ME7

28 AVENUE ROAD,
ST JOHNS WOOD, LONDON NW8

ENERGY AND SUSTAINABILITY STATEMENT

JB/682: March 2021

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28 AVENUE ROAD,
ST JOHNS WOOD, LONDON NW8

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INTRODUCTION
Our client is applying for planning permission to construct a new family home and as part of the process; he is taking the opportunity to significantly enhance its sustainability; including the potential for renewable technologies. 28 Avenue Road is proposed is to be constructed as a sustainable low carbon house, finished to a high quality and standard.

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 (SAP 2012) 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 Adopted London Plan requirements and Camden Energy efficiency and adaption policies requirements.

Key points/measures proposed:

- A CO_2 reduction of 53% (Cumulative), for the site over the baseline; confirming that the proposed refurbished dwelling exceeds the requirements of the Camden Energy efficiency and adaption 2019, The Adopted London Plan 2016 and the National Planning Policy Framework.
- 17.094 tonnes of CO2 saving per annum for the site over the baseline.
- Zero NOx emissions for the GSHP system and low NOx emissions from efficient backup heating plant, complying with the Adopted 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.
- Fully insulating/ providing double glazed windows to the new elements – low U values.
- Air tightness of 4.0m3/m2/hr@50Pa.
- Heat recovery ventilation to the lower ground floor (lower) area – 80% efficiency.
- New materials to be responsibly sourced and life cycle reviewed.
- Inclusion of a renewable energy system (GSHP) and a renewable energy system (PV).
- 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 B (87) and a CO2 impact rating of Grade B (87).

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 GSHP system (COP 5.08), will be suitable for providing 90% of the yearly heating demand. With gas boilers for providing heating and domestic hot water production top up and backup 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.

Heat gains have been reduced with passive measures; building orientation, tree shading, concrete slabs/ brick facades, internal blinds, high performance glazing and passive/ MVHR ventilation. Where cooling is proposed, this is only to some parts of the house and only at peak times. This will be provided by a renewable source, a vertical borehole GSHP system based on high efficiency water cooled condensors with a high efficiency EER of 5.84 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 Adopted London Plan 2016, the National Planning Policy Framework, Camden Energy efficiency and adaption 2019 and Building Regulations.

Section 1.0

RENEWABLE
ENERGY STATEMENT

ME7 Ltd
Jorand House
Bebington Close
Billericay
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Assessment information

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Date:
08 March 2021

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 construction of a new house at 28 Avenue Road; a duty of care is not owed to other parties.

Executive Summary

About the energy statement

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.

Baseline and all estimated energy consumptions have been calculated using full SAP 2012 assessment of the development in accordance with Part L procedures and SAP 10 emission factors in line with the latest GLA planning guidance.

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	32.6	4.6
After energy demand reduction	32.5	4.6
After renewable energy	15.4	4.6

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

	Regulated domestic carbon dioxide savings	
	(Tonnes CO_2 per annum)	(%)
Savings from energy demand reduction	0.040	0.1%
Savings from renewable energy	17.094	52%
Cumulative on site savings	**17.140**	**53%**

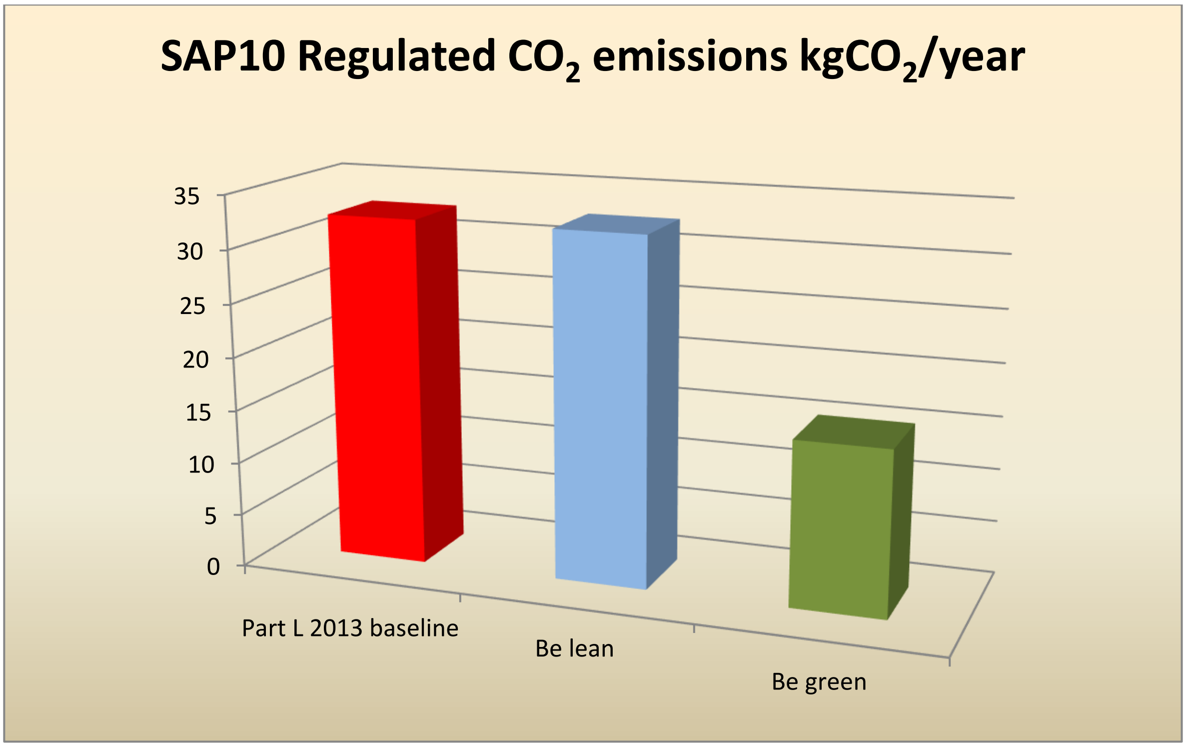


Table 3: SAP calculation specification for each stage of the energy hierarchy

Specification	Notional Baseline	Efficient Baseline (Be Lean)	Proposed Development (Be Green)
External Wall U-value	0.18	0.18	0.18
Ground floor	0.13	0.12	0.12
Roof U-value	0.13	0.12	0.12
Windows U-value	1.50	1.30	1.30
Thermal bridging	Accredited construction details throughout	Accredited construction details throughout, lintels with psi-value of 0.05 W/mK (e.g. Keystone Hi Therm lintels or similar)	Accredited construction details throughout, lintels with psi-value of 0.05 W/mK (e.g. Keystone Hi Therm lintels or similar)
Air Permeability	5	4	4
Main Heating System	Condensing gas boiler, SEDBUK 2009 efficiency 88%, underfloor heating, programmer and at least 2 room thermostats	High efficiency gas condensing boiler (e.g. Remeha Quinta Pro or equivalent), underfloor heating, time and temperature zone control, delayed start thermostat	GSHP with wet underfloor heating, assumed to provide 90% of heat demand, backed up by gas boiler (10% of demand)
Secondary heating		Gas fires with 80% efficiency	Gas fires with 80% efficiency
DHW System	Condensing gas boiler, SEDBUK 2009 efficiency 88%,	2No 1,000L Heatrae Sadia Megaflo commercial, fed from the main heating system	2No 1,000L Heatrae Sadia Megaflo commercial, fed from the main heating system
Cooling system	-	GSHP system with seasonal cooling SEER of 5.0 or higher	GSHP system with seasonal cooling SEER of 5.0 or higher
Ventilation System	Natural with intermittent mechanical extracts	Natural with intermittent mechanical extracts	Natural with intermittent mechanical extracts
Energy Efficient Lighting	75%	100%	100%
Renewable energy sources			PV system with total peak output of 4.4kWp, e.g. 11 No PV panels Sunpower Maxeon 400, installed horizontally on the flat roof
% Improvement in CO2 over Building regulations compliant baseline	**0.0%**	**0.1%**	**53%**

The proposed house will achieve:

- 52% reduction in regulated CO2 emissions by renewable sources (PV system and GSHP)
- 53% reduction in regulated CO2 emissions compared to 2013 Part L1A notional baseline

All CO2 reductions are calculated using SAP10 emission factors

Energy consumption of the proposed house

									SAP10 CO2 PERFORMANCE	
DOMESTIC ENERGY CONSUMPTION AND CO_2 ANALYSIS										
Unit identifier (e.g. plot number, dwelling type etc.)	Model total floor area (m²)	REGULATED ENERGY CONSUMPTION PER UNIT (kWh p.a.) - 'BE GREEN' SAP DER WORKSHEET							REGULATED CO2 EMISSIONS PER UNIT	
		Space Heating (Heat Source 1)	Domestic Hot Water (Heat Source 1)	Space Heating (Heat source 2)	Electricity generated by renewable (-)	Lighting	Auxiliary	Cooling	SAP10 CO2 emissions (kgCO2 p.a.)	Calculated DER SAP10 (kgCO2 / m2)
28 Avenue Road	*2525.6*	*34679*	*5142*	*30312*	*-3346*	*2871*	*105*	*24*	**15,445**	**6.1**

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 development

Construction of a new 11-bedroom house arranged over basement, ground, 1st and 2nd floor.

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.

