location, building design and the occupants.

Location

The climate or, microclimate is subject to the geographic site location. Sun, wind and rain intensity are dependent upon where the development is situated and as such the design approach will vary accordingly - for example, average summertime temperatures are higher in the south east of England compared to the north east therefore, increased ventilation levels may be less effective.

Dense urban development with minimal open green space may present risk associated with the 'urban heat island' effect. This comprises of heat absorbed by heavy man-made structures which is then radiated at night increasing the local temperature.

Building Design

There are several elements of building design that effect overheating performance. Fundamentally, the orientation of a building together with the proportion and location of glazing areas will determine the level of transmitted solar gain. Where solar gain cannot be absorbed or, removed, internal temperature levels will increase. Although there is benefit in utilising 'free' solar energy to heat a building, the amount of energy must be controlled.

Due to increasing energy efficiency standards, modern structures are often well insulated and constructed to high levels of air tightness. In addition to lower levels of thermal mass, this often results in a reduced ability to absorb or, purge heat compared to that of older buildings.

Occupants

Although the exact occupant use cannot generally be controlled for new construction projects, the setting out of a building should consider the impact of room use type and location in the context of solar and other incident heat gains. Overheating risk is effected by both the occupant density and anticipated activity type in a zone.

6.3.2. Mitigation

For new-build construction projects, design considerations to reduce an overheating risk should be made at the earliest possible opportunity. Although performance measures can be incorporated at later stages, the most robust and effective techniques are often inherent to a buildings design.

The 'cooling hierarchy', defined by the London Plan and often referred to by other regions indicates the preferred approach to reducing overheating risk and a reliance upon mechanical cooling. The hierarchal steps are as follows;

1. Minimise heat generation through energy efficient design.
2. Reduce the amount of heat entering a building in summer through orientation, shading, albedo, fenestration, insulation and green roofs and walls.
3. Manage the heat within the building through exposed thermal mass and high ceilings.
4. Passive ventilation.
5. Mechanical cooling.

Further to appropriate siting and orientation, there are several properties or, functions that influence overheating performance.

Glazed proportion and specification

The location, proportion and specification of glazing should balance the benefits of natural light and 'free heat' though also ensure that levels of gain are not excessive. Glass manufacturers offer a broad variety of products including solar control coatings to enable the level of transmitted solar gain (denoted by the glass 'g-value') to be reduced with minimal impact upon visual performance. Certain glass specifications may be more appropriate for certain orientations, e.g. a lower g-value to a south façade than the north.

Solar shading

In a similar vein to solar control glass coatings, external solar shading can be used to prevent the direct transmission of solar gain whilst enabling glazed areas to be maintained or, maximized. Horizontal overhangs are usually more appropriate for south facing windows due to higher sun angles. Conversely, vertical fins are more appropriate for east and west facing windows.

Figure 6. External solar shading[4]

4 http://levolux.com/tag/timber-fins/

Thermal Mass

Thermal mass is a physical property which defines the ability of an object or, construction to absorb heat energy; the greater the mass, the greater the heat absorption potential. Higher thermal mass construction enables heat to be absorbed during the day then released at night. This can reduce daytime temperatures and improve the thermal *stability* of a building. However, as greater energy is also then required to 'heat' the fabric, overall consumption can increase. Therefore, as with all of these approaches, a balance must be struck. Thermal mass can be increased by exposing dense fabric or increasing the physical connection between finishing materials, e.g. plaster, and the structural core, e.g. blockwork.

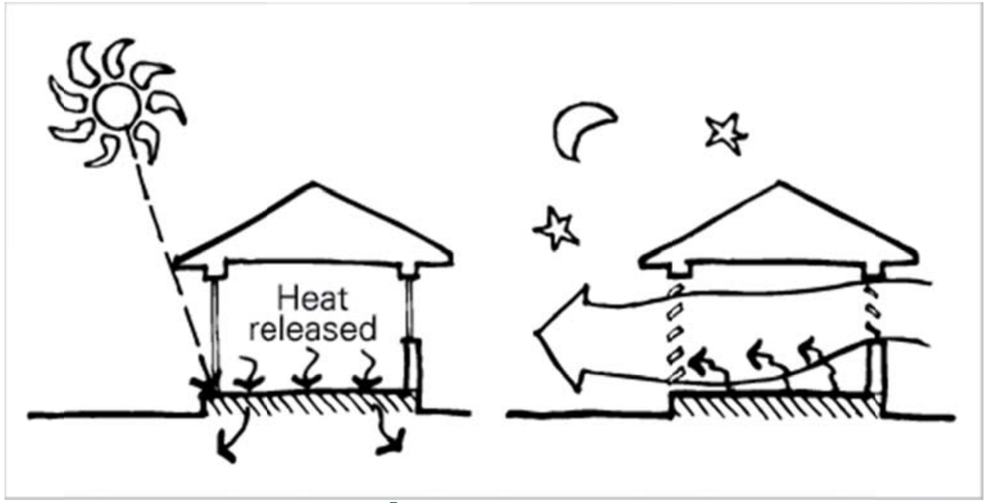


Figure 7. Principles of thermal mass[5]

Ventilation

The ventilation strategy is critical to overheating performance. Background ventilation levels are low compared to the rates generally required to purge heat. Therefore, the ventilation strategy must enable the greatest volume of air to be moved should the requirement arise. The potential rate of ventilation is determined by a number of factors including;

- Opening type, size and duration.

- Building height and exposure.

- The number of storeys and opportunity for cross-ventilation.

Ventilation openings should enable the greatest possible opening for the greatest duration without compromising security and water ingress protection.

5 http://levolux.com/tag/timber-fins/

6.3.3. Quantifying Overheating Risk

Several guidance documents exist which define overheating risk assessment and acceptable thresholds. These include; CIBSE Guide A, BB101 (schools), TM52 and SAP. The first three methods predominantly concern non-domestic development and require a Dynamic Simulation Modelling (DSM) exercise to be undertaken to calculate predicted internal temperatures against standard regional weather data. Predicted temperatures are compared against recommended limits to determine whether they are acceptable or, excessive.

The SAP assessments process is used for new residential developments and incorporates a summer overheating risk calculation. Similarly to the other methods, SAP calculations consider heat gain from regional weather data, site exposure, solar and internal heat gains. The calculation determines a mean internal temperature which can be compared against the following thresholds. In order to comply with the SAP and Part L1a criteria, 'the likelihood of high internal temperatures during hot weather' must be less than 'high'.

Threshold Temperature (°C)	**'Likelihood of high internal temperatures during hot weather'**
< 20.5 °C	**Not Significant**
≥ 20.5 °C and < 22.0 °C	**Slight**
≥ 22.0 °C and < 23.5 °C	**Medium**
≥ 23.5 °C	**High**

Table 6. **SAP overheating criteria** [6]

6.3.4. Results

The development incorporates the following features to mitigate the risk of overheating;

- Substantial trees are located along the North elevation, with the existing flats to the South which will provide shelter to the building from solar gain.
- External shading is also provided by the projecting roofs.
- In accordance with the proposed construction type, an indicative thermal mass of 'low' has been applied to the SAP calculation (corresponding to a TMP of 100 kJ/m2.K).
- Large opening windows will enable heat to be purged.

SAP calculations carried out for the development show all dwellings to comply with the overheating criteria. Results of all calculations are appended to this report.

