Land at St. Margaret's Business Centre

Energy Assessment

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Document History and Status

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Contents

1 Executive Summary

1.1 Introduction

1.1.1 Erban Consulting Ltd. was instructed by Godstone Development Ltd. to prepare an energy assessment for the proposed development at Land at St. Margaret's Business Centre, Twickenham, London, TW1 1JN.

1.1.2 The purpose of this report is to serve as evidence that policy LP 22 of the London Borough of Richmond Upon Thames *Local Plan,* policies 5.2, 5.6, 5.7, and 5.9 of *The London Plan,* and policies SI2, SI3 and SI4 of the *Intend to Publish London Plan* have been satisfied subject to approval of the proposals and their implementation thereafter.

1.2 Development description

1.2.1 Erection of 4 no. residential dwellings (Class C3) with associated parking, access, and landscaping (incl. removal of existing trees).

1.3 Key measures and carbon dioxide (CO_2) reductions

1.3.1 The development would adopt a fabric-first approach and would be constructed in accordance with the energy hierarchy:

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

1.3.2 Using SAP 10.0 carbon factors, it is proposed that the dwellings would achieve at least a 35 per cent on-site reduction in regulated CO_2 emissions.

1.3.3 Tables 1 and 2 and Figure 1 provide a summary of the estimated CO_2 emissions and emissions savings from each stage of the energy hierarchy.

1.3.4 It should be noted that whilst this report sets out the specification used to calculate the reduction in CO_2 emissions, this is subject to change as the detailed design of the development progresses. As a result of this, the actual reduction in CO_2 emissions may differ from the estimates provided in this report. The commitment that the dwellings would achieve at least a 35 per cent on-site reduction in CO_2 emissions, will not change.

Table 1: Dwellings' CO_2 emissions after each stage of the energy hierarchy

	Carbon dioxide emission (tonnes CO_2 per annum)	
	Regulated	Unregulated
Baseline: Part L 2013 of the Building Regulations Compliant Development	8.1	3.8
After energy demand reduction (be lean)	8.0	3.8
After heat network connection (be clean)	8.0	3.8
After renewable energy (be green)	4.4	3.8

Table 2: Dwellings' regulated carbon dioxide savings from each stage of the energy hierarchy

	Regulated carbon dioxide savings	
	tonnes CO_2 per annum	%
Be lean: Savings from energy demand reduction	0.1	2
Be clean: Savings from heat network	0.0	0
Be green: Savings from renewable energy	3.5	44
Cumulative on-site savings	3.7	45
Carbon shortfall	4.4	-

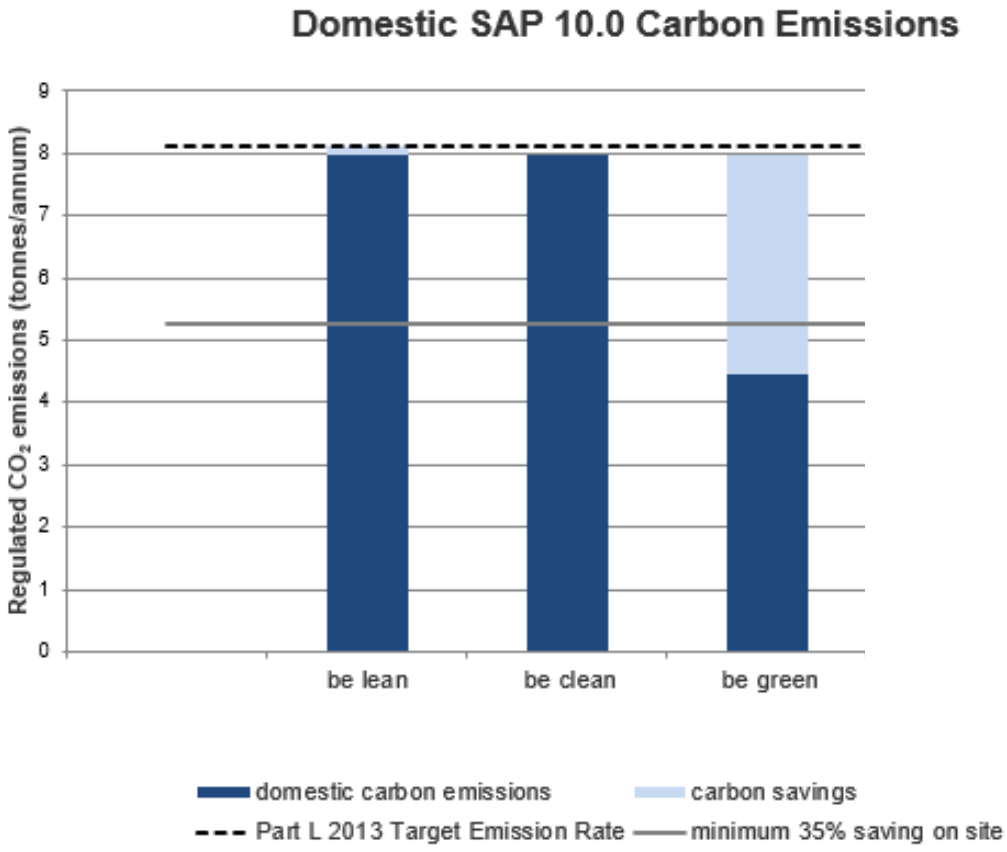

Figure 1: Domestic energy hierarchy and CO_2 savings

2 Legislation, Policy and Guidance

2.1 Legislation, Policy and Guidance

2.1.1 The following national, regional and local planning policy guidance have been considered in applying the energy standards for the proposed development.

2.2 National: National Planning Policy Framework (NPPF) (February 2019)

2.2.1 The *National Planning Policy Framework (NPPF)* was designed to simplify and clarify planning policy and to make the planning system more accessible. It details the government's view of what sustainable development in England means in practice and states that there are three objectives to sustainable development:

- **an economic objective** – to help build a strong, responsive and competitive economy, by ensuring that sufficient land of the right types is available in the right places and at the right time to support growth, innovation and improved productivity; and by identifying and coordinating the provision of infrastructure;
- **a social objective** – to support strong, vibrant and healthy communities, by ensuring that a sufficient number and range of homes can be provided to meet the needs of present and future generations; and by fostering a well-designed and safe built environment, with accessible services and open spaces that reflect current and future needs and support communities' health, social and cultural well-being; and
- **an environmental objective** – to contribute to protecting and enhancing our natural, built and historic environment; including making effective use of land, helping to improve biodiversity, using natural resources prudently, minimising waste and pollution, and mitigating and adapting to climate change, including moving to a low carbon economy.

2.2.2 The following are extracts from the NPPF that specifically relate to energy which have been referenced due to their relevance to this report.

> ***Paragraph 150***
>
> *New development should be planned for in ways that:*
>
> *a) avoid increased vulnerability to the range of impacts arising from climate change. When new development is brought forward in areas which are vulnerable, care should be taken to ensure that risks can be managed through suitable adaptation measures, including through the planning of green infrastructure; and*
>
> *b) can help to reduce greenhouse gas emissions, such as through its location, orientation and design. Any local requirements for the sustainability of buildings should reflect the Government's policy for national technical standards.*

> ***Paragraph 153***
>
> *In determining planning applications, local planning authorities should expect new development to:*
>
> *a) comply with any development plan policies on local requirements for decentralised energy supply unless it can be demonstrated by the applicant, having regard to the type of development involved and its design, that this is not feasible or viable; and*
>
> *b) take account of landform, layout, building orientation, massing and landscaping to minimise energy consumption.*

2.3 Regional: The London Plan (March 2016)

2.3.1 *The London Plan (incorporating Minor Alterations)* was adopted in March 2016. It includes the following summarised policies relating to energy:

Policy 5.2 – Minimising Carbon Dioxide Emissions

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 emissions reduction in buildings:

Building type	***Year***	***Improvement on 2010 Building Regulations***
Residential buildings	*2016-2031*	*Zero carbon*
Non-domestic buildings	*2016-2019*	*As per building regulations requirements*

Major developments 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.

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

Policy 5.6 – 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 networks*
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.

Policy 5.9 – Overheating and Cooling

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

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

Major development proposals should demonstrate how the design, materials, construction and operation of the development would minimise overheating and also meet its cooling needs.

2.4 Regional: Intend to Publish London Plan (December 2019)

2.4.1 Policies SI2, SI3 and SI4 of the *Intend to Publish London Plan* propose updated energy targets for both residential and non-residential development. Relevant extracts from these policies are provided below:

Policy SI2 Minimising greenhouse gas emissions

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

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

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

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

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

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

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

Policy SI3 Energy infrastructure

A Major development proposals within Heat Network Priority Areas should have a communal low-temperature heating system:

1) the heat source for the communal heating system should be selected in accordance with the following heating hierarchy:

a) Connect to local existing or planned heat networks
b) Use zero-emission or local secondary heat sources (in conjunction with heat pump if required)
c) Use low emission combined heat and power (CHP) (only where there is a case for CHP to enable the delivery of an area-wide heat network)
d) Use ultra-low NOx gas boilers

2) CHP and ultra-low NOx gas boiler communal or district heating systems should be designed to ensure that they meet the requirements of policy SI1
3) where a heat network is planned but not yet in existence the development should be designed for connection at a later date.

Policy SI4 Managing heat risk

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

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

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

2.5 Regional: Draft GLA Energy Assessment Guidance (April 2020)

2.5.1 The draft GLA *Energy Assessment Guidance* provides detail on how to prepare an energy assessment to demonstrate compliance with policies SI2, SI3 and SI4 of the *Intend to Publish London Plan.*

2.6 Local: London Borough of Richmond Upon Thames Local Plan (July 2018)

2.6.1 Policy LP 22 (B, C, D) is the Council's energy and carbon reduction policy:

Policy LP 22

Reducing Carbon Dioxide Emission

B. Developers are required to incorporate measures to improve energy conservation and efficiency as well as contributions to renewable and low carbon energy generation. Proposed developments are required to meet the following minimum reductions in carbon dioxide emissions:

1. *All new major residential developments (10 units or more) should achieve zero carbon standards in line with London Plan policy.*
2. *All other new residential buildings should achieve a 35% reduction.*
3. *All non-residential buildings over 100sqm should achieve a 35% reduction. From 2019 all major non- residential buildings should achieve zero carbon standards in line with London Plan policy.*

Targets are expressed as a percentage improvement over the target emission rate (TER) based on Part L of the 2013 Building Regulations.

C. This should be achieved by following the Energy Hierarchy:

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

Decentralised Energy Networks

D. The Council requires developments to contribute towards the Mayor of London target of 25% of heat and power to be generated through localised decentralised energy (DE) systems by 2025. The following will be required:

1. *All new development will be required to connect to existing DE networks where feasible. This also applies where a DE network is planned and expected to be operational within 5 years of the development being completed.*
2. *Development proposals of 50 units or more, or new non-residential development of 1000sqm or more, will need to provide an assessment of the provision of on-site decentralised energy (DE) networks and combined heat and power (CHP).*
3. *Where feasible, new development of 50 units or more, or new non-residential development of 1000sqm or more, as well as schemes for the Proposal Sites identified in this Plan, will need to provide on-site DE and CHP; this is particularly necessary within the clusters identified for DE opportunities in the borough-wide Heat Mapping Study. Where on-site provision is not feasible, provision should be made for future connection to a local DE network should one become available.*

Applicants are required to consider the installation of low, or preferably ultra-low, NOx boilers to reduce the amount of NOx emitted in the borough.

Local opportunities to contribute towards decentralised energy supply from renewable and low-carbon technologies will be encouraged where appropriate.

3 Assessment

3.1 Targeted CO_2 reduction

3.1.1 The development is a minor development and, in accordance with Policy LP 22 of the London Borough of Richmond Upon Thames Local Plan, it will target a minimum 35% reduction in CO_2 emissions.