BUILDING REGULATIONS 2013 PART L1A

Part L1A sets out 3 main criteria for energy efficiency in newly constructed dwellings:

- CO_2 emissions from the proposed dwellings, i.e. Dwelling Emission Rate (DER) has to be lower than the Target Emission Rate (TER)
- Dwelling Fabric Energy Efficiency has to be lower than the Target Fabric Energy Efficiency
- Risk of overheating has to be assessed using SAP appendix P

THE ADOPTED LONDON PLAN

The Adopted London Plan is the name given to the Mayor's spatial development strategy. The current version of the Adopted London Plan was published in 2011 with Further Alterations to the Adopted London Plan published in March 2016. The aim is to develop London as an exemplary sustainable world city, based on three interwoven themes.

1. Strong, diverse long term economic growth
2. Social inclusivity to give all Londoners the opportunity to share in London's future success
3. 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 CO_2 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

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)

ZERO CARBON POLICY

As outlined in the Housing SPG, from 1 October 2016 the Mayor applies a zero carbon standard to new residential development. The Housing SPG defines 'Zero carbon' homes as homes forming part of major development applications where the residential element of the application achieves 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). This payment is currently fixed (in most boroughs) at £60/tonne of CO_2 per year for 30 years.

As the proposed development comprises less than 10 newly constructed dwellings, it is not considered a major development in accordance with the Adopted London Plan definitions. The zero carbon policy, policies 5.2, 5.6 and 5.7 are therefore not applicable.

Baseline Energy Consumption & CO2 Emissions

Energy assessment using SAP 2012 has been carried out on the actual proposed dwellings using notional baseline specification achieving compliance with 2013 Part L. The specification is set out in Table 3 above.
The notional baseline is based on 2013 Part L1A notional building for calculating Target Emission Rate (TER)

						SAP10 CO2 PERFORMANCE	
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 CO2 EMISSIONS PER UNIT	
		Space Heating	Domestic Hot Water	Lighting	Auxiliary	SAP10 CO2 emissions (kgCO2 p.a.)	Calculated TER SAP10 (kgCO2 / m2)
28 Avenue Road	*2525.6*	*146768*	*5129*	*2871*	*75*	**32,585**	**12.9**

Be Lean: Passive 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, including:

- Newly constructed elements with U-values going beyond the building regs requirement
- High efficiency condensing boiler
- 100% low energy lights

Full specification of the efficient baseline is described in Table 3.

							SAP10 CO2 PERFORMANCE	
DOMESTIC ENERGY CONSUMPTION AND CO_2 ANALYSIS								
Unit identifier (e.g. plot number, dwelling type etc.)	Model total floor area (m²)	REGULATED ENERGY CONSUMPTION PER UNIT (kWh p.a.) - 'BE LEAN' SAP DER WORKSHEET					REGULATED CO2 EMISSIONS PER UNIT	
		Space Heating	Domestic Hot Water	Lighting	Auxiliary	Cooling	SAP10 CO2 emissions (kgCO2 p.a.)	Calculated DER SAP10 (kgCO2 / m2)
28 Avenue Road	*2525.6*	*146623*	*5055.05*	*2871.02*	*75*	*24.0*	**32,544**	**12.9**

Overheating and Cooling

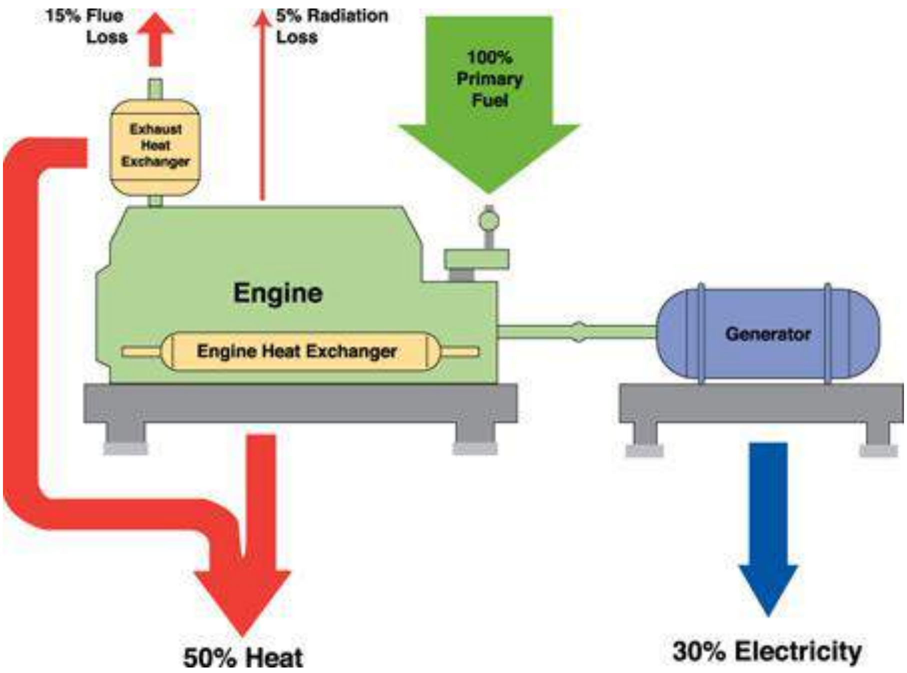
The house has also been assessed against overheating criteria set out in SAP Appendix P.

The house complies with the criteria using passive measures - openable windows. Mechanical cooling is also proposed for the development.

BE LEAN: 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

Due to significant de-carbonisation of the grid electricity in the recent years and further decarbonisation expected in near future, gas CHP is no longer beneficial in terms of CO2 reduction. It is therefore not proposed for the development.

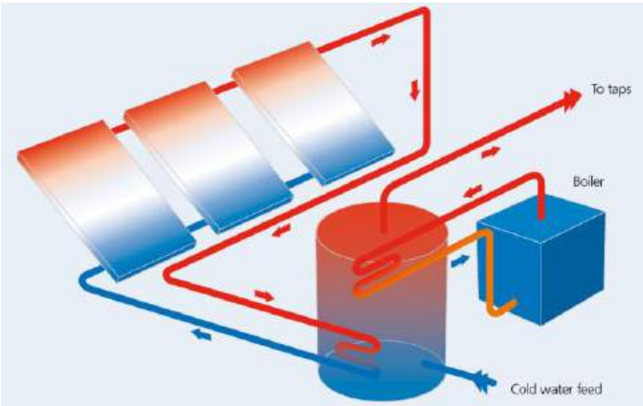
Be Green: On-site Renewable Energy Source – Solar Hot Water (SHW)

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

Solar hot water system has been ruled out due to relatively low hot water demand compared to space heating and lower CO2 reduction potential compared to solar photovoltaic.

BE GREEN: ON-SITE RENEWABLE ENERGY SOURCE – AIR SOURCE HEAT PUMP (ASHP)

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 considered, however have been ruled out due to lower efficiency compared to ground source heat pump, as well as potential problems with noise from the outdoor unit.

BE GREEN: ON-SITE RENEWABLE ENERGY SOURCE – SOLAR PHOTOVOLTAICS (PV)

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 5 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 15° and 35° inclination.

RECOMMENDATIONS SPECIFIC TO THIS DEVELOPMENT

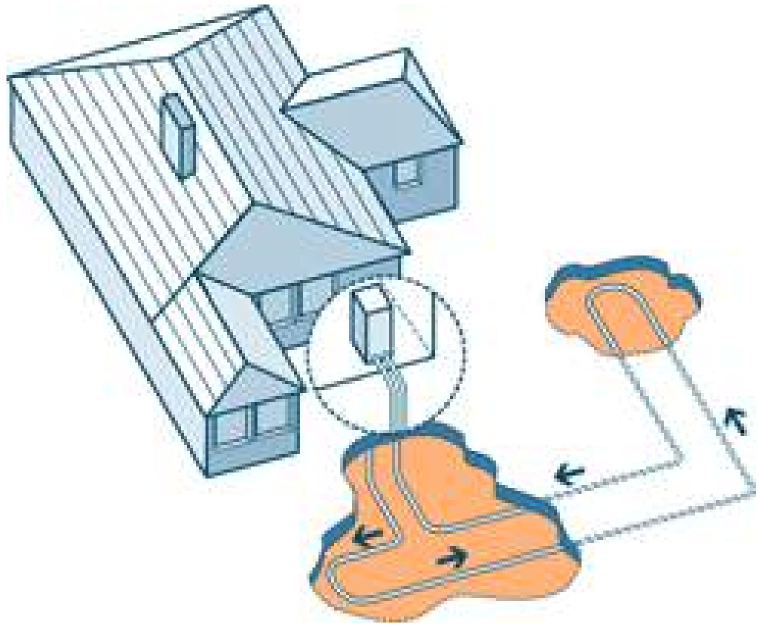
It is proposed to install a PV system with a total peak output of 4.4 kWp with horizontally mounted PV panels on the inner roof slopes. An example of this system would be 11 No PV panels Sunpower Maxeon 400.