[6] The governments Standard Assessment Procedure (SAP) for Energy Rating of Dwellings (2012)

BE CLEAN

SUPPLY ENERGY EFFICIENTLY

7. Be Clean – Decentralised Energy

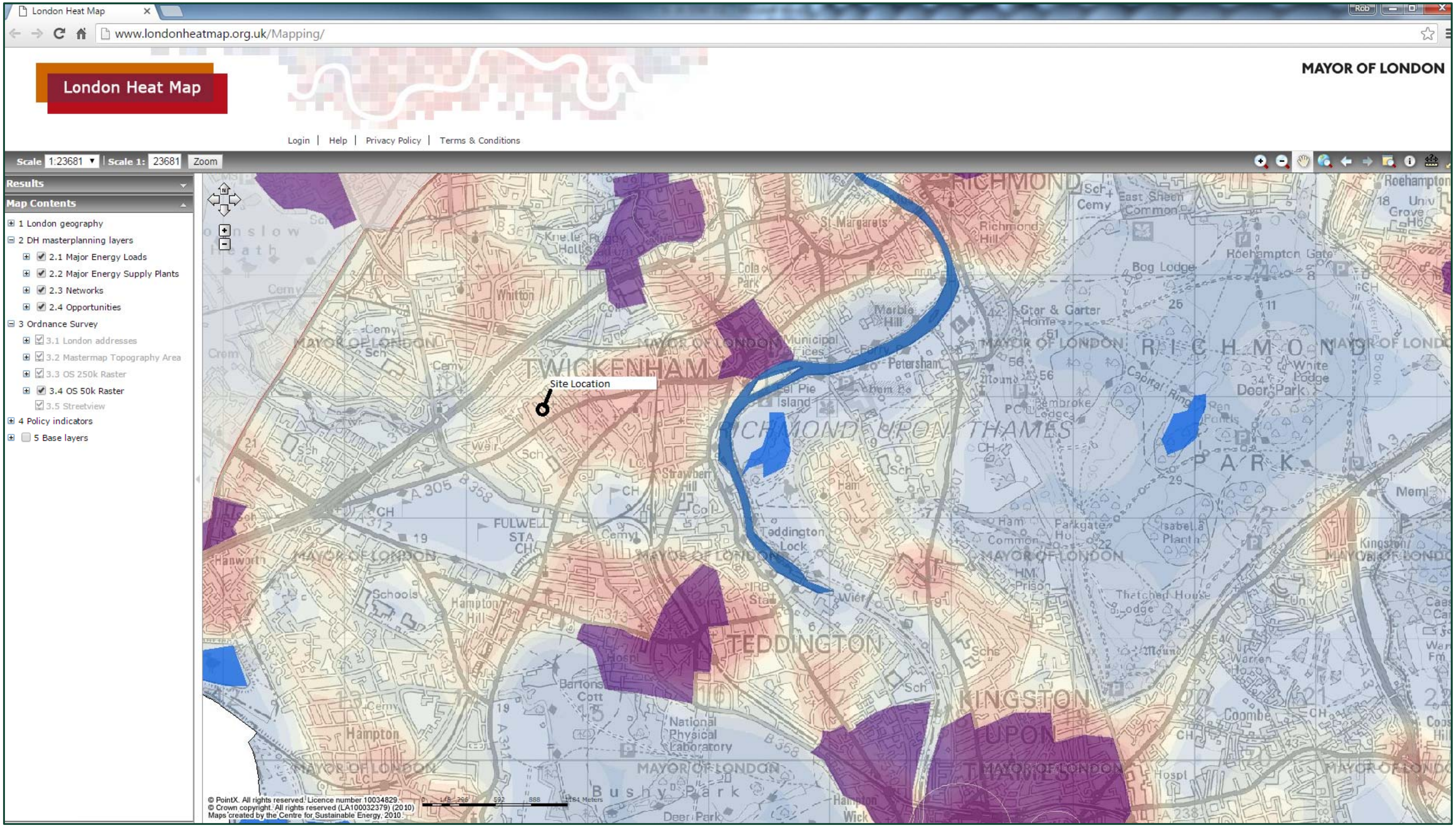


Figure 8. London heat map for site region

7.1. District Heating

Analysis of the UK CHP Development Map and London Heat Map was made to determine whether existing or proposed district heating networks are present in the vicinity of the development site. There are no existing district heat networks (yellow), proposed networks (red) and the development does not lie in a District Heating Opportunity Area (purple). As such it is not recommended to add development cost through the provision for future connection.

7.2. Combined Heat And Power

The development size and nature renders Combined Heat and Power systems unsuitable due to the lack of a sufficient base heating load. The well insulated fabric naturally lowers the demand for heat. Analysis of the Department of Energy & Climate Change CHP Site Assessment Tool supports this assertion, indicating that a CHP engine which has been sized to meet such a small demand would have poor efficiency and high maintenance costs.

Given that the development is solely residential this also means that the relatively low demand will very likely be limited to short periods in the morning and evening. This would create further operational inefficiencies, as the CHP engine would need to run uninterrupted for long periods. This is required to generate enough electricity to provide CO_2 reductions and financial economies which justify the capital and maintenance costs, and make it a practical and economically viable installation. CHP is much better suited to larger developments where the efficiencies and CO_2 savings can be greater. Therefore it is not considered viable to achieve further CO_2 reductions through a decentralised energy strategy on this development.

	Predicted Annual CO_2 Emissions (kg.CO_2/year)	CO_2 Reduction (%)	Cumulative CO_2 Reduction (%)
Baseline	1,857	-	-
Be Lean	1,853	0.2%	0.2%
Be Clean	1,853	0.0%	0.2%
Be Green			
Target	1,207	35.0%	**Insuffcient Reduction**

Table 7. **Whole site CO_2 emissions after 'Be Clean' measures**

BE GREEN

USE RENEWABLE ENERGY

8. Be Green – Renewable Technology

The CO_2 emissions after 'Be Lean' and 'Be Clean' measures have been assessed against the baseline CO_2 emissions. Reductions have been recorded after each stage in the energy hierarchy; this will help clarify the impact that renewable energy generation has on whole site CO_2 emissions.

8.1. Solar Photovoltaics

Solar Photovoltaic (PV) panels comprise of a number of inter-connected cells that utilise semi-conductor technology to convert solar energy into electricity. High voltage, direct current is converted to alternating current and phased into the mains supply via an inverter. PV panels are most effective where mounted on exposed, south-facing areas, at an inclination close to 30° from the horizontal.

The technology is well proven and requires little maintenance; most panels are designed to be self-cleaning when mounted at appropriate angles and the design life of a panel typically exceeds the likely pay-back period by a considerable margin. PV has the significant advantage of reducing energy use and costs on site for residents whilst also reducing demand from the national grid and even contributing to grid energy. This can save significant carbon dioxide emissions by reducing the relatively inefficient and fossil-fuel heavy heat generation in the national infrastructure.

8.2. Technology Analysis – Solar Photovoltaics

The potential for CO2 savings from solar PV has been assessed using the Governments approved SAP: 2012 (Standard Assessment Procedure) methodology. This SAP methodology considers UK solar irradiance data, collector pitch, orientation and over-shading to determine the expected annual energy yield. In order to represent a semi-optimal installation, it is taken that solar PV could be installed on the rear elevation roof area to all dwellings. On this basis, calculations show that a total minimum installed PV capacity of 1.55 kWp (kilo-Watt peak) would be expected to generate 1276 kWh per annum. Applying the current CO2 emissions factor for grid-displaced electricity (0.519 kg.CO2/kWh), this generation corresponds to a CO2 abatement of 662 kg.CO2 per annum; to meet the target of 35% reduction from baseline site emissions.

Using current known PV panel efficiencies, 1.55 kWp of PV corresponds to approximately 10.385 m2. Therefore, it is considered feasible that solar PV could be used to meet the 35% CO2 saving requirement.

	Predicted Annual CO_2 Emissions (kg.CO_2/year)	CO_2 Reduction (%)	Cumulative CO_2 Reduction (%)
Baseline	1,857	-	-
Be Lean	1,853	0.2%	0.2%
Be Clean	1,853	0.0%	0.2%
Be Green	1,193	35.6%	35.8%
Target	1,207	35.0%	**Target Achieved**

Table 8. **Whole site CO_2 emissions after 'Be Green' measures**

8.3. Unregulated Energy

Unregulated energy use is not currently measured under Building Regulations Part L, which focuses on the **building energy load** otherwise known as **regulated energy**. The building energy load is limited to consumption covered by space and water heating, cooling, ventilation and fixed lighting. The **occupant energy load** is known as **unregulated energy** which covers energy used for appliances used for refrigeration, cooking and personal use (computers, televisions etc.).

