HOARE LEA

4B Hampstead Hill Gardens. Camden, London.

SUSTAINABILITY
ENERGY & SUSTAINABILITY REPORT

REVISION 0 – 19 DECEMBER 2019

Audit Sheet.

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Executive Summary.

This report describes the Energy Strategy and Sustainability Statement for the proposed dwelling at 4b Hampstead Hill Gardens in the London Borough of Camden (LBC). A CGI of the proposed development is shown in Figure 1.

Figure 1 Proposed CGI (Credit GRID Architects)

Energy Targets

The proposed development is a single dwelling of approximately 210 m^2 and therefore not considered a *major development* as detailed in the Camden Local Plan. All development in Camden is expected to reduce carbon dioxide emissions by following the energy hierarchy in accordance with Local Plan policy CC1.

A summary of the key energy requirements for the Proposed Development are:

1. The Council will require all development to minimise the effects of climate change and encourage all developments to meet the highest feasible environmental standards that are financially viable during construction and occupation.
2. All new residential development is required to demonstrate a 19% CO_2 reduction below Part L 2013 Building Regulations.

Energy Strategy

The Energy Strategy will seek to achieve targets on site where feasible and will follow the Energy Hierarchy of Be Lean, Be Clean and Be Green to reduce the carbon dioxide emissions of the entire development. The regulated CO_2 emission reduction will be reported using the SAP 10 Carbon Factors, to represent the grid decarbonisation.

Be Lean: Passive Design and Energy Efficiency

As part of the Be Lean strategy, a range of passive and active energy efficiency measures are to be employed within the development.

The investigation into passive design addressed the issue of limiting the effects of heat gains in summer, associated cooling demand alongside the carbon emission targets.

Be Clean: Decentralised Energy

The first part of the Be Clean strategy is to establish if an area or local District Heating Network (DHN) can be used to serve the development with low carbon heating. Initial investigations have shown there are no existing or proposed DHN in proximity of the site.

Be Green: Low and Zero Carbon Technologies

Roof-mounted solar photovoltaic (PV) will be included in order to maximise the energy generation on site.

Results

The overall predicted reduction in CO_2 emissions from the Baseline development model (which is Part L1A 2013 compliant) is approximately 42%, which represents an annual saving of approximately 2 tonnes of CO_2.

Figure 2 below sets out the Proposed Development reduction in CO_2 emissions in line with the Energy Hierarchy.

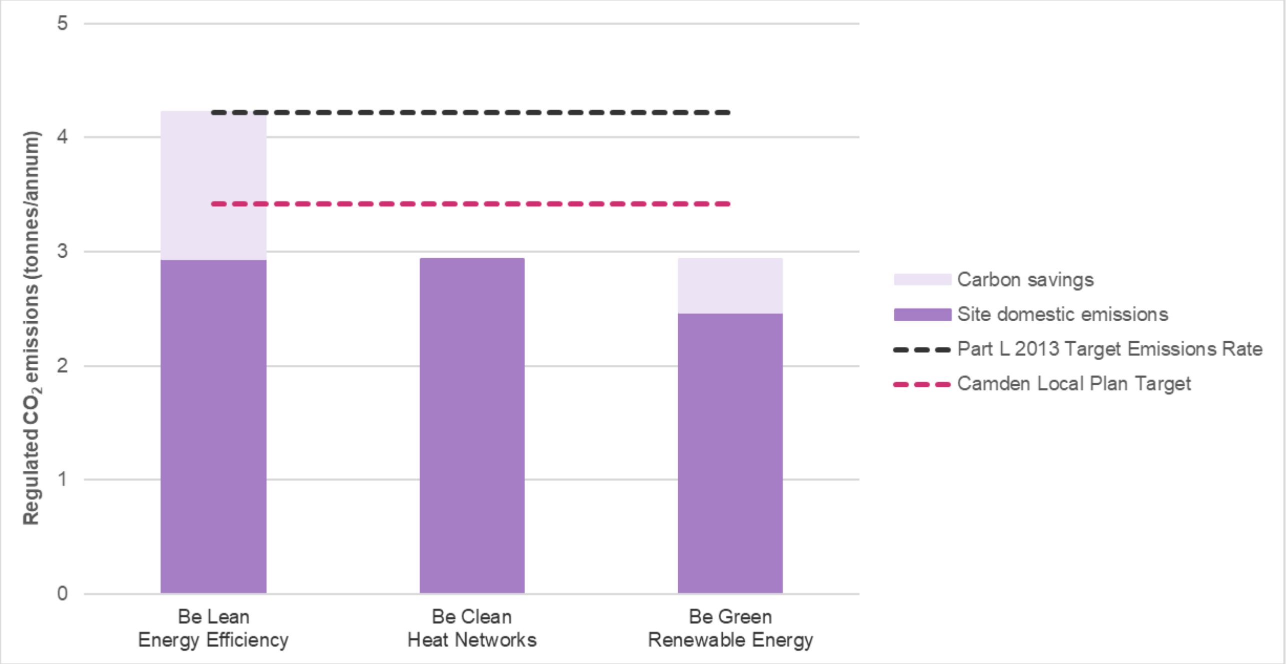


Figure 2 Proposed Development Energy Hierarchy

Sustainability

The wider sustainability measures include the following:

- The contractors will be selected with consideration of their ability to comply with the Considerate Constructors Scheme;
- Internal and external lighting will be designed to promote a healthy, and safe internal and external environment;
- Energy efficient light fittings will be installed for all external areas of the development. In addition, they will be automatically controlled for the prevention of operation during daylight hours;
- The proposed development will reduce potable water consumption through the specification of efficient sanitary ware; and
- Materials with a low environmental impact will be implemented where feasible.

1. Introduction.

1.1 The Site

The proposed development consists of the redevelopment of 1 new dwelling in Hampstead Hill Gardens, Camden. Hereafter referred to as the Proposed Development.

The site location (red line) is shown in Figure 3.

Figure 3: Site Plan (Credit: GRID Architects).

1.2 Energy Hierarchy

The energy assessment for the Proposed Development has taken a three-step approach to reducing the building's carbon dioxide emissions:

Be Lean	Reduce the building's energy requirements by incorporating passive design measures and reduce the building's energy consumption through the use of energy efficient mechanical and electrical engineering systems.
Be Clean	Reduce the building's carbon dioxide emissions by supplying energy more efficiently
Be Green	Reduce the building's carbon dioxide emissions through the use of renewable technologies.

The energy assessment comprised the following stages:

- Estimating a target for total regulated and unregulated annual energy consumption and CO_2 emissions of the Proposed Development. The estimates are based primarily on Part L approved software modelling results.
- Estimating savings in regulated annual energy consumption and CO_2 emissions of the Proposed Development through the incorporation of passive and active energy efficiency measures. The estimates are based primarily on Part L approved software modelling results.
- Estimating the potential contribution to carbon dioxide reductions that could be achieved by the use of energy networks.
- Estimating the potential contribution to carbon dioxide reductions that could be achieved by the use of renewable technologies.

1.3 Establishing CO_2 Emissions

The total regulated carbon emissions at each stage of the energy hierarchy and the percentage savings in regulated emissions over Part L 2013 of the Building Regulations compliant development will be calculated for the Proposed Development.

The first step of this assessment is to establish the regulated CO_2 emissions assuming the development complied with Part L1A 2013 of the Building Regulations using Building Regulations approved compliance software. Elmhurst Design SAP 2012 was used to assess these domestic areas.

The TER outputs from this assessment were then used to calculate the baseline carbon dioxide emissions, these can be located in Appendix A.

1.4 SAP 10 Carbon Emission Factors

In July of 2018, the BRE released an update to the Standard Assessment Procedure (SAP) – used to assess dwellings' compliance with Building Regulations – for consultation. This SAP 10 update incorporated amended carbon emission factors to reflect the decarbonisation of the grid and other national infrastructure changes.

The next update to Building Regulations Part L (likely to be adopted in 2020) will specify a completed update to the SAP methodology alongside the carbon factors associated with natural gas and electricity.

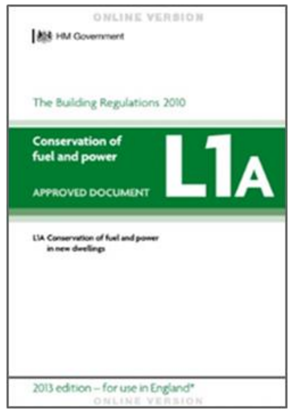
For the purpose of this energy strategy, the updated SAP 10 carbon factors have been used in order to quantify the carbon emission targets. As previously discussed, these carbon factors are a closer representation of the current carbon intensity of the electricity grid and therefore are more appropriate than the Part L 2013 carbon factors for estimating potential carbon emission savings.

2. Policy Requirements & Building Regulations.

Drivers of the energy and sustainability targets for the Proposed Development include national legislations, local planning policies and client aspirations. This section of the report outlines the energy and carbon emissions related targets for the project and identifies the design approach taken to achieve them.

2.1 Building Regulations

Part L Conservation of Fuel and Power deals with energy efficiency requirements in the Building Regulations. New domestic buildings are assessed under Approved Document Part L1A of the Building Regulations.

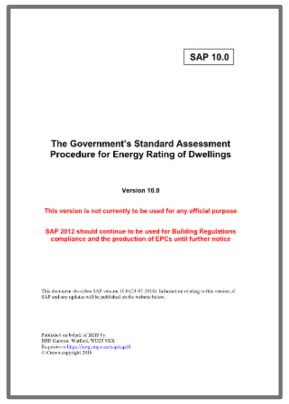


Part L1A 2013 of the Building Regulations

On a national level, Part L1A of the Building Regulations sets the energy efficiency requirements in new domestic buildings.

Under Building Regulations Approved Document Part L1A, compliance is achieved by demonstrating that the Dwelling Emission Rate (DER) does not exceed the Target Emission Rate (TER) and that the Dwelling Fabric Efficiency (DFEE) does not exceed the Target Fabric Efficiency (TFEE).

In addition, Part L1A also requires that the fabric elements and the fixed building services all meet minimum energy efficiency standards (Criterion 2), and reasonable provision for limiting solar gain through the building fabric (Criterion 3).

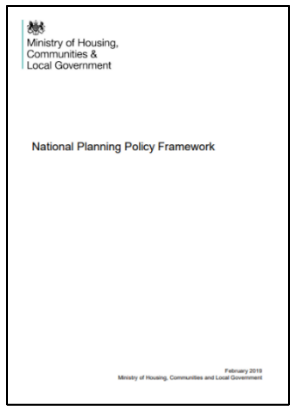


SAP 10.0

The Government's Standard Assessment Procedure for Energy Rating of Dwellings Version 10.0 was released for information in July 2018. It is not currently to be used for any official purpose. However, some Local Authorities have already adopted elements of the methodology prior to it being introduced in the next version of Part L.

The carbon factors have been updated to reflect the current decarbonisation of the grid.

2.2 National Planning Guidance



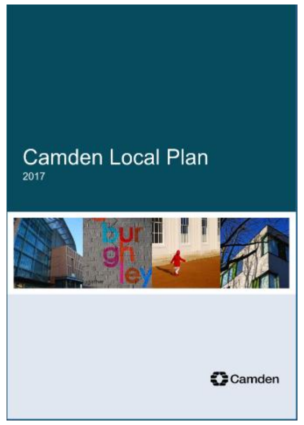
The National Planning Policy Framework, February 2019

The National Planning Policy Framework (NPPF) was published in July 2018 and updated in February 2019. The NPPF sets out the Government's strategy on the delivery of sustainable development through the planning system. It provides a framework within which locally-prepared plans for housing and other development can be produced.

Planning law requires that applications for planning permission be determined in accordance with the development plan, unless material considerations indicate otherwise. The NPPF must be considered in preparing the development plan and is a material consideration in planning decisions. Planning policies and decisions must also reflect relevant international obligations and statutory requirements. The purpose of the planning system is to contribute to the achievement of sustainable development.

At a very high level, the objective of sustainable development can be summarised as meeting the needs of the present without compromising the ability of future generations to meet their own needs.

2.3 Local Planning Guidance



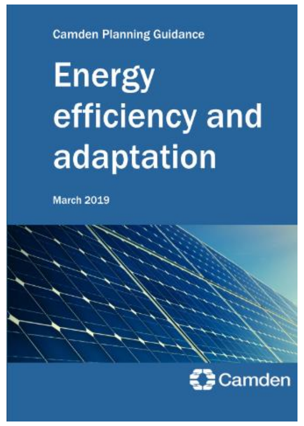
Camden Local Plan, 2017

The Local Plan ensures that Camden continues to have robust, effective and up-to-date planning policies that respond to changing circumstances and the borough's unique characteristics and contribute to delivering the Camden Plan and other local priorities. The Local Plan will cover the period from 2016-2031.

Green Action for Change: Camden's environmental sustainability plan (2011-2020) commits Camden to a 27% borough wide Carbon Dioxide (CO_2) reduction by 2017 and a 40% borough wide CO_2 reduction by 2020 (London carbon reduction target). Over 90% of Camden's carbon dioxide emissions are produced by the operation of buildings.

The following policies have been identified as being appropriate to the development:

- Policy CC1 Climate change mitigation
- Policy CC2 Adapting to climate change
- Policy CC3 Water and flooding
- Policy CC5 Waste
- Policy A3 Biodiversity



Camden Planning Advice (CPA) – Energy Efficiency and Adaption (March 2019)

The Council has prepared this Camden Planning Guidance (CPG) on Energy and resources to support the policies in the Camden Local Plan 2017. This guidance is therefore consistent with the Local Plan and forms a Supplementary Planning Document (SPD) which is an additional "material consideration" in planning decisions.