BE GREEN: ON-SITE RENEWABLE ENERGY SOURCE – GROUND SOURCE HEAT PUMP (GSHP)

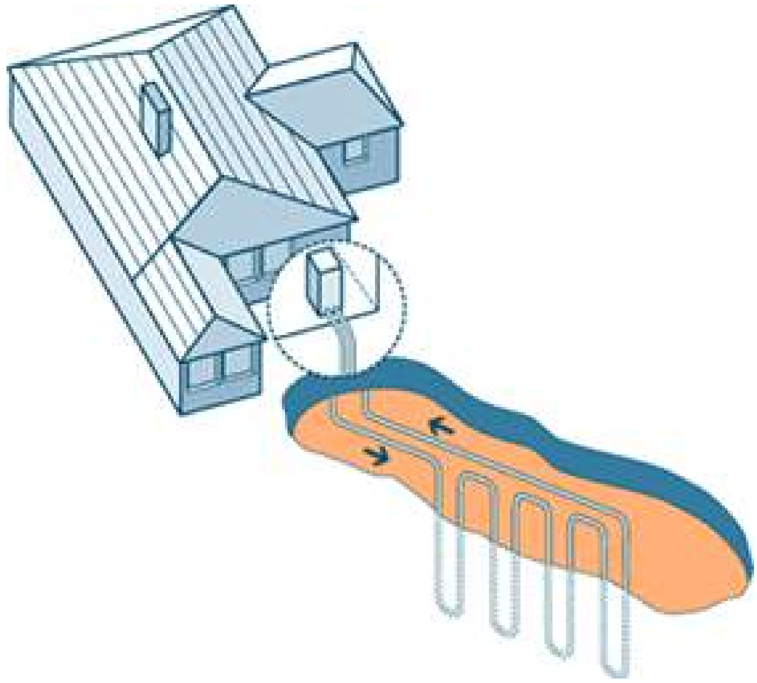
GENERAL INFORMATION

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 a closed loop vertical borehole ground source heat pump system which will serve as the main heating system through wet underfloor heating, as well as a part cooling source. It will be backed up by high efficiency gas fired boilers for the heating systems.

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 CO_2 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.

WATER

Internal Water consumption will be reduced by specification of water efficient fittings. The water consumption will be reduced to 105 litres per person per day or less by specifying water fittings with the following parameters:

WC's: All dual flush capacity 3/6 Litres or less
Kitchen taps flow aret: 6 l/min or less
Bathroom taps flow rate: 5 l/min or less
Bath capacity to overflow: 140 l or less
Showers flow rate: 9 l/min or less
Dishwasher consumption: 0.5 Litres per place setting or less
Washing machine consumption: 5.5 litres per kg dry load or less

MATERIALS

Environmental impact of construction materials will be taken into account. Where possible, construction materials will be sourced from local producers and suppliers with environmental impact certification. All timber will be FSC (or equivalent) certified.

ENERGY

Besides the energy efficiency measures relating to regulated energy, which are described in the energy statement, there will be additional energy saving measures implemented in the development:

- Energy efficient white goods will be used

- Low energy external lighting

WASTE

Adequate internal and external storage of recycled and non-recycled waste will be ensured. The external storage will be sized according to the frequency of collection, based on guidance from the recycling scheme operator.

Construction waste will be minimised by implementing a site waste management plan containing procedures to minimise and divert waste from landfill.

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
Pool hall	30°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. This also includes low NOX levels for CHP units.
- 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 Adopted 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 GSHP vertical borehole system with water source heat pumps (Mitsubishi CRHV), with a COP of 5.08 complete with buffer vessel and thermal check meter. With backup/ top up from condensing boilers with ultra low NOX levels (eg Broag Remeha Quinta ACE). 90% of the heating load will be produced by the GSHP system.

The GSHP/ boilers system will serve LTHW pressurised supplies to the majority of underfloor heating systems in the principal living and bedroom areas (High thermal mass concrete floors). 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 AHU/ water systems.

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

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

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 the basins within each principle en-suite bathroom.

A water softener will be provided within the main basement 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 basement plantroom will be provided with boosted and conditioned cold water. The hot water cylinders will be complete with a pumped return system. The system will be heated 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 shall be provided to the system.

2.7 NATURAL VENTILATION

Background habitable room passive ventilation is generally to be provided by trickle vents incorporated into windows or walls to the building above ground level. The LGF will be provided with an MVHR system.

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 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

Mechanical Extract Ventilation (MEV or intermittent) units will be provided for the purposes of sanitary accommodation, kitchen and utility ventilation. These dedicated fan systems shall comprise of isolated (low noise) ducted fan units located either within plant areas and discharge to the main roof areas or via external walls. Ductwork to be pre-insulated PVC and galvanised steel with insulation.

2.10 COMFORT COOLING

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

Cooling may also be considered to certain rooms/spaces.

This is proposed to be via a high efficiency GSHP system (5.84 EER), with water heat pumps located in the basement 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 basement 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.

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 thermally/ acoustically insulated.

2.14 UNDERGROUND DRAINAGE
By others.

Section 3.0

ELECTRICAL SERVICES

3.1 INCOMING UTILITY SUPPLY
A new main incoming TP&N supply connection will be provided 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, however G99 export details TBA with UKPN. A PV generation meter and a GSHP thermal 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 LSF 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/LSF 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 LSF 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 occupiers 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 CAT 5e/6 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 CAT 5e/6 cabling.

- CCTV security monitoring around the vicinity of the building in CAT 5e/6 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 BT Redcare line and GSM. 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.

Generally smoke detectors, incorporating base sounder units will be installed throughout the premises except within the kitchen area, plant spaces and gallery – these will be heat detectors; to avoid nuisance alarm conditions. The plant room/kitchen areas will also have carbon monoxide (CO) detectors installed.

Consideration will be given to an 'Ion' based (Air sampling - Vesda), detection system in some principal areas including for CO detection.

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.
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 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;

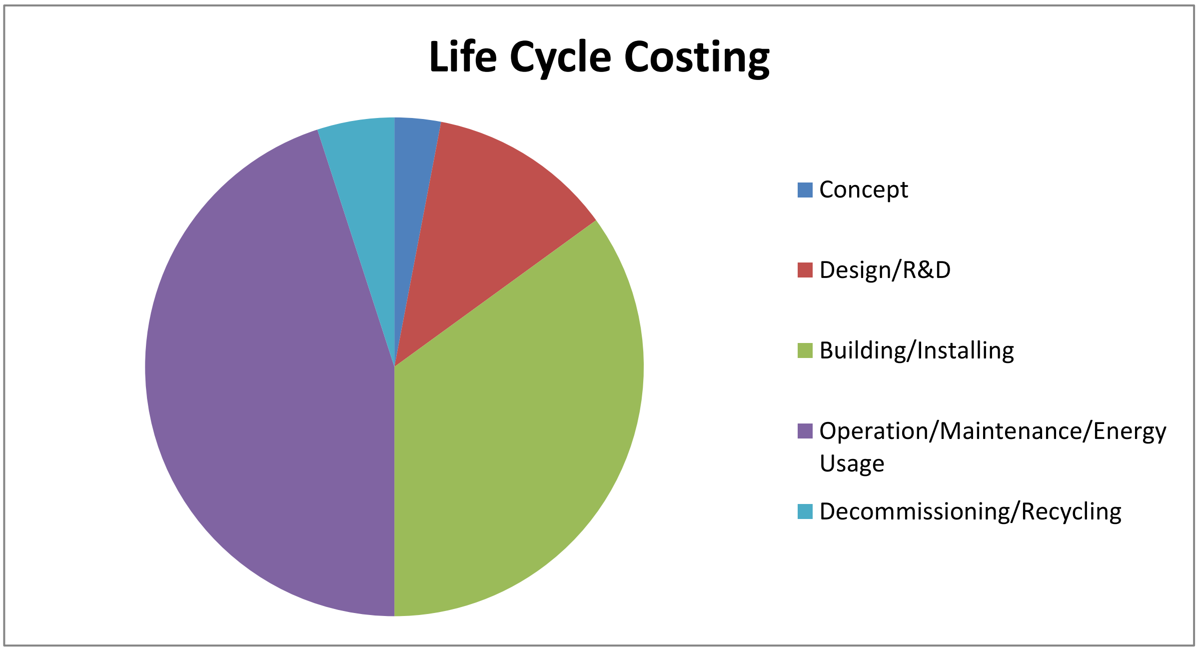
- Water pipework - Copper (Recyclable).
- Valves - Brass (Recyclable).
- Electrical cables - PVC twin & earth (XLPE/LSF) (Recyclable)
- Pipework insulation - Rock wool (Recyclable)
- Pipework Insulation - Phenolic foam – (Recyclable)
- Concrete - Portland cement based - (Recyclable)
- Light fittings – 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 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 February 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: 1.0.5.7

Property Address: 28, Avenue Road

Address : 28, Avenue Road, LONDON, NW8 6BU

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Basement	789.3	(1a) x	3.3	(2a) =	2604.69	(3a)
Ground floor	617	(1b) x	5.5	(2b) =	3393.5	(3b)
First floor	570.3	(1c) x	4.2	(2c) =	2395.26	(3c)
Second floor	549	(1d) x	3.1	(2d) =	1701.9	(3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	2525.6	(4)				
Dwelling volume			(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =		10095.35	(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	+	4	=	4	x 20 =	80	(6b)
Number of intermittent fans							16	x 10 =	160	(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) =	240	÷ (5) =	0.02	(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		4	(17)
If based on air permeability value, then (18) = [(17) ÷ 20]+(8), otherwise (18) = (16)		0.22	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
Number of sides sheltered		0	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	1	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.22	(21)