The unregulated energy demand for this development has been measured using the methodology outlined within **SAP 2012, Appendix L: Energy for lighting and electrical appliances**. The data extracted from Appendix L is then applied a fuel factor measured in kg.CO_2 per kWh.

The methodology used to derive the total unregulated energy use is shown in figure 8 for electrical appliances and figure 9 for cooking. Using this calculation method has produced an unregulated energy load figure of **1,472 kg.CO_2/yr** or **2,836 kWh/yr**.

Unregulated energy use can be reduced for the development through occupant awareness using the following methods:

- Specifying energy efficient white goods and technology;
- Installing automatic lighting control and LED fittings;
- Effective use of heating controls and reducing thermostat temperatures;
- Ensuring all electrical devices are turned off at the mains when not in use;
- Power monitoring.

L2 Electrical Appliances

The initial value of the annual energy use in kWh for electrical appliances is:

$$E_A = 207.8 \times (TFA \times N)^{0.4714} \quad (L10)$$

where TFA is the total floor area in m² and N is the assumed number of occupants (see Table 1b).

The appliances energy use in kWh in month m (January = 1 to December = 12) is

$$E_{A,m} = E_A \times [1 + 0.157 \times \cos(2\pi (m - 1.78) / 12)] \times n_m / 365 \quad \text{kWh} \quad (L11)$$

Then re-calculate the annual total as the sum of the monthly values:

$$E_A = \sum_{m=1}^{12} E_{A.m} \quad (L12)$$

The associated internal heat gain for each month in watts is

$$G_{A,m} = E_{A,m} \times 1000 / (24 \times n_m) \quad (L13)$$

where n_m is the number of days in month m. When reduced internal heat gains are assumed for the calculation the appliance gains are based on efficient cold and wet appliances and below average use of other appliances:

$$G_{A,m} = 0.67 \times E_{A,m} \times 1000 / (24 \times n_m) \quad (L13a)$$

The annual CO_2 emissions in kg/m²/year associated with electrical appliances is

$$E_A \times EF_{electricity} / TFA \quad (L14)$$

where $EF_{electricity}$ is the emission factor for electricity (Table 12).

Equation (L13) or (L13a) is used for the heat gain from appliances in each month in Section 5 of the calculation. Equation (L14) is used for the annual emissions for appliances in Section 16 of the calculation (which is applicable only for calculations in relation to Level 6 of the Code for Sustainable Homes).

Figure 9. SAP Methodology extracted from Appendix L for electrical appliances

L3 Cooking

Internal heat gains in watts from cooking:

$$G_C = 35 + 7 N \quad (L15)$$

When lower internal heat gains are assumed for the calculation,

$$G_C = 23 + 5 N \quad (L15a)$$

CO_2 emissions in kg/m²/year associated with cooking:

$$(119 + 24 N) / TFA \quad (L16)$$

where TFA is the total floor area in m² and N is the assumed number of occupants (see Table 1b).

Equation (L15) or (L15a) is used for the heat gain from cooking in Section 5 of the calculation. Equation (L16) is used for the annual emissions for cooking in Section 16 of the calculation (which is applicable only for calculations in relation to Level 6 of the Code for Sustainable Homes and to Stamp Duty Land Tax).

Figure 10. SAP Methodology extracted from Appendix L for cooking

9. Conclusion

This Energy Strategy has outlined how this development will meet the requirements by following the energy hierarchy from the London Plan 2015. This structure suggests to initially address the fabric first approach by upgrading thermal elements and building services. Decentralised energy has been researched as part of the 'Be Clean' section and finally renewable technology has been implemented to achieve a 19% reduction in CO_2 emissions.

9.1. Be Lean – use less energy

A building fabric and services specification is proposed which incorporates high efficiency heating, lighting and controls and a thermally efficient building fabric: low u-values; limiting air leakage and limiting thermal bridging.

9.2. Be Clean – supply energy efficiently

There is no current district heating network in the locality of this site. Combined Heat and Power is deemed unsuitable for a development of this type due to it requiring the provision for large plant area and a community heating infrastructure.

9.3. Be Green – use renewable energy

The renewable analysis has highlighted that the most appropriate technology for this development is Solar PV with a 1.55 kWp system. The PV output will need to be verified at detailed design stage to ensure compliance.

10. Summary

This statement has set out how the development will incorporate an energy efficient design which exceeds Part L 2013 regulations and, with the application of PV arrays to the roof, can achieve the required 35% reduction carbon dioxide emissions as required for the London Borough of Richmond upon Thames Development Management Plan Policy DM SD1.

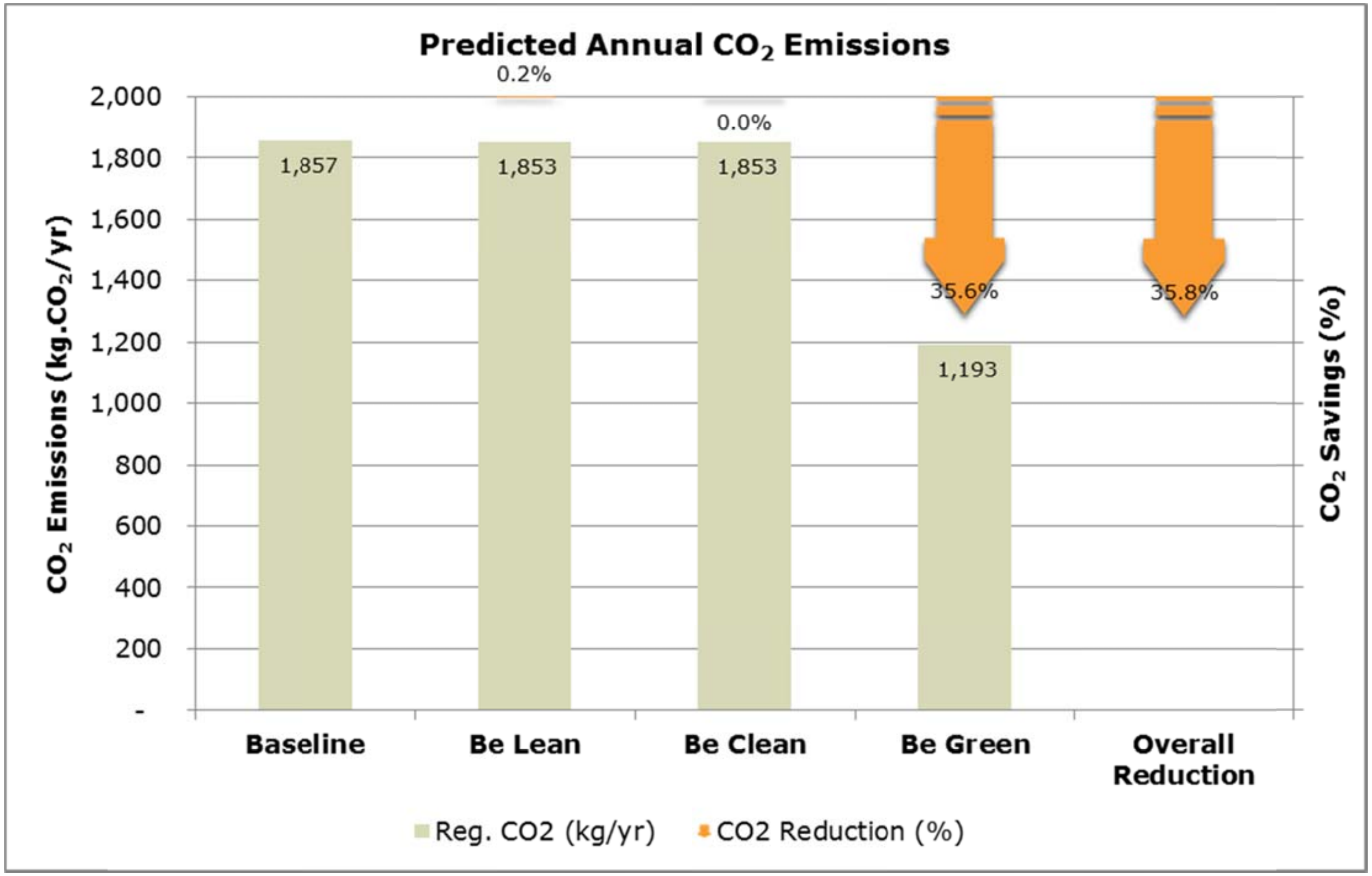


Figure 11. Whole site reduction in CO_2 emissions

Appendices

Notes on presentation

An Energy Statement should present technical data while remaining easy to read and to understand. Clearly laid out tables should be used to present data for ease of reading and comparison. Site plans should be used where possible, e.g. to indicate suitable roof areas for installing solar technologies or the location of a plant room. References should be used to explain where data has been obtained from.