The following key messages appropriate to the development are highlighted below:

- All development in Camden is expected to reduce carbon dioxide emissions by following the energy hierarchy in accordance with Local Plan policy CC1.
- Energy strategies are to be designed following the steps set out in the energy hierarchy.
- Natural 'passive' measures should be prioritised over active measures to reduce energy.
- There are a variety of renewable energy technologies that can be installed to supplement a development's energy needs.
- All development in Camden is expected to reduce carbon dioxide emissions through the application of the energy hierarchy.
- All new build residential development (of 1 – 9 dwellings) must meet 19% carbon dioxide reduction;
- Proposals for substantial demolition should be justified in terms of the optimisation of resources and energy use, in comparison with the existing building.
- Where demolition cannot be avoided, developments are expected to divert 85% of waste from landfill (see paragraph 8.17 Local Plan).
- Development is expected to reduce overheating risk through following the steps in the cooling hierarchy. All new development should submit a statement demonstrating how the cooling hierarchy has been followed (Local Plan policy CC2).
- All developments should seek opportunities to make a positive contribution to green space provision or greening.

3. Demand Reduction (Be Lean).

A key principle of the design of this development is to provide environments that need minimal intervention of engineering systems to create comfortable spaces. All buildings should maximise the use of energy efficiently and to adopt energy conservation measures in the design, layout and orientation to reduce the overall energy demand.

To be succinct with the above, this energy strategy has considered passive design and energy efficient solutions at the forefront of the design. The Proposed Development is seeking to maximise the potential of the measures by the strategy outlined in the following sections.

3.1 Passive Measures

Passive design and energy efficiency measures form the basis for the reduction in overall energy demand and carbon emissions for the proposed development. This energy strategy aims to reduce the energy demand initially by optimising the envelope and building services within the development.

3.2 Opaque Construction

The proposal is to maximise insulation on the external walls, resulting in good U-Values. Table 1 below details the U-value/construction types used within the model for the opaque constructions.

Table 1 Opaque Construction and U-values

	Exposed Floor (W/m^2K)	Exposed Roof (W/m^2K)	External Wall (W/m^2K)	Walls to Unheated Spaces (W/m^2K)	Walls to Heated Spaces
Domestic	0.13	0.13	0.15	0.15	N/A

3.2.1 Glazing Specification

Investigations have been carried out to understand the optimum glazing specification to balance the requirements of Criterion 1 & 2 of Part L, alongside Criterion 3 (Solar Gains) and daylighting requirements.

Table 2 below details the glazing parameters used within the model for all glazing constructions.

Table 2 Glazing Specification

	U-Value (W/m^2K)	G-Value	Fraction Glazed	Frame Factor	Light Transmittance
Domestic	1.10	0.42	80%	20%	70

3.2.2 Thermal Mass Parameter

A low/medium thermal mass parameter has been assumed based on the proposed construction details.

3.2.3 Air Permeability

An air permeability of 3 m^3/hm^2 (@ 50Pa) has been assumed for the development.

3.3 Active Measures

The energy consumption of the development could be further reduced by the incorporation of active energy efficiency measures in the design of the mechanical and electrical engineering systems. The following energy efficiency measures will be considered for this development:

- Windows carefully designed to balance daylight, heat loss and heat gain;
- Efficient ventilation system with heat recovery; and
- Low energy lighting throughout.

3.4 Be Lean Results

The dwelling assessed to gain SAP results were taken from pre-planning issue drawings.

With the inclusion of all feasible passive and active design measures as detailed in Section 2 of the report Figure 4 below shows that the domestic regulated carbon dioxide emissions of the Energy Efficient Scheme are approximately 30% below that of the Baseline Scheme.

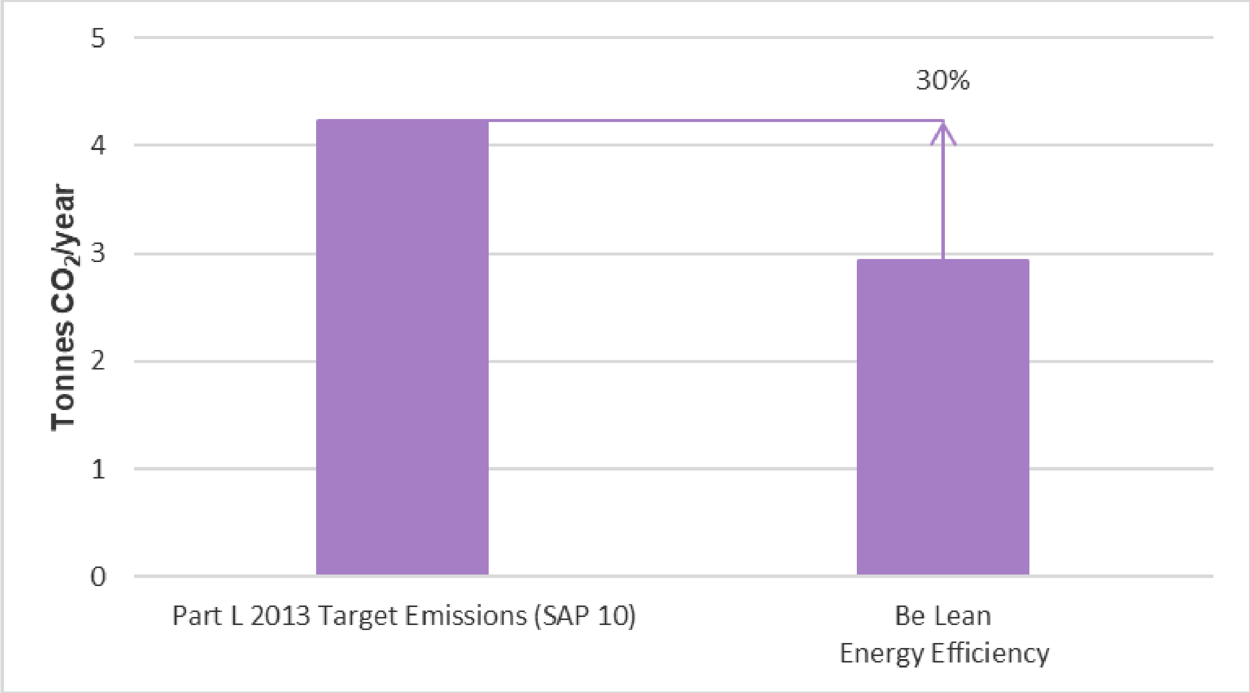


Figure 4 Site Wide Carbon Dioxide Emissions - Be Lean

3.5 Cooling and Overheating

Policy CC1 states that major development proposals should reduce potential overheating and reliance on air conditioning systems and demonstrate this in accordance with the cooling hierarchy. This policy seeks to reduce the impact of the urban heat island effect.

Below are the steps of the hierarchy and the proposals to demonstrate compliance:

1. Minimise internal heat generation through energy efficient design.
   - Heat generation will be minimised through the specification of an energy efficient ventilation system, insulation on pipework and low energy lighting.
2. Reduce the amount of heat entering a building in summer through orientation, shading, fenestration, albedo and insulation.
   - The amount of heat entering the building will be reduced by:
     - Energy efficient facades with appropriate proportions of glazing; and
     - A glazing shading coefficient carefully selected to minimise solar gain in the summer, but also to maximise solar gain in winter.
3. Manage the heat within the building through exposed internal thermal mass and high ceilings.
   - Due to the residential nature of the development there is a need to conceal services, which reduces the possibility of incorporating exposed internal thermal mass.

- Ceiling heights in the development have been maximised within the constraints of the overall building height and massing.

4. Passive Ventilation
   - Passive Ventilation (openable windows) has been incorporated within the development. In addition, ventilation will be provided through infiltration.
5. Mechanical Ventilation
   - Background ventilation will be provided by Mechanical Ventilation with Heat Recovery (MVHR). This unit will incorporate a summer by-pass, which will allow the unit to supply fresh air without heat being transferred from the extract air into the supply air.
6. Active Cooling Systems
   - There is no comfort cooling proposed for the development

The dwelling has been designed to minimise internal gains as much as possible within the constraints of the overall architectural design. This includes optimised glazing to limit solar gain without a detrimental effect on beneficial solar gains for heating and the natural daylighting into the dwelling.

The lighting will be low energy fittings that minimise heat omitted to the space. All heating & domestic hot water pipework will be thermally insulated to best practice standards to limit heat given off to the space. Mechanical Ventilation with Heat Recovery systems will be provided incorporating a summer by-pass to allow the utilisation of the ventilation or summer time purge of the space.

4. Heating Infrastructure (Be Clean).

Be Clean measures are those which serve to reduce the overall emissions of the development by supplying energy efficiently.

This section addresses the requirements of London Plan policies 5.5 and 5.6.

4.1 Area Wide Heat Networks

The first step in selecting energy systems according to London Plan Policy 5.6 is to consider a connection to an existing heating and cooling network.

An investigation has been carried out to determine if there are any area wide heat networks currently existing in the area or if any are planned in the future. The London Heat Map for the area, shown in Figure 5 reveals that there is no existing or potential area wide heat networks in the vicinity of the proposed development site. As a result, it has been assumed that no connection is possible

The London Heat Map has identified that the proposed development is not located within an area that has the potential for decentralised energy.

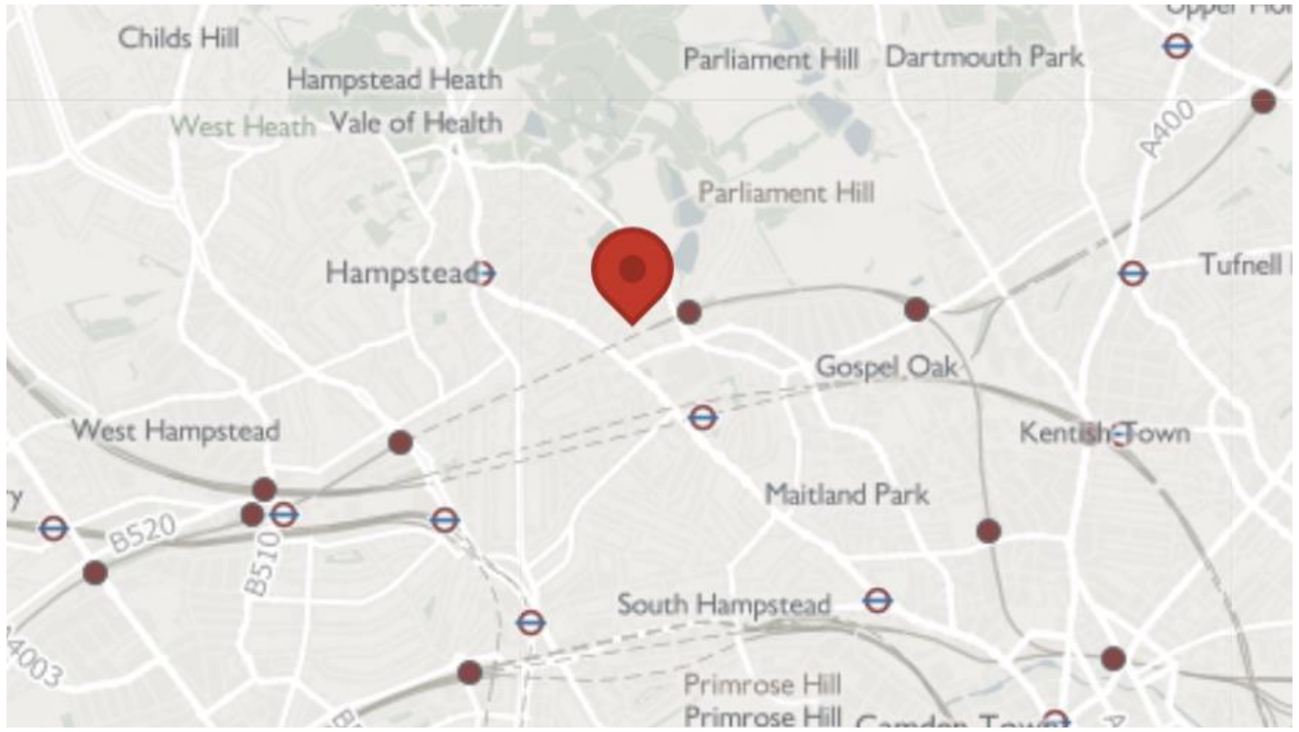


Figure 5 London Heat Map (Existing and Potential DH Networks)

4.2 Site Wide Heat Networks

Due to the development consisting of a single dwelling a central energy centre is not appropriate and therefore no site wide heat network can be established.

With the recognition that the generation of electricity is a much cleaner fuel now than it used to be due to the decarbonisation of the grid, along with the reduction of the electricity carbon factors, it is intended that the heating and hot water for the scheme will be provided by direct electric.

4.3 Be Clean Results

As detailed in Section 3 of the report there are no further measures that have been identified at the Be Clean stage, therefore Figure 6 shows the domestic regulated carbon dioxide emissions at the Be Clean stage remains the same as the Be Lean scheme, 30% below the baseline scheme.