Infiltration rate modified for monthly wind speed

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

DER WorkSheet: New dwelling design stage

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

0.29	0.28	0.27	0.25	0.24	0.21	0.21	0.21	0.22	0.24	0.25	0.26

Calculate effective air change rate for the applicable case

If mechanical ventilation:	0	(23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a)	0	(23b)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =	0	(23c)

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

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

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

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

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

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

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

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

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

(25)m=	0.54	0.54	0.54	0.53	0.53	0.52	0.52	0.52	0.53	0.53	0.53	0.53	(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			6.28	x 1.3 =	8.164			(26)
Windows Type 1			4.79	x1/[1/(1.3)+ 0.04] =	5.92			(27)
Windows Type 2			13.04	x1/[1/(1.3)+ 0.04] =	16.11			(27)
Windows Type 3			16.83	x1/[1/(1.3)+ 0.04] =	20.8			(27)
Windows Type 4			7.19	x1/[1/(1.3)+ 0.04] =	8.88			(27)
Windows Type 5			3.38	x1/[1/(1.3)+ 0.04] =	4.18			(27)
Windows Type 6			2.73	x1/[1/(1.3)+ 0.04] =	3.37			(27)
Windows Type 7			1.96	x1/[1/(1.3)+ 0.04] =	2.42			(27)
Windows Type 8			5.58	x1/[1/(1.3)+ 0.04] =	6.9			(27)
Windows Type 9			3.38	x1/[1/(1.3)+ 0.04] =	4.18			(27)
Windows Type 10			2.73	x1/[1/(1.3)+ 0.04] =	3.37			(27)
Windows Type 11			1.96	x1/[1/(1.3)+ 0.04] =	2.42			(27)
Windows Type 12			11.16	x1/[1/(1.3)+ 0.04] =	13.79			(27)
Windows Type 13			5.58	x1/[1/(1.3)+ 0.04] =	6.9			(27)

DER WorkSheet: New dwelling design stage

Windows Type 14			2.73	x1/[1/(1.3)+ 0.04] =	3.37				(27)
Windows Type 15			5.4	x1/[1/(1.3)+ 0.04] =	6.67				(27)
Windows Type 16			1.96	x1/[1/(1.3)+ 0.04] =	2.42				(27)
Windows Type 17			4.08	x1/[1/(1.3)+ 0.04] =	5.04				(27)
Windows Type 18			3.38	x1/[1/(1.3)+ 0.04] =	4.18				(27)
Windows Type 19			5.58	x1/[1/(1.3)+ 0.04] =	6.9				(27)
Windows Type 20			2.73	x1/[1/(1.3)+ 0.04] =	3.37				(27)
Windows Type 21			3.9	x1/[1/(1.3)+ 0.04] =	4.82				(27)
Windows Type 22			1.96	x1/[1/(1.3)+ 0.04] =	2.42				(27)
Rooflights			46.34	x1/[1/(1.3) + 0.04] =	60.242				(27b)
Floor Type 1			789.3	x 0.12 =	94.716				(28)
Floor Type 2			29.2	x 0.12 =	3.504				(28)
Walls Type1	350.79	0	350.79	x 0.15 =	52.62				(29)
Walls Type2	1116.81	275.51	841.3	x 0.18 =	151.43				(29)
Walls Type3	123.7	33.48	90.22	x 0.18 =	16.24				(29)
Roof Type1	153.3	0	153.3	x 0.12 =	18.4				(30)
Roof Type2	21.3	0	21.3	x 0.12 =	2.56				(30)
Roof Type3	360.1	46.34	313.76	x 0.12 =	37.65				(30)
Roof Type4	263.8	0	263.8	x 0.12 =	31.66				(30)
Roof Type5	37.6	0	37.6	x 0.12 =	4.51				(30)
Total area of elements, m²			3245.9						(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) =	852.78	(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		74.78	(36)

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

Total fabric heat loss	(33) + (36) =	927.56	(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=	1801.33	1796.06	1790.9	1766.66	1762.12	1741.01	1741.01	1737.1	1749.14	1762.12	1771.3	1780.89		(38)

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

(39)m=	2728.89	2723.63	2718.46	2694.22	2689.69	2668.57	2668.57	2664.66	2676.71	2689.69	2698.86	2708.45		
										Average = Sum(39)1...12 /12=			2694.2	(39)

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

(40)m=	1.08	1.08	1.08	1.07	1.06	1.06	1.06	1.06	1.06	1.06	1.07	1.07		
										Average = Sum(40)1...12 /12=			1.07	(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)

DER WorkSheet: New dwelling design stage

4. Water heating energy requirement:	kWh/year:

Assumed occupancy, N — 6.03 (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 — 177.3 (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=	195.03	187.94	180.84	173.75	166.66	159.57	159.57	166.66	173.75	180.84	187.94	195.03		
											Total = Sum(44)1...12 =		2127.58	(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=	289.22	252.96	261.03	227.57	218.36	188.43	174.61	200.36	202.75	236.29	257.93	280.1		
											Total = Sum(45)1...12 =		2789.6	(45)
If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)														
(46)m=	43.38	37.94	39.15	34.14	32.75	28.26	26.19	30.05	30.41	35.44	38.69	42.01		(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel — 2000 (47)

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

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

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): — 6.67 (48)

Temperature factor from Table 2b — 0.54 (49)

Energy lost from water storage, kWh/year — (48) x (49) = — 3.6 (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) — 3.6 (55)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(56)m=	111.66	100.85	111.66	108.05	111.66	108.05	111.66	111.66	108.05	111.66	108.05	111.66	(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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(57)m=	111.66	100.85	111.66	108.05	111.66	108.05	111.66	111.66	108.05	111.66	108.05	111.66	(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)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(62)m=	424.14	374.82	395.95	358.14	353.28	318.99	309.52	335.28	333.32	371.21	388.5	415.01	(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)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(63)m=	0	0	0	0	0	0	0	0	0	0	0	0	(63)

Output from water heater

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
(64)m=	424.14	374.82	395.95	358.14	353.28	318.99	309.52	335.28	333.32	371.21	388.5	415.01		
									Output from water heater (annual)₁…₁₂				4378.15	(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=	204.1	181.6	194.73	180.12	180.54	167.1	165.99	174.55	171.87	186.5	190.21	201.07	(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=	301.26	301.26	301.26	301.26	301.26	301.26	301.26	301.26	301.26	301.26	301.26	301.26	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m=	162.57	144.39	117.43	88.9	66.45	56.1	60.62	78.8	105.76	134.29	156.74	167.09	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m=	1703.06	1720.73	1676.19	1581.39	1461.71	1349.23	1274.09	1256.41	1300.95	1395.76	1515.43	1627.91	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m=	53.13	53.13	53.13	53.13	53.13	53.13	53.13	53.13	53.13	53.13	53.13	53.13	(69)
Pumps and fans gains (Table 5a)													
(70)m=	6	6	6	6	6	6	6	6	6	6	6	6	(70)
Losses e.g. evaporation (negative values) (Table 5)													
(71)m=	-241.01	-241.01	-241.01	-241.01	-241.01	-241.01	-241.01	-241.01	-241.01	-241.01	-241.01	-241.01	(71)
Water heating gains (Table 5)													
(72)m=	274.33	270.23	261.73	250.17	242.66	232.09	223.11	234.62	238.71	250.67	264.19	270.25	(72)
Total internal gains =						(66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m							
(73)m=	2259.33	2254.73	2174.73	2039.83	1890.2	1756.8	1677.19	1689.21	1764.8	1900.1	2055.73	2184.63	(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)	
North	0.9x	0.77	x	11.16	x	10.63	x	0.63	x	0.7	=	72.53	(74)
North	0.9x	0.77	x	5.58	x	10.63	x	0.63	x	0.7	=	90.67	(74)
North	0.9x	0.77	x	2.73	x	10.63	x	0.63	x	0.7	=	53.23	(74)
North	0.9x	0.77	x	5.4	x	10.63	x	0.63	x	0.7	=	17.55	(74)
North	0.9x	0.77	x	1.96	x	10.63	x	0.63	x	0.7	=	25.48	(74)
North	0.9x	0.77	x	4.08	x	10.63	x	0.63	x	0.7	=	13.26	(74)
North	0.9x	0.77	x	11.16	x	20.32	x	0.63	x	0.7	=	138.61	(74)
North	0.9x	0.77	x	5.58	x	20.32	x	0.63	x	0.7	=	173.27	(74)
North	0.9x	0.77	x	2.73	x	20.32	x	0.63	x	0.7	=	101.73	(74)
North	0.9x	0.77	x	5.4	x	20.32	x	0.63	x	0.7	=	33.54	(74)
North	0.9x	0.77	x	1.96	x	20.32	x	0.63	x	0.7	=	48.69	(74)
North	0.9x	0.77	x	4.08	x	20.32	x	0.63	x	0.7	=	25.34	(74)