Example Tables

1. Summary of baseline energy demand.

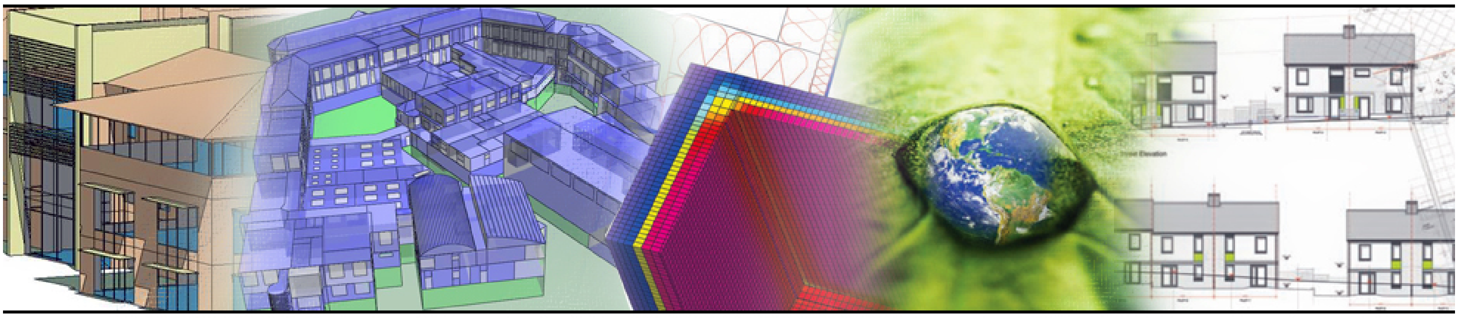
This table may be amended or duplicated to show energy demand before and after the application of energy efficiency measures or renewable energy technologies.

	Total Energy Demand (kWh/yr)	Associated Total CO2 (kgCO2/yr)
Hot water	1921.18	414.99
Space Heating	5663.38	1223.29
Fixed Electrical	418.81	217.37
Appliances/Non-regulated	2836	1472
… (any other energy consumption)		
TOTAL	10839.37	3327.65

2. Summary of CO_2 emissions reductions

	Total CO2 emissions (kgCO2/year)
Baseline emissions	1856.59
Improved emissions (after application of energy efficiency measures)	1855.63
Improved emissions (after incorporation of efficient energy supply)	1855.63
Improved emissions (after incorporation of renewable energy technology)	1193.28
% CO2 displaced in total	35.8
% CO2 displaced by energy efficiency measures	0.2
% CO2 displaced by efficient supply of energy	0.0
% CO2 displaced by renewable energy	35.6

STROMA TECH



SAP Summary Report

61 Belmont Road

Twickenham

As Designed

Part L1A (2012)

Ref: 01-16-55567

Issue Date 01/02/2016

Prepared for: Hazan Smith & Partners

Project Name	61 Belmont Road
Project Number	01-16-55567
Revision	-
SAP Assessor	Joseph Price-Buchanan
Assessor Number	STRO016219

Project Status
SAP compliance achieved

Project Status Details
SAP compliance achieved, but assumptions have been made that require client review and response to finalise the calculations, please see details below;

Comments by Assessor

DISCLAIMER

The results in the attached schedule have been prepared based on drawings, specification and other correspondence provided, unless otherwise stated above. Any deviation from any of this document or the specifications will invalidate the SAP, DER, and TER results.

Project Name	61 Belmont Road
Project Number	01-16-55567
Revision	-
SAP Assessor	Joseph Price-Buchanan
Assessor Number	STRO016219

Project Status
SAP compliance achieved

SAP Summary Report

Property Type	Plot	Built Form	TER	DER	Percent Improvement	Total Floor Area	FEE	Air permeability	Air Target (if Sample testing, only applies to 2010 B Regs)	Building Regulations Results	DFEE - BR 2012	TFEE - BR 2012
House	Plot 1	Detached	23.36	15.01	35.74	79.49	66.60	4	n/a	Yes	66.60	79.10

Project Name	61 Belmont Road
Project Number	01-16-55567
Revision	-
SAP Assessor	Joseph Price-Buchanan
Assessor Reference	STRO016219

Design SAP Input Data Table

Description		Reference/Source	Details	Comments
Fabric U-values (W/m^2K)	Roof	Architect calculation	0.15	100mm phenolic foam board between studs, 50mm board over (0.02λ), 12.5mm plasterboard
	External Wall	Architect calculation	0.20	100mm concrete block, 150mm mineral wool quilt (0.02λ), brick outer leaf
	Ground Floor	Architect calculation	0.13	75mm screed, 150mm Celotex (0.022λ), 100mm concrete beam & block
	Windows / Roof light	Email & specification	1.40	Double glazed, Argon filled, low-e
	Doors	Email & specification	1.20	Double glazed, Argon filled, low-e
	y-value	Default	0.03	Based on accredited construction details and enhanced details for lintel and ground floor junctions
Thermal Mass		Specification	Indicative - Low	
Ventilation	Airtightness $m3/(hr.m^2)$	Email	4.0	
	Mechanical Ventilation	Email & Specification	Natural ventilation and intermittent extract fans	
Heating	Main Heating System	Email confirmation	Potterton Promax Ultra 24 ErP	
	Controls	Email confirmation	Time and temperature zone control	
	Water Heating	Specification	From main heating system	
	Secondary Heating System	N/A	None	
Low energy lighting		Email Specification	100%	
Renewables		Email Specification	1.55 kWp	

REVISION	DESCRIPTION OF AMENDMENTS	DATE
1	First issue	01/02/2016

STROMA® TECHNOLOGY

Regulations Compliance Report

Approved Document L1A, 2013 Edition, England assessed by Stroma FSAP 2012 program, Version: 1.0.1.24
Printed on 01 February 2016 at 09:59:37

Project Information:

Assessed By: Joseph Price-Buchanan (STRO016219) **Building Type:** Detached House

Dwelling Details:

NEW DWELLING DESIGN STAGE Total Floor Area: 79.49m²

Site Reference : 61 Belmont Road - Twickenham **Plot Reference:** 01-16-55567 Plot 1 PL1

Address :

Client Details:

Name: Hazan Smith & Partners

Address :

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

1a TER and DER

Fuel for main heating system: Mains gas
Fuel factor: 1.00 (mains gas)

Target Carbon Dioxide Emission Rate (TER)	23.36 kg/m²	
Dwelling Carbon Dioxide Emission Rate (DER)	15.01 kg/m²	OK

1b TFEE and DFEE

Target Fabric Energy Efficiency (TFEE)	79.2 kWh/m²	
Dwelling Fabric Energy Efficiency (DFEE)	66.6 kWh/m²	
		OK

2 Fabric U-values

Element	Average	Highest	
External wall	0.20 (max. 0.30)	0.20 (max. 0.70)	OK
Floor	0.13 (max. 0.25)	0.13 (max. 0.70)	OK
Roof	0.15 (max. 0.20)	0.15 (max. 0.35)	OK
Openings	1.21 (max. 2.00)	1.40 (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: Database: (rev 387, product index 017614):
Boiler systems with radiators or underfloor heating - mains gas
Brand name: Potterton
Model: Promax Ultra
Model qualifier: Combi 24 ErP
(Combi)
Efficiency 89.1 % SEDBUK2009
Minimum 88.0 % OK