3.2 Carbon emission factors

3.2.1 This energy assessment uses SAP 10.0 carbon emission factors in accordance with the draft GLA *Energy Assessment Guidance.*

3.3 Baseline regulated CO_2 emissions

3.3.1 To establish the development's predicted baseline regulated CO_2 emissions, preliminary Standard Assessment Procedure (SAP) calculations have been undertaken to all dwellings.

3.3.2 SAP uses the target emission rate (TER), which is expressed in kilograms of carbon dioxide per metre square of total useful floor area per annum, as the benchmark for compliance with *Approved Document L1A: Conservation of fuel and power in dwellings (2013 edition incorporating 2016 amendments)* (L1A).

3.3.3 By extracting the relevant energy consumption figures from the SAP calculations, and by using the *GLA Carbon Emission Reporting Spreadsheet* to apply the relevant SAP 10.0 carbon emissions factors, the baseline predicted regulated CO_2 emissions of the proposed development have been calculated as 8.1 tonnes CO_2 per annum.

3.3.4 In the calculation of the CO_2 emissions for the 'baseline' scenario and the 'be lean' scenario, a gas boiler with an efficiency of 93.5% has been specified to the dwellings, in accordance with L1A notional values.

3.4 Baseline unregulated CO_2 emissions

3.4.1 To establish the dwellings' baseline predicted unregulated CO_2 emissions, the CO_2 emissions from appliances and cooking have been calculated in accordance with BREDEM 2012 and converted into SAP 10 carbon emission factors. The annual cooking energy has been calculated on the assumption that normal size electric cookers would be installed.

3.4.2 By following this approach, the baseline predicted unregulated CO_2 emissions of the development have been calculated as 3.8 tonnes CO_2 per annum.

3.5 Be lean: use less energy

3.5.1 It is estimated that baseline regulated domestic CO_2 emissions would be reduced by 2% through the following energy efficiency measures.

Passive solar design

3.5.2 The buildings have been designed in accordance with the principles of passive solar design as far as is practical. The site has very good solar access with little overshading from existing buildings. Where practical, relatively large south-facing windows have been incorporated so that the dwellings can benefit from solar gain in the winter months.

Passive cooling design

3.5.3 The buildings have also been designed in accordance with the cooling hierarchy to reduce the risk of overheating and to reduce the demand for active cooling.

3.5.4 Internal heat generation would be minimised by:

- Specifying a heating system that does not require permanently heated distribution pipework;
- Insulating all hot water pipes beyond Building Regulation standards;
- Installing low energy lighting; and
- Installing energy efficient equipment where applicable.

3.5.5 Heat entering the buildings would be minimised through:

- High levels of insulation; and
- Specifying glazing with a solar transmittance value that has been carefully considered to strike the balance between useful solar gain in the winter and unwanted solar gain in the summer.

3.5.6 Passive ventilation has been designed for by:

- Avoiding small, south facing single façade units; and
- Including openable windows to all rooms.

3.5.7 In addition, soft landscaping and the installation of a sedum flat roof would provide evaporative cooling around the buildings.

3.5.8 These measures mean that the dwellings would be at reduced risk of overheating and would not be specified with active cooling systems.

High standards of energy efficiency

3.5.9 Estimations of the dwellings' CO_2 emissions have been based on the construction specification proposed in Table 3. The second column in this table sets out L1A limiting fabric parameters to show the elements of the specification that provide an improvement. The specification incorporates low U-values, a low air leakage, and 100% low energy lighting.

Table 3: Proposed construction specification to the dwellings

	L1A limiting fabric parameters	Proposed construction specification
U-value of main external walls	0.30 W/m^{2}K	0.22 W/m^{2}K
U-value of floors	0.25 W/m^{2}K	0.14-0.16 W/m^{2}K
U-value of roofs	0.20 W/m^{2}K	0.11-0.20 W/m^{2}K
U-value of windows	2.00 W/m^{2}K	1.30 W/m^{2}K
Air permeability	10 m^3/h.m^2 at 50 Pa	5 m^3/h.m^2 at 50 Pa
Thermal bridging	Default y-value of 0.15	The use of calculated details to provide a y-value between 0.080 and 0.113
Ventilation	Intermittent extracts	Mechanical extract ventilation
Lighting	75% low energy lighting	100% low energy lighting

3.5.10 The construction specification ensures that the dwellings exceed L1A target fabric energy efficiency (FEE) standards. Table 4 details the total Part L FEEs for the dwellings.

Table 4: FEEs

	Target fabric energy efficiency (kWh/m^2)	Design fabric energy efficiency (kWh/m^2)	Improvement (%)
Development total	50.66	45.48	10

3.5.11 The combination of the energy efficiency measures detailed means that it is estimated that development CO_2 emissions would be reduced by 0.1 tonnes CO_2 per annum beyond the baseline CO_2 emissions of the development. This equates to a 2% reduction.

3.5.12 A DER/TER calculation printout for Unit 04, showing the 'baseline' scenario and the 'be lean' scenario is provided in appendix A so that the method for calculating emissions can be validated.

3.6 Be clean: supply energy efficiently

3.6.1 Having reduced the energy demand of the development, the next step in the energy hierarchy is to supply energy efficiently. The extract from the *London Heat Map* provided in appendix B shows that the development lies in a Heat Network Priority Area. It is expected that major development proposals within Heat Priority Network Areas should have a communal low-temperature heating system with the heat source selected in accordance with the following heating hierarchy:

a) Connect to local existing or planned heat networks
b) Use zero-emission or local secondary heat sources (in conjunction with heat pump if required)
c) Use low emission combined heat and power (CHP) (only where there is a case for CHP to enable the delivery of an area-wide heat network)
d) Use ultra-low NOx gas boilers

Connect to local existing or planned heat networks

3.6.2 The extract from the *London Heat Map* provided in appendix B indicates that there are no existing or proposed networks in the vicinity of the development to connect to.

Communal low-temperature heating system

3.6.3 Communal heating systems can operate at higher efficiencies than individual heating systems. They can also provide a single energy centre solution meaning that it can be easier to connect to a future district energy network. However, they have the following disadvantages which have led to the conclusion that it is not practical or desirable solution on this minor development of four dwellings:

- Distribution losses for a communal system can be high and it is estimated that at least 15% of heat generated would be lost before it reaches the intended location.
- Residents would have to pay more via their service charge for maintenance and depreciation of the equipment installed.
- System failure would mean that there is no heating and hot water for all properties.
- Residents would not be able to choose who their supplier is.
- Residents would not have access to the same services offered by mainstream utility companies including discounts for payments by direct debit or single occupancy.
- Space would be required for a plant room and it is anticipated that this would result in a reduction of the number of dwellings proposed.

Use of local secondary heat sources

3.6.4 The publication of SAP 10 carbon factors has considerably strengthened the case for electric heating solutions and, in particular, highly-efficient electric heat pump technology that uses local secondary heat sources. In the development of the energy strategy, calculations have been undertaken which show that a strategy based on electric heat pumps could provide the dwellings with up to a 44% reduction in CO_2 emissions compared to a communal heating system served by gas boilers or a gas combined heat and power (CHP) system. An even greater disparity between an electric solution and a gas solution is evident if SAP10.1 carbon factors are considered.

3.6.5 It is proposed that individual air source heat pumps are installed in each of the dwellings to provide space heating and hot water. In addition to achieving greater CO_2 emissions reductions than a communal gas heating solution, there are no on-site emissions associated with combustion and so the heating strategy has no impact on local air quality.

3.6.6 The CO_2 emissions reductions achieved through the installation of heat pumps are included within the 'be green' stage of the energy hierarchy. Therefore, there are zero emissions reductions from the 'be clean' stage.

3.7 Be green: use renewable energy

3.7.1 Renewable energy is the final consideration in the energy hierarchy. Below is an assessment of the feasibility of incorporating additional low or zero carbon (LZC) energy systems at this site, beyond the installation of air source heat pumps.

Biomass

3.7.2 New buildings have short heating response times because they are well insulated. They also have variable space heating demand and intermittent water heating demand. Biomass boilers are not suited to this because the burning of fuel is not instantaneous and they take a long time to heat up and cool down. The boilers are not usually able to modulate below 30% of output, potentially meaning that a back-up heating system would be required to not only provide output when heat demand was high, but also to provide output when heat demand was low. These factors reduce the potential running hours of a biomass boiler and mean that it would likely be sized to meet a small proportion of the maximum heat output required.

3.7.3 Further concerns regarding the installation of a biomass heating system at this development include:

- The Nitrous Oxide (NOx) and particulate matter (PM10) emissions from biomass systems are higher than for gas and electricity, and their use can have a significant impact on local air quality.
- A significant amount of space would be required for plant, fuel storage and delivery.

3.7.4 For these reasons, biomass boilers are not considered a viable solution at this development.

Wind power

3.7.5 Locating a wind turbine in an urban area presents several difficulties. These include the area required for the turbine, turbulence caused by nearby buildings, installation and maintenance access, environmental impact from noise and vibration, and visual impact on the landscape.

3.7.6 The RenSMART Maps Wind Speed Tool shows that average wind speed at 10 metres above ground at this development is 4.5m/s. Once the turbulence from the man-made obstacles around the development has been taken into consideration, it is unlikely that a wind turbine would generate sufficient electricity to make it cost effective. For these reasons wind power is not considered a feasible solution.

Ground source heat pumps

3.7.7 Ground source heat pumps require the installation of either a ground loop or a vertical borehole which means that their installation is more expensive and more complicated than the installation of air source heat pumps. They are considered a potential solution for this development. However, air source heat pumps are preferred.

Solar thermal collectors

3.7.8 Solar thermal collectors are a mature and reliable technology. They are considered a potential solution for this development. However, when considered in conjunction with the proposed heat pump strategy, solar thermal collectors are not considered a feasible solution as hot water demand is already provided by an LZC technology in the form of the heat pumps.

Solar photovoltaic (PV) panels

3.7.9 Solar PV panels are a mature and reliable technology and are considered a potential solution at this development. There is flat roof area to the rear of the dwellings that could be used for their installation.

LZC strategy

3.7.10 It is proposed that that the development's CO_2 emissions would be reduced by 3.5 tonnes CO_2 per annum through the installation of an LZC energy system in the form of heat pumps. This equates to a 44% reduction in site wide emissions. This has been calculated based on the assumption that a Mitsubishi PUHZ-W112VAA(-BS) outdoor unit and a Mitsubishi EHPT30X-UKHCW cylinder would be specified to each of the dwellings.

3.7.11 The proposed locations of the outdoor units and the cylinders are shown in appendix C.

3.7.12 A DER/TER calculation printout for Unit 04, showing the 'be green' scenario is provided in appendix D so that the method for calculating emissions can be validated.

3.8 Reducing peak energy demand

3.8.1 Smart meters and energy display devices would be provided to display electrical consumption data to future residents. This would allow residents to better understand the energy implications of the way they occupy and use their home. The installation of smart meters would enable the development to take advantage of demand side response and smart appliances and/or information on smart appliances would be provided to each of the dwellings.

3.9 Unregulated emissions

3.9.1 In addition to the numerous measures adopted to reduce regulated CO_2 emissions, unregulated operational CO_2 emissions would be minimised by:

- Ensuring that any fridges or fridge-freezers installed would have an A+ rating under the EU Energy Efficiency Labelling Scheme;
- Ensuring that any washing machines or dishwashers installed would have an A rating under the EU Energy Efficiency Labelling Scheme;
- Ensuring that any tumble dryers or washer dryers installed would have a B rating under the EU Energy Efficiency Labelling Scheme;
- Providing building users with a leaflet explaining the EU Energy Efficiency Labelling Scheme to encourage responsible purchasing of white goods;
- Installing an energy display device in each dwelling to display electricity fuel consumption data to building users; and

- Providing all external space lighting with energy efficient lamps and passive infrared red (PIR) sensors.