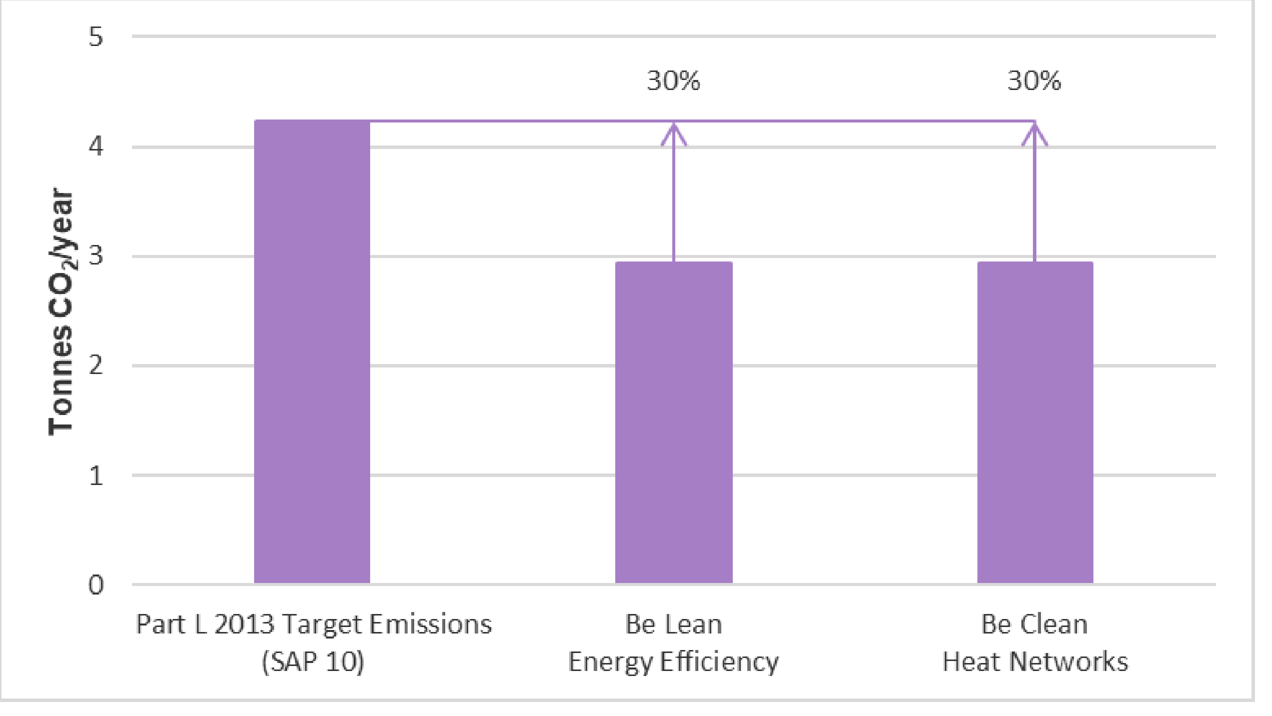


Figure 6 Site Wide Carbon Dioxide Emissions – Be Clean

5. Renewable Energy (Be Green).

Be Green measures are those which serve to reduce the overall emissions of the development through the inclusion of renewable technologies.

The Be Green DER Worksheet is located in Appendix B.

Another key principle of the design of this development is to maximise the carbon reduction over the long-term life of the building. The most effective way to achieve this is through renewable technologies. These measures are those which serve to reduce the overall emissions of the development through the inclusion of these renewable technologies such as Solar Photovoltaic array (PV panels), Ground Source Heat Pump (GSHP), besides others.

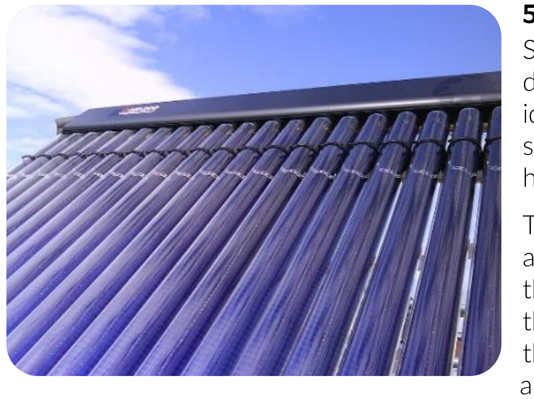
A number of renewable technologies have been appraised in terms of technical and physical feasibility as potential renewable systems for use on the project.

5.1 Solar Photovoltaics

Solar photovoltaic (PV) cells generate electricity from the sun's energy. Solid PV panels can be either roof or façade mounted (although solar modules fitted on a south facing façade have only 75% the output of roof mounted modules).

Solar PV can be seen as an on-site zero carbon energy source as it will produce useable electrical energy without requiring any energy input. Although the output from the panels is unpredictable and weather dependent, the electrical energy produced by Solar PV panels could be used to provide additional carbon emission reductions and are compatible with the use of other energy generating technologies. Once installed they are very low maintenance and will also have a low visual impact at street level. In addition, this development has suitable south facing roof space available.

Taking the above into account, solar PV is considered an appropriate technology for this development and will be adopted into the site.

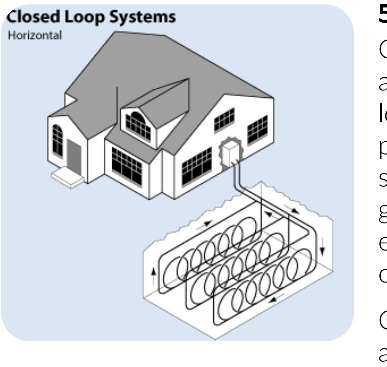


5.2 Solar Water Heating Panels

Solar water heating systems use heat from the sun to heat domestic hot water. The system requires solar panels on the roof, ideally south facing, linked to hot water storage cylinders. For solar water panels to be effective the development should have a high hot water demand.

This development has suitable south facing roof space available and has a high hot water demand due to the residential nature of the development, which initially makes this technology suitable for this development. However the panels have a higher maintenance than PV and they are highly dependent on the weather/season, arguably more so than photovoltaics, leading to unpredictability with the hot water load. In addition, the heat gained from the panels cannot be sold back to the grid and so if the hot water is not used once it has been produced it will eventually be wasted.

Due to the reasons highlighted above, solar water heating panels are therefore not proposed for this development.



5.3 Ground Source Heat Pumps

Ground source heat pumps (GSHP) utilise either water extracted from an aquifer (open loop) or water circulated within underground pipework (closed loop) as the heat source in a refrigeration process. This enables them to produce hot water, typically at around 45°C that can be used as means of space heating in buildings. Due to the relatively constant temperature of the ground at depth (typically 10-14°C in the UK) this produces heat more efficiently in winter than an air source heat pump, and usually with lower carbon emissions than a gas-fired boiler.

Open loop systems require the water extracted to be re-injected into the aquifer at another borehole on another part of the site. A licence from the Environment Agency (EA) is required for both abstraction and discharge although these licences cannot be obtained until a test borehole has been constructed and the appropriate EA tests undertaken.

The high capital cost and the configuration of the site makes the use of GSHPs unsuitable due to the relatively small area available for ground coupling. GSHP is therefore not proposed for the development.

5.4 Biomass Boilers

A biomass boiler uses a natural fuel such as wood chips or wood pellets for combustion. Since it uses a natural resource that can be replanted it is considered as a renewable energy source subject to the distance the fuel is transported. The carbon dioxide emitted from burning biomass is balanced by that absorbed during the fuel's production. Biomass heating therefore approaches a carbon neutral process.

The primary disadvantage of a biomass boiler is that it would require a substantial amount of fuel storage for a development of this size, which would make for an inefficient use of space. Further to this, regular deliveries are required to ensure the boiler works as efficiently and continuously as possible and biomass exhaust gases would require significant treatment to avoid degrading local air quality. In addition, the nature of the fuel within the boiler would require regular cleaning which would increase the downtime of the boiler, whilst also effecting air quality through the emissions.

Due to the reasons highlighted above, biomass boilers are therefore not proposed for the development.

5.5 Wind Turbines

Wind turbines use the wind's lift forces to turn aerodynamic blades that turn a rotor thus generating electricity. There are three basic types to consider: horizontal axis (propeller type), vertical access (helical type) and building integrated (where the building design is adapted to suit the wind turbine).

Wind turbines have a significant visual impact and the roof space will be sensitive in townscape terms, which is likely to preclude wind turbines. They can create noise and vibration problems. Additionally, there is limited roof area across the site where clean air flows and good wind speeds can be realised and which are vital to delivering a useful electrical output. Even if a suitable location could be found, the output of a wind turbine and the consequential carbon dioxide emissions will be very limited when compared to the emissions of the whole development.

Due to the reasons highlighted above, wind turbines are therefore not proposed for the development.

5.6 Air Source Heat Pumps

Air Source Heat Pumps (ASHP) employ the same technology as Ground Source Heat Pumps (GSHP). However, instead of using heat exchangers buried in the ground, heat is extracted from the external ambient air.

The efficiency of heat pumps is very much dependent on the temperature difference between the heat source and the space required to be heated. As a result, ASHPs tend to have a lower Coefficient of Performance (COP) than GSHP. This is due to the varying levels of air temperature throughout the year when compared to the relatively stable ground temperature. The lower the difference between internal and external air temperature, the more efficient the system. The use of ASHPs will also impact on rights of light and outside space for the occupant, whilst also being a source of noise to local residents.

Taking the above into account, ASHP is not considered an appropriate technology for this development.

5.7 Be Green Results

With the inclusion of the contribution of the PV Array, Figure 7 below shows the estimated reduction in domestic regulated carbon dioxide emissions is 42% below the baseline scheme.

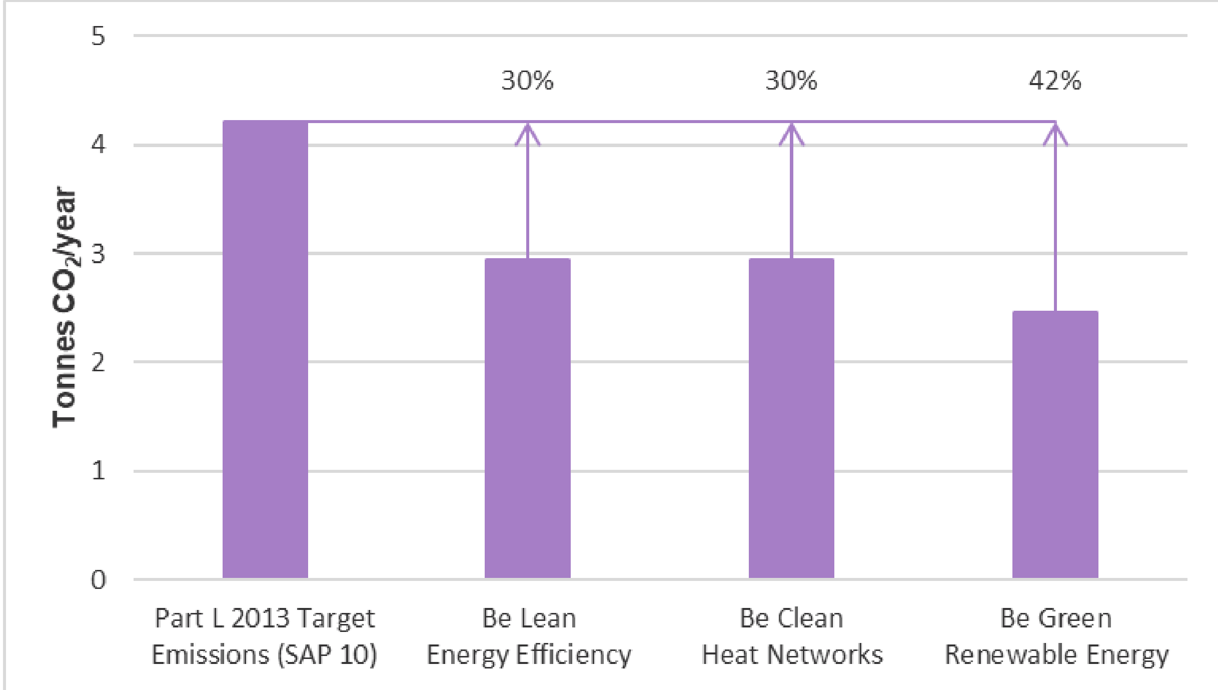


Figure 7 Site Wide Carbon Dioxide Emissions - Be Green

6. Sustainability.

Sustainability has been a key design consideration for this development from the outset of the project. Consideration has been given to the impact of the design proposals and measures with regard to the sustainable credentials of the development throughout the design development to date and will continue throughout the design and construction process going forwards.

The following is a summary of the key sustainability issues for the overall strategy for the project.

6.1 Management

To encourage an integrated design process, the project delivery stakeholders will identify and define roles, responsibilities for each of the key phases of project delivery.

To ensure that the construction site is managed in an environmentally and socially considerate, responsible and accountable manner, the contractor will be selected with consideration of their ability to comply with the Considerate Constructors Scheme.

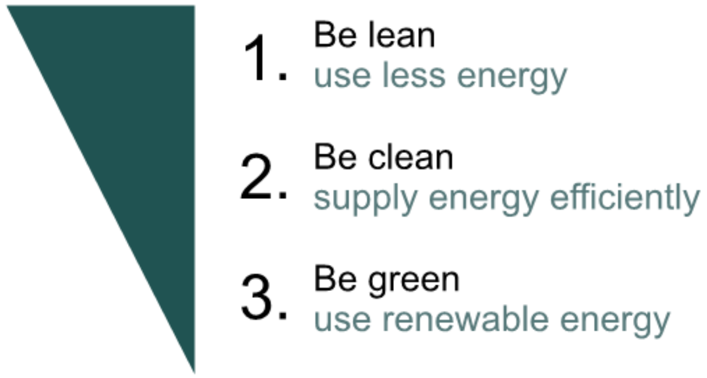
6.2 Health and Wellbeing

The development will be designed to encourage a healthy and safe internal and external environment.

All external lighting will be photocell and time controlled. Luminaires will be carefully selected to limit night sky pollution.

6.3 Energy

An overall carbon reduction of 42% over Part L 2013 has been targeted. This reduction in carbon dioxide emissions will be achieved through the incorporation of passive and active energy efficiency measures and the inclusion of a PV Array.



Please refer to Sections 2-5 for further details on the performance.

Energy efficient light fittings will be installed for all external areas of the development.

Heat recovery will be incorporated into the mechanical ventilation reducing the overall energy demand.

6.4 Transport

The application site is located at 4b Hampstead Hill Gardens, which is to the north of the London Borough of Camden (LBC), within the Hampstead Town Ward of the Borough.

