ME7

7 GREENAWAY GARDENS, HAMPSTEAD, LONDON NW3

ENERGY AND SUSTAINABILITY STATEMENT

JB/692: January 2021

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7 GREENAWAY GARDENS,
HAMPSTEAD, LONDON NW3

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INTRODUCTION

Our client is applying for planning permission to refurbish/ extend this family home and as part of the process; he is taking the opportunity to significantly enhance its sustainability; including the potential for renewable technologies. 7 Greenaway Gardens is proposed is to be constructed as a sustainable low carbon house, finished to a high quality and standard; whilst maintaining the original building features.

This report has been prepared by ME7 Ltd, to demonstrate how the development will achieve a low carbon status and covers the proposed sustainable design measures related to the building fabric and mechanical and electrical services.

The proposed building has been modelled using an accredited calculation methodology (SAP2012) and by an accredited energy assessor. Through use of appropriate passive and building fabric design as key points/measures below and energy saving measures, it is shown that the building will release lower net annual CO_2 emissions against baseline levels and satisfies the current Building Regulation Part L, The London Plan requirements and Camden Development Plan/ Camden City Plan: Strategic Policies requirements and The Camden Energy Efficiency & Adaption Guidance 2019,

Key points/measures proposed:

- A large CO_2 reduction of 69% (Cumulative), for the site over the baseline; confirming that the proposed refurbished dwelling exceeds the requirements of the Camden Local Plan, The Camden Energy Efficiency & Adaption Guidance 2019, The London Plan 2015 and the National Planning Policy Framework.
- Low NOx emissions from new efficient heating plant, complying with the London Plan.
- Reusing/recycling and salvage existing materials where possible.
- Reducing water consumption through rainwater harvesting and flow restrictors.
- Utilisation of natural shading, orientation and planting.
- Fabric insulation improvements.
- Providing double glazed windows to the new and existing elements – low U values.
- Heat recovery ventilation to the entire building – 80% efficiency.
- New materials to be responsibly sourced and life cycle reviewed.
- Inclusion of two renewable energy/ low carbon systems; a GSHP and PV system.
- Data logging/internal digital metering/control for efficient management of the building.

Owing to the above improvements over the minimum Part L requirements, the PEA (Predicted Energy Assessment – Outline EPC) for the proposed refurbished building is an energy efficiency rating of Grade C (76) and a CO2 impact rating of Grade C (73).

Included within the report is an appraisal of various renewable technologies, demonstrating their viability and appropriateness to the environment and nature of the development.

It is proposed that a vertical borehole GSHP system will be suitable for providing all of the space heating demand. Based on high efficiency water cooled condensors, with a COP of 6.29 for heating. Gas boilers for providing domestic hot water production top up and backup heating only. This combination will significantly reduce CO2 emissions and be well matched to the building.
Apart from the GSHP and PV systems proposed, other renewable sources are not effective or suitable for the building.

Cooling is proposed to only some parts of the house and only at peak times, this will be provided by a vertical borehole GSHP system based on high efficiency water cooled condensors, with an EER of 5.60 for cooling.

A detailed description of the proposed electrical and mechanical systems is also included within the report, detailing the energy efficient and sustainable design measures to be incorporated.

Full assessment modelling/calculations/reports demonstrating compliance, including energy statement, SAP L1A and PEA (Pre-EPC); can be found in the main sections and appendices of this report.
The M&E proposals outlined in this report are in line with the London Plan 2015, the National Planning Policy Framework, Camden Local Plan: 2017; for new dwellings and Building Regulations.

Section 1.0

RENEWABLE ENERGY STATEMENT

ME7 LTD
Jorand House, Bebington Close
Billericay, Essex
CM12 0DT

ASSESSMENT INFORMATION

Prepared for:

Prepared by:
Ondrej Gajdos

Date: Date:
15 January 2021

Reviewed by:

DISCLAIMER

The findings, conclusions and recommendations of this report are based on the information supplied. ME7 Ltd disclaims responsibility in respect of incorrect information imparted to them or for the actual performance of any of the building services installations.
This Report is prepared for the use of 7 Greenaway Gardens; a duty of care is not owed to other parties.

ME7 Ltd have been appointed to provide an Energy Statement for the proposed development.

This statement covers possible active and passive measures including renewable energy sources to make this development sustainable and environmentally friendly.

Specific requirements of London Plan on Energy Efficiency and Renewable Energy will be met through a combination of passive design features, energy efficient building services and renewable energy sources. This is to comply fully with the London Plan Policies and ensure they are following the "Energy Hierarchy". Specific London Plan policies about CO2 reduction and renewable energy will be met by implementation of passive measures, efficient services and renewable sources. This document has been prepared in line with the GLA Energy Team Guidance on Planning Energy Assessments.

Baseline and all estimated energy consumptions have been calculated using full SAP 2012 assessment of the development in accordance with Part L procedures.

The tables below show a summary of energy requirements for baseline scheme and reduction proposed to be achieved by passive measures, efficient services and on-site renewable energy sources.

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	30.1	2.6
After energy demand reduction (be lean)	28.5	2.6
After heat network connection (be clean)	28.5	2.6
After renewable energy (be green)	9.3	2.6

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

	Regulated domestic carbon dioxide savings	
	(Tonnes CO_2 per annum)	**(%)**
Be lean: Savings from energy demand reduction	1.6	5%
Be clean: Savings from heat network	0.0	0%
Be green: Savings from renewable energy	19.2	64%
Cumulative on site savings	**20.9**	**69%**

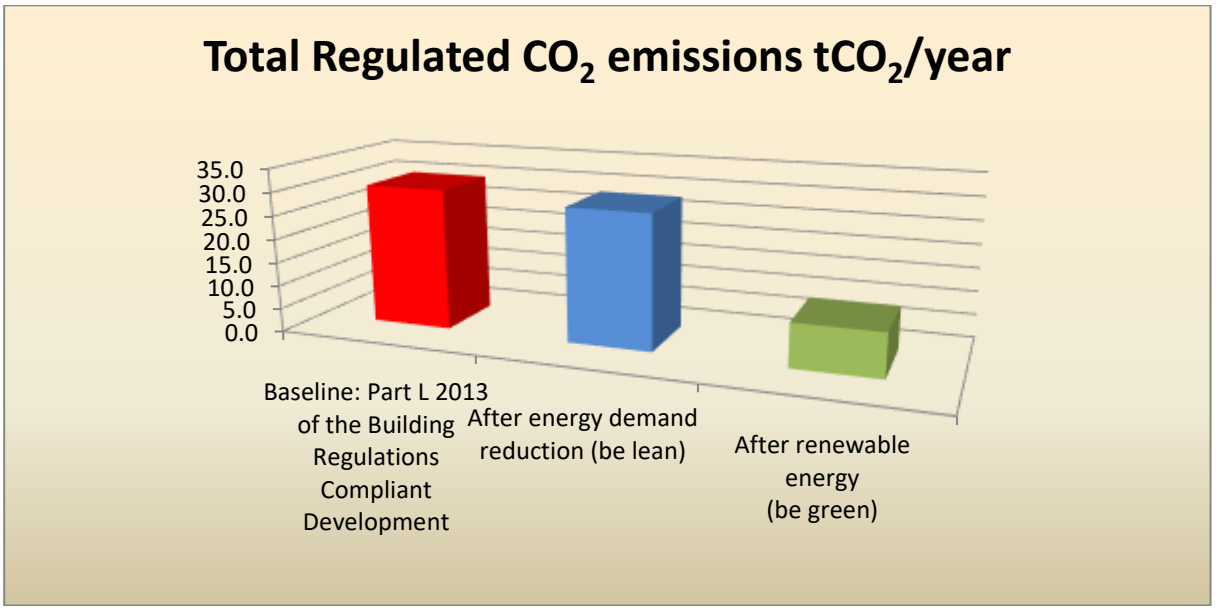


Table 3: SAP calculation specification for each stage of the energy hierarchy

Specification	Notional Baseline	Efficient Baseline (Be Lean)	Proposed Development (Be Green)
Basement/Lower ground floor adjacent to ground	0.22	0.22	0.22
Existing external Wall U-value	1.45	1.45 (380+ mm solid brick wall)	1.45 (380+ mm solid brick wall)
New basement walls (adjacent to ground)	0.28	0.26	0.26
New LGF exposed walls	0.28	0.27	0.27
New GF exposed walls	0.28	0.18	0.18
Dormer cheeks	0.28	0.28	0.28
Pitched Roof U-value	0.18	0.12	0.12
Flat Roof U-value	0.18	0.15	0.15
Entrance doors U-value	1.80	1.20	1.20
Garage door U-value	1.80	0.33	0.33
Sash Windows U-value	1.60	1.1 (existing single glazed windows upgraded with secondary low-e double glazing)	1.1 (existing single glazed windows upgraded with secondary low-e double glazing)
New Windows and glazed doors U-value	1.60	0.87 (triple glazed Sky-Frame)	0.87 (triple glazed Sky-Frame)
Rooflights	1.60	1.2 (double glazed)	1.2 (double glazed)
Space Heating and DHW System	Gas boiler, SEDBUK 2009 efficiency 88%, underfloor heating, time and temperature zone control	Gas boiler, SEDBUK 2009 efficiency 90%, underfloor heating, time and temperature zone control	MCS certified ground source heat pump, underfloor heating, time and temperature zone control
Ventilation System	Natural with intermittent mechanical extracts	MVHR with SFP of 1.2 W/l.s or lower, heat recovery efficiency 80% or higher	MVHR with SFP of 1.2 W/l.s or lower, heat recovery efficiency 80% or higher
Energy Efficient Lighting	75%	100%	100%
Renewable energy sources			PV system (PV tiles) with a total peak output of 6 kWp on SE/SW facing pitched roof
% Improvement in CO2 over Building regulations compliant baseline	**0.0%**	**5.4%**	**69%**

The London Plan approach of "Be lean" – "Be clean" – "Be green" is fully adopted by implementing:

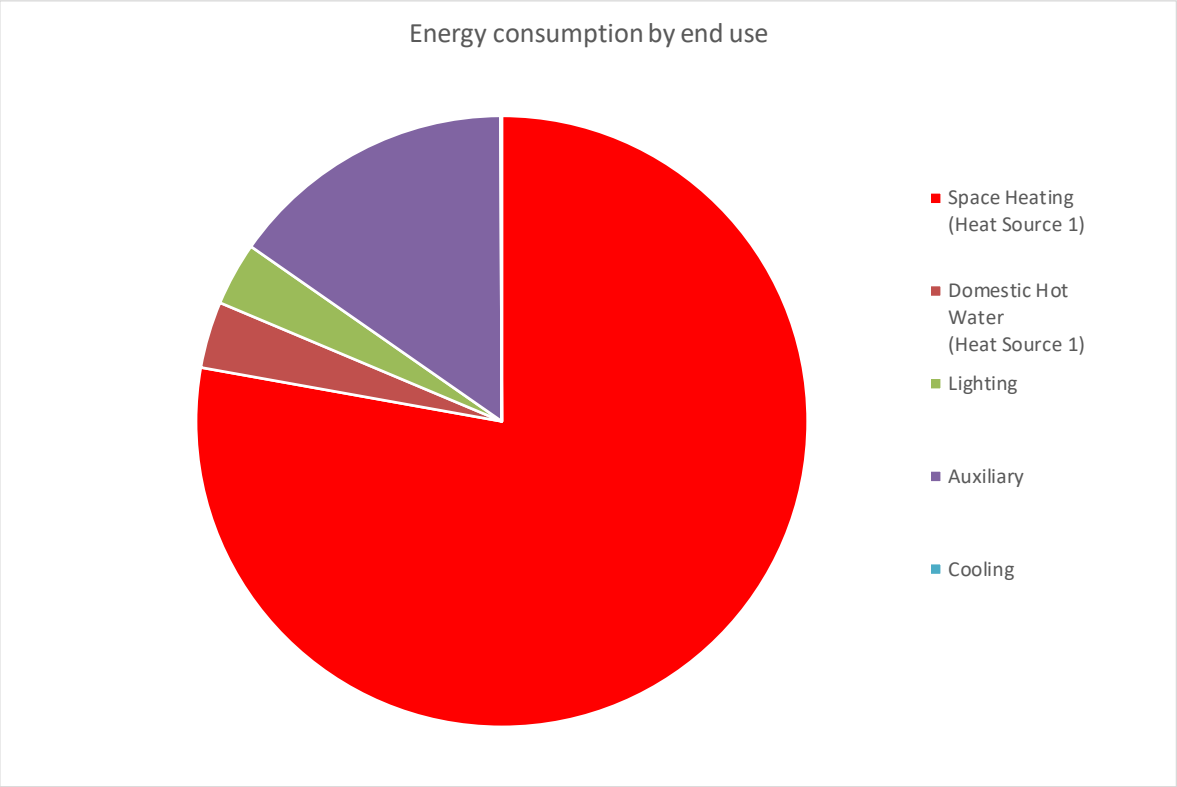
- Passive measures (low U-values, air permeability, avoidance of thermal bridging by accredited details)
- High efficiency services, i.e., boilers, low energy lights, high efficiency ventilation
- Renewable sources: ground source heat pump, Photovoltaic system peak output of 6 kWp,

Excluded renewable sources are:

- Solar hot water
- Biomass
- Wind turbines

SAP result summary of the proposed development

DOMESTIC ENERGY CONSUMPTION AND CO_2 ANALYSIS														
Unit identifier (e.g. plot number, dwelling type etc.)	Model total floor area (m^2)	REGULATED ENERGY CONSUMPTION PER UNIT (kWh p.a.) - 'BE GREEN' SAP DER WORKSHEET						REGULATED CO_2 EMISSIONS PER UNIT						
		Space Heating (Heat Source 1)	Domestic Hot Water (Heat Source 1)	Electricity generated by renewable (-)	Lighting	Auxiliary	Cooling	Space Heating	Domestic Hot Water	Electricity generated by renewable	Lighting	Auxiliary	SAP 10.0 CO_2 emissions ($kgCO_2$ p.a.)	Calculated DER SAP 10.0 ($kgCO_2$ / m^2)
House	*1070.4*	*34829*	*1577*	*-4940*	*1498*	*6817*	*32.98*	8,115	367	-1,151	349	1,588	9,277	8.7



The proposed development will achieve:

- 69% overall domestic regulated CO2 reduction against 2013 Part L1B compliant baseline
- 5.4% domestic regulated CO2 reduction by energy efficiency measures (Be Lean)
- 64% domestic regulated CO2 reduction by renewable sources (Be Green)

INTRODUCTION

BACKGROUND

ME7 Ltd have been appointed to provide an Energy Statement for the proposed development.
This statement covers possible active and passive measures including renewable energy sources to make this development sustainable and environmentally friendly.

DESCRIPTION OF THE SITE

The project at 7 Greenaway Gardens site includes a refurbishment and extension of an existing detached house.

PLANNING FRAMEWORK

NATIONAL POLICY

DCLG sets out basis for local policies in section 14 of National Planning Policy Framework. It requires new development to be planned in ways that can help to reduce greenhouse gas emissions, such as through its location, orientation and design. To help increase the use and supply of renewable and low carbon energy and heat, plans are encouraged to:

a) provide a positive strategy for energy from these sources, that maximises the potential for suitable development, while ensuring that adverse impacts are addressed satisfactorily (including cumulative landscape and visual impacts);

b) consider identifying suitable areas for renewable and low carbon energy sources, and supporting infrastructure, where this would help secure their development; and

c) identify opportunities for development to draw its energy supply from decentralised, renewable or low carbon energy supply systems and for co-locating potential heat customers and suppliers.

CAMDEN LOCAL PLAN

For the works on existing buildings of more than 500 m2, Camden Local Plan policy CC1 requires:

1. All development to reduce carbon dioxide emissions through following the steps in the energy hierarchy
2. 20% reduction in carbon dioxide emissions from on-site renewable energy technologies

Local Plan Policy CC2 discourages active cooling (air conditioning). Air conditioning will only be permitted where thermal modelling demonstrates a clear need for it after all preferred measures are incorporated in line with the London Plan cooling hierarchy

THE LONDON PLAN

The London Plan is the name given to the Mayor's spatial development strategy. The current version of London Plan was published in March 2016, with new guidance on energy updated in 2018 in line with new draft London Plan. The aim is to develop London as an exemplary sustainable world city, based on three interwoven themes.

3. Strong, diverse long term economic growth
4. Social inclusivity to give all Londoners the opportunity to share in London's future success
5. Fundamental improvements in London's environment and use of resources.

Specific requirements on development sustainability are set out in the following policies:

POLICY 5.2 MINIMISING CO2 EMISSIONS

Development proposals should make the fullest contribution to minimising carbon dioxide emissions in accordance with the following energy hierarchy:

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

Major developments are required to meet the following targets for CO2 reduction against building regulations Target Emission Rate (TER):

Residential buildings:

Year	Improvement on 2010 Building Regulations
2010 – 2013	25 per cent
2013 – 2016	40 per cent
2016 – 2031	Zero carbon

Non-domestic buildings:

Year	Improvement on 2010 Building Regulations
2010 – 2013	25 per cent
2013 – 2016	40 per cent
2016 – 2019	As per building regulations requirements
2019 – 2031	Zero carbon

ZERO CARBON POLICY

As outlined in the Housing SPG, from 1 October 2016 the Mayor applies a zero-carbon standard to new residential development. Zero carbon requirement applies to homes forming part of major development applications. The residential element of the application is required to achieve at least a 35 per cent reduction in regulated carbon dioxide emissions (beyond Part L 2013) on-site. The remaining regulated carbon dioxide emissions, to 100 per cent, are to be off-set through a cash in lieu contribution to the relevant borough to be ring fenced to secure delivery of carbon dioxide savings elsewhere (in line with policy 5.2E). The new draft London Plan includes a new recommended carbon offset price of £95 per tonne for a period of 30 years.

POLICY 5.6 - DECENTRALISED ENERGY IN DEVELOPMENT PROPOSALS

Development proposals should evaluate the feasibility of Combined Heat and Power (CHP) systems, and where a new CHP system is appropriate also examine opportunities to extend the system beyond the site boundary to adjacent sites. Major development proposals should select energy systems in accordance with the following hierarchy:

1. Connection to existing heating or cooling networks
2. Site wide CHP network
3. Communal heating and cooling

Potential opportunities to meet the first priority in this hierarchy are outlined in the London Heat Map tool. Where future network opportunities are identified, proposals should be designed to connect to these networks.

POLICY 5.7 - RENEWABLE ENERGY

The Mayor seeks to increase the proportion of energy generated from renewable sources, and expects that the projections for installed renewable energy capacity outlined in the Climate Change Mitigation and Energy Strategy and in supplementary planning guidance will be achieved in London. Within the framework of the energy hierarchy (see Policy 5.2), major development proposals should provide a reduction in expected carbon dioxide emissions through the use of on-site renewable energy generation, where feasible. There is a presumption that all major development proposals will seek to reduce carbon dioxide emissions by at least 20 per cent through the use of on-site renewable energy generation wherever feasible.

POLICY 5.9 – OVERHEATING AND COOLING

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

1. minimise internal heat generation through energy efficient design
2. reduce the amount of heat entering a building in summer through orientation, shading, albedo, fenestration, insulation and green roofs and walls
3. manage the heat within the building through exposed internal thermal mass and high ceilings
4. passive ventilation
5. mechanical ventilation
6. active cooling systems (ensuring they are the lowest carbon options)

COOLING HIERARCHY

SUMMARY

To fully comply with London Plan Policy 5.9 and Camden Plan Policy CC2, a dynamic thermal simulation has been carried out to ascertain a need for mechanical cooling. The dynamic simulation was done for all bedrooms and ground floor Kitchen/Dining/Reception area. After implementing all previous steps in the cooling hierarchy, the tested rooms still don't achieve thermal comfort criteria required by CIBSE TM59. Mechanical cooling is therefore proposed for the building.

RESIDENTIAL CRITERIA
CIBSE TM59

Compliance is based on passing both of the following two criteria:

Criterion 1a: Hours of Exceedance (He):
For living rooms, kitchens and bedrooms:
the number of hours during which DT is greater than or equal to one degree (K) during the period May to September inclusive shall not be more than 3 per cent of occupied hours.

Criterion 1b:
For bedrooms only:
to guarantee comfort during the sleeping hours the operative temperature in the bedroom from 10 pm to 7 am shall not exceed 26 °C for more than 1% of annual hours. (Note: 1% of the annual hours between 22:00 and 07:00 for bedrooms is 32 hours, so 33 or more hours above 26 °C is recorded as a failure).

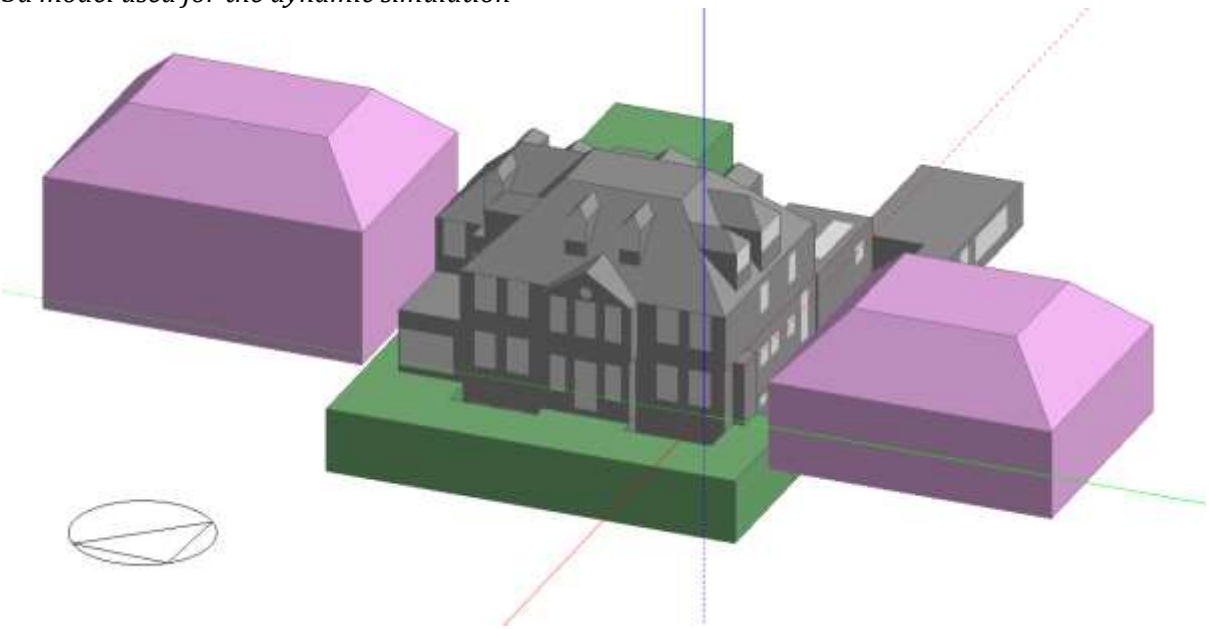
DYNAMIC SIMULATIONS

The analysis was carried out using Design Builder v6 - Energy Plus v8 engine. The 3D model is based on the architectural drawings and specifications.

Thermal mass and U-values used in the dynamic simulation are based on architect specification, as shown in Table 3.

Weather data used for the simulation is the main CIBSE TM49 weather file (DSY1) for the 'future near extreme summer'.

3d model used for the dynamic simulation



INTERNAL DESIGN CONDITIONS

Occupancy in the main Kitchen / Living / Dining area is set to 10 people. All other internal design conditions are modelled as per CIBSE TM59 Table 2:

Double bedroom	2 people at 70% gains from 11 pm to 8 am 2 people at full gains from 8 am to 9 am and from 10 pm to 11 pm 1 person at full gain in the bedroom from 9 am to 10 pm	Peak load of 80 W from 8 am to 11 pm Base load of 10 W during the sleeping hours

Lighting is modelled as 2 W/m2 from 6pm to 11pm.

SOLAR SHADING

All windows and glazed doors are modelled with internal blinds, which are modelled as closed when the solar irradiance exceeds 120 W/m2

THERMAL MASS

Existing retained uninsulated solid brick walls represent relatively high thermal mass, which assists with overheating prevention. Having most of the habitable rooms in the existing part of house makes it impossible to effectively increase the thermal mass.

VENTILATION

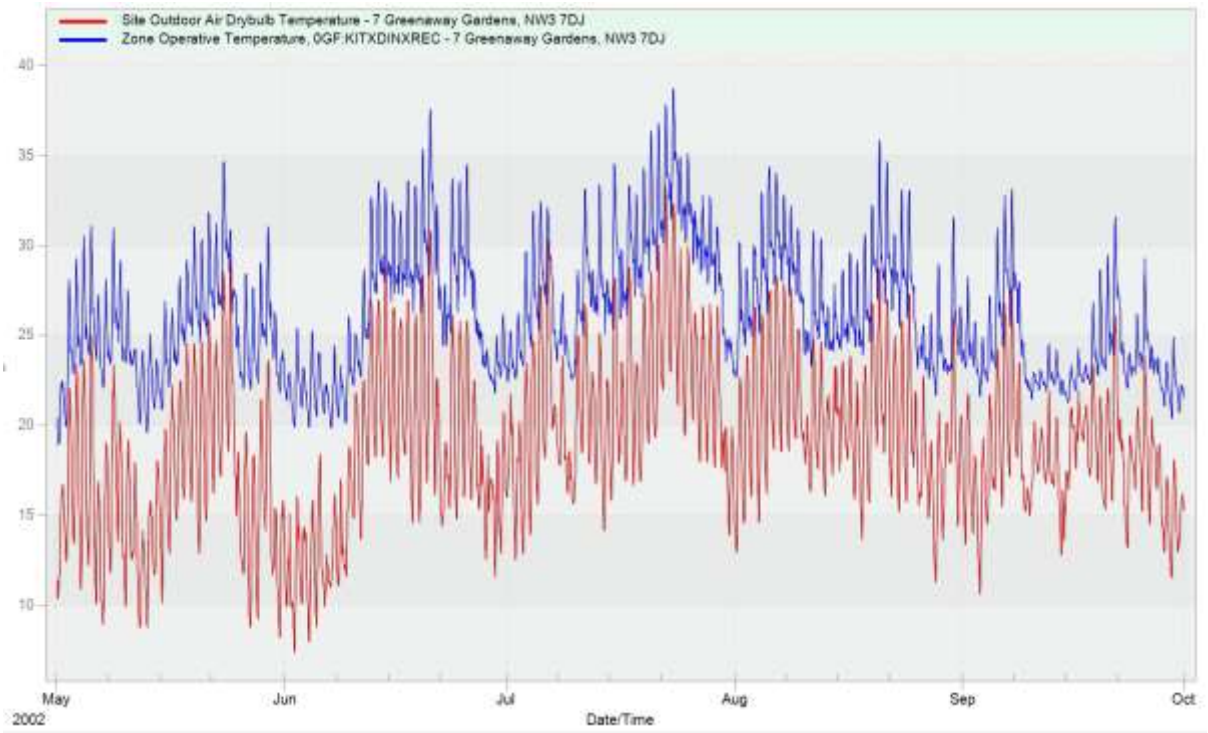
Ventilation strategy has been chosen in line with London Plan Cooling hierarchy and with energy efficiency impacts in mind. It is proposed to install whole house mechanical

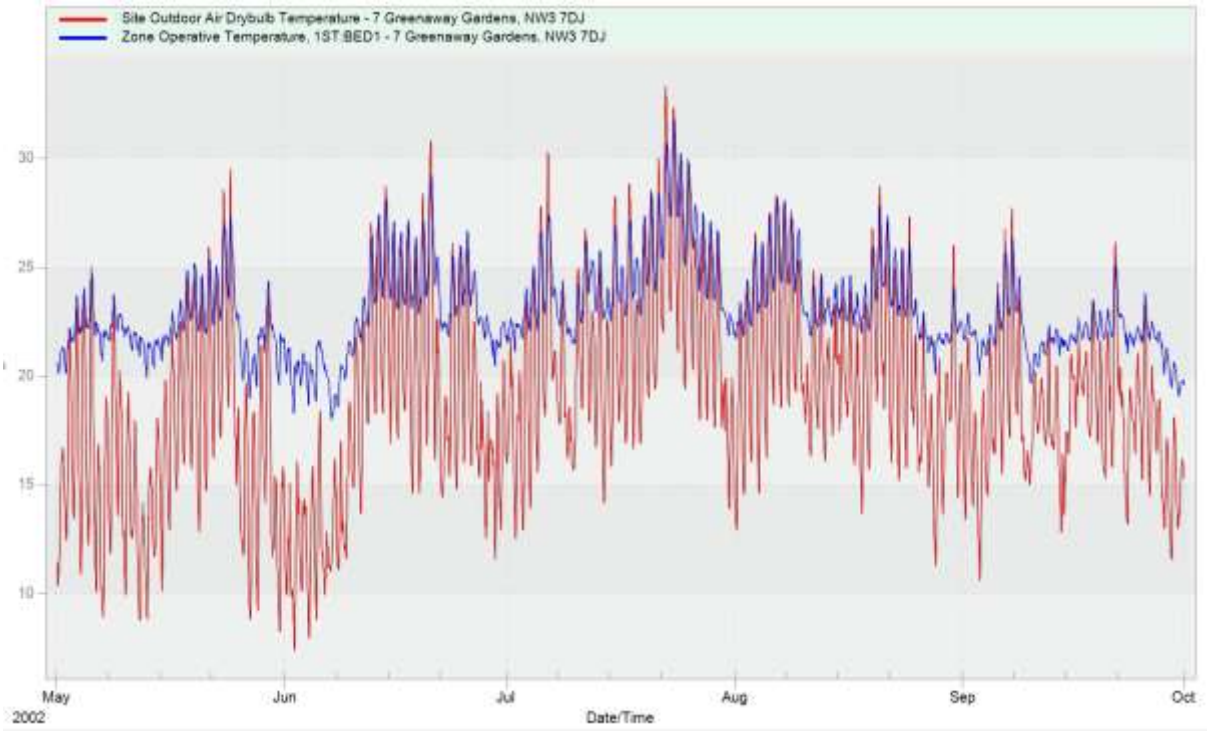
balanced supply and extract ventilation with heat recovery, which shall be able to achieve at least 4 l/s.person flow rate in habitable rooms. The proposed strategy will ensure optimal balance in capital cost, occupant comfort in terms of fresh air and thermal comfort while reducing the cooling requirements. This is included in the dynamic thermal modelling.