3.9.2 Furthermore, each dwelling would be provided with a home user guide to encourage future residents to reduce energy use and to educate them in how to run their home efficiently. The home user guide would cover the following topics:

- Easy to understand operating and maintenance instructions for each of the fixed building services;
- Water saving measures;
- Information about recycling and waste collection;
- Public transport;
- Local amenities; and
- Responsible purchasing.

3.10 Future-proofing

3.10.1 The development would be heated and powered entirely by electricity. Therefore, the development would achieve zero carbon emissions on site at a point when the electric national grid becomes zero carbon.

3.11 Anticipated cost to occupants

3.11.1 The preliminary SAP calculations show that all dwellings would achieve a SAP rating of between 82B and 83B. Based on a fuel price of 18.70p/kWh for electricity, it is estimated that the regulated fuel costs of the dwellings would be between £733.59 and £805.68 per year.

4 Conclusions

4.1.1 The proposed development of 4 dwellings at Land at St Margaret's Business Centre would adopt a fabric-first approach and would be constructed in accordance with the energy hierarchy.

4.1.2 Using SAP 10 carbon factors, it is estimated that energy efficiency measures would enable the dwellings to achieve a 2 per cent reduction in CO_2 emissions beyond the baseline emissions. It is proposed that individual air source heat pumps are installed in each of the dwellings to provide space heating and hot water and provide a further 44 per cent reduction in CO_2 emissions. It is estimated that a combination of energy efficiency measures and the installation of heat pumps would enable the proposed dwellings to achieve a 45 per cent on-site reduction in CO_2 emissions.

5 Appendix A: DER/TER calculation printout for Unit 04 for the 'baseline' and 'be lean' scenarios

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

Design SAP
elmhurst energy

Property Reference	04	**Issued on Date**	29/08/2020
Assessment Reference	04	**Prop Type Ref**	Unit 04
Property	Unit 04, St Margaret's Business Park, St Margaret's, Twickenham		

SAP Rating	84 B	**DER**	16.71	**TER**	17.04
Environmental	84 B	**% DER<TER**	1.94		
CO_2 Emissions (t/year)	1.91	**DFEE**	53.47	**TFEE**	59.68
General Requirements Compliance	Pass	**% DFEE<TFEE**	10.39		

Assessor Details	Mr. George Jones, Erban Consulting Limited, Tel: 01455883250, george.jones@erbanconsulting.co.uk	**Assessor ID**	K945-0001
Client			

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

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REGULATIONS COMPLIANCE REPORT - Approved Document L1A, 2013 Edition, England
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DWELLING AS DESIGNED

End-Terrace House, total floor area 132 m²

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

1a TER and DER
Fuel for main heating:Mains gas
Fuel factor:1.00 (mains gas)
Target Carbon Dioxide Emission Rate (TER) 17.04 kgCO□/m²
Dwelling Carbon Dioxide Emission Rate (DER) 16.71 kgCO□/m²OK

1b TFEE and DFEE
Target Fabric Energy Efficiency (TFEE)59.7 kWh/m²/yr
Dwelling Fabric Energy Efficiency (DFEE)53.5 kWh/m²/yrOK

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2 Fabric U-values

Element	Average	Highest	
External wall	0.21 (max. 0.30)	0.22 (max. 0.70)	OK
Party wall	0.00 (max. 0.20)	-	OK
Floor	0.16 (max. 0.25)	0.16 (max. 0.70)	OK
Roof	0.16 (max. 0.20)	0.20 (max. 0.35)	OK
Openings	1.28 (max. 2.00)	1.30 (max. 3.30)	OK

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

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3 Air permeability
Air permeability at 50 pascals: 5.00 (design value)
Maximum 10.0 OK

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4 Heating efficiency
Main heating system: Boiler system with radiators or underfloor - Mains gas
Data from manufacturer
u u

Efficiency: 89.5% SEDBUK2009
Minimum: 88.0% OK

Secondary heating system: None

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5 Cylinder insulation
Hot water storage: Measured cylinder loss: 1.89 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
Independent timer for DHW OK

Boiler interlock: Yes OK

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

---
8 Mechanical ventilation
Continuous extract system
Specific fan power: 0.17
Maximum: 0.7 OK

---
9 Summertime temperature
Overheating risk (Thames Valley): Medium OK
Based on:
Overshading: Average
Windows facing North: 4.48 m², No overhang
Windows facing North East: 1.60 m², No overhang
Windows facing East: 18.12 m², No overhang
Windows facing South East: 1.60 m², No overhang
Windows facing South: 7.42 m², No overhang
Windows facing North West: 1.60 m², No overhang
Air change rate: 4.00 ach
Blinds/curtains: None

---
10 Key features
External wall U-value 0.12 W/m²K
Party wall U-value 0.00 W/m²K
Party wall U-value 0.00 W/m²K
Party wall U-value 0.00 W/m²K
Roof U-value 0.12 W/m²K
Roof U-value 0.11 W/m²K

CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

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

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	55.1800 (1b)	x	2.5100 (2b)	=	138.5018	(1b) - (3b)
First floor	55.1800 (1c)	x	2.7600 (2c)	=	152.2968	(1c) - (3c)
Second floor	21.6800 (1d)	x	1.9700 (2d)	=	42.7096	(1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	132.0400					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	333.5082	(5)

2. Ventilation rate

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

				Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =			0.0000 / (5) =	0.0000	(8)
Pressure test				Yes	
Measured/design AP50				5.0000	
Infiltration rate				0.2500	(18)
Number of sides sheltered				2	(19)
Shelter factor			(20) = 1 - [0.075 x (19)] =	0.8500	(20)
Infiltration rate adjusted to include shelter factor			(21) = (18) x (20) =	0.2125	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.2709	0.2656	0.2603	0.2338	0.2284	0.2019	0.2019	0.1966	0.2125	0.2284	0.2391	0.2497	(22b)
Mechanical extract ventilation - centralised													
If mechanical ventilation:												0.5000	(23a)
Effective ac	0.5209	0.5156	0.5103	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
Window (Uw = 1.30)			34.8200	1.2357	43.0285			(27)
Door			6.5400	1.2000	7.8480			(26)
Ground Floor			55.1800	0.1600	8.8288	75.0000	4138.5000	(28a)
GF External Wall	58.6300	21.4400	37.1900	0.2200	8.1818	60.0000	2231.4000	(29a)
FF External wall	63.6200	18.5700	45.0500	0.2200	9.9110	60.0000	2703.0000	(29a)
SF External wall	9.6400		9.6400	0.2200	2.1208	60.0000	578.4000	(29a)
Wall to void	11.3800		11.3800	0.1200	1.3656	9.0000	102.4200	(29a)
Dormer	6.8100	1.3500	5.4600	0.2100	1.1466	9.0000	49.1400	(29a)
Sloping	23.5200		23.5200	0.1600	3.7632	9.0000	211.6800	(30)
To void	12.1100		12.1100	0.1200	1.4532	9.0000	108.9900	(30)
Dormer	6.2500		6.2500	0.1500	0.9375	9.0000	56.2500	(30)
Bay	1.1300		1.1300	0.1100	0.1243	9.0000	10.1700	(30)
Flat roof	19.1100		19.1100	0.2000	3.8220	9.0000	171.9900	(30)
Total net area of external elements Aum(A, m2)			267.3800					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		92.5313			(33)
GF Party Wall			28.0400	0.0000	0.0000	45.0000	1261.8000	(32)
FF Party Wall			31.6800	0.0000	0.0000	45.0000	1425.6000	(32)
SF Party Wall			9.6400	0.0000	0.0000	45.0000	433.8000	(32)
GF Timber			78.1600			9.0000	703.4400	(32c)
FF Timber			92.4500			9.0000	832.0500	(32c)
SF Timber			19.4000			9.0000	174.6000	(32c)
Internal Floor 1			55.1800			18.0000	993.2400	(32d)
Internal Floor 2			21.6800			18.0000	390.2400	(32d)
Internal Ceiling 1			55.1800			18.0000	993.2400	(32e)
Internal Ceiling 2			21.6800			18.0000	390.2400	(32e)

Heat capacity Cm = Sum(A x k)	(28)...(30) + (32) + (32a)...(32e) =	17960.1900	(34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		136.0208	(35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)		25.6220	(36)
Total fabric heat loss	(33) + (36) =	118.1534	(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	57.3332	56.7485	56.1638	55.0289	55.0289	55.0289	55.0289	55.0289	55.0289	55.0289	55.0289	55.0289	(38)
Heat transfer coeff	175.4865	174.9019	174.3172	173.1822	173.1822	173.1822	173.1822	173.1822	173.1822	173.1822	173.1822	173.1822	(39)
Average = Sum(39)m / 12 =												173.6121	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.3290	1.3246	1.3202	1.3116	1.3116	1.3116	1.3116	1.3116	1.3116	1.3116	1.3116	1.3116	(40)
HLP (average)												1.3148	(40)

CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

Days in month													
	31	28	31	30	31	30	31	31	30	31	30	31	(41)

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4. Water heating energy requirements (kWh/year)

Assumed occupancy												2.9001	(42)
Average daily hot water use (litres/day)												103.0772	(43)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use													
	113.3849	109.2618	105.1387	101.0156	96.8925	92.7694	92.7694	96.8925	101.0156	105.1387	109.2618	113.3849	(44)
Energy conte	168.1465	147.0620	151.7548	132.3035	126.9484	109.5468	101.5112	116.4856	117.8768	137.3740	149.9545	162.8409	(45)
Energy content (annual)										Total = Sum(45)m =		1621.8050	(45)
Distribution loss (46)m = 0.15 x (45)m													
	25.2220	22.0593	22.7632	19.8455	19.0423	16.4320	15.2267	17.4728	17.6815	20.6061	22.4932	24.4261	(46)
Water storage loss:													
Store volume												300.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												1.8900	(48)
Temperature factor from Table 2b												0.5400	(49)
Enter (49) or (54) in (55)												1.0206	(55)
Total storage loss													
	31.6386	28.5768	31.6386	30.6180	31.6386	30.6180	31.6386	31.6386	30.6180	31.6386	30.6180	31.6386	(56)
If cylinder contains dedicated solar storage													
	31.6386	28.5768	31.6386	30.6180	31.6386	30.6180	31.6386	31.6386	30.6180	31.6386	30.6180	31.6386	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Total heat required for water heating calculated for each month													
	223.0475	196.6500	206.6558	185.4335	181.8494	162.6768	156.4122	171.3866	171.0068	192.2750	203.0845	217.7419	(62)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63)
								Solar input (sum of months) = Sum(63)m =				0.0000	(63)
Output from w/h													
	223.0475	196.6500	206.6558	185.4335	181.8494	162.6768	156.4122	171.3866	171.0068	192.2750	203.0845	217.7419	(64)
								Total per year (kWh/year) = Sum(64)m =				2268.2200	(64)
Heat gains from water heating, kWh/month													
	99.8295	88.5685	94.3793	86.4949	86.1311	78.9283	77.6733	82.6523	81.6980	89.5977	92.3639	98.0654	(65)