Secondary heating system: None

Regulations Compliance Report

5 Cylinder insulation

Hot water Storage:	No cylinder	

6 Controls

Space heating controls	Time and temperature zone control by device in database	**OK**
Hot water controls:	No cylinder	
Boiler interlock:	Yes	**OK**

7 Low energy lights

Percentage of fixed lights with low-energy fittings	100.0%	
Minimum	75.0%	**OK**

8 Mechanical ventilation

Not applicable

9 Summertime temperature

Overheating risk (Thames valley):	Medium	**OK**

Based on:

Overshading:	Average or unknown
Windows facing: South East	0.92m²
Windows facing: North West	16.36m²
Windows facing: South West	12.82m²
Windows facing: North East	4.89m²
Ventilation rate:	3.00
Blinds/curtains:	Dark-coloured curtain or roller blind Closed 100% of daylight hours

10 Key features

Thermal bridging	0.034 W/m²K
Photovoltaic array	

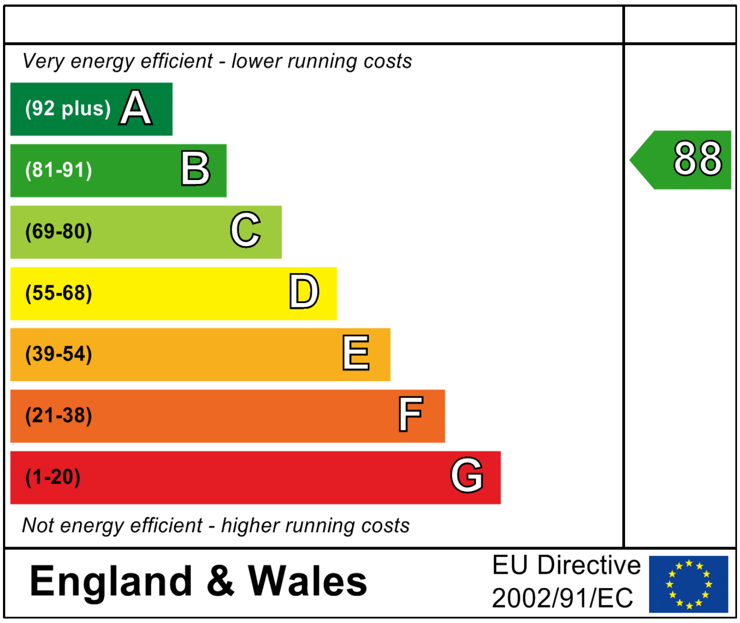
Predicted Energy Assessment

Dwelling type:	Detached House
Date of assessment:	24 January 2016
Produced by:	Joseph Price-Buchanan
Total floor area:	79.49 m²

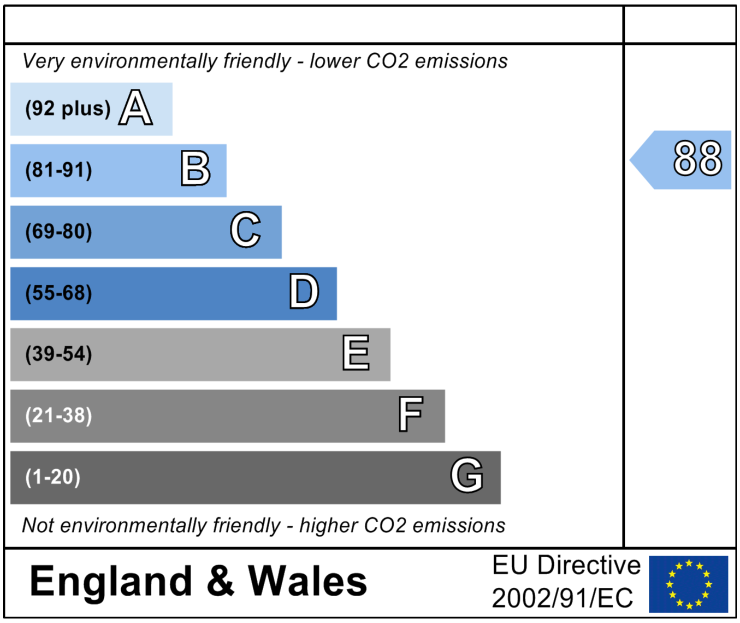
This is a Predicted Energy Assessment for a property which is not yet complete. It includes a predicted energy rating which might not represent the final energy rating of the property on completion. Once the property is completed, an Energy Performance Certificate is required providing information about the energy performance of the completed property.

Energy performance has been assessed using the SAP 2012 methodology and is rated in terms of the energy use per square metre of floor area, energy efficiency based on fuel costs and environmental impact based on carbon dioxide (CO2) emissions.

Energy Efficiency Rating



Environmental Impact (CO_2) Rating



The energy efficiency rating is a measure of the overall efficiency of a home. The higher the rating the more energy efficient the home is and the lower the fuel bills are likely to be.

The environmental impact rating is a measure of a home's impact on the environment in terms of carbonn dioxide (CO2) emissions. The higher the rating the less impact it has on the environment.

SAP Input

Property Details: 01-16-55567 Plot 1 PL1

Address:	
Located in:	England
Region:	Thames valley
UPRN:	
Date of assessment:	24 January 2016
Date of certificate:	01 February 2016
Assessment type:	New dwelling design stage
Transaction type:	New dwelling
Tenure type:	Unknown
Related party disclosure:	No related party
Thermal Mass Parameter:	Indicative Value Low
Water use <= 125 litres/person/day:	True
PCDF Version:	387

Property description:

Dwelling type:	House	
Detachment:	Detached	
Year Completed:	2016	
Floor Location:	Floor area:	Storey height:
Floor 0	79.49 m²	3.32 m
Living area:	17.478 m² (fraction 0.22)	
Front of dwelling faces:	South East	

Opening types:

Name:	Source:	Type:	Glazing:	Argon:	Frame:
SE Elevation	Manufacturer	Solid			Wood
SE Elevation	Manufacturer	Windows	low-E, En = 0.05, soft coat	Yes	PVC-U
NW Elevation	Manufacturer	Windows	low-E, En = 0.05, soft coat	Yes	PVC-U
SW Elevation	Manufacturer	Windows	low-E, En = 0.05, soft coat	Yes	PVC-U
NE Elevation	Manufacturer	Windows	low-E, En = 0.05, soft coat	Yes	PVC-U

Name:	**Gap:**	**Frame Factor:**	**g-value:**	**U-value:**	**Area:**	**No. of Openings:**
SE Elevation	mm	0.7	0	1.4	2	1
SE Elevation	16mm or more	0.7	0.5	1.2	0.92	1
NW Elevation	16mm or more	0.7	0.5	1.2	16.36	1
SW Elevation	16mm or more	0.7	0.5	1.2	12.82	1
NE Elevation	16mm or more	0.7	0.5	1.2	4.89	1

Name:	Type-Name:	Location:	Orient:	Width:	Height:
SE Elevation		External Wall	South East	0	0
SE Elevation		External Wall	South East	0	0
NW Elevation		External Wall	North West	0	0
SW Elevation		External Wall	South West	0	0
NE Elevation		External Wall	North East	0	0

Overshading: Average or unknown

Opaque Elements:

Type:	Gross area:	Openings:	Net area:	U-value:	Ru value:	Curtain wall:	Kappa:
External Elements							
External Wall	118.12	36.99	81.13	0.2	0	False	N/A
Pitched Roof	84.44	0	84.44	0.15	0		N/A
Ground Floor	79.49			0.13			N/A
Internal Elements							

SAP Input

Party Elements

Thermal bridges:

Thermal bridges: User-defined (individual PSI-values) Y-Value = 0.0341

	Length	Psi-value		
	22.67	0.01	E1	Steel lintel with perforated steel base plate
[Approved]	21.77	0.04	E3	Sill
[Approved]	29.3	0.05	E4	Jamb
	48.61	0.067	E5	Ground floor (normal)
[Approved]	18.4	0.04	E11	Eaves (insulation at rafter level)
[Approved]	32.22	0.04	E13	Gable (insulation at rafter level)
[Approved]	15.981	0.09	E16	Corner (normal)
[Approved]	4.015	-0.09	E17	Corner (inverted internal area greater than external area)
[Approved]	9.81	0.07	E6	Intermediate floor within a dwelling

