2 Templewood Avenue
London, EC1M 4AJ

Energy Statement

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1. Executive Summary

This Energy Statement has been prepared to accompany the planning application for the proposed new development at 2 Templewood Avenue, NW3 7XA. It sets out the energy strategy for the site in compliance with the London Plan and the London Borough of Camden requirements for environmental sustainability and efficient energy design.

The Energy Statement contained herein describes the recommended solution to service the proposed development in the most energy efficient and sustainable manner as stipulated by the Greater London Authority (GLA) and The London Plan 2021.

SAP 10 Carbon Factors have been used for the assessment in line with GLA policy, and a SAP 10 worksheet has been provided in Appendix 7 and 8 for the refurbished existing building and new extension.

The existing building will be refurbished and will therefore be assessed against Part L1B of the building regulations. As part of the refurbishment works the existing glazing will be replaced with new. The existing MEP systems are to be stripped out, replaced and upgraded. This includes installation of a highly efficient air source heat pump system providing the space heating and cooling for the entirety of the proposed scheme.

The new extension on the ground floor is the only new build element of the development and will be assessed against Part L1A.

Refurbished Building Carbon Emissions

The table below shows the carbon emissions after each stage of the hierarchy for the existing refurbished building.

	Carbon dioxide emissions for non-domestic buildings (Tonnes of CO_2 per annum)	
	Regulated	**Unregulated**
Baseline: Part L 2013 of the Building Regulations Compliant Development	33.4	12.4
After energy demand reduction	19	12.4
After heat network / CHP	19	12.4
After renewable energy	6.7	12.4

Table 1 Carbon Dioxide Emissions after each stage of the Energy Hierarchy for domestic buildings (refurbished building)

The table below shows the different savings at each stage of the energy hierarchy.

	Regulated non-domestic carbon dioxide savings	
	(Tonnes of CO_2 per annum)	**(%)**
Savings from energy demand reduction	14.4	43.2%
Savings from heat network / CHP	0.0	0.0%
Savings from renewable energy	12.22	36.6%
Cumulative on site savings	**26.63**	**79.81%**

Table 2 Regulated Carbon Dioxide savings from each stage of the Energy Hierarchy for domestic buildings (refurbished building)

Note that the 'Baseline' for existing building is derived using notional values as per Appendix 4 of the GLA Energy Assessment Guidance.

Through energy efficiency techniques as well as the implementation of renewable technologies as mentioned above, the proposed development will reduce annual carbon emissions by 26.63 tonnes of CO_2. This accounts for a reduction of approximately 79.81 % of the proposed refurbishment's expected regulated energy carbon emissions.

There is a saving of 12.22 tonnes of CO_2, equivalent to 36.6% and therefore above the London Borough of Camden's minimum target of 20%.

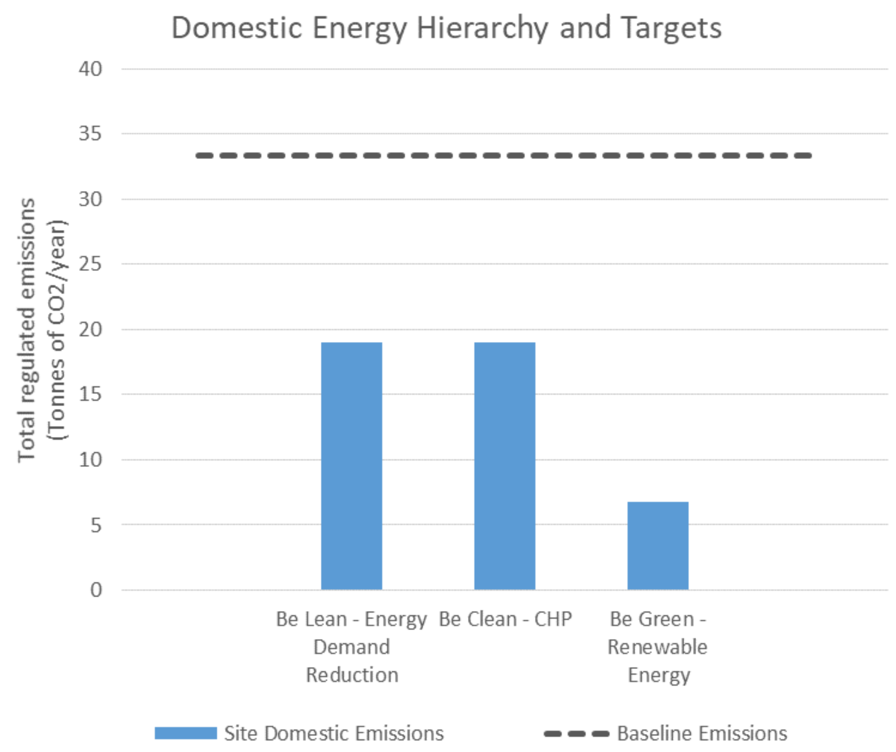


Figure 1 – The Non-Domestic Energy Hierarchy (refurbishment)

New Extension Carbon Emissions

The table below shows the carbon emissions after each stage of the hierarchy for the new extension.

	Carbon dioxide emissions for non-domestic buildings (Tonnes of CO_2 per annum)	
	Regulated	Unregulated
Baseline: Part L 2013 of the Building Regulations Compliant Development	0.24	1.49.
After energy demand reduction	0.24	1.49
After heat network / CHP	0.24	1.49
After renewable energy	0.14	1.49

Table 3 Carbon Dioxide Emissions after each stage of the Energy Hierarchy for domestic buildings (new extension)

The table below shows the different savings at each stage of the energy hierarchy.

	Regulated non-domestic carbon dioxide savings	
	(Tonnes of CO_2 per annum)	(%)
Savings from energy demand reduction	0.00	0.0%
Savings from heat network / CHP	0.00	0.0%
Savings from renewable energy	0.10	42.1%
Cumulative on site savings	**0.10**	**42.11%**

Table 4 Regulated Carbon Dioxide savings from each stage of the Energy Hierarchy for domestic buildings (new extension)

Through energy efficiency techniques as well as the implementation of renewable technologies as mentioned above, the proposed development will reduce annual carbon emissions by 0.1 tonnes of CO_2. This accounts for a reduction of approximately 42.11% of the proposed extension's expected regulated energy carbon emissions.

Despite not needing to comply with the 35% reduction in CO_2 emissions for major developments, the proposed development exceeds The London Plan 2021 target.

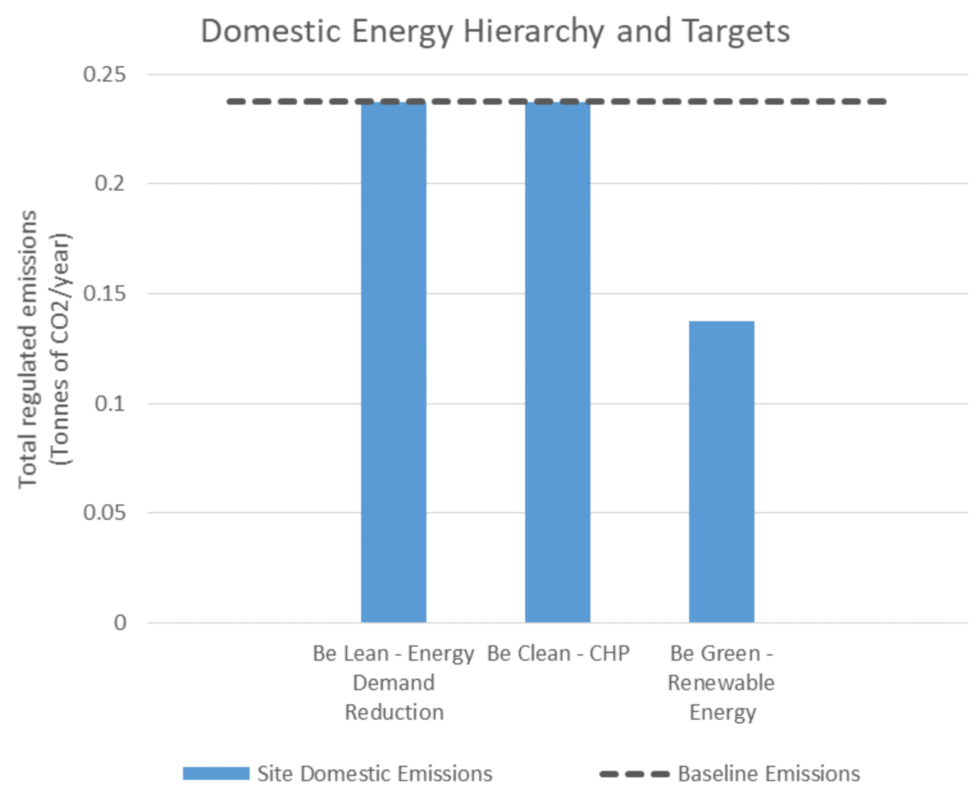


Figure 2 – The Non-Domestic Energy Hierarchy (new extension)

2. Introduction

This energy statement examines the potential for reduction of carbon emissions for the proposed development at 2 Templewood Avenue, London, NW7 7XA, and has been compiled to accompany the planning application.

The development proposals, designed by Marek Wojciechowski Architects, consist of a refurbishment of existing building and the erection of a lower ground floor extension.

This report follows the Greater London Authority's (GLA) planning guidance for residential developments.

The London Borough of Camden and The London Plan 2021 have specific requirements with regards to improvements on carbon emissions in comparison to 2013 Building Regulations Part L.

- In line with London Borough of Camden's Core Strategy and Camden Planning Guidance developments of more than 500sqm must submit an energy statement demonstrating how carbon emissions will be reduced.
- In line with London Borough of Camden's Core Strategy and Camden Planning Guidance there must be a 20% reduction in CO2 from onsite renewables for the existing refurbished building (after all other energy efficiency measures have been incorporated).
- For developments consisting of a refurbishment with a new build extension, the CO2 savings for the new and refurbished elements should be presented separately within the energy strategy. The new build elements should be assessed in line with the methodology for new build development and will be expected to comply with London Plan policy (note the new build element of the project is a minor development and required only to pass part L1A).
- The existing building's total floor area is > 1000m2 and the proposed development includes an extension, therefore the development is subject to consequential improvements as defined in Part L1B.

3. Legislation and Policy Framework

Approved Document Part L 2013

Approved Document Part L 2013 provides requirements and guidance on the Conservation of Fuel and Power. The new building elements (i.e. the extension) must meet or better the **Target Emissions Rate (TER)** of a notional building as specified by Part L 2013 building regulations approved software. In order to provide evidence of this, a Part L 2013 calculation is carried out both on a notional building with fixed parameters and the actual building.

The London Plan 2021

The London Plan 2021 is the overall strategic plan for London setting out an integrated economic, environmental, transport and social framework for the development of the capital to 2036. The Local plans of London Boroughs need to be in general conformity with the London Plan, and its policies guide decisions on planning applications by councils and the Mayor.

The extension is a classed as a minor development and is therefore not required to meet the GLA's carbon emission reduction of 35%.

London Borough of Camden- Camden Local Plan 2017

The Local Plan seeks to minimise Camden's contribution to climate change and ensure that the borough develops in a way which respects environmental limits and improves quality of life.
Its main aims and requirements for developments are summarised as follows:

- Adapt to Camden's growing population and social change
- Supply and cost of housing in the borough
- Maintaining a successful economy and improving opportunities
- Inequalities
- Health and wellbeing
- Improving transport
- Quality of the environment
- Crime and safety

Additional London borough of Camden documentation providing further information on core strategy aims and requirements:

Energy Efficiency and Adaptation Camden Planning Guidance 2021

4. Establishing CO_2 Emissions for a Part L Compliant Development

Part L 2013 calculations have been performed by using approved thermal modelling software (JPA Designer) in order to predict the carbon emissions of the proposed development. The development has been assessed as two entities; the existing refurbished building and the new extension.

To establish the regulated CO_2 emissions for a Part L 2013 compliant development, it has been assumed that the heating for the notional building will be provided by gas boilers and any active cooling will be provided by electrically powered equipment, in line with GLA guidance on preparing Energy Statements.

Existing Building

For the refurbished existing building, notional values have been used for the building fabric in line with GLA Energy Assessment Guidance Appendix 4. A SAP 10 Worksheet has been provided in Appendix 5.

Table 5 below shows the carbon emission rate for the existing portion of the development to meet 2013 Building Regulations (i.e. the Target Emission Rate based on SAP 10).

Baseline Emission Rate for Non-Domestic		
DER (Existing building)	9.16	$kgCO_2/m^2$

Table 5 – Annual carbon emissions for the existing portion of the development

New Extension

SAP 10 Carbon Factors have been used for the assessment in line with GLA policy, and a SAP 10 worksheet has been provided in Appendix 4.

Table 6 below shows the carbon emission rate for the proposed development required to meet 2013 Building Regulations (i.e. the Target Emission Rate based on SAP 10).

Target Emission Rate for Non-Domestic		
TER (Existing building)	9.16	$kgCO_2/m^2$

Table 6 – Annual carbon emissions for the extension

5. Energy Efficiency Measures and Sustainability Strategies - 'Be Lean'

The energy efficiency measures for the Proposed Development will be maximised through the use of passive design features including efficient building fabric, improved building air tightness and efficient lighting. These design features will minimise the active cooling and heating demand as far as possible.

Building fabric U-values

The thermal efficiency of the building elements affects the heating and cooling demand of the proposed development (and thereby affects the demand for natural gas and electricity). Below is a list of the building regulations, and the more stringent target U-values for the new thermal elements (within extension) of this development:

Element	Limiting Factors for Building Regulations (W/m^2K)	Concurrent Notional Building Specifications (W/m^2K)	Proposed for new elements of existing building (W/m^2K)	Proposed for new extension elements (W/m^2K)
Wall	0.35	0.25	-	0.25
Floor	0.25	0.22	-	0.22
Roof	0.25	0.18	0.18	0.18
Windows (overall)	2.20	1.60	1.30	1.30
Windows (g-Value)	N/A	0.40	0.36	0.36

Table 7 – U-Values for the proposed development comparison to Part L 2013

The walls and flooring of the refurbished building will be left as existing and have therefore been modelled using notional values under the GLA Energy Assessment Guidance Appendix 4.

Thermal Bridging

Existing thermal bridging within the extension is to be retained.

All thermal bridging will be mitigated through the use of accredited construction details within the new extension, or bespoke arrangements to ensure the fabrics efficiency is not compromised.

Air permeability

The air permeability (i.e. the tightness to the outdoor elements) of a building affects the heating and cooling demand of the building (and thereby affects the demand for natural gas and electricity).

The air permeability of the refurbished building will be left as existing.

The new extension on this development will achieve an air permeability which will be significantly more energy efficient than required by building control. The target air permeability rate for the new extension to this development is 3.0 $m^3/h/m^2$.

The limiting factors which could make it difficult to achieve this air permeability rate are the junctions between the windows, and openings such as external doors. The developer and the design team will include this air permeability target in a detailed specification so that the contractor is required to build an airtight building in order to achieve the target set above.

HVAC systems

The efficiency of the mechanical systems has a significant impact on the amount of energy which the proposed development consumes in order to deliver the required heating and cooling loads. Highly efficient equipment will be specified for this development, and wherever practically possible equipment from the government's Energy Technology List will be selected.

Both the refurbished existing building and the new extension will be served by the same MEP plant. A highly efficient air source heat pump (ASHP) system has been proposed for the building with integral heat recovery and high SCOPs / SEERs. Domestic hot water requirements for the proposed development will be met using a high efficiency gas boiler.

All pumps and fans shall be selected with high efficiency variable drive motors.

Lighting systems

Lighting represents a significant portion of the annual carbon emissions of this development. In order to maximise the natural light and reduce the energy consumed in order to generate artificial light, high efficiency LED luminaires will be used throughout.

6. Cooling and Overheating

6.1. The Cooling Hierarchy

Minimising Internal Heat Generation through Energy Efficient Design

The servicing infrastructure will be designed to minimise heat gains within occupied spaces, and utilising highly efficient pipe insulation to minimise distribution heat losses.

Reducing the Amount of Heat Entering the Building in Summer

Through design development of the new extension's façade the amount of heat entering the building through the glazing has been significantly reduced, along with providing more energy efficient fabrics to all floors. The glazing on the refurbished existing building will not be increased.

The design of the proposed development will maximise the use of thermal mass where feasible to reduce peaks in cooling and heating requirements.

Passive Ventilation

All windows on both the new extension and refurbished existing building will be openable to allow for purge ventilation.

6.1. Overheating Risk Analysis

An overheating assessment within SAP has been carried out for both the new extension and refurbished existing building, incorporating the use of openable windows, cross ventilation and the VRF cooling system which shows the spaces are not at risk of overheating.

6.2. Active Cooling

Although energy efficient design has been one of the key principles for the proposed developments, due to the nature of a high end residential scheme, cooling will be provided.

7. Decentralised Energy (DE) Networks – 'Be Clean'

7.1. District Heating

System Description

The London Plan's Energy Hierarchy and LBI's Supplementary Planning Guidance encourages developments to connect to existing decentralised energy (DE) networks where these exist or are proposed in the vicinity of the scheme. These systems combine the energy demands and supplies of nearby developments to more efficiently serve the building service requirements of the community as a whole.

Technical Viability

The figure below is an excerpt from the London Heat Map highlighting any existing and proposed DE networks. The red pin indicates the location of the proposed development 2 Templewood Avenue, and shows that the site is currently outside the reach of any existing/proposed district heating networks.