Natural ventilation through openable windows has also been modelled, with all windows open in the model, as per CIBSE TM59 guidance

Overheating Simulation Results

Floor	Zone	Criterion A (%)	Criterion B (hr)	Pass/Fail
0GF	Kit-din-rec	29.81	N/A	Fail
1st	Bed1	0.36	50	Fail
1st	Bed2	0.55	61	Fail
1st	BedM	0.86	33	Fail
2nd	Bed3	0.45	44	Fail
2nd	Bed4	0.41	43.5	Fail
2nd	Bed5	0.71	35.5	Fail
2nd	Bed6	0.42	44	Fail

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Zone Operative Temperature, 1ST BED1 - 7 Greenaway Gardens, NW3 7DJ
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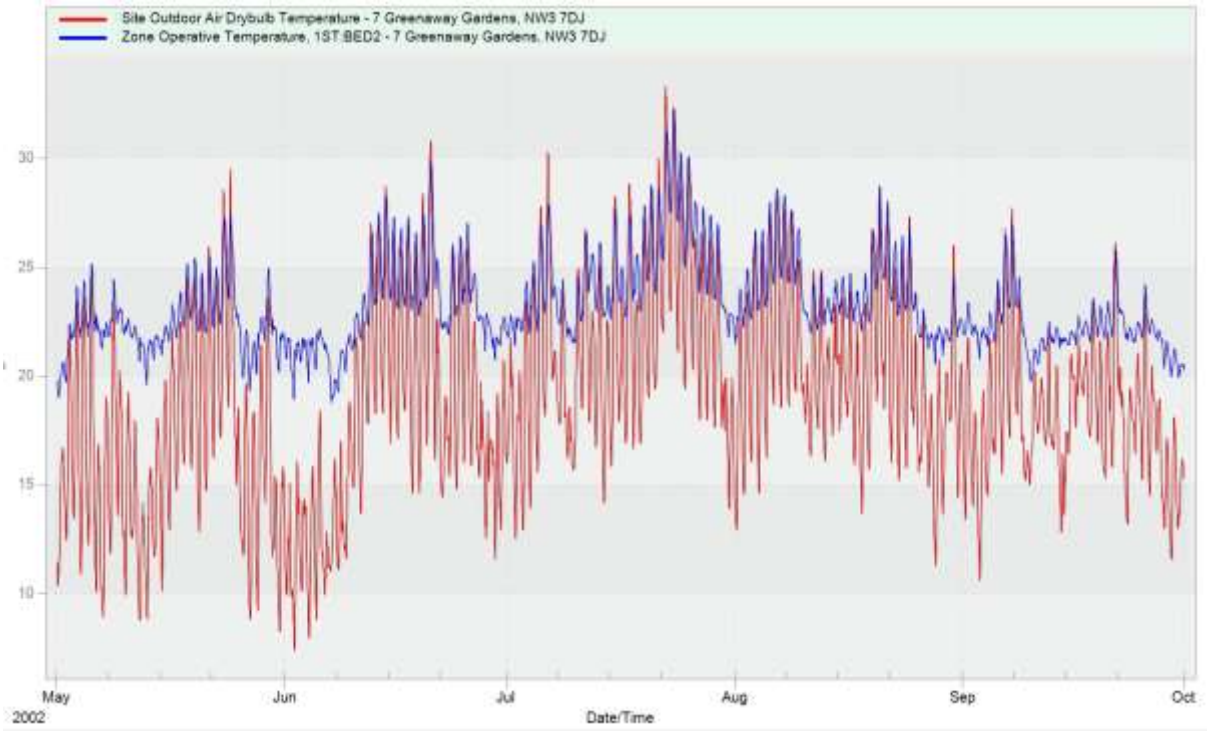
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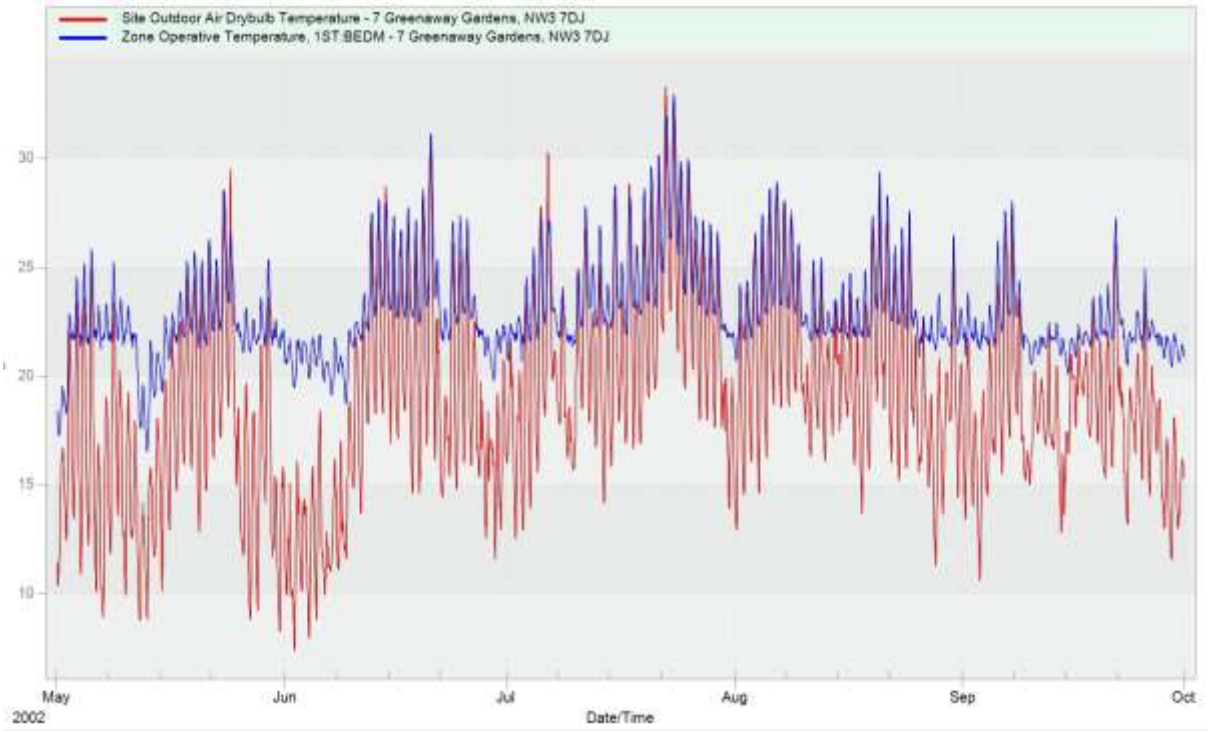
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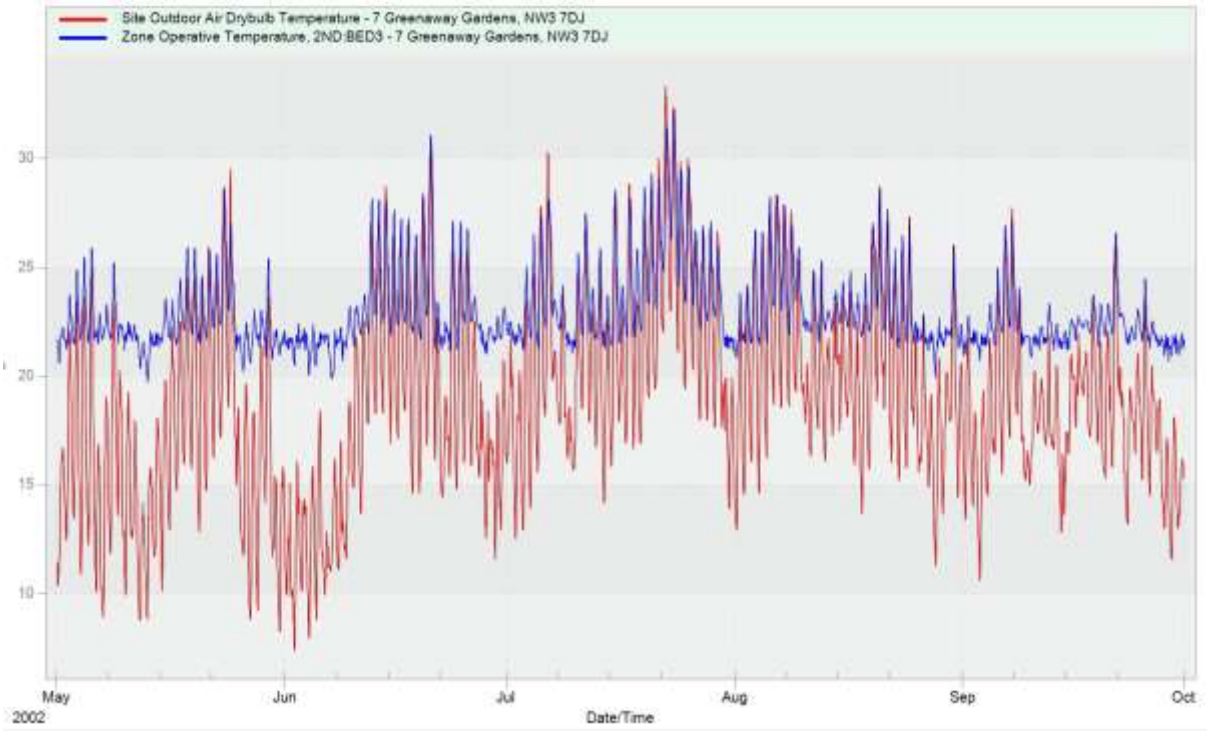
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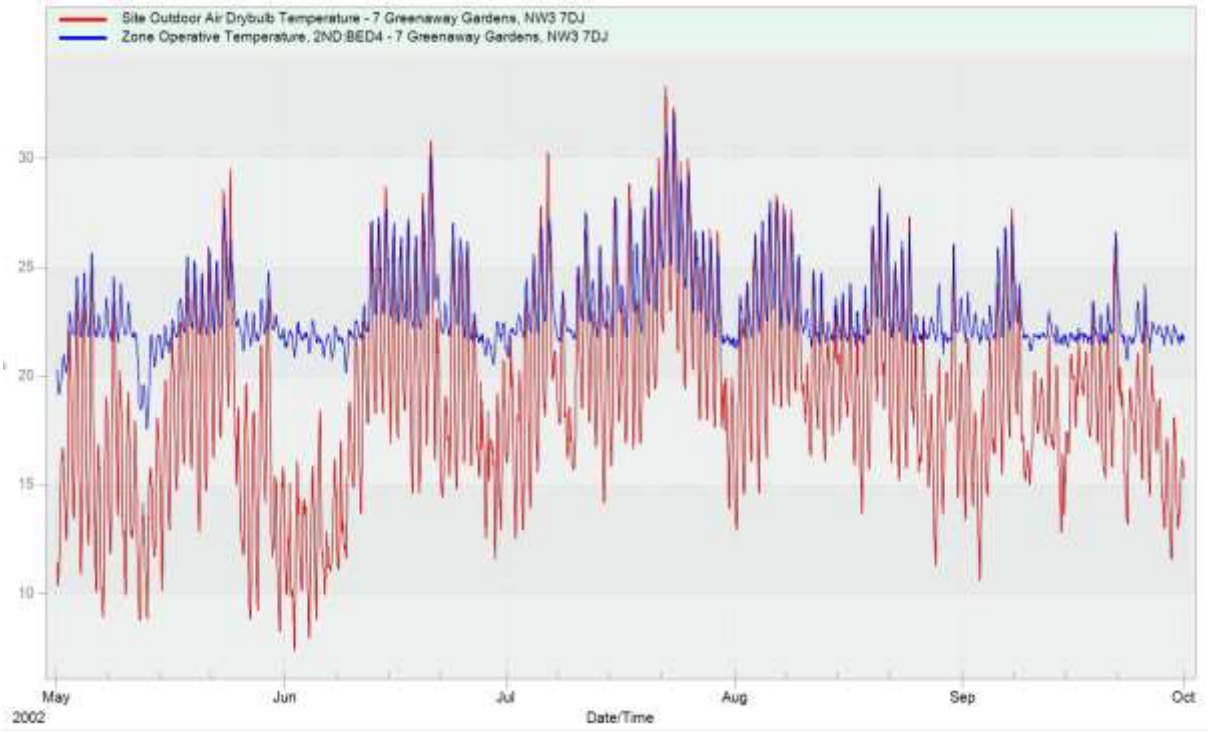
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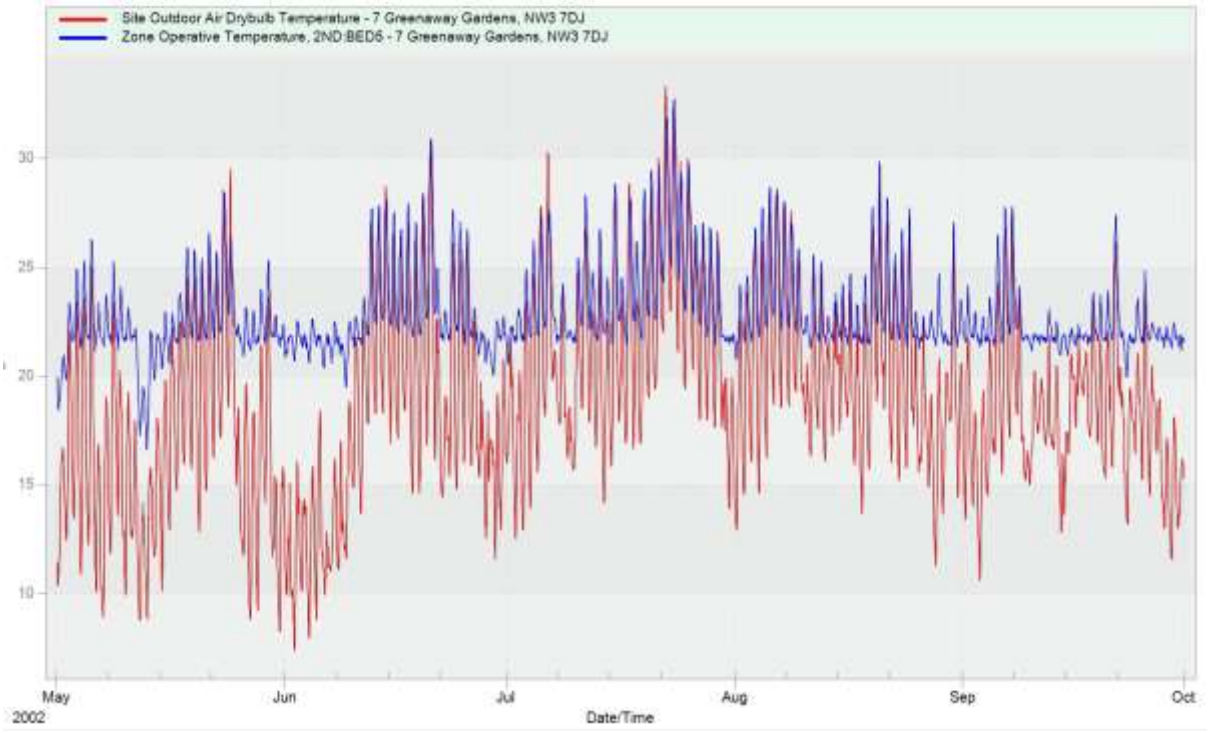
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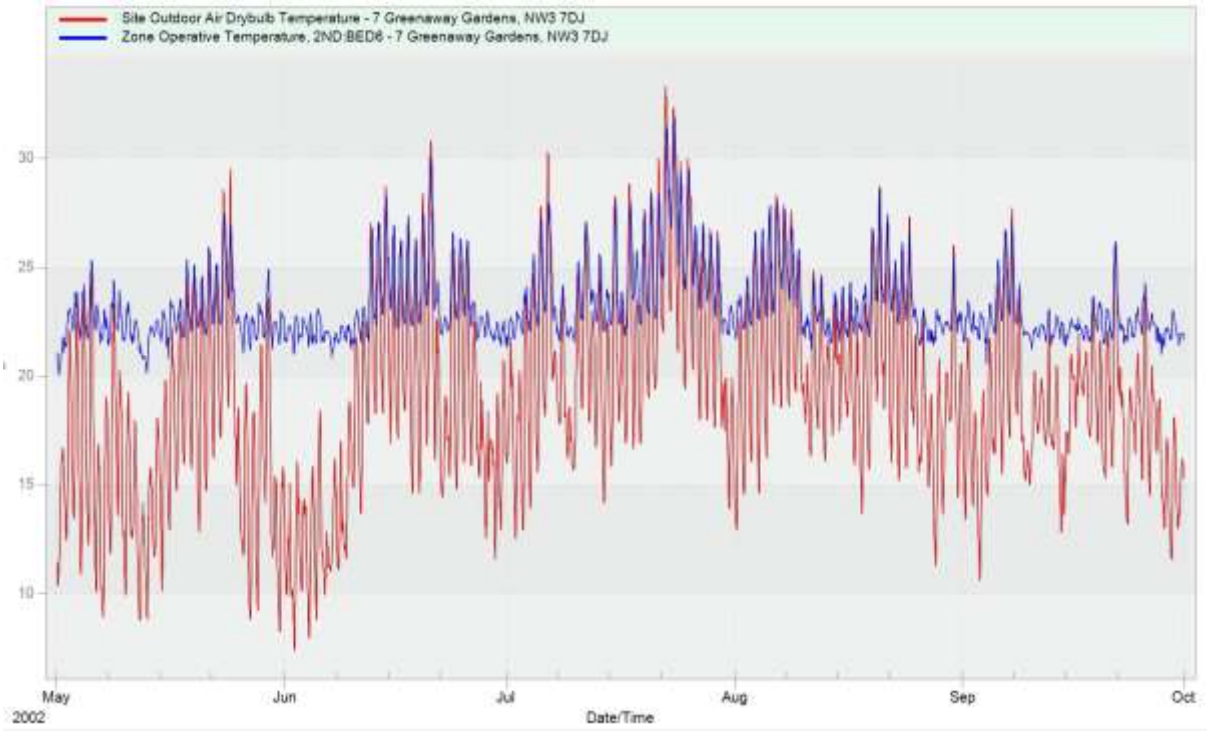


ACTIVE COOLING

As all habitable rooms fail on the overheating assessment against CIBSE TM59 criteria, after implementing all previous steps in the cooling hierarchy, it is proposed to install a mechanical cooling system using ground source heat pump. This is considered to be the most efficient way of active cooling as the heat extracted from house will be transmitted by a closed loop GSHP directly to the ground.

Periods with the highest cooling demand will match the periods with the highest electricity yield from solar photovoltaics system. It is therefore estimated, that most of the electricity demand for ground source cooling will be supplied by PV (on-site renewable source). The active cooling will therefore be a zero or near-zero CO2 emission process.

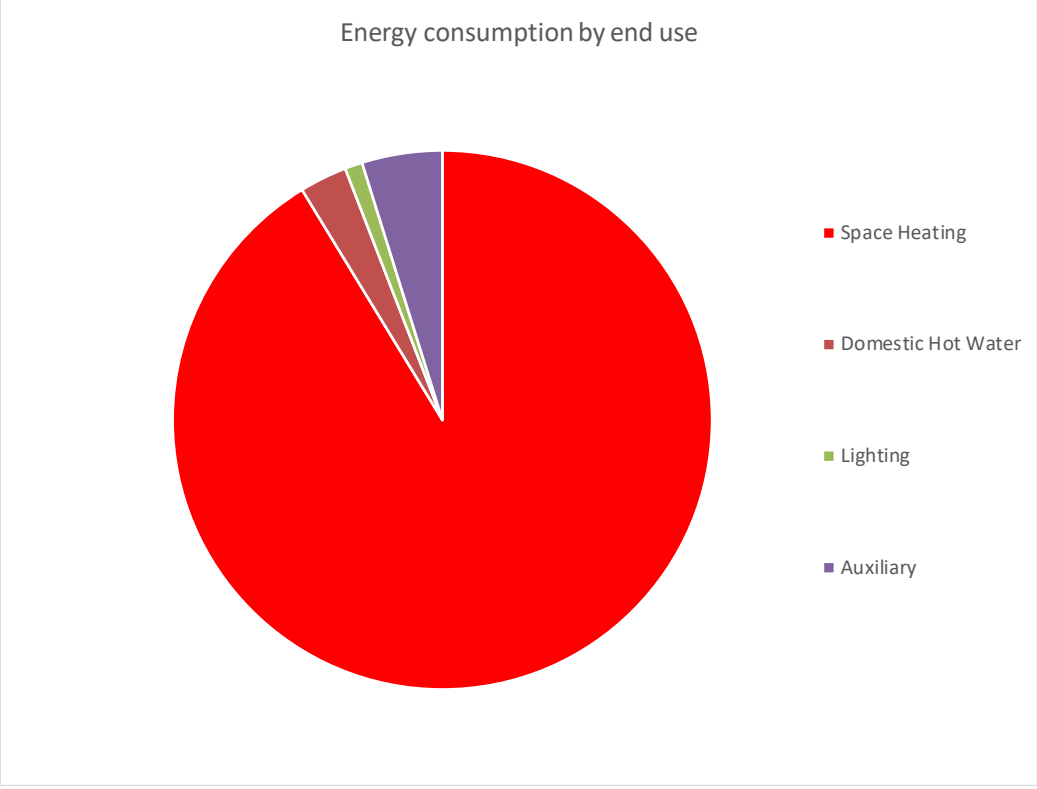
BASELINE ENERGY CONSUMPTION
CO2 EMISSIONS

Energy assessment using SAP 2012 has been carried out on the proposed house with extension, using notional baseline specification achieving compliance with 2012 Part L1B. The specification is set out in Table 6 above.

As a result of the baseline energy calculation, the following values of energy and CO_2 emissions have been obtained. SAP10 carbon emission factors have been used for the CO_2 emissions calculation.

DOMESTIC ENERGY CONSUMPTION AND CO_2 ANALYSIS

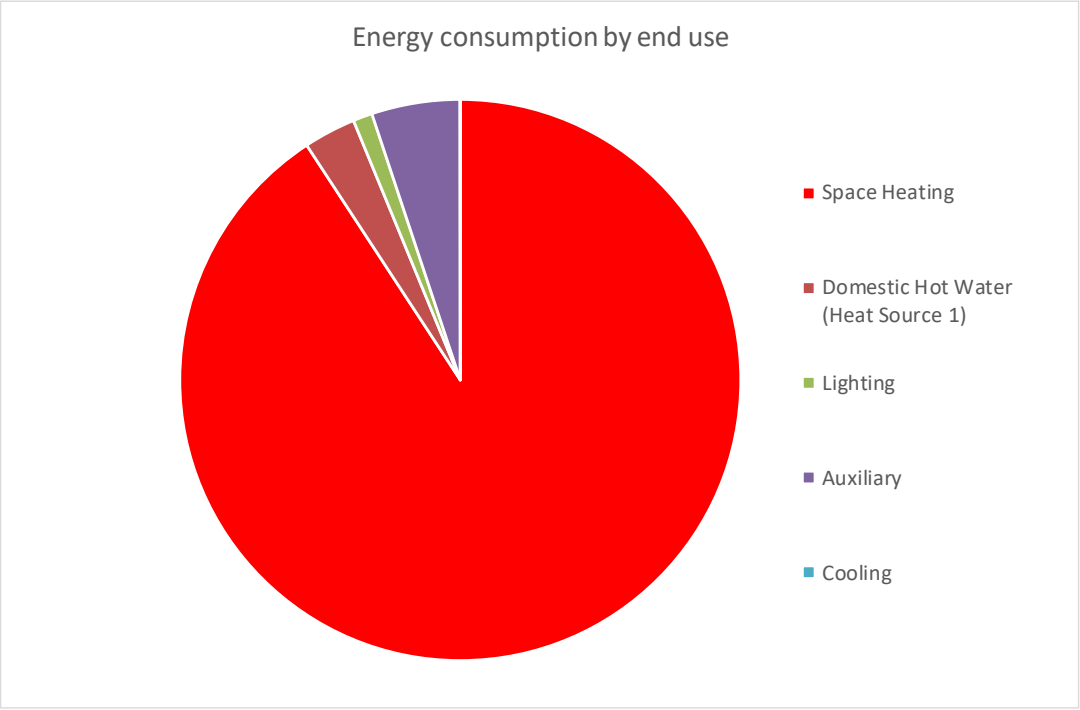
Unit identifier (e.g. plot number, dwelling type etc.)	Model total floor area (m^2)	REGULATED ENERGY CONSUMPTION PER UNIT (kWh p.a.) - TER WORKSHEET				REGULATED CO_2 EMISSIONS PER UNIT				
		Space Heating	Domestic Hot Water	Lighting	Auxiliary	Space Heating	Domestic Hot Water	Lighting	Auxiliary	SAP 10.0 CO_2 emissions ($kgCO_2$ p.a.)
House	*1070.4*	*130146*	*4053*	*1498*	*6862.31*	**27,331**	**851**	**349**	**1,599**	**30,130**



BE LEAN: PASSIVE DESIGN MEASURES AND EFFICIENT SERVICES

Number of passive design measures and measures improving energy efficiency of building services have been included in the design to help to reduce the CO2 emissions. Full specification of the efficient baseline is described in Table 3.
The following table shows results obtained with the improvements over the notional baseline

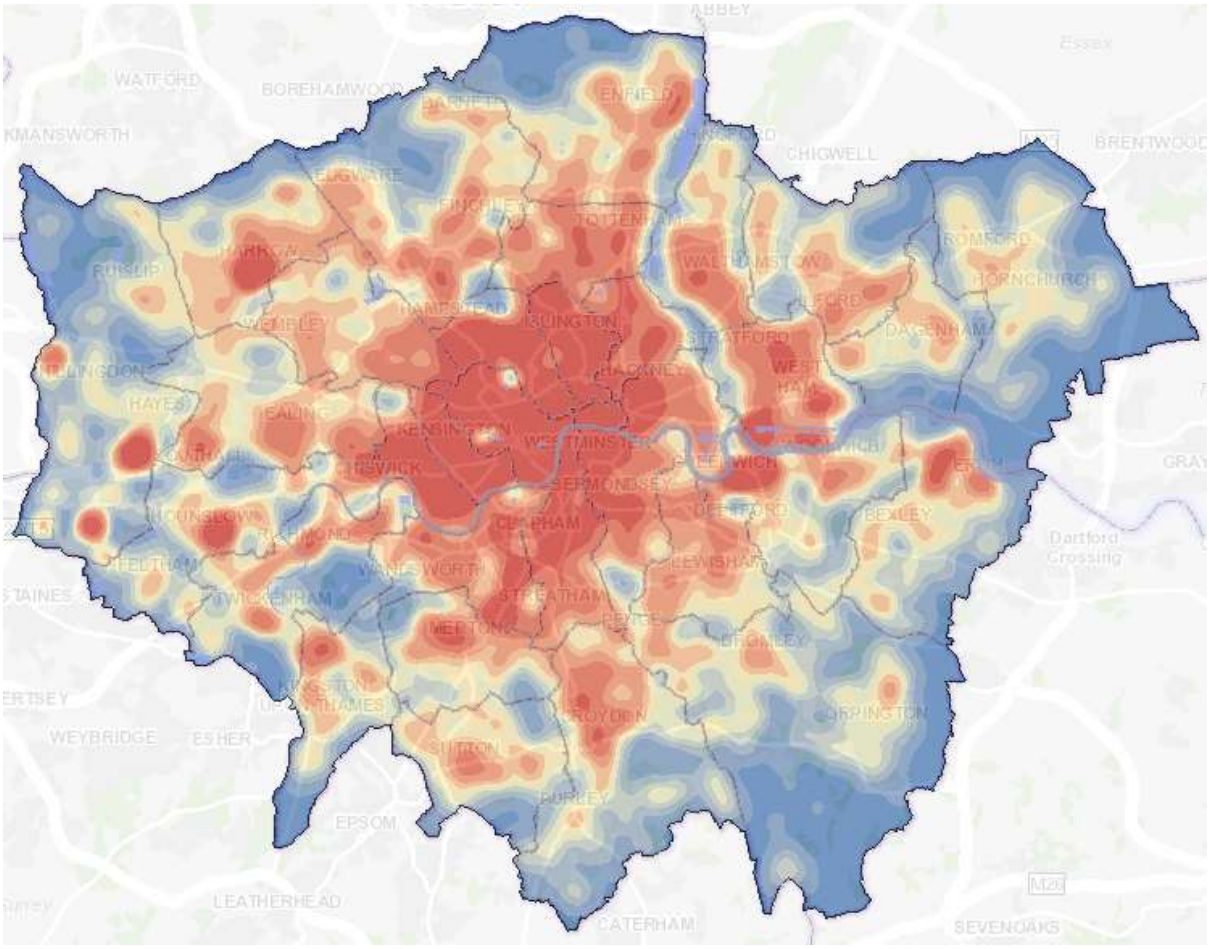
DOMESTIC ENERGY CONSUMPTION AND CO_2 ANALYSIS												
Unit identifier (e.g. plot number, dwelling type etc.)	Model total floor area (m^2)	REGULATED ENERGY CONSUMPTION PER UNIT (kWh p.a.) - 'BE LEAN' SAP DER WORKSHEET					REGULATED CO_2 EMISSIONS PER UNIT					
		Space Heating	Domestic Hot Water (Heat Source 1)	Lighting	Auxiliary	Cooling	Space Heating CO_2 emissions ($kgCO_2$ p.a.)	Domestic Hot Water CO_2 emissions ($kgCO_2$ p.a.)	Lighting CO_2 emissions ($kgCO_2$ p.a.)	Auxiliary CO_2 emissions ($kgCO_2$ p.a.)	SAP 10.0 CO_2 emissions ($kgCO_2$ p.a.)	Calculated DER SAP 10.0 ($kgCO_2$ / m^2)
House	*1070.4*	*122362*	*4053*	*1498*	*6862*	*19.72*	25,696	851	349	1,599	28,500	26.6



BE CLEAN: HEATING INFRASTRUCTURE

LONDON HEAT MAP

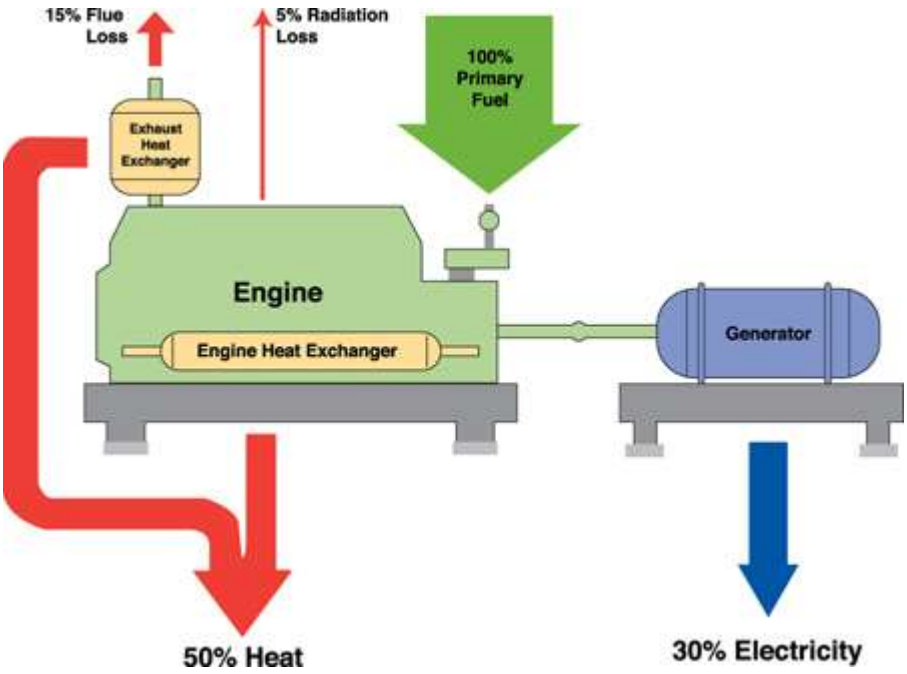
The London Heat Map (shown below) has been consulted to establish the possibility of connecting to heating infrastructure. There are no existing networks present within connectable range of the scheme, therefore a connection is not possible.



BE CLEAN: COMBINED HEAT AND POWER

GENERAL INFORMATION

Although not using any renewable energy source, gas CHP helps to reduce CO2 emissions by delivering heat and electricity locally and reducing the losses that normally occur by conventional power plants. Produced electricity can be exported to grid if the on-site demand is lower than production.



RECOMMENDATIONS SPECIFIC TO THIS DEVELOPMENT

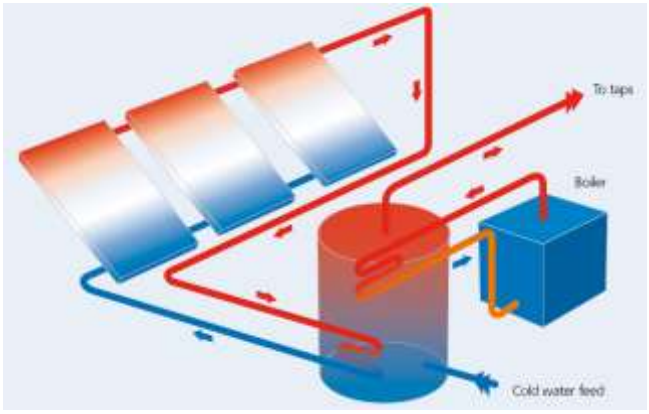
CHP is not considered suitable due to low electricity carbon factor in SAP10 and small size of development

BE GREEN: ON-SITE RENEWABLE ENERGY SOURCES

SOLAR HOT WATER

GENERAL INFORMATION

Solar hot water systems for dwellings use collector which provides a separate heating circuit for hot water cylinder. This is usually backed up by electric immersion heater or other source of heat.
Two types of collectors are available:
- Flat Plate – less expensive, less efficient
- Evacuated Tube – more expensive and more efficient



RECOMMENDATIONS SPECIFIC TO THIS DEVELOPMENT

A solar hot water system has been considered. However, Photovoltaic tile panels are preferable due to smaller visual impact in the conservation area and similar CO2 saving.