Ventilation:

Pressure test:	Yes (As designed)
Ventilation:	Natural ventilation (extract fans)
Number of chimneys:	0
Number of open flues:	0
Number of fans:	2
Number of passive stacks:	0
Number of sides sheltered:	2
Pressure test:	4

Main heating system:

Main heating system:

Boiler systems with radiators or underfloor heating
Gas boilers and oil boilers
Fuel: mains gas
Info Source: Boiler Database
Database: (rev 387, product index 017614) Efficiency: Winter 86.7 % Summer: 90.0
Brand name: Potterton
Model: Promax Ultra
Model qualifier: Combi 24 ErP
(Combi boiler)
Systems with radiators
Central heating pump : 2013 or later
Design flow temperature: Design flow temperature<=35°C
Boiler interlock: Yes

Main heating Control:

Main heating Control:

Time and temperature zone control by device in database
Control code: 2112

Secondary heating system:

Secondary heating system: None

Water heating:

Water heating:

From main heating system
Water code: 901
Fuel :mains gas
No hot water cylinder
Solar panel: False

Others:

Electricity tariff:	Standard Tariff
In Smoke Control Area:	Unknown
Conservatory:	No conservatory
Low energy lights:	100%

SAP Input

Terrain type:	Low rise urban / suburban
EPC language:	English
Wind turbine:	No
Photovoltaics:	Photovoltaic 1 Installed Peak power: 1.55 Tilt of collector: 30° Overshading: None or very little Collector Orientation: South East
Assess Zero Carbon Home:	No

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Joseph Price-Buchanan	**Stroma Number:**	STRO016219
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.1.24

Property Address: 01-16-55567 Plot 1 PL1

Address :

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	79.49	(1a) x	3.32	(2a) =	263.91	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	79.49	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	263.91	(5)

2. Ventilation rate:

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

Air changes per hour

Infiltration due to chimneys, flues and fans =	(6a)+(6b)+(7a)+(7b)+(7c) =	20	÷ (5) =	0.08	(8)

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

Number of storeys in the dwelling (ns)		0	(9)
Additional infiltration	[(9)-1]x0.1 =	0	(10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction *if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35*		0	(11)
If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0	(12)
If no draught lobby, enter 0.05, else enter 0		0	(13)
Percentage of windows and doors draught stripped		0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		4	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.28	(18)

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

Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.23	(21)

Infiltration rate modified for monthly wind speed

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table 7												
(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7
Wind Factor (22a)m = (22)m ÷ 4												
(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18

SAP WorkSheet: New dwelling design stage

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

0.3	0.29	0.29	0.26	0.25	0.22	0.22	0.22	0.23	0.25	0.26	0.28

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 0 (23c)

a) If balanced mechanical ventilation with heat recovery (MVHR) (24a)m = (22b)m + (23b) × [1 – (23c) ÷ 100]

(24a)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24a)

b) If balanced mechanical ventilation without heat recovery (MV) (24b)m = (22b)m + (23b)

(24b)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24b)

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

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

(24c)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24c)

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

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

(24d)m=	0.54	0.54	0.54	0.53	0.53	0.52	0.52	0.52	0.53	0.53	0.53	0.54	(24d)

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

(25)m=	0.54	0.54	0.54	0.53	0.53	0.52	0.52	0.52	0.53	0.53	0.53	0.54	(25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			2	x	1.4	=	2.8			(26)
Windows Type 1			0.92	x1/[1/(1.2)+ 0.04]		=	1.05			(27)
Windows Type 2			16.36	x1/[1/(1.2)+ 0.04]		=	18.73			(27)
Windows Type 3			12.82	x1/[1/(1.2)+ 0.04]		=	14.68			(27)
Windows Type 4			4.89	x1/[1/(1.2)+ 0.04]		=	5.6			(27)
Floor			79.49	x	0.13	=	10.3337			(28)
Walls	118.12	36.99	81.13	x	0.2	=	16.23			(29)
Roof	84.44	0	84.44	x	0.15	=	12.67			(30)
Total area of elements, m²			282.05							(31)

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

*** include the areas on both sides of internal walls and partitions*

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 82.09 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 14371.66 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Low 100 (35)

For design assessments where the details of the construction are not known precisely the indicative values of TMP in Table 1f can be used instead of a detailed calculation.

Thermal bridges : S (L x Y) calculated using Appendix K 9.61 (36)

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

Total fabric heat loss (33) + (36) = 91.7 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	47.43	47.28	47.14	46.44	46.31	45.7	45.7	45.59	45.94	46.31	46.57	46.85	(38)

Heat transfer coefficient, W/K (39)m = (37) + (38)m

(39)m=	139.13	138.98	138.83	138.14	138.01	137.4	137.4	137.29	137.64	138.01	138.27	138.55	

Average = Sum(39)$_{1…12}$ /12= 138.14 (39)

Heat loss parameter (HLP), W/m²K (40)m = (39)m ÷ (4)

(40)m=	1.75	1.75	1.75	1.74	1.74	1.73	1.73	1.73	1.73	1.74	1.74	1.74

Average = Sum(40)$_{1…12}$ /12= 1.74 (40)

Number of days in month (Table 1a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(41)m=	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirement: kWh/year:

Assumed occupancy, N 2.45 (42)

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

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 92.46 (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)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(44)m=	101.71	98.01	94.31	90.61	86.91	83.22	83.22	86.91	90.61	94.31	98.01	101.71

Total = Sum(44)$_{1…12}$ = 1109.54 (44)

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

(45)m=	150.83	131.92	136.13	118.68	113.87	98.26	91.06	104.49	105.74	123.23	134.51	146.07

Total = Sum(45)$_{1…12}$ = 1454.78 (45)

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

(46)m=	22.62	19.79	20.42	17.8	17.08	14.74	13.66	15.67	15.86	18.48	20.18	21.91	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 0 (47)

If community heating and no tank in dwelling, enter 110 litres in (47)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in (47)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): 0 (48)

Temperature factor from Table 2b 0 (49)

Energy lost from water storage, kWh/year (48) x (49) = 0 (50)

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

Hot water storage loss factor from Table 2 (kWh/litre/day) 0 (51)

If community heating see section 4.3

Volume factor from Table 2a 0 (52)

Temperature factor from Table 2b 0 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 0 (54)

Enter (50) or (54) in (55) 0 (55)

Water storage loss calculated for each month ((56)m = (55) × (41)m

(56)m=	0	0	0	0	0	0	0	0	0	0	0	0	(56)

If cylinder contains dedicated solar storage, (57)m = (56)m x [(50) – (H11)] ÷ (50), else (57)m = (56)m where (H11) is from Appendix H

(57)m=	0	0	0	0	0	0	0	0	0	0	0	0	(57)

Primary circuit loss (annual) from Table 3 0 (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

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

(59)m=	0	0	0	0	0	0	0	0	0	0	0	0	(59)

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

(61)m=	21.08	19.01	20.98	20.24	20.86	20.12	20.76	20.82	20.19	20.93	20.34	21.06	(61)

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

(62)m=	171.91	150.93	157.11	138.91	134.73	118.39	111.81	125.31	125.92	144.16	154.85	167.13	(62)

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

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

(63)m=	0	0	0	0	0	0	0	0	0	0	0	0	(63)

Output from water heater

(64)m=	171.91	150.93	157.11	138.91	134.73	118.39	111.81	125.31	125.92	144.16	154.85	167.13	

Output from water heater (annual)$_{1...12}$ 1701.17 (64)

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

(65)m=	55.42	48.61	50.51	44.52	43.08	37.7	35.47	39.95	40.2	46.21	49.81	53.83	(65)

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

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m=	147.19	147.19	147.19	147.19	147.19	147.19	147.19	147.19	147.19	147.19	147.19	147.19	(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