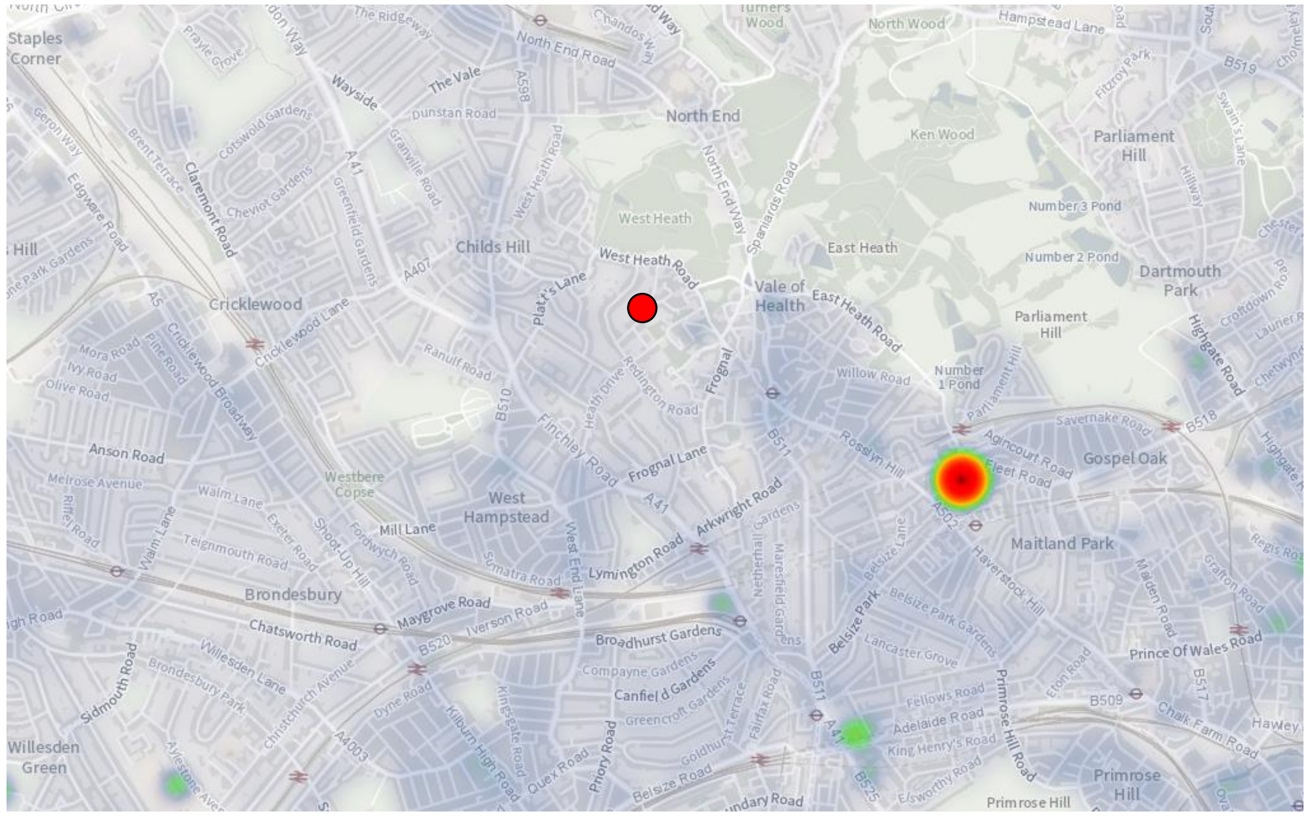


Figure 3 – London Heat Map showing that the proposed development is outside the reach of any existing or proposed heat networks

Existing proposed site sits outside the catchment area of any existing or proposed district heating networks.

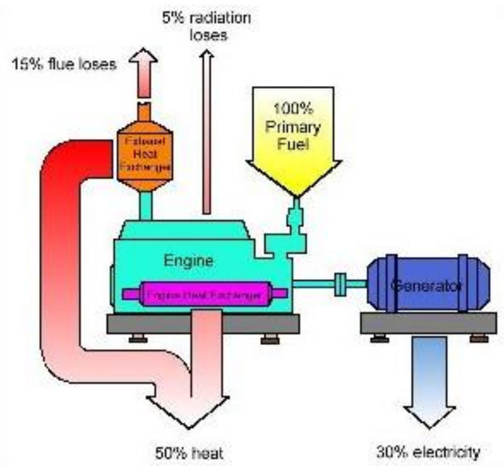
Therefore, connecting to an existing DE network is not a feasible solution for this development.

7.2. Combined Heat and Power (CHP)

CHP Description

Combined Heat and Power, or CHP as it is more commonly referred to, is the simultaneous generation of usable heat and power in a single process. In other words, it utilises the heat produced in electricity generation rather than releasing it wastefully into the atmosphere. In typical conventional power generation, much of the total energy input is wasted. CHP systems, where the heat produced in electricity generation is put to good use, can reach efficiencies up to 85%. A CHP can provide a secure and highly efficient method of generating electricity and heat at the point of use. Due to utilisation of heat from electricity generation and the avoidance of transmission losses because electricity is generated on site, CHP achieves a significant reduction in primary energy usage compared with power stations and heat only boilers. Typically a good CHP scheme can deliver an increase of around 20% in efficiency against the separate energy system it replaces and can result in savings of up to 50% of the annual CO_2 emissions from the site.

Bio-fuel CHP unit



Typical CHP process

Feasibility

For a CHP to be practical for a development there should be a steady demand for hot water and electricity. A CHP should be designed to cope with 100% of the heat base load of a building (i.e. a load that is continuous and steady all year round), with boilers to supply the peaks in demand during the colder months of the year. The only demand for heat that remains constant year round is domestic hot water.

Single family dwellings do not have a constant demand for domestic hot water to enable the use of a CHP system.

The decarbonisation of the UK electrical grid will also reduce the benefits of carbon reduction of a gas fired CHP plant, whilst still coming at a premium in installation cost and plant space.

A CHP is therefore not a feasible solution for this development.

The tables below shows the savings on regulated carbon emissions after the 'Be Clean' stage of the energy hierarchy for the proposed development.

<u>Existing Building</u>

	Regulated non-domestic carbon dioxide savings	
	(Tonnes of CO_2 per annum)	(%)
Savings from energy demand reduction	14.4	43.2%
Savings from heat network / CHP	0	0.0

Table 12 – Non Domestic Carbon emissions after the Be Clean Stage

<u>New Extension</u>

	Regulated non-domestic carbon dioxide savings	
	(Tonnes of CO_2 per annum)	(%)
Savings from energy demand reduction	0.0	0.0%
Savings from heat network / CHP	0.0	0.0%

Table 13 – Non Domestic Carbon emissions after the Be Clean Stage

8. Low & Zero Carbon Technologies Feasibility Study – 'Be Green'

The definition of 'Renewable and low carbon energy' used in the National Planning Policy Framework is:

"Includes energy for heating and cooling as well as generating electricity. Renewable energy covers those energy flows that occur naturally and repeatedly in the environment – from the wind, the fall of water, the movement of the oceans, from the sun and also from biomass and deep geothermal heat. Low carbon technologies are those that can help reduce emissions (compared to conventional use of fossil fuels)."

This definition has been widened by the UK Government by the use of the term 'Low or Zero Carbon Energy Technologies" (LZCs) within the revised Approved Document L. The carbon emissions reduction from applying these technologies when compared to the conventional technologies has also been accepted as 'renewable energy' under the GLA's Energy Hierarchy.

In the following pages, the technical viability, indicative costs, and contribution towards the carbon emissions reduction are considered for the following systems:

1. Wind Turbines;
2. Ground Source Heat Pumps (GSHPs);
3. Air Source Heat Pumps (ASHPs);
4. Solar Photovoltaic (PV) panels; and
5. Solar Water Heating Systems.

8.1. Wind Turbines

System Description

Wind turbines are modern, high-technology descendants of the old technology windmills that have been around for centuries. The difference is that now the kinetic energy of the wind is used to turn a turbine to generate electricity as opposed to moving water or turning a grist mill wheel. There are two types of wind turbine, one being the horizontal-axis variety which faces up-stream or downstream of the wind and where the rotational movement of the blade is connected to a generator to create electricity. The other type is the vertical-axis design, which is the most flexible type of wind turbine and is best suited for the more urban sites as it operates in any wind direction.


Horizontal-axis wind turbine


Vertical Axis Wind Turbine

Technical Viability

One of the largest issues with wind turbines is the available wind speed. Apart from the direction, approximately 4.0 m/s wind velocity is required as a minimum before the turbine will begin to generate electricity. Additionally, if this option were used for this development, the building would need wind turbines protruding from the roof. Wind turbines in urban centres can generate acoustic complaints from both the occupants and the surrounding commercial / residential units.

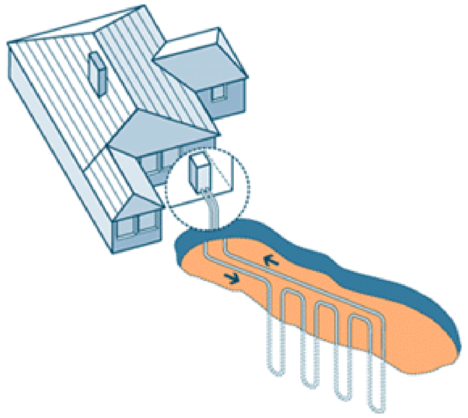
Wind turbines are therefore not recommended for this development.

Summary of Factors Affecting Wind Turbines	
Land Use	Foundation unless building mounted
Planning Issues	Potentially a problem with gaining planning permission
Noise	Problematic
Tariffs	FiT 8.52 (5.57 for export) pence/kWh

8.2. Ground Source Heat Pumps

System Description

Ground source heat pumps take advantage of the stable ground temperatures of 10-12ºC to provide energy efficient heating and cooling to a building. The energy flow is driven by the temperature difference between the ground and the circulating fluid which can be used to reject heat into the ground and deliver heating or cooling to the proposed development.



System Schematic

Horizontal Pipe

Vertical Pipe Drilling Rig

Technical Viability

Proposals to install a Closed Loop Ground Source Heat Pump and/or a direct borehole system to satisfy a large percentage of the heating demand for the proposed development could be a cost-effective option. This system also offers the option of providing "free-cooling" to its occupants via the use of the constant 12°C deep-earth temperature.

The existing building and lack of adjacent space to the site prohibit a successful GSHP installation. Furthermore an ASHP with simultaneous heating and cooling will prove to be more cost effective than a GSHP.

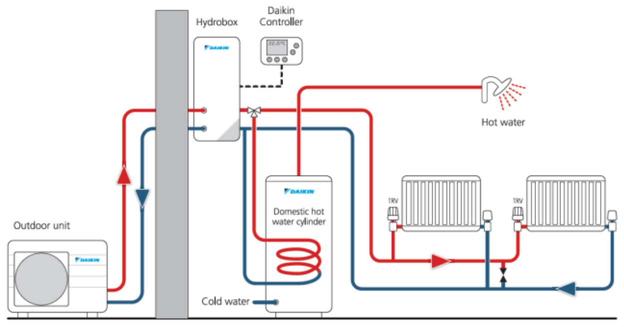
A GSHP system is therefore not a viable solution for the proposed development.

Summary of Factors Affecting Ground Source Heat Pumps	
Land Use	Below ground, minimal impact on future use of land
Planning Issues	Minimal
Noise	Minimal noise in plant room
Tariffs	The Non-Domestic Renewable Heat Incentive Scheme (NDRHI) in Great Britain closed to new applicants at the end of midnight on 31 March 2022. At the time of writing, a replacement scheme has not been established.

8.3. Air Source Heat Pumps

System Description

Air source heat pumps use the atmosphere as a renewable source of heat to generate heating and cooling with a refrigeration machine. The heating and cooling is accomplished by moving refrigerant through the heat pump's various indoor and outdoor coils and components. A compressor, condenser, expansion valve and evaporator are used to change states of the refrigerant from liquid to hot gas and then back from gas to liquid. The refrigerant is used to heat or cool coils in a fan coil unit located in the conditioned space. An external heat exchanger is used to heat or cool the refrigerant by absorbing heat from or rejecting heat to the outside air. This use of outside air is considered renewable, and has lead to the term "Air Source" Heat Pump.



Integrated Heating, Cooling, and DHW ASHP Configuration

Combined 4-Pipe Heat Pump Unit

Technical Viability

The Coefficient of Performance (COPs) achievable with modern ASHPs means that these units will produce about 80% of its energy output from the air, a renewable and clean energy source. This technology can benefit from the Renewable Heat Incentive.

Air sourced heating could provide a large proportion of the proposed development's annual energy demand without a large space requirement for mounting equipment.

Due to the high seasonal coefficient of performance generated (SCOP=3.88, an ASHP system will be more efficient than other heating systems. The table below demonstrates that the proposed Air Source Heat Pump system will produce approximately 71% less CO_2 emissions per kWh of heat generated than a conventional gas boiler system.

	Boiler (natural gas)	Boiler (electric)	ASHP (electric)
Coefficient of Performance (COP)	89%	1	3.88
SAP 10 Carbon Factor ($kgCO_2/kWh$)	0.21	0.233	0.233
Carbon Emissions (per kWh of heat generated)	0.236	0.233	0.060

Table 14 – Comparison of ASHP vs Conventional Gas Boiler

Summary of Factors Affecting Air Source Heat Pumps	
Land Use	Requires external plant area
Planning Issues	Potential issue if located in visible position.
Noise	Noise issues will be evident
Tariffs	The Non-Domestic Renewable Heat Incentive Scheme (NDRHI) in Great Britain closed to new applicants at the end of midnight on 31 March 2021. At the time of writing, a replacement scheme has not been established.

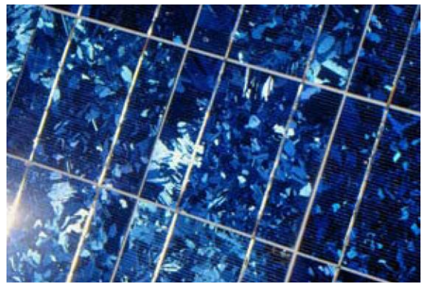
Air source heat pumps providing the space heating and cooling for the development are therefore a viable option for the Proposed Development.

8.4. Solar Photovoltaic Panels

System Description

Solar photovoltaics panels (PVs) convert energy from daylight into electricity using a semiconductor material such as silicon. When light hits the semiconductor, the energy in the light is absorbed, 'exciting' the electrons in the semiconductor so that they break free from their atoms. This allows the electrons to flow through the semiconductor material producing electricity.


Rooftop Installation


PV Cells


Solar Glass

Technical Viability

Solar PV panels are best mounted at an incline with a southerly orientation, although orientations between south-east and south-west are viable. This technology can benefit from the Smart Export Guarantee tariff.

The proposed development has very little appropriate roof space for the PV.

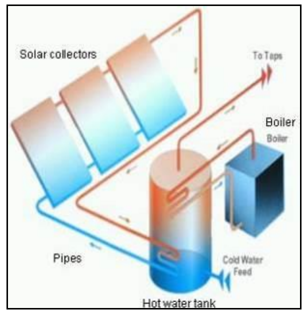
Photovoltaics are therefore not a viable solution for the Proposed Development.

Summary of Factors Affecting Photovoltaics	
Land Use	No land use (roof mounted)
Planning Issues	Potential issue if located in visible position. Can be located in discrete position.
Noise	None
Tariffs	Historic – FiT 2.38 (4.91 for export) pence/kWh. Current – Smart Export Guarantee (SEG) came into effect 1st January 2020, variable payment rate, contract length, etc.

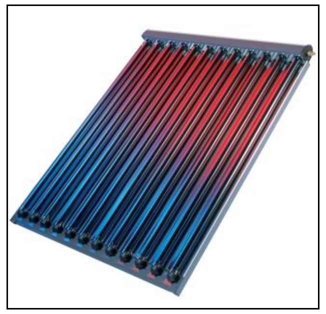
8.5. Solar Water Heating

System Description

Solar Water Heating systems convert solar radiation to heat carried by water for use in space heating or the provision of domestic hot water. Solar water heating systems normally operate with a back-up source of heat, such as gas condensing boilers. The solar water heating pre-heats the incoming water, which is topped-up by the back-up heat source when there is insufficient solar energy to reach the target water temperature.



System Diagram



Evacuated Tube Collector

Glazed Flat Panel Collector

Technical Viability

Solar Collectors perform most efficiently when mounted with a southerly orientation at an incline between 15 and 60 degrees, although orientations between south-east and south-west are viable. As solar radiation is greatest in the summer when demand is lowest, it is not possible to meet the entire annual demand by increasing the size of the system. It is therefore recommended that a solar hot water system meet no more than 65% of the domestic hot water demand.

The proposed development has very little appropriate roof space for installation of solar thermal panels.

Therefore the installation of Solar Thermal panels is not a viable solution.

Summary of Factors Affecting Solar Hot Water	
Land Use	No land use
Planning Issues	Potential issue if visible. Can be located in discrete location
Noise	None
Tariffs	The Non-Domestic Renewable Heat Incentive Scheme (NDRHI) in Great Britain closed to new applicants at the end of midnight on 31 March 2021. At the time of writing, a replacement scheme has not been established.

8.6. Recommended Solution

DSA therefore recommends the following renewable energy strategy for the proposed development at 2 Templewood Avenue, London, NW3 7XA.

The proposed development will benefit from a large reduction in carbon emissions through the implementation of an Air Source Heat Pump System to provide the heating and cooling requirements of the proposed development.

The table below shows the savings on regulated carbon emissions after the 'Be Green' stage of the energy hierarchy.

Existing Building

	Regulated non-domestic carbon dioxide savings	
	(Tonnes of CO_2 per annum)	(%)
Savings from energy demand reduction	14.4	43.2%
Savings from heat network / CHP	0.0	0.0%
Savings from renewable energy	26.63	36.6%

Table 15 – Carbon emissions after the Be Green Stage

The carbon savings (26.63 tonnes of CO_2) for the Be Green stage of the Energy Hierarchy, can be attributed to the installation of ASHPs

New Extension

	Regulated non-domestic carbon dioxide savings	
	(Tonnes of CO_2 per annum)	(%)
Savings from energy demand reduction	0.0	0.0%
Savings from heat network / CHP	0.0	0.0%
Savings from renewable energy	0.1	42.1%

Table 16 – Carbon emissions after the Be Green Stage

The carbon savings (0.1 tonnes of CO_2) for the Be Green stage of the Energy Hierarchy, can be attributed to the installation of ASHPs

9. Conclusion

In order for the proposed development to achieve minimum requirements of energy carbon reductions in line with planning policies the proposed development must achieve:

- In line with London Borough of Camden's Core Strategy and Camden Planning Guidance developments of more than 500sqm must submit an energy statement demonstrating how carbon emissions will be reduced.
- In line with London Borough of Camden's Core Strategy and Camden Planning Guidance there must be a 20% reduction in CO2 from onsite renewables for the existing refurbished building (after all other energy efficiency measures have been incorporated).
- For developments consisting of a refurbishment with a new build extension, the CO2 savings for the new and refurbished elements should be presented separately within the energy strategy. The new build elements should be assessed in line with the methodology for new build development and will be expected to comply with London Plan policy (note the new build element of the project is a minor development and required only to pass part L1A).
- The existing building's total floor area is > 1000m2 and the proposed development includes an extension, therefore the development is subject to consequential improvements as defined in Part L1B.