BE GREEN: ON-SITE RENEWABLE ENERGY SOURCE

AIR SOURCE HEAT PUMPS

GENERAL INFORMATION

An air source heat pump extracts heat from the outside air in the same way that a fridge extracts heat from its inside. It can extract heat from the air even when the outside temperature is as low as minus 15° C.

On 17 December 2008, the European Parliament adopted the EU Directive on promoting the use of energy from renewable sources. For the first time however, in addition to geothermal energy, aerothermal and hydrothermal energy are also recognised as renewable energy sources.

There are two main types of ASHP:

AIR-TO-WATER SYSTEM

Air-to-water system uses the heat to warm water. Heat pumps heat water to a lower temperature than a standard boiler system would, so they are more suitable for underfloor heating systems than radiator systems. Although some ASHP systems are capable of heating the water to the higher temperature, the efficiency is higher when using low temperature underfloor heating or low temperature fan convectors.

AIR-TO-AIR SYSTEM

Air-to-air system uses the heat to warm the indoor air. The air is heated through individual fan-coils or centrally and then distributed to rooms via ductwork.

RECOMMENDATIONS SPECIFIC TO THIS DEVELOPMENT

Air source heat pumps have been ruled out due to lower efficiency and visual impacts compared to the proposed GSHP system.

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BE GREEN: ON-SITE RENEWABLE ENERGY SOURCE

SOLAR PHOTOVOLTAICS

GENERAL INFORMATION

This system uses semi-conductor cells to convert solar energy into electricity. Two main types of PV panels are available:
- Monocrystalline – More expensive and more efficient
- Polycrystalline – Less expensive and less efficient

Depending on type, the output of 1 kWp (kilowatt peak) can be achieved by panels with area between 6 and 20 m2.

The use of PV panels generally requires relatively large unshaded roof area where they can be mounted facing south, ideally having between 30° and 40° inclination.

RECOMMENDATIONS SPECIFIC TO THIS DEVELOPMENT

It is proposed to install a PV system with total peak output of 6 kWp, with integrated PV tiles panels facing south (SE/SW). The system will comprise 400 No PV tiles, requiring a roof area of 40.8 m2

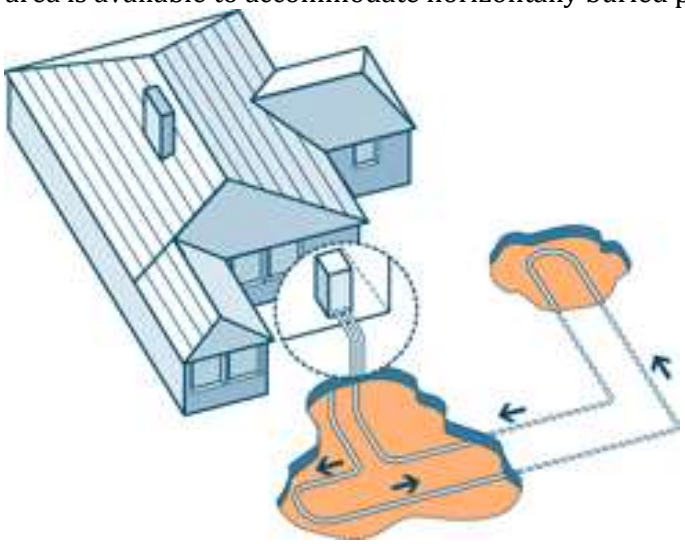
BE GREEN: ON-SITE RENEWABLE ENERGY SOURCE

GROUND SOURCE HEAT PUMP

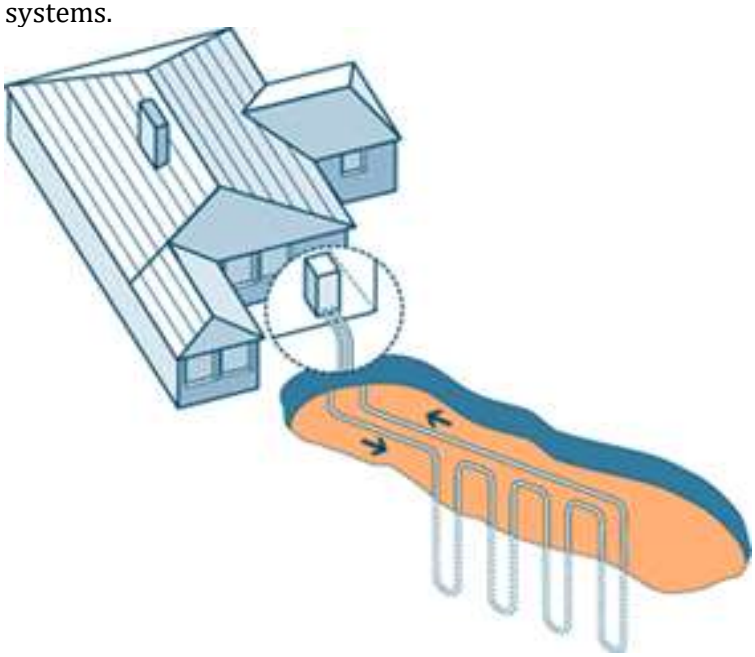
GENERAL INFORMATION

Ground source heat pumps use a buried ground loop which transfers heat from the ground into the building through heating distribution system. GSHP technology can be used both for heating and cooling. Two main types of GSHP are available:

- Horizontal loop is suitable for applications where sufficient area is available to accommodate horizontally buried pipes



- Vertical loop system can be used where ground space is limited, but will require boreholes typically 15-150m deep, and is consequently more expensive to install than horizontal systems.



RECOMMENDATIONS SPECIFIC TO THIS DEVELOPMENT

It is proposed to install an MCS-certified ground source heat pump system Mitsubishi Ecodan CRHV-P600YA. This system will provide space heating through wet underfloor heating and domestic hot water through indirect DHW cylinders.

BE GREEN: ON-SITE RENEWABLE ENERGY SOURCE

BIOMASS / BIOFUELS

GENERAL INFORMATION

Producing energy from biomass has both environmental and economic advantages. It is a carbon neutral process as the CO2 released when energy is generated from biomass is balanced by that absorbed during the fuel's production.
There are two main ways of using biomass to heat a domestic property:

- Standalone stoves providing space heating for a room. These can be fuelled by logs or pellets but only pellets are suitable for automatic feed. Generally, they are 6-12 kW in output, and some models can be fitted with a back boiler to provide water heating.

- Boilers connected to central heating and hot water systems. These are suitable for pellets, logs or chips, and are generally larger than 15 kW.

RECOMMENDATIONS SPECIFIC TO THIS DEVELOPMENT

Biofuels are ruled out due to negative impact on air quality and environmental issues surrounding liquid biofuels as currently there are no established standards relating to the sustainability of biofuels.

BE GREEN: ON-SITE RENEWABLE ENERGY SOURCE

WIND ENERGY

GENERAL INFORMATION

Wind power is a clean, renewable source of energy which produces no carbon dioxide emissions or waste products. The turbines can have horizontal or vertical axis (Darrieus type). Wind turbines use the wind's lift forces to rotate aerodynamic blades that turn a rotor which creates electricity. Most small wind turbines generate direct current (DC) electricity and are not connected to the national grid. A special inverter and controller are required to convert DC electricity to AC at a quality and standard acceptable to the grid if the turbine is to be connected to national grid.

RECOMMENDATIONS SPECIFIC TO THIS DEVELOPMENT

Wind energy systems will not be considered due to negative visual effects, interference, flicker and noise risk. Exposure to wind would be limited by surrounding buildings.

Section 2.0

MECHANICAL SERVICES

2.1 INCOMING UTILITY SERVICES

New gas and water utility supplies/ meters will be provided to the building. The gas meter will be external to the building in a ventilated space and the water meter externally in an underground pit.
(Soil conditions will confirm the water pipe material).

These will be sized to meet the demands of the building.

An additional kW/hr gas sub-meter will be provided with a remote visual display installed to assist in energy monitoring and management as part of the BMS/ audio visual system.

An additional water flow meter (l/s) will be provided with a remote visual display installed to assist in water monitoring and management as part of the BMS/ audio visual system.

2.2 DESIGN CONDITIONS

External temperatures:

Winter	-8°C saturated
Summer	32°C (DB) 20°C (WB)

Internal Temperatures:

Living Rooms	21°C
Kitchen/Dining	21°C
Bedrooms	19°C
Bathrooms	23°C
Hall/Circulation	19°C
Stores/Plant	16°C

2.3 BUILDING REGULATIONS PART L1A (2013/16)

The current part 'L1A' of the Building Regulations (2013/16), consists of minimum requirements for dwellings, briefly consisting of the following:

- Walls, roofs and ceilings need to have adequate resistance to loss of heat.
- Sufficient control needs to be provided for occupants to vary lighting levels, to avoid unnecessary energy use and maximise natural daylight.
- Adequate user control should be available for heating and cooling to avoid unnecessary energy use and maximise passive measures.

Part 'L1A' of the Building Regulations (April 2013/16), is also concerned with the conservation of fuel and power and its aim is to maximum the possible contribution that can be made to the Government's target for reducing CO_2 production whilst allowing flexibility for designers. This philosophy will be followed in our designs.

The measures to be implemented/ investigated to reduce energy consumption are:

- Specifying an efficient heating system and if gas boilers utilised, these are to be high efficiency condensing boilers with very low NOX levels.
- Optimising the boiler selection for the building occupancy and reducing energy consumption through controls and management.
- Installing responsive controls and sub-zoning of the building to allow the part load, low energy and economical use of the system. (Adaptive to user occupancy).
- Review of thermal insulation techniques, limits and air tightness.
- Review of renewable energy sources to comply with the limits dictated by The Local Planning Authority and The London Plan.
- Minimising the effect of solar gain in a passive manner, to provide comfort conditions.
- Limiting fan power usage to noted requirements.
- Reviewing extract fan systems and utilising heat recovery and passive natural ventilation where possible.
- If cooling is utilised, to provide through a very efficient system and utilised only at peak times.

2.4 HEATING

The main space heating system will be led by a high efficiency Mitsubishi GSHP system (Vertical borehole). With backup/ top up condensing boilers with ultra-low NOX levels (Broag Remeha Quinta ACE). All of the main space heating load will be produced by the GSHP system with a 6.29 COP.

The GSHP/ boiler systems will serve LTHW pressurised supplies to the majority of underfloor heating systems in the principal living and bedroom areas. Radiators to secondary areas and towel rails to bathrooms will be served via a separate summer circuit. LTHW supplies will also provide the heat for the HWS system and the pool water/ AHU.

All internal pipework to be copper insulated and pex to underfloor systems.

All flues to discharge above main roof level by balanced/ separate flues.
Fresh air and plantroom cooling via louvers at LGF.

All heating zones/spaces will be provided with zone valves, re-heaters, thermostat control or TRV's (Thermostatic radiator valves), to ensure efficient energy use.

All heating zones/spaces will also be controlled by user interface controls to programme occupancy, holiday periods and set back times; again to ensure efficient energy use.

Future heating network pipework connections and plate heat exchanger space to be included within the scheme.

2.5 WATER SERVICES

A fully pressurised water system will be provided throughout the property to ensure continuity of supply. If after testing a mains water pressure system is acceptable; this will be adopted. The system is to be installed in copper pipework to the sanitary/kitchen appliances.

The general pressure available throughout the system will be approximately 3 bar at the mixers/taps with flow rates accommodated to the sanitary appliances and shower mixer valves in accordance with the Part 'G' calculator; low flow/restrictors.

The system will operate on a variable speed pump principle to maintain a constant pressure throughout the system and limit energy use. Pressure regulating devices will be required to some areas. All sanitary fittings/plant will be individually and zone valved. All pipework to be copper insulated.

Consideration will be given to a leak detection system to provide early warning of any leaks in the systems, to minimise any water loss.

2.5.1 Domestic Cold Water

Sufficient cold water will be stored and boosted to provide continuity of supply. Filtered mains drinking water will be provided to the main kitchens and certain points.

A water softener will be provided within the main LGF plantroom providing softened water to the hot water cylinders, as well as all the baths and shower accommodation. (Softened water will ensure optimum energy performance due to limiting scale build up in plant/pipework).

2.5.2 DOMESTIC HOT WATER

Hot water cylinders located in the LGF plantroom will be provided with boosted and conditioned cold water. The hot water cylinders will be complete with a pumped return system, complete with back up and top up by the boiler system.

Hot water production shall be strictly controlled by weather compensation, timeclock control for occupancy holiday times and maximisation of plant duty. (Conditioned water will ensure optimum performance due to limiting scale build up in plant/pipework).

All basins, baths and sinks will be protected by TMV2/3 valves (Thermostatic mixing valves), above the minimum Part 'G' requirements.

2.6. RECYCLED RAINWATER

The rainwater recycling drainage system will provide recycled rain water for irrigation supplies. This will reduce the reliance on treated mains water. Filters and UV shall be provided to the system.

2.7 NATURAL VENTILATION

Background habitable room ventilation is generally to be provided by MVHR systems to improve energy efficiency and heat recovery.

Rapid ventilation to spaces will be provided by openable windows/ continuous ventilation.

Consideration will be given to a PSV (Passive stack ventilation), system to bathrooms (wet areas), with humidity-controlled trickle vents to habitable spaces.

2.8 FRESH AIR SYSTEMS

Habitable rooms located within the LGF area with no windows will also be provided with fresh air by mechanical ventilation heat recovery units with highly efficient counter flow heat exchangers. Mechanical ventilation system will be fully compliant with Part 'F' of the Building Regulations. Ductwork to be pre-insulated PVC and galvanised steel with insulation or Kool duct.

The swimming pool hall will have an AHU with heat recovery/ humidity control ventilation (By others).

2.9 BATHROOMS, CLOAKROOMS, STORE AND KITCHEN VENTILATION

The general space MVHR units units will also be provided for the purposes of extracting air from sanitary accommodation, kitchen and utility ventilation.

2.10 COMFORT COOLING

Firstly, the building has been designed to limit heat gains by; orientation, thermal mass, insulation, full house MVHR ventilation provision, tree shading, semi underground spaces and overhanging slabs/ roofs.

Cooling may also be considered to some rooms/spaces, noting the dynamic simulations noting over-heating.

This is proposed to be via a high efficiency Mitsubishi WR2 GSHP system (5.6 EER), with vertical boreholes.
The water-cooled condensers will be located in the rear garden LGF plantroom.

The type of cooling for each room will be provided by fancoils mounted either within joinery or false wall/ceiling details.

Pre-insulated discharge ductwork will be attached to these units to discharge through high induction linear grilles incorporated within joinery and wall finishes at high level. The system will have very low noise levels, which is generally to be targeted at NR25 throughout the building.

A refrigerant gas sensor system will be incorporated to provide safety/protection in accordance with FGAS requirements, to all bedrooms and other rooms/spaces.
Internal pipework to be copper insulated, externally PE pipework.

Each room/space will have individual control via a remote room controller to each fan coil, controlled via a discrete room sensor for operation or modification to the set point of the controllers. Cooling and heating will be automatically controlled to ensure no system fighting and undue energy use (interlocked). Overall occupancy and holiday controls to also be provided to ensure efficient energy use and management.

2.11 AUTOMATIC CONTROLS

Automatic control systems will be provided for all of the mechanical services. It is anticipated this will be installed as a complete BMS/ DDC electronic system supervised by a touch screen control/PC positioned within the LGF plantroom.

The client will also have the facility for zoned overrun of various systems and time switch control separate to the main plantroom, via a PC interlink situated within the study and phone app.

Full remote off-site access will also be provided via a modem to this system enabling an ongoing maintenance contract to be provided with the system installers and for the occupiers to efficiently control the systems.

The system will have remote interface modules which will allow the client operation of the heating and cooling, lighting and other systems via the audio-visual keypads. Where this is not provided, individual room control will be provided with more basic visual/manual controls.

Controls are to be zoned to provide more efficiency, occupancy control and management.

2.12 ABOVE GROUND DRAINAGE
The above ground drainage system shall be provided to serve all the sanitaryware accommodation.

It is anticipated that in the house cast iron/HDPE silent pipework will be provided, fully insulated for both thermal and acoustic reasons, with individual local run-outs to the sanitary accommodation being in Upvc pipework. Installation of leak detection systems will be considered to detect leaking water hidden in areas such as voids and shower trays etc. This is being considered to protect the building fabric and internal fixtures and fittings.

2.13 RAINWATER DRAINAGE
All rainwater pipes will be routed from roof level to drain points at ground/ lower ground floor levels. All roof outlets will be sized to take a rainfall intensity of 108 mm per hour. All pipes shall have access before connecting to underground drains. All external rainwater stacks are to be either aluminium or cast iron and where installed internally, the stacks/drains shall be HDPE and thermally/ acoustically insulated. Rainwater will be partly collected for irrigation reuse.

2.14 UNDERGROUND DRAINAGE
Surface water will be reduced to 50% of the existing un-restricted run off rate, by a large surface water attenuation tank and hydrobrake system with pumps. All flat surface areas will have a rainfall intensity of 75mm/Hr.
All LGF areas will be fully pumped drainage and have a backup UPS supply.
All drainage pipes under the building will be cast iron, externally in Upvc/ clayware.
Surface water will be partly collected for irrigation reuse.

Section 3.0

ELECTRICAL SERVICES

3.1 INCOMING UTILITY SUPPLY

The existing main incoming TP&N supply connection may be reused to serve the property; which will be sized to suit the anticipated maximum building load.
The energy usage at the incoming position will be measured and inter-linked to the AV system providing the end-user with accurate power consumption data displayed on a visual display screen. This facility will provide the owner with a user-friendly interface for energy monitoring and management within the house. The PV system electrical load is envisaged to be utilised on site, possibly with battery storage. A PV generation meter will be installed.

3.2 SUB-MAIN DISTRIBUTION

Sub-main distribution boards will be installed to serve various areas within the building. This will reduce cable material costs and installation time. Sub metering to Part L will be provided.
The local sub-distribution boards will incorporate suitably rated MCBs and RCBOs to suit the circuit type and loading.
Separate dedicated feeds will be supplied to life safety systems, such as fire alarm equipment in suitable fire rated cabling.
Sub-main distribution cabling will be multi-core armoured with XLPE outer sheath and LSOH inner sheath with copper conductors.
Adequate spare capacity will be provided within the distribution network for any future expansion of the system, avoiding the need for any significant re-modification works at a later period.

3.3 FINAL CIRCUIT DISTRIBUTION

Final circuit distribution cabling will be multi-core flat twin & earth XLPE/LSOH sheathed copper conductors and will not be of the PVC/PVC type.
The XLPE (cross-linked polyethylene) cable material offers superior electrical performance to PVC and the LSOH insulation produces ‘low smoke and fumes’ when exposed to fire.
RCBOs will be used which combine Residual Current and Overcurrent protection within a single device.
Consequently, each circuit will be individually RCD protected avoiding any nuisance tripping of unaffected circuits as would be the case if a split load distribution arrangement were adopted whereby many circuits are protected by a single RCD.

3.4 SMALL POWER INSTALLATIONS

Single and twin 13A Switched Socket outlets will be provided at various positions within the property for general purpose use and to serve fixed electrical equipment.
The outlets will be positioned to offer the greatest flexibility for different interior space planning options and will be mounted at a suitable height for ease of access conforming to the Building Regulation Part M requirements.
Where the room/spaces are used as ‘home offices’ (e.g., where computers, printers etc. are installed causing potential earth leakage currents) then socket outlets will be of the Dual Earth connection type.
13A switched/un-switched fused connection units with neon lamps will be installed to serve various fixed items of electrical equipment.
All small power faceplate outlets will be sourced from a reputable manufacturer such as ‘MK Electric’ incorporating the required electrical safety standards and allowing ease of installation.

3.5 INTERIOR LIGHTING INSTALLATIONS

The lighting scheme will utilise the latest low energy compact fluorescent and long-life LED/CFL lighting technologies in order to achieve a minimum of 100% low energy lighting throughout the property, exceeding the requirement as stipulated in the Building Regulations Part L.
Dimming control will be provided to the majority of the lighting systems in the form of pre-set scene setting controlled from individual wall plates in each room/space and via a wireless/ hardwired visual display screen as part of the AV control system.
Consideration is also being given to allow energy usage from the lighting system to be monitored via the AV system.
In room/spaces with sufficient natural lighting, day-linked control of the artificial lighting is also being evaluated.
Computational daylight investigation will be carried to principle living areas to ascertain the benefit of day-linked dimming controls.

Room/spaces which are not lit by natural daylight, in particular escape routes and the LGF/ basement areas will incorporate emergency standby lighting with up to 3hr battery back-up. Consideration for additional emergency lighting to all escape routes will be taken.
Special attention will be made to bathrooms and the pool area lighting scheme, ensuring the correct level of Ingress Protection (IP) rating is provided in accordance with the ‘zoning’ requirements of the IEE Regulations.

3.6 EXTERIOR LIGHTING INSTALLATIONS

The external lighting installation will comprise of a combination of low energy compact fluorescent and LED lighting. (Light outputs will not exceed Regulations).
Luminaires will be mounted inground and away from the building for night time perimeter security lighting and will be of the wall-wash type to avoid direct light pollution into the neighbouring community.
Ground recessed and low-level ground mounted garden amenity lighting will also be provided which will be limited in numbers to avoid excessive lighting and light pollution to the night sky.
All external lighting will be daylight-linked via an adjustable external photocell and only switch on during periods of insufficient daylight. Manually adjustable time-clock control will also be provided to allow the occupier to adjust the time period and to switch off the lighting when not required.

3.7 AUDIO VISUAL SYSTEMS

The Audio-Visual installation will generally include the following systems:

- Lighting control and management via user-friendly wireless/hardwired touch screen visual display panels located throughout building to occupier's requirement.
- Building energy monitoring via touch screen panels with scope for split monitoring of various loads e.g., lighting & power.
- Heating, comfort cooling and ventilation control via touch screen panels.
- Terrestrial and Satellite TV installation and control. For signal reception each TV will receive a single CAT6 cable input allowing multi-service viewing. Conventional coax cabling will not be installed saving on material and installation cost.
- Hardwired broadband and telephone service in CAT6 cabling.
- CCTV security monitoring around the vicinity of the building in CAT6 cabling with digital recording facility.
- Security, audio and visual access control systems to main building entrances.

3.8 SECURITY SYSTEM

A wired intruder alarm system will be provided comprising suitable room/space movement detectors, magnetic contacts to perimeter doors and window/door break glass detection. The system will be linked to a 24hr central monitoring station via a dedicated IP line/ 4G and GSM backup. The design and installation will conform to ACPO policy and DD243 requirements for police response service.

3.9 FIRE DETECTION AND ALARM SYSTEM

The building may come under the requirements of BS5839 Part 6. The final installation design will be agreed with the relevant parties, including the Local Fire Office (Fire Brigade) and Local Council District Surveyor.

To provide the highest degree of life and property protection a 'Type L1' category system may be employed and be appropriately zoned, allowing the local fire brigade to promptly identify the location/source of fire occurrence.
The system will have the appropriate level of standby battery back-up to operate under mains power failure.
All cabling will be fire rated to the appropriate required standard. The system will be linked to a 24hr central monitoring station via a dedicated IP line/ 4G and GSM backup.

Generally, an aspirating Vesda ASD smoke detection system will be provide to all FOH areas with remote sounders. BOH areas will be standard smoke detectors incorporating base sounder units, except within the kitchen areas – these will be heat detectors; to avoid nuisance alarm conditions. The plant room/ kitchen areas and rooms with gas fires will also have carbon monoxide (CO) detectors installed; either by Eco gas monitoring on the Vesda system or 7- year battery units locally.

3.10 EARTHING & BONDING

All extraneous conductive parts will be bonded to the main building earth terminal with main equipotential and supplementary earth bonds as required.

Supplementary earth bonding will be provided to areas of increased electric shock risk including bathrooms, shower rooms, swimming pool area and plant rooms.
A separate additional earth electrode system will be provided for earth bonding of the swimming pool areas as required by the IEE Regulations.

3.11 LIGHTNING PROTECTION
A lightning protection system will be installed to prevent damage to the building structure and mitigate; injury to people, physical damage (e.g., fire, explosion) and failure of internal electrical systems.
The system will be designed to intercept the lightning strike and safely discharge the high voltage current to earth via a network of lightning rods and metal conductors or the building frame, connected to an earth electrode designed to provide a low resistance path to earth. Roof tapes to be set to the underside of the roof tiles and down conductors generally set behind rainwater pipes.
To protect sensitive electronic equipment within the property from damage and failure resulting from transient over voltages (surges), caused by lightning strikes; a suitable surge arrester will be installed at the main supply intake and all sub – boards on data/phone lines and for sensitive equipment.

3.12 ELECTRICAL APPLIANCES & MECHANICAL SYSTEM EQUIPMENT
Most ‘white goods’, including the refrigerator/freezer, cooker, microwave oven, washing machine/dryer and dishwasher will be ‘A’ rated (or higher) energy efficient items under the EU energy label classification.
Other major electrical plant, including condenser units and water booster pumps sets will be selected where available and or practicable to incorporate energy efficient motors and intelligent energy saving controls.

Section 4.0

M&E SUSTAINABILITY ITEMS

4.1 DAYLIGHTING
The proposed house has high levels of natural daylighting due to the glazing areas.

All main habitable rooms (Living rooms, kitchen and study), will achieve the minimum daylight factors and view of the sky.

4.2 RECYCLABLE MATERIALS
Each product/material for the M&E services shall be evaluated against Environmental impacts and life cycle costing. The following is a typical list of proposed M&E materials/products that will be utilised;

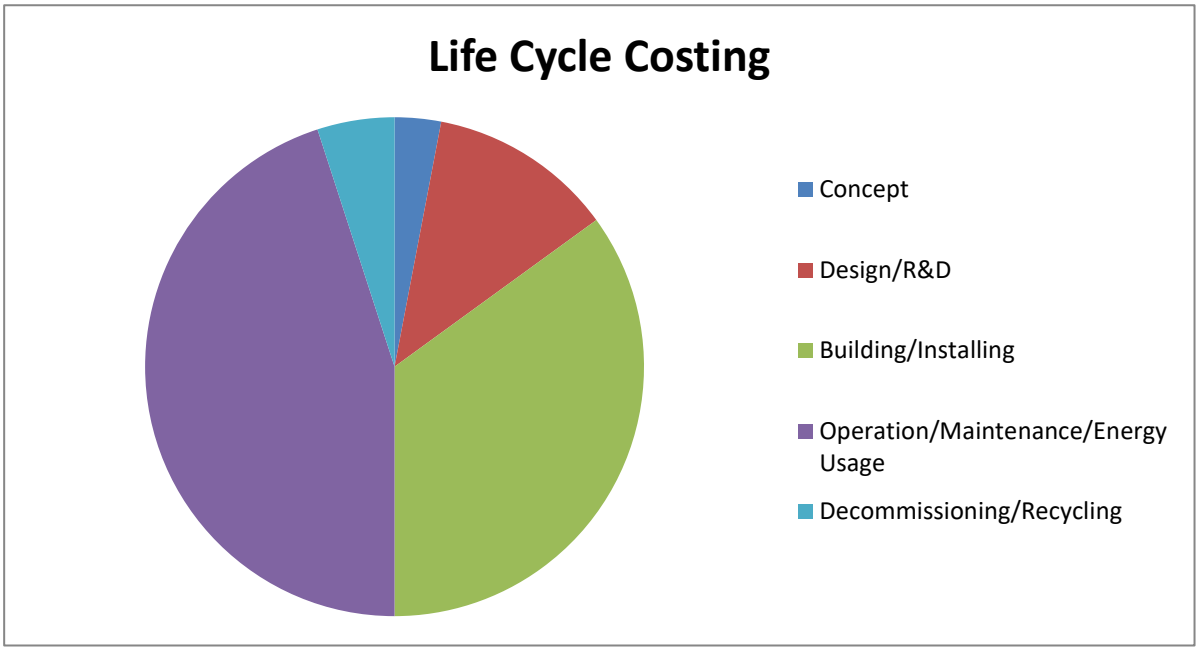
- Water pipework - Copper (Recyclable).
- Valves - Brass (Recyclable).
- Electrical cables - PVC twin & earth (XLPE/LSF) (Recyclable)
- Pipework insulation - Rock wool (Recyclable)
- Pipework Insulation - Phenolic foam – (Recyclable)
- Concrete - Portland cement based - (Recyclable)
- Light fittings – LED's/compact fluorescent - (Recyclable)

4.3 SALVAGE/REUSE OF EXISTING MATERIALS
Each existing material/product will be evaluated for possible salvage/reuse when existing items/materials are removed for the proposed works.

Reuse will have priority over salvage; an economic, viability and safety assessment will be made for each item/material.

4.4 LIFE CYCLE COSTING
Each product/material proposed shall be evaluated on a life cycle costing basis. Recyclable materials shall be utilised where possible in preference to non-Recyclable.

The particular areas of the life cycle to be addressed for M&E Services are:
Building & Installing the system/product, Operation/Maintenance, Energy Usage and finally, Decommissioning/Recycling.



Below is a graph indicating the lift cycle phases;

Typically, the majority of the life of a material/product is spent in the Operation/Maintenance phase. It is in this phase that it creates the value contribution but also absorbs the vast proportion of the costs through maintenance and energy usage.

Products/materials shall be selected on the basis of particularly reducing the impact of this phase, for example, a pump, by selecting long term reliability and low energy usage over initial cost.

The ease and speed of building/installing different products/systems shall also be compared to reduce this phase.

4.5 NOISE & VIBRATION

Noise and vibration associated with moving mechanical services plant, e.g., Pumps, fans, condensers, pipes/ducts, lifts and boilers shall be limited to acceptable levels as follows;

Pumps: Inverter drives providing slow low impact start/stop cycles, intelligent controls, anti-vibration couplings/supports, dense block wall constructed plantrooms.

Fans: Low speed intermittent/ MVHR ventilation fans, flexible duct connections, remote plantroom/cupboard mounting, attenuators and anti-vibration fixings.

Boilers/ GSHP: Low noise units and internally mounted within plant areas.

Pipes: Anti-vibration/flexible couplings to plant, expansion joints/anchors and smooth bends/straight lines.

Ducts: Inline attenuators, anti-vibration/flexible couplings to plant, and smooth bends/straight lines.

An Acoustic Consultant shall further advise on noise, vibration and acoustic items.

4.6 SOLAR GAINS

In compliance with the new Part 'L' of the Building Regulations (April 2013/16 edition) solar gains shall be reduced by the building being designed to limit heat gains by; orientation, thermal mass, provision of green roofs, tree shading, semi underground spaces, overhanging slabs/roofs and higher performance double glazed windows with solar tinting/low emissivity coating and Argon gas filled cavities to the South, East & West Elevations.

Additionally, internal blinds to the South, East & West Elevations may be provided as part of the development for occupiers to assist in compliance with Solar Gains.

Section 5.0

DISCLAIMER

This non-assignable report has been prepared solely for the client as a pre-planning report for the proposed development. The contents and views expressed in this report remain the copyright and opinion of ME7 Ltd. The client is to check and verify the contents with no admission of liability, duty of care or warranty to any Third Party.

This report is based on the information provided/available at the time of production.