Hampstead Hill Gardens forms a loop between Pond Street and Rosslyn Hill and is within a few minutes' walk of Hampstead Heath, Hampstead Heath Railway Station, Hampstead Village, Belsize Park Underground and Hampstead Underground.

Figure 8 below demonstrates that the PTAL rating for the site is 4.

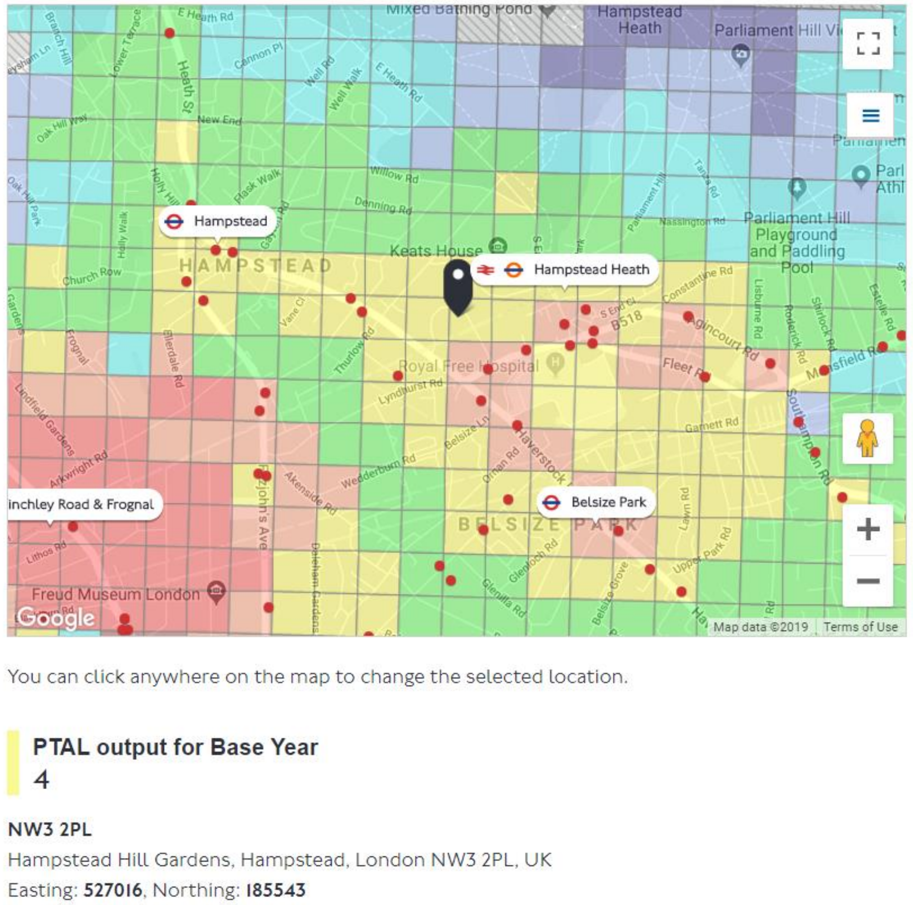


Figure 8 PTAL Image

Cycle storage is housed in a secure enclosure against the existing boundary wall to 4b.

6.5 Water

Reducing the consumption of potable water will be a significant consideration in the design process. Water use will be reduced as much as possible mainly through the specification of efficient sanitary ware.

The dwelling will be designed to comply with the requirements of Building Regulations Part G.

A water meter will be specified on the mains water supply to the building, ensuring that water consumption can be monitored and managed and therefore encourage reductions.

6.6 Materials

Materials with low environmental impact will be implemented were feasible. Recycled, sustainable and locally sourced materials will be used where possible.

Thermal insulation used in the building fabric and services will be selected with consideration of their embodied environmental impact relative to its thermal properties.

6.7 Waste

Storage facilities for waste and recycling will be provided in accordance with, as a minimum, BS5906.

The refuse and recyclable storage will be located on hard, level surface and easily accessible to all users.

In line with the Local Plan requirements, the development will divert a minimum of 85% of waste from landfill.

6.8 Land Use and Ecology

At least 75% of the proposed development's footprint is on an area of land which has previously been occupied by an existing building.

6.9 Pollution

The site is located in Flood Zone 1 as demonstrated in Figure 9 below and will not lead to an increase in surface water run-off; this principle will be followed as far as possible within the drainage design.

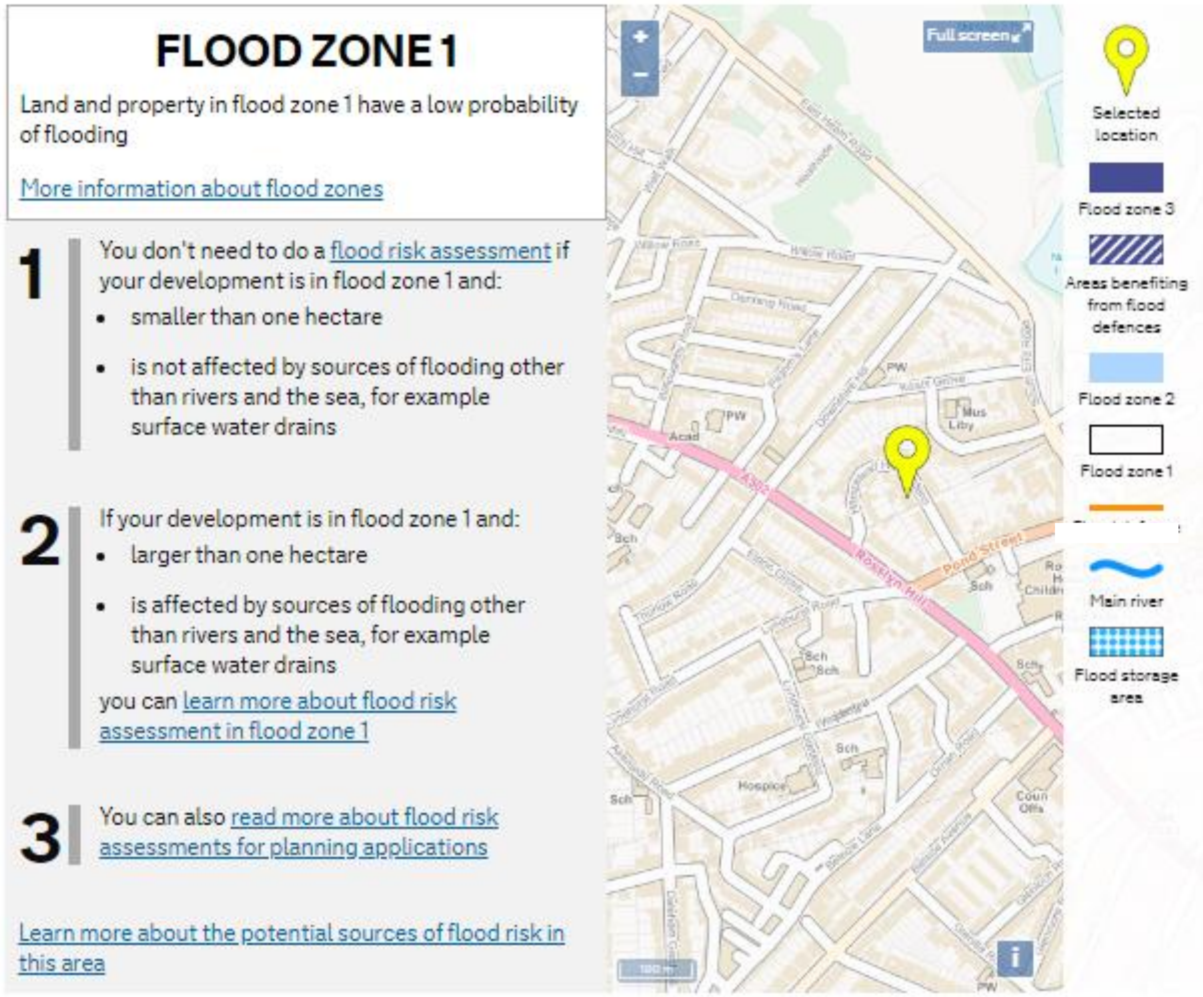


Figure 9 Flood Zone Map

Permeable paving has been adopted into design for the hard-landscaping at the front of the property to assist with reducing surface water run-off, compared with the existing development.

External lighting will be designed to ensure upward lighting is minimised, reducing unnecessary light pollution, energy consumption and nuisance to neighbouring properties.

7. Conclusion.

An energy assessment has been undertaken in line with LBC guidance to address the Camden Local Plan.

A range of passive and active energy efficiency measures will be employed on the Proposed Development.

Considering there is no opportunity for connection to a local DHN, provision of standalone heating plant to supply all the heat requirements of the development will be proposed.

For the Be Green stage a number of renewable technologies were appraised in terms of their technical, physical and financial feasibility, as potential renewable systems for use on the project. The technology which best suited the Proposed Development is Photovoltaics (PV).

7.1 Carbon Reduction

The requirement of Camden's Local Plan (Policy CC1) is 19% below Part L 2013

The CO_2 emissions after the incorporation of the passive and active energy efficiency measures (Be Lean) are 30% lower than a Part L1A compliant development.

No Be Clean measures have been identified for inclusion in the development and therefore there is no further carbon reduction at this stage.

Be Green measures include a PV Array. This renewable technology is delivering an additional 12% reduction over the Be Lean case.

The reduction in CO_2 emissions from the Baseline development model (which is Part L1A 2013 compliant) is approximately 42% which represents an annual saving of approximately 2 tonnes of CO_2.

Figure 10 below sets out how the proposed domestic energy efficiency measures and LZC systems reduce CO_2 emissions in line with the CPA Guidance.

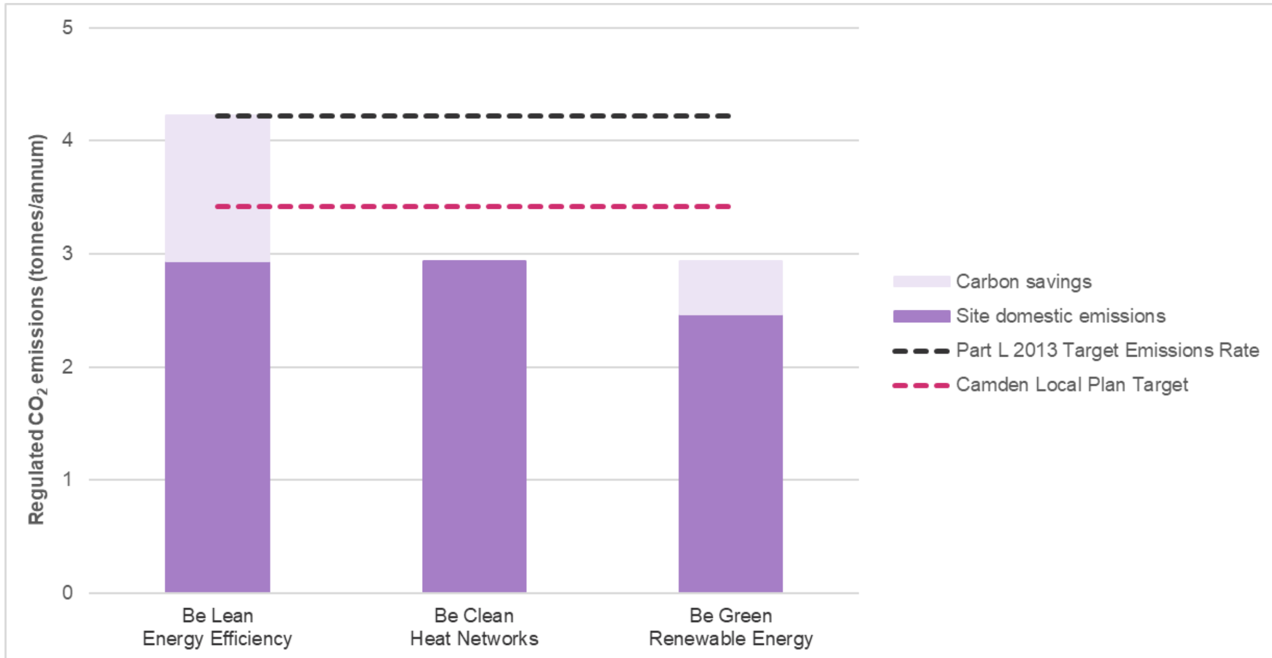


Figure 10 The Energy Hierarchy and targets

Table 3 below shows the CO_2 emissions breakdown and Table 4 shows the percentage breakdown at each stage of the hierarchy.

Table 3 CO_2 Emissions Breakdown

	Carbon Dioxide Emissions (tonnes CO_2 per annum)	
	Regulated	Unregulated
Baseline: Part L1A 2013 Compliant Development	4	1
After energy demand reduction (Be Lean)	3	1
After heat network (Be Clean)	3	1
After renewable energy (Be Green)	2	1

Table 4 CO_2 Emissions Savings

	Regulated Carbon Dioxide Savings	
	(Tonnes CO_2 per annum)	(%)
Savings from energy demand reduction	1	30%
Savings from heat network	0	0%
Savings from renewable energy	1	12%
Cumulative on-site savings	2	42%

7.2 Sustainability

The sustainability measures include the following:

- The project design team will identify and define roles, responsibilities of each of the key phases of project delivery;
- The contractors will be selected with consideration of their ability to comply with the Considerate Constructors Scheme;
- Internal and external lighting will be designed to promote a healthy, and safe internal and external environment;
- Energy efficient light fittings will be installed for all external areas of the development. In addition, they will be automatically controlled for the prevention of operation during daylight hours;
- The proposed development will reduce potable water consumption through the specification of efficient sanitary ware;
- Materials with a low environmental impact will be implemented where feasible; and
- External lighting will be designed to reduce night time light pollution.