In order to maximise carbon reductions, the design team has followed the "Be Lean, Be Clean, Be Green, Be Seen" energy hierarchy as advised by the London Plan. This included reducing the proposed developments energy demand through energy efficient techniques, exploring the possibility of using decentralised energy systems, and including renewable energy technologies on site.

The proposed development will benefit from a large reduction in carbon emissions through the implementation of an Air Source Heat Pump System to provide the heating and cooling requirements of the proposed development.

This will result in the following carbon emissions following the Be Lean, Be Clean, Be Green, Be Seen energy hierarchy for both regulated and unregulated use.

Existing Building Carbon Emissions

The table below shows the carbon emissions after each stage of the hierarchy for the refurbished existing building.

	Carbon dioxide emissions for non-domestic buildings (Tonnes of CO_2 per annum)	
	Regulated	**Unregulated**
Baseline: Part L 2013 of the Building Regulations Compliant Development	33.4	12.4
After energy demand reduction	19	12.4
After heat network / CHP	19	12.4
After renewable energy	6.7	12.4

Table 17 Carbon Dioxide Emissions after each stage of the Energy Hierarchy for domestic buildings (refurbished building)

The table below shows the different savings at each stage of the energy hierarchy.

	Regulated non-domestic carbon dioxide savings	
	(Tonnes of CO_2 per annum)	**(%)**
Savings from energy demand reduction	14.4	43.2%
Savings from heat network / CHP	0.0	0.0%
Savings from renewable energy	12.22	36.6%
Cumulative on site savings	**26.63**	**79.81%**

Table 18 Regulated Carbon Dioxide savings from each stage of the Energy Hierarchy for domestic buildings (refurbished building)

Extension Carbon Emissions

The table below shows the carbon emissions for the proposed development after each stage of the energy hierarchy.

	Carbon dioxide emissions for non-domestic buildings (Tonnes of CO_2 per annum)	
	Regulated	**Unregulated**
Baseline: Part L 2013 of the Building Regulations Compliant Development	6	5
After energy demand reduction	4	5
After heat network / CHP	4	5
After renewable energy	3	5

Table 19 Carbon Dioxide Emissions after each stage of the Energy Hierarchy for domestic buildings (New Extension)

The table below shows the different savings at each stage of the energy hierarchy for the proposed development.

	Regulated non-domestic carbon dioxide savings	
	(Tonnes of CO_2 per annum)	**(%)**
Savings from energy demand reduction	0.00	0.0%
Savings from heat network / CHP	0.00	0.0%
Savings from renewable energy	0.10	42.1%
Cumulative on site savings	**0.10**	**42.11%**
Annual savings from offset payment	**1.1**	
Tonnes of CO_2		
Cumulative savings from offset payment	33	

Table 20 Regulated Carbon Dioxide savings from each stage of the Energy Hierarchy for domestic buildings (New Extension)

Through energy efficiency techniques as well as the implementation of renewable technologies as mentioned above, the proposed development will reduce annual carbon emissions by 0.1 tonnes of CO_2. This accounts for a reduction of approximately 42.11% of the proposed development's expected regulated energy carbon emissions.

Despite not needing to comply with the 35% reduction in CO_2 emissions for buildings of a larger size, the proposed development exceeds The London Plan 2021 target, and has a further carbon saving requirement of 1.1 tonnes of carbon in line with The London Plan 2021 policies in order to achieve net-zero emissions.

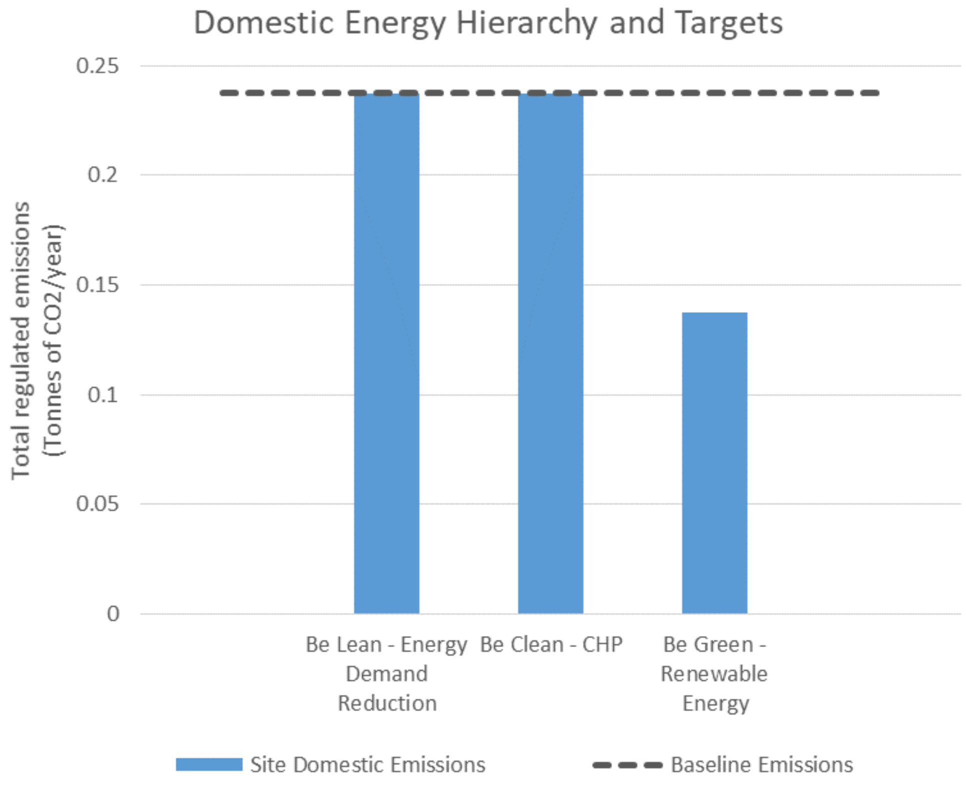


Figure 1 – The Domestic Energy Hierarchy for the extension

10. Appendix

10.1. Appendix 1 – SAP Worksheet 'Baseline' Existing Building

Project Information

Building type	Detached house		
Reference			
Date	18 January 2022		
Client	Marek Wojciechowski Architects	Project	2 Templewood Avenue
	66-68 Margaret Street		LONDON
	London		NW3 7XA
	W1W 8SR		
Tel:	020 7580 9336		

SAP 2012 worksheet for New dwelling as designed - calculation of energy ratings

1. Overall dwelling dimensions

	Area (m^2)	Av. Storey height (m)	Volume (m^3)	
Ground floor (1)	233.18	3.65	851.11	(3a)
Second floor	259.91	3.30	857.70	(3b)
Third floor	244.49	3.28	801.93	(3c)
Fourth and other floors	233.34	2.78	648.69	(3d)
	970.92			**(4)**
			3159.42	**(5)**

2. Ventilation rate

	main + seondary + other heating		m³ per hour	
Number of chimneys	0 + 0 + 0	x 40	0.00	(6a)
Number of open flues	2 + 0 + 0	x 20	40.00	(6b)
Number of intermittent fans	8	x 10	80.00	(7a)
Number of passive vents	0	x 10	0.00	(7b)
Number of flueless gas fires	0	x 40	0.00	(7c)

		Air changes per hour	
		0.04	**(8)**
Pressure test, result q50	17.00		(17)
Air permeability		0.89	(18)
		2.00	**(19)**
		0.85	**(20)**
Infiltration rate incorporating shelter factor		0.75	(21)

Infiltration rate modified for monthly wind speed

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70

52.50 (22)

Wind Factor

1.27	1.25	1.23	1.10	1.07	0.95	0.95	0.93	1.00	1.07	1.13	1.18

13.13 (22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.96	0.94	0.92	0.83	0.81	0.72	0.72	0.70	0.75	0.81	0.85	0.89

9.91 (22b)

Ventilation : natural ventilation, intermittent extract fans

Effective air change rate

0.96	0.95	0.93	0.84	0.83	0.76	0.76	0.74	0.78	0.83	0.86	0.89	(25)

3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²	U-value W/m²K	A x U W/K	kappa-value kJ/m²K	A x K kJ/K	
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (SouthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 02-BED-5			**2.400**	**1.68 (1.80)**	4.03			(27)
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (SouthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-BED-STAFF			**7.700**	**1.68 (1.80)**	12.93			(27)
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-STAIRS			**4.290**	**1.68 (1.80)**	7.20			(27)
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 02-BATH-FAMILY			**1.700**	**1.68 (1.80)**	2.85			(27)
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 02-BED-06			**1.700**	**1.68 (1.80)**	2.85			(27)
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (SouthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BREAKFAST ROOM			**1.260**	**1.68 (1.80)**	2.12			(27)
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (SouthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 02-BED-04			**2.530**	**1.68 (1.80)**	4.25			(27)
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-ANTE ROOM			**1.120**	**1.68 (1.80)**	1.88			(27)

4. Water heating energy requirements

		kWh/year	
Assumed occupancy, N		4.00	(42)
Annual average hot water usage in litres per day Vd,average		136.10	(43)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month												
149.71	144.27	138.83	133.38	127.94	122.49	122.49	127.94	133.38	138.83	144.27	149.71	(44)
Energy content of hot water used												
222.02	194.18	200.38	174.69	167.62	144.65	134.04	153.81	155.64	181.39	198.00	215.02	

Energy content (annual)		2141.43	(45)

Distribution loss

33.30	29.13	30.06	26.20	25.14	21.70	20.11	23.07	23.35	27.21	29.70	32.25	(46)

Cylinder volume, l	210.00		(47)
Manufacturer's declared cylinder loss factor (kWh/day)	1.42		(48)
Temperature Factor	0.5400		(49)
Energy lost from hot water cylinder (kWh/day)		0.77	(55)

Total storage loss												
23.77	21.47	23.77	23.00	23.77	23.00	23.77	23.77	23.00	23.77	23.00	23.77	(56)
Net storage loss												
23.77	21.47	23.77	23.00	23.77	23.00	23.77	23.77	23.00	23.77	23.00	23.77	(57)
Primary loss												
43.31	39.12	43.31	41.92	43.31	41.92	43.31	43.31	41.92	43.31	41.92	43.31	(59)
Total heat required for water heating calculated for each month												
289.10	254.77	267.46	239.61	234.71	209.57	201.12	220.89	220.56	248.47	262.92	282.10	(62)
Output from water heater for each month, kWh/month												
289.10	254.77	267.46	239.61	234.71	209.57	201.12	220.89	220.56	248.47	262.92	282.10	(64)
											2931.29	(64)
Heat gains from water heating, kWh/month												
127.49	113.04	120.29	110.02	109.40	100.03	98.23	104.81	103.69	113.98	117.77	125.16	(65)

5. Internal gains

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains, Watts												
240.25	240.25	240.25	240.25	240.25	240.25	240.25	240.25	240.25	240.25	240.25	240.25	(66)
Lighting gains												
442.83	393.32	319.87	242.16	181.02	152.82	165.13	214.64	288.09	365.80	426.94	455.14	(67)
Appliances gains												
1335.92	1349.78	1314.85	1240.48	1146.60	1058.37	999.43	985.56	1020.50	1094.87	1188.75	1276.98	(68)
Cooking gains												
63.03	63.03	63.03	63.03	63.03	63.03	63.03	63.03	63.03	63.03	63.03	63.03	(69)
Pumps and fans gains												
3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
Losses e.g. evaporation (negative values)												
-160.17	-160.17	-160.17	-160.17	-160.17	-160.17	-160.17	-160.17	-160.17	-160.17	-160.17	-160.17	(71)
Water heating gains												
171.36	168.21	161.68	152.81	147.05	138.93	132.03	140.87	144.01	153.20	163.57	168.23	(72)
Total internal gains												
2096.2	2057.4	1942.51	1781.56	1620.78	1496.24	1442.70	1487.19	1598.71	1759.98	1925.37	2046.5	(73)

6. Solar gains (calculation for January)

	Area & Flux	g & FF	Shading	Gains
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (SouthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 02-BED-5	0.9 x 2.400 36.79	0.40 x 0.80	0.77	19.5826
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (SouthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-BED-STAFF	0.9 x 7.700 36.79	0.40 x 0.80	0.77	62.8274
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-STAIRS	0.9 x 4.290 11.28	0.40 x 0.80	0.77	10.7340
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 02-BATH-FAMILY	0.9 x 1.700 11.28	0.40 x 0.80	0.77	4.2536
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 02-BED-06	0.9 x 1.700 11.28	0.40 x 0.80	0.77	4.2536
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (SouthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BREAKFAST ROOM	0.9 x 1.260 36.79	0.40 x 0.80	0.77	10.2808
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (SouthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 02-BED-04	0.9 x 2.530 36.79	0.40 x 0.80	0.77	20.6433
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-ANTE ROOM	0.9 x 1.120 11.28	0.40 x 0.80	0.77	2.8024

6. Solar gains (calculation for January)

	Area & Flux	g & FF	Shading	Gains
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-ANTE ROOM	0.9 x 1.680 11.28	0.40 x 0.80	0.77	4.2035
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-ANTE ROOM	0.9 x 1.680 11.28	0.40 x 0.80	0.77	4.2035
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (SouthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, RF-PLAY ROOM	0.9 x 1.800 36.79	0.40 x 0.80	0.77	14.6869
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (SouthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 02-BED-04	0.9 x 2.160 36.79	0.40 x 0.80	0.77	17.6243
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (SouthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-POWDER ROOM-01	0.9 x 1.430 36.79	0.40 x 0.80	0.77	11.6679
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BAR	0.9 x 1.732 11.28	0.40 x 0.80	0.77	4.3336
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 02-BED-5	0.9 x 1.100 11.28	0.40 x 0.80	0.77	2.7523
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BREAKFAST ROOM	0.9 x 1.120 11.28	0.40 x 0.80	0.77	2.8024
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BREAKFAST ROOM	0.9 x 1.680 11.28	0.40 x 0.80	0.77	4.2035
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BREAKFAST ROOM	0.9 x 1.680 11.28	0.40 x 0.80	0.77	4.2035
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BREAKFAST ROOM	0.9 x 1.155 11.28	0.40 x 0.80	0.77	2.8899
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BREAKFAST ROOM	0.9 x 1.155 11.28	0.40 x 0.80	0.77	2.8899
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (SouthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-RECEPTION ROOM	0.9 x 1.430 36.79	0.40 x 0.80	0.77	11.6679
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (SouthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-RECEPTION ROOM	0.9 x 1.020 36.79	0.40 x 0.80	0.77	8.3226

6. Solar gains (calculation for January)

	Area & Flux	g & FF	Shading	Gains
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (SouthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-RECEPTION ROOM	0.9 x 2.975 36.79	0.40 x 0.80	0.77	24.2742
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (SouthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-RECEPTION ROOM	0.9 x 1.020 36.79	0.40 x 0.80	0.77	8.3226
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-LIVING ROOM	0.9 x 1.155 11.28	0.40 x 0.80	0.77	2.8899
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-LIVING ROOM	0.9 x 1.155 11.28	0.40 x 0.80	0.77	2.8899
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-LIVING ROOM	0.9 x 3.675 11.28	0.40 x 0.80	0.77	9.1952
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-MASTER	0.9 x 1.260 11.28	0.40 x 0.80	0.77	3.1527
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (SouthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-DINING ROOM	0.9 x 1.020 36.79	0.40 x 0.80	0.77	8.3226
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (SouthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-DINING ROOM	0.9 x 2.975 36.79	0.40 x 0.80	0.77	24.2742
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (SouthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-DINING ROOM	0.9 x 1.020 36.79	0.40 x 0.80	0.77	8.3226
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (SouthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-01	0.9 x 3.150 36.79	0.40 x 0.80	0.77	25.7021
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (SouthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-01	0.9 x 1.080 36.79	0.40 x 0.80	0.77	8.8122
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (SouthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-01	0.9 x 1.080 36.79	0.40 x 0.80	0.77	8.8122
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, RF-PLAY ROOM	0.9 x 1.815 11.28	0.40 x 0.80	0.77	4.5413
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (SouthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BATH-MASTER	0.9 x 1.190 36.79	0.40 x 0.80	0.77	9.7097

6. Solar gains (calculation for January)

	Area & Flux	g & FF	Shading	Gains
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (SouthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BATH-MASTER	0.9 x 1.190 36.79	0.40 x 0.80	0.77	9.7097
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 02-STAIRS	0.9 x 1.700 11.28	0.40 x 0.80	0.77	4.2536
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-LIVING ROOM	0.9 x 1.050 11.28	0.40 x 0.80	0.77	2.6272
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BREAKFAST ROOM	0.9 x 1.155 11.28	0.40 x 0.80	0.77	2.8899
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, RF-STAIRS	0.9 x 2.200 11.28	0.40 x 0.80	0.77	5.5046
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (SouthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-02-LIVING	0.9 x 1.815 36.79	0.40 x 0.80	0.77	14.8093
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-ENSUITE-02	0.9 x 1.087 11.28	0.40 x 0.80	0.77	2.7198
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-MASTER-DRESSING	0.9 x 2.970 11.28	0.40 x 0.80	0.77	7.4313
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (SouthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 02-BED-03	0.9 x 2.530 36.79	0.40 x 0.80	0.77	20.6433
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (SouthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-01-LIVING	0.9 x 1.815 36.79	0.40 x 0.80	0.77	14.8093
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (SouthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-01-LIVING	0.9 x 0.990 36.79	0.40 x 0.80	0.77	8.0778
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-LIVING-MASTER	0.9 x 1.087 11.28	0.40 x 0.80	0.77	2.7198
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-LIVING-MASTER	0.9 x 1.080 11.28	0.40 x 0.80	0.77	2.7023

6. Solar gains (calculation for January)

	Area & Flux	g & FF	Shading	Gains
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-LIVING-MASTER	0.9 x 1.080 11.28	0.40 x 0.80	0.77	2.7023
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-LIVING-MASTER	0.9 x 2.970 11.28	0.40 x 0.80	0.77	7.4313
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-MASTER	0.9 x 1.080 11.28	0.40 x 0.80	0.77	2.7023
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-MASTER	0.9 x 1.080 11.28	0.40 x 0.80	0.77	2.7023
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-MASTER	0.9 x 3.060 11.28	0.40 x 0.80	0.77	7.6564
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (SouthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-GYM-CROSSFIT	0.9 x 7.700 36.79	0.40 x 0.80	0.77	62.8274
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-GYM-CARDIO	0.9 x 3.220 11.28	0.40 x 0.80	0.77	8.0568
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (SouthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-02	0.9 x 1.080 36.79	0.40 x 0.80	0.77	8.8122
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (SouthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-02	0.9 x 3.150 36.79	0.40 x 0.80	0.77	25.7021
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (SouthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-02	0.9 x 1.080 36.79	0.40 x 0.80	0.77	8.8122
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (SouthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-ENSUITE-01	0.9 x 1.120 36.79	0.40 x 0.80	0.77	9.1385
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (SouthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-LIVING ROOM	0.9 x 1.155 36.79	0.64 x 0.80	0.77	15.0786
Solid door 2013 Door, 00-ENTRANCE LOBBY	0.9 x 2.200 0.00	0.00 x 0.80	0.77	0.0000