ME7 January 2021

APPENDIX (i)

SAP L1A 2013/16 REGULATIONS

(DER Worksheet)

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Ondrej Gajdos	**Stroma Number:**	STRO006629
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.5.12

Property Address: Be Green

Address : 7 Greenaway Gardens, LONDON, NW3 7DJ

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Basement	73.8	(1a) x	2.5	(2a) =	184.5	(3a)
Ground floor	429.4	(1b) x	3.8	(2b) =	1631.72	(3b)
First floor	232.6	(1c) x	3.55	(2c) =	825.73	(3c)
Second floor	215.8	(1d) x	3.1	(2d) =	668.98	(3d)
Third floor	118.8	(1e) x	3.35	(2e) =	397.98	(3e)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	1070.4	(4)				
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =		3708.91	(5)

2. Ventilation rate:

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

		Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	0	+ (5) =	0 (8)
If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)			
Number of storeys in the dwelling (ns)			0 (9)
Additional infiltration		[(9)-1]x0.1 =	0 (10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction			0 (11)
if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35			
If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0			0 (12)
If no draught lobby, enter 0.05, else enter 0			0 (13)
Percentage of windows and doors draught stripped			0 (14)
Window infiltration		0.25 - [0.2 x (14) ÷ 100] =	0 (15)
Infiltration rate		(8) + (10) + (11) + (12) + (13) + (15) =	0 (16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area			15 (17)
If based on air permeability value, then (18) = [(17) ÷ 20]+(8), otherwise (18) = (16)			0.75 (18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
Number of sides sheltered			2 (19)
Shelter factor		(20) = 1 - [0.075 x (19)] =	0.85 (20)
Infiltration rate incorporating shelter factor		(21) = (18) x (20) =	0.64 (21)

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Infiltration rate modified for monthly wind speed

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table 7												
(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7
Wind Factor (22a)m = (22)m ÷ 4												
(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18
Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m												
	0.81	0.8	0.78	0.7	0.69	0.61	0.61	0.59	0.64	0.69	0.72	0.75

Calculate effective air change rate for the applicable case

If mechanical ventilation:	0.5	(23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a)	0.5	(23b)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =	68	(23c)

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

(24a)m=	0.97	0.96	0.94	0.86	0.85	0.77	0.77	0.75	0.8	0.85	0.88	0.91	(24a)

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

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

c) If whole house extract ventilation or positive input ventilation from outside
if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 × (23b)

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

d) If natural ventilation or whole house positive input ventilation from loft
if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

(24d)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24d)

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

(25)m=	0.97	0.96	0.94	0.86	0.85	0.77	0.77	0.75	0.8	0.85	0.88	0.91	(25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors Type 1			3.24	x	1.2	=	3.888			(26)
Doors Type 2			6.14	x	0.33	=	2.0262			(26)
Doors Type 3			2.54	x	1.2	=	3.048			(26)
Doors Type 4			2.98	x	1.2	=	3.576			(26)
Windows Type 1			2.29	x1/[1/(1.1)+ 0.04]		=	2.41			(27)
Windows Type 2			1.68	x1/[1/(1.1)+ 0.04]		=	1.77			(27)
Windows Type 3			2.37	x1/[1/(1.1)+ 0.04]		=	2.5			(27)
Windows Type 4			1.76	x1/[1/(1.1)+ 0.04]		=	1.85			(27)
Windows Type 5			3.83	x1/[1/(1.1)+ 0.04]		=	4.04			(27)
Windows Type 6			1.34	x1/[1/(1.1)+ 0.04]		=	1.41			(27)
Windows Type 7			0.3	x1/[1/(1.1)+ 0.04]		=	0.32			(27)
Windows Type 8			0.46	x1/[1/(0.87)+ 0.04]		=	0.39			(27)
Windows Type 9			0.57	x1/[1/(0.87)+ 0.04]		=	0.48			(27)

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Windows Type 10			6.67	x0.87[1/(0.87)+ 0.04] =	5.61			(27)
Windows Type 11			2.07	x1[1/(1.1)+ 0.04] =	2.18			(27)
Windows Type 12			2.07	x0.87[1/(0.87)+ 0.04] =	1.74			(27)
Windows Type 13			2.22	x0.87[1/(0.87)+ 0.04] =	1.87			(27)
Windows Type 14			1.82	x1[1/(1.1)+ 0.04] =	1.92			(27)
Windows Type 15			1.82	x0.87[1/(0.87)+ 0.04] =	1.53			(27)
Windows Type 16			2.2	x1[1/(1.1)+ 0.04] =	2.32			(27)
Windows Type 17			3.08	x0.87[1/(0.87)+ 0.04] =	2.59			(27)
Windows Type 18			0.95	x1[1/(1.1)+ 0.04] =	1			(27)
Windows Type 19			2	x1[1/(1.1)+ 0.04] =	2.11			(27)
Windows Type 20			7.38	x0.87[1/(0.87)+ 0.04] =	6.2			(27)
Windows Type 21			10.59	x0.87[1/(0.87)+ 0.04] =	8.9			(27)
Windows Type 22			3.83	x0.87[1/(0.87)+ 0.04] =	3.22			(27)
Windows Type 23			13.1	x0.87[1/(0.87)+ 0.04] =	11.01			(27)
Windows Type 24			3.96	x0.87[1/(0.87)+ 0.04] =	3.33			(27)
Windows Type 25			1.38	x0.87[1/(0.87)+ 0.04] =	1.16			(27)
Windows Type 26			2.25	x0.87[1/(0.87)+ 0.04] =	1.89			(27)
Windows Type 27			23.96	x0.87[1/(0.87)+ 0.04] =	20.14			(27)
Windows Type 28			4.13	x0.87[1/(0.87)+ 0.04] =	3.47			(27)
Windows Type 29			2.19	x0.87[1/(0.87)+ 0.04] =	1.84			(27)
Windows Type 30			2.2	x0.87[1/(0.87)+ 0.04] =	1.85			(27)
Windows Type 31			2.26	x1[1/(1.1)+ 0.04] =	2.38			(27)
Windows Type 32			2.2	x1[1/(1.1)+ 0.04] =	2.32			(27)
Windows Type 33			2.19	x1[1/(1.1)+ 0.04] =	2.31			(27)
Windows Type 34			2.93	x1[1/(1.1)+ 0.04] =	3.09			(27)
Windows Type 35			1.49	x1[1/(1.1)+ 0.04] =	1.57			(27)
Windows Type 36			2.03	x0.87[1/(0.87)+ 0.04] =	1.71			(27)
Rooflights Type 1			4.472	x1[1/(1.2) + 0.04] =	5.3664			(27b)
Rooflights Type 2			2.043	x1[1/(1.2) + 0.04] =	2.4516			(27b)
Rooflights Type 3			5.52	x1[1/(1.2) + 0.04] =	6.624			(27b)
Rooflights Type 4			9.2736	x1[1/(1.2) + 0.04] =	11.12832			(27b)
Rooflights Type 5			7.696	x1[1/(1.2) + 0.04] =	9.235201			(27b)
Floor			503.2	x 0.22 =	110.704			(28)
Walls Type1	172.48	61.38	111.1	x 0.27 =	30			(29)
Walls Type2	326.33	0	326.33	x 0.26 =	84.85			(29)
Walls Type3	431.67	82.39	349.28	x 1.45 =	506.46			(29)
Walls Type4	73.13	36.72	36.41	x 0.18 =	6.55			(29)
Walls Type5	39.8	17.76	22.04	x 0.28 =	6.17			(29)
Walls Type6	5.6	3.08	2.52	x 0.28 =	0.71			(29)

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Roof Type1	369.4	32.35	337.05	x	0.15	=	50.56		(30)
Roof Type2	11.7	7.7	4	x	0.15	=	0.6		(30)
Roof Type3	172.7	0	172.7	x	0.12	=	20.72		(30)
Total area of elements, m²			2106.01						(31)

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

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

Fabric heat loss, W/K = S (A x U) (26)...(30) + (32) = 1047.9 (33)

Heat capacity Cm = S(A x k) ((28)...(30) + (32) + (32a)...(32e) = 0 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Medium 250 (35)

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

Thermal bridges : S (L x Y) calculated using Appendix K 315.9 (36)

If details of thermal bridging are not known (36) = 0.05 x (31)

Total fabric heat loss (33) + (36) = 1363.8 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	1190.66	1171.16	1151.65	1054.12	1034.61	937.08	937.08	917.57	976.09	1034.61	1073.63	1112.64	(38)

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

(39)m=	2554.47	2534.96	2515.45	2417.92	2398.42	2300.88	2300.88	2281.38	2339.9	2398.42	2437.43	2476.44	

Average = Sum(39)$_{1..12}$ /12= 2413.05 (39)

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

(40)m=	2.39	2.37	2.35	2.26	2.24	2.15	2.15	2.13	2.19	2.24	2.28	2.31	

Average = Sum(40)$_{1..12}$ /12= 2.25 (40)

Number of days in month (Table 1a)

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

4. Water heating energy requirement: kWh/year:

Assumed occupancy, N 4.13 (42)

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

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 132.37 (43)

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

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

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

(44)m=	145.61	140.31	135.02	129.72	124.43	119.13	119.13	124.43	129.72	135.02	140.31	145.61	

Total = Sum(44)$_{1..12}$ = 1588.43 (44)

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

(45)m=	215.93	188.85	194.88	169.9	163.02	140.68	130.36	149.59	151.37	176.41	192.57	209.12	

Total = Sum(45)$_{1..12}$ = 2082.69 (45)

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

(46)m=	32.39	28.33	29.23	25.49	24.45	21.1	19.55	22.44	22.71	26.46	28.89	31.37	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 1000 (47)

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If community heating and no tank in dwelling, enter 110 litres in (47)
Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in (47)
Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day):		6	(48)
Temperature factor from Table 2b		0.54	(49)
Energy lost from water storage, kWh/year	(48) x (49) =	3.24	(50)
b) If manufacturer's declared cylinder loss factor is not known:			
Hot water storage loss factor from Table 2 (kWh/litre/day)		0	(51)
If community heating see section 4.3			
Volume factor from Table 2a		0	(52)
Temperature factor from Table 2b		0	(53)
Energy lost from water storage, kWh/year	(47) x (51) x (52) x (53) =	0	(54)
Enter (50) or (54) in (55)		3.24	(55)

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

(56)m=	100.44	90.72	100.44	97.2	100.44	97.2	100.44	100.44	97.2	100.44	97.2	100.44	(56)

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

(57)m=	100.44	90.72	100.44	97.2	100.44	97.2	100.44	100.44	97.2	100.44	97.2	100.44	(57)

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

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m
(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m=	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)

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

(61)m=	0	0	0	0	0	0	0	0	0	0	0	0	(61)

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

(62)m=	339.63	300.59	318.58	289.61	286.73	260.39	254.06	273.29	271.09	300.12	312.28	332.82	(62)

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)
(add additional lines if FGHRS and/or WWHRS applies, see Appendix G)

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

Output from water heater

(64)m=	339.63	300.59	318.58	289.61	286.73	260.39	254.06	273.29	271.09	300.12	312.28	332.82	

Output from water heater (annual)₁₂ 3539.18 (64)

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

(65)m=	170.76	152.18	163.76	152.26	153.17	142.54	142.31	148.7	146.1	157.62	159.8	168.49	(65)

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

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m=	206.67	206.67	206.67	206.67	206.67	206.67	206.67	206.67	206.67	206.67	206.67	206.67	(66)

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

(67)m=	84.81	75.33	61.26	46.38	34.67	29.27	31.62	41.11	55.17	70.06	81.77	87.16	(67)

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

(68)m=	951.33	961.21	936.33	883.37	816.52	753.69	711.71	701.84	726.72	779.68	846.53	909.36	(68)

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

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(69)m=	43.67	43.67	43.67	43.67	43.67	43.67	43.67	43.67	43.67	43.67	43.67	43.67	(69)

Pumps and fans gains (Table 5a)

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

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

(71)m=	-165.34	-165.34	-165.34	-165.34	-165.34	-165.34	-165.34	-165.34	-165.34	-165.34	-165.34	-165.34	(71)

Water heating gains (Table 5)

(72)m=	229.51	226.46	220.11	211.47	205.87	197.98	191.27	199.87	202.92	211.85	221.94	226.47	(72)

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

(73)m=	1353.66	1350.99	1305.7	1229.22	1145.06	1068.93	1022.61	1030.81	1072.81	1149.59	1238.24	1311	(73)

6. Solar gains:

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

Orientation:	Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Northeast 0.9x	0.77	x	2.29	x	11.28	x	0.63	x	0.7	=	31.59	(75)
Northeast 0.9x	0.77	x	1.68	x	11.28	x	0.63	x	0.7	=	11.59	(75)
Northeast 0.9x	0.77	x	2.37	x	11.28	x	0.63	x	0.7	=	49.03	(75)
Northeast 0.9x	0.77	x	1.76	x	11.28	x	0.63	x	0.7	=	12.14	(75)
Northeast 0.9x	0.77	x	3.83	x	11.28	x	0.63	x	0.7	=	13.21	(75)
Northeast 0.9x	0.77	x	1.34	x	11.28	x	0.63	x	0.7	=	13.86	(75)
Northeast 0.9x	0.77	x	0.3	x	11.28	x	0.63	x	0.7	=	1.03	(75)
Northeast 0.9x	0.54	x	2.03	x	11.28	x	0.57	x	0.8	=	20.3	(75)
Northeast 0.9x	0.77	x	2.29	x	22.97	x	0.63	x	0.7	=	64.29	(75)
Northeast 0.9x	0.77	x	1.68	x	22.97	x	0.63	x	0.7	=	23.58	(75)
Northeast 0.9x	0.77	x	2.37	x	22.97	x	0.63	x	0.7	=	99.81	(75)
Northeast 0.9x	0.77	x	1.76	x	22.97	x	0.63	x	0.7	=	24.71	(75)
Northeast 0.9x	0.77	x	3.83	x	22.97	x	0.63	x	0.7	=	26.88	(75)
Northeast 0.9x	0.77	x	1.34	x	22.97	x	0.63	x	0.7	=	28.22	(75)
Northeast 0.9x	0.77	x	0.3	x	22.97	x	0.63	x	0.7	=	2.11	(75)
Northeast 0.9x	0.54	x	2.03	x	22.97	x	0.57	x	0.8	=	41.33	(75)
Northeast 0.9x	0.77	x	2.29	x	41.38	x	0.63	x	0.7	=	115.84	(75)
Northeast 0.9x	0.77	x	1.68	x	41.38	x	0.63	x	0.7	=	42.49	(75)
Northeast 0.9x	0.77	x	2.37	x	41.38	x	0.63	x	0.7	=	179.82	(75)
Northeast 0.9x	0.77	x	1.76	x	41.38	x	0.63	x	0.7	=	44.51	(75)
Northeast 0.9x	0.77	x	3.83	x	41.38	x	0.63	x	0.7	=	48.43	(75)
Northeast 0.9x	0.77	x	1.34	x	41.38	x	0.63	x	0.7	=	50.84	(75)
Northeast 0.9x	0.77	x	0.3	x	41.38	x	0.63	x	0.7	=	3.79	(75)
Northeast 0.9x	0.54	x	2.03	x	41.38	x	0.57	x	0.8	=	74.46	(75)
Northeast 0.9x	0.77	x	2.29	x	67.96	x	0.63	x	0.7	=	190.24	(75)
Northeast 0.9x	0.77	x	1.68	x	67.96	x	0.63	x	0.7	=	69.78	(75)
Northeast 0.9x	0.77	x	2.37	x	67.96	x	0.63	x	0.7	=	295.32	(75)
Northeast 0.9x	0.77	x	1.76	x	67.96	x	0.63	x	0.7	=	73.1	(75)

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Northeast	0.9x	0.77	x	3.83	x	67.96	x	0.63	x	0.7	=	79.54	(75)
Northeast	0.9x	0.77	x	1.34	x	67.96	x	0.63	x	0.7	=	83.49	(75)
Northeast	0.9x	0.77	x	0.3	x	67.96	x	0.63	x	0.7	=	6.23	(75)
Northeast	0.9x	0.54	x	2.03	x	67.96	x	0.57	x	0.8	=	122.29	(75)
Northeast	0.9x	0.77	x	2.29	x	91.35	x	0.63	x	0.7	=	255.72	(75)
Northeast	0.9x	0.77	x	1.68	x	91.35	x	0.63	x	0.7	=	93.8	(75)
Northeast	0.9x	0.77	x	2.37	x	91.35	x	0.63	x	0.7	=	396.97	(75)
Northeast	0.9x	0.77	x	1.76	x	91.35	x	0.63	x	0.7	=	98.27	(75)
Northeast	0.9x	0.77	x	3.83	x	91.35	x	0.63	x	0.7	=	106.92	(75)
Northeast	0.9x	0.77	x	1.34	x	91.35	x	0.63	x	0.7	=	112.22	(75)
Northeast	0.9x	0.77	x	0.3	x	91.35	x	0.63	x	0.7	=	8.37	(75)
Northeast	0.9x	0.54	x	2.03	x	91.35	x	0.57	x	0.8	=	164.38	(75)
Northeast	0.9x	0.77	x	2.29	x	97.38	x	0.63	x	0.7	=	272.62	(75)
Northeast	0.9x	0.77	x	1.68	x	97.38	x	0.63	x	0.7	=	100	(75)
Northeast	0.9x	0.77	x	2.37	x	97.38	x	0.63	x	0.7	=	423.22	(75)
Northeast	0.9x	0.77	x	1.76	x	97.38	x	0.63	x	0.7	=	104.76	(75)
Northeast	0.9x	0.77	x	3.83	x	97.38	x	0.63	x	0.7	=	113.99	(75)
Northeast	0.9x	0.77	x	1.34	x	97.38	x	0.63	x	0.7	=	119.64	(75)
Northeast	0.9x	0.77	x	0.3	x	97.38	x	0.63	x	0.7	=	8.93	(75)
Northeast	0.9x	0.54	x	2.03	x	97.38	x	0.57	x	0.8	=	175.25	(75)
Northeast	0.9x	0.77	x	2.29	x	91.1	x	0.63	x	0.7	=	255.03	(75)
Northeast	0.9x	0.77	x	1.68	x	91.1	x	0.63	x	0.7	=	93.55	(75)
Northeast	0.9x	0.77	x	2.37	x	91.1	x	0.63	x	0.7	=	395.91	(75)
Northeast	0.9x	0.77	x	1.76	x	91.1	x	0.63	x	0.7	=	98	(75)
Northeast	0.9x	0.77	x	3.83	x	91.1	x	0.63	x	0.7	=	106.63	(75)
Northeast	0.9x	0.77	x	1.34	x	91.1	x	0.63	x	0.7	=	111.92	(75)
Northeast	0.9x	0.77	x	0.3	x	91.1	x	0.63	x	0.7	=	8.35	(75)
Northeast	0.9x	0.54	x	2.03	x	91.1	x	0.57	x	0.8	=	163.94	(75)
Northeast	0.9x	0.77	x	2.29	x	72.63	x	0.63	x	0.7	=	203.31	(75)
Northeast	0.9x	0.77	x	1.68	x	72.63	x	0.63	x	0.7	=	74.58	(75)
Northeast	0.9x	0.77	x	2.37	x	72.63	x	0.63	x	0.7	=	315.62	(75)
Northeast	0.9x	0.77	x	1.76	x	72.63	x	0.63	x	0.7	=	78.13	(75)
Northeast	0.9x	0.77	x	3.83	x	72.63	x	0.63	x	0.7	=	85.01	(75)
Northeast	0.9x	0.77	x	1.34	x	72.63	x	0.63	x	0.7	=	89.23	(75)
Northeast	0.9x	0.77	x	0.3	x	72.63	x	0.63	x	0.7	=	6.66	(75)
Northeast	0.9x	0.54	x	2.03	x	72.63	x	0.57	x	0.8	=	130.69	(75)
Northeast	0.9x	0.77	x	2.29	x	50.42	x	0.63	x	0.7	=	141.15	(75)
Northeast	0.9x	0.77	x	1.68	x	50.42	x	0.63	x	0.7	=	51.77	(75)
Northeast	0.9x	0.77	x	2.37	x	50.42	x	0.63	x	0.7	=	219.12	(75)
Northeast	0.9x	0.77	x	1.76	x	50.42	x	0.63	x	0.7	=	54.24	(75)
Northeast	0.9x	0.77	x	3.83	x	50.42	x	0.63	x	0.7	=	59.02	(75)

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Northeast	0.9x	0.77	x	1.34	x	50.42	x	0.63	x	0.7	=	61.95	(75)
Northeast	0.9x	0.77	x	0.3	x	50.42	x	0.63	x	0.7	=	4.62	(75)
Northeast	0.9x	0.54	x	2.03	x	50.42	x	0.57	x	0.8	=	90.73	(75)
Northeast	0.9x	0.77	x	2.29	x	28.07	x	0.63	x	0.7	=	78.57	(75)
Northeast	0.9x	0.77	x	1.68	x	28.07	x	0.63	x	0.7	=	28.82	(75)
Northeast	0.9x	0.77	x	2.37	x	28.07	x	0.63	x	0.7	=	121.97	(75)
Northeast	0.9x	0.77	x	1.76	x	28.07	x	0.63	x	0.7	=	30.19	(75)
Northeast	0.9x	0.77	x	3.83	x	28.07	x	0.63	x	0.7	=	32.85	(75)
Northeast	0.9x	0.77	x	1.34	x	28.07	x	0.63	x	0.7	=	34.48	(75)
Northeast	0.9x	0.77	x	0.3	x	28.07	x	0.63	x	0.7	=	2.57	(75)
Northeast	0.9x	0.54	x	2.03	x	28.07	x	0.57	x	0.8	=	50.51	(75)
Northeast	0.9x	0.77	x	2.29	x	14.2	x	0.63	x	0.7	=	39.74	(75)
Northeast	0.9x	0.77	x	1.68	x	14.2	x	0.63	x	0.7	=	14.58	(75)
Northeast	0.9x	0.77	x	2.37	x	14.2	x	0.63	x	0.7	=	61.7	(75)
Northeast	0.9x	0.77	x	1.76	x	14.2	x	0.63	x	0.7	=	15.27	(75)
Northeast	0.9x	0.77	x	3.83	x	14.2	x	0.63	x	0.7	=	16.62	(75)
Northeast	0.9x	0.77	x	1.34	x	14.2	x	0.63	x	0.7	=	17.44	(75)
Northeast	0.9x	0.77	x	0.3	x	14.2	x	0.63	x	0.7	=	1.3	(75)
Northeast	0.9x	0.54	x	2.03	x	14.2	x	0.57	x	0.8	=	25.55	(75)
Northeast	0.9x	0.77	x	2.29	x	9.21	x	0.63	x	0.7	=	25.79	(75)
Northeast	0.9x	0.77	x	1.68	x	9.21	x	0.63	x	0.7	=	9.46	(75)
Northeast	0.9x	0.77	x	2.37	x	9.21	x	0.63	x	0.7	=	40.04	(75)
Northeast	0.9x	0.77	x	1.76	x	9.21	x	0.63	x	0.7	=	9.91	(75)
Northeast	0.9x	0.77	x	3.83	x	9.21	x	0.63	x	0.7	=	10.79	(75)
Northeast	0.9x	0.77	x	1.34	x	9.21	x	0.63	x	0.7	=	11.32	(75)
Northeast	0.9x	0.77	x	0.3	x	9.21	x	0.63	x	0.7	=	0.84	(75)
Northeast	0.9x	0.54	x	2.03	x	9.21	x	0.57	x	0.8	=	16.58	(75)
Southeast	0.9x	0.77	x	0.95	x	36.79	x	0.63	x	0.7	=	10.68	(77)
Southeast	0.9x	0.77	x	2	x	36.79	x	0.63	x	0.7	=	22.49	(77)
Southeast	0.9x	0.77	x	0.95	x	62.67	x	0.63	x	0.7	=	18.2	(77)
Southeast	0.9x	0.77	x	2	x	62.67	x	0.63	x	0.7	=	38.31	(77)
Southeast	0.9x	0.77	x	0.95	x	85.75	x	0.63	x	0.7	=	24.9	(77)
Southeast	0.9x	0.77	x	2	x	85.75	x	0.63	x	0.7	=	52.41	(77)
Southeast	0.9x	0.77	x	0.95	x	106.25	x	0.63	x	0.7	=	30.85	(77)
Southeast	0.9x	0.77	x	2	x	106.25	x	0.63	x	0.7	=	64.94	(77)
Southeast	0.9x	0.77	x	0.95	x	119.01	x	0.63	x	0.7	=	34.55	(77)
Southeast	0.9x	0.77	x	2	x	119.01	x	0.63	x	0.7	=	72.74	(77)
Southeast	0.9x	0.77	x	0.95	x	118.15	x	0.63	x	0.7	=	34.3	(77)
Southeast	0.9x	0.77	x	2	x	118.15	x	0.63	x	0.7	=	72.22	(77)
Southeast	0.9x	0.77	x	0.95	x	113.91	x	0.63	x	0.7	=	33.07	(77)
Southeast	0.9x	0.77	x	2	x	113.91	x	0.63	x	0.7	=	69.62	(77)

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Southeast	0.9x	0.77	x	0.95	x	104.39	x	0.63	x	0.7	=	30.31	(77)
Southeast	0.9x	0.77	x	2	x	104.39	x	0.63	x	0.7	=	63.81	(77)
Southeast	0.9x	0.77	x	0.95	x	92.85	x	0.63	x	0.7	=	26.96	(77)
Southeast	0.9x	0.77	x	2	x	92.85	x	0.63	x	0.7	=	56.75	(77)
Southeast	0.9x	0.77	x	0.95	x	69.27	x	0.63	x	0.7	=	20.11	(77)
Southeast	0.9x	0.77	x	2	x	69.27	x	0.63	x	0.7	=	42.34	(77)
Southeast	0.9x	0.77	x	0.95	x	44.07	x	0.63	x	0.7	=	12.8	(77)
Southeast	0.9x	0.77	x	2	x	44.07	x	0.63	x	0.7	=	26.94	(77)
Southeast	0.9x	0.77	x	0.95	x	31.49	x	0.63	x	0.7	=	9.14	(77)
Southeast	0.9x	0.77	x	2	x	31.49	x	0.63	x	0.7	=	19.25	(77)
Southwest	0.9x	0.77	x	7.38	x	36.79		0.57	x	0.8	=	85.81	(79)
Southwest	0.9x	0.77	x	10.59	x	36.79		0.57	x	0.8	=	123.13	(79)
Southwest	0.9x	0.77	x	3.83	x	36.79		0.57	x	0.8	=	89.06	(79)
Southwest	0.9x	0.77	x	2.25	x	36.79		0.57	x	0.8	=	52.32	(79)
Southwest	0.9x	0.77	x	23.96	x	36.79		0.57	x	0.8	=	278.59	(79)
Southwest	0.9x	0.77	x	4.13	x	36.79		0.57	x	0.8	=	96.04	(79)
Southwest	0.9x	0.77	x	2.19	x	36.79		0.57	x	0.8	=	50.93	(79)
Southwest	0.9x	0.77	x	2.2	x	36.79		0.57	x	0.8	=	25.58	(79)
Southwest	0.9x	0.77	x	2.26	x	36.79		0.63	x	0.7	=	127.06	(79)
Southwest	0.9x	0.77	x	2.2	x	36.79		0.63	x	0.7	=	24.74	(79)
Southwest	0.9x	0.77	x	2.19	x	36.79		0.63	x	0.7	=	24.63	(79)
Southwest	0.9x	0.77	x	2.93	x	36.79		0.63	x	0.7	=	65.89	(79)
Southwest	0.9x	0.77	x	1.49	x	36.79		0.63	x	0.7	=	16.75	(79)
Southwest	0.9x	0.77	x	7.38	x	62.67		0.57	x	0.8	=	146.16	(79)
Southwest	0.9x	0.77	x	10.59	x	62.67		0.57	x	0.8	=	209.74	(79)
Southwest	0.9x	0.77	x	3.83	x	62.67		0.57	x	0.8	=	151.71	(79)
Southwest	0.9x	0.77	x	2.25	x	62.67		0.57	x	0.8	=	89.12	(79)
Southwest	0.9x	0.77	x	23.96	x	62.67		0.57	x	0.8	=	474.54	(79)
Southwest	0.9x	0.77	x	4.13	x	62.67		0.57	x	0.8	=	163.59	(79)
Southwest	0.9x	0.77	x	2.19	x	62.67		0.57	x	0.8	=	86.75	(79)
Southwest	0.9x	0.77	x	2.2	x	62.67		0.57	x	0.8	=	43.57	(79)
Southwest	0.9x	0.77	x	2.26	x	62.67		0.63	x	0.7	=	216.44	(79)
Southwest	0.9x	0.77	x	2.2	x	62.67		0.63	x	0.7	=	42.14	(79)
Southwest	0.9x	0.77	x	2.19	x	62.67		0.63	x	0.7	=	41.95	(79)
Southwest	0.9x	0.77	x	2.93	x	62.67		0.63	x	0.7	=	112.24	(79)
Southwest	0.9x	0.77	x	1.49	x	62.67		0.63	x	0.7	=	28.54	(79)
Southwest	0.9x	0.77	x	7.38	x	85.75		0.57	x	0.8	=	199.99	(79)
Southwest	0.9x	0.77	x	10.59	x	85.75		0.57	x	0.8	=	286.97	(79)
Southwest	0.9x	0.77	x	3.83	x	85.75		0.57	x	0.8	=	207.57	(79)
Southwest	0.9x	0.77	x	2.25	x	85.75		0.57	x	0.8	=	121.94	(79)
Southwest	0.9x	0.77	x	23.96	x	85.75		0.57	x	0.8	=	649.28	(79)

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Southwest	0.9x	0.77	x	4.13	x	85.75	x	0.57	x	0.8	=	223.83 (79)
Southwest	0.9x	0.77	x	2.19	x	85.75	x	0.57	x	0.8	=	118.69 (79)
Southwest	0.9x	0.77	x	2.2	x	85.75	x	0.57	x	0.8	=	59.62 (79)
Southwest	0.9x	0.77	x	2.26	x	85.75	x	0.63	x	0.7	=	296.14 (79)
Southwest	0.9x	0.77	x	2.2	x	85.75	x	0.63	x	0.7	=	57.66 (79)
Southwest	0.9x	0.77	x	2.19	x	85.75	x	0.63	x	0.7	=	57.39 (79)
Southwest	0.9x	0.77	x	2.93	x	85.75	x	0.63	x	0.7	=	153.57 (79)
Southwest	0.9x	0.77	x	1.49	x	85.75	x	0.63	x	0.7	=	39.05 (79)
Southwest	0.9x	0.77	x	7.38	x	106.25	x	0.57	x	0.8	=	247.79 (79)
Southwest	0.9x	0.77	x	10.59	x	106.25	x	0.57	x	0.8	=	355.57 (79)
Southwest	0.9x	0.77	x	3.83	x	106.25	x	0.57	x	0.8	=	257.19 (79)
Southwest	0.9x	0.77	x	2.25	x	106.25	x	0.57	x	0.8	=	151.09 (79)
Southwest	0.9x	0.77	x	23.96	x	106.25	x	0.57	x	0.8	=	804.49 (79)
Southwest	0.9x	0.77	x	4.13	x	106.25	x	0.57	x	0.8	=	277.34 (79)
Southwest	0.9x	0.77	x	2.19	x	106.25	x	0.57	x	0.8	=	147.06 (79)
Southwest	0.9x	0.77	x	2.2	x	106.25	x	0.57	x	0.8	=	73.87 (79)
Southwest	0.9x	0.77	x	2.26	x	106.25	x	0.63	x	0.7	=	366.93 (79)
Southwest	0.9x	0.77	x	2.2	x	106.25	x	0.63	x	0.7	=	71.44 (79)
Southwest	0.9x	0.77	x	2.19	x	106.25	x	0.63	x	0.7	=	71.11 (79)
Southwest	0.9x	0.77	x	2.93	x	106.25	x	0.63	x	0.7	=	190.29 (79)
Southwest	0.9x	0.77	x	1.49	x	106.25	x	0.63	x	0.7	=	48.38 (79)
Southwest	0.9x	0.77	x	7.38	x	119.01	x	0.57	x	0.8	=	277.55 (79)
Southwest	0.9x	0.77	x	10.59	x	119.01	x	0.57	x	0.8	=	398.27 (79)
Southwest	0.9x	0.77	x	3.83	x	119.01	x	0.57	x	0.8	=	288.08 (79)
Southwest	0.9x	0.77	x	2.25	x	119.01	x	0.57	x	0.8	=	169.24 (79)
Southwest	0.9x	0.77	x	23.96	x	119.01	x	0.57	x	0.8	=	901.1 (79)
Southwest	0.9x	0.77	x	4.13	x	119.01	x	0.57	x	0.8	=	310.64 (79)
Southwest	0.9x	0.77	x	2.19	x	119.01	x	0.57	x	0.8	=	164.72 (79)
Southwest	0.9x	0.77	x	2.2	x	119.01	x	0.57	x	0.8	=	82.74 (79)
Southwest	0.9x	0.77	x	2.26	x	119.01	x	0.63	x	0.7	=	410.99 (79)
Southwest	0.9x	0.77	x	2.2	x	119.01	x	0.63	x	0.7	=	80.02 (79)
Southwest	0.9x	0.77	x	2.19	x	119.01	x	0.63	x	0.7	=	79.65 (79)
Southwest	0.9x	0.77	x	2.93	x	119.01	x	0.63	x	0.7	=	213.14 (79)
Southwest	0.9x	0.77	x	1.49	x	119.01	x	0.63	x	0.7	=	54.19 (79)
Southwest	0.9x	0.77	x	7.38	x	118.15	x	0.57	x	0.8	=	275.54 (79)
Southwest	0.9x	0.77	x	10.59	x	118.15	x	0.57	x	0.8	=	395.39 (79)
Southwest	0.9x	0.77	x	3.83	x	118.15	x	0.57	x	0.8	=	286 (79)
Southwest	0.9x	0.77	x	2.25	x	118.15	x	0.57	x	0.8	=	168.01 (79)
Southwest	0.9x	0.77	x	23.96	x	118.15	x	0.57	x	0.8	=	894.58 (79)
Southwest	0.9x	0.77	x	4.13	x	118.15	x	0.57	x	0.8	=	308.4 (79)
Southwest	0.9x	0.77	x	2.19	x	118.15	x	0.57	x	0.8	=	163.53 (79)