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North	0.9x	0.77	x	11.16	x	34.53	x	0.63	x	0.7	=	235.54	(74)
North	0.9x	0.77	x	5.58	x	34.53	x	0.63	x	0.7	=	294.43	(74)
North	0.9x	0.77	x	2.73	x	34.53	x	0.63	x	0.7	=	172.86	(74)
North	0.9x	0.77	x	5.4	x	34.53	x	0.63	x	0.7	=	56.99	(74)
North	0.9x	0.77	x	1.96	x	34.53	x	0.63	x	0.7	=	82.73	(74)
North	0.9x	0.77	x	4.08	x	34.53	x	0.63	x	0.7	=	43.06	(74)
North	0.9x	0.77	x	11.16	x	55.46	x	0.63	x	0.7	=	378.34	(74)
North	0.9x	0.77	x	5.58	x	55.46	x	0.63	x	0.7	=	472.92	(74)
North	0.9x	0.77	x	2.73	x	55.46	x	0.63	x	0.7	=	277.65	(74)
North	0.9x	0.77	x	5.4	x	55.46	x	0.63	x	0.7	=	91.53	(74)
North	0.9x	0.77	x	1.96	x	55.46	x	0.63	x	0.7	=	132.89	(74)
North	0.9x	0.77	x	4.08	x	55.46	x	0.63	x	0.7	=	69.16	(74)
North	0.9x	0.77	x	11.16	x	74.72	x	0.63	x	0.7	=	509.66	(74)
North	0.9x	0.77	x	5.58	x	74.72	x	0.63	x	0.7	=	637.07	(74)
North	0.9x	0.77	x	2.73	x	74.72	x	0.63	x	0.7	=	374.02	(74)
North	0.9x	0.77	x	5.4	x	74.72	x	0.63	x	0.7	=	123.3	(74)
North	0.9x	0.77	x	1.96	x	74.72	x	0.63	x	0.7	=	179.02	(74)
North	0.9x	0.77	x	4.08	x	74.72	x	0.63	x	0.7	=	93.16	(74)
North	0.9x	0.77	x	11.16	x	79.99	x	0.63	x	0.7	=	545.6	(74)
North	0.9x	0.77	x	5.58	x	79.99	x	0.63	x	0.7	=	682	(74)
North	0.9x	0.77	x	2.73	x	79.99	x	0.63	x	0.7	=	400.4	(74)
North	0.9x	0.77	x	5.4	x	79.99	x	0.63	x	0.7	=	132	(74)
North	0.9x	0.77	x	1.96	x	79.99	x	0.63	x	0.7	=	191.65	(74)
North	0.9x	0.77	x	4.08	x	79.99	x	0.63	x	0.7	=	99.73	(74)
North	0.9x	0.77	x	11.16	x	74.68	x	0.63	x	0.7	=	509.39	(74)
North	0.9x	0.77	x	5.58	x	74.68	x	0.63	x	0.7	=	636.74	(74)
North	0.9x	0.77	x	2.73	x	74.68	x	0.63	x	0.7	=	373.83	(74)
North	0.9x	0.77	x	5.4	x	74.68	x	0.63	x	0.7	=	123.24	(74)
North	0.9x	0.77	x	1.96	x	74.68	x	0.63	x	0.7	=	178.93	(74)
North	0.9x	0.77	x	4.08	x	74.68	x	0.63	x	0.7	=	93.11	(74)
North	0.9x	0.77	x	11.16	x	59.25	x	0.63	x	0.7	=	404.14	(74)
North	0.9x	0.77	x	5.58	x	59.25	x	0.63	x	0.7	=	505.17	(74)
North	0.9x	0.77	x	2.73	x	59.25	x	0.63	x	0.7	=	296.58	(74)
North	0.9x	0.77	x	5.4	x	59.25	x	0.63	x	0.7	=	97.77	(74)
North	0.9x	0.77	x	1.96	x	59.25	x	0.63	x	0.7	=	141.95	(74)
North	0.9x	0.77	x	4.08	x	59.25	x	0.63	x	0.7	=	73.87	(74)
North	0.9x	0.77	x	11.16	x	41.52	x	0.63	x	0.7	=	283.2	(74)
North	0.9x	0.77	x	5.58	x	41.52	x	0.63	x	0.7	=	354	(74)
North	0.9x	0.77	x	2.73	x	41.52	x	0.63	x	0.7	=	207.83	(74)
North	0.9x	0.77	x	5.4	x	41.52	x	0.63	x	0.7	=	68.52	(74)
North	0.9x	0.77	x	1.96	x	41.52	x	0.63	x	0.7	=	99.47	(74)

DER WorkSheet: New dwelling design stage

North	0.9x	0.77	x	4.08	x	41.52	x	0.63	x	0.7	=	51.77	(74)
North	0.9x	0.77	x	11.16	x	24.19	x	0.63	x	0.7	=	165	(74)
North	0.9x	0.77	x	5.58	x	24.19	x	0.63	x	0.7	=	206.25	(74)
North	0.9x	0.77	x	2.73	x	24.19	x	0.63	x	0.7	=	121.09	(74)
North	0.9x	0.77	x	5.4	x	24.19	x	0.63	x	0.7	=	39.92	(74)
North	0.9x	0.77	x	1.96	x	24.19	x	0.63	x	0.7	=	57.96	(74)
North	0.9x	0.77	x	4.08	x	24.19	x	0.63	x	0.7	=	30.16	(74)
North	0.9x	0.77	x	11.16	x	13.12	x	0.63	x	0.7	=	89.48	(74)
North	0.9x	0.77	x	5.58	x	13.12	x	0.63	x	0.7	=	111.85	(74)
North	0.9x	0.77	x	2.73	x	13.12	x	0.63	x	0.7	=	65.67	(74)
North	0.9x	0.77	x	5.4	x	13.12	x	0.63	x	0.7	=	21.65	(74)
North	0.9x	0.77	x	1.96	x	13.12	x	0.63	x	0.7	=	31.43	(74)
North	0.9x	0.77	x	4.08	x	13.12	x	0.63	x	0.7	=	16.36	(74)
North	0.9x	0.77	x	11.16	x	8.86	x	0.63	x	0.7	=	60.47	(74)
North	0.9x	0.77	x	5.58	x	8.86	x	0.63	x	0.7	=	75.58	(74)
North	0.9x	0.77	x	2.73	x	8.86	x	0.63	x	0.7	=	44.38	(74)
North	0.9x	0.77	x	5.4	x	8.86	x	0.63	x	0.7	=	14.63	(74)
North	0.9x	0.77	x	1.96	x	8.86	x	0.63	x	0.7	=	21.24	(74)
North	0.9x	0.77	x	4.08	x	8.86	x	0.63	x	0.7	=	11.05	(74)
East	0.9x	0.54	x	4.79	x	19.64	x	0.63	x	0.7	=	20.16	(76)
East	0.9x	0.54	x	13.04	x	19.64	x	0.63	x	0.7	=	54.89	(76)
East	0.9x	0.54	x	16.83	x	19.64	x	0.63	x	0.7	=	70.84	(76)
East	0.9x	0.54	x	7.19	x	19.64	x	0.63	x	0.7	=	30.27	(76)
East	0.9x	0.77	x	3.38	x	19.64	x	0.63	x	0.7	=	20.29	(76)
East	0.9x	0.77	x	5.58	x	19.64	x	0.63	x	0.7	=	200.96	(76)
East	0.9x	0.77	x	2.73	x	19.64	x	0.63	x	0.7	=	81.93	(76)
East	0.9x	0.77	x	3.9	x	19.64	x	0.63	x	0.7	=	46.82	(76)
East	0.9x	0.77	x	1.96	x	19.64	x	0.63	x	0.7	=	35.29	(76)
East	0.9x	0.54	x	4.79	x	38.42	x	0.63	x	0.7	=	39.44	(76)
East	0.9x	0.54	x	13.04	x	38.42	x	0.63	x	0.7	=	107.38	(76)
East	0.9x	0.54	x	16.83	x	38.42	x	0.63	x	0.7	=	138.59	(76)
East	0.9x	0.54	x	7.19	x	38.42	x	0.63	x	0.7	=	59.21	(76)
East	0.9x	0.77	x	3.38	x	38.42	x	0.63	x	0.7	=	39.69	(76)
East	0.9x	0.77	x	5.58	x	38.42	x	0.63	x	0.7	=	393.12	(76)
East	0.9x	0.77	x	2.73	x	38.42	x	0.63	x	0.7	=	160.28	(76)
East	0.9x	0.77	x	3.9	x	38.42	x	0.63	x	0.7	=	91.59	(76)
East	0.9x	0.77	x	1.96	x	38.42	x	0.63	x	0.7	=	69.04	(76)
East	0.9x	0.54	x	4.79	x	63.27	x	0.63	x	0.7	=	64.96	(76)
East	0.9x	0.54	x	13.04	x	63.27	x	0.63	x	0.7	=	176.84	(76)
East	0.9x	0.54	x	16.83	x	63.27	x	0.63	x	0.7	=	228.23	(76)
East	0.9x	0.54	x	7.19	x	63.27	x	0.63	x	0.7	=	97.5	(76)