7. Mean internal temperature

Temperature during heating periods in the living area, Th1 (°C) 21.00 (85)
Heating system responsiveness 1.00

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	19.02	19.19	19.37	20.25	20.42	21.27	21.27	21.44	20.94	20.42	20.08	19.72	
alpha	2.27	2.28	2.29	2.35	2.36	2.42	2.42	2.43	2.40	2.36	2.34	2.31	
Utilisation factor for gains for living area	1.00	1.00	0.99	0.99	0.97	0.94	0.89	0.91	0.97	0.99	1.00	1.00	(86)
Mean internal temperature in living area T1	17.38	17.60	18.04	18.73	19.40	20.08	20.47	20.41	19.87	19.01	18.14	17.43	(87)
Temperature during heating periods in rest of dwelling Th2	19.96	19.97	19.98	20.02	20.03	20.07	20.07	20.07	20.05	20.03	20.01	19.99	(88)
Utilisation factor for gains for rest of dwelling	1.00	0.99	0.99	0.98	0.96	0.92	0.84	0.87	0.96	0.99	0.99	1.00	(89)
Mean internal temperature in the rest of dwelling T2	16.58	16.81	17.25	17.97	18.65	19.34	19.72	19.67	19.13	18.25	17.38	16.65	(90)

Living area fraction (36.43 / 970.92) 0.04 (91)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Mean internal temperature (for the whole dwelling)	16.61	16.84	17.28	18.00	18.68	19.37	19.75	19.70	19.15	18.28	17.41	16.68	(92)
Apply adjustment to the mean internal temperature, where appropriate	17.21	17.44	17.88	18.60	19.28	19.97	20.35	20.30	19.75	18.88	18.01	17.28	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains	0.99	0.99	0.99	0.98	0.96	0.92	0.86	0.88	0.95	0.98	0.99	1.00	(94)
Useful gains	2723.1	3171.2	3578.2	3979.4	4184.5	3953.6	3530.7	3357.7	3315.4	2999.9	2682.6	2578.4	(95)
Monthly average external temperature	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature	26170.9	25166.8	22644.5	18452.0	14295.6	9726.9	6793.0	7007.7	10408.4	15628.0	20937.5	25555.5	(97)
Fraction of month for heating	1.00	1.00	1.00	1.00	1.00	-	-	-	-	1.00	1.00	1.00	
Space heating requirement for each month, kWh/month	17445.1	14781.0	14185.3	10420.3	7522.7	-	-	-	-	9395.3	13143.5	17095.0	

Total space heating requirement per year (kWh/year) (October to May) 103988.23 (98)
Space heating requirement per m² (kWh/m²/year) 107.10 (99)

8c. Space cooling requirement - not applicable

9a. Energy requirements

		kWh/year	
No secondary heating system selected			
Fraction of space heat from main system(s)	1.0000		(202)
Efficiency of main heating system	79.00%		(206)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement												
17445.1	14781.0	14185.3	10420.3	7522.7	-	-	-	-	9395.3	13143.5	17095.0	(98)
Appendix Q - monthly energy saved (main heating system 1)												
0.00	0.00	0.00	0.00	0.00	-	-	-	-	0.00	0.00	0.00	(210)
Space heating fuel (main heating system 1)												
22082.5	18710.2	17956.1	13190.2	9522.4	-	-	-	-	11892.8	16637.4	21639.2	(211)
Appendix Q - monthly energy saved (main heating system 2)												
0.00	0.00	0.00	0.00	0.00	-	-	-	-	0.00	0.00	0.00	(212)
Space heating fuel (main heating system 2)												
0.00	0.00	0.00	0.00	0.00	-	-	-	-	0.00	0.00	0.00	(213)
Appendix Q - monthly energy saved (secondary heating system)												
0.00	0.00	0.00	0.00	0.00	-	-	-	-	0.00	0.00	0.00	(214)
Space heating fuel (secondary)												
0.00	0.00	0.00	0.00	0.00	-	-	-	-	0.00	0.00	0.00	(215)
Water heating												
Water heating requirement												
289.10	254.77	267.46	239.61	234.71	209.57	201.12	220.89	220.56	248.47	262.92	282.10	(64)
Efficiency of water heater											65.00	(216)
65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	(217)
Water heating fuel												
444.78	391.96	411.48	368.64	361.09	322.41	309.41	339.83	339.33	382.27	404.49	434.00	(219)

Annual totals	kWh/year	
Space heating fuel used, main system 1	131630.67	(211)
Space heating fuel (secondary)	0.00	(215)
Water heating fuel	4509.68	(219)
Electricity for pumps, fans and electric keep-hot		
central heating pump	39.00	(230c)
Total electricity for the above, kWh/year	39.00	(231)
Electricity for lighting (0.00% fixed LEL)	3128.22	(232)
Energy saving/generation technologies		
Appendix Q -		
Energy saved or generated ():	0.000	(236a)
Energy used ():	0.000	(237a)
Total delivered energy for all uses	139307.57	(238)

10a. Fuel costs using Table 12 prices

	kWh/year	Fuel price p/kWh	£/year	
Space heating - main system 1	131630.674	3.480	4580.75	(240)
Space heating - main system 2	0.000	0.000	0.00	(241)
Water heating cost	4509.68	3.480	156.94	(247)
Mech vent fans cost	0.000	13.190	0.00	(249)
Pump/fan energy cost	39.000	13.190	5.14	(249)
Energy for lighting	3128.218	13.190	412.61	(250)
Additional standing charges			120.00	(251)
Electricity generated - PVs	0.000	0.000	0.00	(252)
Appendix Q -				
Energy saved or generated ():	0.000	0.000	0.00	(253)
Energy used ():	0.000	0.000	0.00	(254)
Total energy cost			5275.44	(255)

11a. SAP rating

	0.42	**(256)**
	2.18	**(257)**
SAP value	69.58	
	70	(258)
SAP band	**C**	

12a. Carbon dioxide emissions

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating, main system 1	131630.67	0.216	28432.23	(261)
Space heating, main system 2	0.00	0.000	0.00	(262)
Space heating, secondary	0.00	0.519	0.00	(263)
Water heating	4509.68	0.216	974.09	(264)
Space and water heating			29406.32	(265)
Electricity for pumps and fans	39.00	0.519	20.24	(267)
Electricity for lighting	3128.22	0.519	1623.55	(268)
Electricity generated - PVs	0.00	0.519	0.00	(269)
Electricity generated - µCHP	0.00	0.000	0.00	(269)
Appendix Q -				
Energy saved ():	0.00	0.000	0.00	(270)
Energy used ():	0.00	0.000	0.00	(271)
Total CO2, kg/year			31050.10	(272)

	kg/m²/year	
CO2 emissions per m²	**31.98**	(273)
EI value	58.91	(273a)
EI rating	**59**	(274)
EI band	**D**	

Calculation of stars for heating and DHW

Main heating energy efficiency	(3.48 / 0.8400) x (1 + (0.29 x 0.00)) = 4.1429, stars = 4
Main heating environmental impact	(0.2160 / 0.8400) x (1 + (0.29 x 0.00)) = 0.2571, stars = 4
Water heating energy efficiency	3.48 / 0.7000 = 4.9714, stars = 4
Water heating environmental impact	0.2160 / 0.7000 = 0.3086, stars = 4

10.2. Appendix 2 – SAP Worksheet 'Be Lean' Refurbished Existing Building

Project Information

Building type Detached house

Reference			
Date	18 January 2022		
Client	Marek Wojciechowski Architects 66-68 Margaret Street London W1W 8SR	Project	2 Templewood Avenue LONDON NW3 7XA
Tel:	020 7580 9336		

SAP 2012 worksheet for New dwelling as designed - calculation of energy ratings

1. Overall dwelling dimensions

	Area (m^2)	Av. Storey height (m)	Volume (m^3)	
Ground floor (1)	233.18	3.65	851.11	(3a)
Second floor	259.91	3.30	857.70	(3b)
Third floor	244.49	3.28	801.93	(3c)
	970.92			**(4)**
			2510.74	**(5)**

2. Ventilation rate

	main + seondary + other heating		m³ per hour	
Number of chimneys	0 + 0 + 0	x 40	0.00	(6a)
Number of open flues	2 + 0 + 0	x 20	40.00	(6b)
Number of intermittent fans	8	x 10	80.00	(7a)
Number of passive vents	0	x 10	0.00	(7b)
Number of flueless gas fires	0	x 40	0.00	(7c)

		Air changes per hour	
		0.05	**(8)**
Pressure test, result q50	17.00		(17)
Air permeability		0.90	(18)
		2.00	**(19)**
		0.85	**(20)**
Infiltration rate incorporating shelter factor		0.76	(21)

Infiltration rate modified for monthly wind speed

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70

52.50 (22)

Wind Factor

1.27	1.25	1.23	1.10	1.07	0.95	0.95	0.93	1.00	1.07	1.13	1.18

13.13 (22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.97	0.95	0.93	0.84	0.82	0.72	0.72	0.71	0.76	0.82	0.86	0.90

10.02 (22b)

Ventilation : natural ventilation, intermittent extract fans
Effective air change rate

0.97	0.95	0.94	0.85	0.84	0.76	0.76	0.75	0.79	0.84	0.87	0.90	(25)

3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²	U-value W/m²K	A x U W/K	kappa-value kJ/m²K	A x K kJ/K	
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 02-BED-5			**2.400**	**1.24 (1.30)**	2.97			(27)
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-BED-STAFF			**7.700**	**1.24 (1.30)**	9.52			(27)
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (East) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-STAIRS			**4.290**	**1.24 (1.30)**	5.30			(27)
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 02-BATH-FAMILY			**1.700**	**1.24 (1.30)**	2.10			(27)
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 02-BED-06			**1.700**	**1.24 (1.30)**	2.10			(27)
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BREAKFAST ROOM			**1.260**	**1.24 (1.30)**	1.56			(27)
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 02-BED-04			**2.530**	**1.24 (1.30)**	3.13			(27)
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-ANTE ROOM			**1.680**	**1.24 (1.30)**	2.08			(27)

4. Water heating energy requirements

		kWh/year	
Assumed occupancy, N		4.00	(42)
Annual average hot water usage in litres per day Vd,average		129.30	(43)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month												
142.23	137.06	131.88	126.71	121.54	116.37	116.37	121.54	126.71	131.88	137.06	142.23	(44)
Energy content of hot water used												
210.92	184.47	190.36	165.96	159.24	137.41	127.33	146.12	147.86	172.32	188.10	204.26	

Energy content (annual)		2034.36	(45)

Distribution loss

31.64	27.67	28.55	24.89	23.89	20.61	19.10	21.92	22.18	25.85	28.22	30.64	(46)

Cylinder volume, l	210.00		(47)
Manufacturer's declared cylinder loss factor (kWh/day)	1.42		(48)
Temperature Factor	0.5400		(49)
Energy lost from hot water cylinder (kWh/day)		0.77	(55)

Total storage loss												
23.77	21.47	23.77	23.00	23.77	23.00	23.77	23.77	23.00	23.77	23.00	23.77	(56)
Net storage loss												
23.77	21.47	23.77	23.00	23.77	23.00	23.77	23.77	23.00	23.77	23.00	23.77	(57)
Primary loss												
23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)
Total heat required for water heating calculated for each month												
257.95	226.95	237.39	211.47	206.27	182.93	174.37	193.15	193.38	219.35	233.62	251.30	(62)
Output from water heater for each month, kWh/month												
257.95	226.95	237.39	211.47	206.27	182.93	174.37	193.15	193.38	219.35	233.62	251.30	(64)
											2588.14	(64)
Heat gains from water heating, kWh/month												
107.76	95.32	100.92	91.59	90.57	82.10	79.97	86.21	85.58	94.92	98.96	105.54	(65)

5. Internal gains

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains, Watts												
240.25	240.25	240.25	240.25	240.25	240.25	240.25	240.25	240.25	240.25	240.25	240.25	(66)
Lighting gains												
423.85	376.46	306.16	231.78	173.26	146.27	158.05	205.44	275.75	350.12	408.65	435.63	(67)
Appliances gains												
1335.92	1349.78	1314.85	1240.48	1146.60	1058.37	999.43	985.56	1020.50	1094.87	1188.75	1276.98	(68)
Cooking gains												
63.03	63.03	63.03	63.03	63.03	63.03	63.03	63.03	63.03	63.03	63.03	63.03	(69)
Pumps and fans gains												
3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
Losses e.g. evaporation (negative values)												
-160.17	-160.17	-160.17	-160.17	-160.17	-160.17	-160.17	-160.17	-160.17	-160.17	-160.17	-160.17	(71)
Water heating gains												
144.84	141.85	135.65	127.21	121.74	114.03	107.48	115.87	118.86	127.58	137.44	141.86	(72)
Total internal gains												
2050.7	2014.2	1902.77	1745.59	1587.71	1464.79	1411.07	1452.99	1561.21	1718.69	1880.94	2000.6	(73)

6. Solar gains (calculation for January)

	Area & Flux	g & FF	Shading	Gains
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 02-BED-5	0.9 x 2.400 19.64	0.64 x 0.80	0.77	16.7248
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-BED-STAFF	0.9 x 7.700 46.75	0.64 x 0.80	0.77	127.7305
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (East) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-STAIRS	0.9 x 4.290 19.64	0.64 x 0.80	0.77	29.8956
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 02-BATH-FAMILY	0.9 x 1.700 10.63	0.64 x 0.80	0.77	6.4139
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 02-BED-06	0.9 x 1.700 10.63	0.64 x 0.80	0.77	6.4139
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BREAKFAST ROOM	0.9 x 1.260 19.64	0.64 x 0.80	0.77	8.7805
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 02-BED-04	0.9 x 2.530 46.75	0.64 x 0.80	0.77	41.9686
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-ANTE ROOM	0.9 x 1.680 10.63	0.64 x 0.80	0.77	6.3385

6. Solar gains (calculation for January)

	Area & Flux	g & FF	Shading	Gains
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-ANTE ROOM	0.9 x 1.680 10.63	0.64 x 0.80	0.77	6.3385
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-ANTE ROOM	0.9 x 1.120 10.63	0.64 x 0.80	0.77	4.2256
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, RF-PLAY ROOM	0.9 x 1.800 19.64	0.64 x 0.80	0.77	12.5436
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 02-BED-04	0.9 x 2.160 19.64	0.64 x 0.80	0.77	15.0523
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-POWDER ROOM-01	0.9 x 1.430 46.75	0.64 x 0.80	0.77	23.7214
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (East) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BAR	0.9 x 1.732 19.64	0.64 x 0.80	0.77	12.0732
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 02-BED-5	0.9 x 1.100 10.63	0.64 x 0.80	0.77	4.1502
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BREAKFAST ROOM	0.9 x 1.155 10.63	0.64 x 0.80	0.77	4.3577
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BREAKFAST ROOM	0.9 x 1.155 10.63	0.64 x 0.80	0.77	4.3577
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BREAKFAST ROOM	0.9 x 1.680 10.63	0.64 x 0.80	0.77	6.3385
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BREAKFAST ROOM	0.9 x 1.680 10.63	0.64 x 0.80	0.77	6.3385
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BREAKFAST ROOM	0.9 x 1.120 10.63	0.64 x 0.80	0.77	4.2256
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-RECEPTION ROOM	0.9 x 1.020 46.75	0.64 x 0.80	0.77	16.9201
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-RECEPTION ROOM	0.9 x 2.975 46.75	0.64 x 0.80	0.77	49.3504

6. Solar gains (calculation for January)

	Area & Flux	g & FF	Shading	Gains
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-RECEPTION ROOM	0.9 x 1.020 46.75	0.64 x 0.80	0.77	16.9201
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-RECEPTION ROOM	0.9 x 1.430 46.75	0.64 x 0.80	0.77	23.7214
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-LIVING ROOM	0.9 x 3.675 10.63	0.64 x 0.80	0.77	13.8654
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-LIVING ROOM	0.9 x 1.155 10.63	0.64 x 0.80	0.77	4.3577
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-LIVING ROOM	0.9 x 1.155 10.63	0.64 x 0.80	0.77	4.3577
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (East) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-MASTER	0.9 x 1.260 19.64	0.64 x 0.80	0.77	8.7805
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-DINING ROOM	0.9 x 1.020 46.75	0.64 x 0.80	0.77	16.9201
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-DINING ROOM	0.9 x 2.975 46.75	0.64 x 0.80	0.77	49.3504
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-DINING ROOM	0.9 x 1.020 46.75	0.64 x 0.80	0.77	16.9201
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-01	0.9 x 1.080 46.75	0.64 x 0.80	0.77	17.9155
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-01	0.9 x 1.080 46.75	0.64 x 0.80	0.77	17.9155
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-01	0.9 x 3.150 46.75	0.64 x 0.80	0.77	52.2534
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, RF-PLAY ROOM	0.9 x 1.815 10.63	0.64 x 0.80	0.77	6.8478
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BATH-MASTER	0.9 x 1.190 19.64	0.64 x 0.80	0.77	8.2927

6. Solar gains (calculation for January)

	Area & Flux	g & FF	Shading	Gains
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BATH-MASTER	0.9 x 1.190 19.64	0.64 x 0.80	0.77	8.2927
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (East) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 02-STAIRS	0.9 x 1.700 19.64	0.64 x 0.80	0.77	11.8468
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (East) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-LIVING ROOM	0.9 x 1.050 19.64	0.64 x 0.80	0.77	7.3171
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (East) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BREAKFAST ROOM	0.9 x 1.155 19.64	0.64 x 0.80	0.77	8.0488
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (East) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, RF-STAIRS	0.9 x 2.200 19.64	0.64 x 0.80	0.77	15.3311
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-02-LIVING	0.9 x 1.815 46.75	0.64 x 0.80	0.77	30.1079
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (East) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-ENSUITE-02	0.9 x 1.087 19.64	0.64 x 0.80	0.77	7.5784
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-MASTER-DRESSING	0.9 x 2.970 10.63	0.64 x 0.80	0.77	11.2055
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 02-BED-03	0.9 x 2.530 46.75	0.64 x 0.80	0.77	41.9686
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-01-LIVING	0.9 x 0.990 46.75	0.64 x 0.80	0.77	16.4225
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-01-LIVING	0.9 x 1.815 46.75	0.64 x 0.80	0.77	30.1079
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (East) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-LIVING-MASTER	0.9 x 1.087 19.64	0.64 x 0.80	0.77	7.5784
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-LIVING-MASTER	0.9 x 2.970 10.63	0.64 x 0.80	0.77	11.2055