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Southwest	0.9x	0.77	x	2.2	x	118.15		0.57	x	0.8	=	82.14	(79)
Southwest	0.9x	0.77	x	2.26	x	118.15		0.63	x	0.7	=	408.02	(79)
Southwest	0.9x	0.77	x	2.2	x	118.15		0.63	x	0.7	=	79.44	(79)
Southwest	0.9x	0.77	x	2.19	x	118.15		0.63	x	0.7	=	79.08	(79)
Southwest	0.9x	0.77	x	2.93	x	118.15		0.63	x	0.7	=	211.59	(79)
Southwest	0.9x	0.77	x	1.49	x	118.15		0.63	x	0.7	=	53.8	(79)
Southwest	0.9x	0.77	x	7.38	x	113.91		0.57	x	0.8	=	265.65	(79)
Southwest	0.9x	0.77	x	10.59	x	113.91		0.57	x	0.8	=	381.2	(79)
Southwest	0.9x	0.77	x	3.83	x	113.91		0.57	x	0.8	=	275.73	(79)
Southwest	0.9x	0.77	x	2.25	x	113.91		0.57	x	0.8	=	161.98	(79)
Southwest	0.9x	0.77	x	23.96	x	113.91		0.57	x	0.8	=	862.47	(79)
Southwest	0.9x	0.77	x	4.13	x	113.91		0.57	x	0.8	=	297.33	(79)
Southwest	0.9x	0.77	x	2.19	x	113.91		0.57	x	0.8	=	157.66	(79)
Southwest	0.9x	0.77	x	2.2	x	113.91		0.57	x	0.8	=	79.19	(79)
Southwest	0.9x	0.77	x	2.26	x	113.91		0.63	x	0.7	=	393.38	(79)
Southwest	0.9x	0.77	x	2.2	x	113.91		0.63	x	0.7	=	76.59	(79)
Southwest	0.9x	0.77	x	2.19	x	113.91		0.63	x	0.7	=	76.24	(79)
Southwest	0.9x	0.77	x	2.93	x	113.91		0.63	x	0.7	=	204	(79)
Southwest	0.9x	0.77	x	1.49	x	113.91		0.63	x	0.7	=	51.87	(79)
Southwest	0.9x	0.77	x	7.38	x	104.39		0.57	x	0.8	=	243.45	(79)
Southwest	0.9x	0.77	x	10.59	x	104.39		0.57	x	0.8	=	349.35	(79)
Southwest	0.9x	0.77	x	3.83	x	104.39		0.57	x	0.8	=	252.69	(79)
Southwest	0.9x	0.77	x	2.25	x	104.39		0.57	x	0.8	=	148.45	(79)
Southwest	0.9x	0.77	x	23.96	x	104.39		0.57	x	0.8	=	790.4	(79)
Southwest	0.9x	0.77	x	4.13	x	104.39		0.57	x	0.8	=	272.48	(79)
Southwest	0.9x	0.77	x	2.19	x	104.39		0.57	x	0.8	=	144.49	(79)
Southwest	0.9x	0.77	x	2.2	x	104.39		0.57	x	0.8	=	72.57	(79)
Southwest	0.9x	0.77	x	2.26	x	104.39		0.63	x	0.7	=	360.5	(79)
Southwest	0.9x	0.77	x	2.2	x	104.39		0.63	x	0.7	=	70.19	(79)
Southwest	0.9x	0.77	x	2.19	x	104.39		0.63	x	0.7	=	69.87	(79)
Southwest	0.9x	0.77	x	2.93	x	104.39		0.63	x	0.7	=	186.95	(79)
Southwest	0.9x	0.77	x	1.49	x	104.39		0.63	x	0.7	=	47.54	(79)
Southwest	0.9x	0.77	x	7.38	x	92.85		0.57	x	0.8	=	216.54	(79)
Southwest	0.9x	0.77	x	10.59	x	92.85		0.57	x	0.8	=	310.73	(79)
Southwest	0.9x	0.77	x	3.83	x	92.85		0.57	x	0.8	=	224.76	(79)
Southwest	0.9x	0.77	x	2.25	x	92.85		0.57	x	0.8	=	132.04	(79)
Southwest	0.9x	0.77	x	23.96	x	92.85		0.57	x	0.8	=	703.03	(79)
Southwest	0.9x	0.77	x	4.13	x	92.85		0.57	x	0.8	=	242.36	(79)
Southwest	0.9x	0.77	x	2.19	x	92.85		0.57	x	0.8	=	128.52	(79)
Southwest	0.9x	0.77	x	2.2	x	92.85		0.57	x	0.8	=	64.55	(79)
Southwest	0.9x	0.77	x	2.26	x	92.85		0.63	x	0.7	=	320.66	(79)

DER WorkSheet: New dwelling design stage

Southwest	0.9x	0.77	x	2.2	x	92.85	x	0.63	x	0.7	=	62.43	(79)
Southwest	0.9x	0.77	x	2.19	x	92.85	x	0.63	x	0.7	=	62.15	(79)
Southwest	0.9x	0.77	x	2.93	x	92.85	x	0.63	x	0.7	=	166.29	(79)
Southwest	0.9x	0.77	x	1.49	x	92.85	x	0.63	x	0.7	=	42.28	(79)
Southwest	0.9x	0.77	x	7.38	x	69.27	x	0.57	x	0.8	=	161.54	(79)
Southwest	0.9x	0.77	x	10.59	x	69.27	x	0.57	x	0.8	=	231.81	(79)
Southwest	0.9x	0.77	x	3.83	x	69.27	x	0.57	x	0.8	=	167.67	(79)
Southwest	0.9x	0.77	x	2.25	x	69.27	x	0.57	x	0.8	=	98.5	(79)
Southwest	0.9x	0.77	x	23.96	x	69.27	x	0.57	x	0.8	=	524.46	(79)
Southwest	0.9x	0.77	x	4.13	x	69.27	x	0.57	x	0.8	=	180.8	(79)
Southwest	0.9x	0.77	x	2.19	x	69.27	x	0.57	x	0.8	=	95.87	(79)
Southwest	0.9x	0.77	x	2.2	x	69.27	x	0.57	x	0.8	=	48.16	(79)
Southwest	0.9x	0.77	x	2.26	x	69.27	x	0.63	x	0.7	=	239.21	(79)
Southwest	0.9x	0.77	x	2.2	x	69.27	x	0.63	x	0.7	=	46.57	(79)
Southwest	0.9x	0.77	x	2.19	x	69.27	x	0.63	x	0.7	=	46.36	(79)
Southwest	0.9x	0.77	x	2.93	x	69.27	x	0.63	x	0.7	=	124.05	(79)
Southwest	0.9x	0.77	x	1.49	x	69.27	x	0.63	x	0.7	=	31.54	(79)
Southwest	0.9x	0.77	x	7.38	x	44.07	x	0.57	x	0.8	=	102.78	(79)
Southwest	0.9x	0.77	x	10.59	x	44.07	x	0.57	x	0.8	=	147.48	(79)
Southwest	0.9x	0.77	x	3.83	x	44.07	x	0.57	x	0.8	=	106.68	(79)
Southwest	0.9x	0.77	x	2.25	x	44.07	x	0.57	x	0.8	=	62.67	(79)
Southwest	0.9x	0.77	x	23.96	x	44.07	x	0.57	x	0.8	=	333.68	(79)
Southwest	0.9x	0.77	x	4.13	x	44.07	x	0.57	x	0.8	=	115.03	(79)
Southwest	0.9x	0.77	x	2.19	x	44.07	x	0.57	x	0.8	=	61	(79)
Southwest	0.9x	0.77	x	2.2	x	44.07	x	0.57	x	0.8	=	30.64	(79)
Southwest	0.9x	0.77	x	2.26	x	44.07	x	0.63	x	0.7	=	152.19	(79)
Southwest	0.9x	0.77	x	2.2	x	44.07	x	0.63	x	0.7	=	29.63	(79)
Southwest	0.9x	0.77	x	2.19	x	44.07	x	0.63	x	0.7	=	29.5	(79)
Southwest	0.9x	0.77	x	2.93	x	44.07	x	0.63	x	0.7	=	78.93	(79)
Southwest	0.9x	0.77	x	1.49	x	44.07	x	0.63	x	0.7	=	20.07	(79)
Southwest	0.9x	0.77	x	7.38	x	31.49	x	0.57	x	0.8	=	73.43	(79)
Southwest	0.9x	0.77	x	10.59	x	31.49	x	0.57	x	0.8	=	105.37	(79)
Southwest	0.9x	0.77	x	3.83	x	31.49	x	0.57	x	0.8	=	76.22	(79)
Southwest	0.9x	0.77	x	2.25	x	31.49	x	0.57	x	0.8	=	44.78	(79)
Southwest	0.9x	0.77	x	23.96	x	31.49	x	0.57	x	0.8	=	238.41	(79)
Southwest	0.9x	0.77	x	4.13	x	31.49	x	0.57	x	0.8	=	82.19	(79)
Southwest	0.9x	0.77	x	2.19	x	31.49	x	0.57	x	0.8	=	43.58	(79)
Southwest	0.9x	0.77	x	2.2	x	31.49	x	0.57	x	0.8	=	21.89	(79)
Southwest	0.9x	0.77	x	2.26	x	31.49	x	0.63	x	0.7	=	108.74	(79)
Southwest	0.9x	0.77	x	2.2	x	31.49	x	0.63	x	0.7	=	21.17	(79)
Southwest	0.9x	0.77	x	2.19	x	31.49	x	0.63	x	0.7	=	21.07	(79)

DER WorkSheet: New dwelling design stage

Southwest	0.9x	0.77	x	2.93	x	31.49		0.63	x	0.7	=	56.39	(79)
Southwest	0.9x	0.77	x	1.49	x	31.49		0.63	x	0.7	=	14.34	(79)
Northwest	0.9x	0.77	x	0.46	x	11.28	x	0.57	x	0.8	=	4.92	(81)
Northwest	0.9x	0.77	x	0.57	x	11.28	x	0.57	x	0.8	=	4.06	(81)
Northwest	0.9x	0.77	x	6.67	x	11.28	x	0.57	x	0.8	=	23.78	(81)
Northwest	0.9x	0.77	x	2.07	x	11.28	x	0.63	x	0.7	=	14.28	(81)
Northwest	0.9x	0.77	x	2.07	x	11.28	x	0.57	x	0.8	=	7.38	(81)
Northwest	0.9x	0.77	x	2.22	x	11.28	x	0.57	x	0.8	=	7.92	(81)
Northwest	0.9x	0.77	x	1.82	x	11.28	x	0.63	x	0.7	=	6.28	(81)
Northwest	0.9x	0.77	x	1.82	x	11.28	x	0.57	x	0.8	=	6.49	(81)
Northwest	0.9x	0.77	x	2.2	x	11.28	x	0.63	x	0.7	=	7.59	(81)
Northwest	0.9x	0.77	x	3.08	x	11.28	x	0.57	x	0.8	=	10.98	(81)
Northwest	0.9x	0.77	x	13.1	x	11.28	x	0.57	x	0.8	=	46.71	(81)
Northwest	0.9x	0.77	x	3.96	x	11.28	x	0.57	x	0.8	=	14.12	(81)
Northwest	0.9x	0.77	x	1.38	x	11.28	x	0.57	x	0.8	=	4.92	(81)
Northwest	0.9x	0.77	x	0.46	x	22.97	x	0.57	x	0.8	=	10.02	(81)
Northwest	0.9x	0.77	x	0.57	x	22.97	x	0.57	x	0.8	=	8.27	(81)
Northwest	0.9x	0.77	x	6.67	x	22.97	x	0.57	x	0.8	=	48.41	(81)
Northwest	0.9x	0.77	x	2.07	x	22.97	x	0.63	x	0.7	=	29.06	(81)
Northwest	0.9x	0.77	x	2.07	x	22.97	x	0.57	x	0.8	=	15.02	(81)
Northwest	0.9x	0.77	x	2.22	x	22.97	x	0.57	x	0.8	=	16.11	(81)
Northwest	0.9x	0.77	x	1.82	x	22.97	x	0.63	x	0.7	=	12.77	(81)
Northwest	0.9x	0.77	x	1.82	x	22.97	x	0.57	x	0.8	=	13.21	(81)
Northwest	0.9x	0.77	x	2.2	x	22.97	x	0.63	x	0.7	=	15.44	(81)
Northwest	0.9x	0.77	x	3.08	x	22.97	x	0.57	x	0.8	=	22.35	(81)
Northwest	0.9x	0.77	x	13.1	x	22.97	x	0.57	x	0.8	=	95.08	(81)
Northwest	0.9x	0.77	x	3.96	x	22.97	x	0.57	x	0.8	=	28.74	(81)
Northwest	0.9x	0.77	x	1.38	x	22.97	x	0.57	x	0.8	=	10.02	(81)
Northwest	0.9x	0.77	x	0.46	x	41.38	x	0.57	x	0.8	=	18.04	(81)
Northwest	0.9x	0.77	x	0.57	x	41.38	x	0.57	x	0.8	=	14.91	(81)
Northwest	0.9x	0.77	x	6.67	x	41.38	x	0.57	x	0.8	=	87.22	(81)
Northwest	0.9x	0.77	x	2.07	x	41.38	x	0.63	x	0.7	=	52.35	(81)
Northwest	0.9x	0.77	x	2.07	x	41.38	x	0.57	x	0.8	=	27.07	(81)
Northwest	0.9x	0.77	x	2.22	x	41.38	x	0.57	x	0.8	=	29.03	(81)
Northwest	0.9x	0.77	x	1.82	x	41.38	x	0.63	x	0.7	=	23.02	(81)
Northwest	0.9x	0.77	x	1.82	x	41.38	x	0.57	x	0.8	=	23.8	(81)
Northwest	0.9x	0.77	x	2.2	x	41.38	x	0.63	x	0.7	=	27.82	(81)
Northwest	0.9x	0.77	x	3.08	x	41.38	x	0.57	x	0.8	=	40.27	(81)
Northwest	0.9x	0.77	x	13.1	x	41.38	x	0.57	x	0.8	=	171.3	(81)
Northwest	0.9x	0.77	x	3.96	x	41.38	x	0.57	x	0.8	=	51.78	(81)
Northwest	0.9x	0.77	x	1.38	x	41.38	x	0.57	x	0.8	=	18.04	(81)

DER WorkSheet: New dwelling design stage

Northwest	0.9x	0.77	x	0.46	x	67.96	x	0.57	x	0.8	=	29.63	(81)
Northwest	0.9x	0.77	x	0.57	x	67.96	x	0.57	x	0.8	=	24.48	(81)
Northwest	0.9x	0.77	x	6.67	x	67.96	x	0.57	x	0.8	=	143.24	(81)
Northwest	0.9x	0.77	x	2.07	x	67.96	x	0.63	x	0.7	=	85.98	(81)
Northwest	0.9x	0.77	x	2.07	x	67.96	x	0.57	x	0.8	=	44.45	(81)
Northwest	0.9x	0.77	x	2.22	x	67.96	x	0.57	x	0.8	=	47.67	(81)
Northwest	0.9x	0.77	x	1.82	x	67.96	x	0.63	x	0.7	=	37.8	(81)
Northwest	0.9x	0.77	x	1.82	x	67.96	x	0.57	x	0.8	=	39.08	(81)
Northwest	0.9x	0.77	x	2.2	x	67.96	x	0.63	x	0.7	=	45.69	(81)
Northwest	0.9x	0.77	x	3.08	x	67.96	x	0.57	x	0.8	=	66.14	(81)
Northwest	0.9x	0.77	x	13.1	x	67.96	x	0.57	x	0.8	=	281.32	(81)
Northwest	0.9x	0.77	x	3.96	x	67.96	x	0.57	x	0.8	=	85.04	(81)
Northwest	0.9x	0.77	x	1.38	x	67.96	x	0.57	x	0.8	=	29.63	(81)
Northwest	0.9x	0.77	x	0.46	x	91.35	x	0.57	x	0.8	=	39.84	(81)
Northwest	0.9x	0.77	x	0.57	x	91.35	x	0.57	x	0.8	=	32.91	(81)
Northwest	0.9x	0.77	x	6.67	x	91.35	x	0.57	x	0.8	=	192.54	(81)
Northwest	0.9x	0.77	x	2.07	x	91.35	x	0.63	x	0.7	=	115.57	(81)
Northwest	0.9x	0.77	x	2.07	x	91.35	x	0.57	x	0.8	=	59.75	(81)
Northwest	0.9x	0.77	x	2.22	x	91.35	x	0.57	x	0.8	=	64.08	(81)
Northwest	0.9x	0.77	x	1.82	x	91.35	x	0.63	x	0.7	=	50.81	(81)
Northwest	0.9x	0.77	x	1.82	x	91.35	x	0.57	x	0.8	=	52.54	(81)
Northwest	0.9x	0.77	x	2.2	x	91.35	x	0.63	x	0.7	=	61.42	(81)
Northwest	0.9x	0.77	x	3.08	x	91.35	x	0.57	x	0.8	=	88.91	(81)
Northwest	0.9x	0.77	x	13.1	x	91.35	x	0.57	x	0.8	=	378.15	(81)
Northwest	0.9x	0.77	x	3.96	x	91.35	x	0.57	x	0.8	=	114.31	(81)
Northwest	0.9x	0.77	x	1.38	x	91.35	x	0.57	x	0.8	=	39.84	(81)
Northwest	0.9x	0.77	x	0.46	x	97.38	x	0.57	x	0.8	=	42.47	(81)
Northwest	0.9x	0.77	x	0.57	x	97.38	x	0.57	x	0.8	=	35.08	(81)
Northwest	0.9x	0.77	x	6.67	x	97.38	x	0.57	x	0.8	=	205.26	(81)
Northwest	0.9x	0.77	x	2.07	x	97.38	x	0.63	x	0.7	=	123.21	(81)
Northwest	0.9x	0.77	x	2.07	x	97.38	x	0.57	x	0.8	=	63.7	(81)
Northwest	0.9x	0.77	x	2.22	x	97.38	x	0.57	x	0.8	=	68.32	(81)
Northwest	0.9x	0.77	x	1.82	x	97.38	x	0.63	x	0.7	=	54.17	(81)
Northwest	0.9x	0.77	x	1.82	x	97.38	x	0.57	x	0.8	=	56.01	(81)
Northwest	0.9x	0.77	x	2.2	x	97.38	x	0.63	x	0.7	=	65.48	(81)
Northwest	0.9x	0.77	x	3.08	x	97.38	x	0.57	x	0.8	=	94.78	(81)
Northwest	0.9x	0.77	x	13.1	x	97.38	x	0.57	x	0.8	=	403.14	(81)
Northwest	0.9x	0.77	x	3.96	x	97.38	x	0.57	x	0.8	=	121.87	(81)
Northwest	0.9x	0.77	x	1.38	x	97.38	x	0.57	x	0.8	=	42.47	(81)
Northwest	0.9x	0.77	x	0.46	x	91.1	x	0.57	x	0.8	=	39.73	(81)
Northwest	0.9x	0.77	x	0.57	x	91.1	x	0.57	x	0.8	=	32.82	(81)

DER WorkSheet: New dwelling design stage

Northwest	0.9x	0.77	x	6.67	x	91.1	x	0.57	x	0.8	=	192.02	(81)
Northwest	0.9x	0.77	x	2.07	x	91.1	x	0.63	x	0.7	=	115.26	(81)
Northwest	0.9x	0.77	x	2.07	x	91.1	x	0.57	x	0.8	=	59.59	(81)
Northwest	0.9x	0.77	x	2.22	x	91.1	x	0.57	x	0.8	=	63.91	(81)
Northwest	0.9x	0.77	x	1.82	x	91.1	x	0.63	x	0.7	=	50.67	(81)
Northwest	0.9x	0.77	x	1.82	x	91.1	x	0.57	x	0.8	=	52.4	(81)
Northwest	0.9x	0.77	x	2.2	x	91.1	x	0.63	x	0.7	=	61.25	(81)
Northwest	0.9x	0.77	x	3.08	x	91.1	x	0.57	x	0.8	=	88.67	(81)
Northwest	0.9x	0.77	x	13.1	x	91.1	x	0.57	x	0.8	=	377.13	(81)
Northwest	0.9x	0.77	x	3.96	x	91.1	x	0.57	x	0.8	=	114	(81)
Northwest	0.9x	0.77	x	1.38	x	91.1	x	0.57	x	0.8	=	39.73	(81)
Northwest	0.9x	0.77	x	0.46	x	72.63	x	0.57	x	0.8	=	31.67	(81)
Northwest	0.9x	0.77	x	0.57	x	72.63	x	0.57	x	0.8	=	26.16	(81)
Northwest	0.9x	0.77	x	6.67	x	72.63	x	0.57	x	0.8	=	153.08	(81)
Northwest	0.9x	0.77	x	2.07	x	72.63	x	0.63	x	0.7	=	91.89	(81)
Northwest	0.9x	0.77	x	2.07	x	72.63	x	0.57	x	0.8	=	47.51	(81)
Northwest	0.9x	0.77	x	2.22	x	72.63	x	0.57	x	0.8	=	50.95	(81)
Northwest	0.9x	0.77	x	1.82	x	72.63	x	0.63	x	0.7	=	40.4	(81)
Northwest	0.9x	0.77	x	1.82	x	72.63	x	0.57	x	0.8	=	41.77	(81)
Northwest	0.9x	0.77	x	2.2	x	72.63	x	0.63	x	0.7	=	48.83	(81)
Northwest	0.9x	0.77	x	3.08	x	72.63	x	0.57	x	0.8	=	70.69	(81)
Northwest	0.9x	0.77	x	13.1	x	72.63	x	0.57	x	0.8	=	300.65	(81)
Northwest	0.9x	0.77	x	3.96	x	72.63	x	0.57	x	0.8	=	90.88	(81)
Northwest	0.9x	0.77	x	1.38	x	72.63	x	0.57	x	0.8	=	31.67	(81)
Northwest	0.9x	0.77	x	0.46	x	50.42	x	0.57	x	0.8	=	21.99	(81)
Northwest	0.9x	0.77	x	0.57	x	50.42	x	0.57	x	0.8	=	18.16	(81)
Northwest	0.9x	0.77	x	6.67	x	50.42	x	0.57	x	0.8	=	106.28	(81)
Northwest	0.9x	0.77	x	2.07	x	50.42	x	0.63	x	0.7	=	63.79	(81)
Northwest	0.9x	0.77	x	2.07	x	50.42	x	0.57	x	0.8	=	32.98	(81)
Northwest	0.9x	0.77	x	2.22	x	50.42	x	0.57	x	0.8	=	35.37	(81)
Northwest	0.9x	0.77	x	1.82	x	50.42	x	0.63	x	0.7	=	28.04	(81)
Northwest	0.9x	0.77	x	1.82	x	50.42	x	0.57	x	0.8	=	29	(81)
Northwest	0.9x	0.77	x	2.2	x	50.42	x	0.63	x	0.7	=	33.9	(81)
Northwest	0.9x	0.77	x	3.08	x	50.42	x	0.57	x	0.8	=	49.07	(81)
Northwest	0.9x	0.77	x	13.1	x	50.42	x	0.57	x	0.8	=	208.73	(81)
Northwest	0.9x	0.77	x	3.96	x	50.42	x	0.57	x	0.8	=	63.1	(81)
Northwest	0.9x	0.77	x	1.38	x	50.42	x	0.57	x	0.8	=	21.99	(81)
Northwest	0.9x	0.77	x	0.46	x	28.07	x	0.57	x	0.8	=	12.24	(81)
Northwest	0.9x	0.77	x	0.57	x	28.07	x	0.57	x	0.8	=	10.11	(81)
Northwest	0.9x	0.77	x	6.67	x	28.07	x	0.57	x	0.8	=	59.16	(81)
Northwest	0.9x	0.77	x	2.07	x	28.07	x	0.63	x	0.7	=	35.51	(81)

DER WorkSheet: New dwelling design stage

Northwest 0.9x	0.77	x	2.07	x	28.07	x	0.57	x	0.8	=	18.36	(81)
Northwest 0.9x	0.77	x	2.22	x	28.07	x	0.57	x	0.8	=	19.69	(81)
Northwest 0.9x	0.77	x	1.82	x	28.07	x	0.63	x	0.7	=	15.61	(81)
Northwest 0.9x	0.77	x	1.82	x	28.07	x	0.57	x	0.8	=	16.14	(81)
Northwest 0.9x	0.77	x	2.2	x	28.07	x	0.63	x	0.7	=	18.87	(81)
Northwest 0.9x	0.77	x	3.08	x	28.07	x	0.57	x	0.8	=	27.32	(81)
Northwest 0.9x	0.77	x	13.1	x	28.07	x	0.57	x	0.8	=	116.19	(81)
Northwest 0.9x	0.77	x	3.96	x	28.07	x	0.57	x	0.8	=	35.12	(81)
Northwest 0.9x	0.77	x	1.38	x	28.07	x	0.57	x	0.8	=	12.24	(81)
Northwest 0.9x	0.77	x	0.46	x	14.2	x	0.57	x	0.8	=	6.19	(81)
Northwest 0.9x	0.77	x	0.57	x	14.2	x	0.57	x	0.8	=	5.11	(81)
Northwest 0.9x	0.77	x	6.67	x	14.2	x	0.57	x	0.8	=	29.92	(81)
Northwest 0.9x	0.77	x	2.07	x	14.2	x	0.63	x	0.7	=	17.96	(81)
Northwest 0.9x	0.77	x	2.07	x	14.2	x	0.57	x	0.8	=	9.29	(81)
Northwest 0.9x	0.77	x	2.22	x	14.2	x	0.57	x	0.8	=	9.96	(81)
Northwest 0.9x	0.77	x	1.82	x	14.2	x	0.63	x	0.7	=	7.9	(81)
Northwest 0.9x	0.77	x	1.82	x	14.2	x	0.57	x	0.8	=	8.17	(81)
Northwest 0.9x	0.77	x	2.2	x	14.2	x	0.63	x	0.7	=	9.55	(81)
Northwest 0.9x	0.77	x	3.08	x	14.2	x	0.57	x	0.8	=	13.82	(81)
Northwest 0.9x	0.77	x	13.1	x	14.2	x	0.57	x	0.8	=	58.77	(81)
Northwest 0.9x	0.77	x	3.96	x	14.2	x	0.57	x	0.8	=	17.77	(81)
Northwest 0.9x	0.77	x	1.38	x	14.2	x	0.57	x	0.8	=	6.19	(81)
Northwest 0.9x	0.77	x	0.46	x	9.21	x	0.57	x	0.8	=	4.02	(81)
Northwest 0.9x	0.77	x	0.57	x	9.21	x	0.57	x	0.8	=	3.32	(81)
Northwest 0.9x	0.77	x	6.67	x	9.21	x	0.57	x	0.8	=	19.42	(81)
Northwest 0.9x	0.77	x	2.07	x	9.21	x	0.63	x	0.7	=	11.66	(81)
Northwest 0.9x	0.77	x	2.07	x	9.21	x	0.57	x	0.8	=	6.03	(81)
Northwest 0.9x	0.77	x	2.22	x	9.21	x	0.57	x	0.8	=	6.46	(81)
Northwest 0.9x	0.77	x	1.82	x	9.21	x	0.63	x	0.7	=	5.13	(81)
Northwest 0.9x	0.77	x	1.82	x	9.21	x	0.57	x	0.8	=	5.3	(81)
Northwest 0.9x	0.77	x	2.2	x	9.21	x	0.63	x	0.7	=	6.2	(81)
Northwest 0.9x	0.77	x	3.08	x	9.21	x	0.57	x	0.8	=	8.97	(81)
Northwest 0.9x	0.77	x	13.1	x	9.21	x	0.57	x	0.8	=	38.14	(81)
Northwest 0.9x	0.77	x	3.96	x	9.21	x	0.57	x	0.8	=	11.53	(81)
Northwest 0.9x	0.77	x	1.38	x	9.21	x	0.57	x	0.8	=	4.02	(81)
Rooflights 0.9x	1	x	4.47	x	26	x	0.63	x	0.7	=	46.15	(82)
Rooflights 0.9x	1	x	2.04	x	26	x	0.63	x	0.7	=	21.08	(82)
Rooflights 0.9x	1	x	5.52	x	26	x	0.63	x	0.7	=	170.89	(82)
Rooflights 0.9x	1	x	9.27	x	26	x	0.63	x	0.7	=	95.7	(82)
Rooflights 0.9x	1	x	7.7	x	26	x	0.63	x	0.7	=	79.42	(82)
Rooflights 0.9x	1	x	4.47	x	54	x	0.63	x	0.7	=	95.85	(82)