Appendix A: Be Lean TER & DER SAP Worksheet.

Property Reference	4B HH	**Issued on Date**	18/12/2019
Assessment Reference	V01	**Prop Type Ref**	01
Property			

SAP Rating	65 D	**DER**	31.62	**TER**	21.91
Environmental	68 D	**% DER<TER**	-44.29		
CO_2 Emissions (t/year)	5.32	**DFEE**	56.65	**TFEE**	56.34
General Requirements Compliance	Fail	**% DFEE<TFEE**	-0.56		

Assessor Details	Mr. Liam Holden, Liam Holden, Tel: 01202 654600, liamholden@hoarelea.com	**Assessor ID**	P624-0001
Client			

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

Design SAP
elmhurst energy

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

Semi-Detached House, total floor area 207 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) 21.91 kgCO□/m²
Dwelling Carbon Dioxide Emission Rate (DER) 31.62 kgCO□/m²Fail
Excess emissions =9.71 kgCO□/m²  (44.3%)
-----------------------------------------------------------------------------------------------------
1b TFEE and DFEE
Target Fabric Energy Efficiency (TFEE)56.3 kWh/m²/yr
Dwelling Fabric Energy Efficiency (DFEE)56.7 kWh/m²/yrFail
Excess energy =0.4 kWh/m²/yr  (0.7%)
-----------------------------------------------------------------------------------------------------
2 Fabric U-values
Element         Average                 Highest
External wall   0.15 (max. 0.30)        0.15 (max. 0.70)          OK
Party wall      0.00 (max. 0.20)         -                        OK
Floor           0.13 (max. 0.25)        0.13 (max. 0.70)          OK
Roof            0.13 (max. 0.20)        0.13 (max. 0.35)          OK
Openings and
curtain wall    0.92 (max. 2.00)        2.00 (max. 3.30)          OK
-----------------------------------------------------------------------------------------------------
2a Thermal bridging
Thermal bridging calculated using default y-value of 0.15
-----------------------------------------------------------------------------------------------------
3 Air permeability
Air permeability at 50 pascals:         3.00 (design value)
Maximum                                 10.0                                                OK
-----------------------------------------------------------------------------------------------------
4 Heating efficiency
Main heating system:                    Electric underfloor heating - Electric
Underfloor heating in thin screed (standard tariff)



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:             No primary pipework
-----------------------------------------------------------------------------------------------------
6 Controls
Space heating controls:                 Time and temperature zone control                   OK


Hot water controls:                     Cylinderstat                                        OK


-----------------------------------------------------------------------------------------------------
7 Low energy lights
Percentage of fixed lights with low-energy fittings:100%
Minimum                                 75%                                                 OK
-----------------------------------------------------------------------------------------------------
8 Mechanical ventilation
Continuous supply and extract system
Specific fan power:                     0.66
Maximum                                 1.5                                                 OK
MVHR efficiency:                        93%
Minimum:                                70%                                                 OK
-----------------------------------------------------------------------------------------------------
9 Summertime temperature
Overheating risk (Thames Valley):       Not significant                                     OK
Based on:
Overshading:                            Average
Windows facing South East:              14.86 m², No overhang
Windows facing South West:              2.13 m², No overhang
Windows facing North West:              11.60 m², Overhang width less than twice window, ratio 0.70
Air change rate:                        8.00 ach
Blinds/curtains:                        Dark-coloured curtain or roller blind, closed 100% of daylight hours
-----------------------------------------------------------------------------------------------------
10 Key features
Party wall U-value                      0.00 W/m²K
Party wall U-value                      0.00 W/m²K
Window U-value                          1.10 W/m²K
Roof window U-value                     1.10 W/m²K
Air permeability                        3.0 m³/m²h



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----------------------------------------------------------------------------------------------------
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          Storey height          Volume
                                                                   (m2)              (m)                 (m3)
Ground floor                                                 52.9900 (1b)    x     2.5300 (2b)    =    134.0647 (1b) - (3b)
First floor                                                  52.5400 (1c)    x     2.6500 (2c)    =    139.2310 (1c) - (3c)
Second floor                                                 55.5900 (1d)    x     2.5000 (2d)    =    138.9750 (1d) - (3d)
Third floor                                                  45.9300 (1e)    x     2.5900 (2e)    =    118.9587 (1e) - (3e)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)        207.0500                                          (4)
Dwelling volume                                                     (3a)+(3b)+(3c)+(3d)+(3e)...(3n) =    531.2294 (5)



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

                                                                                          Air changes per hour
Infiltration due to chimneys, flues and fans   = (6a)+(6b)+(7a)+(7b)+(7c) =          0.0000 / (5) =     0.0000 (8)
Pressure test                                                                                               Yes
Measured/design AP50                                                                                     3.0000
Infiltration rate                                                                                        0.1500 (18)
Number of sides sheltered                                                                                     2 (19)

Shelter factor                                                           (20) =  1  -  [0.075 x (19)]  =     0.8500 (20)
Infiltration rate adjusted to include shelter factor                           (21) = (18) x (20)  =     0.1275 (21)


                Jan       Feb       Mar       Apr       May       Jun       Jul       Aug       Sep       Oct       Nov       Dec
Wind speed    5.1000    5.0000    4.9000    4.4000    4.3000    3.8000    3.8000    3.7000    4.0000    4.3000    4.5000    4.7000 (22)
Wind factor   1.2750    1.2500    1.2250    1.1000    1.0750    0.9500    0.9500    0.9250    1.0000    1.0750    1.1250    1.1750 (22a)
Adj infilt rate
              0.1626    0.1594    0.1562    0.1403    0.1371    0.1211    0.1211    0.1179    0.1275    0.1371    0.1434    0.1498 (22b)
 Balanced mechanical ventilation with heat recovery
If mechanical ventilation:                                                                                             0.5000 (23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =                          65.1000 (23c)

Effective ac  0.3371    0.3339    0.3307    0.3148    0.3116    0.2956    0.2956    0.2924    0.3020    0.3116    0.3179    0.3243 (25)



----------------------------------------------------------------------------------------------------
3. Heat losses and heat loss parameter
----------------------------------------------------------------------------------------------------
Element                                     Gross    Openings     NetArea     U-value       A x U     K-value       A x K
                                               m2          m2          m2       W/m2K         W/K      kJ/m2K        kJ/K
Windows (Uw = 1.10)                                                28.5900      1.0536     30.1236                       (27)
Doors                                                               2.9000      2.0000      5.8000                       (26)
Rooflights (Uw = 1.10)                                              2.8400      1.0536      2.9923                       (27a)
Heat Loss Floor 1                                                  49.5400      0.1300      6.4402                       (28)
Heat Loss Floor 2                                                   3.4500      0.1300      0.4485                       (28b)
Basement Wall                             90.5500                  90.5500      0.1500     13.5825                       (29a)
External Wall 1                           75.3500     31.4900      43.8600      0.1500      6.5790                       (29a)
External Wall 2                           66.4400                  66.4400      0.1500      9.9660                       (29a)
External Wall 3                           75.4000                  75.4000      0.1500     11.3100                       (29a)
Curtain Walling                           13.0800                  13.0800      0.2500      3.2700                       (29a)
External Roof 1                            6.0600      2.8400       3.2200      0.1300      0.4186                       (30)
External Roof 2                            9.6500                   9.6500      0.1300      1.2545                       (30)
External Roof 3                           45.9900                  45.9900      0.1300      5.9787                       (30)
Total net area of external elements Aum(A, m2)                    435.5100                                               (31)
Fabric heat loss, W/K = Sum (A x U)                                   (26)...(30) + (32) =     98.1639                       (33)
Party Wall 1                                                       17.2800      0.0000      0.0000                       (32)
Party Wall 2                                                       18.0500      0.0000      0.0000                       (32)
Party Floor 1                                                      52.5400                                               (32d)
Party Floor 2                                                      52.1400                                               (32d)
Party Floor 3                                                      45.9300                                               (32d)
Party Ceilings 1                                                   46.9300                                               (32b)
Party Ceilings 2                                                   52.5400                                               (32b)
Party Ceilings 3                                                   45.9400                                               (32b)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K                                                          175.0000 (35)
Thermal bridges (Default value 0.150 * total exposed area)                                                  65.3265 (36)
Total fabric heat loss                                                                  (33) + (36) =     163.4904 (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        59.0890   58.5302   57.9714   55.1775   54.6187   51.8247   51.8247   51.2660   52.9423   54.6187   55.7363   56.8538 (38)
Heat transfer coeff
            222.5794  222.0206  221.4618  218.6679  218.1091  215.3151  215.3151  214.7564  216.4327  218.1091  219.2267  220.3442 (39)
Average = Sum(39)m / 12 =                                                                                            218.5282 (39)

                Jan       Feb       Mar       Apr       May       Jun       Jul       Aug       Sep       Oct       Nov       Dec
HLP           1.0750    1.0723    1.0696    1.0561    1.0534    1.0399    1.0399    1.0372    1.0453    1.0534    1.0588    1.0642 (40)
HLP (average)                                                                                                          1.0554 (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                                                                                                    3.0111 (42)
Average daily hot water use (litres/day)                                                                           111.2773 (43)

                Jan       Feb       Mar       Apr       May       Jun       Jul       Aug       Sep       Oct       Nov       Dec
Daily hot water use
            122.4050  117.9539  113.5028  109.0517  104.6006  100.1495  100.1495  104.6006  109.0517  113.5028  117.9539  122.4050 (44)
Energy conte 181.5231  158.7613  163.8274  142.8287  137.0475  118.2616  109.5868  125.7524  127.2543  148.3026  161.8839  175.7954 (45)
Energy content (annual)                                                                             Total = Sum(45)m =  1750.8249 (45)
Distribution loss  (46)m = 0.15 x (45)m
             27.2285   23.8142   24.5741   21.4243   20.5571   17.7392   16.4380   18.8629   19.0881   22.2454   24.2826   26.3693 (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                                                                                   0.6000 (49)
Enter (49) or (54) in (55)                                                                                           1.1340 (55)
Total storage loss
             35.1540   31.7520   35.1540   34.0200   35.1540   34.0200   35.1540   35.1540   34.0200   35.1540   34.0200   35.1540 (56)
If cylinder contains dedicated solar storage
             35.1540   31.7520   35.1540   34.0200   35.1540   34.0200   35.1540   35.1540   34.0200   35.1540   34.0200   35.1540 (57)
Primary loss  0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000 (59)
Total heat required for water heating calculated for each month
            216.6771  190.5133  198.9814  176.8487  172.2015  152.2816  144.7408  160.9064  161.2743  183.4566  195.9039  210.9494 (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
            216.6771  190.5133  198.9814  176.8487  172.2015  152.2816  144.7408  160.9064  161.2743  183.4566  195.9039  210.9494 (64)
                                                                          Total per year (kWh/year) = Sum(64)m =  2164.7349 (64)
Heat gains from water heating, kWh/month
             88.4796   78.1897   82.5958   74.7065   73.6915   66.5380   64.5608   69.9359   69.5280   77.4338   81.0424   86.5752 (65)



----------------------------------------------------------------------------------------------------
5. Internal gains (see Table 5 and 5a)
----------------------------------------------------------------------------------------------------
Metabolic gains (Table 5), Watts
                Jan       Feb       Mar       Apr       May       Jun       Jul       Aug       Sep       Oct       Nov       Dec
(66)m       150.5546  150.5546  150.5546  150.5546  150.5546  150.5546  150.5546  150.5546  150.5546  150.5546  150.5546  150.5546 (66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
             34.4954   30.6385   24.9169   18.8637   14.1008   11.9045   12.8632   16.7201   22.4417   28.4949   33.2578   35.4541 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
            377.6972  381.6165  371.7400  350.7140  324.1724  299.2271  282.5621  278.6428  288.5193  309.5453  336.0869  361.0322 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
             38.0555   38.0555   38.0555   38.0555   38.0555   38.0555   38.0555   38.0555   38.0555   38.0555   38.0555   38.0555 (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)
           -120.4436 -120.4436 -120.4436 -120.4436 -120.4436 -120.4436 -120.4436 -120.4436 -120.4436 -120.4436 -120.4436 -120.4436 (71)
Water heating gains (Table 5)
            118.9242  116.3537  111.0159  103.7591   99.0477   92.4139   86.7753   93.9998   96.5667  104.0777  112.5589  116.3645 (72)
Total internal gains
            599.2832  596.7751  575.8391  541.5031  505.4873  471.7119  450.3670  457.5291  475.6942  510.2844  550.0699  581.0172 (73)



----------------------------------------------------------------------------------------------------
6. Solar gains
----------------------------------------------------------------------------------------------------

[Jan]                                         Area       Solar flux             g            FF        Access           Gains
                                                m2         Table 6a  Specific data  Specific data      factor               W
                                                               W/m2   or Table 6b    or Table 6c     Table 6d
----------------------------------------------------------------------------------------------------
Southeast                                  14.8600          36.7938        0.4200         0.8000       0.7700        127.3111 (77)
Southwest                                   2.1300          36.7938        0.4200         0.8000       0.7700         18.2485 (79)
Northwest                                  11.6000          11.2829        0.4200         0.8000       0.7700         30.4756 (81)
Horizontal                                  2.8400          26.0000        0.4200         0.8000       1.0000         22.3292 (82)
----------------------------------------------------------------------------------------------------

Solar gains 198.3645  356.3520  533.4569  732.7145  882.4384  902.2144  859.0191  743.9800  602.2825  406.5210  241.0340  167.4918 (83)
Total gains 797.6477  953.1271 1109.2960 1274.2177 1387.9257 1373.9263 1309.3861 1201.5091 1077.9767  916.8053  791.1040  748.5090 (84)