6. Solar gains (calculation for January)

	Area & Flux	g & FF	Shading	Gains
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-LIVING-MASTER	0.9 x 1.080 10.63	0.64 x 0.80	0.77	4.0747
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-LIVING-MASTER	0.9 x 1.080 10.63	0.64 x 0.80	0.77	4.0747
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-MASTER	0.9 x 3.060 10.63	0.64 x 0.80	0.77	11.5451
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-MASTER	0.9 x 1.080 10.63	0.64 x 0.80	0.77	4.0747
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-MASTER	0.9 x 1.080 10.63	0.64 x 0.80	0.77	4.0747
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-GYM-CROSSFIT	0.9 x 7.700 46.75	0.64 x 0.80	0.77	127.7305
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-GYM-CARDIO	0.9 x 3.220 10.63	0.64 x 0.80	0.77	12.1487
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-02	0.9 x 1.080 46.75	0.64 x 0.80	0.77	17.9155
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-02	0.9 x 3.150 46.75	0.64 x 0.80	0.77	52.2534
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-02	0.9 x 1.080 46.75	0.64 x 0.80	0.77	17.9155
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-ENSUITE-01	0.9 x 1.120 19.64	0.64 x 0.80	0.77	7.8049
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-LIVING ROOM	0.9 x 1.155 19.64	0.64 x 0.80	0.77	8.0488
Solid door 2013 Door, 00-ENTRANCE LOBBY	0.9 x 2.200 0.00	0.00 x 0.80	0.77	0.0000

7. Mean internal temperature

Temperature during heating periods in the living area, Th1 (°C)	21.00	(85)
Heating system responsiveness	1.00	

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau												
21.68	21.87	22.06	22.98	23.16	24.04	24.04	24.22	23.70	23.16	22.80	22.43	
alpha												
2.45	2.46	2.47	2.53	2.54	2.60	2.60	2.61	2.58	2.54	2.52	2.50	
Utilisation factor for gains for living area												
1.00	0.99	0.99	0.97	0.95	0.89	0.81	0.84	0.94	0.98	0.99	1.00	(86)
Mean internal temperature in living area T1												
17.74	17.98	18.43	19.10	19.73	20.33	20.66	20.60	20.12	19.30	18.45	17.77	(87)
Temperature during heating periods in rest of dwelling Th2												
19.45	19.46	19.47	19.52	19.53	19.58	19.58	19.58	19.56	19.53	19.51	19.49	(88)
Utilisation factor for gains for rest of dwelling												
1.00	0.99	0.98	0.97	0.93	0.83	0.67	0.73	0.90	0.97	0.99	1.00	(89)
Mean internal temperature in the rest of dwelling T2												
15.17	15.53	16.19	17.18	18.10	18.96	19.37	19.32	18.68	17.49	16.24	15.23	(90)

Living area fraction (36.43 / 970.92)	0.04	(91)
Mean internal temperature (for the whole dwelling)		

15.26	15.62	16.28	17.26	18.16	19.01	19.42	19.37	18.73	17.56	16.33	15.32	(92)
Apply adjustment to the mean internal temperature, where appropriate												
15.11	15.47	16.13	17.11	18.01	18.86	19.27	19.22	18.58	17.41	16.18	15.17	(93)

8. Space heating requirement

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains												
0.99	0.98	0.97	0.94	0.89	0.79	0.63	0.68	0.86	0.95	0.98	0.99	(94)
Useful gains												
3168.7	3930.9	4553.7	5037.4	5111.8	4448.1	3427.5	3425.4	3981.2	3758.0	3212.6	2957.5	(95)
Monthly average external temperature												
4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature												
19215.7	18631.7	16817.7	13760.0	10503.8	6831.2	4272.2	4481.8	7290.3	11321.9	15340.9	18850.8	(97)
Fraction of month for heating												
1.00	1.00	1.00	1.00	1.00	-	-	-	-	1.00	1.00	1.00	
Space heating requirement for each month, kWh/month												
11939.0	9878.9	9124.4	6280.3	4011.6	-	-	-	-	5627.5	8732.3	11824.6	

Total space heating requirement per year (kWh/year) (October to May)	67418.75	(98)
Space heating requirement per m² (kWh/m²/year)	69.44	(99)

8c. Space cooling requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Ref
External temperaturers	-	-	-	-	-	14.60	16.60	16.40	-	-	-	-		
Heat loss rate W	-	-	-	-	-	15065.0	11859.7	12094.3	-	-	-	-		(100)
Utilisation factor for loss	-	-	-	-	-	0.39	0.47	0.43	-	-	-	-		(101)
Useful loss W	-	-	-	-	-	5949.5	5522.0	5204.4	-	-	-	-		(102)
Internal gains W	0.00	0.00	0.00	0.00	0.00	1461.79	1408.07	1449.99	0.00	0.00	0.00	0.00		
Solar gains W	0.00	0.00	0.00	0.00	0.00	4894.7	4691.2	4192.3	0.00	0.00	0.00	0.00		
Gains W	-	-	-	-	-	6356.5	6099.3	5642.3	-	-	-	-		(103)
Fraction of month for cooling	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00		(103a)
Space heating kWh	-	-	-	-	-	1262.16	165.50	59.48	-	-	-	-		(98)
Space cooling kWh	-	-	-	-	-	293.02	429.52	325.82	-	-	-	-		(104)
Total													1048.36	(104)
Cooled fraction													0.10	(105)
Intermittency factor	-	-	-	-	-	0.25	0.25	0.25	-	-	-	-		(106)
Space cooling requirement for month	-	-	-	-	-	7.33	10.74	8.15	-	-	-	-		
Space cooling (June to August)													26.21	(107)
Space cooling requirement per m² (kWh/m²/year)													0.03	(108)

9a. Energy requirements

kWh/year

No secondary heating system selected

Fraction of space heat from main system(s)	1.0000	(202)
Efficiency of main heating system	93.90%	(206)
Cooling system energy efficiency ratio	4.29%	(209)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	11939.0	9878.9	9124.4	6280.3	4011.6	-	-	-	-	5627.5	8732.3	11824.6	(98)
Appendix Q - monthly energy saved (main heating system 1)	0.00	0.00	0.00	0.00	0.00	-	-	-	-	0.00	0.00	0.00	(210)
Space heating fuel (main heating system 1)	12714.6	10520.7	9717.2	6688.3	4272.3	-	-	-	-	5993.1	9299.6	12592.8	(211)
Appendix Q - monthly energy saved (main heating system 2)	0.00	0.00	0.00	0.00	0.00	-	-	-	-	0.00	0.00	0.00	(212)
Space heating fuel (main heating system 2)	0.00	0.00	0.00	0.00	0.00	-	-	-	-	0.00	0.00	0.00	(213)
Appendix Q - monthly energy saved (secondary heating system)	0.00	0.00	0.00	0.00	0.00	-	-	-	-	0.00	0.00	0.00	(214)
Space heating fuel (secondary)	0.00	0.00	0.00	0.00	0.00	-	-	-	-	0.00	0.00	0.00	(215)

<u>Water heating</u>

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water heating requirement	257.95	226.95	237.39	211.47	206.27	182.93	174.37	193.15	193.38	219.35	233.62	251.30	(64)
Efficiency of water heater 65.00 (216)	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	(217)
Water heating fuel	396.85	349.16	365.22	325.35	317.35	281.43	268.26	297.15	297.51	337.47	359.41	386.61	(219)

Annual totals	kWh/year	
Space heating fuel used, main system 1	71798.46	(211)
Space heating fuel (secondary)	0.00	(215)
Water heating fuel	3981.75	(219)
Space cooling fuel used	6.11	(221)

-	-	-	-	-	1.71	2.50	1.90	-	-	-	-	(221)

Electricity for pumps, fans and electric keep-hot		
central heating pump	30.00	(230c)
boiler with a fan-assisted flue	45.00	(230e)
Total electricity for the above, kWh/year	75.00	(231)
Electricity for lighting (9.00% fixed LEL)	2994.14	(232)
Energy saving/generation technologies		
Appendix Q -		
Energy saved or generated ():	0.000	(236a)
Energy used ():	0.000	(237a)
Total delivered energy for all uses	78855.47	(238)

10a. Fuel costs using Table 12 prices

	kWh/year	Fuel price p/kWh	£/year	
Space heating - main system 1	71798.458	3.480	2498.59	(240)
Space heating - main system 2	0.000	0.000	0.00	(241)
Water heating cost	3981.75	3.480	138.56	(247)
Space cooling	6.113	13.190	0.81	(248)
Mech vent fans cost	0.000	13.190	0.00	(249)
Pump/fan energy cost	75.000	13.190	9.89	(249)
Energy for lighting	2994.143	13.190	394.93	(250)
Additional standing charges			120.00	(251)
Electricity generated - PVs	0.000	0.000	0.00	(252)
Appendix Q -				
Energy saved or generated ():	0.000	0.000	0.00	(253)
Energy used ():	0.000	0.000	0.00	(254)
Total energy cost			3162.78	(255)

11a. SAP rating

	0.42	**(256)**
	1.31	**(257)**
SAP value	81.76	
	82	(258)
SAP band	**B**	

12a. Carbon dioxide emissions

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating, main system 1	71798.46	0.216	15508.47	(261)
Space heating, main system 2	0.00	0.000	0.00	(262)
Space heating, secondary	0.00	0.519	0.00	(263)
Water heating	3981.75	0.216	860.06	(264)
Space and water heating			16368.53	(265)
Space cooling	6.11	0.519	3.17	(266)
Electricity for pumps and fans	75.00	0.519	38.93	(267)
Electricity for lighting	2994.14	0.519	1553.96	(268)
Electricity generated - PVs	0.00	0.519	0.00	(269)
Electricity generated - µCHP	0.00	0.000	0.00	(269)
Appendix Q -				
Energy saved ():	0.00	0.000	0.00	(270)
Energy used ():	0.00	0.000	0.00	(271)
Total CO2, kg/year			17964.58	(272)

	kg/m²/year	
CO2 emissions per m²	**18.50**	(273)
EI value	76.30	(273a)
EI rating	**76**	(274)
EI band	**C**	

Calculation of stars for heating and DHW

Main heating energy efficiency	(3.48 / 0.9090) x (1 + (0.29 x 0.00)) = 3.8284, stars = 4
Main heating environmental impact	(0.2160 / 0.9090) x (1 + (0.29 x 0.00)) = 0.2376, stars = 4
Water heating energy efficiency	3.48 / 0.6500 = 5.3538, stars = 3
Water heating environmental impact	0.2160 / 0.6500 = 0.3323, stars = 3

10.3. Appendix 2 – SAP Worksheet 'Be Clean' Refurbished Existing Building

(Refer to Appendix 1. 'Be Clean' and 'Be Lean' SAP Worksheets are identical)

10.4. Appendix 3 – SAP Worksheet 'Be Green' Refurbished Existing Building

Project Information

Building type	Detached house		
Reference			
Date	18 January 2022		
Client	Marek Wojciechowski Architects	Project	2 Templewood Avenue
	66-68 Margaret Street		LONDON
	London		NW3 7XA
	W1W 8SR		
Tel:	020 7580 9336		

SAP 2012 worksheet for New extension to existing dwelling - calculation of energy ratings

1. Overall dwelling dimensions

	Area (m^2)	**Av. Storey height (m)**	**Volume (m^3)**	
Ground floor (1)	233.18	3.65	851.11	(3a)
Second floor	259.91	3.30	857.70	(3b)
Third floor	244.49	3.28	801.93	(3c)
	970.92			**(4)**
			2510.74	**(5)**

2. Ventilation rate

	main + seondary + other heating		m³ per hour	
Number of chimneys	0 + 0 + 0	x 40	0.00	(6a)
Number of open flues	2 + 0 + 0	x 20	40.00	(6b)
Number of intermittent fans	8	x 10	80.00	(7a)
Number of passive vents	0	x 10	0.00	(7b)
Number of flueless gas fires	0	x 40	0.00	(7c)

		Air changes per hour	
		0.05	**(8)**
Pressure test, result q50	5.00		(17)
Air permeability		0.30	(18)
		2.00	**(19)**
		0.85	**(20)**
Infiltration rate incorporating shelter factor		0.25	(21)

Infiltration rate modified for monthly wind speed

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70

52.50 (22)

Wind Factor

1.27	1.25	1.23	1.10	1.07	0.95	0.95	0.93	1.00	1.07	1.13	1.18

13.13 (22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.32	0.32	0.31	0.28	0.27	0.24	0.24	0.23	0.25	0.27	0.28	0.30

3.32 (22b)

Ventilation : natural ventilation, intermittent extract fans

Effective air change rate

0.55	0.55	0.55	0.54	0.54	0.53	0.53	0.53	0.53	0.54	0.54	0.54

(25)

3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²	U-value W/m²K	A x U W/K	kappa-value kJ/m²K	A x K kJ/K	
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 02-BED-5			**2.400**	**1.24 (1.30)**	2.97			(27)
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-BED-STAFF			**7.700**	**1.24 (1.30)**	9.52			(27)
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (East) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-STAIRS			**4.290**	**1.24 (1.30)**	5.30			(27)
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 02-BATH-FAMILY			**1.700**	**1.24 (1.30)**	2.10			(27)
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 02-BED-06			**1.700**	**1.24 (1.30)**	2.10			(27)
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BREAKFAST ROOM			**1.260**	**1.24 (1.30)**	1.56			(27)
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 02-BED-04			**2.530**	**1.24 (1.30)**	3.13			(27)
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-ANTE ROOM			**1.680**	**1.24 (1.30)**	2.08			(27)

4. Water heating energy requirements

		kWh/year	
Assumed occupancy, N		4.00	(42)
Annual average hot water usage in litres per day Vd,average		129.30	(43)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month												
142.23	137.06	131.88	126.71	121.54	116.37	116.37	121.54	126.71	131.88	137.06	142.23	(44)
Energy content of hot water used												
210.92	184.47	190.36	165.96	159.24	137.41	127.33	146.12	147.86	172.32	188.10	204.26	

Energy content (annual)		2034.36	(45)
Distribution loss			

31.64	27.67	28.55	24.89	23.89	20.61	19.10	21.92	22.18	25.85	28.22	30.64	(46)

Cylinder volume, l	210.00		(47)
Manufacturer's declared cylinder loss factor (kWh/day)	1.42		(48)
Temperature Factor	0.5400		(49)
Energy lost from hot water cylinder (kWh/day)		0.77	(55)

Total storage loss												
23.77	21.47	23.77	23.00	23.77	23.00	23.77	23.77	23.00	23.77	23.00	23.77	(56)
Net storage loss												
23.77	21.47	23.77	23.00	23.77	23.00	23.77	23.77	23.00	23.77	23.00	23.77	(57)
Primary loss												
23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)
Total heat required for water heating calculated for each month												
257.95	226.95	237.39	211.47	206.27	182.93	174.37	193.15	193.38	219.35	233.62	251.30	(62)
Output from water heater for each month, kWh/month												
257.95	226.95	237.39	211.47	206.27	182.93	174.37	193.15	193.38	219.35	233.62	251.30	(64)
											2588.14	(64)
Heat gains from water heating, kWh/month												
107.76	95.32	100.92	91.59	90.57	82.10	79.97	86.21	85.58	94.92	98.96	105.54	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains, Watts	240.25	240.25	240.25	240.25	240.25	240.25	240.25	240.25	240.25	240.25	240.25	240.25	(66)
Lighting gains	221.42	196.66	159.93	121.08	90.51	76.41	82.57	107.32	144.05	182.90	213.47	227.57	(67)
Appliances gains	1335.92	1349.78	1314.85	1240.48	1146.60	1058.37	999.43	985.56	1020.50	1094.87	1188.75	1276.98	(68)
Cooking gains	63.03	63.03	63.03	63.03	63.03	63.03	63.03	63.03	63.03	63.03	63.03	63.03	(69)
Pumps and fans gains	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
Losses e.g. evaporation (negative values)	-160.17	-160.17	-160.17	-160.17	-160.17	-160.17	-160.17	-160.17	-160.17	-160.17	-160.17	-160.17	(71)
Water heating gains	144.84	141.85	135.65	127.21	121.74	114.03	107.48	115.87	118.86	127.58	137.44	141.86	(72)
Total internal gains	1848.28	1834.40	1756.54	1634.89	1504.96	1394.93	1335.58	1354.87	1429.51	1551.46	1685.77	1792.52	(73)

6. Solar gains (calculation for January)

	Area & Flux	g & FF	Shading	Gains
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 02-BED-5	0.9 x 2.400 19.64	0.64 x 0.80	0.77	16.7248
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-BED-STAFF	0.9 x 7.700 46.75	0.64 x 0.80	0.77	127.7305
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (East) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-STAIRS	0.9 x 4.290 19.64	0.64 x 0.80	0.77	29.8956
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 02-BATH-FAMILY	0.9 x 1.700 10.63	0.64 x 0.80	0.77	6.4139
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 02-BED-06	0.9 x 1.700 10.63	0.64 x 0.80	0.77	6.4139
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BREAKFAST ROOM	0.9 x 1.260 19.64	0.64 x 0.80	0.77	8.7805
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 02-BED-04	0.9 x 2.530 46.75	0.64 x 0.80	0.77	41.9686
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-ANTE ROOM	0.9 x 1.680 10.63	0.64 x 0.80	0.77	6.3385

6. Solar gains (calculation for January)

	Area & Flux	g & FF	Shading	Gains
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-ANTE ROOM	0.9 x 1.680 10.63	0.64 x 0.80	0.77	6.3385
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-ANTE ROOM	0.9 x 1.120 10.63	0.64 x 0.80	0.77	4.2256
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, RF-PLAY ROOM	0.9 x 1.800 19.64	0.64 x 0.80	0.77	12.5436
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 02-BED-04	0.9 x 2.160 19.64	0.64 x 0.80	0.77	15.0523
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-POWDER ROOM-01	0.9 x 1.430 46.75	0.64 x 0.80	0.77	23.7214
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (East) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BAR	0.9 x 1.732 19.64	0.64 x 0.80	0.77	12.0732
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 02-BED-5	0.9 x 1.100 10.63	0.64 x 0.80	0.77	4.1502
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BREAKFAST ROOM	0.9 x 1.155 10.63	0.64 x 0.80	0.77	4.3577
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BREAKFAST ROOM	0.9 x 1.155 10.63	0.64 x 0.80	0.77	4.3577
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BREAKFAST ROOM	0.9 x 1.680 10.63	0.64 x 0.80	0.77	6.3385
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BREAKFAST ROOM	0.9 x 1.680 10.63	0.64 x 0.80	0.77	6.3385
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BREAKFAST ROOM	0.9 x 1.120 10.63	0.64 x 0.80	0.77	4.2256
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-RECEPTION ROOM	0.9 x 1.020 46.75	0.64 x 0.80	0.77	16.9201
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-RECEPTION ROOM	0.9 x 2.975 46.75	0.64 x 0.80	0.77	49.3504