DER WorkSheet: New dwelling design stage

Rooflights 0.9x	1	x	2.04	x	54	x	0.63	x	0.7	=	43.79	(82)
Rooflights 0.9x	1	x	5.52	x	54	x	0.63	x	0.7	=	354.92	(82)
Rooflights 0.9x	1	x	9.27	x	54	x	0.63	x	0.7	=	198.76	(82)
Rooflights 0.9x	1	x	7.7	x	54	x	0.63	x	0.7	=	164.95	(82)
Rooflights 0.9x	1	x	4.47	x	96	x	0.63	x	0.7	=	170.39	(82)
Rooflights 0.9x	1	x	2.04	x	96	x	0.63	x	0.7	=	77.84	(82)
Rooflights 0.9x	1	x	5.52	x	96	x	0.63	x	0.7	=	630.98	(82)
Rooflights 0.9x	1	x	9.27	x	96	x	0.63	x	0.7	=	353.35	(82)
Rooflights 0.9x	1	x	7.7	x	96	x	0.63	x	0.7	=	293.24	(82)
Rooflights 0.9x	1	x	4.47	x	150	x	0.63	x	0.7	=	266.24	(82)
Rooflights 0.9x	1	x	2.04	x	150	x	0.63	x	0.7	=	121.63	(82)
Rooflights 0.9x	1	x	5.52	x	150	x	0.63	x	0.7	=	985.9	(82)
Rooflights 0.9x	1	x	9.27	x	150	x	0.63	x	0.7	=	552.1	(82)
Rooflights 0.9x	1	x	7.7	x	150	x	0.63	x	0.7	=	458.18	(82)
Rooflights 0.9x	1	x	4.47	x	192	x	0.63	x	0.7	=	340.79	(82)
Rooflights 0.9x	1	x	2.04	x	192	x	0.63	x	0.7	=	155.69	(82)
Rooflights 0.9x	1	x	5.52	x	192	x	0.63	x	0.7	=	1261.95	(82)
Rooflights 0.9x	1	x	9.27	x	192	x	0.63	x	0.7	=	706.69	(82)
Rooflights 0.9x	1	x	7.7	x	192	x	0.63	x	0.7	=	586.47	(82)
Rooflights 0.9x	1	x	4.47	x	200	x	0.63	x	0.7	=	354.99	(82)
Rooflights 0.9x	1	x	2.04	x	200	x	0.63	x	0.7	=	162.17	(82)
Rooflights 0.9x	1	x	5.52	x	200	x	0.63	x	0.7	=	1314.53	(82)
Rooflights 0.9x	1	x	9.27	x	200	x	0.63	x	0.7	=	736.14	(82)
Rooflights 0.9x	1	x	7.7	x	200	x	0.63	x	0.7	=	610.91	(82)
Rooflights 0.9x	1	x	4.47	x	189	x	0.63	x	0.7	=	335.46	(82)
Rooflights 0.9x	1	x	2.04	x	189	x	0.63	x	0.7	=	153.25	(82)
Rooflights 0.9x	1	x	5.52	x	189	x	0.63	x	0.7	=	1242.23	(82)
Rooflights 0.9x	1	x	9.27	x	189	x	0.63	x	0.7	=	695.65	(82)
Rooflights 0.9x	1	x	7.7	x	189	x	0.63	x	0.7	=	577.31	(82)
Rooflights 0.9x	1	x	4.47	x	157	x	0.63	x	0.7	=	278.67	(82)
Rooflights 0.9x	1	x	2.04	x	157	x	0.63	x	0.7	=	127.31	(82)
Rooflights 0.9x	1	x	5.52	x	157	x	0.63	x	0.7	=	1031.91	(82)
Rooflights 0.9x	1	x	9.27	x	157	x	0.63	x	0.7	=	577.87	(82)
Rooflights 0.9x	1	x	7.7	x	157	x	0.63	x	0.7	=	479.56	(82)
Rooflights 0.9x	1	x	4.47	x	115	x	0.63	x	0.7	=	204.12	(82)
Rooflights 0.9x	1	x	2.04	x	115	x	0.63	x	0.7	=	93.25	(82)
Rooflights 0.9x	1	x	5.52	x	115	x	0.63	x	0.7	=	755.86	(82)
Rooflights 0.9x	1	x	9.27	x	115	x	0.63	x	0.7	=	423.28	(82)
Rooflights 0.9x	1	x	7.7	x	115	x	0.63	x	0.7	=	351.27	(82)
Rooflights 0.9x	1	x	4.47	x	66	x	0.63	x	0.7	=	117.15	(82)
Rooflights 0.9x	1	x	2.04	x	66	x	0.63	x	0.7	=	53.52	(82)

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Rooflights 0.9x	1	x	5.52	x	66	x	0.63	x	0.7	=	433.8	(82)
Rooflights 0.9x	1	x	9.27	x	66	x	0.63	x	0.7	=	242.93	(82)
Rooflights 0.9x	1	x	7.7	x	66	x	0.63	x	0.7	=	201.6	(82)
Rooflights 0.9x	1	x	4.47	x	33	x	0.63	x	0.7	=	58.57	(82)
Rooflights 0.9x	1	x	2.04	x	33	x	0.63	x	0.7	=	26.76	(82)
Rooflights 0.9x	1	x	5.52	x	33	x	0.63	x	0.7	=	216.9	(82)
Rooflights 0.9x	1	x	9.27	x	33	x	0.63	x	0.7	=	121.46	(82)
Rooflights 0.9x	1	x	7.7	x	33	x	0.63	x	0.7	=	100.8	(82)
Rooflights 0.9x	1	x	4.47	x	21	x	0.63	x	0.7	=	37.27	(82)
Rooflights 0.9x	1	x	2.04	x	21	x	0.63	x	0.7	=	17.03	(82)
Rooflights 0.9x	1	x	5.52	x	21	x	0.63	x	0.7	=	138.03	(82)
Rooflights 0.9x	1	x	9.27	x	21	x	0.63	x	0.7	=	77.29	(82)
Rooflights 0.9x	1	x	7.7	x	21	x	0.63	x	0.7	=	64.15	(82)

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

(83)m=	1819.11	3356.68	5219.66	7422.57	9116.52	9385.16	8910.42	7607.74	5982.83	3884.53	2227.29	1524.69	(83)

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

(84)m=	3172.77	4707.67	6525.36	8651.8	10261.58	10454.09	9933.03	8638.56	7055.64	5034.11	3465.53	2835.68	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	1	1	1	0.98	0.95	0.87	0.77	0.83	0.96	0.99	1	1	(86)

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

(87)m=	18.79	18.96	19.29	19.78	20.22	20.6	20.77	20.73	20.39	19.82	19.25	18.81	(87)

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

(88)m=	19.09	19.1	19.11	19.17	19.18	19.24	19.24	19.25	19.21	19.18	19.15	19.13	(88)

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

(89)m=	1	1	0.99	0.97	0.91	0.77	0.55	0.64	0.91	0.99	1	1	(89)

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

(90)m=	16.23	16.5	16.98	17.72	18.36	18.89	19.06	19.05	18.64	17.8	16.95	16.29	(90)

fLA = Living area ÷ (4) = 0.03 (91)

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

(92)m=	16.31	16.58	17.06	17.79	18.42	18.95	19.12	19.1	18.69	17.86	17.03	16.37	(92)

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

(93)m=	16.31	16.58	17.06	17.79	18.42	18.95	19.12	19.1	18.69	17.86	17.03	16.37	(93)

8. Space heating requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, hm:													
(94)m=	1	1	0.99	0.96	0.89	0.74	0.53	0.62	0.89	0.98	1	1	(94)

Useful gains, hmGm , W = (94)m x (84)m

(95)m=	3169.17	4690.35	6448.87	8321.1	9150.88	7761.42	5301.66	5360.75	6263.09	4953.96	3457.34	2833.55	(95)

DER WorkSheet: New dwelling design stage

Monthly average external temperature from Table 8

(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)

Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]

(97)m=	30690.31	29600.08	26551.89	21490.82	16119.94	10007.49	5795.82	6160.69	10748.26	17414.4	24194.59	30130.83	(97)

Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m

(98)m=	20475.73	16739.34	14956.64	9482.2	5184.98	0	0	0	0	9270.57	14930.82	20309.18	

Total per year (kWh/year) = Sum(98)$_{1,\ldots,12}$ = 111349.45 (98)

Space heating requirement in kWh/m²/year 104.03 (99)

8c. Space cooling requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat loss rate Lm (calculated using 25°C internal temperature and external temperature from Table 10)													
(100)m=	0	0	0	0	0	21628.3	17026.53	17338.46	0	0	0	0	(100)
Utilisation factor for loss hm													
(101)m=	0	0	0	0	0	0.51	0.59	0.53	0	0	0	0	(101)
Useful loss, hmLm (Watts) = (100)m x (101)m													
(102)m=	0	0	0	0	0	11086.13	10094.24	9167.25	0	0	0	0	(102)
Gains (solar gains calculated for applicable weather region, see Table 10)													
(103)m=	0	0	0	0	0	11997.98	11407.72	9984.3	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) = 0.024 x [(103)m – (102)m] x (41)m
set (104)m to zero if (104)m < 3 × (98)m

(104)m=	0	0	0	0	0	656.53	977.23	0	0	0	0	0	

Total = Sum(104) = 1633.76 (104)

Cooled fraction f C = cooled area ÷ (4) = 0.65 (105)

Intermittency factor (Table 10b)

(106)m=	0	0	0	0	0	0.25	0.25	0.25	0	0	0	0	

Total = Sum(104) = 0 (106)

Space cooling requirement for month = (104)m × (105) × (106)m

(107)m=	0	0	0	0	0	107.34	159.77	0	0	0	0	0	

Total = Sum(107) = 267.1 (107)

Space cooling requirement in kWh/m²/year (107) ÷ (4) = 0.25 (108)

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

Space heating:

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

Fraction of space heat from main system(s) (202) = 1 – (201) = 1 (202)

Fraction of total heating from main system 1 (204) = (202) × [1 – (203)] = 1 (204)

Efficiency of main space heating system 1 319.7 (206)

Efficiency of secondary/supplementary heating system, % 0 (208)

Cooling System Energy Efficiency Ratio 8.1 (209)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year
Space heating requirement (calculated above)													
	20475.73	16739.34	14956.64	9482.2	5184.98	0	0	0	0	9270.57	14930.82	20309.18	

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(211)m = {[(98)m x (204)] } x 100 ÷ (206) (211)

6404.67	5235.95	4678.34	2965.97	1621.83	0	0	0	0	2899.77	4670.26	6352.57

Total (kWh/year) =Sum(211)$_{1...12}$= 34829.36 (211)

Space heating fuel (secondary), kWh/month
= {[(98)m x (201)] } x 100 ÷ (208)

(215)m=	0	0	0	0	0	0	0	0	0	0	0	0

Total (kWh/year) =Sum(215)$_{1...12}$= 0 (215)

Water heating

Output from water heater (calculated above)

339.63	300.59	318.58	289.61	286.73	260.39	254.06	273.29	271.09	300.12	312.28	332.82

Efficiency of water heater 224.4 (216)

(217)m=	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4

(217)

Fuel for water heating, kWh/month
(219)m = (64)m x 100 ÷ (217)m

(219)m=	151.35	133.95	141.97	129.06	127.77	116.04	113.22	121.79	120.81	133.74	139.16	148.32

Total = Sum(219a)$_{1...12}$ = 1577.18 (219)

Space cooling fuel, kWh/month.
(221)m = (107)m÷ (209)

(221)m=	0	0	0	0	0	13.25	19.72	0	0	0	0	0

Total = Sum(221)$_{5...9}$ = 32.98 (221)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			34829.36	
Water heating fuel used			1577.18	
Space cooling fuel used			32.98	
Electricity for pumps, fans and electric keep-hot				
mechanical ventilation - balanced, extract or positive input from outside		6787.31		(230a)
central heating pump:		30		(230c)
Total electricity for the above, kWh/year	sum of (230a)...(230g) =		6817.31	(231)
Electricity for lighting			1497.73	(232)
Electricity generated by PVs			-4819.18	(233)

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

	Energy kWh/year		**Emission factor** kg CO2/kWh		**Emissions** kg CO2/year	
Space heating (main system 1)	(211) x		0.519	=	18076.44	(261)
Space heating (secondary)	(215) x		0.519	=	0	(263)
Water heating	(219) x		0.519	=	818.55	(264)
Space and water heating	(261) + (262) + (263) + (264) =				18894.99	(265)
Space cooling	(221) x		0.519	=	17.11	(266)
Electricity for pumps, fans and electric keep-hot	(231) x		0.519	=	3538.18	(267)
Electricity for lighting	(232) x		0.519	=	777.32	(268)

DER WorkSheet: New dwelling design stage

Energy saving/generation technologies				
Item 1	0.519	=	-2501.16	(269)
Total CO2, kg/year	sum of (265)...(271) =		20726.45	(272)
Dwelling CO2 Emission Rate	(272) ÷ (4) =		19.36	(273)
EI rating (section 14)			75	(274)

APPENDIX (ii)

SAP L1A 2013/16 REGULATIONS

(SAP Worksheet)

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Ondrej Gajdos	**Stroma Number:**	STRO006629
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.5.12

Property Address: Be Green

Address : 7 Greenaway Gardens, LONDON, NW3 7DJ

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Basement	73.8	(1a) x	2.5	(2a) =	184.5	(3a)
Ground floor	429.4	(1b) x	3.8	(2b) =	1631.72	(3b)
First floor	232.6	(1c) x	3.55	(2c) =	825.73	(3c)
Second floor	215.8	(1d) x	3.1	(2d) =	668.98	(3d)
Third floor	118.8	(1e) x	3.35	(2e) =	397.98	(3e)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	1070.4	(4)				
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =		3708.91	(5)

2. Ventilation rate:

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

			Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	0	÷ (5) =	0	(8)
If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)				
Number of storeys in the dwelling (ns)			0	(9)
Additional infiltration		[(9)-1]x0.1 =	0	(10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction			0	(11)
if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35				
If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0			0	(12)
If no draught lobby, enter 0.05, else enter 0			0	(13)
Percentage of windows and doors draught stripped			0	(14)
Window infiltration		0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate		(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area			15	(17)
If based on air permeability value, then (18) = [(17) ÷ 20]+(8), otherwise (18) = (16)			0.75	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used				
Number of sides sheltered			2	(19)
Shelter factor		(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor		(21) = (18) x (20) =	0.64	(21)

SAP WorkSheet: New dwelling design stage

Infiltration rate modified for monthly wind speed

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table 7												
(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7
Wind Factor (22a)m = (22)m ÷ 4												
(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18
Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m												
	0.81	0.8	0.78	0.7	0.69	0.61	0.61	0.59	0.64	0.69	0.72	0.75

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0.5 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0.5 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 68 (23c)

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

(24a)m=	0.97	0.96	0.94	0.86	0.85	0.77	0.77	0.75	0.8	0.85	0.88	0.91	(24a)

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

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

c) If whole house extract ventilation or positive input ventilation from outside
if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 × (23b)

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

d) If natural ventilation or whole house positive input ventilation from loft
if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

(24d)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24d)

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

(25)m=	0.97	0.96	0.94	0.86	0.85	0.77	0.77	0.75	0.8	0.85	0.88	0.91	(25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors Type 1			3.24	x	1.2	=	3.888			(26)
Doors Type 2			6.14	x	0.33	=	2.0262			(26)
Doors Type 3			2.54	x	1.2	=	3.048			(26)
Doors Type 4			2.98	x	1.2	=	3.576			(26)
Windows Type 1			2.29	x1/[1/(1.1)+ 0.04]		=	2.41			(27)
Windows Type 2			1.68	x1/[1/(1.1)+ 0.04]		=	1.77			(27)
Windows Type 3			2.37	x1/[1/(1.1)+ 0.04]		=	2.5			(27)
Windows Type 4			1.76	x1/[1/(1.1)+ 0.04]		=	1.85			(27)
Windows Type 5			3.83	x1/[1/(1.1)+ 0.04]		=	4.04			(27)
Windows Type 6			1.34	x1/[1/(1.1)+ 0.04]		=	1.41			(27)
Windows Type 7			0.3	x1/[1/(1.1)+ 0.04]		=	0.32			(27)
Windows Type 8			0.46	x1/[1/(0.87)+ 0.04]		=	0.39			(27)
Windows Type 9			0.57	x1/[1/(0.87)+ 0.04]		=	0.48			(27)

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Windows Type 10			6.67	x0.77[1/(0.87)+ 0.04] =	5.61				(27)
Windows Type 11			2.07	x1[1/(1.1)+ 0.04] =	2.18				(27)
Windows Type 12			2.07	x0.77[1/(0.87)+ 0.04] =	1.74				(27)
Windows Type 13			2.22	x0.77[1/(0.87)+ 0.04] =	1.87				(27)
Windows Type 14			1.82	x1[1/(1.1)+ 0.04] =	1.92				(27)
Windows Type 15			1.82	x0.77[1/(0.87)+ 0.04] =	1.53				(27)
Windows Type 16			2.2	x1[1/(1.1)+ 0.04] =	2.32				(27)
Windows Type 17			3.08	x0.77[1/(0.87)+ 0.04] =	2.59				(27)
Windows Type 18			0.95	x1[1/(1.1)+ 0.04] =	1				(27)
Windows Type 19			2	x1[1/(1.1)+ 0.04] =	2.11				(27)
Windows Type 20			7.38	x0.77[1/(0.87)+ 0.04] =	6.2				(27)
Windows Type 21			10.59	x0.77[1/(0.87)+ 0.04] =	8.9				(27)
Windows Type 22			3.83	x0.77[1/(0.87)+ 0.04] =	3.22				(27)
Windows Type 23			13.1	x0.77[1/(0.87)+ 0.04] =	11.01				(27)
Windows Type 24			3.96	x0.77[1/(0.87)+ 0.04] =	3.33				(27)
Windows Type 25			1.38	x0.77[1/(0.87)+ 0.04] =	1.16				(27)
Windows Type 26			2.25	x0.77[1/(0.87)+ 0.04] =	1.89				(27)
Windows Type 27			23.96	x0.77[1/(0.87)+ 0.04] =	20.14				(27)
Windows Type 28			4.13	x0.77[1/(0.87)+ 0.04] =	3.47				(27)
Windows Type 29			2.19	x0.77[1/(0.87)+ 0.04] =	1.84				(27)
Windows Type 30			2.2	x0.77[1/(0.87)+ 0.04] =	1.85				(27)
Windows Type 31			2.26	x1[1/(1.1)+ 0.04] =	2.38				(27)
Windows Type 32			2.2	x1[1/(1.1)+ 0.04] =	2.32				(27)
Windows Type 33			2.19	x1[1/(1.1)+ 0.04] =	2.31				(27)
Windows Type 34			2.93	x1[1/(1.1)+ 0.04] =	3.09				(27)
Windows Type 35			1.49	x1[1/(1.1)+ 0.04] =	1.57				(27)
Windows Type 36			2.03	x0.77[1/(0.87)+ 0.04] =	1.71				(27)
Rooflights Type 1			4.472	x1[1/(1.2) + 0.04] =	5.3664				(27b)
Rooflights Type 2			2.043	x1[1/(1.2) + 0.04] =	2.4516				(27b)
Rooflights Type 3			5.52	x1[1/(1.2) + 0.04] =	6.624				(27b)
Rooflights Type 4			9.2736	x1[1/(1.2) + 0.04] =	11.12832				(27b)
Rooflights Type 5			7.696	x1[1/(1.2) + 0.04] =	9.235201				(27b)
Floor			503.2	x	0.22	=	110.704		(28)
Walls Type1	172.48	61.38	111.1	x	0.27	=	30		(29)
Walls Type2	326.33	0	326.33	x	0.26	=	84.85		(29)
Walls Type3	431.67	82.39	349.28	x	1.45	=	506.46		(29)
Walls Type4	73.13	36.72	36.41	x	0.18	=	6.55		(29)
Walls Type5	39.8	17.76	22.04	x	0.28	=	6.17		(29)
Walls Type6	5.6	3.08	2.52	x	0.28	=	0.71		(29)

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Roof Type1	369.4	32.35	337.05	x	0.15	=	50.56		(30)
Roof Type2	11.7	7.7	4	x	0.15	=	0.6		(30)
Roof Type3	172.7	0	172.7	x	0.12	=	20.72		(30)
Total area of elements, m²			2106.01						(31)

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

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

Fabric heat loss, W/K = S (A x U)	(26)...(30) + (32) =	1047.9 (33)
Heat capacity Cm = S(A x k)	((28)...(30) + (32) + (32a)...(32e) =	0 (34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	Indicative Value: Medium	250 (35)

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

Thermal bridges : S (L x Y) calculated using Appendix K		315.9 (36)
If details of thermal bridging are not known (36) = 0.05 x (31)		
Total fabric heat loss	(33) + (36) =	1363.8 (37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	1190.66	1171.16	1151.65	1054.12	1034.61	937.08	937.08	917.57	976.09	1034.61	1073.63	1112.64	(38)

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

(39)m=	2554.47	2534.96	2515.45	2417.92	2398.42	2300.88	2300.88	2281.38	2339.9	2398.42	2437.43	2476.44	
											Average = Sum(39)$_{1..12}$ /12=		2413.05 (39)

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

(40)m=	2.39	2.37	2.35	2.26	2.24	2.15	2.15	2.13	2.19	2.24	2.28	2.31	
											Average = Sum(40)$_{1..12}$ /12=		2.25 (40)

Number of days in month (Table 1a)

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

4. Water heating energy requirement: kWh/year:

Assumed occupancy, N 4.13 (42)

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

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 132.37 (43)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)													
(44)m=	145.61	140.31	135.02	129.72	124.43	119.13	119.13	124.43	129.72	135.02	140.31	145.61	
											Total = Sum(44)$_{1..12}$ =		1588.43 (44)

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

(45)m=	215.93	188.85	194.88	169.9	163.02	140.68	130.36	149.59	151.37	176.41	192.57	209.12	
											Total = Sum(45)$_{1..12}$ =		2082.69 (45)

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

(46)m=	32.39	28.33	29.23	25.49	24.45	21.1	19.55	22.44	22.71	26.46	28.89	31.37	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 1000 (47)

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If community heating and no tank in dwelling, enter 110 litres in (47)
Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in (47)
Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day):		6	(48)
Temperature factor from Table 2b		0.54	(49)
Energy lost from water storage, kWh/year	(48) x (49) =	3.24	(50)
b) If manufacturer's declared cylinder loss factor is not known:			
Hot water storage loss factor from Table 2 (kWh/litre/day)		0	(51)
If community heating see section 4.3			
Volume factor from Table 2a		0	(52)
Temperature factor from Table 2b		0	(53)
Energy lost from water storage, kWh/year	(47) x (51) x (52) x (53) =	0	(54)
Enter (50) or (54) in (55)		3.24	(55)

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

(56)m=	100.44	90.72	100.44	97.2	100.44	97.2	100.44	100.44	97.2	100.44	97.2	100.44	(56)

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

(57)m=	100.44	90.72	100.44	97.2	100.44	97.2	100.44	100.44	97.2	100.44	97.2	100.44	(57)

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

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m
(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m=	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)

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

(61)m=	0	0	0	0	0	0	0	0	0	0	0	0	(61)

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

(62)m=	339.63	300.59	318.58	289.61	286.73	260.39	254.06	273.29	271.09	300.12	312.28	332.82	(62)

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)
(add additional lines if FGHRS and/or WWHRS applies, see Appendix G)

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

Output from water heater

(64)m=	339.63	300.59	318.58	289.61	286.73	260.39	254.06	273.29	271.09	300.12	312.28	332.82	

Output from water heater (annual)(64): 3539.18

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

(65)m=	170.76	152.18	163.76	152.26	153.17	142.54	142.31	148.7	146.1	157.62	159.8	168.49	(65)

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

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m=	248.01	248.01	248.01	248.01	248.01	248.01	248.01	248.01	248.01	248.01	248.01	248.01	(66)

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

(67)m=	212.02	188.31	153.15	115.94	86.67	73.17	79.06	102.77	137.93	175.14	204.41	217.91	(67)

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

(68)m=	1419.9	1434.64	1397.51	1318.46	1218.68	1124.9	1062.25	1047.52	1084.65	1163.69	1263.47	1357.25	(68)

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

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(69)m=	63.93	63.93	63.93	63.93	63.93	63.93	63.93	63.93	63.93	63.93	63.93	63.93	(69)

Pumps and fans gains (Table 5a)

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

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

(71)m=	-165.34	-165.34	-165.34	-165.34	-165.34	-165.34	-165.34	-165.34	-165.34	-165.34	-165.34	-165.34	(71)

Water heating gains (Table 5)

(72)m=	229.51	226.46	220.11	211.47	205.87	197.98	191.27	199.87	202.92	211.85	221.94	226.47	(72)

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

(73)m=	2011.04	1999.01	1920.36	1795.48	1660.82	1545.66	1482.19	1499.76	1575.11	1700.29	1839.43	1951.24	(73)

6. Solar gains:

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

Orientation:	Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Northeast 0.9x	0.77	x	2.29	x	11.28	x	0.63	x	0.7	=	31.59	(75)
Northeast 0.9x	0.77	x	1.68	x	11.28	x	0.63	x	0.7	=	11.59	(75)
Northeast 0.9x	0.77	x	2.37	x	11.28	x	0.63	x	0.7	=	49.03	(75)
Northeast 0.9x	0.77	x	1.76	x	11.28	x	0.63	x	0.7	=	12.14	(75)
Northeast 0.9x	0.77	x	3.83	x	11.28	x	0.63	x	0.7	=	13.21	(75)
Northeast 0.9x	0.77	x	1.34	x	11.28	x	0.63	x	0.7	=	13.86	(75)
Northeast 0.9x	0.77	x	0.3	x	11.28	x	0.63	x	0.7	=	1.03	(75)
Northeast 0.9x	0.54	x	2.03	x	11.28	x	0.57	x	0.8	=	20.3	(75)
Northeast 0.9x	0.77	x	2.29	x	22.97	x	0.63	x	0.7	=	64.29	(75)
Northeast 0.9x	0.77	x	1.68	x	22.97	x	0.63	x	0.7	=	23.58	(75)
Northeast 0.9x	0.77	x	2.37	x	22.97	x	0.63	x	0.7	=	99.81	(75)
Northeast 0.9x	0.77	x	1.76	x	22.97	x	0.63	x	0.7	=	24.71	(75)
Northeast 0.9x	0.77	x	3.83	x	22.97	x	0.63	x	0.7	=	26.88	(75)
Northeast 0.9x	0.77	x	1.34	x	22.97	x	0.63	x	0.7	=	28.22	(75)
Northeast 0.9x	0.77	x	0.3	x	22.97	x	0.63	x	0.7	=	2.11	(75)
Northeast 0.9x	0.54	x	2.03	x	22.97	x	0.57	x	0.8	=	41.33	(75)
Northeast 0.9x	0.77	x	2.29	x	41.38	x	0.63	x	0.7	=	115.84	(75)
Northeast 0.9x	0.77	x	1.68	x	41.38	x	0.63	x	0.7	=	42.49	(75)
Northeast 0.9x	0.77	x	2.37	x	41.38	x	0.63	x	0.7	=	179.82	(75)
Northeast 0.9x	0.77	x	1.76	x	41.38	x	0.63	x	0.7	=	44.51	(75)
Northeast 0.9x	0.77	x	3.83	x	41.38	x	0.63	x	0.7	=	48.43	(75)
Northeast 0.9x	0.77	x	1.34	x	41.38	x	0.63	x	0.7	=	50.84	(75)
Northeast 0.9x	0.77	x	0.3	x	41.38	x	0.63	x	0.7	=	3.79	(75)
Northeast 0.9x	0.54	x	2.03	x	41.38	x	0.57	x	0.8	=	74.46	(75)
Northeast 0.9x	0.77	x	2.29	x	67.96	x	0.63	x	0.7	=	190.24	(75)
Northeast 0.9x	0.77	x	1.68	x	67.96	x	0.63	x	0.7	=	69.78	(75)
Northeast 0.9x	0.77	x	2.37	x	67.96	x	0.63	x	0.7	=	295.32	(75)
Northeast 0.9x	0.77	x	1.76	x	67.96	x	0.63	x	0.7	=	73.1	(75)

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Northeast	0.9x	0.77	x	3.83	x	67.96	x	0.63	x	0.7	=	79.54	(75)
Northeast	0.9x	0.77	x	1.34	x	67.96	x	0.63	x	0.7	=	83.49	(75)
Northeast	0.9x	0.77	x	0.3	x	67.96	x	0.63	x	0.7	=	6.23	(75)
Northeast	0.9x	0.54	x	2.03	x	67.96	x	0.57	x	0.8	=	122.29	(75)
Northeast	0.9x	0.77	x	2.29	x	91.35	x	0.63	x	0.7	=	255.72	(75)
Northeast	0.9x	0.77	x	1.68	x	91.35	x	0.63	x	0.7	=	93.8	(75)
Northeast	0.9x	0.77	x	2.37	x	91.35	x	0.63	x	0.7	=	396.97	(75)
Northeast	0.9x	0.77	x	1.76	x	91.35	x	0.63	x	0.7	=	98.27	(75)
Northeast	0.9x	0.77	x	3.83	x	91.35	x	0.63	x	0.7	=	106.92	(75)
Northeast	0.9x	0.77	x	1.34	x	91.35	x	0.63	x	0.7	=	112.22	(75)
Northeast	0.9x	0.77	x	0.3	x	91.35	x	0.63	x	0.7	=	8.37	(75)
Northeast	0.9x	0.54	x	2.03	x	91.35	x	0.57	x	0.8	=	164.38	(75)
Northeast	0.9x	0.77	x	2.29	x	97.38	x	0.63	x	0.7	=	272.62	(75)
Northeast	0.9x	0.77	x	1.68	x	97.38	x	0.63	x	0.7	=	100	(75)
Northeast	0.9x	0.77	x	2.37	x	97.38	x	0.63	x	0.7	=	423.22	(75)
Northeast	0.9x	0.77	x	1.76	x	97.38	x	0.63	x	0.7	=	104.76	(75)
Northeast	0.9x	0.77	x	3.83	x	97.38	x	0.63	x	0.7	=	113.99	(75)
Northeast	0.9x	0.77	x	1.34	x	97.38	x	0.63	x	0.7	=	119.64	(75)
Northeast	0.9x	0.77	x	0.3	x	97.38	x	0.63	x	0.7	=	8.93	(75)
Northeast	0.9x	0.54	x	2.03	x	97.38	x	0.57	x	0.8	=	175.25	(75)
Northeast	0.9x	0.77	x	2.29	x	91.1	x	0.63	x	0.7	=	255.03	(75)
Northeast	0.9x	0.77	x	1.68	x	91.1	x	0.63	x	0.7	=	93.55	(75)
Northeast	0.9x	0.77	x	2.37	x	91.1	x	0.63	x	0.7	=	395.91	(75)
Northeast	0.9x	0.77	x	1.76	x	91.1	x	0.63	x	0.7	=	98	(75)
Northeast	0.9x	0.77	x	3.83	x	91.1	x	0.63	x	0.7	=	106.63	(75)
Northeast	0.9x	0.77	x	1.34	x	91.1	x	0.63	x	0.7	=	111.92	(75)
Northeast	0.9x	0.77	x	0.3	x	91.1	x	0.63	x	0.7	=	8.35	(75)
Northeast	0.9x	0.54	x	2.03	x	91.1	x	0.57	x	0.8	=	163.94	(75)
Northeast	0.9x	0.77	x	2.29	x	72.63	x	0.63	x	0.7	=	203.31	(75)
Northeast	0.9x	0.77	x	1.68	x	72.63	x	0.63	x	0.7	=	74.58	(75)
Northeast	0.9x	0.77	x	2.37	x	72.63	x	0.63	x	0.7	=	315.62	(75)
Northeast	0.9x	0.77	x	1.76	x	72.63	x	0.63	x	0.7	=	78.13	(75)
Northeast	0.9x	0.77	x	3.83	x	72.63	x	0.63	x	0.7	=	85.01	(75)
Northeast	0.9x	0.77	x	1.34	x	72.63	x	0.63	x	0.7	=	89.23	(75)
Northeast	0.9x	0.77	x	0.3	x	72.63	x	0.63	x	0.7	=	6.66	(75)
Northeast	0.9x	0.54	x	2.03	x	72.63	x	0.57	x	0.8	=	130.69	(75)
Northeast	0.9x	0.77	x	2.29	x	50.42	x	0.63	x	0.7	=	141.15	(75)
Northeast	0.9x	0.77	x	1.68	x	50.42	x	0.63	x	0.7	=	51.77	(75)
Northeast	0.9x	0.77	x	2.37	x	50.42	x	0.63	x	0.7	=	219.12	(75)
Northeast	0.9x	0.77	x	1.76	x	50.42	x	0.63	x	0.7	=	54.24	(75)
Northeast	0.9x	0.77	x	3.83	x	50.42	x	0.63	x	0.7	=	59.02	(75)