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

Metabolic gains (Table 5), Watts													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	145.0045	145.0045	145.0045	145.0045	145.0045	145.0045	145.0045	145.0045	145.0045	145.0045	145.0045	145.0045	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	26.7597	23.7678	19.3292	14.6335	10.9387	9.2349	9.9786	12.9706	17.4091	22.1049	25.7997	27.5035	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	300.1628	303.2775	295.4285	278.7187	257.6257	237.8012	224.5572	221.4425	229.2915	246.0013	267.0943	286.9188	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	37.5005	37.5005	37.5005	37.5005	37.5005	37.5005	37.5005	37.5005	37.5005	37.5005	37.5005	37.5005	(69)
Pumps, fans	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)													
	-116.0036	-116.0036	-116.0036	-116.0036	-116.0036	-116.0036	-116.0036	-116.0036	-116.0036	-116.0036	-116.0036	-116.0036	(71)
Water heating gains (Table 5)													
	134.1794	131.7984	126.8539	120.1318	115.7677	109.6226	104.3996	111.0917	113.4695	120.4270	128.2832	131.8083	(72)
Total internal gains													
	530.6033	528.3450	511.1129	482.9854	453.8334	426.1601	408.4368	415.0062	429.6715	458.0345	490.6785	515.7320	(73)

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6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	4.4800	10.6334	0.6300	0.7000	0.7700	14.5587	(74)
Northeast	1.6000	11.2829	0.6300	0.7000	0.7700	5.5171	(75)
East	18.1200	19.6403	0.6300	0.7000	0.7700	108.7620	(76)
Southeast	1.6000	36.7938	0.6300	0.7000	0.7700	17.9915	(77)
South	7.4200	46.7521	0.6300	0.7000	0.7700	106.0172	(78)
Northwest	1.6000	11.2829	0.6300	0.7000	0.7700	5.5171	(81)

Solar gains	258.3637	467.3197	701.2358	955.3452	1136.5851	1154.3099	1102.3256	965.3393	790.1112	534.1727	314.6737	217.5942	(83)
Total gains	788.9670	995.6647	1212.3487	1438.3306	1590.4185	1580.4700	1510.7623	1380.3454	1219.7827	992.2072	805.3522	733.3262	(84)

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7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C)												21.0000	(85)
Utilisation factor for gains for living area, nil,m (see Table 9a)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	28.4292	28.5242	28.6199	28.8075	28.8075	28.8075	28.8075	28.8075	28.8075	28.8075	28.8075	28.8075	
alpha	2.8953	2.9016	2.9080	2.9205	2.9205	2.9205	2.9205	2.9205	2.9205	2.9205	2.9205	2.9205	
util living area													
	0.9835	0.9678	0.9349	0.8645	0.7496	0.6024	0.4680	0.5217	0.7372	0.9129	0.9724	0.9866	(86)
MIT	18.7201	19.0376	19.5212	20.0941	20.5552	20.8338	20.9416	20.9186	20.6856	20.0481	19.2733	18.6759	(87)
Th 2	19.8182	19.8216	19.8251	19.8318	19.8318	19.8318	19.8318	19.8318	19.8318	19.8318	19.8318	19.8318	(88)
util rest of house													
	0.9802	0.9613	0.9217	0.8367	0.6980	0.5190	0.3574	0.4088	0.6640	0.8887	0.9658	0.9838	(89)
MIT 2	16.7962	17.2573	17.9524	18.7578	19.3676	19.6981	19.8010	19.7851	19.5472	18.7152	17.6096	16.7397	(90)
Living area fraction									fLA = Living area / (4) =			0.1530	(91)
MIT	17.0905	17.5296	18.1924	18.9622	19.5492	19.8719	19.9755	19.9585	19.7214	18.9191	17.8641	17.0360	(92)
Temperature adjustment												0.0000	

CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

adjusted MIT	17.0905	17.5296	18.1924	18.9622	19.5492	19.8719	19.9755	19.9585	19.7214	18.9191	17.8641	17.0360	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9680	0.9431	0.8970	0.8114	0.6839	0.5221	0.3717	0.4220	0.6560	0.8637	0.9491	0.9734	(94)
Useful gains	763.7462	938.9682	1087.5184	1167.1265	1087.6797	825.1271	561.6244	582.4684	800.1993	856.9303	764.3986	713.8058	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W	2244.5660	2208.9466	2038.1902	1742.5942	1359.3504	912.9915	584.5685	616.2675	973.5249	1440.7231	1864.1514	2222.9590	(97)
Month fracti	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000	(97a)
Space heating kWh	1101.7299	853.4255	707.2998	414.3368	202.1230	0.0000	0.0000	0.0000	0.0000	434.3418	791.8220	1122.8100	(98)
Space heating												5627.8888	(98)
Space heating per m2											(98) / (4) =	42.6226	(99)

8c. Space cooling requirement

Not applicable

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

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(201)
Fraction of space heat from main system(s)	1.0000	(202)
Efficiency of main space heating system 1 (in %)	93.5000	(206)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)
Space heating requirement	6019.1324	(211)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	1101.7299	853.4255	707.2998	414.3368	202.1230	0.0000	0.0000	0.0000	0.0000	434.3418	791.8220	1122.8100	(98)
Space heating efficiency (main heating system 1)	93.5000	93.5000	93.5000	93.5000	93.5000	0.0000	0.0000	0.0000	0.0000	93.5000	93.5000	93.5000	(210)
Space heating fuel (main heating system)	1178.3207	912.7545	756.4704	443.1409	216.1744	0.0000	0.0000	0.0000	0.0000	464.5367	846.8685	1200.8663	(211)
Water heating requirement	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)
Water heating													
Water heating requirement	223.0475	196.6500	206.6558	185.4335	181.8494	162.6768	156.4122	171.3866	171.0068	192.2750	203.0845	217.7419	(64)
Efficiency of water heater												79.8000	(216)
(217)m	88.5020	88.2832	87.8369	86.8976	85.0962	79.8000	79.8000	79.8000	79.8000	86.9237	88.0890	88.5710	(217)
Fuel for water heating, kWh/month	252.0253	222.7491	235.2721	213.3931	213.6987	203.8556	196.0053	214.7702	214.2942	221.1999	230.5447	245.8388	(219)
Water heating fuel used												2663.6469	(219)
Annual totals kWh/year													
Space heating fuel - main system												6019.1324	(211)
Space heating fuel - secondary												0.0000	(215)
Electricity for pumps and fans:													
(MEVCentralised, Database: in-use factor = 1.3000, SFP = 0.2210)													
mechanical ventilation fans (SFP = 0.2210)												89.9205	(230a)
central heating pump												30.0000	(230c)
main heating flue fan												45.0000	(230e)
Total electricity for the above, kWh/year												164.9205	(231)
Electricity for lighting (calculated in Appendix L)												472.5852	(232)
Total delivered energy for all uses												9320.2851	(238)

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	6019.1324	0.2160	1300.1326	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	2663.6469	0.2160	575.3477	(264)
Space and water heating			1875.4803	(265)
Pumps and fans	164.9205	0.5190	85.5937	(267)
Energy for lighting	472.5852	0.5190	245.2717	(268)
Total CO2, kg/year			2206.3458	(272)
Dwelling Carbon Dioxide Emission Rate (DER)			16.7100	(273)

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

DER		16.7100	ZC1
Total Floor Area	TFA	132.0400	
Assumed number of occupants	N	2.9001	
CO2 emission factor in Table 12 for electricity displaced from grid	EF	0.5190	
CO2 emissions from appliances, equation (L14)		13.4709	ZC2
CO2 emissions from cooking, equation (L16)		1.4284	ZC3
Total CO2 emissions		31.6093	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		31.6093	ZC8

CALCULATION OF TARGET EMISSIONS 09 Jan 2014

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

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	55.1800 (1b)	x	2.5100 (2b)	=	138.5018	(1b) - (3b)
First floor	55.1800 (1c)	x	2.7600 (2c)	=	152.2968	(1c) - (3c)
Second floor	21.6800 (1d)	x	1.9700 (2d)	=	42.7096	(1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	132.0400					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	333.5082	(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) =	0.1199	(8)
Pressure test		Yes	
Measured/design AP50		5.0000	
Infiltration rate		0.3699	(18)
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.3144	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.4009	0.3931	0.3852	0.3459	0.3380	0.2987	0.2987	0.2909	0.3144	0.3380	0.3538	0.3695	(22b)
Effective ac	0.5804	0.5772	0.5742	0.5598	0.5571	0.5446	0.5446	0.5423	0.5494	0.5571	0.5626	0.5683	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
TER Opaque door			6.5400	1.0000	6.5400			(26)
TER Opening Type (Uw = 1.40)			26.4800	1.3258	35.1061			(27)
Ground Floor			55.1800	0.1300	7.1734			(28a)
GF External Wall	58.6300	17.8600	40.7700	0.1800	7.3386			(29a)
FF External wall	63.6200	14.1300	49.4900	0.1800	8.9082			(29a)
SF External wall	9.6400		9.6400	0.1800	1.7352			(29a)
Wall to void	11.3800		11.3800	0.1800	2.0484			(29a)
Dormer	6.8100	1.0300	5.7800	0.1800	1.0404			(29a)
Sloping	23.5200		23.5200	0.1300	3.0576			(30)
To void	12.1100		12.1100	0.1300	1.5743			(30)
Dormer	6.2500		6.2500	0.1300	0.8125			(30)
Bay	1.1300		1.1300	0.1300	0.1469			(30)
Flat roof	19.1100		19.1100	0.1300	2.4843			(30)
Total net area of external elements Aum(A, m2)			267.3800					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	77.9659			(33)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K							250.0000	(35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)							24.4610	(36)
Total fabric heat loss						(33) + (36) =	102.4269	(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	63.8740	63.5305	63.1939	61.6125	61.3167	59.9394	59.9394	59.6844	60.4699	61.3167	61.9152	62.5409	(38)
Heat transfer coeff	166.3008	165.9574	165.6207	164.0394	163.7435	162.3663	162.3663	162.1112	162.8968	163.7435	164.3421	164.9678	(39)
Average = Sum(39)m / 12 =												164.0380	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.2595	1.2569	1.2543	1.2423	1.2401	1.2297	1.2297	1.2277	1.2337	1.2401	1.2446	1.2494	(40)
HLP (average)												1.2423	(40)
Days in month	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy	2.9001	(42)
Average daily hot water use (litres/day)	103.0772	(43)

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

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	113.3849	109.2618	105.1387	101.0156	96.8925	92.7694	92.7694	96.8925	101.0156	105.1387	109.2618	113.3849	(44)
Energy conte	168.1465	147.0620	151.7548	132.3035	126.9484	109.5468	101.5112	116.4856	117.8768	137.3740	149.9545	162.8409	(45)
Energy content (annual)										Total = Sum(45)m =		1621.8050	(45)
Distribution loss (46)m = 0.15 x (45)m													
	25.2220	22.0593	22.7632	19.8455	19.0423	16.4320	15.2267	17.4728	17.6815	20.6061	22.4932	24.4261	(46)
Water storage loss:													
Store volume												300.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												2.1127	(48)
Temperature factor from Table 2b												0.5400	(49)
Enter (49) or (54) in (55)												1.1409	(55)
Total storage loss													
	35.3664	31.9439	35.3664	34.2256	35.3664	34.2256	35.3664	35.3664	34.2256	35.3664	34.2256	35.3664	(56)
If cylinder contains dedicated solar storage													
	35.3664	31.9439	35.3664	34.2256	35.3664	34.2256	35.3664	35.3664	34.2256	35.3664	34.2256	35.3664	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Total heat required for water heating calculated for each month													
	226.7753	200.0170	210.3836	189.0411	185.5772	166.2843	160.1400	175.1144	174.6144	196.0029	206.6921	221.4697	(62)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63)
								Solar input (sum of months) = Sum(63)m =				0.0000	(63)
Output from w/h													
	226.7753	200.0170	210.3836	189.0411	185.5772	166.2843	160.1400	175.1144	174.6144	196.0029	206.6921	221.4697	(64)
								Total per year (kWh/year) = Sum(64)m =				2312.1119	(64)
Heat gains from water heating, kWh/month													
	102.8118	91.2622	97.3615	89.3810	89.1134	81.8144	80.6555	85.6345	84.5841	92.5799	95.2499	101.0476	(65)