----------------------------------------------------------------------------------------------------
7. Mean internal temperature (heating season)
----------------------------------------------------------------------------------------------------
Temperature during heating periods in the living area from Table 9, Th1 (C)                                        21.0000 (85)
Utilisation factor for gains for living area, ni1,m (see Table 9a)
                Jan       Feb       Mar       Apr       May       Jun       Jul       Aug       Sep       Oct       Nov       Dec
tau          45.2195   45.3333   45.4477   46.0284   46.1463   46.7451   46.7451   46.8667   46.5037   46.1463   45.9111   45.6782
alpha         4.0146    4.0222    4.0298    4.0686    4.0764    4.1163    4.1163    4.1244    4.1002    4.0764    4.0607    4.0452
util living area
              0.9984    0.9964    0.9909    0.9728    0.9213    0.8057    0.6583    0.7192    0.9098    0.9850    0.9969    0.9988 (86)

MIT          19.6064   19.7401   19.9726   20.2920   20.5914   20.8101   20.8951   20.8777   20.6995   20.3104   19.9037   19.5881 (87)
Th 2         20.0213   20.0235   20.0257   20.0368   20.0391   20.0502   20.0502   20.0524   20.0457   20.0391   20.0346   20.0302 (88)
util rest of house
              0.9980    0.9955    0.9884    0.9645    0.8946    0.7365    0.5422    0.6088    0.8680    0.9792    0.9960    0.9984 (89)
MIT 2        18.1248   18.3218   18.6628   19.1334   19.5559   19.8455   19.9318   19.9209   19.7138   19.1656   18.5698   18.1046 (90)
Living area fraction                                                             fLA = Living area / (4) =    0.1037 (91)
MIT          18.2784   18.4689   18.7986   19.2536   19.6633   19.9456   20.0317   20.0201   19.8160   19.2843   18.7081   18.2584 (92)
Temperature adjustment                                                                                          0.0000
adjusted MIT 18.2784   18.4689   18.7986   19.2536   19.6633   19.9456   20.0317   20.0201   19.8160   19.2843   18.7081   18.2584 (93)
```

CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

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-----------------------------------------------------------------------------------------------------
8. Space heating requirement
-----------------------------------------------------------------------------------------------------

                   Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Utilisation      0.9968     0.9933     0.9839     0.9554     0.8815     0.7277     0.5397     0.6046     0.8550     0.9725     0.9940     0.9976 (94)
Useful gains   795.1331   946.7437  1091.4890  1217.3970  1223.4935   999.7423   706.6211   726.3886   921.7136   891.6081   786.3483   746.6928 (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
              3111.3016  3012.5744  2723.6704  2263.9946  1736.8703  1150.9807   738.8915   777.4341  1237.1361  1894.1221  2544.8004  3097.6966 (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
              1723.2294  1388.2383  1214.3429   753.5503   381.9523     0.0000     0.0000     0.0000     0.0000   745.8705  1266.0855  1749.1468 (98)
Space heating                                                                                                                  9222.4161 (98)
Space heating per m2                                                                                             (98) / (4) =     44.5420 (99)


-----------------------------------------------------------------------------------------------------
8c. Space cooling requirement
-----------------------------------------------------------------------------------------------------
Calculated for June, July and August. See Table 10b
                   Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Ext. temp.       4.3000     4.9000     6.5000     8.9000    11.7000    14.6000    16.6000    16.4000    14.1000    10.6000     7.1000     4.2000
Heat loss rate W
                 0.0000     0.0000     0.0000     0.0000     0.0000  2023.9624  1593.3321  1632.1483     0.0000     0.0000     0.0000     0.0000 (100)
Utilisation      0.0000     0.0000     0.0000     0.0000     0.0000     0.7317     0.8145     0.7737     0.0000     0.0000     0.0000     0.0000 (101)
Useful loss      0.0000     0.0000     0.0000     0.0000     0.0000  1480.9842  1297.7030  1262.8376     0.0000     0.0000     0.0000     0.0000 (102)
Total gains      0.0000     0.0000     0.0000     0.0000     0.0000  1710.6196  1633.6116  1514.8072     0.0000     0.0000     0.0000     0.0000 (103)
Month fracti     0.0000     0.0000     0.0000     0.0000     0.0000     1.0000     1.0000     1.0000     0.0000     0.0000     0.0000     0.0000 (103a)
Space cooling kWh
                 0.0000     0.0000     0.0000     0.0000     0.0000   165.3375   249.9160   187.4654     0.0000     0.0000     0.0000     0.0000 (104)
Space cooling                                                                                                                   602.7189 (104)
Cooled fraction                                                                               fC = cooled area / (4) =     0.5931 (105)
Intermittency factor (Table 10b)
                 0.0000     0.0000     0.0000     0.0000     0.0000     0.2500     0.2500     0.2500     0.0000     0.0000     0.0000     0.0000 (106)
Space cooling kWh
                 0.0000     0.0000     0.0000     0.0000     0.0000    24.5151    37.0559    27.7961     0.0000     0.0000     0.0000     0.0000 (107)
Space cooling                                                                                                                    89.3672 (107)
Space cooling per m2                                                                                                              0.4316 (108)


-----------------------------------------------------------------------------------------------------
9a. Energy requirements - Individual heating systems, including micro-CHP
-----------------------------------------------------------------------------------------------------
Fraction of space heat from secondary/supplementary system (Table 11)                                                             0.0000 (201)
Fraction of space heat from main system(s)                                                                                        1.0000 (202)
Efficiency of main space heating system 1 (in %)                                                                                100.0000 (206)
Efficiency of secondary/supplementary heating system, %                                                                           0.0000 (208)
Space heating requirement                                                                                                      9222.4161 (211)
Cooling System Energy Efficiency Ratio (see Table 10c)                                                                            4.7250 (209)

                   Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Space heating requirement
              1723.2294  1388.2383  1214.3429   753.5503   381.9523     0.0000     0.0000     0.0000     0.0000   745.8705  1266.0855  1749.1468 (98)
Space heating efficiency (main heating system 1)
               100.0000   100.0000   100.0000   100.0000   100.0000     0.0000     0.0000     0.0000     0.0000   100.0000   100.0000   100.0000 (210)
Space heating fuel (main heating system)
              1723.2294  1388.2383  1214.3429   753.5503   381.9523     0.0000     0.0000     0.0000     0.0000   745.8705  1266.0855  1749.1468 (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
               216.6771   190.5133   198.9814   176.8487   172.2015   152.2816   144.7408   160.9064   161.2743   183.4566   195.9039   210.9494 (64)
Efficiency of water heater                                                                                                      100.0000 (216)
(217)m         100.0000   100.0000   100.0000   100.0000   100.0000   100.0000   100.0000   100.0000   100.0000   100.0000   100.0000   100.0000 (217)
Fuel for water heating, kWh/month
               216.6771   190.5133   198.9814   176.8487   172.2015   152.2816   144.7408   160.9064   161.2743   183.4566   195.9039   210.9494 (219)
Water heating fuel used                                                                                                        2164.7349 (219)
Space cooling fuel requirement
(221)m           0.0000     0.0000     0.0000     0.0000     0.0000     5.1884     7.8425     5.8828     0.0000     0.0000     0.0000     0.0000 (221)
Cooling                                                                                                                          18.9137 (221)
Annual totals kWh/year
Space heating fuel - main system                                                                                               9222.4161 (211)
Space heating fuel - secondary                                                                                                    0.0000 (215)

Electricity for pumps and fans:
    (BalancedWithHeatRecovery, Database: in-use factor = 1.4000, SFP = 0.9240)
   mechanical ventilation fans (SFP =        0.9240)                                                                            598.8443 (230a)
Total electricity for the above, kWh/year                                                                                       598.8443 (231)
Electricity for lighting (calculated in Appendix L)                                                                             609.1991 (232)
Total delivered energy for all uses                                                                                           12614.1080 (238)


-----------------------------------------------------------------------------------------------------
12a. Carbon dioxide emissions - Individual heating systems including micro-CHP
-----------------------------------------------------------------------------------------------------
                                                                                      Energy      Emission factor        Emissions
                                                                                    kWh/year          kg CO2/kWh      kg CO2/year
Space heating - main system 1                                                      9222.4161              0.5190        4786.4339 (261)
Space heating - secondary                                                             0.0000              0.0000           0.0000 (263)
Water heating (other fuel)                                                         2164.7349              0.5190        1123.4974 (264)
Space and water heating                                                                                                 5909.9313 (265)
Space cooling                                                                        18.9137              0.5190           9.8162 (266)
Pumps and fans                                                                      598.8443              0.5190         310.8002 (267)
Energy for lighting                                                                 609.1991              0.5190         316.1744 (268)
Total CO2, kg/year                                                                                                      6546.7221 (272)
Dwelling Carbon Dioxide Emission Rate (DER)                                                                               31.6200 (273)
```


CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

```
16 CO2 EMISSIONS ASSOCIATED WITH APPLIANCES AND COOKING AND SITE-WIDE ELECTRICITY GENERATION TECHNOLOGIES
DER                                                                                          31.6200 ZC1
Total Floor Area                                                                   TFA     207.0500
Assumed number of occupants                                                          N       3.0111
CO2 emission factor in Table 12 for electricity displaced from grid                 EF       0.5190
CO2 emissions from appliances, equation (L14)                                               10.8097 ZC2
CO2 emissions from cooking, equation (L16)                                                   0.9238 ZC3
Total CO2 emissions                                                                         43.3535 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                                                                           43.3535 ZC8


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CALCULATION OF TARGET EMISSIONS 09 Jan 2014

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-------------------------------------------------------------------------------------
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          Storey height             Volume
                                                                      (m2)                (m)                  (m3)
Ground floor                                                     52.9900 (1b)    x       2.5300 (2b)    =    134.0647 (1b) - (3b)
First floor                                                      52.5400 (1c)    x       2.6500 (2c)    =    139.2310 (1c) - (3c)
Second floor                                                     55.5900 (1d)    x       2.5000 (2d)    =    138.9750 (1d) - (3d)
Third floor                                                      45.9300 (1e)    x       2.5900 (2e)    =    118.9587 (1e) - (3e)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)          207.0500                                                (4)
Dwelling volume                                                      (3a)+(3b)+(3c)+(3d)+(3e)...(3n) =    531.2294 (5)


-------------------------------------------------------------------------------------
2. Ventilation rate
-------------------------------------------------------------------------------------
                                              main         secondary         other           total       m3 per hour
                                            heating         heating
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) =     0.0753 (8)
Pressure test                                                                                                  Yes
Measured/design AP50                                                                                        5.0000
Infiltration rate                                                                                           0.3253 (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)  =    0.2765 (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
                0.3525    0.3456    0.3387    0.3042    0.2972    0.2627    0.2627    0.2558    0.2765    0.2972    0.3111    0.3249 (22b)
Effective ac    0.5621    0.5597    0.5574    0.5463    0.5442    0.5345    0.5345    0.5327    0.5382    0.5442    0.5484    0.5528 (25)


-------------------------------------------------------------------------------------
3. Heat losses and heat loss parameter
-------------------------------------------------------------------------------------
Element                                    Gross      Openings      NetArea      U-value        A x U      K-value        A x K
                                             m2           m2           m2         W/m2K          W/K       kJ/m2K          kJ/K
TER Opaque door                                                      2.9000       1.0000       2.9000                          (26)
TER Opening Type (Uw = 1.40)                                        28.5900       1.3258      37.9034                          (27)
TER Room Window (Uw = 1.70)                                          2.8400       1.5918       4.5206                          (27a)
Heat Loss Floor 1                                                   49.5400       0.1300       6.4402                          (28)
Heat Loss Floor 2                                                    3.4500       0.1300       0.4485                          (28b)
Basement Wall                             90.5500                   90.5500       0.1800      16.2990                          (29a)
External Wall 1                           75.3500      31.4900      43.8600       0.1800       7.8948                          (29a)
External Wall 2                           66.4400                   66.4400       0.1800      11.9592                          (29a)
External Wall 3                           75.4000                   75.4000       0.1800      13.5720                          (29a)
Curtain Walling                           13.0800                   13.0800       0.1800       2.3544                          (29a)
External Roof 1                            6.0600       2.8400       3.2200       0.1300       0.4186                          (30)
External Roof 2                            9.6500                    9.6500       0.1300       1.2545                          (30)
External Roof 3                           45.9900                   45.9900       0.1300       5.9787                          (30)
Total net area of external elements Aum(A, m2)                     435.5100                                                    (31)
Fabric heat loss, W/K = Sum (A x U)                                   (26)...(30) + (32) =   111.9439                          (33)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K                                                                250.0000 (35)
Thermal bridges (User defined value 0.050 * total exposed area)                                                   21.7755 (36)
Total fabric heat loss                                                                            (33) + (36) =  133.7194 (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          98.5468   98.1238   97.7091   95.7615   95.3971   93.7008   93.7008   93.3867   94.3542   95.3971   96.1343   96.9049 (38)
Heat transfer coeff
              232.2662  231.8432  231.4285  229.4809  229.1165  227.4203  227.4203  227.1061  228.0736  229.1165  229.8537  230.6243 (39)
Average = Sum(39)m / 12 =                                                                                            229.4792 (39)

                 Jan       Feb       Mar       Apr       May       Jun       Jul       Aug       Sep       Oct       Nov       Dec
HLP             1.1218    1.1197    1.1177    1.1083    1.1066    1.0984    1.0984    1.0969    1.1015    1.1066    1.1101    1.1139 (40)
HLP (average)                                                                                                         1.1083 (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                                                                                                     3.0111 (42)
Average daily hot water use (litres/day)                                                                            105.7134 (43)

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


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

Design SAP
elmhurst energy

CALCULATION OF TARGET EMISSIONS 09 Jan 2014