(67)m=	48.67	43.23	35.16	26.61	19.9	16.8	18.15	23.59	31.66	40.2	46.92	50.02	(67)

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

(68)m=	325.93	329.31	320.79	302.64	279.74	258.21	243.83	240.45	248.97	267.12	290.02	311.55	(68)

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

(69)m=	52.17	52.17	52.17	52.17	52.17	52.17	52.17	52.17	52.17	52.17	52.17	52.17	(69)

Pumps and fans gains (Table 5a)

(70)m=	3	3	3	3	3	3	3	3	3	3	3	3	(70)

Losses e.g. evaporation (negative values) (Table 5)

(71)m=	-98.12	-98.12	-98.12	-98.12	-98.12	-98.12	-98.12	-98.12	-98.12	-98.12	-98.12	-98.12	(71)

Water heating gains (Table 5)

(72)m=	74.49	72.34	67.89	61.83	57.9	52.37	47.67	53.69	55.84	62.1	69.18	72.36	(72)

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

(73)m=	553.32	549.12	528.06	495.32	461.77	431.61	413.88	421.97	440.71	473.66	510.36	538.16	(73)

6. Solar gains:

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

Orientation:	Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Northeast 0.9x	0.77	x	4.89	x	11.28	x	0.5	x	0.7	=	13.38	(75)
Northeast 0.9x	0.77	x	4.89	x	22.97	x	0.5	x	0.7	=	27.24	(75)
Northeast 0.9x	0.77	x	4.89	x	41.38	x	0.5	x	0.7	=	49.08	(75)
Northeast 0.9x	0.77	x	4.89	x	67.96	x	0.5	x	0.7	=	80.6	(75)
Northeast 0.9x	0.77	x	4.89	x	91.35	x	0.5	x	0.7	=	108.34	(75)

Northeast	0.9x	0.77	x	4.89	x	97.38	x	0.5	x	0.7	=	115.5	(75)
Northeast	0.9x	0.77	x	4.89	x	91.1	x	0.5	x	0.7	=	108.05	(75)
Northeast	0.9x	0.77	x	4.89	x	72.63	x	0.5	x	0.7	=	86.14	(75)
Northeast	0.9x	0.77	x	4.89	x	50.42	x	0.5	x	0.7	=	59.8	(75)
Northeast	0.9x	0.77	x	4.89	x	28.07	x	0.5	x	0.7	=	33.29	(75)
Northeast	0.9x	0.77	x	4.89	x	14.2	x	0.5	x	0.7	=	16.84	(75)
Northeast	0.9x	0.77	x	4.89	x	9.21	x	0.5	x	0.7	=	10.93	(75)
Southeast	0.9x	0.77	x	0.92	x	36.79	x	0.5	x	0.7	=	8.21	(77)
Southeast	0.9x	0.77	x	0.92	x	62.67	x	0.5	x	0.7	=	13.99	(77)
Southeast	0.9x	0.77	x	0.92	x	85.75	x	0.5	x	0.7	=	19.14	(77)
Southeast	0.9x	0.77	x	0.92	x	106.25	x	0.5	x	0.7	=	23.71	(77)
Southeast	0.9x	0.77	x	0.92	x	119.01	x	0.5	x	0.7	=	26.56	(77)
Southeast	0.9x	0.77	x	0.92	x	118.15	x	0.5	x	0.7	=	26.36	(77)
Southeast	0.9x	0.77	x	0.92	x	113.91	x	0.5	x	0.7	=	25.42	(77)
Southeast	0.9x	0.77	x	0.92	x	104.39	x	0.5	x	0.7	=	23.29	(77)
Southeast	0.9x	0.77	x	0.92	x	92.85	x	0.5	x	0.7	=	20.72	(77)
Southeast	0.9x	0.77	x	0.92	x	69.27	x	0.5	x	0.7	=	15.46	(77)
Southeast	0.9x	0.77	x	0.92	x	44.07	x	0.5	x	0.7	=	9.83	(77)
Southeast	0.9x	0.77	x	0.92	x	31.49	x	0.5	x	0.7	=	7.03	(77)
Southwest	0.9x	0.77	x	12.82	x	36.79		0.5	x	0.7	=	114.41	(79)
Southwest	0.9x	0.77	x	12.82	x	62.67		0.5	x	0.7	=	194.88	(79)
Southwest	0.9x	0.77	x	12.82	x	85.75		0.5	x	0.7	=	266.65	(79)
Southwest	0.9x	0.77	x	12.82	x	106.25		0.5	x	0.7	=	330.39	(79)
Southwest	0.9x	0.77	x	12.82	x	119.01		0.5	x	0.7	=	370.06	(79)
Southwest	0.9x	0.77	x	12.82	x	118.15		0.5	x	0.7	=	367.39	(79)
Southwest	0.9x	0.77	x	12.82	x	113.91		0.5	x	0.7	=	354.2	(79)
Southwest	0.9x	0.77	x	12.82	x	104.39		0.5	x	0.7	=	324.6	(79)
Southwest	0.9x	0.77	x	12.82	x	92.85		0.5	x	0.7	=	288.72	(79)
Southwest	0.9x	0.77	x	12.82	x	69.27		0.5	x	0.7	=	215.39	(79)
Southwest	0.9x	0.77	x	12.82	x	44.07		0.5	x	0.7	=	137.04	(79)
Southwest	0.9x	0.77	x	12.82	x	31.49		0.5	x	0.7	=	97.91	(79)
Northwest	0.9x	0.77	x	16.36	x	11.28	x	0.5	x	0.7	=	44.77	(81)
Northwest	0.9x	0.77	x	16.36	x	22.97	x	0.5	x	0.7	=	91.13	(81)
Northwest	0.9x	0.77	x	16.36	x	41.38	x	0.5	x	0.7	=	164.2	(81)
Northwest	0.9x	0.77	x	16.36	x	67.96	x	0.5	x	0.7	=	269.66	(81)
Northwest	0.9x	0.77	x	16.36	x	91.35	x	0.5	x	0.7	=	362.47	(81)
Northwest	0.9x	0.77	x	16.36	x	97.38	x	0.5	x	0.7	=	386.43	(81)
Northwest	0.9x	0.77	x	16.36	x	91.1	x	0.5	x	0.7	=	361.5	(81)
Northwest	0.9x	0.77	x	16.36	x	72.63	x	0.5	x	0.7	=	288.19	(81)
Northwest	0.9x	0.77	x	16.36	x	50.42	x	0.5	x	0.7	=	200.08	(81)
Northwest	0.9x	0.77	x	16.36	x	28.07	x	0.5	x	0.7	=	111.37	(81)

Northwest	0.9x	0.77	x	16.36	x	14.2	x	0.5	x	0.7	=	56.33	(81)
Northwest	0.9x	0.77	x	16.36	x	9.21	x	0.5	x	0.7	=	36.56	(81)

Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

(83)m=	180.77	327.24	499.06	704.36	867.43	895.69	849.17	722.23	569.32	375.51	220.04	152.43	(83)

Total gains – internal and solar (84)m = (73)m + (83)m , watts

(84)m=	734.1	876.36	1027.12	1199.68	1329.2	1327.3	1263.06	1144.2	1010.03	849.17	730.4	690.59	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (°C) 21 (85)

Utilisation factor for gains for living area, h1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	0.93	0.91	0.86	0.78	0.66	0.53	0.42	0.47	0.65	0.83	0.91	0.94	(86)

Mean internal temperature in living area T1 (follow steps 3 to 7 in Table 9c)

(87)m=	17.95	18.31	18.9	19.62	20.25	20.67	20.86	20.82	20.46	19.63	18.66	17.87	(87)

Temperature during heating periods in rest of dwelling from Table 9, Th2 (°C)

(88)m=	19.5	19.51	19.51	19.51	19.52	19.52	19.52	19.52	19.52	19.52	19.51	19.51	(88)

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

(89)m=	0.92	0.89	0.84	0.74	0.6	0.44	0.3	0.34	0.57	0.79	0.89	0.93	(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