6. Solar gains (calculation for January)

	Area & Flux	g & FF	Shading	Gains
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-RECEPTION ROOM	0.9 x 1.020 46.75	0.64 x 0.80	0.77	16.9201
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-RECEPTION ROOM	0.9 x 1.430 46.75	0.64 x 0.80	0.77	23.7214
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-LIVING ROOM	0.9 x 3.675 10.63	0.64 x 0.80	0.77	13.8654
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-LIVING ROOM	0.9 x 1.155 10.63	0.64 x 0.80	0.77	4.3577
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-LIVING ROOM	0.9 x 1.155 10.63	0.64 x 0.80	0.77	4.3577
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (East) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-MASTER	0.9 x 1.260 19.64	0.64 x 0.80	0.77	8.7805
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-DINING ROOM	0.9 x 1.020 46.75	0.64 x 0.80	0.77	16.9201
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-DINING ROOM	0.9 x 2.975 46.75	0.64 x 0.80	0.77	49.3504
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-DINING ROOM	0.9 x 1.020 46.75	0.64 x 0.80	0.77	16.9201
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-01	0.9 x 1.080 46.75	0.64 x 0.80	0.77	17.9155
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-01	0.9 x 1.080 46.75	0.64 x 0.80	0.77	17.9155
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-01	0.9 x 3.150 46.75	0.64 x 0.80	0.77	52.2534
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, RF-PLAY ROOM	0.9 x 1.815 10.63	0.64 x 0.80	0.77	6.8478
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BATH-MASTER	0.9 x 1.190 19.64	0.64 x 0.80	0.77	8.2927

6. Solar gains (calculation for January)

	Area & Flux	g & FF	Shading	Gains
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BATH-MASTER	0.9 x 1.190 19.64	0.64 x 0.80	0.77	8.2927
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (East) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 02-STAIRS	0.9 x 1.700 19.64	0.64 x 0.80	0.77	11.8468
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (East) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-LIVING ROOM	0.9 x 1.050 19.64	0.64 x 0.80	0.77	7.3171
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (East) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BREAKFAST ROOM	0.9 x 1.155 19.64	0.64 x 0.80	0.77	8.0488
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (East) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, RF-STAIRS	0.9 x 2.200 19.64	0.64 x 0.80	0.77	15.3311
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-02-LIVING	0.9 x 1.815 46.75	0.64 x 0.80	0.77	30.1079
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (East) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-ENSUITE-02	0.9 x 1.087 19.64	0.64 x 0.80	0.77	7.5784
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-MASTER-DRESSING	0.9 x 2.970 10.63	0.64 x 0.80	0.77	11.2055
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 02-BED-03	0.9 x 2.530 46.75	0.64 x 0.80	0.77	41.9686
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-01-LIVING	0.9 x 0.990 46.75	0.64 x 0.80	0.77	16.4225
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-01-LIVING	0.9 x 1.815 46.75	0.64 x 0.80	0.77	30.1079
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (East) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-LIVING-MASTER	0.9 x 1.087 19.64	0.64 x 0.80	0.77	7.5784
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-LIVING-MASTER	0.9 x 2.970 10.63	0.64 x 0.80	0.77	11.2055

6. Solar gains (calculation for January)

	Area & Flux	g & FF	Shading	Gains
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-LIVING-MASTER	0.9 x 1.080 10.63	0.64 x 0.80	0.77	4.0747
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-LIVING-MASTER	0.9 x 1.080 10.63	0.64 x 0.80	0.77	4.0747
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-MASTER	0.9 x 3.060 10.63	0.64 x 0.80	0.77	11.5451
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-MASTER	0.9 x 1.080 10.63	0.64 x 0.80	0.77	4.0747
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-MASTER	0.9 x 1.080 10.63	0.64 x 0.80	0.77	4.0747
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-GYM-CROSSFIT	0.9 x 7.700 46.75	0.64 x 0.80	0.77	127.7305
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-GYM-CARDIO	0.9 x 3.220 10.63	0.64 x 0.80	0.77	12.1487
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-02	0.9 x 1.080 46.75	0.64 x 0.80	0.77	17.9155
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-02	0.9 x 3.150 46.75	0.64 x 0.80	0.77	52.2534
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (South) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-BED-02	0.9 x 1.080 46.75	0.64 x 0.80	0.77	17.9155
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 01-ENSUITE-01	0.9 x 1.120 19.64	0.64 x 0.80	0.77	7.8049
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-LIVING ROOM	0.9 x 1.155 19.64	0.64 x 0.80	0.77	8.0488
Solid door 2013 Door, 00-ENTRANCE LOBBY	0.9 x 2.200 0.00	0.00 x 0.80	0.77	0.0000

7. Mean internal temperature

Temperature during heating periods in the living area, Th1 (°C) 21.00 (85)
Heating system responsiveness 1.00

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau												
31.64	31.68	31.73	31.93	31.97	32.15	32.15	32.18	32.08	31.97	31.89	31.81	
alpha												
3.11	3.11	3.12	3.13	3.13	3.14	3.14	3.15	3.14	3.13	3.13	3.12	
Utilisation factor for gains for living area												
1.00	1.00	0.99	0.97	0.94	0.86	0.75	0.80	0.93	0.98	1.00	1.00	(86)
Mean internal temperature in living area T1												
18.53	18.76	19.13	19.64	20.16	20.59	20.82	20.78	20.41	19.74	19.04	18.50	(87)
Temperature during heating periods in rest of dwelling Th2												
19.88	19.88	19.88	19.89	19.89	19.89	19.89	19.89	19.89	19.89	19.88	19.88	(88)
Utilisation factor for gains for rest of dwelling												
1.00	0.99	0.99	0.97	0.92	0.80	0.63	0.69	0.89	0.98	0.99	1.00	(89)
Mean internal temperature in the rest of dwelling T2												
16.55	16.87	17.43	18.17	18.91	19.50	19.78	19.73	19.28	18.32	17.30	16.50	(90)

Living area fraction (36.43 / 970.92) 0.04 (91)
Mean internal temperature (for the whole dwelling)

16.62	16.94	17.49	18.23	18.96	19.55	19.82	19.77	19.32	18.37	17.36	16.57	(92)
Apply adjustment to the mean internal temperature, where appropriate												
16.62	16.94	17.49	18.23	18.96	19.55	19.82	19.77	19.32	18.37	17.36	16.57	(93)

8. Space heating requirement

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains												
0.99	0.99	0.98	0.95	0.89	0.78	0.62	0.68	0.87	0.96	0.99	1.00	(94)
Useful gains												
2983.5	3779.8	4447.9	4969.5	5051.3	4359.6	3336.7	3348.6	3901.2	3636.4	3040.3	2763.0	(95)
Monthly average external temperature												
4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature												
15009.1	14649.7	13351.6	11258.2	8747.7	5928.4	3854.4	4039.0	6268.8	9367.8	12400.4	14987.0	(97)
Fraction of month for heating												
1.00	1.00	1.00	1.00	1.00	-	-	-	-	1.00	1.00	1.00	
Space heating requirement for each month, kWh/month												
8947.0	7304.6	6624.3	4527.9	2750.1	-	-	-	-	4264.2	6739.3	9094.7	

Total space heating requirement per year (kWh/year) (October to May) 50252.04 (98)
Space heating requirement per m² (kWh/m²/year) 51.76 (99)

8c. Space cooling requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
External temperaturers	-	-	-	-	-	14.60	16.60	16.40	-	-	-	-	
Heat loss rate W	-	-	-	-	-	11268.3	8870.8	9101.1	-	-	-	-	(100)
Utilisation factor for loss	-	-	-	-	-	0.51	0.60	0.55	-	-	-	-	(101)
Useful loss W	-	-	-	-	-	5799.2	5306.8	5021.4	-	-	-	-	(102)
Internal gains W	0.00	0.00	0.00	0.00	0.00	1391.93	1332.58	1351.87	0.00	0.00	0.00	0.00	
Solar gains W	0.00	0.00	0.00	0.00	0.00	4894.7	4691.2	4192.3	0.00	0.00	0.00	0.00	
Gains W	-	-	-	-	-	6286.7	6023.8	5544.2	-	-	-	-	(103)
Fraction of month for cooling	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	(103a)
Space heating kWh	-	-	-	-	-	872.03	123.93	47.42	-	-	-	-	(98)
Space cooling kWh	-	-	-	-	-	350.94	533.45	388.95	-	-	-	-	(104)

Total	1273.34	(104)
Cooled fraction	0.10	(105)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Intermittency factor	-	-	-	-	-	0.25	0.25	0.25	-	-	-	-	(106)
Space cooling requirement for month	-	-	-	-	-	8.77	13.34	9.72	-	-	-	-	

Space cooling (June to August)	31.83	(107)
Space cooling requirement per m² (kWh/m²/year)	0.03	(108)

9a. Energy requirements

kWh/year

No secondary heating system selected

Fraction of space heat from main system(s)	1.0000	(202)
Efficiency of main heating system	249.90%	(206)
Cooling system energy efficiency ratio	6.22%	(209)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	8947.0	7304.6	6624.3	4527.9	2750.1	-	-	-	-	4264.2	6739.3	9094.7	(98)
Appendix Q - monthly energy saved (main heating system 1)	0.00	0.00	0.00	0.00	0.00	-	-	-	-	0.00	0.00	0.00	(210)
Space heating fuel (main heating system 1)	3580.2	2923.0	2650.8	1811.88	1100.50	-	-	-	-	1706.35	2696.8	3639.3	(211)
Appendix Q - monthly energy saved (main heating system 2)	0.00	0.00	0.00	0.00	0.00	-	-	-	-	0.00	0.00	0.00	(212)
Space heating fuel (main heating system 2)	0.00	0.00	0.00	0.00	0.00	-	-	-	-	0.00	0.00	0.00	(213)
Appendix Q - monthly energy saved (secondary heating system)	0.00	0.00	0.00	0.00	0.00	-	-	-	-	0.00	0.00	0.00	(214)
Space heating fuel (secondary)	0.00	0.00	0.00	0.00	0.00	-	-	-	-	0.00	0.00	0.00	(215)

<u>Water heating</u>

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water heating requirement	257.95	226.95	237.39	211.47	206.27	182.93	174.37	193.15	193.38	219.35	233.62	251.30	(64)
Efficiency of water heater 65.00													(216)
	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	(217)
Water heating fuel	396.85	349.16	365.22	325.35	317.35	281.43	268.26	297.15	297.51	337.47	359.41	386.61	(219)

Annual totals	kWh/year	
Space heating fuel used, main system 1	20108.86	(211)
Space heating fuel (secondary)	0.00	(215)
Water heating fuel	3981.75	(219)
Space cooling fuel used	5.12	(221)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
-	-	-	-	-	1.41	2.14	1.56	-	-	-	-	(221)

Electricity for pumps, fans and electric keep-hot		
central heating pump	30.00	(230c)
Total electricity for the above, kWh/year	30.00	(231)
Electricity for lighting (100.00% fixed LEL)	1564.10	(232)
Energy saving/generation technologies		
Appendix Q -		
Energy saved or generated ():	0.000	(236a)
Energy used ():	0.000	(237a)
Total delivered energy for all uses	25689.83	(238)

10a. Fuel costs using Table 12 prices

	kWh/year	Fuel price p/kWh	£/year	
Space heating - main system 1	20108.861	13.190	2652.36	(240)
Space heating - main system 2	0.000	0.000	0.00	(241)
High-rate percentage	0.000%			(243)
Low-rate percentage	0.000%			(244)
High-rate cost	0.00	0.000	0.00	(245)
Low-rate	0.00	0.000	0.00	(246)
Space cooling	5.115	13.190	0.67	(248)
Mech vent fans cost	0.000	13.190	0.00	(249)
Pump/fan energy cost	30.000	13.190	3.96	(249)
Energy for lighting	1564.105	13.190	206.31	(250)
Additional standing charges			120.00	(251)
Electricity generated - PVs	0.000	0.000	0.00	(252)
Appendix Q -				
Energy saved or generated ():	0.000	0.000	0.00	(253)
Energy used ():	0.000	0.000	0.00	(254)
Total energy cost			3121.86	(255)

11a. SAP rating

	0.42	**(256)**
	1.29	**(257)**
SAP value	82.00	
	82	(258)
SAP band	**B**	

12a. Carbon dioxide emissions

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating, main system 1	20108.86	0.519	10436.50	(261)
Space heating, main system 2	0.00	0.000	0.00	(262)
Space heating, secondary	0.00	0.519	0.00	(263)
Water heating	3981.75	0.216	860.06	(264)
Space and water heating			11296.56	(265)
Space cooling	5.12	0.519	2.65	(266)
Electricity for pumps and fans	30.00	0.519	15.57	(267)
Electricity for lighting	1564.10	0.519	811.77	(268)
Electricity generated - PVs	0.00	0.519	0.00	(269)
Electricity generated - µCHP	0.00	0.000	0.00	(269)
Appendix Q -				
Energy saved ():	0.00	0.000	0.00	(270)
Energy used ():	0.00	0.000	0.00	(271)
Total CO2, kg/year			12126.55	(272)

	kg/m²/year	
CO2 emissions per m²	**12.49**	(273)
EI value	84.01	(273a)
EI rating	**84**	(274)
EI band	**B**	

Calculation of stars for heating and DHW

Main heating energy efficiency	(13.19 / 2.4990) x (1 + (0.29 x 0.00)) = 5.2781, stars = 4
Main heating environmental impact	(0.5190 / 2.4990) x (1 + (0.29 x 0.00)) = 0.2077, stars = 5
Water heating energy efficiency	3.48 / 0.6500 = 5.3538, stars = 3
Water heating environmental impact	0.2160 / 0.6500 = 0.3323, stars = 3

10.1. Appendix 4 – SAP Worksheet 'Be Lean' New Extension

Project Information

Building type	Detached house		
Reference			
Date	18 January 2022		
Client	Marek Wojciechowski Architects 66-68 Margaret Street London W1W 8SR	Project	2 Templewood Avenue LONDON NW3 7XA
Tel:	020 7580 9336		

SAP 2012 worksheet for New dwelling as designed - calculation of energy ratings

1. Overall dwelling dimensions

	Area (m²)	**Av. Storey height (m)**	**Volume (m³)**	
Ground floor (1)	159.39	3.17	505.27	(3a)
First floor	58.58	2.80	164.02	(3b)
	217.97			**(4)**
			669.29	**(5)**

2. Ventilation rate

	main + seondary + other heating		m³ per hour	
Number of chimneys	0 + 0 + 0	x 40	0.00	(6a)
Number of open flues	2 + 0 + 0	x 20	40.00	(6b)
Number of intermittent fans	2	x 10	20.00	(7a)
Number of passive vents	0	x 10	0.00	(7b)
Number of flueless gas fires	0	x 40	0.00	(7c)

		Air changes per hour	
		0.09	**(8)**
Pressure test, result q50	5.00		(17)
Air permeability		0.34	(18)
		2.00	**(19)**
		0.85	**(20)**
Infiltration rate incorporating shelter factor		0.29	(21)

Infiltration rate modified for monthly wind speed

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70

52.50 (22)

Wind Factor

1.27	1.25	1.23	1.10	1.07	0.95	0.95	0.93	1.00	1.07	1.13	1.18

13.13 (22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.37	0.36	0.35	0.32	0.31	0.27	0.27	0.27	0.29	0.31	0.32	0.34

3.79 (22b)

Ventilation : natural ventilation, intermittent extract fans

Effective air change rate

0.57	0.57	0.56	0.55	0.55	0.54	0.54	0.54	0.54	0.55	0.55	0.56	(25)

3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²	U-value W/m²K	A x U W/K	kappa-value kJ/m²K	A x K kJ/K	
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-STUDY			**3.360**	**1.24 (1.30)**	4.15			(27)
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (East) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-POOL			**18.340**	**1.24 (1.30)**	22.66			(27)
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-GARAGE			**2.640**	**1.24 (1.30)**	3.26			(27)
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-STUDY			**1.358**	**1.24 (1.30)**	1.68			(27)
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BOOT ROOM			**2.640**	**1.24 (1.30)**	3.26			(27)
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BOOT ROOM			**2.640**	**1.24 (1.30)**	3.26			(27)
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-POOL			**6.160**	**1.24 (1.30)**	7.61			(27)
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-STUDY			**1.358**	**1.24 (1.30)**	1.68			(27)

4. Water heating energy requirements

	kWh/year	
Assumed occupancy, N	3.03	(42)
Annual average hot water usage in litres per day Vd,average	106.05	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month	116.66	112.41	108.17	103.93	99.69	95.45	95.45	99.69	103.93	108.17	112.41	116.66	(44)
Energy content of hot water used	173.00	151.30	156.13	136.12	130.61	112.71	104.44	119.85	121.28	141.34	154.28	167.54	

Energy content (annual)	1668.59	(45)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Distribution loss	25.95	22.70	23.42	20.42	19.59	16.91	15.67	17.98	18.19	21.20	23.14	25.13	(46)

Cylinder volume, l	210.00		(47)
Manufacturer's declared cylinder loss factor (kWh/day)	1.42		(48)
Temperature Factor	0.5400		(49)
Energy lost from hot water cylinder (kWh/day)		0.77	(55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Total storage loss	23.77	21.47	23.77	23.00	23.77	23.00	23.77	23.77	23.00	23.77	23.00	23.77	(56)
Net storage loss	23.77	21.47	23.77	23.00	23.77	23.00	23.77	23.77	23.00	23.77	23.00	23.77	(57)
Primary loss	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)
Total heat required for water heating calculated for each month	220.03	193.79	203.17	181.64	177.64	158.22	151.47	166.88	166.79	188.37	199.80	214.57	(62)
Output from water heater for each month, kWh/month	220.03	193.79	203.17	181.64	177.64	158.22	151.47	166.88	166.79	188.37	199.80	214.57	(64)
												2222.37	(64)
Heat gains from water heating, kWh/month	95.15	84.29	89.54	81.67	81.05	73.89	72.35	77.48	76.74	84.62	87.71	93.33	(65)