```
Daily hot water use
              116.2848  112.0562  107.8277  103.5991   99.3706   95.1421   95.1421   99.3706  103.5991  107.8277  112.0562  116.2848 (44)
Energy conte  172.4469  150.8232  155.6360  135.6873  130.1952  112.3485  104.1074  119.4648  120.8916  140.8875  153.7897  167.0056 (45)
Energy content (annual)                                                                             Total = Sum(45)m =  1663.2836 (45)
Distribution loss  (46)m = 0.15 x (45)m
               25.8670   22.6235   23.3454   20.3531   19.5293   16.8523   15.6161   17.9197   18.1337   21.1331   23.0685   25.0508 (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
              231.0757  203.7782  214.2648  192.4248  188.8240  169.0861  162.7362  178.0936  177.6291  199.5163  210.5273  225.6345 (62)
Solar input     0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000 (63)
                                                                    Solar input (sum of months) = Sum(63)m =     0.0000 (63)
Output from w/h
              231.0757  203.7782  214.2648  192.4248  188.8240  169.0861  162.7362  178.0936  177.6291  199.5163  210.5273  225.6345 (64)
                                                                     Total per year (kWh/year) = Sum(64)m =  2353.5906 (64)
Heat gains from water heating, kWh/month
              104.2417   92.5128   98.6520   90.5061   90.1929   82.7459   81.5188   86.6251   85.5865   93.7481   96.5251  102.4324 (65)


-------------------------------------------------------------------------------------
5. Internal gains (see Table 5 and 5a)
-------------------------------------------------------------------------------------
Metabolic gains (Table 5), Watts
                 Jan       Feb       Mar       Apr       May       Jun       Jul       Aug       Sep       Oct       Nov       Dec
(66)m         150.5546  150.5546  150.5546  150.5546  150.5546  150.5546  150.5546  150.5546  150.5546  150.5546  150.5546  150.5546 (66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5
               35.3722   31.4172   25.5502   19.3432   14.4592   12.2071   13.1902   17.1451   23.0121   29.2192   34.1031   36.3553 (67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5
              377.6972  381.6165  371.7400  350.7140  324.1724  299.2271  282.5621  278.6428  288.5193  309.5453  336.0869  361.0322 (68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5
               38.0555   38.0555   38.0555   38.0555   38.0555   38.0555   38.0555   38.0555   38.0555   38.0555   38.0555   38.0555 (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)
             -120.4436 -120.4436 -120.4436 -120.4436 -120.4436 -120.4436 -120.4436 -120.4436 -120.4436 -120.4436 -120.4436 -120.4436 (71)
Water heating gains (Table 5)
              140.1098  137.6678  132.5968  125.7029  121.2271  114.9249  109.5682  116.4316  118.8701  126.0056  134.0627  137.6780 (72)
Total internal gains
              624.3455  621.8679  601.0534  566.9264  531.0251  497.5255  476.4869  483.3859  501.5680  535.9365  575.4191  606.2318 (73)


-------------------------------------------------------------------------------------
6. Solar gains
-------------------------------------------------------------------------------------

[Jan]                                 Area        Solar flux            g              FF           Access           Gains
                                        m2          Table 6a   Specific data   Specific data        factor               W
                                                        W/m2     or Table 6b     or Table 6c      Table 6d
-------------------------------------------------------------------------------------
Southeast                          14.8600         36.7938          0.6300          0.7000        0.7700        167.0958 (77)
Southwest                           2.1300         36.7938          0.6300          0.7000        0.7700         23.9512 (79)
Northwest                          11.6000         11.2829          0.6300          0.7000        0.7700         39.9993 (81)
Horizontal                          2.8400         26.0000          0.6300          0.7000        1.0000         29.3071 (82)
-------------------------------------------------------------------------------------

Solar gains   260.3534  467.7120  700.1621  961.6878 1158.2004 1184.1565 1127.4626  976.4737  790.4958  533.5588  316.3572  219.8330 (83)
Total gains   884.6989 1089.5799 1301.2155 1528.6142 1689.2255 1681.6819 1603.9495 1459.8596 1292.0638 1069.4953  891.7763  826.0648 (84)


-------------------------------------------------------------------------------------
7. Mean internal temperature (heating season)
-------------------------------------------------------------------------------------
Temperature during heating periods in the living area from Table 9, Th1 (C)                                        21.0000 (85)
Utilisation factor for gains for living area, ni1,m (see Table 9a)
                 Jan       Feb       Mar       Apr       May       Jun       Jul       Aug       Sep       Oct       Nov       Dec
tau            61.9051   62.0181   62.1292   62.6565   62.7562   63.2242   63.2242   63.3117   63.0431   62.7562   62.5549   62.3459
alpha           5.1270    5.1345    5.1419    5.1771    5.1837    5.2149    5.2149    5.2208    5.2029    5.1837    5.1703    5.1564
util living area
                0.9996    0.9987    0.9953    0.9790    0.9184    0.7730    0.6027    0.6751    0.9091    0.9913    0.9990    0.9997 (86)

MIT            19.6347   19.7938   20.0598   20.4149   20.7351   20.9288   20.9845   20.9729   20.8174   20.3953   19.9473   19.6080 (87)
Th 2           19.9831   19.9847   19.9864   19.9940   19.9955   20.0022   20.0022   20.0034   19.9996   19.9955   19.9926   19.9895 (88)
util rest of house
                0.9995    0.9983    0.9935    0.9702    0.8834    0.6859    0.4767    0.5482    0.8553    0.9864    0.9986    0.9996 (89)
MIT 2          18.1411   18.3751   18.7645   19.2826   19.7220   19.9518   19.9961   19.9913   19.8384   19.2604   18.6054   18.1065 (90)
Living area fraction                                                                    fLA = Living area / (4) =     0.1037 (91)
MIT            18.2959   18.5222   18.8988   19.4000   19.8271   20.0531   20.0986   20.0931   19.9399   19.3781   18.7445   18.2622 (92)
Temperature adjustment                                                                                               0.0000
adjusted MIT   18.2959   18.5222   18.8988   19.4000   19.8271   20.0531   20.0986   20.0931   19.9399   19.3781   18.7445   18.2622 (93)


-------------------------------------------------------------------------------------
8. Space heating requirement
-------------------------------------------------------------------------------------

                 Jan       Feb       Mar       Apr       May       Jun       Jul       Aug       Sep       Oct       Nov       Dec
Utilisation     0.9991    0.9972    0.9906    0.9631    0.8762    0.6909    0.4895    0.5605    0.8513    0.9819    0.9977    0.9994 (94)
Useful gains  883.8837 1086.5527 1288.9310 1472.2439 1480.0935 1161.8392  785.1544  818.3105 1099.8745 1050.1449  889.7492  825.5317 (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
             3250.7833 3158.2079 2869.4387 2409.5514 1862.0438 1240.1504  795.6477  838.7251 1331.9340 2011.2054 2676.5354 3243.0916 (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)
```

CALCULATION OF TARGET EMISSIONS 09 Jan 2014

```
Space heating kWh
              1760.9733  1392.1523  1175.8978   674.8614   284.1710     0.0000     0.0000     0.0000     0.0000   715.0290  1286.4861  1798.6646 (98)
Space heating                                                                                                                           9088.2354 (98)
Space heating per m2                                                                                                 (98) / (4) =      43.8939 (99)
```

```
----------------------------------------------------------------------------------------------------
8c. Space cooling requirement
----------------------------------------------------------------------------------------------------
Not applicable
```

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----------------------------------------------------------------------------------------------------
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                                                                                                            9720.0379 (211)

                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Space heating requirement
              1760.9733  1392.1523  1175.8978   674.8614   284.1710     0.0000     0.0000     0.0000     0.0000   715.0290  1286.4861  1798.6646 (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)
              1883.3939  1488.9329  1257.6447   721.7769   303.9262     0.0000     0.0000     0.0000     0.0000   764.7369  1375.9210  1923.7054 (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
               231.0757   203.7782   214.2648   192.4248   188.8240   169.0861   162.7362   178.0936   177.6291   199.5163   210.5273   225.6345 (64)
Efficiency of water heater                                                                                                             79.8000 (216)
(217)m          89.1139    88.9766    88.6676    87.8855    85.9018    79.8000    79.8000    79.8000    79.8000    87.9279    88.8251    89.1673 (217)
Fuel for water heating, kWh/month
               259.3037   229.0244   241.6496   218.9496   219.8136   211.8873   203.9301   223.1749   222.5929   226.9089   237.0133   253.0461 (219)
Water heating fuel used                                                                                                              2747.2945 (219)
Annual totals kWh/year
Space heating fuel - main system                                                                                                     9720.0379 (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)                                                                                   624.6836 (232)
Total delivered energy for all uses                                                                                                 13167.0159 (238)
```

```
----------------------------------------------------------------------------------------------------
12a. Carbon dioxide emissions - Individual heating systems including micro-CHP
----------------------------------------------------------------------------------------------------
                                                                                      Energy      Emission factor           Emissions
                                                                                    kWh/year          kg CO2/kWh         kg CO2/year
Space heating - main system 1                                                      9720.0379              0.2160           2099.5282 (261)
Space heating - secondary                                                             0.0000              0.0000              0.0000 (263)
Water heating (other fuel)                                                         2747.2945              0.2160            593.4156 (264)
Space and water heating                                                                                                  2692.9438 (265)
Pumps and fans                                                                       75.0000              0.5190             38.9250 (267)
Energy for lighting                                                                 624.6836              0.5190            324.2108 (268)
Total CO2, kg/m2/year                                                                                                    3056.0796 (272)
Emissions per m2 for space and water heating                                                                               13.0062 (272a)
Fuel factor (electricity)                                                                                                   1.5500
Emissions per m2 for lighting                                                                                               1.5659 (272b)
Emissions per m2 for pumps and fans                                                                                         0.1880 (272c)
Target Carbon Dioxide Emission Rate (TER) = (13.0062 * 1.55) + 1.5659 + 0.1880, rounded to 2 d.p.                          21.9100 (273)
```

Appendix B: Be Green DER Worksheet.

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

Design SAP
elmhurst energy

Property Reference	4B HH	Issued on Date	18/12/2019
Assessment Reference	V02	Prop Type Ref	01
Property			

SAP Rating	71 C	DER	26.42	TER	21.91
Environmental	74 C	% DER<TER	-20.56		
CO_2 Emissions (t/year)	4.18	DFEE	56.65	TFEE	56.34
General Requirements Compliance	Fail	% DFEE<TFEE	-0.56		

Assessor Details	Mr. Liam Holden, Liam Holden, Tel: 01202 654600, liamholden@hoarelea.com	Assessor ID	P624-0001
Client			

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

Design SAP
elmhurst energy

CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

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--------------------------------------------------------------------------------------------------
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        Storey height          Volume
                                                                        (m2)               (m)              (m3)
Ground floor                                                       52.9900 (1b)    x     2.5300 (2b)   =   134.0647 (1b) - (3b)
First floor                                                        52.5400 (1c)    x     2.6500 (2c)   =   139.2310 (1c) - (3c)
Second floor                                                       55.5900 (1d)    x     2.5000 (2d)   =   138.9750 (1d) - (3d)
Third floor                                                        45.9300 (1e)    x     2.5900 (2e)   =   118.9587 (1e) - (3e)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n)        207.0500                                            (4)
Dwelling volume                                                         (3a)+(3b)+(3c)+(3d)+(3e)...(3n) =   531.2294 (5)


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

                                                                                                     Air changes per hour
Infiltration due to chimneys, flues and fans   = (6a)+(6b)+(7a)+(7b)+(7c) =                       0.0000 / (5) =      0.0000 (8)
Pressure test                                                                                                           Yes
Measured/design AP50                                                                                                3.0000
Infiltration rate                                                                                                   0.1500 (18)
Number of sides sheltered                                                                                                2 (19)

Shelter factor                                                                         (20) = 1  -  [0.075 x (19)]  =      0.8500 (20)
Infiltration rate adjusted to include shelter factor                                          (21) = (18) x (20)  =      0.1275 (21)


                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
Wind speed     5.1000     5.0000     4.9000     4.4000     4.3000     3.8000     3.8000     3.7000     4.0000     4.3000     4.5000     4.7000 (22)
Wind factor    1.2750     1.2500     1.2250     1.1000     1.0750     0.9500     0.9500     0.9250     1.0000     1.0750     1.1250     1.1750 (22a)
Adj infilt rate
               0.1626     0.1594     0.1562     0.1403     0.1371     0.1211     0.1211     0.1179     0.1275     0.1371     0.1434     0.1498 (22b)
 Balanced mechanical ventilation with heat recovery
If mechanical ventilation:                                                                                                   0.5000 (23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =                                65.1000 (23c)

Effective ac   0.3371     0.3339     0.3307     0.3148     0.3116     0.2956     0.2956     0.2924     0.3020     0.3116     0.3179     0.3243 (25)