DER WorkSheet: New dwelling design stage

East	0.9x	0.77	x	3.38	x	63.27	x	0.63	x	0.7	=	65.36	(76)
East	0.9x	0.77	x	5.58	x	63.27	x	0.63	x	0.7	=	647.41	(76)
East	0.9x	0.77	x	2.73	x	63.27	x	0.63	x	0.7	=	263.95	(76)
East	0.9x	0.77	x	3.9	x	63.27	x	0.63	x	0.7	=	150.83	(76)
East	0.9x	0.77	x	1.96	x	63.27	x	0.63	x	0.7	=	113.7	(76)
East	0.9x	0.54	x	4.79	x	92.28	x	0.63	x	0.7	=	94.74	(76)
East	0.9x	0.54	x	13.04	x	92.28	x	0.63	x	0.7	=	257.91	(76)
East	0.9x	0.54	x	16.83	x	92.28	x	0.63	x	0.7	=	332.86	(76)
East	0.9x	0.54	x	7.19	x	92.28	x	0.63	x	0.7	=	142.2	(76)
East	0.9x	0.77	x	3.38	x	92.28	x	0.63	x	0.7	=	95.32	(76)
East	0.9x	0.77	x	5.58	x	92.28	x	0.63	x	0.7	=	944.2	(76)
East	0.9x	0.77	x	2.73	x	92.28	x	0.63	x	0.7	=	384.96	(76)
East	0.9x	0.77	x	3.9	x	92.28	x	0.63	x	0.7	=	219.98	(76)
East	0.9x	0.77	x	1.96	x	92.28	x	0.63	x	0.7	=	165.83	(76)
East	0.9x	0.54	x	4.79	x	113.09	x	0.63	x	0.7	=	116.1	(76)
East	0.9x	0.54	x	13.04	x	113.09	x	0.63	x	0.7	=	316.07	(76)
East	0.9x	0.54	x	16.83	x	113.09	x	0.63	x	0.7	=	407.94	(76)
East	0.9x	0.54	x	7.19	x	113.09	x	0.63	x	0.7	=	174.28	(76)
East	0.9x	0.77	x	3.38	x	113.09	x	0.63	x	0.7	=	116.82	(76)
East	0.9x	0.77	x	5.58	x	113.09	x	0.63	x	0.7	=	1157.16	(76)
East	0.9x	0.77	x	2.73	x	113.09	x	0.63	x	0.7	=	471.78	(76)
East	0.9x	0.77	x	3.9	x	113.09	x	0.63	x	0.7	=	269.59	(76)
East	0.9x	0.77	x	1.96	x	113.09	x	0.63	x	0.7	=	203.23	(76)
East	0.9x	0.54	x	4.79	x	115.77	x	0.63	x	0.7	=	118.85	(76)
East	0.9x	0.54	x	13.04	x	115.77	x	0.63	x	0.7	=	323.56	(76)
East	0.9x	0.54	x	16.83	x	115.77	x	0.63	x	0.7	=	417.6	(76)
East	0.9x	0.54	x	7.19	x	115.77	x	0.63	x	0.7	=	178.4	(76)
East	0.9x	0.77	x	3.38	x	115.77	x	0.63	x	0.7	=	119.59	(76)
East	0.9x	0.77	x	5.58	x	115.77	x	0.63	x	0.7	=	1184.56	(76)
East	0.9x	0.77	x	2.73	x	115.77	x	0.63	x	0.7	=	482.95	(76)
East	0.9x	0.77	x	3.9	x	115.77	x	0.63	x	0.7	=	275.97	(76)
East	0.9x	0.77	x	1.96	x	115.77	x	0.63	x	0.7	=	208.04	(76)
East	0.9x	0.54	x	4.79	x	110.22	x	0.63	x	0.7	=	113.15	(76)
East	0.9x	0.54	x	13.04	x	110.22	x	0.63	x	0.7	=	308.04	(76)
East	0.9x	0.54	x	16.83	x	110.22	x	0.63	x	0.7	=	397.57	(76)
East	0.9x	0.54	x	7.19	x	110.22	x	0.63	x	0.7	=	169.85	(76)
East	0.9x	0.77	x	3.38	x	110.22	x	0.63	x	0.7	=	113.85	(76)
East	0.9x	0.77	x	5.58	x	110.22	x	0.63	x	0.7	=	1127.74	(76)
East	0.9x	0.77	x	2.73	x	110.22	x	0.63	x	0.7	=	459.79	(76)
East	0.9x	0.77	x	3.9	x	110.22	x	0.63	x	0.7	=	262.74	(76)
East	0.9x	0.77	x	1.96	x	110.22	x	0.63	x	0.7	=	198.06	(76)

DER WorkSheet: New dwelling design stage

East	0.9x	0.54	x	4.79	x	94.68	x	0.63	x	0.7	=	97.2	(76)
East	0.9x	0.54	x	13.04	x	94.68	x	0.63	x	0.7	=	264.6	(76)
East	0.9x	0.54	x	16.83	x	94.68	x	0.63	x	0.7	=	341.51	(76)
East	0.9x	0.54	x	7.19	x	94.68	x	0.63	x	0.7	=	145.9	(76)
East	0.9x	0.77	x	3.38	x	94.68	x	0.63	x	0.7	=	97.8	(76)
East	0.9x	0.77	x	5.58	x	94.68	x	0.63	x	0.7	=	968.72	(76)
East	0.9x	0.77	x	2.73	x	94.68	x	0.63	x	0.7	=	394.95	(76)
East	0.9x	0.77	x	3.9	x	94.68	x	0.63	x	0.7	=	225.69	(76)
East	0.9x	0.77	x	1.96	x	94.68	x	0.63	x	0.7	=	170.13	(76)
East	0.9x	0.54	x	4.79	x	73.59	x	0.63	x	0.7	=	75.55	(76)
East	0.9x	0.54	x	13.04	x	73.59	x	0.63	x	0.7	=	205.67	(76)
East	0.9x	0.54	x	16.83	x	73.59	x	0.63	x	0.7	=	265.44	(76)
East	0.9x	0.54	x	7.19	x	73.59	x	0.63	x	0.7	=	113.4	(76)
East	0.9x	0.77	x	3.38	x	73.59	x	0.63	x	0.7	=	76.02	(76)
East	0.9x	0.77	x	5.58	x	73.59	x	0.63	x	0.7	=	752.96	(76)
East	0.9x	0.77	x	2.73	x	73.59	x	0.63	x	0.7	=	306.99	(76)
East	0.9x	0.77	x	3.9	x	73.59	x	0.63	x	0.7	=	175.42	(76)
East	0.9x	0.77	x	1.96	x	73.59	x	0.63	x	0.7	=	132.24	(76)
East	0.9x	0.54	x	4.79	x	45.59	x	0.63	x	0.7	=	46.8	(76)
East	0.9x	0.54	x	13.04	x	45.59	x	0.63	x	0.7	=	127.41	(76)
East	0.9x	0.54	x	16.83	x	45.59	x	0.63	x	0.7	=	164.45	(76)
East	0.9x	0.54	x	7.19	x	45.59	x	0.63	x	0.7	=	70.25	(76)
East	0.9x	0.77	x	3.38	x	45.59	x	0.63	x	0.7	=	47.09	(76)
East	0.9x	0.77	x	5.58	x	45.59	x	0.63	x	0.7	=	466.47	(76)
East	0.9x	0.77	x	2.73	x	45.59	x	0.63	x	0.7	=	190.18	(76)
East	0.9x	0.77	x	3.9	x	45.59	x	0.63	x	0.7	=	108.67	(76)
East	0.9x	0.77	x	1.96	x	45.59	x	0.63	x	0.7	=	81.92	(76)
East	0.9x	0.54	x	4.79	x	24.49	x	0.63	x	0.7	=	25.14	(76)
East	0.9x	0.54	x	13.04	x	24.49	x	0.63	x	0.7	=	68.44	(76)
East	0.9x	0.54	x	16.83	x	24.49	x	0.63	x	0.7	=	88.33	(76)
East	0.9x	0.54	x	7.19	x	24.49	x	0.63	x	0.7	=	37.74	(76)
East	0.9x	0.77	x	3.38	x	24.49	x	0.63	x	0.7	=	25.3	(76)
East	0.9x	0.77	x	5.58	x	24.49	x	0.63	x	0.7	=	250.57	(76)
East	0.9x	0.77	x	2.73	x	24.49	x	0.63	x	0.7	=	102.16	(76)
East	0.9x	0.77	x	3.9	x	24.49	x	0.63	x	0.7	=	58.38	(76)
East	0.9x	0.77	x	1.96	x	24.49	x	0.63	x	0.7	=	44.01	(76)
East	0.9x	0.54	x	4.79	x	16.15	x	0.63	x	0.7	=	16.58	(76)
East	0.9x	0.54	x	13.04	x	16.15	x	0.63	x	0.7	=	45.14	(76)
East	0.9x	0.54	x	16.83	x	16.15	x	0.63	x	0.7	=	58.26	(76)
East	0.9x	0.54	x	7.19	x	16.15	x	0.63	x	0.7	=	24.89	(76)
East	0.9x	0.77	x	3.38	x	16.15	x	0.63	x	0.7	=	16.68	(76)