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Northeast	0.9x	0.77	x	1.34	x	50.42	x	0.63	x	0.7	=	61.95	(75)
Northeast	0.9x	0.77	x	0.3	x	50.42	x	0.63	x	0.7	=	4.62	(75)
Northeast	0.9x	0.54	x	2.03	x	50.42	x	0.57	x	0.8	=	90.73	(75)
Northeast	0.9x	0.77	x	2.29	x	28.07	x	0.63	x	0.7	=	78.57	(75)
Northeast	0.9x	0.77	x	1.68	x	28.07	x	0.63	x	0.7	=	28.82	(75)
Northeast	0.9x	0.77	x	2.37	x	28.07	x	0.63	x	0.7	=	121.97	(75)
Northeast	0.9x	0.77	x	1.76	x	28.07	x	0.63	x	0.7	=	30.19	(75)
Northeast	0.9x	0.77	x	3.83	x	28.07	x	0.63	x	0.7	=	32.85	(75)
Northeast	0.9x	0.77	x	1.34	x	28.07	x	0.63	x	0.7	=	34.48	(75)
Northeast	0.9x	0.77	x	0.3	x	28.07	x	0.63	x	0.7	=	2.57	(75)
Northeast	0.9x	0.54	x	2.03	x	28.07	x	0.57	x	0.8	=	50.51	(75)
Northeast	0.9x	0.77	x	2.29	x	14.2	x	0.63	x	0.7	=	39.74	(75)
Northeast	0.9x	0.77	x	1.68	x	14.2	x	0.63	x	0.7	=	14.58	(75)
Northeast	0.9x	0.77	x	2.37	x	14.2	x	0.63	x	0.7	=	61.7	(75)
Northeast	0.9x	0.77	x	1.76	x	14.2	x	0.63	x	0.7	=	15.27	(75)
Northeast	0.9x	0.77	x	3.83	x	14.2	x	0.63	x	0.7	=	16.62	(75)
Northeast	0.9x	0.77	x	1.34	x	14.2	x	0.63	x	0.7	=	17.44	(75)
Northeast	0.9x	0.77	x	0.3	x	14.2	x	0.63	x	0.7	=	1.3	(75)
Northeast	0.9x	0.54	x	2.03	x	14.2	x	0.57	x	0.8	=	25.55	(75)
Northeast	0.9x	0.77	x	2.29	x	9.21	x	0.63	x	0.7	=	25.79	(75)
Northeast	0.9x	0.77	x	1.68	x	9.21	x	0.63	x	0.7	=	9.46	(75)
Northeast	0.9x	0.77	x	2.37	x	9.21	x	0.63	x	0.7	=	40.04	(75)
Northeast	0.9x	0.77	x	1.76	x	9.21	x	0.63	x	0.7	=	9.91	(75)
Northeast	0.9x	0.77	x	3.83	x	9.21	x	0.63	x	0.7	=	10.79	(75)
Northeast	0.9x	0.77	x	1.34	x	9.21	x	0.63	x	0.7	=	11.32	(75)
Northeast	0.9x	0.77	x	0.3	x	9.21	x	0.63	x	0.7	=	0.84	(75)
Northeast	0.9x	0.54	x	2.03	x	9.21	x	0.57	x	0.8	=	16.58	(75)
Southeast	0.9x	0.77	x	0.95	x	36.79	x	0.63	x	0.7	=	10.68	(77)
Southeast	0.9x	0.77	x	2	x	36.79	x	0.63	x	0.7	=	22.49	(77)
Southeast	0.9x	0.77	x	0.95	x	62.67	x	0.63	x	0.7	=	18.2	(77)
Southeast	0.9x	0.77	x	2	x	62.67	x	0.63	x	0.7	=	38.31	(77)
Southeast	0.9x	0.77	x	0.95	x	85.75	x	0.63	x	0.7	=	24.9	(77)
Southeast	0.9x	0.77	x	2	x	85.75	x	0.63	x	0.7	=	52.41	(77)
Southeast	0.9x	0.77	x	0.95	x	106.25	x	0.63	x	0.7	=	30.85	(77)
Southeast	0.9x	0.77	x	2	x	106.25	x	0.63	x	0.7	=	64.94	(77)
Southeast	0.9x	0.77	x	0.95	x	119.01	x	0.63	x	0.7	=	34.55	(77)
Southeast	0.9x	0.77	x	2	x	119.01	x	0.63	x	0.7	=	72.74	(77)
Southeast	0.9x	0.77	x	0.95	x	118.15	x	0.63	x	0.7	=	34.3	(77)
Southeast	0.9x	0.77	x	2	x	118.15	x	0.63	x	0.7	=	72.22	(77)
Southeast	0.9x	0.77	x	0.95	x	113.91	x	0.63	x	0.7	=	33.07	(77)
Southeast	0.9x	0.77	x	2	x	113.91	x	0.63	x	0.7	=	69.62	(77)

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Southeast 0.9x	0.77	x	0.95	x	104.39	x	0.63	x	0.7	=	30.31	(77)
Southeast 0.9x	0.77	x	2	x	104.39	x	0.63	x	0.7	=	63.81	(77)
Southeast 0.9x	0.77	x	0.95	x	92.85	x	0.63	x	0.7	=	26.96	(77)
Southeast 0.9x	0.77	x	2	x	92.85	x	0.63	x	0.7	=	56.75	(77)
Southeast 0.9x	0.77	x	0.95	x	69.27	x	0.63	x	0.7	=	20.11	(77)
Southeast 0.9x	0.77	x	2	x	69.27	x	0.63	x	0.7	=	42.34	(77)
Southeast 0.9x	0.77	x	0.95	x	44.07	x	0.63	x	0.7	=	12.8	(77)
Southeast 0.9x	0.77	x	2	x	44.07	x	0.63	x	0.7	=	26.94	(77)
Southeast 0.9x	0.77	x	0.95	x	31.49	x	0.63	x	0.7	=	9.14	(77)
Southeast 0.9x	0.77	x	2	x	31.49	x	0.63	x	0.7	=	19.25	(77)
Southwest 0.9x	0.77	x	7.38	x	36.79		0.57	x	0.8	=	85.81	(79)
Southwest 0.9x	0.77	x	10.59	x	36.79		0.57	x	0.8	=	123.13	(79)
Southwest 0.9x	0.77	x	3.83	x	36.79		0.57	x	0.8	=	89.06	(79)
Southwest 0.9x	0.77	x	2.25	x	36.79		0.57	x	0.8	=	52.32	(79)
Southwest 0.9x	0.77	x	23.96	x	36.79		0.57	x	0.8	=	278.59	(79)
Southwest 0.9x	0.77	x	4.13	x	36.79		0.57	x	0.8	=	96.04	(79)
Southwest 0.9x	0.77	x	2.19	x	36.79		0.57	x	0.8	=	50.93	(79)
Southwest 0.9x	0.77	x	2.2	x	36.79		0.57	x	0.8	=	25.58	(79)
Southwest 0.9x	0.77	x	2.26	x	36.79		0.63	x	0.7	=	127.06	(79)
Southwest 0.9x	0.77	x	2.2	x	36.79		0.63	x	0.7	=	24.74	(79)
Southwest 0.9x	0.77	x	2.19	x	36.79		0.63	x	0.7	=	24.63	(79)
Southwest 0.9x	0.77	x	2.93	x	36.79		0.63	x	0.7	=	65.89	(79)
Southwest 0.9x	0.77	x	1.49	x	36.79		0.63	x	0.7	=	16.75	(79)
Southwest 0.9x	0.77	x	7.38	x	62.67		0.57	x	0.8	=	146.16	(79)
Southwest 0.9x	0.77	x	10.59	x	62.67		0.57	x	0.8	=	209.74	(79)
Southwest 0.9x	0.77	x	3.83	x	62.67		0.57	x	0.8	=	151.71	(79)
Southwest 0.9x	0.77	x	2.25	x	62.67		0.57	x	0.8	=	89.12	(79)
Southwest 0.9x	0.77	x	23.96	x	62.67		0.57	x	0.8	=	474.54	(79)
Southwest 0.9x	0.77	x	4.13	x	62.67		0.57	x	0.8	=	163.59	(79)
Southwest 0.9x	0.77	x	2.19	x	62.67		0.57	x	0.8	=	86.75	(79)
Southwest 0.9x	0.77	x	2.2	x	62.67		0.57	x	0.8	=	43.57	(79)
Southwest 0.9x	0.77	x	2.26	x	62.67		0.63	x	0.7	=	216.44	(79)
Southwest 0.9x	0.77	x	2.2	x	62.67		0.63	x	0.7	=	42.14	(79)
Southwest 0.9x	0.77	x	2.19	x	62.67		0.63	x	0.7	=	41.95	(79)
Southwest 0.9x	0.77	x	2.93	x	62.67		0.63	x	0.7	=	112.24	(79)
Southwest 0.9x	0.77	x	1.49	x	62.67		0.63	x	0.7	=	28.54	(79)
Southwest 0.9x	0.77	x	7.38	x	85.75		0.57	x	0.8	=	199.99	(79)
Southwest 0.9x	0.77	x	10.59	x	85.75		0.57	x	0.8	=	286.97	(79)
Southwest 0.9x	0.77	x	3.83	x	85.75		0.57	x	0.8	=	207.57	(79)
Southwest 0.9x	0.77	x	2.25	x	85.75		0.57	x	0.8	=	121.94	(79)
Southwest 0.9x	0.77	x	23.96	x	85.75		0.57	x	0.8	=	649.28	(79)

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Southwest	0.9x	0.77	x	4.13	x	85.75	0.57	x	0.8	=	223.83	(79)
Southwest	0.9x	0.77	x	2.19	x	85.75	0.57	x	0.8	=	118.69	(79)
Southwest	0.9x	0.77	x	2.2	x	85.75	0.57	x	0.8	=	59.62	(79)
Southwest	0.9x	0.77	x	2.26	x	85.75	0.63	x	0.7	=	296.14	(79)
Southwest	0.9x	0.77	x	2.2	x	85.75	0.63	x	0.7	=	57.66	(79)
Southwest	0.9x	0.77	x	2.19	x	85.75	0.63	x	0.7	=	57.39	(79)
Southwest	0.9x	0.77	x	2.93	x	85.75	0.63	x	0.7	=	153.57	(79)
Southwest	0.9x	0.77	x	1.49	x	85.75	0.63	x	0.7	=	39.05	(79)
Southwest	0.9x	0.77	x	7.38	x	106.25	0.57	x	0.8	=	247.79	(79)
Southwest	0.9x	0.77	x	10.59	x	106.25	0.57	x	0.8	=	355.57	(79)
Southwest	0.9x	0.77	x	3.83	x	106.25	0.57	x	0.8	=	257.19	(79)
Southwest	0.9x	0.77	x	2.25	x	106.25	0.57	x	0.8	=	151.09	(79)
Southwest	0.9x	0.77	x	23.96	x	106.25	0.57	x	0.8	=	804.49	(79)
Southwest	0.9x	0.77	x	4.13	x	106.25	0.57	x	0.8	=	277.34	(79)
Southwest	0.9x	0.77	x	2.19	x	106.25	0.57	x	0.8	=	147.06	(79)
Southwest	0.9x	0.77	x	2.2	x	106.25	0.57	x	0.8	=	73.87	(79)
Southwest	0.9x	0.77	x	2.26	x	106.25	0.63	x	0.7	=	366.93	(79)
Southwest	0.9x	0.77	x	2.2	x	106.25	0.63	x	0.7	=	71.44	(79)
Southwest	0.9x	0.77	x	2.19	x	106.25	0.63	x	0.7	=	71.11	(79)
Southwest	0.9x	0.77	x	2.93	x	106.25	0.63	x	0.7	=	190.29	(79)
Southwest	0.9x	0.77	x	1.49	x	106.25	0.63	x	0.7	=	48.38	(79)
Southwest	0.9x	0.77	x	7.38	x	119.01	0.57	x	0.8	=	277.55	(79)
Southwest	0.9x	0.77	x	10.59	x	119.01	0.57	x	0.8	=	398.27	(79)
Southwest	0.9x	0.77	x	3.83	x	119.01	0.57	x	0.8	=	288.08	(79)
Southwest	0.9x	0.77	x	2.25	x	119.01	0.57	x	0.8	=	169.24	(79)
Southwest	0.9x	0.77	x	23.96	x	119.01	0.57	x	0.8	=	901.1	(79)
Southwest	0.9x	0.77	x	4.13	x	119.01	0.57	x	0.8	=	310.64	(79)
Southwest	0.9x	0.77	x	2.19	x	119.01	0.57	x	0.8	=	164.72	(79)
Southwest	0.9x	0.77	x	2.2	x	119.01	0.57	x	0.8	=	82.74	(79)
Southwest	0.9x	0.77	x	2.26	x	119.01	0.63	x	0.7	=	410.99	(79)
Southwest	0.9x	0.77	x	2.2	x	119.01	0.63	x	0.7	=	80.02	(79)
Southwest	0.9x	0.77	x	2.19	x	119.01	0.63	x	0.7	=	79.65	(79)
Southwest	0.9x	0.77	x	2.93	x	119.01	0.63	x	0.7	=	213.14	(79)
Southwest	0.9x	0.77	x	1.49	x	119.01	0.63	x	0.7	=	54.19	(79)
Southwest	0.9x	0.77	x	7.38	x	118.15	0.57	x	0.8	=	275.54	(79)
Southwest	0.9x	0.77	x	10.59	x	118.15	0.57	x	0.8	=	395.39	(79)
Southwest	0.9x	0.77	x	3.83	x	118.15	0.57	x	0.8	=	286	(79)
Southwest	0.9x	0.77	x	2.25	x	118.15	0.57	x	0.8	=	168.01	(79)
Southwest	0.9x	0.77	x	23.96	x	118.15	0.57	x	0.8	=	894.58	(79)
Southwest	0.9x	0.77	x	4.13	x	118.15	0.57	x	0.8	=	308.4	(79)
Southwest	0.9x	0.77	x	2.19	x	118.15	0.57	x	0.8	=	163.53	(79)

Southwest	0.9x	0.77	x	2.2	x	118.15		0.57	x	0.8	=	82.14	(79)
Southwest	0.9x	0.77	x	2.26	x	118.15		0.63	x	0.7	=	408.02	(79)
Southwest	0.9x	0.77	x	2.2	x	118.15		0.63	x	0.7	=	79.44	(79)
Southwest	0.9x	0.77	x	2.19	x	118.15		0.63	x	0.7	=	79.08	(79)
Southwest	0.9x	0.77	x	2.93	x	118.15		0.63	x	0.7	=	211.59	(79)
Southwest	0.9x	0.77	x	1.49	x	118.15		0.63	x	0.7	=	53.8	(79)
Southwest	0.9x	0.77	x	7.38	x	113.91		0.57	x	0.8	=	265.65	(79)
Southwest	0.9x	0.77	x	10.59	x	113.91		0.57	x	0.8	=	381.2	(79)
Southwest	0.9x	0.77	x	3.83	x	113.91		0.57	x	0.8	=	275.73	(79)
Southwest	0.9x	0.77	x	2.25	x	113.91		0.57	x	0.8	=	161.98	(79)
Southwest	0.9x	0.77	x	23.96	x	113.91		0.57	x	0.8	=	862.47	(79)
Southwest	0.9x	0.77	x	4.13	x	113.91		0.57	x	0.8	=	297.33	(79)
Southwest	0.9x	0.77	x	2.19	x	113.91		0.57	x	0.8	=	157.66	(79)
Southwest	0.9x	0.77	x	2.2	x	113.91		0.57	x	0.8	=	79.19	(79)
Southwest	0.9x	0.77	x	2.26	x	113.91		0.63	x	0.7	=	393.38	(79)
Southwest	0.9x	0.77	x	2.2	x	113.91		0.63	x	0.7	=	76.59	(79)
Southwest	0.9x	0.77	x	2.19	x	113.91		0.63	x	0.7	=	76.24	(79)
Southwest	0.9x	0.77	x	2.93	x	113.91		0.63	x	0.7	=	204	(79)
Southwest	0.9x	0.77	x	1.49	x	113.91		0.63	x	0.7	=	51.87	(79)
Southwest	0.9x	0.77	x	7.38	x	104.39		0.57	x	0.8	=	243.45	(79)
Southwest	0.9x	0.77	x	10.59	x	104.39		0.57	x	0.8	=	349.35	(79)
Southwest	0.9x	0.77	x	3.83	x	104.39		0.57	x	0.8	=	252.69	(79)
Southwest	0.9x	0.77	x	2.25	x	104.39		0.57	x	0.8	=	148.45	(79)
Southwest	0.9x	0.77	x	23.96	x	104.39		0.57	x	0.8	=	790.4	(79)
Southwest	0.9x	0.77	x	4.13	x	104.39		0.57	x	0.8	=	272.48	(79)
Southwest	0.9x	0.77	x	2.19	x	104.39		0.57	x	0.8	=	144.49	(79)
Southwest	0.9x	0.77	x	2.2	x	104.39		0.57	x	0.8	=	72.57	(79)
Southwest	0.9x	0.77	x	2.26	x	104.39		0.63	x	0.7	=	360.5	(79)
Southwest	0.9x	0.77	x	2.2	x	104.39		0.63	x	0.7	=	70.19	(79)
Southwest	0.9x	0.77	x	2.19	x	104.39		0.63	x	0.7	=	69.87	(79)
Southwest	0.9x	0.77	x	2.93	x	104.39		0.63	x	0.7	=	186.95	(79)
Southwest	0.9x	0.77	x	1.49	x	104.39		0.63	x	0.7	=	47.54	(79)
Southwest	0.9x	0.77	x	7.38	x	92.85		0.57	x	0.8	=	216.54	(79)
Southwest	0.9x	0.77	x	10.59	x	92.85		0.57	x	0.8	=	310.73	(79)
Southwest	0.9x	0.77	x	3.83	x	92.85		0.57	x	0.8	=	224.76	(79)
Southwest	0.9x	0.77	x	2.25	x	92.85		0.57	x	0.8	=	132.04	(79)
Southwest	0.9x	0.77	x	23.96	x	92.85		0.57	x	0.8	=	703.03	(79)
Southwest	0.9x	0.77	x	4.13	x	92.85		0.57	x	0.8	=	242.36	(79)
Southwest	0.9x	0.77	x	2.19	x	92.85		0.57	x	0.8	=	128.52	(79)
Southwest	0.9x	0.77	x	2.2	x	92.85		0.57	x	0.8	=	64.55	(79)
Southwest	0.9x	0.77	x	2.26	x	92.85		0.63	x	0.7	=	320.66	(79)

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Southwest	0.9x	0.77	x	2.2	x	92.85	x	0.63	x	0.7	=	62.43	(79)
Southwest	0.9x	0.77	x	2.19	x	92.85	x	0.63	x	0.7	=	62.15	(79)
Southwest	0.9x	0.77	x	2.93	x	92.85	x	0.63	x	0.7	=	166.29	(79)
Southwest	0.9x	0.77	x	1.49	x	92.85	x	0.63	x	0.7	=	42.28	(79)
Southwest	0.9x	0.77	x	7.38	x	69.27	x	0.57	x	0.8	=	161.54	(79)
Southwest	0.9x	0.77	x	10.59	x	69.27	x	0.57	x	0.8	=	231.81	(79)
Southwest	0.9x	0.77	x	3.83	x	69.27	x	0.57	x	0.8	=	167.67	(79)
Southwest	0.9x	0.77	x	2.25	x	69.27	x	0.57	x	0.8	=	98.5	(79)
Southwest	0.9x	0.77	x	23.96	x	69.27	x	0.57	x	0.8	=	524.46	(79)
Southwest	0.9x	0.77	x	4.13	x	69.27	x	0.57	x	0.8	=	180.8	(79)
Southwest	0.9x	0.77	x	2.19	x	69.27	x	0.57	x	0.8	=	95.87	(79)
Southwest	0.9x	0.77	x	2.2	x	69.27	x	0.57	x	0.8	=	48.16	(79)
Southwest	0.9x	0.77	x	2.26	x	69.27	x	0.63	x	0.7	=	239.21	(79)
Southwest	0.9x	0.77	x	2.2	x	69.27	x	0.63	x	0.7	=	46.57	(79)
Southwest	0.9x	0.77	x	2.19	x	69.27	x	0.63	x	0.7	=	46.36	(79)
Southwest	0.9x	0.77	x	2.93	x	69.27	x	0.63	x	0.7	=	124.05	(79)
Southwest	0.9x	0.77	x	1.49	x	69.27	x	0.63	x	0.7	=	31.54	(79)
Southwest	0.9x	0.77	x	7.38	x	44.07	x	0.57	x	0.8	=	102.78	(79)
Southwest	0.9x	0.77	x	10.59	x	44.07	x	0.57	x	0.8	=	147.48	(79)
Southwest	0.9x	0.77	x	3.83	x	44.07	x	0.57	x	0.8	=	106.68	(79)
Southwest	0.9x	0.77	x	2.25	x	44.07	x	0.57	x	0.8	=	62.67	(79)
Southwest	0.9x	0.77	x	23.96	x	44.07	x	0.57	x	0.8	=	333.68	(79)
Southwest	0.9x	0.77	x	4.13	x	44.07	x	0.57	x	0.8	=	115.03	(79)
Southwest	0.9x	0.77	x	2.19	x	44.07	x	0.57	x	0.8	=	61	(79)
Southwest	0.9x	0.77	x	2.2	x	44.07	x	0.57	x	0.8	=	30.64	(79)
Southwest	0.9x	0.77	x	2.26	x	44.07	x	0.63	x	0.7	=	152.19	(79)
Southwest	0.9x	0.77	x	2.2	x	44.07	x	0.63	x	0.7	=	29.63	(79)
Southwest	0.9x	0.77	x	2.19	x	44.07	x	0.63	x	0.7	=	29.5	(79)
Southwest	0.9x	0.77	x	2.93	x	44.07	x	0.63	x	0.7	=	78.93	(79)
Southwest	0.9x	0.77	x	1.49	x	44.07	x	0.63	x	0.7	=	20.07	(79)
Southwest	0.9x	0.77	x	7.38	x	31.49	x	0.57	x	0.8	=	73.43	(79)
Southwest	0.9x	0.77	x	10.59	x	31.49	x	0.57	x	0.8	=	105.37	(79)
Southwest	0.9x	0.77	x	3.83	x	31.49	x	0.57	x	0.8	=	76.22	(79)
Southwest	0.9x	0.77	x	2.25	x	31.49	x	0.57	x	0.8	=	44.78	(79)
Southwest	0.9x	0.77	x	23.96	x	31.49	x	0.57	x	0.8	=	238.41	(79)
Southwest	0.9x	0.77	x	4.13	x	31.49	x	0.57	x	0.8	=	82.19	(79)
Southwest	0.9x	0.77	x	2.19	x	31.49	x	0.57	x	0.8	=	43.58	(79)
Southwest	0.9x	0.77	x	2.2	x	31.49	x	0.57	x	0.8	=	21.89	(79)
Southwest	0.9x	0.77	x	2.26	x	31.49	x	0.63	x	0.7	=	108.74	(79)
Southwest	0.9x	0.77	x	2.2	x	31.49	x	0.63	x	0.7	=	21.17	(79)
Southwest	0.9x	0.77	x	2.19	x	31.49	x	0.63	x	0.7	=	21.07	(79)

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Southwest	0.9x	0.77	x	2.93	x	31.49		0.63	x	0.7	=	56.39	(79)
Southwest	0.9x	0.77	x	1.49	x	31.49		0.63	x	0.7	=	14.34	(79)
Northwest	0.9x	0.77	x	0.46	x	11.28	x	0.57	x	0.8	=	4.92	(81)
Northwest	0.9x	0.77	x	0.57	x	11.28	x	0.57	x	0.8	=	4.06	(81)
Northwest	0.9x	0.77	x	6.67	x	11.28	x	0.57	x	0.8	=	23.78	(81)
Northwest	0.9x	0.77	x	2.07	x	11.28	x	0.63	x	0.7	=	14.28	(81)
Northwest	0.9x	0.77	x	2.07	x	11.28	x	0.57	x	0.8	=	7.38	(81)
Northwest	0.9x	0.77	x	2.22	x	11.28	x	0.57	x	0.8	=	7.92	(81)
Northwest	0.9x	0.77	x	1.82	x	11.28	x	0.63	x	0.7	=	6.28	(81)
Northwest	0.9x	0.77	x	1.82	x	11.28	x	0.57	x	0.8	=	6.49	(81)
Northwest	0.9x	0.77	x	2.2	x	11.28	x	0.63	x	0.7	=	7.59	(81)
Northwest	0.9x	0.77	x	3.08	x	11.28	x	0.57	x	0.8	=	10.98	(81)
Northwest	0.9x	0.77	x	13.1	x	11.28	x	0.57	x	0.8	=	46.71	(81)
Northwest	0.9x	0.77	x	3.96	x	11.28	x	0.57	x	0.8	=	14.12	(81)
Northwest	0.9x	0.77	x	1.38	x	11.28	x	0.57	x	0.8	=	4.92	(81)
Northwest	0.9x	0.77	x	0.46	x	22.97	x	0.57	x	0.8	=	10.02	(81)
Northwest	0.9x	0.77	x	0.57	x	22.97	x	0.57	x	0.8	=	8.27	(81)
Northwest	0.9x	0.77	x	6.67	x	22.97	x	0.57	x	0.8	=	48.41	(81)
Northwest	0.9x	0.77	x	2.07	x	22.97	x	0.63	x	0.7	=	29.06	(81)
Northwest	0.9x	0.77	x	2.07	x	22.97	x	0.57	x	0.8	=	15.02	(81)
Northwest	0.9x	0.77	x	2.22	x	22.97	x	0.57	x	0.8	=	16.11	(81)
Northwest	0.9x	0.77	x	1.82	x	22.97	x	0.63	x	0.7	=	12.77	(81)
Northwest	0.9x	0.77	x	1.82	x	22.97	x	0.57	x	0.8	=	13.21	(81)
Northwest	0.9x	0.77	x	2.2	x	22.97	x	0.63	x	0.7	=	15.44	(81)
Northwest	0.9x	0.77	x	3.08	x	22.97	x	0.57	x	0.8	=	22.35	(81)
Northwest	0.9x	0.77	x	13.1	x	22.97	x	0.57	x	0.8	=	95.08	(81)
Northwest	0.9x	0.77	x	3.96	x	22.97	x	0.57	x	0.8	=	28.74	(81)
Northwest	0.9x	0.77	x	1.38	x	22.97	x	0.57	x	0.8	=	10.02	(81)
Northwest	0.9x	0.77	x	0.46	x	41.38	x	0.57	x	0.8	=	18.04	(81)
Northwest	0.9x	0.77	x	0.57	x	41.38	x	0.57	x	0.8	=	14.91	(81)
Northwest	0.9x	0.77	x	6.67	x	41.38	x	0.57	x	0.8	=	87.22	(81)
Northwest	0.9x	0.77	x	2.07	x	41.38	x	0.63	x	0.7	=	52.35	(81)
Northwest	0.9x	0.77	x	2.07	x	41.38	x	0.57	x	0.8	=	27.07	(81)
Northwest	0.9x	0.77	x	2.22	x	41.38	x	0.57	x	0.8	=	29.03	(81)
Northwest	0.9x	0.77	x	1.82	x	41.38	x	0.63	x	0.7	=	23.02	(81)
Northwest	0.9x	0.77	x	1.82	x	41.38	x	0.57	x	0.8	=	23.8	(81)
Northwest	0.9x	0.77	x	2.2	x	41.38	x	0.63	x	0.7	=	27.82	(81)
Northwest	0.9x	0.77	x	3.08	x	41.38	x	0.57	x	0.8	=	40.27	(81)
Northwest	0.9x	0.77	x	13.1	x	41.38	x	0.57	x	0.8	=	171.3	(81)
Northwest	0.9x	0.77	x	3.96	x	41.38	x	0.57	x	0.8	=	51.78	(81)
Northwest	0.9x	0.77	x	1.38	x	41.38	x	0.57	x	0.8	=	18.04	(81)

Northwest	0.9x	0.77	x	0.46	x	67.96	x	0.57	x	0.8	=	29.63	(81)
Northwest	0.9x	0.77	x	0.57	x	67.96	x	0.57	x	0.8	=	24.48	(81)
Northwest	0.9x	0.77	x	6.67	x	67.96	x	0.57	x	0.8	=	143.24	(81)
Northwest	0.9x	0.77	x	2.07	x	67.96	x	0.63	x	0.7	=	85.98	(81)
Northwest	0.9x	0.77	x	2.07	x	67.96	x	0.57	x	0.8	=	44.45	(81)
Northwest	0.9x	0.77	x	2.22	x	67.96	x	0.57	x	0.8	=	47.67	(81)
Northwest	0.9x	0.77	x	1.82	x	67.96	x	0.63	x	0.7	=	37.8	(81)
Northwest	0.9x	0.77	x	1.82	x	67.96	x	0.57	x	0.8	=	39.08	(81)
Northwest	0.9x	0.77	x	2.2	x	67.96	x	0.63	x	0.7	=	45.69	(81)
Northwest	0.9x	0.77	x	3.08	x	67.96	x	0.57	x	0.8	=	66.14	(81)
Northwest	0.9x	0.77	x	13.1	x	67.96	x	0.57	x	0.8	=	281.32	(81)
Northwest	0.9x	0.77	x	3.96	x	67.96	x	0.57	x	0.8	=	85.04	(81)
Northwest	0.9x	0.77	x	1.38	x	67.96	x	0.57	x	0.8	=	29.63	(81)
Northwest	0.9x	0.77	x	0.46	x	91.35	x	0.57	x	0.8	=	39.84	(81)
Northwest	0.9x	0.77	x	0.57	x	91.35	x	0.57	x	0.8	=	32.91	(81)
Northwest	0.9x	0.77	x	6.67	x	91.35	x	0.57	x	0.8	=	192.54	(81)
Northwest	0.9x	0.77	x	2.07	x	91.35	x	0.63	x	0.7	=	115.57	(81)
Northwest	0.9x	0.77	x	2.07	x	91.35	x	0.57	x	0.8	=	59.75	(81)
Northwest	0.9x	0.77	x	2.22	x	91.35	x	0.57	x	0.8	=	64.08	(81)
Northwest	0.9x	0.77	x	1.82	x	91.35	x	0.63	x	0.7	=	50.81	(81)
Northwest	0.9x	0.77	x	1.82	x	91.35	x	0.57	x	0.8	=	52.54	(81)
Northwest	0.9x	0.77	x	2.2	x	91.35	x	0.63	x	0.7	=	61.42	(81)
Northwest	0.9x	0.77	x	3.08	x	91.35	x	0.57	x	0.8	=	88.91	(81)
Northwest	0.9x	0.77	x	13.1	x	91.35	x	0.57	x	0.8	=	378.15	(81)
Northwest	0.9x	0.77	x	3.96	x	91.35	x	0.57	x	0.8	=	114.31	(81)
Northwest	0.9x	0.77	x	1.38	x	91.35	x	0.57	x	0.8	=	39.84	(81)
Northwest	0.9x	0.77	x	0.46	x	97.38	x	0.57	x	0.8	=	42.47	(81)
Northwest	0.9x	0.77	x	0.57	x	97.38	x	0.57	x	0.8	=	35.08	(81)
Northwest	0.9x	0.77	x	6.67	x	97.38	x	0.57	x	0.8	=	205.26	(81)
Northwest	0.9x	0.77	x	2.07	x	97.38	x	0.63	x	0.7	=	123.21	(81)
Northwest	0.9x	0.77	x	2.07	x	97.38	x	0.57	x	0.8	=	63.7	(81)
Northwest	0.9x	0.77	x	2.22	x	97.38	x	0.57	x	0.8	=	68.32	(81)
Northwest	0.9x	0.77	x	1.82	x	97.38	x	0.63	x	0.7	=	54.17	(81)
Northwest	0.9x	0.77	x	1.82	x	97.38	x	0.57	x	0.8	=	56.01	(81)
Northwest	0.9x	0.77	x	2.2	x	97.38	x	0.63	x	0.7	=	65.48	(81)
Northwest	0.9x	0.77	x	3.08	x	97.38	x	0.57	x	0.8	=	94.78	(81)
Northwest	0.9x	0.77	x	13.1	x	97.38	x	0.57	x	0.8	=	403.14	(81)
Northwest	0.9x	0.77	x	3.96	x	97.38	x	0.57	x	0.8	=	121.87	(81)
Northwest	0.9x	0.77	x	1.38	x	97.38	x	0.57	x	0.8	=	42.47	(81)
Northwest	0.9x	0.77	x	0.46	x	91.1	x	0.57	x	0.8	=	39.73	(81)
Northwest	0.9x	0.77	x	0.57	x	91.1	x	0.57	x	0.8	=	32.82	(81)