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

Metabolic gains (Table 5), Watts	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	145.0045	145.0045	145.0045	145.0045	145.0045	145.0045	145.0045	145.0045	145.0045	145.0045	145.0045	145.0045	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	26.9406	23.9284	19.4599	14.7324	11.0126	9.2973	10.0461	13.0583	17.5268	22.2543	25.9741	27.6894	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	300.1628	303.2775	295.4285	278.7187	257.6257	237.8012	224.5572	221.4425	229.2915	246.0013	267.0943	286.9188	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	37.5005	37.5005	37.5005	37.5005	37.5005	37.5005	37.5005	37.5005	37.5005	37.5005	37.5005	37.5005	(69)
Pumps, fans	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)													
	-116.0036	-116.0036	-116.0036	-116.0036	-116.0036	-116.0036	-116.0036	-116.0036	-116.0036	-116.0036	-116.0036	-116.0036	(71)
Water heating gains (Table 5)													
	138.1878	135.8068	130.8623	124.1402	119.7761	113.6310	108.4080	115.1001	117.4779	124.4354	132.2916	135.8167	(72)
Total internal gains													
	534.7926	532.5141	515.2520	487.0927	457.9157	430.2309	412.5126	419.1023	433.7976	462.1923	494.8613	519.9263	(73)

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6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	3.4100	10.6334	0.6300	0.7000	0.7700	11.0815	(74)
Northeast	1.2200	11.2829	0.6300	0.7000	0.7700	4.2068	(75)
East	13.7700	19.6403	0.6300	0.7000	0.7700	82.6519	(76)
Southeast	1.2200	36.7938	0.6300	0.7000	0.7700	13.7185	(77)
South	5.6400	46.7521	0.6300	0.7000	0.7700	80.5845	(78)
Northwest	1.2200	11.2829	0.6300	0.7000	0.7700	4.2068	(81)

Solar gains	196.4501	355.3326	533.2007	726.4397	864.2789	877.7697	838.2341	734.0481	600.7852	406.1665	239.2660	165.4507	(83)
Total gains	731.2428	887.8468	1048.4527	1213.5324	1322.1946	1308.0007	1250.7467	1153.1504	1034.5828	868.3588	734.1273	685.3770	(84)

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7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C)												21.0000	(85)
Utilisation factor for gains for living area, nil,m (see Table 9a)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	55.1377	55.2518	55.3641	55.8978	55.9988	56.4738	56.4738	56.5627	56.2899	55.9988	55.7949	55.5832	
alpha	4.6758	4.6835	4.6909	4.7265	4.7333	4.7649	4.7649	4.7708	4.7527	4.7333	4.7197	4.7055	
util living area													
	0.9986	0.9962	0.9884	0.9596	0.8784	0.7202	0.5535	0.6156	0.8585	0.9793	0.9968	0.9989	(86)
MIT	19.5725	19.7529	20.0470	20.4262	20.7471	20.9319	20.9845	20.9749	20.8348	20.4034	19.9144	19.5421	(87)
Th 2	19.8727	19.8748	19.8768	19.8863	19.8880	19.8963	19.8963	19.8979	19.8931	19.8880	19.8845	19.8807	(88)
util rest of house													
	0.9981	0.9948	0.9840	0.9438	0.8313	0.6239	0.4236	0.4831	0.7861	0.9685	0.9954	0.9986	(89)
MIT 2	17.9730	18.2378	18.6666	19.2133	19.6404	19.8513	19.8908	19.8877	19.7594	19.1912	18.4812	17.9341	(90)
Living area fraction									fLA = Living area / (4) =			0.1530	(91)
MIT	18.2177	18.4696	18.8778	19.3988	19.8097	20.0166	20.0581	20.0540	19.9239	19.3767	18.7004	18.1801	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.2177	18.4696	18.8778	19.3988	19.8097	20.0166	20.0581	20.0540	19.9239	19.3767	18.7004	18.1801	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9969	0.9922	0.9785	0.9347	0.8274	0.6354	0.4434	0.5030	0.7885	0.9614	0.9932	0.9977	(94)
Useful gains	728.9519	880.9339	1025.9052	1134.3486	1093.9245	831.0991	554.6015	580.0905	815.8138	834.8316	729.1111	683.7793	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W													
	2314.5235	2251.9731	2050.0140	1722.2223	1327.9114	879.4778	561.4794	592.3557	948.6950	1437.1261	1906.4405	2306.2645	(97)

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Month fracti	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000	(97a)
Space heating kWh													
	1179.6653	921.3383	761.9369	423.2691	174.0863	0.0000	0.0000	0.0000	0.0000	448.1071	847.6771	1207.1289	(98)
Space heating												5963.2090	(98)
Space heating per m2											(98) / (4) =	45.1621	(99)

8c. Space cooling requirement

Not applicable

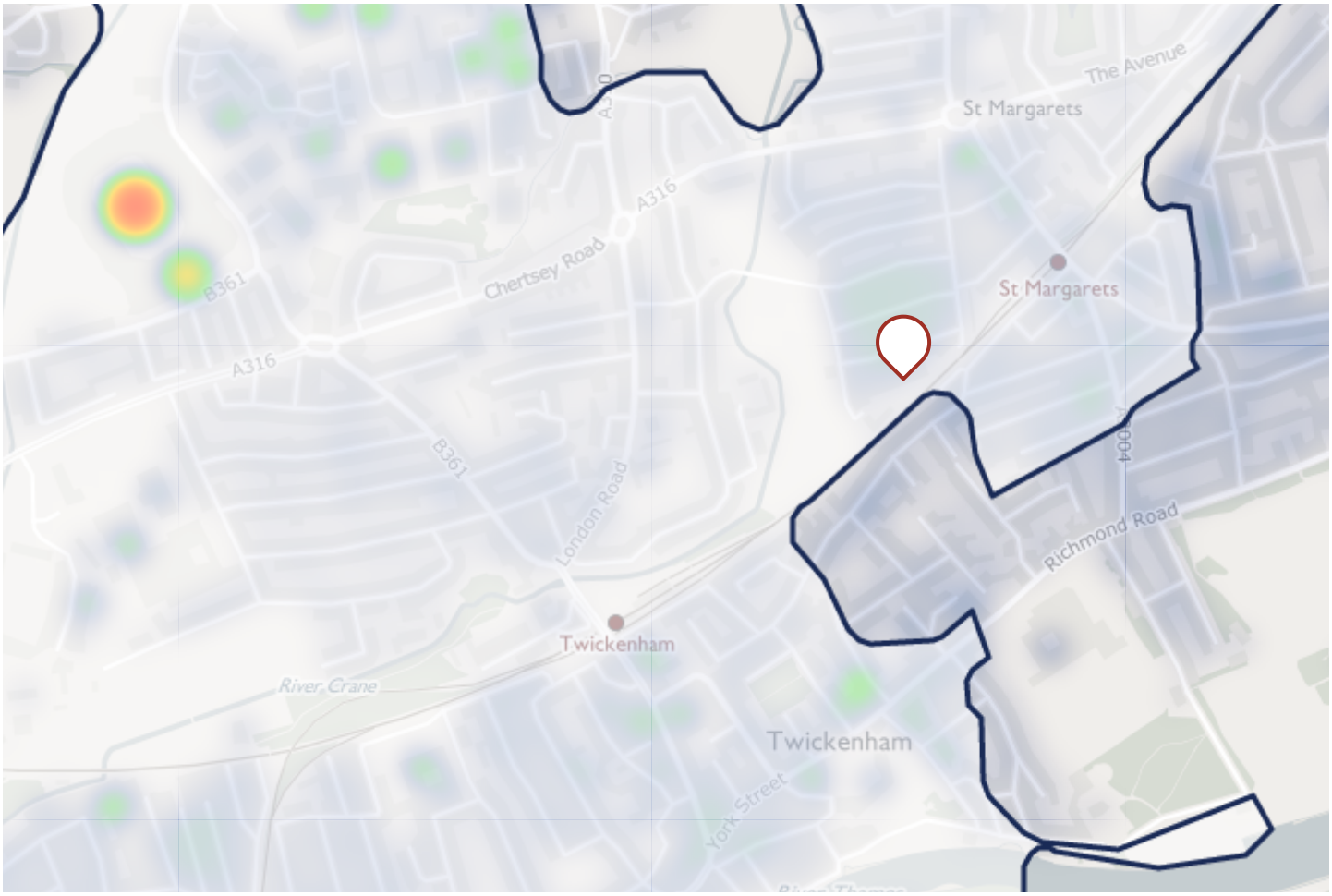
9a. Energy requirements - Individual heating systems, including micro-CHP

Fraction of space heat from secondary/supplementary system (Table 11)												0.0000	(201)
Fraction of space heat from main system(s)												1.0000	(202)
Efficiency of main space heating system 1 (in %)												93.5000	(206)
Efficiency of secondary/supplementary heating system, %												0.0000	(208)
Space heating requirement												6377.7637	(211)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement													
	1179.6653	921.3383	761.9369	423.2691	174.0863	0.0000	0.0000	0.0000	0.0000	448.1071	847.6771	1207.1289	(98)
Space heating efficiency (main heating system 1)													
	93.5000	93.5000	93.5000	93.5000	93.5000	0.0000	0.0000	0.0000	0.0000	93.5000	93.5000	93.5000	(210)
Space heating fuel (main heating system)													
	1261.6741	985.3886	814.9058	452.6942	186.1885	0.0000	0.0000	0.0000	0.0000	479.2589	906.6066	1291.0470	(211)
Water heating requirement													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)
Water heating													
Water heating requirement													
	226.7753	200.0170	210.3836	189.0411	185.5772	166.2843	160.1400	175.1144	174.6144	196.0029	206.6921	221.4697	(64)
Efficiency of water heater												79.8000	(216)
(217)m	88.5848	88.3861	87.9484	86.9025	84.6439	79.8000	79.8000	79.8000	79.8000	86.9522	88.1821	88.6571	(217)
Fuel for water heating, kWh/month													
	255.9980	226.2993	239.2125	217.5323	219.2445	208.3764	200.6767	219.4416	218.8150	225.4146	234.3923	249.8048	(219)
Water heating fuel used												2715.2079	(219)
Annual totals kWh/year													
Space heating fuel - main system												6377.7637	(211)
Space heating fuel - secondary												0.0000	(215)
Electricity for pumps and fans:													
central heating pump												30.0000	(230c)
main heating flue fan												45.0000	(230e)
Total electricity for the above, kWh/year												75.0000	(231)
Electricity for lighting (calculated in Appendix L)												475.7801	(232)
Total delivered energy for all uses												9643.7517	(238)

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	6377.7637	0.2160	1377.5970	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	2715.2079	0.2160	586.4849	(264)
Space and water heating			1964.0819	(265)
Pumps and fans	75.0000	0.5190	38.9250	(267)
Energy for lighting	475.7801	0.5190	246.9299	(268)
Total CO2, kg/m2/year			2249.9367	(272)
Emissions per m2 for space and water heating			14.8749	(272a)
Fuel factor (mains gas)			1.0000	
Emissions per m2 for lighting			1.8701	(272b)
Emissions per m2 for pumps and fans			0.2948	(272c)
Target Carbon Dioxide Emission Rate (TER) = (14.8749 * 1.00) + 1.8701 + 0.2948, rounded to 2 d.p.			17.0400	(273)