DER WorkSheet: New dwelling design stage

East	0.9x	0.77	x	5.58	x	16.15	x	0.63	x	0.7	=	165.26	(76)
East	0.9x	0.77	x	2.73	x	16.15	x	0.63	x	0.7	=	67.38	(76)
East	0.9x	0.77	x	3.9	x	16.15	x	0.63	x	0.7	=	38.5	(76)
East	0.9x	0.77	x	1.96	x	16.15	x	0.63	x	0.7	=	29.02	(76)
South	0.9x	0.77	x	3.38	x	46.75	x	0.63	x	0.7	=	386.35	(78)
South	0.9x	0.77	x	2.73	x	46.75	x	0.63	x	0.7	=	351.06	(78)
South	0.9x	0.77	x	1.96	x	46.75	x	0.63	x	0.7	=	140.02	(78)
South	0.9x	0.77	x	3.38	x	76.57	x	0.63	x	0.7	=	632.74	(78)
South	0.9x	0.77	x	2.73	x	76.57	x	0.63	x	0.7	=	574.94	(78)
South	0.9x	0.77	x	1.96	x	76.57	x	0.63	x	0.7	=	229.32	(78)
South	0.9x	0.77	x	3.38	x	97.53	x	0.63	x	0.7	=	806	(78)
South	0.9x	0.77	x	2.73	x	97.53	x	0.63	x	0.7	=	732.37	(78)
South	0.9x	0.77	x	1.96	x	97.53	x	0.63	x	0.7	=	292.11	(78)
South	0.9x	0.77	x	3.38	x	110.23	x	0.63	x	0.7	=	910.95	(78)
South	0.9x	0.77	x	2.73	x	110.23	x	0.63	x	0.7	=	827.74	(78)
South	0.9x	0.77	x	1.96	x	110.23	x	0.63	x	0.7	=	330.15	(78)
South	0.9x	0.77	x	3.38	x	114.87	x	0.63	x	0.7	=	949.27	(78)
South	0.9x	0.77	x	2.73	x	114.87	x	0.63	x	0.7	=	862.56	(78)
South	0.9x	0.77	x	1.96	x	114.87	x	0.63	x	0.7	=	344.04	(78)
South	0.9x	0.77	x	3.38	x	110.55	x	0.63	x	0.7	=	913.54	(78)
South	0.9x	0.77	x	2.73	x	110.55	x	0.63	x	0.7	=	830.09	(78)
South	0.9x	0.77	x	1.96	x	110.55	x	0.63	x	0.7	=	331.09	(78)
South	0.9x	0.77	x	3.38	x	108.01	x	0.63	x	0.7	=	892.59	(78)
South	0.9x	0.77	x	2.73	x	108.01	x	0.63	x	0.7	=	811.05	(78)
South	0.9x	0.77	x	1.96	x	108.01	x	0.63	x	0.7	=	323.5	(78)
South	0.9x	0.77	x	3.38	x	104.89	x	0.63	x	0.7	=	866.82	(78)
South	0.9x	0.77	x	2.73	x	104.89	x	0.63	x	0.7	=	787.64	(78)
South	0.9x	0.77	x	1.96	x	104.89	x	0.63	x	0.7	=	314.16	(78)
South	0.9x	0.77	x	3.38	x	101.89	x	0.63	x	0.7	=	841.96	(78)
South	0.9x	0.77	x	2.73	x	101.89	x	0.63	x	0.7	=	765.05	(78)
South	0.9x	0.77	x	1.96	x	101.89	x	0.63	x	0.7	=	305.15	(78)
South	0.9x	0.77	x	3.38	x	82.59	x	0.63	x	0.7	=	682.47	(78)
South	0.9x	0.77	x	2.73	x	82.59	x	0.63	x	0.7	=	620.13	(78)
South	0.9x	0.77	x	1.96	x	82.59	x	0.63	x	0.7	=	247.34	(78)
South	0.9x	0.77	x	3.38	x	55.42	x	0.63	x	0.7	=	457.95	(78)
South	0.9x	0.77	x	2.73	x	55.42	x	0.63	x	0.7	=	416.12	(78)
South	0.9x	0.77	x	1.96	x	55.42	x	0.63	x	0.7	=	165.97	(78)
South	0.9x	0.77	x	3.38	x	40.4	x	0.63	x	0.7	=	333.84	(78)
South	0.9x	0.77	x	2.73	x	40.4	x	0.63	x	0.7	=	303.35	(78)
South	0.9x	0.77	x	1.96	x	40.4	x	0.63	x	0.7	=	120.99	(78)
West	0.9x	0.77	x	5.58	x	19.64	x	0.63	x	0.7	=	133.97	(80)

DER WorkSheet: New dwelling design stage

West	0.9x	0.77	x	3.38	x	19.64	x	0.63	x	0.7	=	40.58	(80)
West	0.9x	0.77	x	2.73	x	19.64	x	0.63	x	0.7	=	98.32	(80)
West	0.9x	0.77	x	1.96	x	19.64	x	0.63	x	0.7	=	35.29	(80)
West	0.9x	0.77	x	5.58	x	38.42	x	0.63	x	0.7	=	262.08	(80)
West	0.9x	0.77	x	3.38	x	38.42	x	0.63	x	0.7	=	79.37	(80)
West	0.9x	0.77	x	2.73	x	38.42	x	0.63	x	0.7	=	192.33	(80)
West	0.9x	0.77	x	1.96	x	38.42	x	0.63	x	0.7	=	69.04	(80)
West	0.9x	0.77	x	5.58	x	63.27	x	0.63	x	0.7	=	431.6	(80)
West	0.9x	0.77	x	3.38	x	63.27	x	0.63	x	0.7	=	130.72	(80)
West	0.9x	0.77	x	2.73	x	63.27	x	0.63	x	0.7	=	316.74	(80)
West	0.9x	0.77	x	1.96	x	63.27	x	0.63	x	0.7	=	113.7	(80)
West	0.9x	0.77	x	5.58	x	92.28	x	0.63	x	0.7	=	629.47	(80)
West	0.9x	0.77	x	3.38	x	92.28	x	0.63	x	0.7	=	190.65	(80)
West	0.9x	0.77	x	2.73	x	92.28	x	0.63	x	0.7	=	461.95	(80)
West	0.9x	0.77	x	1.96	x	92.28	x	0.63	x	0.7	=	165.83	(80)
West	0.9x	0.77	x	5.58	x	113.09	x	0.63	x	0.7	=	771.44	(80)
West	0.9x	0.77	x	3.38	x	113.09	x	0.63	x	0.7	=	233.64	(80)
West	0.9x	0.77	x	2.73	x	113.09	x	0.63	x	0.7	=	566.14	(80)
West	0.9x	0.77	x	1.96	x	113.09	x	0.63	x	0.7	=	203.23	(80)
West	0.9x	0.77	x	5.58	x	115.77	x	0.63	x	0.7	=	789.7	(80)
West	0.9x	0.77	x	3.38	x	115.77	x	0.63	x	0.7	=	239.18	(80)
West	0.9x	0.77	x	2.73	x	115.77	x	0.63	x	0.7	=	579.54	(80)
West	0.9x	0.77	x	1.96	x	115.77	x	0.63	x	0.7	=	208.04	(80)
West	0.9x	0.77	x	5.58	x	110.22	x	0.63	x	0.7	=	751.83	(80)
West	0.9x	0.77	x	3.38	x	110.22	x	0.63	x	0.7	=	227.7	(80)
West	0.9x	0.77	x	2.73	x	110.22	x	0.63	x	0.7	=	551.75	(80)
West	0.9x	0.77	x	1.96	x	110.22	x	0.63	x	0.7	=	198.06	(80)
West	0.9x	0.77	x	5.58	x	94.68	x	0.63	x	0.7	=	645.81	(80)
West	0.9x	0.77	x	3.38	x	94.68	x	0.63	x	0.7	=	195.59	(80)
West	0.9x	0.77	x	2.73	x	94.68	x	0.63	x	0.7	=	473.94	(80)
West	0.9x	0.77	x	1.96	x	94.68	x	0.63	x	0.7	=	170.13	(80)
West	0.9x	0.77	x	5.58	x	73.59	x	0.63	x	0.7	=	501.97	(80)
West	0.9x	0.77	x	3.38	x	73.59	x	0.63	x	0.7	=	152.03	(80)
West	0.9x	0.77	x	2.73	x	73.59	x	0.63	x	0.7	=	368.38	(80)
West	0.9x	0.77	x	1.96	x	73.59	x	0.63	x	0.7	=	132.24	(80)
West	0.9x	0.77	x	5.58	x	45.59	x	0.63	x	0.7	=	310.98	(80)
West	0.9x	0.77	x	3.38	x	45.59	x	0.63	x	0.7	=	94.18	(80)
West	0.9x	0.77	x	2.73	x	45.59	x	0.63	x	0.7	=	228.22	(80)
West	0.9x	0.77	x	1.96	x	45.59	x	0.63	x	0.7	=	81.92	(80)
West	0.9x	0.77	x	5.58	x	24.49	x	0.63	x	0.7	=	167.05	(80)
West	0.9x	0.77	x	3.38	x	24.49	x	0.63	x	0.7	=	50.59	(80)

West	0.9x	0.77	x	2.73	x	24.49	x	0.63	x	0.7	=	122.59	(80)
West	0.9x	0.77	x	1.96	x	24.49	x	0.63	x	0.7	=	44.01	(80)
West	0.9x	0.77	x	5.58	x	16.15	x	0.63	x	0.7	=	110.17	(80)
West	0.9x	0.77	x	3.38	x	16.15	x	0.63	x	0.7	=	33.37	(80)
West	0.9x	0.77	x	2.73	x	16.15	x	0.63	x	0.7	=	80.85	(80)
West	0.9x	0.77	x	1.96	x	16.15	x	0.63	x	0.7	=	29.02	(80)
Rooflights	0.9x	1	x	46.34	x	26	x	0.63	x	0.7	=	478.2	(82)
Rooflights	0.9x	1	x	46.34	x	54	x	0.63	x	0.7	=	993.19	(82)
Rooflights	0.9x	1	x	46.34	x	96	x	0.63	x	0.7	=	1765.67	(82)
Rooflights	0.9x	1	x	46.34	x	150	x	0.63	x	0.7	=	2758.85	(82)
Rooflights	0.9x	1	x	46.34	x	192	x	0.63	x	0.7	=	3531.33	(82)
Rooflights	0.9x	1	x	46.34	x	200	x	0.63	x	0.7	=	3678.47	(82)
Rooflights	0.9x	1	x	46.34	x	189	x	0.63	x	0.7	=	3476.15	(82)
Rooflights	0.9x	1	x	46.34	x	157	x	0.63	x	0.7	=	2887.6	(82)
Rooflights	0.9x	1	x	46.34	x	115	x	0.63	x	0.7	=	2115.12	(82)
Rooflights	0.9x	1	x	46.34	x	66	x	0.63	x	0.7	=	1213.89	(82)
Rooflights	0.9x	1	x	46.34	x	33	x	0.63	x	0.7	=	606.95	(82)
Rooflights	0.9x	1	x	46.34	x	21	x	0.63	x	0.7	=	386.24	(82)