(90)m=	17.78	18	18.37	18.81	19.18	19.41	19.49	19.48	19.31	18.84	18.23	17.73	(90)

fLA = Living area ÷ (4) = 0.22 (91)

Mean internal temperature (for the whole dwelling) = fLA × T1 + (1 – fLA) × T2

(92)m=	17.81	18.07	18.48	18.99	19.41	19.68	19.79	19.77	19.56	19.01	18.32	17.76	(92)

Apply adjustment to the mean internal temperature from Table 4e, where appropriate

(93)m=	17.81	18.07	18.48	18.99	19.41	19.68	19.79	19.77	19.56	19.01	18.32	17.76	(93)

8. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that Ti,m=(76)m and re-calculate the utilisation factor for gains using Table 9a

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, hm:													
(94)m=	0.91	0.87	0.82	0.72	0.6	0.45	0.32	0.37	0.57	0.77	0.88	0.92	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	665.65	764.36	838.51	867.16	793.23	596.89	405.01	417.8	576.78	655.41	639.83	632.44	(95)
Monthly average external temperature from Table 8													
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1880.31	1830.55	1663.68	1393.92	1064.43	698.64	438.25	462.84	751.86	1160.91	1551.84	1878.71	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	903.71	716.48	613.93	379.27	201.78	0	0	0	0	376.09	656.65	927.22	

Total per year (kWh/year) = Sum(98)$_{1…5,9…12}$ = 4775.13 (98)

Space heating requirement in kWh/m²/year 60.07 (99)

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

Space heating:

Fraction of space heat from secondary/supplementary system 0 (201)

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Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		93	(206)
Efficiency of secondary/supplementary heating system, %		0	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Space heating requirement (calculated above)	903.71	716.48	613.93	379.27	201.78	0	0	0	0	376.09	656.65	927.22		
(211)m = {[(98)m x (204)] } x 100 ÷ (206)	971.73	770.41	660.14	407.82	216.96	0	0	0	0	404.4	706.07	997.02		(211)
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													5134.54	(211)
Space heating fuel (secondary), kWh/month = {[(98)m x (201)] } x 100 ÷ (208)														
(215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
Total (kWh/year) =Sum(215)$_{1...5,10....12}$=													0	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Output from water heater (calculated above)	171.91	150.93	157.11	138.91	134.73	118.39	111.81	125.31	125.92	144.16	154.85	167.13		
Efficiency of water heater													86.7	(216)
(217)m=	89.46	89.41	89.31	89.09	88.65	86.7	86.7	86.7	86.7	89.06	89.35	89.48		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	192.17	168.81	175.92	155.92	151.98	136.55	128.97	144.54	145.24	161.87	173.31	186.78		
Total = Sum(219a)$_{1...12}$ =													1922.05	(219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			5134.54	
Water heating fuel used			1922.05	
Electricity for pumps, fans and electric keep-hot				
central heating pump:		30		(230c)
boiler with a fan-assisted flue		45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		75	(231)
Electricity for lighting			343.81	(232)
Electricity generated by PVs			-1276.19	(233)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year	**Fuel Price** (Table 12)		**Fuel Cost** £/year	
Space heating - main system 1	(211) x	3.48	x 0.01 =	178.68	(240)
Space heating - main system 2	(213) x	0	x 0.01 =	0	(241)
Space heating - secondary	(215) x	13.19	x 0.01 =	0	(242)
Water heating cost (other fuel)	(219)	3.48	x 0.01 =	66.89	(247)
Pumps, fans and electric keep-hot	(231)	13.19	x 0.01 =	9.89	(249)

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(if off-peak tariff, list each of (230a) to (230g) separately as applicable and apply fuel price according to Table 12a

Energy for lighting	(232)	13.19	x 0.01 =	45.35	(250)
Additional standing charges (Table 12)				120	(251)
	one of (233) to (235) x)	13.19	x 0.01 =	-168.33	(252)
Appendix Q items: repeat lines (253) and (254) as needed					
Total energy cost	(245)...(247) + (250)…(254) =			252.48	(255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.42	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	0.85	(257)
SAP rating (Section 12)		88.12	(258)

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)	(211) x	0.216	=	1109.06	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	415.16	(264)
Space and water heating	(261) + (262) + (263) + (264) =			1524.23	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	38.93	(267)
Electricity for lighting	(232) x	0.519	=	178.44	(268)
Energy saving/generation technologies					
Item 1		0.519	=	-662.34	(269)
Total CO2, kg/year		sum of (265)…(271) =		1079.24	(272)
CO2 emissions per m²		(272) ÷ (4) =		13.58	(273)
EI rating (section 14)				88	(274)

13a. Primary Energy

	Energy kWh/year	**Primary** factor		**P. Energy** kWh/year	
Space heating (main system 1)	(211) x	1.22	=	6264.14	(261)
Space heating (secondary)	(215) x	3.07	=	0	(263)
Energy for water heating	(219) x	1.22	=	2344.91	(264)
Space and water heating	(261) + (262) + (263) + (264) =			8609.05	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	3.07	=	230.25	(267)
Electricity for lighting	(232) x	0	=	1055.5	(268)
Energy saving/generation technologies					
Item 1		3.07	=	-3917.91	(269)
'Total Primary Energy		sum of (265)…(271) =		5976.89	(272)
Primary energy kWh/m²/year		(272) ÷ (4) =		75.19	(273)

SAP 2012 Overheating Assessment

Calculated by Stroma FSAP 2012 program, produced and printed on 01 February 2016

Property Details: 01-16-55567 Plot 1 PL1

Dwelling type:	Detached House
Located in:	England
Region:	Thames valley
Cross ventilation possible:	Yes
Number of storeys:	1
Front of dwelling faces:	South East
Overshading:	Average or unknown
Overhangs:	None
Thermal mass parameter:	Indicative Value Low
Night ventilation:	False
Blinds, curtains, shutters:	Dark-coloured curtain or roller blind
Ventilation rate during hot weather (ach):	3 (Windows open half the time)

Overheating Details:

Summer ventilation heat loss coefficient:	261.27	**(P1)**
Transmission heat loss coefficient:	91.7	
Summer heat loss coefficient:	352.97	**(P2)**

Overhangs:

Orientation:	**Ratio:**	**Z_overhangs:**
South East (SE Elevation)	0	1
North West (NW Elevation)	0	1
South West (SW Elevation)	0	1
North East (NE Elevation)	0	1

Solar shading:

Orientation:	**Z blinds:**	**Solar access:**	**Overhangs:**	**Z summer:**	
South East (SE Elevation)	0.85	0.9	1	0.76	**(P8)**
North West (NW Elevation)	0.85	0.9	1	0.76	**(P8)**
South West (SW Elevation)	0.85	0.9	1	0.76	**(P8)**
North East (NE Elevation)	0.85	0.9	1	0.76	**(P8)**

Solar gains:

Orientation		**Area**	**Flux**	**g_**	**FF**	**Shading**	**Gains**	
South East (SE Elevation)	0.9 x	0.92	119.92	0.5	0.7	0.76	26.59	
North West (NW Elevation)	0.9 x	16.36	98.85	0.5	0.7	0.76	389.68	
South West (SW Elevation)	0.9 x	12.82	119.92	0.5	0.7	0.76	370.48	
North East (NE Elevation)	0.9 x	4.89	98.85	0.5	0.7	0.76	116.48	
						Total	903.22	**(P3/P4)**

Internal gains:

	June	**July**	**August**	
Internal gains	428.61	410.88	418.97	
Total summer gains	1391.85	1314.11	1203.48	**(P5)**
Summer gain/loss ratio	3.94	3.72	3.41	**(P6)**
Mean summer external temperature (Thames valley)	16	17.9	17.8	
Thermal mass temperature increment	1.3	1.3	1.3	
Threshold temperature	21.24	22.92	22.51	**(P7)**
Likelihood of high internal temperature	**Slight**	**Medium**	**Medium**	

SAP 2012 Overheating Assessment

Assessment of likelihood of high internal temperature: Medium