6 Appendix B: Extract from the London Heat Map



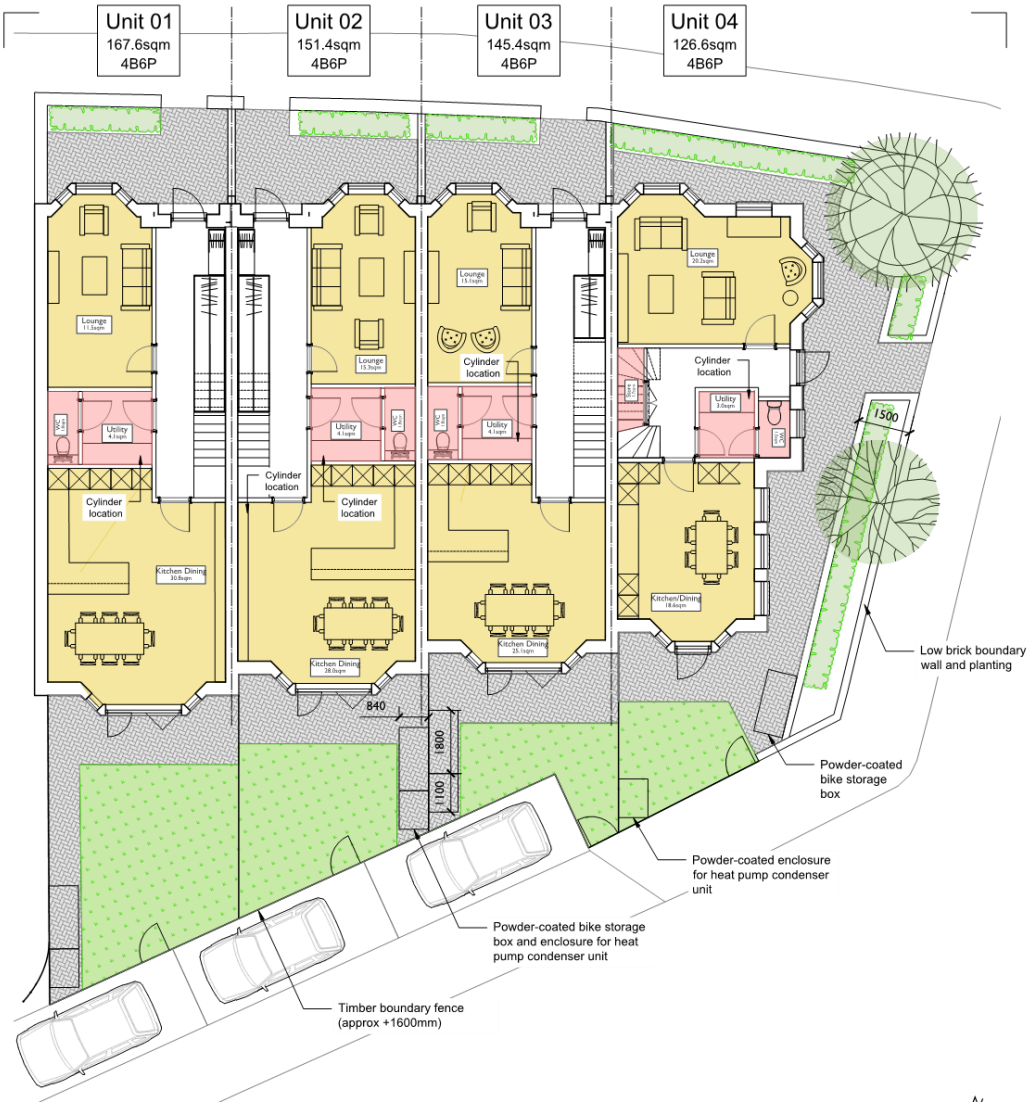
Layers shown on map

Existing heat networks, proposed heat networks, heat network priority areas (areas with blue border)

Filters applied to map

None

7 Appendix C: Location of the proposed ASHPs and cylinders



8 Appendix D: DER/TER calculation printout for Unit 04 for the 'be green' scenario

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

Design SAP
elmhurst energy

Property Reference	04	**Issued on Date**	29/08/2020
Assessment Reference	04	**Prop Type Ref**	Unit 04
Property	Unit 04, St Margaret's Business Park, St Margaret's, Twickenham		

SAP Rating	82 B	**DER**	17.85	**TER**	25.22
Environmental	83 B	**% DER<TER**	29.23		
CO_2 Emissions (t/year)	2.04	**DFEE**	53.47	**TFEE**	59.68
General Requirements Compliance	Pass	**% DFEE<TFEE**	10.39		

Assessor Details	Mr. George Jones, Erban Consulting Limited, Tel: 01455883250, george.jones@erbanconsulting.co.uk	**Assessor ID**	K945-0001
Client			

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DWELLING AS DESIGNED

End-Terrace House, total floor area 132 m²

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

1a TER and DER
Fuel for main heating:Electricity
Fuel factor:1.55 (electricity)
Target Carbon Dioxide Emission Rate (TER) 25.22 kgCO□/m²
Dwelling Carbon Dioxide Emission Rate (DER) 17.85 kgCO□/m²OK

1b TFEE and DFEE
Target Fabric Energy Efficiency (TFEE)59.7 kWh/m²/yr
Dwelling Fabric Energy Efficiency (DFEE)53.5 kWh/m²/yrOK

---
2 Fabric U-values

Element	Average	Highest	
External wall	0.21 (max. 0.30)	0.22 (max. 0.70)	OK
Party wall	0.00 (max. 0.20)	-	OK
Floor	0.16 (max. 0.25)	0.16 (max. 0.70)	OK
Roof	0.16 (max. 0.20)	0.20 (max. 0.35)	OK
Openings	1.28 (max. 2.00)	1.30 (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: 5.00 (design value)
Maximum 10.0 OK

---
4 Heating efficiency
Main heating system: Heat pump with radiators or underfloor - Electric
Mitsubishi Ecodan 11.2 kW PUHZ-W112VHA-BS

Secondary heating system: None

---
5 Cylinder insulation
Hot water storage: Measured cylinder loss: 1.89 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
Independent timer for DHW OK

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

---
8 Mechanical ventilation
Continuous extract system
Specific fan power: 0.17
Maximum 0.7 OK

---
9 Summertime temperature
Overheating risk (Thames Valley): Medium OK
Based on:
Overshading: Average
Windows facing North: 4.48 m², No overhang
Windows facing North East: 1.60 m², No overhang
Windows facing East: 18.12 m², No overhang
Windows facing South East: 1.60 m², No overhang
Windows facing South: 7.42 m², No overhang
Windows facing North West: 1.60 m², No overhang
Air change rate: 4.00 ach
Blinds/curtains: None

---
10 Key features
External wall U-value 0.12 W/m²K
Party wall U-value 0.00 W/m²K
Party wall U-value 0.00 W/m²K
Party wall U-value 0.00 W/m²K
Roof U-value 0.12 W/m²K
Roof U-value 0.11 W/m²K

CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

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

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	55.1800 (1b)	x	2.5100 (2b)	=	138.5018	(1b) - (3b)
First floor	55.1800 (1c)	x	2.7600 (2c)	=	152.2968	(1c) - (3c)
Second floor	21.6800 (1d)	x	1.9700 (2d)	=	42.7096	(1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	132.0400					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	333.5082	(5)

2. Ventilation rate

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

				Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =			0.0000 / (5) =	0.0000	(8)
Pressure test				Yes	
Measured/design AP50				5.0000	
Infiltration rate				0.2500	(18)
Number of sides sheltered				2	(19)
Shelter factor			(20) = 1 - [0.075 x (19)] =	0.8500	(20)
Infiltration rate adjusted to include shelter factor			(21) = (18) x (20) =	0.2125	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.2709	0.2656	0.2603	0.2338	0.2284	0.2019	0.2019	0.1966	0.2125	0.2284	0.2391	0.2497	(22b)
Mechanical extract ventilation - centralised													
If mechanical ventilation:												0.5000	(23a)
Effective ac	0.5209	0.5156	0.5103	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
Window (Uw = 1.30)			34.8200	1.2357	43.0285			(27)
Door			6.5400	1.2000	7.8480			(26)
Ground Floor			55.1800	0.1600	8.8288	75.0000	4138.5000	(28a)
GF External Wall	58.6300	21.4400	37.1900	0.2200	8.1818	60.0000	2231.4000	(29a)
FF External wall	63.6200	18.5700	45.0500	0.2200	9.9110	60.0000	2703.0000	(29a)
SF External wall	9.6400		9.6400	0.2200	2.1208	60.0000	578.4000	(29a)
Wall to void	11.3800		11.3800	0.1200	1.3656	9.0000	102.4200	(29a)
Dormer	6.8100	1.3500	5.4600	0.2100	1.1466	9.0000	49.1400	(29a)
Sloping	23.5200		23.5200	0.1600	3.7632	9.0000	211.6800	(30)
To void	12.1100		12.1100	0.1200	1.4532	9.0000	108.9900	(30)
Dormer	6.2500		6.2500	0.1500	0.9375	9.0000	56.2500	(30)
Bay	1.1300		1.1300	0.1100	0.1243	9.0000	10.1700	(30)
Flat roof	19.1100		19.1100	0.2000	3.8220	9.0000	171.9900	(30)
Total net area of external elements Aum(A, m2)			267.3800					(31)
Fabric heat loss, W/K = Sum (A x U)			(26)...(30) + (32) =		92.5313			(33)
GF Party Wall			28.0400	0.0000	0.0000	45.0000	1261.8000	(32)
FF Party Wall			31.6800	0.0000	0.0000	45.0000	1425.6000	(32)
SF Party Wall			9.6400	0.0000	0.0000	45.0000	433.8000	(32)
GF Timber			78.1600			9.0000	703.4400	(32c)
FF Timber			92.4500			9.0000	832.0500	(32c)
SF Timber			19.4000			9.0000	174.6000	(32c)
Internal Floor 1			55.1800			18.0000	993.2400	(32d)
Internal Floor 2			21.6800			18.0000	390.2400	(32d)
Internal Ceiling 1			55.1800			18.0000	993.2400	(32e)
Internal Ceiling 2			21.6800			18.0000	390.2400	(32e)

Heat capacity Cm = Sum(A x k)	(28)...(30) + (32) + (32a)...(32e) =	17960.1900	(34)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K		136.0208	(35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)		25.6220	(36)
Total fabric heat loss	(33) + (36) =	118.1534	(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	57.3332	56.7485	56.1638	55.0289	55.0289	55.0289	55.0289	55.0289	55.0289	55.0289	55.0289	55.0289	(38)
Heat transfer coeff	175.4865	174.9019	174.3172	173.1822	173.1822	173.1822	173.1822	173.1822	173.1822	173.1822	173.1822	173.1822	(39)
Average = Sum(39)m / 12 =												173.6121	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.3290	1.3246	1.3202	1.3116	1.3116	1.3116	1.3116	1.3116	1.3116	1.3116	1.3116	1.3116	(40)
HLP (average)												1.3148	(40)

CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

Days in month												
	31	28	31	30	31	30	31	31	30	31	30	31 (41)

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4. Water heating energy requirements (kWh/year)