5. Internal gains

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains, Watts												
181.52	181.52	181.52	181.52	181.52	181.52	181.52	181.52	181.52	181.52	181.52	181.52	(66)
Lighting gains												
86.44	76.77	62.43	47.27	35.33	29.83	32.23	41.90	56.23	71.40	83.33	88.84	(67)
Appliances gains												
578.83	584.84	569.70	537.48	496.81	458.58	433.04	427.03	442.17	474.39	515.07	553.29	(68)
Cooking gains												
56.18	56.18	56.18	56.18	56.18	56.18	56.18	56.18	56.18	56.18	56.18	56.18	(69)
Pumps and fans gains												
3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
Losses e.g. evaporation (negative values)												
-121.01	-121.01	-121.01	-121.01	-121.01	-121.01	-121.01	-121.01	-121.01	-121.01	-121.01	-121.01	(71)
Water heating gains												
127.89	125.44	120.35	113.43	108.94	102.62	97.25	104.13	106.58	113.74	121.82	125.45	(72)
Total internal gains												
912.84	906.73	872.17	817.87	760.77	710.71	682.20	692.74	724.66	779.21	839.90	887.26	(73)

6. Solar gains (calculation for January)

	Area & Flux	g & FF	Shading	Gains
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-STUDY	0.9 x 3.360 10.63	0.64 x 0.80	0.77	12.6769
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (East) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-POOL	0.9 x 18.340 19.64	0.64 x 0.80	0.77	127.8056
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-GARAGE	0.9 x 2.640 19.64	0.64 x 0.80	0.77	18.3973
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-STUDY	0.9 x 1.358 11.28	0.64 x 0.80	0.77	5.4350
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BOOT ROOM	0.9 x 2.640 19.64	0.64 x 0.80	0.77	18.3973
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BOOT ROOM	0.9 x 2.640 19.64	0.64 x 0.80	0.77	18.3973
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-POOL	0.9 x 6.160 19.64	0.64 x 0.80	0.77	42.9271
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-STUDY	0.9 x 1.358 11.28	0.64 x 0.80	0.77	5.4350

6. Solar gains (calculation for January)

	Area & Flux	g & FF	Shading	Gains	
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-POOL	0.9 x 8.120 10.63	0.64 x 0.80	0.77	30.6359	
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-POOL	0.9 x 8.120 10.63	0.64 x 0.80	0.77	30.6359	
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-POOL	0.9 x 8.120 10.63	0.64 x 0.80	0.77	30.6359	
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-POOL	0.9 x 8.120 10.63	0.64 x 0.80	0.77	30.6359	
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-POOL	0.9 x 4.200 10.63	0.64 x 0.80	0.77	15.8462	
Solid door 2013 Door, 00-BOOT ROOM	0.9 x 2.160 0.00	0.00 x 0.80	0.77	0.0000	
Total solar gains, January				387.86	(83-1)

Solar gains

387.86	752.78	1258.27	1914.95	2450.4	2561.9	2416.5	2000.7	1484.90	895.11	481.74	320.60	(83)

Total gains

1300.70	1659.51	2130.4	2732.8	3211.2	3272.6	3098.7	2693.5	2209.6	1674.32	1321.64	1207.87	(84)

Lighting calculations

	Area	g	FF x Shading	
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-STUDY	0.9 x 3.36	0.70	0.80 x 0.83	1.41
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (East) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-POOL	0.9 x 18.34	0.70	0.80 x 0.83	7.67
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-GARAGE	0.9 x 2.64	0.70	0.80 x 0.83	1.10
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-STUDY	0.9 x 1.36	0.70	0.80 x 0.83	0.57
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BOOT ROOM	0.9 x 2.64	0.70	0.80 x 0.83	1.10
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BOOT ROOM	0.9 x 2.64	0.70	0.80 x 0.83	1.10
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-POOL	0.9 x 6.16	0.70	0.80 x 0.83	2.58

Lighting calculations

	Area	g	FF x Shading	
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthWest)	0.9 x 1.36	0.70	0.80 x 0.83	0.57
New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-STUDY				
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North)	0.9 x 8.12	0.70	0.80 x 0.83	3.40
New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-POOL				
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North)	0.9 x 8.12	0.70	0.80 x 0.83	3.40
New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-POOL				
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North)	0.9 x 8.12	0.70	0.80 x 0.83	3.40
New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-POOL				
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North)	0.9 x 8.12	0.70	0.80 x 0.83	3.40
New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-POOL				
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North)	0.9 x 4.20	0.70	0.80 x 0.83	1.76
New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-POOL				

GL = 31.45 / 217.97 = 0.144
C1 = 0.500
C2 = 0.960
El = 611

7. Mean internal temperature

Temperature during heating periods in the living area, Th1 (°C) 21.00 (85)
Heating system responsiveness 1.00

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	27.88	27.93	27.98	28.22	28.26	28.47	28.47	28.51	28.39	28.26	28.17	28.08	
alpha	2.86	2.86	2.87	2.88	2.88	2.90	2.90	2.90	2.89	2.88	2.88	2.87	
Utilisation factor for gains for living area	0.99	0.97	0.94	0.85	0.71	0.54	0.42	0.49	0.73	0.92	0.98	0.99	(86)
Mean internal temperature in living area T1	18.62	18.93	19.46	20.12	20.61	20.87	20.96	20.93	20.68	19.98	19.17	18.56	(87)
Temperature during heating periods in rest of dwelling Th2	19.72	19.72	19.72	19.73	19.73	19.74	19.74	19.74	19.74	19.73	19.73	19.72	(88)
Utilisation factor for gains for rest of dwelling	0.98	0.97	0.92	0.82	0.65	0.46	0.31	0.37	0.65	0.90	0.97	0.99	(89)
Mean internal temperature in the rest of dwelling T2	16.58	17.03	17.79	18.71	19.35	19.64	19.72	19.71	19.46	18.55	17.39	16.50	(90)

Living area fraction (11.36 / 217.97) 0.05 (91)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Mean internal temperature (for the whole dwelling)	16.68	17.13	17.88	18.79	19.41	19.71	19.78	19.77	19.53	18.62	17.48	16.61	(92)
Apply adjustment to the mean internal temperature, where appropriate	16.53	16.98	17.73	18.64	19.26	19.56	19.63	19.62	19.38	18.47	17.33	16.46	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains	0.97	0.95	0.89	0.78	0.62	0.44	0.30	0.36	0.63	0.87	0.95	0.98	(94)
Useful gains	1262.47	1570.58	1902.96	2139.7	1999.61	1447.60	924.41	965.67	1385.11	1449.18	1259.78	1178.31	(95)
Monthly average external temperature	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature	3895.0	3839.1	3562.4	3062.3	2375.1	1545.60	945.69	1002.19	1649.05	2472.4	3223.6	3875.5	(97)
Fraction of month for heating	1.00	1.00	1.00	1.00	1.00	-	-	-	-	1.00	1.00	1.00	
Space heating requirement for each month, kWh/month	1958.63	1524.42	1234.66	664.26	279.36	-	-	-	-	761.30	1413.96	2006.7	

Total space heating requirement per year (kWh/year) (October to May)	9843.29	(98)
Space heating requirement per m² (kWh/m²/year)	45.16	(99)

8c. Space cooling requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
External temperaturers	-	-	-	-	-	14.60	16.60	16.40	-	-	-	-	
Heat loss rate W	-	-	-	-	-	2930.1	2306.7	2365.8	-	-	-	-	(100)
Utilisation factor for loss	-	-	-	-	-	0.82	0.87	0.83	-	-	-	-	(101)
Useful loss W	-	-	-	-	-	2411.5	2014.8	1956.75	-	-	-	-	(102)
Internal gains W	0.00	0.00	0.00	0.00	0.00	707.71	679.20	689.74	0.00	0.00	0.00	0.00	
Solar gains W	0.00	0.00	0.00	0.00	0.00	2994.4	2824.5	2338.5	0.00	0.00	0.00	0.00	
Gains W	-	-	-	-	-	3702.1	3503.7	3028.3	-	-	-	-	(103)
Fraction of month for cooling	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	(103a)
Space heating kWh	-	-	-	-	-	149.28	23.93	1.23	-	-	-	-	(98)
Space cooling kWh	-	-	-	-	-	929.28	1107.73	797.21	-	-	-	-	(104)

Total	2834.22	(104)
Cooled fraction	0.10	(105)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Intermittency factor	-	-	-	-	-	0.25	0.25	0.25	-	-	-	-	(106)
Space cooling requirement for month	-	-	-	-	-	23.23	27.69	19.93	-	-	-	-	

Space cooling (June to August)	70.86	(107)
Space cooling requirement per m² (kWh/m²/year)	0.33	(108)

9a. Energy requirements

kWh/year

No secondary heating system selected

Fraction of space heat from main system(s)	1.0000	(202)
Efficiency of main heating system	93.90%	(206)
Cooling system energy efficiency ratio	4.29%	(209)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement	1958.63	1524.42	1234.66	664.26	279.36	-	-	-	-	761.30	1413.96	2006.7	(98)
Appendix Q - monthly energy saved (main heating system 1)	0.00	0.00	0.00	0.00	0.00	-	-	-	-	0.00	0.00	0.00	(210)
Space heating fuel (main heating system 1)	2085.9	1623.45	1314.86	707.41	297.51	-	-	-	-	810.75	1505.82	2137.1	(211)
Appendix Q - monthly energy saved (main heating system 2)	0.00	0.00	0.00	0.00	0.00	-	-	-	-	0.00	0.00	0.00	(212)
Space heating fuel (main heating system 2)	0.00	0.00	0.00	0.00	0.00	-	-	-	-	0.00	0.00	0.00	(213)
Appendix Q - monthly energy saved (secondary heating system)	0.00	0.00	0.00	0.00	0.00	-	-	-	-	0.00	0.00	0.00	(214)
Space heating fuel (secondary)	0.00	0.00	0.00	0.00	0.00	-	-	-	-	0.00	0.00	0.00	(215)

<u>Water heating</u>

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water heating requirement	220.03	193.79	203.17	181.64	177.64	158.22	151.47	166.88	166.79	188.37	199.80	214.57	(64)
Efficiency of water heater 65.00 (216)	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	(217)
Water heating fuel	338.51	298.13	312.56	279.44	273.30	243.42	233.03	256.74	256.60	289.80	307.38	330.11	(219)

Annual totals	kWh/year	
Space heating fuel used, main system 1	10482.74	(211)
Space heating fuel (secondary)	0.00	(215)
Water heating fuel	3419.03	(219)
Space cooling fuel used	16.53	(221)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	-	-	-	-	-	5.42	6.46	4.65	-	-	-	-	(221)

Electricity for pumps, fans and electric keep-hot		
central heating pump	30.00	(230c)
boiler with a fan-assisted flue	45.00	(230e)
Total electricity for the above, kWh/year	75.00	(231)
Electricity for lighting (100.00% fixed LEL)	610.59	(232)
Energy saving/generation technologies		
Appendix Q -		
Energy saved or generated ():	0.000	(236a)
Energy used ():	0.000	(237a)
Total delivered energy for all uses	14603.89	(238)

10a. Fuel costs using Table 12 prices

	kWh/year	Fuel price p/kWh	£/year	
Space heating - main system 1	10482.740	3.480	364.80	(240)
Space heating - main system 2	0.000	0.000	0.00	(241)
Water heating cost	3419.03	3.480	118.98	(247)
Space cooling	16.526	13.190	2.18	(248)
Mech vent fans cost	0.000	13.190	0.00	(249)
Pump/fan energy cost	75.000	13.190	9.89	(249)
Energy for lighting	610.594	13.190	80.54	(250)
Additional standing charges			120.00	(251)
Electricity generated - PVs	0.000	0.000	0.00	(252)
Appendix Q -				
Energy saved or generated ():	0.000	0.000	0.00	(253)
Energy used ():	0.000	0.000	0.00	(254)
Total energy cost			696.39	(255)

11a. SAP rating

	0.42	**(256)**
	1.11	**(257)**
SAP value	84.48	
	84	(258)
SAP band	**B**	

12a. Carbon dioxide emissions

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating, main system 1	10482.74	0.216	2264.27	(261)
Space heating, main system 2	0.00	0.000	0.00	(262)
Space heating, secondary	0.00	0.519	0.00	(263)
Water heating	3419.03	0.216	738.51	(264)
Space and water heating			3002.78	(265)
Space cooling	16.53	0.519	8.58	(266)
Electricity for pumps and fans	75.00	0.519	38.93	(267)
Electricity for lighting	610.59	0.519	316.90	(268)
Electricity generated - PVs	0.00	0.519	0.00	(269)
Electricity generated - µCHP	0.00	0.000	0.00	(269)
Appendix Q -				
Energy saved ():	0.00	0.000	0.00	(270)
Energy used ():	0.00	0.000	0.00	(271)
Total CO2, kg/year			3367.18	(272)

	kg/m²/year	
CO2 emissions per m²	**15.45**	(273)
EI value	82.84	(273a)
EI rating	**83**	(274)
EI band	**B**	

Calculation of stars for heating and DHW

Main heating energy efficiency	(3.48 / 0.9090) x (1 + (0.29 x 0.00)) = 3.8284, stars = 4
Main heating environmental impact	(0.2160 / 0.9090) x (1 + (0.29 x 0.00)) = 0.2376, stars = 4
Water heating energy efficiency	3.48 / 0.6500 = 5.3538, stars = 3
Water heating environmental impact	0.2160 / 0.6500 = 0.3323, stars = 3

10.2. Appendix 5 – SAP Worksheet 'Be Clean' New Extension

(Refer to Appendix 4. 'Be Clean' and 'Be Lean' SAP Worksheets are identical)

10.3. Appendix 6 – SAP Worksheet 'Be Green' New Extension

Project Information

Building type Detached house

Reference			
Date	18 January 2022		
Client	Marek Wojciechowski Architects 66-68 Margaret Street London W1W 8SR	Project	2 Templewood Avenue LONDON NW3 7XA
Tel:	020 7580 9336		

SAP 2012 worksheet for New extension to existing dwelling - calculation of energy ratings

1. Overall dwelling dimensions

	Area (m²)	Av. Storey height (m)	Volume (m³)	
Ground floor (1)	159.39	3.17	505.27	(3a)
First floor	58.58	2.80	164.02	(3b)
	217.97			**(4)**
			669.29	**(5)**

2. Ventilation rate

	main + seondary + other heating		m³ per hour	
Number of chimneys	0 + 0 + 0	x 40	0.00	(6a)
Number of open flues	2 + 0 + 0	x 20	40.00	(6b)
Number of intermittent fans	2	x 10	20.00	(7a)
Number of passive vents	0	x 10	0.00	(7b)
Number of flueless gas fires	0	x 40	0.00	(7c)

		Air changes per hour	
		0.09	**(8)**
Pressure test, result q50	5.00		(17)
Air permeability		0.34	(18)
		2.00	**(19)**
		0.85	**(20)**
Infiltration rate incorporating shelter factor		0.29	(21)

Infiltration rate modified for monthly wind speed

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70

52.50 (22)

Wind Factor

1.27	1.25	1.23	1.10	1.07	0.95	0.95	0.93	1.00	1.07	1.13	1.18

13.13 (22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.37	0.36	0.35	0.32	0.31	0.27	0.27	0.27	0.29	0.31	0.32	0.34

3.79 (22b)

Ventilation : natural ventilation, intermittent extract fans

Effective air change rate

0.57	0.57	0.56	0.55	0.55	0.54	0.54	0.54	0.54	0.55	0.55	0.56	(25)

3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²	U-value W/m²K	A x U W/K	kappa-value kJ/m²K	A x K kJ/K	
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-STUDY			**3.360**	**1.24 (1.30)**	4.15			(27)
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (East) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-POOL			**18.340**	**1.24 (1.30)**	22.66			(27)
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-GARAGE			**2.640**	**1.24 (1.30)**	3.26			(27)
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-STUDY			**1.358**	**1.24 (1.30)**	1.68			(27)
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BOOT ROOM			**2.640**	**1.24 (1.30)**	3.26			(27)
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BOOT ROOM			**2.640**	**1.24 (1.30)**	3.26			(27)
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-POOL			**6.160**	**1.24 (1.30)**	7.61			(27)
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-STUDY			**1.358**	**1.24 (1.30)**	1.68			(27)

4. Water heating energy requirements

	kWh/year	
Assumed occupancy, N	3.03	(42)
Annual average hot water usage in litres per day Vd,average	106.05	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month	116.66	112.41	108.17	103.93	99.69	95.45	95.45	99.69	103.93	108.17	112.41	116.66	(44)
Energy content of hot water used	173.00	151.30	156.13	136.12	130.61	112.71	104.44	119.85	121.28	141.34	154.28	167.54	

		kWh/year	
Energy content (annual)		1668.59	(45)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Distribution loss	25.95	22.70	23.42	20.42	19.59	16.91	15.67	17.98	18.19	21.20	23.14	25.13	(46)

Cylinder volume, l	210.00		(47)
Manufacturer's declared cylinder loss factor (kWh/day)	1.42		(48)
Temperature Factor	0.5400		(49)
Energy lost from hot water cylinder (kWh/day)		0.77	(55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Total storage loss	23.77	21.47	23.77	23.00	23.77	23.00	23.77	23.77	23.00	23.77	23.00	23.77	(56)
Net storage loss	23.77	21.47	23.77	23.00	23.77	23.00	23.77	23.77	23.00	23.77	23.00	23.77	(57)
Primary loss	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)
Total heat required for water heating calculated for each month	220.03	193.79	203.17	181.64	177.64	158.22	151.47	166.88	166.79	188.37	199.80	214.57	(62)
Output from water heater for each month, kWh/month	220.03	193.79	203.17	181.64	177.64	158.22	151.47	166.88	166.79	188.37	199.80	214.57	(64)
												2222.37	(64)
Heat gains from water heating, kWh/month	95.15	84.29	89.54	81.67	81.05	73.89	72.35	77.48	76.74	84.62	87.71	93.33	(65)