Northwest	0.9x	0.77	x	6.67	x	91.1	x	0.57	x	0.8	=	192.02	(81)
Northwest	0.9x	0.77	x	2.07	x	91.1	x	0.63	x	0.7	=	115.26	(81)
Northwest	0.9x	0.77	x	2.07	x	91.1	x	0.57	x	0.8	=	59.59	(81)
Northwest	0.9x	0.77	x	2.22	x	91.1	x	0.57	x	0.8	=	63.91	(81)
Northwest	0.9x	0.77	x	1.82	x	91.1	x	0.63	x	0.7	=	50.67	(81)
Northwest	0.9x	0.77	x	1.82	x	91.1	x	0.57	x	0.8	=	52.4	(81)
Northwest	0.9x	0.77	x	2.2	x	91.1	x	0.63	x	0.7	=	61.25	(81)
Northwest	0.9x	0.77	x	3.08	x	91.1	x	0.57	x	0.8	=	88.67	(81)
Northwest	0.9x	0.77	x	13.1	x	91.1	x	0.57	x	0.8	=	377.13	(81)
Northwest	0.9x	0.77	x	3.96	x	91.1	x	0.57	x	0.8	=	114	(81)
Northwest	0.9x	0.77	x	1.38	x	91.1	x	0.57	x	0.8	=	39.73	(81)
Northwest	0.9x	0.77	x	0.46	x	72.63	x	0.57	x	0.8	=	31.67	(81)
Northwest	0.9x	0.77	x	0.57	x	72.63	x	0.57	x	0.8	=	26.16	(81)
Northwest	0.9x	0.77	x	6.67	x	72.63	x	0.57	x	0.8	=	153.08	(81)
Northwest	0.9x	0.77	x	2.07	x	72.63	x	0.63	x	0.7	=	91.89	(81)
Northwest	0.9x	0.77	x	2.07	x	72.63	x	0.57	x	0.8	=	47.51	(81)
Northwest	0.9x	0.77	x	2.22	x	72.63	x	0.57	x	0.8	=	50.95	(81)
Northwest	0.9x	0.77	x	1.82	x	72.63	x	0.63	x	0.7	=	40.4	(81)
Northwest	0.9x	0.77	x	1.82	x	72.63	x	0.57	x	0.8	=	41.77	(81)
Northwest	0.9x	0.77	x	2.2	x	72.63	x	0.63	x	0.7	=	48.83	(81)
Northwest	0.9x	0.77	x	3.08	x	72.63	x	0.57	x	0.8	=	70.69	(81)
Northwest	0.9x	0.77	x	13.1	x	72.63	x	0.57	x	0.8	=	300.65	(81)
Northwest	0.9x	0.77	x	3.96	x	72.63	x	0.57	x	0.8	=	90.88	(81)
Northwest	0.9x	0.77	x	1.38	x	72.63	x	0.57	x	0.8	=	31.67	(81)
Northwest	0.9x	0.77	x	0.46	x	50.42	x	0.57	x	0.8	=	21.99	(81)
Northwest	0.9x	0.77	x	0.57	x	50.42	x	0.57	x	0.8	=	18.16	(81)
Northwest	0.9x	0.77	x	6.67	x	50.42	x	0.57	x	0.8	=	106.28	(81)
Northwest	0.9x	0.77	x	2.07	x	50.42	x	0.63	x	0.7	=	63.79	(81)
Northwest	0.9x	0.77	x	2.07	x	50.42	x	0.57	x	0.8	=	32.98	(81)
Northwest	0.9x	0.77	x	2.22	x	50.42	x	0.57	x	0.8	=	35.37	(81)
Northwest	0.9x	0.77	x	1.82	x	50.42	x	0.63	x	0.7	=	28.04	(81)
Northwest	0.9x	0.77	x	1.82	x	50.42	x	0.57	x	0.8	=	29	(81)
Northwest	0.9x	0.77	x	2.2	x	50.42	x	0.63	x	0.7	=	33.9	(81)
Northwest	0.9x	0.77	x	3.08	x	50.42	x	0.57	x	0.8	=	49.07	(81)
Northwest	0.9x	0.77	x	13.1	x	50.42	x	0.57	x	0.8	=	208.73	(81)
Northwest	0.9x	0.77	x	3.96	x	50.42	x	0.57	x	0.8	=	63.1	(81)
Northwest	0.9x	0.77	x	1.38	x	50.42	x	0.57	x	0.8	=	21.99	(81)
Northwest	0.9x	0.77	x	0.46	x	28.07	x	0.57	x	0.8	=	12.24	(81)
Northwest	0.9x	0.77	x	0.57	x	28.07	x	0.57	x	0.8	=	10.11	(81)
Northwest	0.9x	0.77	x	6.67	x	28.07	x	0.57	x	0.8	=	59.16	(81)
Northwest	0.9x	0.77	x	2.07	x	28.07	x	0.63	x	0.7	=	35.51	(81)

Northwest 0.9x	0.77	x	2.07	x	28.07	x	0.57	x	0.8	=	18.36	(81)
Northwest 0.9x	0.77	x	2.22	x	28.07	x	0.57	x	0.8	=	19.69	(81)
Northwest 0.9x	0.77	x	1.82	x	28.07	x	0.63	x	0.7	=	15.61	(81)
Northwest 0.9x	0.77	x	1.82	x	28.07	x	0.57	x	0.8	=	16.14	(81)
Northwest 0.9x	0.77	x	2.2	x	28.07	x	0.63	x	0.7	=	18.87	(81)
Northwest 0.9x	0.77	x	3.08	x	28.07	x	0.57	x	0.8	=	27.32	(81)
Northwest 0.9x	0.77	x	13.1	x	28.07	x	0.57	x	0.8	=	116.19	(81)
Northwest 0.9x	0.77	x	3.96	x	28.07	x	0.57	x	0.8	=	35.12	(81)
Northwest 0.9x	0.77	x	1.38	x	28.07	x	0.57	x	0.8	=	12.24	(81)
Northwest 0.9x	0.77	x	0.46	x	14.2	x	0.57	x	0.8	=	6.19	(81)
Northwest 0.9x	0.77	x	0.57	x	14.2	x	0.57	x	0.8	=	5.11	(81)
Northwest 0.9x	0.77	x	6.67	x	14.2	x	0.57	x	0.8	=	29.92	(81)
Northwest 0.9x	0.77	x	2.07	x	14.2	x	0.63	x	0.7	=	17.96	(81)
Northwest 0.9x	0.77	x	2.07	x	14.2	x	0.57	x	0.8	=	9.29	(81)
Northwest 0.9x	0.77	x	2.22	x	14.2	x	0.57	x	0.8	=	9.96	(81)
Northwest 0.9x	0.77	x	1.82	x	14.2	x	0.63	x	0.7	=	7.9	(81)
Northwest 0.9x	0.77	x	1.82	x	14.2	x	0.57	x	0.8	=	8.17	(81)
Northwest 0.9x	0.77	x	2.2	x	14.2	x	0.63	x	0.7	=	9.55	(81)
Northwest 0.9x	0.77	x	3.08	x	14.2	x	0.57	x	0.8	=	13.82	(81)
Northwest 0.9x	0.77	x	13.1	x	14.2	x	0.57	x	0.8	=	58.77	(81)
Northwest 0.9x	0.77	x	3.96	x	14.2	x	0.57	x	0.8	=	17.77	(81)
Northwest 0.9x	0.77	x	1.38	x	14.2	x	0.57	x	0.8	=	6.19	(81)
Northwest 0.9x	0.77	x	0.46	x	9.21	x	0.57	x	0.8	=	4.02	(81)
Northwest 0.9x	0.77	x	0.57	x	9.21	x	0.57	x	0.8	=	3.32	(81)
Northwest 0.9x	0.77	x	6.67	x	9.21	x	0.57	x	0.8	=	19.42	(81)
Northwest 0.9x	0.77	x	2.07	x	9.21	x	0.63	x	0.7	=	11.66	(81)
Northwest 0.9x	0.77	x	2.07	x	9.21	x	0.57	x	0.8	=	6.03	(81)
Northwest 0.9x	0.77	x	2.22	x	9.21	x	0.57	x	0.8	=	6.46	(81)
Northwest 0.9x	0.77	x	1.82	x	9.21	x	0.63	x	0.7	=	5.13	(81)
Northwest 0.9x	0.77	x	1.82	x	9.21	x	0.57	x	0.8	=	5.3	(81)
Northwest 0.9x	0.77	x	2.2	x	9.21	x	0.63	x	0.7	=	6.2	(81)
Northwest 0.9x	0.77	x	3.08	x	9.21	x	0.57	x	0.8	=	8.97	(81)
Northwest 0.9x	0.77	x	13.1	x	9.21	x	0.57	x	0.8	=	38.14	(81)
Northwest 0.9x	0.77	x	3.96	x	9.21	x	0.57	x	0.8	=	11.53	(81)
Northwest 0.9x	0.77	x	1.38	x	9.21	x	0.57	x	0.8	=	4.02	(81)
Rooflights 0.9x	1	x	4.47	x	26	x	0.63	x	0.7	=	46.15	(82)
Rooflights 0.9x	1	x	2.04	x	26	x	0.63	x	0.7	=	21.08	(82)
Rooflights 0.9x	1	x	5.52	x	26	x	0.63	x	0.7	=	170.89	(82)
Rooflights 0.9x	1	x	9.27	x	26	x	0.63	x	0.7	=	95.7	(82)
Rooflights 0.9x	1	x	7.7	x	26	x	0.63	x	0.7	=	79.42	(82)
Rooflights 0.9x	1	x	4.47	x	54	x	0.63	x	0.7	=	95.85	(82)

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Rooflights 0.9x	1	x	2.04	x	54	x	0.63	x	0.7	=	43.79	(82)
Rooflights 0.9x	1	x	5.52	x	54	x	0.63	x	0.7	=	354.92	(82)
Rooflights 0.9x	1	x	9.27	x	54	x	0.63	x	0.7	=	198.76	(82)
Rooflights 0.9x	1	x	7.7	x	54	x	0.63	x	0.7	=	164.95	(82)
Rooflights 0.9x	1	x	4.47	x	96	x	0.63	x	0.7	=	170.39	(82)
Rooflights 0.9x	1	x	2.04	x	96	x	0.63	x	0.7	=	77.84	(82)
Rooflights 0.9x	1	x	5.52	x	96	x	0.63	x	0.7	=	630.98	(82)
Rooflights 0.9x	1	x	9.27	x	96	x	0.63	x	0.7	=	353.35	(82)
Rooflights 0.9x	1	x	7.7	x	96	x	0.63	x	0.7	=	293.24	(82)
Rooflights 0.9x	1	x	4.47	x	150	x	0.63	x	0.7	=	266.24	(82)
Rooflights 0.9x	1	x	2.04	x	150	x	0.63	x	0.7	=	121.63	(82)
Rooflights 0.9x	1	x	5.52	x	150	x	0.63	x	0.7	=	985.9	(82)
Rooflights 0.9x	1	x	9.27	x	150	x	0.63	x	0.7	=	552.1	(82)
Rooflights 0.9x	1	x	7.7	x	150	x	0.63	x	0.7	=	458.18	(82)
Rooflights 0.9x	1	x	4.47	x	192	x	0.63	x	0.7	=	340.79	(82)
Rooflights 0.9x	1	x	2.04	x	192	x	0.63	x	0.7	=	155.69	(82)
Rooflights 0.9x	1	x	5.52	x	192	x	0.63	x	0.7	=	1261.95	(82)
Rooflights 0.9x	1	x	9.27	x	192	x	0.63	x	0.7	=	706.69	(82)
Rooflights 0.9x	1	x	7.7	x	192	x	0.63	x	0.7	=	586.47	(82)
Rooflights 0.9x	1	x	4.47	x	200	x	0.63	x	0.7	=	354.99	(82)
Rooflights 0.9x	1	x	2.04	x	200	x	0.63	x	0.7	=	162.17	(82)
Rooflights 0.9x	1	x	5.52	x	200	x	0.63	x	0.7	=	1314.53	(82)
Rooflights 0.9x	1	x	9.27	x	200	x	0.63	x	0.7	=	736.14	(82)
Rooflights 0.9x	1	x	7.7	x	200	x	0.63	x	0.7	=	610.91	(82)
Rooflights 0.9x	1	x	4.47	x	189	x	0.63	x	0.7	=	335.46	(82)
Rooflights 0.9x	1	x	2.04	x	189	x	0.63	x	0.7	=	153.25	(82)
Rooflights 0.9x	1	x	5.52	x	189	x	0.63	x	0.7	=	1242.23	(82)
Rooflights 0.9x	1	x	9.27	x	189	x	0.63	x	0.7	=	695.65	(82)
Rooflights 0.9x	1	x	7.7	x	189	x	0.63	x	0.7	=	577.31	(82)
Rooflights 0.9x	1	x	4.47	x	157	x	0.63	x	0.7	=	278.67	(82)
Rooflights 0.9x	1	x	2.04	x	157	x	0.63	x	0.7	=	127.31	(82)
Rooflights 0.9x	1	x	5.52	x	157	x	0.63	x	0.7	=	1031.91	(82)
Rooflights 0.9x	1	x	9.27	x	157	x	0.63	x	0.7	=	577.87	(82)
Rooflights 0.9x	1	x	7.7	x	157	x	0.63	x	0.7	=	479.56	(82)
Rooflights 0.9x	1	x	4.47	x	115	x	0.63	x	0.7	=	204.12	(82)
Rooflights 0.9x	1	x	2.04	x	115	x	0.63	x	0.7	=	93.25	(82)
Rooflights 0.9x	1	x	5.52	x	115	x	0.63	x	0.7	=	755.86	(82)
Rooflights 0.9x	1	x	9.27	x	115	x	0.63	x	0.7	=	423.28	(82)
Rooflights 0.9x	1	x	7.7	x	115	x	0.63	x	0.7	=	351.27	(82)
Rooflights 0.9x	1	x	4.47	x	66	x	0.63	x	0.7	=	117.15	(82)
Rooflights 0.9x	1	x	2.04	x	66	x	0.63	x	0.7	=	53.52	(82)

Rooflights 0.9x	1	x	5.52	x	66	x	0.63	x	0.7	=	433.8	(82)
Rooflights 0.9x	1	x	9.27	x	66	x	0.63	x	0.7	=	242.93	(82)
Rooflights 0.9x	1	x	7.7	x	66	x	0.63	x	0.7	=	201.6	(82)
Rooflights 0.9x	1	x	4.47	x	33	x	0.63	x	0.7	=	58.57	(82)
Rooflights 0.9x	1	x	2.04	x	33	x	0.63	x	0.7	=	26.76	(82)
Rooflights 0.9x	1	x	5.52	x	33	x	0.63	x	0.7	=	216.9	(82)
Rooflights 0.9x	1	x	9.27	x	33	x	0.63	x	0.7	=	121.46	(82)
Rooflights 0.9x	1	x	7.7	x	33	x	0.63	x	0.7	=	100.8	(82)
Rooflights 0.9x	1	x	4.47	x	21	x	0.63	x	0.7	=	37.27	(82)
Rooflights 0.9x	1	x	2.04	x	21	x	0.63	x	0.7	=	17.03	(82)
Rooflights 0.9x	1	x	5.52	x	21	x	0.63	x	0.7	=	138.03	(82)
Rooflights 0.9x	1	x	9.27	x	21	x	0.63	x	0.7	=	77.29	(82)
Rooflights 0.9x	1	x	7.7	x	21	x	0.63	x	0.7	=	64.15	(82)

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

(83)m=	1819.11	3356.68	5219.66	7422.57	9116.52	9385.16	8910.42	7607.74	5982.83	3884.53	2227.29	1524.69	(83)

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

(84)m=	3830.15	5355.69	7140.02	9218.06	10777.34	10930.81	10392.61	9107.5	7557.94	5584.82	4066.72	3475.92	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	1	1	0.99	0.98	0.94	0.86	0.75	0.81	0.95	0.99	1	1	(86)

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

(87)m=	18.82	19	19.32	19.8	20.24	20.62	20.78	20.74	20.42	19.85	19.28	18.84	(87)

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

(88)m=	19.09	19.1	19.11	19.17	19.18	19.24	19.24	19.25	19.21	19.18	19.15	19.13	(88)

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

(89)m=	1	1	0.99	0.97	0.9	0.75	0.53	0.62	0.9	0.99	1	1	(89)

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

(90)m=	16.28	16.55	17.03	17.76	18.39	18.91	19.07	19.05	18.67	17.84	17	16.34	(90)

fLA = Living area ÷ (4) = 0.03 (91)

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

(92)m=	16.37	16.63	17.1	17.83	18.45	18.96	19.12	19.11	18.72	17.9	17.07	16.42	(92)

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

(93)m=	16.37	16.63	17.1	17.83	18.45	18.96	19.12	19.11	18.72	17.9	17.07	16.42	(93)

8. Space heating requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, hm:													
(94)m=	1	0.99	0.99	0.96	0.88	0.73	0.52	0.6	0.87	0.98	1	1	(94)

Useful gains, hmGm , W = (94)m x (84)m

(95)m=	3822.85	5327.92	7035.09	8810.84	9498.28	7937.05	5357.88	5454.92	6592.3	5469.37	4051.77	3471.27	(95)

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Monthly average external temperature from Table 8

(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)

Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]

(97)m=	30820.64	29727.08	26669.26	21588.43	16190.22	10041.38	5806.47	6178.62	10814.06	17514.96	24309.79	30255.35	(97)

Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m

(98)m=	20086.35	16396.24	14607.82	9199.86	4978.8	0	0	0	0	8961.91	14585.78	19927.36	

Total per year (kWh/year) = Sum(98)$_{1,\ldots,12}$ = 108744.13 (98)

Space heating requirement in kWh/m²/year 101.59 (99)

8c. Space cooling requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat loss rate Lm (calculated using 25°C internal temperature and external temperature from Table 10)													
(100)m=	0	0	0	0	0	21628.3	17026.53	17338.46	0	0	0	0	(100)
Utilisation factor for loss hm													
(101)m=	0	0	0	0	0	0.51	0.59	0.53	0	0	0	0	(101)
Useful loss, hmLm (Watts) = (100)m x (101)m													
(102)m=	0	0	0	0	0	11086.13	10094.24	9167.25	0	0	0	0	(102)
Gains (solar gains calculated for applicable weather region, see Table 10)													
(103)m=	0	0	0	0	0	11997.98	11407.72	9984.3	0	0	0	0	(103)

Space cooling requirement for month, whole dwelling, continuous (kWh) = 0.024 x [(103)m – (102)m] x (41)m
set (104)m to zero if (104)m < 3 × (98)m

(104)m=	0	0	0	0	0	656.53	977.23	0	0	0	0	0	

Total = Sum(104) = 1633.76 (104)

Cooled fraction f C = cooled area ÷ (4) = 0.65 (105)

Intermittency factor (Table 10b)

(106)m=	0	0	0	0	0	0.25	0.25	0.25	0	0	0	0	

Total = Sum(104) = 0 (106)

Space cooling requirement for month = (104)m × (105) × (106)m

(107)m=	0	0	0	0	0	107.34	159.77	0	0	0	0	0	

Total = Sum(107) = 267.1 (107)

Space cooling requirement in kWh/m²/year (107) ÷ (4) = 0.25 (108)

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

Space heating:

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

Fraction of space heat from main system(s) (202) = 1 – (201) = 1 (202)

Fraction of total heating from main system 1 (204) = (202) × [1 – (203)] = 1 (204)

Efficiency of main space heating system 1 319.7 (206)

Efficiency of secondary/supplementary heating system, % 0 (208)

Cooling System Energy Efficiency Ratio 8.1 (209)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year
Space heating requirement (calculated above)													
	20086.35	16396.24	14607.82	9199.86	4978.8	0	0	0	0	8961.91	14585.78	19927.36	

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(211)m = {[(98)m x (204)] } x 100 ÷ (206) (211)

6282.88	5128.63	4569.23	2877.66	1557.34	0	0	0	0	2803.23	4562.33	6233.14

Total (kWh/year) =Sum(211)$_{1,\ldots,12}$= 34014.43 (211)

Space heating fuel (secondary), kWh/month
= {[(98)m x (201)] } x 100 ÷ (208)

(215)m=	0	0	0	0	0	0	0	0	0	0	0	0

Total (kWh/year) =Sum(215)$_{1,\ldots,12}$= 0 (215)

Water heating

Output from water heater (calculated above)

339.63	300.59	318.58	289.61	286.73	260.39	254.06	273.29	271.09	300.12	312.28	332.82

Efficiency of water heater 224.4 (216)

(217)m=	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4	224.4

(217)

Fuel for water heating, kWh/month
(219)m = (64)m x 100 ÷ (217)m

(219)m=	151.35	133.95	141.97	129.06	127.77	116.04	113.22	121.79	120.81	133.74	139.16	148.32

Total = Sum(219a)$_{1,\ldots,12}$ = 1577.18 (219)

Space cooling fuel, kWh/month.
(221)m = (107)m÷ (209)

(221)m=	0	0	0	0	0	13.25	19.72	0	0	0	0	0

Total = Sum(221)$_{5,\ldots,9}$ = 32.98 (221)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			34014.43	
Water heating fuel used			1577.18	
Space cooling fuel used			32.98	
Electricity for pumps, fans and electric keep-hot				
mechanical ventilation - balanced, extract or positive input from outside		6787.31		(230a)
central heating pump:		30		(230c)
Total electricity for the above, kWh/year	sum of (230a)...(230g) =		6817.31	(231)
Electricity for lighting			1497.73	(232)
Electricity generated by PVs			-4819.18	(233)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year		**Fuel Price** (Table 12)		**Fuel Cost** £/year	
Space heating - main system 1	(211)	x	13.19	x 0.01 =	4486.5	(240)
Space heating - main system 2	(213)	x	0	x 0.01 =	0	(241)
Space heating - secondary	(215)	x	13.19	x 0.01 =	0	(242)
Water heating cost (other fuel)	(219)		13.19	x 0.01 =	208.03	(247)
Space cooling	(221)		13.19	x 0.01 =	4.35	(248)
Pumps, fans and electric keep-hot	(231)		13.19	x 0.01 =	899.2	(249)
(if off-peak tariff, list each of (230a) to (230g) separately as applicable and apply fuel price according to Table 12a						
Energy for lighting	(232)		13.19	x 0.01 =	197.55	(250)

SAP WorkSheet: New dwelling design stage

Additional standing charges (Table 12)				0	(251)
	one of (233) to (235) x)	13.19	x 0.01 =	-635.65	(252)
Appendix Q items: repeat lines (253) and (254) as needed					
Total energy cost	(245)...(247) + (250)...(254) =			5159.99	(255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)				0.42	(256)
Energy cost factor (ECF)	[(255) x (256)] + [(4) + 45.0] =			1.94	(257)
SAP rating (Section 12)				72.9	(258)

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

	Energy kWh/year		Emission factor kg CO2/kWh		Emissions kg CO2/year	
Space heating (main system 1)	(211) x		0.519	=	17653.49	(261)
Space heating (secondary)	(215) x		0.519	=	0	(263)
Water heating	(219) x		0.519	=	818.55	(264)
Space and water heating	(261) + (262) + (263) + (264) =				18472.04	(265)
Space cooling	(221) x		0.519	=	17.11	(266)
Electricity for pumps, fans and electric keep-hot	(231) x		0.519	=	3538.18	(267)
Electricity for lighting	(232) x		0.519	=	777.32	(268)
Energy saving/generation technologies Item 1			0.519	=	-2501.16	(269)
Total CO2, kg/year		sum of (265)...(271) =			20303.51	(272)
CO2 emissions per m²		(272) ÷ (4) =			18.97	(273)
EI rating (section 14)					76	(274)

13a. Primary Energy

	Energy kWh/year		Primary factor		P. Energy kWh/year	
Space heating (main system 1)	(211) x		3.07	=	104424.3	(261)
Space heating (secondary)	(215) x		3.07	=	0	(263)
Energy for water heating	(219) x		3.07	=	4841.93	(264)
Space and water heating	(261) + (262) + (263) + (264) =				109266.23	(265)
Space cooling	(221) x		3.07	=	101.24	(266)
Electricity for pumps, fans and electric keep-hot	(231) x		3.07	=	20929.13	(267)
Electricity for lighting	(232) x		0	=	4598.03	(268)
Energy saving/generation technologies Item 1			3.07	=	-14794.89	(269)
'Total Primary Energy		sum of (265)...(271) =			120099.74	(272)

SAP WorkSheet: New dwelling design stage

Primary energy kWh/m²/year	(272) ÷ (4) =	112.2	(273)

APPENDIX (iii)

PEA – PREDICTED ENERGY ASSESSMENT (PRE-EPC)

Predicted Energy Assessment

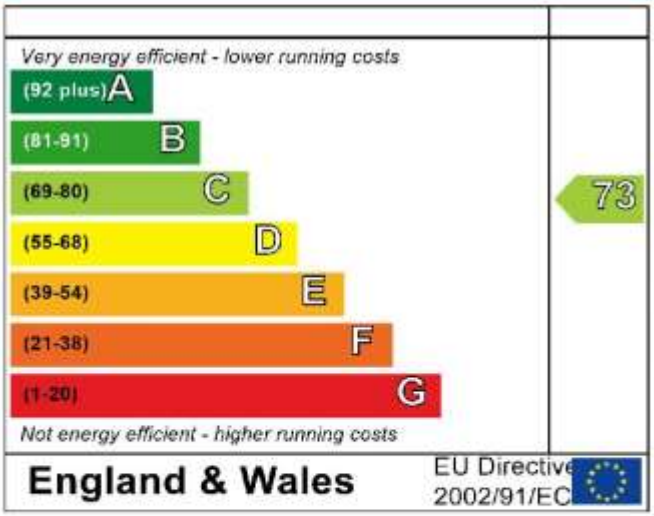
7 Greenaway Gardens
LONDON
NW3 7DJ

Dwelling type: Detached House
Date of assessment: 16 December 2020
Produced by: Ondrej Gajdos
Total floor area: 1070.4 m²

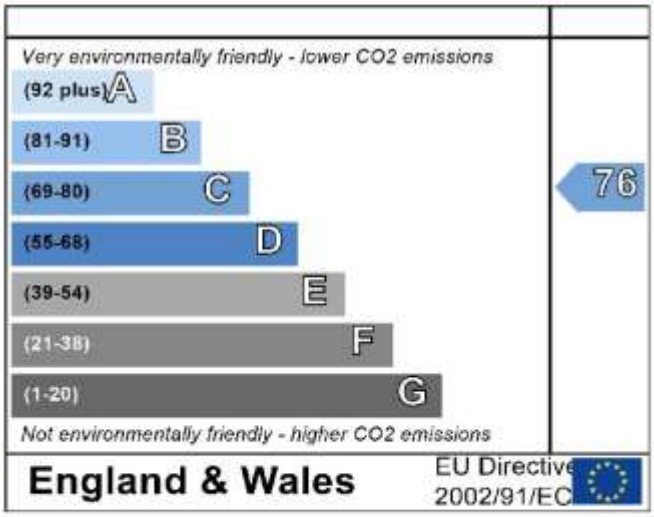
This is a Predicted Energy Assessment for a property which is not yet complete. It includes a predicted energy rating which might not represent the final energy rating of the property on completion. Once the property is completed, an Energy Performance Certificate is required providing information about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

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

Energy Efficiency Rating



Environmental Impact (CO_2) Rating

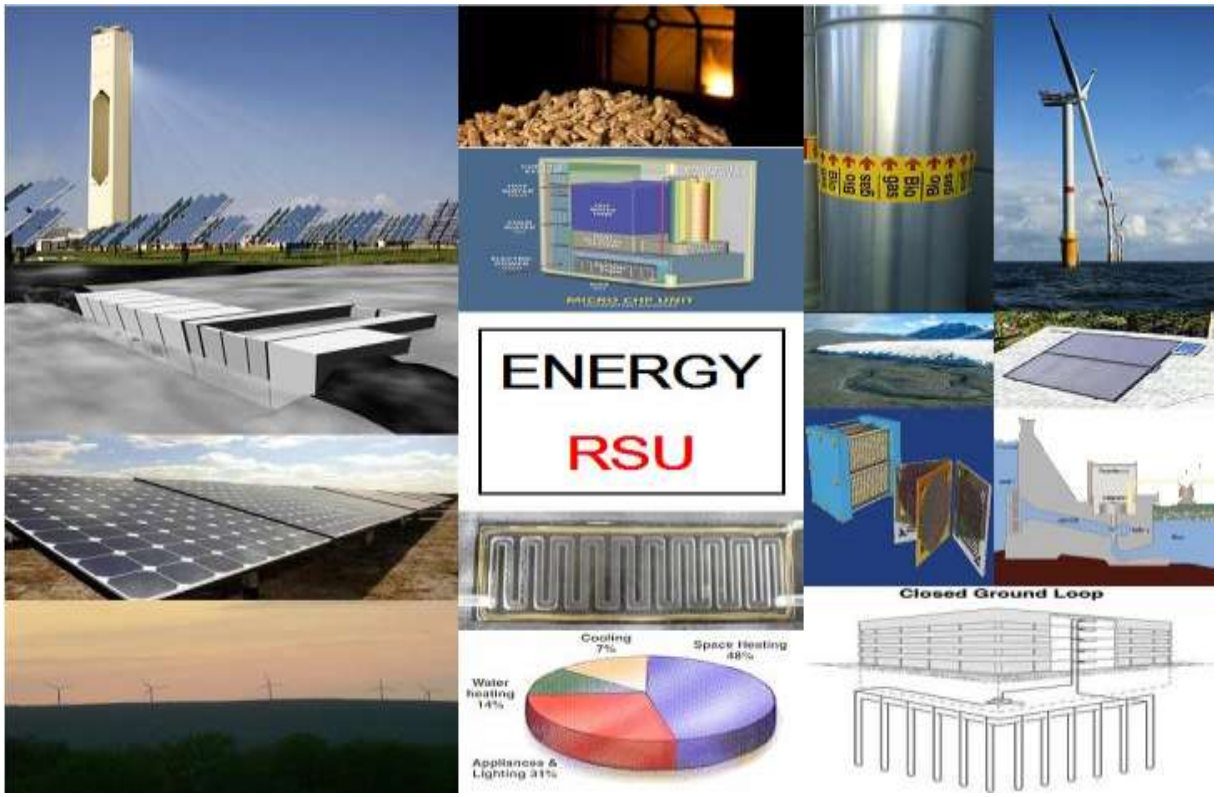


The energy efficiency rating is a measure of the overall efficiency of a home. The higher the rating the more energy efficient the home is and the lower the fuel bills are likely to be.

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

APPENDIX (iv)

ENERGY RSU –



RENEWABLES & SUSTAINABILITY UNIT

ENERGY RSU is an integrated energy sustainability unit able to provide the following:

- SAP Calculations & Certificates - L1A&B New/Existing Buildings (NHER certified)
- SBEM Calculations & Certificates - L2A&B New/Existing Buildings (BRE certified)
- EPC & DEC Certificates – New Build (CIBSE certified)
- Rd SAP Survey EPC Certificates – Existing Buildings (NHER certified)
- Commercial EPC Survey certificates – Existing Buildings (BRE certified) - Level 3, 4 & 5
- Energy Statements & Renewable Reports for Planning
- LEED/ BREEAM assessments (USGBC/BRE certified)
- Low/Zero Carbon (LZC) and Sustainability Appraisals/designs (CIBSE Low Carbon Consultant)
- Renewable Energy Appraisals and Designs
- Carbon Rating assessments
- 2D/3D CFD and Dynamic Thermal Simulations
- EPBD Air Conditioning Inspections (Article 20) and EPBD Asset Ratings & Certificates
- Energy Usage (Running Costs)
- Utility/ Bill Analysis and Recommendations
- Advice on Green and Environmental Issues Relating to M&E Building Services
- Code for Sustainable Homes New Build and Domestic Refurbishment (BRE certified)
- Solar Shading/Sun Studies

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