Assumed occupancy												2.9001	(42)
Average daily hot water use (litres/day)												103.0772	(43)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use													
	113.3849	109.2618	105.1387	101.0156	96.8925	92.7694	92.7694	96.8925	101.0156	105.1387	109.2618	113.3849	(44)
Energy conte	168.1465	147.0620	151.7548	132.3035	126.9484	109.5468	101.5112	116.4856	117.8768	137.3740	149.9545	162.8409	(45)
Energy content (annual)										Total = Sum(45)m =		1621.8050	(45)
Distribution loss (46)m = 0.15 x (45)m													
	25.2220	22.0593	22.7632	19.8455	19.0423	16.4320	15.2267	17.4728	17.6815	20.6061	22.4932	24.4261	(46)
Water storage loss:													
Store volume												300.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												1.8900	(48)
Temperature factor from Table 2b												0.5400	(49)
Enter (49) or (54) in (55)												1.0206	(55)
Total storage loss													
	31.6386	28.5768	31.6386	30.6180	31.6386	30.6180	31.6386	31.6386	30.6180	31.6386	30.6180	31.6386	(56)
If cylinder contains dedicated solar storage													
	31.6386	28.5768	31.6386	30.6180	31.6386	30.6180	31.6386	31.6386	30.6180	31.6386	30.6180	31.6386	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Total heat required for water heating calculated for each month													
	223.0475	196.6500	206.6558	185.4335	181.8494	162.6768	156.4122	171.3866	171.0068	192.2750	203.0845	217.7419	(62)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63)
								Solar input (sum of months) = Sum(63)m =				0.0000	(63)
Output from w/h													
	223.0475	196.6500	206.6558	185.4335	181.8494	162.6768	156.4122	171.3866	171.0068	192.2750	203.0845	217.7419	(64)
								Total per year (kWh/year) = Sum(64)m =				2268.2200	(64)
Heat gains from water heating, kWh/month													
	99.8295	88.5685	94.3793	86.4949	86.1311	78.9283	77.6733	82.6523	81.6980	89.5977	92.3639	98.0654	(65)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5), Watts													
(66)m	145.0045	145.0045	145.0045	145.0045	145.0045	145.0045	145.0045	145.0045	145.0045	145.0045	145.0045	145.0045	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	26.7597	23.7678	19.3292	14.6335	10.9387	9.2349	9.9786	12.9706	17.4091	22.1049	25.7997	27.5035	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	300.1628	303.2775	295.4285	278.7187	257.6257	237.8012	224.5572	221.4425	229.2915	246.0013	267.0943	286.9188	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	37.5005	37.5005	37.5005	37.5005	37.5005	37.5005	37.5005	37.5005	37.5005	37.5005	37.5005	37.5005	(69)
Pumps, fans	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)
Losses e.g. evaporation (negative values) (Table 5)													
	-116.0036	-116.0036	-116.0036	-116.0036	-116.0036	-116.0036	-116.0036	-116.0036	-116.0036	-116.0036	-116.0036	-116.0036	(71)
Water heating gains (Table 5)													
	134.1794	131.7984	126.8539	120.1318	115.7677	109.6226	104.3996	111.0917	113.4695	120.4270	128.2832	131.8083	(72)
Total internal gains													
	527.6033	525.3450	508.1129	479.9854	450.8334	423.1601	405.4368	412.0062	426.6715	455.0345	487.6785	512.7320	(73)

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6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	4.4800	10.6334	0.6300	0.7000	0.7700	14.5587	(74)
Northeast	1.6000	11.2829	0.6300	0.7000	0.7700	5.5171	(75)
East	18.1200	19.6403	0.6300	0.7000	0.7700	108.7620	(76)
Southeast	1.6000	36.7938	0.6300	0.7000	0.7700	17.9915	(77)
South	7.4200	46.7521	0.6300	0.7000	0.7700	106.0172	(78)
Northwest	1.6000	11.2829	0.6300	0.7000	0.7700	5.5171	(81)

Solar gains	258.3637	467.3197	701.2358	955.3452	1136.5851	1154.3099	1102.3256	965.3393	790.1112	534.1727	314.6737	217.5942	(83)
Total gains	785.9670	992.6647	1209.3487	1435.3306	1587.4185	1577.4700	1507.7623	1377.3454	1216.7827	989.2072	802.3522	730.3262	(84)

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7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C)												21.0000	(85)
Utilisation factor for gains for living area, nil,m (see Table 9a)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	28.4292	28.5242	28.6199	28.8075	28.8075	28.8075	28.8075	28.8075	28.8075	28.8075	28.8075	28.8075	
alpha	2.8953	2.9016	2.9080	2.9205	2.9205	2.9205	2.9205	2.9205	2.9205	2.9205	2.9205	2.9205	
util living area													
	0.9837	0.9680	0.9352	0.8651	0.7503	0.6032	0.4688	0.5226	0.7382	0.9134	0.9727	0.9867	(86)
Tweekday	16.7919	17.2532	17.9489	18.7552	19.3662	19.6976	19.8008	19.7848	19.5460	18.7121	17.6054	16.7353	
Tweekend	19.5242	19.7296	20.0424	20.4131	20.7116	20.8922	20.9621	20.9472	20.7960	20.3831	19.8819	19.4956	
24 / 16	9	8	9	8	9	9	9	9	8	9	8	9	
24 / 9	22	20	22	22	22	21	22	22	22	22	22	22	
16 / 9	0	0	0	0	0	0	0	0	0	0	0	0	
MIT	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	21.0000	(87)
Th 2	19.8182	19.8216	19.8251	19.8318	19.8318	19.8318	19.8318	19.8318	19.8318	19.8318	19.8318	19.8318	(88)
util rest of house													

CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

	0.9804	0.9616	0.9221	0.8373	0.6988	0.5197	0.3580	0.4096	0.6650	0.8893	0.9661	0.9840	(89)
Tweekday	16.7919	17.2532	17.9489	18.7552	19.3662	19.6976	19.8008	19.7848	19.5460	18.7121	17.6054	16.7353	
Tweekend	16.7919	17.2532	17.9489	18.7552	19.3662	19.6976	19.8008	19.7848	19.5460	18.7121	17.6054	16.7353	
MIT 2	19.8182	19.8216	19.8251	19.8318	19.8318	19.8318	19.8318	19.8318	19.8318	19.8318	19.8318	19.8318	(90)
Living area fraction									fLA = Living area / (4) =			0.1530	(91)
MIT	19.9990	20.0019	20.0048	20.0105	20.0105	20.0105	20.0105	20.0105	20.0105	20.0105	20.0105	20.0105	(92)
Temperature adjustment												0.0000	
adjusted MIT	19.9990	20.0019	20.0048	20.0105	20.0105	20.0105	20.0105	20.0105	20.0105	20.0105	20.0105	20.0105	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9809	0.9627	0.9243	0.8420	0.7074	0.5335	0.3759	0.4281	0.6775	0.8935	0.9673	0.9845	(94)
Useful gains	770.9793	955.6387	1117.8032	1208.5201	1122.8962	841.5113	566.7634	589.6492	824.3411	883.8698	776.0890	718.9744	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W	2754.9559	2641.3468	2354.1193	1924.1388	1439.2286	937.0002	590.6358	625.2722	1023.5913	1629.7290	2235.8668	2738.0952	(97)
Month fracti	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000	(97a)
Space heating kWh	1476.0786	1132.7959	919.8192	515.2455	235.3513	0.0000	0.0000	0.0000	0.0000	554.9192	1051.0400	1502.2259	(98)
Space heating												7387.4755	(98)
Space heating per m2											(98) / (4) =	55.9488	(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 %)	287.0336	(206)
Efficiency of secondary/supplementary heating system, %	100.0000	(208)
Space heating requirement	2573.7317	(211)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	1476.0786	1132.7959	919.8192	515.2455	235.3513	0.0000	0.0000	0.0000	0.0000	554.9192	1051.0400	1502.2259	(98)
Space heating efficiency (main heating system 1)	287.0336	287.0336	287.0336	287.0336	287.0336	0.0000	0.0000	0.0000	0.0000	287.0336	287.0336	287.0336	(210)
Space heating fuel (main heating system)	514.2529	394.6561	320.4569	179.5070	81.9943	0.0000	0.0000	0.0000	0.0000	193.3290	366.1731	523.3623	(211)
Water heating requirement	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)
Water heating													
Water heating requirement	223.0475	196.6500	206.6558	185.4335	181.8494	162.6768	156.4122	171.3866	171.0068	192.2750	203.0845	217.7419	(64)
Efficiency of water heater												161.3100	(216)
(217)m	161.3100	161.3100	161.3100	161.3100	161.3100	161.3100	161.3100	161.3100	161.3100	161.3100	161.3100	161.3100	(217)
Fuel for water heating, kWh/month	138.2726	121.9081	128.1110	114.9548	112.7329	100.8473	96.9637	106.2467	106.0113	119.1960	125.8970	134.9835	(219)
Water heating fuel used												1406.1248	(219)
Annual totals kWh/year													
Space heating fuel - main system												2573.7317	(211)
Space heating fuel - secondary												0.0000	(215)
Electricity for pumps and fans:													
(MEVCentralised, Database: in-use factor = 1.3000, SFP = 0.2210)													
mechanical ventilation fans (SFP = 0.2210)												89.9205	(230a)
Total electricity for the above, kWh/year												89.9205	(231)
Electricity for lighting (calculated in Appendix L)												472.5852	(232)
Total delivered energy for all uses												4542.3622	(238)

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	2573.7317	0.5190	1335.7667	(261)
Space heating - secondary	0.0000	0.5190	0.0000	(263)
Water heating (other fuel)	1406.1248	0.5190	729.7788	(264)
Space and water heating			2065.5455	(265)
Pumps and fans	89.9205	0.5190	46.6687	(267)
Energy for lighting	472.5852	0.5190	245.2717	(268)
Total CO2, kg/year			2357.4860	(272)
Dwelling Carbon Dioxide Emission Rate (DER)			17.8500	(273)

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

DER		17.8500	ZC1
Total Floor Area	TFA	132.0400	
Assumed number of occupants	N	2.9001	
CO2 emission factor in Table 12 for electricity displaced from grid	EF	0.5190	
CO2 emissions from appliances, equation (L14)		13.4709	ZC2
CO2 emissions from cooking, equation (L16)		1.4284	ZC3
Total CO2 emissions		32.7493	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		32.7493	ZC8

CALCULATION OF TARGET EMISSIONS 09 Jan 2014

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

1. Overall dwelling dimensions

	Area (m2)		Storey height (m)		Volume (m3)	
Ground floor	55.1800 (1b)	x	2.5100 (2b)	=	138.5018	(1b) - (3b)
First floor	55.1800 (1c)	x	2.7600 (2c)	=	152.2968	(1c) - (3c)
Second floor	21.6800 (1d)	x	1.9700 (2d)	=	42.7096	(1d) - (3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)	132.0400					(4)
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)...(3n)	=	333.5082	(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) =	0.1199	(8)
Pressure test		Yes	
Measured/design AP50		5.0000	
Infiltration rate		0.3699	(18)
Number of sides sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.8500	(20)
Infiltration rate adjusted to include shelter factor	(21) = (18) x (20) =	0.3144	(21)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Wind speed	5.1000	5.0000	4.9000	4.4000	4.3000	3.8000	3.8000	3.7000	4.0000	4.3000	4.5000	4.7000	(22)
Wind factor	1.2750	1.2500	1.2250	1.1000	1.0750	0.9500	0.9500	0.9250	1.0000	1.0750	1.1250	1.1750	(22a)
Adj infilt rate	0.4009	0.3931	0.3852	0.3459	0.3380	0.2987	0.2987	0.2909	0.3144	0.3380	0.3538	0.3695	(22b)
Effective ac	0.5804	0.5772	0.5742	0.5598	0.5571	0.5446	0.5446	0.5423	0.5494	0.5571	0.5626	0.5683	(25)