--------------------------------------------------------------------------------------------------
3. Heat losses and heat loss parameter
--------------------------------------------------------------------------------------------------
Element                                       Gross        Openings        NetArea        U-value          A x U          K-value          A x K
                                                 m2              m2             m2          W/m2K            W/K          kJ/m2K           kJ/K
Windows (Uw = 1.10)                                                        28.5900         1.0536        30.1236                                (27)
Doors                                                                       2.9000         2.0000         5.8000                                (26)
Rooflights (Uw = 1.10)                                                      2.8400         1.0536         2.9923                                (27a)
Heat Loss Floor 1                                                          49.5400         0.1300         6.4402                                (28)
Heat Loss Floor 2                                                           3.4500         0.1300         0.4485                                (28b)
Basement Wall                               90.5500                        90.5500         0.1500        13.5825                                (29a)
External Wall 1                             75.3500         31.4900        43.8600         0.1500         6.5790                                (29a)
External Wall 2                             66.4400                        66.4400         0.1500         9.9660                                (29a)
External Wall 3                             75.4000                        75.4000         0.1500        11.3100                                (29a)
Curtain Walling                             13.0800                        13.0800         0.2500         3.2700                                (29a)
External Roof 1                              6.0600          2.8400         3.2200         0.1300         0.4186                                (30)
External Roof 2                              9.6500                         9.6500         0.1300         1.2545                                (30)
External Roof 3                             45.9900                        45.9900         0.1300         5.9787                                (30)
Total net area of external elements Aum(A, m2)                            435.5100                                                          (31)
Fabric heat loss, W/K = Sum (A x U)                                            (26)...(30) + (32) =       98.1639                                (33)
Party Wall 1                                                               17.2800         0.0000         0.0000                                (32)
Party Wall 2                                                               18.0500         0.0000         0.0000                                (32)
Party Floor 1                                                              52.5400                                                          (32d)
Party Floor 2                                                              52.1400                                                          (32d)
Party Floor 3                                                              45.9300                                                          (32d)
Party Ceilings 1                                                           46.9300                                                          (32b)
Party Ceilings 2                                                           52.5400                                                          (32b)
Party Ceilings 3                                                           45.9400                                                          (32b)

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K                                                                        175.0000 (35)
Thermal bridges (Default value 0.150 * total exposed area)                                                                65.3265 (36)
Total fabric heat loss                                                                                     (33) + (36) =   163.4904 (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         59.0890    58.5302    57.9714    55.1775    54.6187    51.8247    51.8247    51.2660    52.9423    54.6187    55.7363    56.8538 (38)
Heat transfer coeff
             222.5794   222.0206   221.4618   218.6679   218.1091   215.3151   215.3151   214.7564   216.4327   218.1091   219.2267   220.3442 (39)
Average = Sum(39)m / 12 =                                                                                                      218.5282 (39)

                 Jan        Feb        Mar        Apr        May        Jun        Jul        Aug        Sep        Oct        Nov        Dec
HLP            1.0750     1.0723     1.0696     1.0561     1.0534     1.0399     1.0399     1.0372     1.0453     1.0534     1.0588     1.0642 (40)
HLP (average)                                                                                                                1.0554 (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	3.0111	(42)
Average daily hot water use (litres/day)	111.2773	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daily hot water use	122.4050	117.9539	113.5028	109.0517	104.6006	100.1495	100.1495	104.6006	109.0517	113.5028	117.9539	122.4050	(44)
Energy conte	181.5231	158.7613	163.8274	142.8287	137.0475	118.2616	109.5868	125.7524	127.2543	148.3026	161.8839	175.7954	(45)
Energy content (annual)											Total = Sum(45)m =	1750.8249	(45)
Distribution loss (46)m = 0.15 x (45)m	27.2285	23.8142	24.5741	21.4243	20.5571	17.7392	16.4380	18.8629	19.0881	22.2454	24.2826	26.3693	(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	0.6000	(49)
Enter (49) or (54) in (55)	1.1340	(55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Total storage loss	35.1540	31.7520	35.1540	34.0200	35.1540	34.0200	35.1540	35.1540	34.0200	35.1540	34.0200	35.1540	(56)
If cylinder contains dedicated solar storage	35.1540	31.7520	35.1540	34.0200	35.1540	34.0200	35.1540	35.1540	34.0200	35.1540	34.0200	35.1540	(57)
Primary loss	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	(59)
Total heat required for water heating calculated for each month	216.6771	190.5133	198.9814	176.8487	172.2015	152.2816	144.7408	160.9064	161.2743	183.4566	195.9039	210.9494	(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	216.6771	190.5133	198.9814	176.8487	172.2015	152.2816	144.7408	160.9064	161.2743	183.4566	195.9039	210.9494	(64)
								Total per year (kWh/year) = Sum(64)m =				2164.7349	(64)
Heat gains from water heating, kWh/month	88.4796	78.1897	82.5958	74.7065	73.6915	66.5380	64.5608	69.9359	69.5280	77.4338	81.0424	86.5752	(65)

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m	150.5546	150.5546	150.5546	150.5546	150.5546	150.5546	150.5546	150.5546	150.5546	150.5546	150.5546	150.5546	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	34.4954	30.6385	24.9169	18.8637	14.1008	11.9045	12.8632	16.7201	22.4417	28.4949	33.2578	35.4541	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	377.6972	381.6165	371.7400	350.7140	324.1724	299.2271	282.5621	278.6428	288.5193	309.5453	336.0869	361.0322	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	38.0555	38.0555	38.0555	38.0555	38.0555	38.0555	38.0555	38.0555	38.0555	38.0555	38.0555	38.0555	(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)	-120.4436	-120.4436	-120.4436	-120.4436	-120.4436	-120.4436	-120.4436	-120.4436	-120.4436	-120.4436	-120.4436	-120.4436	(71)
Water heating gains (Table 5)	118.9242	116.3537	111.0159	103.7591	99.0477	92.4139	86.7753	93.9998	96.5667	104.0777	112.5589	116.3645	(72)
Total internal gains	599.2832	596.7751	575.8391	541.5031	505.4873	471.7119	450.3670	457.5291	475.6942	510.2844	550.0699	581.0172	(73)

6. Solar gains

[Jan]	Area m2	Solar flux Table 6a W/m2	g Specific data or Table 6b	FF Specific data or Table 6c	Access factor Table 6d	Gains W	
Southeast	14.8600	36.7938	0.4200	0.8000	0.7700	127.3111	(77)
Southwest	2.1300	36.7938	0.4200	0.8000	0.7700	18.2485	(79)
Northwest	11.6000	11.2829	0.4200	0.8000	0.7700	30.4756	(81)
Horizontal	2.8400	26.0000	0.4200	0.8000	1.0000	22.3292	(82)

Solar gains	198.3645	356.3520	533.4569	732.7145	882.4384	902.2144	859.0191	743.9800	602.2825	406.5210	241.0340	167.4918	(83)
Total gains	797.6477	953.1271	1109.2960	1274.2177	1387.9257	1373.9263	1309.3861	1201.5091	1077.9767	916.8053	791.1040	748.5090	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	45.2195	45.3333	45.4477	46.0284	46.1463	46.7451	46.7451	46.8667	46.5037	46.1463	45.9111	45.6782	
alpha	4.0146	4.0222	4.0298	4.0686	4.0764	4.1163	4.1163	4.1244	4.1002	4.0764	4.0607	4.0452	
util living area	0.9984	0.9964	0.9909	0.9728	0.9213	0.8057	0.6583	0.7192	0.9098	0.9850	0.9969	0.9988	(86)
MIT	19.6064	19.7401	19.9726	20.2920	20.5914	20.8101	20.8951	20.8777	20.6995	20.3104	19.9037	19.5881	(87)
Th 2	20.0213	20.0235	20.0257	20.0368	20.0391	20.0502	20.0502	20.0524	20.0457	20.0391	20.0346	20.0302	(88)
util rest of house	0.9980	0.9955	0.9884	0.9645	0.8946	0.7365	0.5422	0.6088	0.8680	0.9792	0.9960	0.9984	(89)
MIT 2	18.1248	18.3218	18.6628	19.1334	19.5559	19.8455	19.9318	19.9209	19.7138	19.1656	18.5698	18.1046	(90)
Living area fraction									fLA = Living area / (4) =			0.1037	(91)
MIT	18.2784	18.4689	18.7986	19.2536	19.6633	19.9456	20.0317	20.0201	19.8160	19.2843	18.7081	18.2584	(92)
Temperature adjustment												0.0000	
adjusted MIT	18.2784	18.4689	18.7986	19.2536	19.6633	19.9456	20.0317	20.0201	19.8160	19.2843	18.7081	18.2584	(93)

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

Design SAP
elmhurst energy

CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation	0.9968	0.9933	0.9839	0.9554	0.8815	0.7277	0.5397	0.6046	0.8550	0.9725	0.9940	0.9976	(94)
Useful gains	795.1331	946.7437	1091.4890	1217.3970	1223.4935	999.7423	706.6211	726.3886	921.7136	891.6081	786.3483	746.6928	(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	3111.3016	3012.5744	2723.6704	2263.9946	1736.8703	1150.9807	738.8915	777.4341	1237.1361	1894.1221	2544.8004	3097.6966	(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	1723.2294	1388.2383	1214.3429	753.5503	381.9523	0.0000	0.0000	0.0000	0.0000	745.8705	1266.0855	1749.1468	(98)
Space heating												9222.4161	(98)
Space heating per m2											(98) / (4) =	44.5420	(99)

8c. Space cooling requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ext. temp.	4.3000	4.9000	6.5000	8.9000	11.7000	14.6000	16.6000	16.4000	14.1000	10.6000	7.1000	4.2000	
Heat loss rate W	0.0000	0.0000	0.0000	0.0000	0.0000	2023.9624	1593.3321	1632.1483	0.0000	0.0000	0.0000	0.0000	(100)
Utilisation	0.0000	0.0000	0.0000	0.0000	0.0000	0.7317	0.8145	0.7737	0.0000	0.0000	0.0000	0.0000	(101)
Useful loss	0.0000	0.0000	0.0000	0.0000	0.0000	1480.9842	1297.7030	1262.8376	0.0000	0.0000	0.0000	0.0000	(102)
Total gains	0.0000	0.0000	0.0000	0.0000	0.0000	1710.6196	1633.6116	1514.8072	0.0000	0.0000	0.0000	0.0000	(103)
Month fracti	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	(103a)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	165.3375	249.9160	187.4654	0.0000	0.0000	0.0000	0.0000	(104)
Space cooling												602.7189	(104)
Cooled fraction										fC = cooled area / (4) =		0.5931	(105)
Intermittency factor (Table 10b)	0.0000	0.0000	0.0000	0.0000	0.0000	0.2500	0.2500	0.2500	0.0000	0.0000	0.0000	0.0000	(106)
Space cooling kWh	0.0000	0.0000	0.0000	0.0000	0.0000	24.5151	37.0559	27.7961	0.0000	0.0000	0.0000	0.0000	(107)
Space cooling												89.3672	(107)
Space cooling per m2												0.4316	(108)

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

Fraction of space heat from secondary/supplementary system (Table 11)	0.0000	(201)
Fraction of space heat from main system(s)	1.0000	(202)
Efficiency of main space heating system 1 (in %)	100.0000	(206)
Efficiency of secondary/supplementary heating system, %	0.0000	(208)
Space heating requirement	9222.4161	(211)
Cooling System Energy Efficiency Ratio (see Table 10c)	4.7250	(209)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	1723.2294	1388.2383	1214.3429	753.5503	381.9523	0.0000	0.0000	0.0000	0.0000	745.8705	1266.0855	1749.1468	(98)
Space heating efficiency (main heating system 1)	100.0000	100.0000	100.0000	100.0000	100.0000	0.0000	0.0000	0.0000	0.0000	100.0000	100.0000	100.0000	(210)
Space heating fuel (main heating system)	1723.2294	1388.2383	1214.3429	753.5503	381.9523	0.0000	0.0000	0.0000	0.0000	745.8705	1266.0855	1749.1468	(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	216.6771	190.5133	198.9814	176.8487	172.2015	152.2816	144.7408	160.9064	161.2743	183.4566	195.9039	210.9494	(64)
Efficiency of water heater												100.0000	(216)
(217)m	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	100.0000	(217)
Fuel for water heating, kWh/month	216.6771	190.5133	198.9814	176.8487	172.2015	152.2816	144.7408	160.9064	161.2743	183.4566	195.9039	210.9494	(219)
Water heating fuel used												2164.7349	(219)
Space cooling fuel requirement													
(221)m	0.0000	0.0000	0.0000	0.0000	0.0000	5.1884	7.8425	5.8828	0.0000	0.0000	0.0000	0.0000	(221)
Cooling												18.9137	(221)

Annual totals kWh/year

Space heating fuel - main system	9222.4161	(211)
Space heating fuel - secondary	0.0000	(215)

Electricity for pumps and fans:
(BalancedWithHeatRecovery, Database: in-use factor = 1.4000, SFP = 0.9240)

mechanical ventilation fans (SFP = 0.9240)		598.8443	(230a)
Total electricity for the above, kWh/year		598.8443	(231)
Electricity for lighting (calculated in Appendix L)		609.1991	(232)

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

PV Unit 0 (0.80 * 3.00 * 1080 * 0.80) =	-2072.6873	-2072.6873	(233)
Total delivered energy for all uses		10541.4208	(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	9222.4161	0.5190	4786.4339	(261)
Space heating - secondary	0.0000	0.0000	0.0000	(263)
Water heating (other fuel)	2164.7349	0.5190	1123.4974	(264)
Space and water heating			5909.9313	(265)
Space cooling	18.9137	0.5190	9.8162	(266)
Pumps and fans	598.8443	0.5190	310.8002	(267)
Energy for lighting	609.1991	0.5190	316.1744	(268)

CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

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 Energy saving/generation technologies
PV Unit                                                               -2072.6873            0.5190          -1075.7247 (269)
Total CO2, kg/year                                                                                            5470.9974 (272)
Dwelling Carbon Dioxide Emission Rate (DER)                                                                     26.4200 (273)


16 CO2 EMISSIONS ASSOCIATED WITH APPLIANCES AND COOKING AND SITE-WIDE ELECTRICITY GENERATION TECHNOLOGIES
DER                                                                                                             26.4200 ZC1
Total Floor Area                                                                                      TFA   207.0500
Assumed number of occupants                                                                             N     3.0111
CO2 emission factor in Table 12 for electricity displaced from grid                                    EF     0.5190
CO2 emissions from appliances, equation (L14)                                                                  10.8097 ZC2
CO2 emissions from cooking, equation (L16)                                                                      0.9238 ZC3
Total CO2 emissions                                                                                            38.1535 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                                                                                              38.1535 ZC8


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