5. Internal gains

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains, Watts												
181.52	181.52	181.52	181.52	181.52	181.52	181.52	181.52	181.52	181.52	181.52	181.52	(66)
Lighting gains												
86.44	76.77	62.43	47.27	35.33	29.83	32.23	41.90	56.23	71.40	83.33	88.84	(67)
Appliances gains												
578.83	584.84	569.70	537.48	496.81	458.58	433.04	427.03	442.17	474.39	515.07	553.29	(68)
Cooking gains												
56.18	56.18	56.18	56.18	56.18	56.18	56.18	56.18	56.18	56.18	56.18	56.18	(69)
Pumps and fans gains												
3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
Losses e.g. evaporation (negative values)												
-121.01	-121.01	-121.01	-121.01	-121.01	-121.01	-121.01	-121.01	-121.01	-121.01	-121.01	-121.01	(71)
Water heating gains												
127.89	125.44	120.35	113.43	108.94	102.62	97.25	104.13	106.58	113.74	121.82	125.45	(72)
Total internal gains												
912.84	906.73	872.17	817.87	760.77	710.71	682.20	692.74	724.66	779.21	839.90	887.26	(73)

6. Solar gains (calculation for January)

	Area & Flux	g & FF	Shading	Gains
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-STUDY	0.9 x 3.360 10.63	0.64 x 0.80	0.77	12.6769
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (East) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-POOL	0.9 x 18.340 19.64	0.64 x 0.80	0.77	127.8056
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-GARAGE	0.9 x 2.640 19.64	0.64 x 0.80	0.77	18.3973
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-STUDY	0.9 x 1.358 11.28	0.64 x 0.80	0.77	5.4350
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BOOT ROOM	0.9 x 2.640 19.64	0.64 x 0.80	0.77	18.3973
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BOOT ROOM	0.9 x 2.640 19.64	0.64 x 0.80	0.77	18.3973
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-POOL	0.9 x 6.160 19.64	0.64 x 0.80	0.77	42.9271
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthWest) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-STUDY	0.9 x 1.358 11.28	0.64 x 0.80	0.77	5.4350

6. Solar gains (calculation for January)

	Area & Flux	g & FF	Shading	Gains	
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-POOL	0.9 x 8.120 10.63	0.64 x 0.80	0.77	30.6359	
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-POOL	0.9 x 8.120 10.63	0.64 x 0.80	0.77	30.6359	
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-POOL	0.9 x 8.120 10.63	0.64 x 0.80	0.77	30.6359	
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-POOL	0.9 x 8.120 10.63	0.64 x 0.80	0.77	30.6359	
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-POOL	0.9 x 4.200 10.63	0.64 x 0.80	0.77	15.8462	
Solid door 2013 Door, 00-BOOT ROOM	0.9 x 2.160 0.00	0.00 x 0.80	0.77	0.0000	
Total solar gains, January				387.86	(83-1)

Solar gains

387.86	752.78	1258.27	1914.95	2450.4	2561.9	2416.5	2000.7	1484.90	895.11	481.74	320.60	(83)

Total gains

1300.70	1659.51	2130.4	2732.8	3211.2	3272.6	3098.7	2693.5	2209.6	1674.32	1321.64	1207.87	(84)

Lighting calculations

	Area	g	FF x Shading	
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-STUDY	0.9 x 3.36	0.70	0.80 x 0.83	1.41
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (East) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-POOL	0.9 x 18.34	0.70	0.80 x 0.83	7.67
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-GARAGE	0.9 x 2.64	0.70	0.80 x 0.83	1.10
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthEast) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-STUDY	0.9 x 1.36	0.70	0.80 x 0.83	0.57
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BOOT ROOM	0.9 x 2.64	0.70	0.80 x 0.83	1.10
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-BOOT ROOM	0.9 x 2.64	0.70	0.80 x 0.83	1.10
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (West) New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-POOL	0.9 x 6.16	0.70	0.80 x 0.83	2.58

Lighting calculations

	Area	g	FF x Shading	
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (NorthWest)	0.9 x 1.36	0.70	0.80 x 0.83	0.57
New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, 00-STUDY				
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North)	0.9 x 8.12	0.70	0.80 x 0.83	3.40
New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-POOL				
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North)	0.9 x 8.12	0.70	0.80 x 0.83	3.40
New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-POOL				
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North)	0.9 x 8.12	0.70	0.80 x 0.83	3.40
New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-POOL				
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North)	0.9 x 8.12	0.70	0.80 x 0.83	3.40
New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-POOL				
Window - Triple-glazed, air-filled, low-E, En=0.2, hard coat (North)	0.9 x 4.20	0.70	0.80 x 0.83	1.76
New Build U=1.3; G=0.36 - U=0.24(1.36); SHGC=0.36; VT=0.60, LG-POOL				

GL = 31.45 / 217.97 = 0.144
C1 = 0.500
C2 = 0.960
El = 611

7. Mean internal temperature

Temperature during heating periods in the living area, Th1 (°C) 21.00 (85)
Heating system responsiveness 1.00

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
tau	27.51	27.56	27.61	27.84	27.88	28.09	28.09	28.13	28.01	27.88	27.79	27.70	
alpha	2.83	2.84	2.84	2.86	2.86	2.87	2.87	2.88	2.87	2.86	2.85	2.85	
Utilisation factor for gains for living area	0.99	0.97	0.94	0.85	0.71	0.55	0.42	0.49	0.74	0.92	0.98	0.99	(86)
Mean internal temperature in living area T1	18.59	18.90	19.43	20.10	20.60	20.86	20.95	20.93	20.67	19.96	19.14	18.53	(87)
Temperature during heating periods in rest of dwelling Th2	19.70	19.70	19.71	19.72	19.72	19.73	19.73	19.73	19.72	19.72	19.71	19.71	(88)
Utilisation factor for gains for rest of dwelling	0.98	0.97	0.92	0.82	0.65	0.46	0.31	0.37	0.66	0.90	0.97	0.99	(89)
Mean internal temperature in the rest of dwelling T2	16.53	16.98	17.74	18.67	19.32	19.62	19.70	19.69	19.44	18.51	17.34	16.45	(90)

Living area fraction (11.36 / 217.97) 0.05 (91)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Mean internal temperature (for the whole dwelling)	16.63	17.08	17.83	18.75	19.38	19.69	19.77	19.75	19.50	18.59	17.44	16.56	(92)
Apply adjustment to the mean internal temperature, where appropriate	16.63	17.08	17.83	18.75	19.38	19.69	19.77	19.75	19.50	18.59	17.44	16.56	(93)

8. Space heating requirement

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains												
0.97	0.95	0.90	0.79	0.63	0.46	0.31	0.38	0.64	0.87	0.95	0.98	(94)
Useful gains												
1263.37	1572.93	1909.62	2157.7	2034.4	1494.72	974.48	1013.24	1416.02	1457.92	1261.69	1178.99	(95)
Monthly average external temperature												
4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature												
3979.4	3922.7	3643.4	3139.0	2446.2	1608.25	1001.22	1058.23	1711.63	2542.2	3301.0	3959.7	(97)
Fraction of month for heating												
1.00	1.00	1.00	1.00	1.00	-	-	-	-	1.00	1.00	1.00	
Space heating requirement for each month, kWh/month												
2020.7	1579.08	1289.94	706.52	306.39	-	-	-	-	806.74	1468.33	2068.8	

Total space heating requirement per year (kWh/year) (October to May)	10246.59	(98)
Space heating requirement per m² (kWh/m²/year)	47.01	(99)

8c. Space cooling requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
External temperaturers	-	-	-	-	-	14.60	16.60	16.40	-	-	-	-		
Heat loss rate W	-	-	-	-	-	2970.5	2338.5	2398.4	-	-	-	-		(100)
Utilisation factor for loss	-	-	-	-	-	0.82	0.87	0.82	-	-	-	-		(101)
Useful loss W	-	-	-	-	-	2426.8	2030.7	1969.47	-	-	-	-		(102)
Internal gains W	0.00	0.00	0.00	0.00	0.00	707.71	679.20	689.74	0.00	0.00	0.00	0.00		
Solar gains W	0.00	0.00	0.00	0.00	0.00	2994.4	2824.5	2338.5	0.00	0.00	0.00	0.00		
Gains W	-	-	-	-	-	3702.1	3503.7	3028.3	-	-	-	-		(103)
Fraction of month for cooling	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00		(103a)
Space heating kWh	-	-	-	-	-	154.60	24.65	1.86	-	-	-	-		(98)
Space cooling kWh	-	-	-	-	-	918.20	1095.93	787.75	-	-	-	-		(104)
Total													2801.88	(104)
Cooled fraction													0.10	(105)
Intermittency factor	-	-	-	-	-	0.25	0.25	0.25	-	-	-	-		(106)
Space cooling requirement for month	-	-	-	-	-	22.96	27.40	19.69	-	-	-	-		
Space cooling (June to August)													70.05	(107)
Space cooling requirement per m² (kWh/m²/year)													0.32	(108)

9a. Energy requirements

		kWh/year	
No secondary heating system selected			
Fraction of space heat from main system(s)	1.0000		(202)
Efficiency of main heating system	249.90%		(206)
Cooling system energy efficiency ratio	6.22%		(209)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating requirement												
2020.7	1579.08	1289.94	706.52	306.39	-	-	-	-	806.74	1468.33	2068.8	(98)
Appendix Q - monthly energy saved (main heating system 1)												
0.00	0.00	0.00	0.00	0.00	-	-	-	-	0.00	0.00	0.00	(210)
Space heating fuel (main heating system 1)												
808.61	631.89	516.18	282.72	122.61	-	-	-	-	322.83	587.57	827.87	(211)
Appendix Q - monthly energy saved (main heating system 2)												
0.00	0.00	0.00	0.00	0.00	-	-	-	-	0.00	0.00	0.00	(212)
Space heating fuel (main heating system 2)												
0.00	0.00	0.00	0.00	0.00	-	-	-	-	0.00	0.00	0.00	(213)
Appendix Q - monthly energy saved (secondary heating system)												
0.00	0.00	0.00	0.00	0.00	-	-	-	-	0.00	0.00	0.00	(214)
Space heating fuel (secondary)												
0.00	0.00	0.00	0.00	0.00	-	-	-	-	0.00	0.00	0.00	(215)
Water heating												
Water heating requirement												
220.03	193.79	203.17	181.64	177.64	158.22	151.47	166.88	166.79	188.37	199.80	214.57	(64)
Efficiency of water heater											65.00	(216)
65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	(217)
Water heating fuel												
338.51	298.13	312.56	279.44	273.30	243.42	233.03	256.74	256.60	289.80	307.38	330.11	(219)

Annual totals	kWh/year	
Space heating fuel used, main system 1	4100.28	(211)
Space heating fuel (secondary)	0.00	(215)
Water heating fuel	3419.03	(219)
Space cooling fuel used	11.26	(221)

-	-	-	-	-	3.69	4.40	3.16	-	-	-	-	(221)

Electricity for pumps, fans and electric keep-hot		
central heating pump	30.00	(230c)
Total electricity for the above, kWh/year	30.00	(231)
Electricity for lighting (100.00% fixed LEL)	610.59	(232)
Energy saving/generation technologies		
Appendix Q -		
Energy saved or generated ():	0.000	(236a)
Energy used ():	0.000	(237a)
Total delivered energy for all uses	8171.15	(238)

10a. Fuel costs using Table 12 prices

	kWh/year	Fuel price p/kWh	£/year	
Space heating - main system 1	4100.275	13.190	540.83	(240)
Space heating - main system 2	0.000	0.000	0.00	(241)
High-rate percentage	0.000%			(243)
Low-rate percentage	0.000%			(244)
High-rate cost	0.00	0.000	0.00	(245)
Low-rate	0.00	0.000	0.00	(246)
Space cooling	11.255	13.190	1.48	(248)
Mech vent fans cost	0.000	13.190	0.00	(249)
Pump/fan energy cost	30.000	13.190	3.96	(249)
Energy for lighting	610.594	13.190	80.54	(250)
Additional standing charges			120.00	(251)
Electricity generated - PVs	0.000	0.000	0.00	(252)
Appendix Q -				
Energy saved or generated ():	0.000	0.000	0.00	(253)
Energy used ():	0.000	0.000	0.00	(254)
Total energy cost			865.79	(255)

11a. SAP rating

	0.42	**(256)**
	1.38	**(257)**
SAP value	80.71	
	81	(258)
SAP band	**B**	

12a. Carbon dioxide emissions

	Energy kWh/year	Emission factor kg CO2/kWh	Emissions kg CO2/year	
Space heating, main system 1	4100.28	0.519	2128.04	(261)
Space heating, main system 2	0.00	0.000	0.00	(262)
Space heating, secondary	0.00	0.519	0.00	(263)
Water heating	3419.03	0.216	738.51	(264)
Space and water heating			2866.55	(265)
Space cooling	11.26	0.519	5.84	(266)
Electricity for pumps and fans	30.00	0.519	15.57	(267)
Electricity for lighting	610.59	0.519	316.90	(268)
Electricity generated - PVs	0.00	0.519	0.00	(269)
Electricity generated - µCHP	0.00	0.000	0.00	(269)
Appendix Q -				
Energy saved ():	0.00	0.000	0.00	(270)
Energy used ():	0.00	0.000	0.00	(271)
Total CO2, kg/year			3204.86	(272)

	kg/m²/year	
CO2 emissions per m²	**14.70**	(273)
EI value	83.67	(273a)
EI rating	**84**	(274)
EI band	**B**	

Calculation of stars for heating and DHW

Main heating energy efficiency	(13.19 / 2.4990) x (1 + (0.29 x 0.00)) = 5.2781, stars = 4
Main heating environmental impact	(0.5190 / 2.4990) x (1 + (0.29 x 0.00)) = 0.2077, stars = 5
Water heating energy efficiency	3.48 / 0.6500 = 5.3538, stars = 3
Water heating environmental impact	0.2160 / 0.6500 = 0.3323, stars = 3

10.4. Appendix 7 – SAP 10 Conversion Worksheet Existing Building

SAP 2012 Performance

Domestic

Table 1: Carbon Dioxide Emissions after each stage of the Energy Hierarchy for domestic buildings

	Carbon Dioxide Emissions for domestic buildings (Tonnes CO_2 per annum)	
	Regulated	Unregulated
Baseline: Part L 2013 of the Building Regulations Compliant Development	34.0	
After energy demand reduction (be lean)	19.8	
After heat network connection (be clean)	19.8	
After renewable energy (be green)	13.5	

Table 2: Regulated Carbon Dioxide savings from each stage of the Energy Hierarchy for domestic buildings

	Regulated domestic carbon dioxide savings	
	(Tonnes CO_2 per annum)	(%)
Be lean: savings from energy demand reduction	14.2	42%
Be clean: savings from heat network	0.0	0%
Be green: savings from renewable energy	6.3	19%
Cumulative on site savings	**20.6**	**60%**
Annual savings from off-set payment	13.5	-
	(Tonnes CO_2)	
Cumulative savings for off-set payment	**404**	-
Cash in-lieu contribution (£)	**38,365**	

*carbon price is based on GLA recommended price of £95 per tonne of carbon dioxide unless Local Planning Authority price is inputted in the 'Development Information' tab

SAP 10.0 Performance

Table 1: Carbon Dioxide Emissions after each stage of the Energy Hierarchy for domestic buildings

	Carbon Dioxide Emissions for domestic buildings (Tonnes CO_2 per annum)	
	Regulated	Unregulated
Baseline: Part L 2013 of the Building Regulations Compliant Development	32.2	
After energy demand reduction (be lean)	18.3	
After heat network connection (be clean)	18.3	
After renewable energy (be green)	6.5	

Table 2: Regulated Carbon Dioxide savings from each stage of the Energy Hierarchy for domestic buildings

	Regulated domestic carbon dioxide savings	
	(Tonnes CO_2 per annum)	(%)
Be lean: Savings from energy demand reduction	13.8	43%
Be clean: Savings from heat network	0.0	0%
Be green: Savings from renewable energy	11.8	37%
Cumulative on site savings	**25.6**	**80%**
Annual savings from off-set payment	6.5	-
	(Tonnes CO_2)	
Cumulative savings for off-set payment	**196**	-
Cash in-lieu contribution (£)	**18,594**	

*carbon price is based on GLA recommended price of £95 per tonne of carbon dioxide unless Local Planning Authority price is inputted in the 'Development Information' tab

10.5. Appendix 8 – SAP 10 Conversion Worksheet New Extension

SAP 2012 Performance	SAP 10.0 Performance

Domestic

SAP 2012 Performance

Table 1: Carbon Dioxide Emissions after each stage of the Energy Hierarchy for domestic buildings

	Carbon Dioxide Emissions for domestic buildings (Tonnes CO_2 per annum)	
	Regulated	Unregulated
Baseline: Part L 2013 of the Building Regulations Compliant Development	2.1	
After energy demand reduction (be lean)	2.0	
After heat network connection (be clean)	2.0	
After renewable energy (be green)	1.9	

Table 2: Regulated Carbon Dioxide savings from each stage of the Energy Hierarchy for domestic buildings

	Regulated domestic carbon dioxide savings	
	(Tonnes CO_2 per annum)	(%)
Be lean: savings from energy demand reduction	0.0	1%
Be clean: savings from heat network	0.0	0%
Be green: savings from renewable energy	0.1	5%
Cumulative on site savings	**0.1**	**6%**
Annual savings from off-set payment	1.9	-
	(Tonnes CO_2)	
Cumulative savings for off-set payment	**58**	-
Cash in-lieu contribution (£)	**5,520**	

*carbon price is based on GLA recommended price of £95 per tonne of carbon dioxide unless Local Planning Authority price is inputted in the 'Development Information' tab

SAP 10.0 Performance

Table 1: Carbon Dioxide Emissions after each stage of the Energy Hierarchy for domestic buildings

	Carbon Dioxide Emissions for domestic buildings (Tonnes CO_2 per annum)	
	Regulated	Unregulated
Baseline: Part L 2013 of the Building Regulations Compliant Development	1.9	
After energy demand reduction (be lean)	1.9	
After heat network connection (be clean)	1.9	
After renewable energy (be green)	1.1	

Table 2: Regulated Carbon Dioxide savings from each stage of the Energy Hierarchy for domestic buildings

	Regulated domestic carbon dioxide savings	
	(Tonnes CO_2 per annum)	(%)
Be lean: Savings from energy demand reduction	0.0	1%
Be clean: Savings from heat network	0.0	0%
Be green: Savings from renewable energy	0.8	41%
Cumulative on site savings	**0.8**	**42%**
Annual savings from off-set payment	1.1	-
	(Tonnes CO_2)	
Cumulative savings for off-set payment	**33**	-
Cash in-lieu contribution (£)	**3,110**	

*carbon price is based on GLA recommended price of £95 per tonne of carbon dioxide unless Local Planning Authority price is inputted in the 'Development Information' tab