3. Heat losses and heat loss parameter

Element	Gross m2	Openings m2	NetArea m2	U-value W/m2K	A x U W/K	K-value kJ/m2K	A x K kJ/K	
TER Opaque door			6.5400	1.0000	6.5400			(26)
TER Opening Type (Uw = 1.40)			26.4800	1.3258	35.1061			(27)
Ground Floor			55.1800	0.1300	7.1734			(28a)
GF External Wall	58.6300	17.8600	40.7700	0.1800	7.3386			(29a)
FF External wall	63.6200	14.1300	49.4900	0.1800	8.9082			(29a)
SF External wall	9.6400		9.6400	0.1800	1.7352			(29a)
Wall to void	11.3800		11.3800	0.1800	2.0484			(29a)
Dormer	6.8100	1.0300	5.7800	0.1800	1.0404			(29a)
Sloping	23.5200		23.5200	0.1300	3.0576			(30)
To void	12.1100		12.1100	0.1300	1.5743			(30)
Dormer	6.2500		6.2500	0.1300	0.8125			(30)
Bay	1.1300		1.1300	0.1300	0.1469			(30)
Flat roof	19.1100		19.1100	0.1300	2.4843			(30)
Total net area of external elements Aum(A, m2)			267.3800					(31)
Fabric heat loss, W/K = Sum (A x U)				(26)...(30) + (32) =	77.9659			(33)
Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K							250.0000	(35)
Thermal bridges (Sum(L x Psi) calculated using Appendix K)							24.4610	(36)
Total fabric heat loss						(33) + (36) =	102.4269	(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	63.8740	63.5305	63.1939	61.6125	61.3167	59.9394	59.9394	59.6844	60.4699	61.3167	61.9152	62.5409	(38)
Heat transfer coeff	166.3008	165.9574	165.6207	164.0394	163.7435	162.3663	162.3663	162.1112	162.8968	163.7435	164.3421	164.9678	(39)
Average = Sum(39)m / 12 =												164.0380	(39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
HLP	1.2595	1.2569	1.2543	1.2423	1.2401	1.2297	1.2297	1.2277	1.2337	1.2401	1.2446	1.2494	(40)
HLP (average)												1.2423	(40)
Days in month	31	28	31	30	31	30	31	31	30	31	30	31	(41)

4. Water heating energy requirements (kWh/year)

Assumed occupancy	2.9001	(42)
Average daily hot water use (litres/day)	103.0772	(43)

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

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	113.3849	109.2618	105.1387	101.0156	96.8925	92.7694	92.7694	96.8925	101.0156	105.1387	109.2618	113.3849	(44)
Energy conte	168.1465	147.0620	151.7548	132.3035	126.9484	109.5468	101.5112	116.4856	117.8768	137.3740	149.9545	162.8409	(45)
Energy content (annual)										Total = Sum(45)m =		1621.8050	(45)
Distribution loss (46)m = 0.15 x (45)m													
	25.2220	22.0593	22.7632	19.8455	19.0423	16.4320	15.2267	17.4728	17.6815	20.6061	22.4932	24.4261	(46)
Water storage loss:													
Store volume												300.0000	(47)
a) If manufacturer declared loss factor is known (kWh/day):												2.1127	(48)
Temperature factor from Table 2b												0.5400	(49)
Enter (49) or (54) in (55)												1.1409	(55)
Total storage loss													
	35.3664	31.9439	35.3664	34.2256	35.3664	34.2256	35.3664	35.3664	34.2256	35.3664	34.2256	35.3664	(56)
If cylinder contains dedicated solar storage													
	35.3664	31.9439	35.3664	34.2256	35.3664	34.2256	35.3664	35.3664	34.2256	35.3664	34.2256	35.3664	(57)
Primary loss	23.2624	21.0112	23.2624	22.5120	23.2624	22.5120	23.2624	23.2624	22.5120	23.2624	22.5120	23.2624	(59)
Total heat required for water heating calculated for each month													
	226.7753	200.0170	210.3836	189.0411	185.5772	166.2843	160.1400	175.1144	174.6144	196.0029	206.6921	221.4697	(62)
Solar input	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(63)
								Solar input (sum of months) = Sum(63)m =				0.0000	(63)
Output from w/h													
	226.7753	200.0170	210.3836	189.0411	185.5772	166.2843	160.1400	175.1144	174.6144	196.0029	206.6921	221.4697	(64)
								Total per year (kWh/year) = Sum(64)m =				2312.1119	(64)
Heat gains from water heating, kWh/month													
	102.8118	91.2622	97.3615	89.3810	89.1134	81.8144	80.6555	85.6345	84.5841	92.5799	95.2499	101.0476	(65)

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

Metabolic gains (Table 5), Watts	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	145.0045	145.0045	145.0045	145.0045	145.0045	145.0045	145.0045	145.0045	145.0045	145.0045	145.0045	145.0045	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	26.9406	23.9284	19.4599	14.7324	11.0126	9.2973	10.0461	13.0583	17.5268	22.2543	25.9741	27.6894	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	300.1628	303.2775	295.4285	278.7187	257.6257	237.8012	224.5572	221.4425	229.2915	246.0013	267.0943	286.9188	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	37.5005	37.5005	37.5005	37.5005	37.5005	37.5005	37.5005	37.5005	37.5005	37.5005	37.5005	37.5005	(69)
Pumps, fans	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	(70)
Losses e.g. evaporation (negative values) (Table 5)													
	-116.0036	-116.0036	-116.0036	-116.0036	-116.0036	-116.0036	-116.0036	-116.0036	-116.0036	-116.0036	-116.0036	-116.0036	(71)
Water heating gains (Table 5)													
	138.1878	135.8068	130.8623	124.1402	119.7761	113.6310	108.4080	115.1001	117.4779	124.4354	132.2916	135.8167	(72)
Total internal gains													
	534.7926	532.5141	515.2520	487.0927	457.9157	430.2309	412.5126	419.1023	433.7976	462.1923	494.8613	519.9263	(73)

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6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
North	3.4100	10.6334	0.6300	0.7000	0.7700	11.0815	(74)
Northeast	1.2200	11.2829	0.6300	0.7000	0.7700	4.2068	(75)
East	13.7700	19.6403	0.6300	0.7000	0.7700	82.6519	(76)
Southeast	1.2200	36.7938	0.6300	0.7000	0.7700	13.7185	(77)
South	5.6400	46.7521	0.6300	0.7000	0.7700	80.5845	(78)
Northwest	1.2200	11.2829	0.6300	0.7000	0.7700	4.2068	(81)

Solar gains	196.4501	355.3326	533.2007	726.4397	864.2789	877.7697	838.2341	734.0481	600.7852	406.1665	239.2660	165.4507	(83)
Total gains	731.2428	887.8468	1048.4527	1213.5324	1322.1946	1308.0007	1250.7467	1153.1504	1034.5828	868.3588	734.1273	685.3770	(84)

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7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C)												21.0000	(85)
Utilisation factor for gains for living area, nil,m (see Table 9a)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	55.1377	55.2518	55.3641	55.8978	55.9988	56.4738	56.4738	56.5627	56.2899	55.9988	55.7949	55.5832	
alpha	4.6758	4.6835	4.6909	4.7265	4.7333	4.7649	4.7649	4.7708	4.7527	4.7333	4.7197	4.7055	
util living area													
	0.9986	0.9962	0.9884	0.9596	0.8784	0.7202	0.5535	0.6156	0.8585	0.9793	0.9968	0.9989	(86)
MIT	19.5725	19.7529	20.0470	20.4262	20.7471	20.9319	20.9845	20.9749	20.8348	20.4034	19.9144	19.5421	(87)
Th 2	19.8727	19.8748	19.8768	19.8863	19.8880	19.8963	19.8963	19.8979	19.8931	19.8880	19.8845	19.8807	(88)
util rest of house													
	0.9981	0.9948	0.9840	0.9438	0.8313	0.6239	0.4236	0.4831	0.7861	0.9685	0.9954	0.9986	(89)
MIT 2	17.9730	18.2378	18.6666	19.2133	19.6404	19.8513	19.8908	19.8877	19.7594	19.1912	18.4812	17.9341	(90)
Living area fraction									fLA = Living area / (4) =			0.1530	(91)
MIT	18.2177	18.4696	18.8778	19.3988	19.8097	20.0166	20.0581	20.0540	19.9239	19.3767	18.7004	18.1801	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.2177	18.4696	18.8778	19.3988	19.8097	20.0166	20.0581	20.0540	19.9239	19.3767	18.7004	18.1801	(93)

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8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9969	0.9922	0.9785	0.9347	0.8274	0.6354	0.4434	0.5030	0.7885	0.9614	0.9932	0.9977	(94)
Useful gains	728.9519	880.9339	1025.9052	1134.3486	1093.9245	831.0991	554.6015	580.0905	815.8138	834.8316	729.1111	683.7793	(95)
Ext temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	(96)
Heat loss rate W													
	2314.5235	2251.9731	2050.0140	1722.2223	1327.9114	879.4778	561.4794	592.3557	948.6950	1437.1261	1906.4405	2306.2645	(97)

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Month fracti	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000	(97a)
Space heating kWh													
	1179.6653	921.3383	761.9369	423.2691	174.0863	0.0000	0.0000	0.0000	0.0000	448.1071	847.6771	1207.1289	(98)
Space heating												5963.2090	(98)
Space heating per m2											(98) / (4) =	45.1621	(99)

8c. Space cooling requirement

Not applicable

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

Fraction of space heat from secondary/supplementary system (Table 11)												0.0000	(201)
Fraction of space heat from main system(s)												1.0000	(202)
Efficiency of main space heating system 1 (in %)												93.5000	(206)
Efficiency of secondary/supplementary heating system, %												0.0000	(208)
Space heating requirement												6377.7637	(211)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement													
	1179.6653	921.3383	761.9369	423.2691	174.0863	0.0000	0.0000	0.0000	0.0000	448.1071	847.6771	1207.1289	(98)
Space heating efficiency (main heating system 1)													
	93.5000	93.5000	93.5000	93.5000	93.5000	0.0000	0.0000	0.0000	0.0000	93.5000	93.5000	93.5000	(210)
Space heating fuel (main heating system)													
	1261.6741	985.3886	814.9058	452.6942	186.1885	0.0000	0.0000	0.0000	0.0000	479.2589	906.6066	1291.0470	(211)
Water heating requirement													
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(215)
Water heating													
Water heating requirement													
	226.7753	200.0170	210.3836	189.0411	185.5772	166.2843	160.1400	175.1144	174.6144	196.0029	206.6921	221.4697	(64)
Efficiency of water heater												79.8000	(216)
(217)m	88.5848	88.3861	87.9484	86.9025	84.6439	79.8000	79.8000	79.8000	79.8000	86.9522	88.1821	88.6571	(217)
Fuel for water heating, kWh/month													
	255.9980	226.2993	239.2125	217.5323	219.2445	208.3764	200.6767	219.4416	218.8150	225.4146	234.3923	249.8048	(219)
Water heating fuel used												2715.2079	(219)
Annual totals kWh/year													
Space heating fuel - main system												6377.7637	(211)
Space heating fuel - secondary												0.0000	(215)
Electricity for pumps and fans:													
central heating pump												30.0000	(230c)
main heating flue fan												45.0000	(230e)
Total electricity for the above, kWh/year												75.0000	(231)
Electricity for lighting (calculated in Appendix L)												475.7801	(232)
Total delivered energy for all uses												9643.7517	(238)

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

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating - main system 1	6377.7637	0.2160	1377.5970	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	2715.2079	0.2160	586.4849	(264)
Space and water heating			1964.0819	(265)
Pumps and fans	75.0000	0.5190	38.9250	(267)
Energy for lighting	475.7801	0.5190	246.9299	(268)
Total CO2, kg/m2/year			2249.9367	(272)
Emissions per m2 for space and water heating			14.8749	(272a)
Fuel factor (electricity)			1.5500	
Emissions per m2 for lighting			1.8701	(272b)
Emissions per m2 for pumps and fans			0.2948	(272c)
Target Carbon Dioxide Emission Rate (TER) = (14.8749 * 1.55) + 1.8701 + 0.2948, rounded to 2 d.p.			25.2200	(273)