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

(83)m=	2497.96	4652.51	7283.29	10336.08	12610.84	12930.56	12298.66	10567.68	8350.37	5402.78	3067.73	2086.89	(83)

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

(84)m=	4757.29	6907.24	9458.02	12375.92	14501.04	14687.36	13975.85	12256.89	10115.16	7302.88	5123.47	4271.52	(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	1	0.98	0.9	0.76	0.84	0.98	1	1	1	(86)

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

(87)m=	19.8	19.9	20.1	20.38	20.64	20.84	20.92	20.9	20.71	20.36	20.03	19.78	(87)

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

(88)m=	20.02	20.02	20.02	20.03	20.03	20.04	20.04	20.04	20.03	20.03	20.03	20.02	(88)

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

(89)m=	1	1	1	0.99	0.96	0.84	0.63	0.73	0.97	1	1	1	(89)

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

(90)m=	18.36	18.52	18.81	19.22	19.61	19.87	19.95	19.93	19.71	19.21	18.72	18.35	(90)

fLA = Living area ÷ (4) = 0.05 (91)

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

(92)m=	18.43	18.59	18.88	19.28	19.66	19.92	20	19.98	19.76	19.26	18.78	18.42	(92)

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

(93)m=	18.43	18.59	18.88	19.28	19.66	19.92	20	19.98	19.76	19.26	18.78	18.42	(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	1	1	0.99	0.96	0.83	0.62	0.72	0.96	1	1	1	(94)

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

(95)m=	4757.22	6906.49	9449.88	12286.56	13863.63	12168.2	8731.49	8854.13	9697.66	7292.73	5123.2	4271.49	(95)

Monthly average external temperature from Table 8

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

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

(97)m=	38571.4	37294.47	33649.62	27959.38	21399.65	14192.09	9061.79	9541.08	15137.08	23299.7	31529.76	38515.46	(97)

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

(98)m=	25157.75	20420.72	18004.61	11284.43	5606.8	0	0	0	0	11909.18	19012.72	25477.51

Total per year (kWh/year) = Sum(98)1...5,9...12 = 136873.73 (98)

Space heating requirement in kWh/m²/year 54.19 (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	25084.6	19747.45	20251.45	0	0	0	0	(100)
Utilisation factor for loss hm													
(101)m=	0	0	0	0	0	0.65	0.76	0.68	0	0	0	0	(101)
Useful loss, hmLm (Watts) = (100)m x (101)m													
(102)m=	0	0	0	0	0	16427.14	14919.22	13710.78	0	0	0	0	(102)
Gains (solar gains calculated for applicable weather region, see Table 10)													
(103)m=	0	0	0	0	0	17208.77	16388.15	14477.1	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	562.77	1092.88	0	0	0	0	0

Total = Sum(104) = 1655.65 (104)

Cooled fraction — f C = cooled area ÷ (4) = 0.59 (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	83.56	162.27	0	0	0	0	0

Total = Sum(107) = 245.83 (107)

Space cooling requirement in kWh/m²/year — (107) ÷ (4) = 0.1 (108)

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

Space heating:

Fraction of space heat from secondary/supplementary system		0.1	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	0.9	(202)
Fraction of main heating from main system 2		0.1	(203)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	0.81	(204)
Fraction of total heating from main system 2	(205) = (202) × (203) =	0.09	(205)
Efficiency of main space heating system 1		319.7	(206)

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Efficiency of main space heating system 2	93.3	(207)
Efficiency of secondary/supplementary heating system, %	80	(208)
Cooling System Energy Efficiency Ratio	6.75	(209)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Space heating requirement (calculated above)	25157.75	20420.72	18004.61	11284.43	5606.8	0	0	0	0	11909.18	19012.72	25477.51		
(211)m = {[(98)m x (204)] } x 100 ÷ (206)	6374.03	5173.85	4561.69	2859.05	1420.55	0	0	0	0	3017.34	4817.11	6455.05		(211)
Total (kWh/year) =Sum(211)$_{1...5,10...12}$=													34678.67	(211)
(213)m =(98)m x (203) x 100 ÷ (207)	2426.79	1969.84	1736.78	1088.53	540.85	0	0	0	0	1148.8	1834.02	2457.64		
Total (kWh/year) =Sum(213)$_{1...5,10...12}$=													13203.25	(213)
Space heating fuel (secondary), kWh/month = {[(98)m x (201)] } x 100 ÷ (208) (215)m=	3144.72	2552.59	2250.58	1410.55	700.85	0	0	0	0	1488.65	2376.59	3184.69		
Total (kWh/year) =Sum(215)$_{1...5,10...12}$=													17109.22	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Output from water heater (calculated above)	424.14	374.82	395.95	358.14	353.28	318.99	309.52	335.28	333.32	371.21	388.5	415.01		
Efficiency of water heater													79.6	(216)
(217)m=	88.42	88.29	87.98	87.24	85.56	79.6	79.6	79.6	79.6	87.28	88.11	88.48		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m (219)m=	479.66	424.53	450.05	410.51	412.88	400.74	388.85	421.21	418.74	425.3	440.93	469.06		
Total = Sum(219a)$_{1...12}$ =													5142.47	(219)

Space cooling fuel, kWh/month.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
(221)m = (107)m÷ (209) (221)m=	0	0	0	0	0	12.38	24.04	0	0	0	0	0		
Total = Sum(221)$_{6...8}$ =													36.42	(221)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		34678.67	
Space heating fuel used, main system 2		13203.25	
Space heating fuel used, secondary		17109.22	
Water heating fuel used		5142.47	
Space cooling fuel used		36.42	
Electricity for pumps, fans and electric keep-hot			
central heating pump:	60		(230c)
boiler with a fan-assisted flue	45		(230e)
Total electricity for the above, kWh/year — sum of (230a)...(230g) =		105	(231)
Electricity for lighting		2871.02	(232)
Electricity generated by PVs		-3346.17	(233)

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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	=	17998.23	(261)
Space heating (main system 2)	(213) x	0.216	=	2851.9	(262)
Space heating (secondary)	(215) x	0.216	=	3695.59	(263)
Water heating	(219) x	0.216	=	1110.77	(264)
Space and water heating	(261) + (262) + (263) + (264) =			25656.5	(265)
Space cooling	(221) x	0.519	=	18.9	(266)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	54.5	(267)
Electricity for lighting	(232) x	0.519	=	1490.06	(268)
Energy saving/generation technologies Item 1		0.519	=	-1736.66	(269)
Total CO2, kg/year		sum of (265)...(271) =		25483.29	(272)
Dwelling CO2 Emission Rate		(272) ÷ (4) =		10.09	(273)
EI rating (section 14)				87	(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: 1.0.5.7

Property Address: 28, Avenue Road

Address : 28, Avenue Road, LONDON, NW8 6BU

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Basement	789.3	(1a) x	3.3	(2a) =	2604.69	(3a)
Ground floor	617	(1b) x	5.5	(2b) =	3393.5	(3b)
First floor	570.3	(1c) x	4.2	(2c) =	2395.26	(3c)
Second floor	549	(1d) x	3.1	(2d) =	1701.9	(3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	2525.6	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	10095.35	(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	+	4	=	4	x 20 =	80	(6b)
Number of intermittent fans							16	x 10 =	160	(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) =	240	÷ (5) =	0.02	(8)

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

Number of storeys in the dwelling (ns)		0	(9)
Additional infiltration	[(9)-1]x0.1 =	0	(10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction *if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35*		0	(11)
If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0	(12)
If no draught lobby, enter 0.05, else enter 0		0	(13)
Percentage of windows and doors draught stripped		0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		4	(17)
If based on air permeability value, then (18) = [(17) ÷ 20]+(8), otherwise (18) = (16)		0.22	(18)

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

Number of sides sheltered		0	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	1	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.22	(21)

Infiltration rate modified for monthly wind speed

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

SAP WorkSheet: New dwelling design stage

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

0.29	0.28	0.27	0.25	0.24	0.21	0.21	0.21	0.22	0.24	0.25	0.26

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0 (23a)

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

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

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

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

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

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

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

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

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

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

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

(25)m=	0.54	0.54	0.54	0.53	0.53	0.52	0.52	0.52	0.53	0.53	0.53	0.53	(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			6.28	x 1.3 =	8.164			(26)
Windows Type 1			4.79	x1/[1/(1.3)+ 0.04] =	5.92			(27)
Windows Type 2			13.04	x1/[1/(1.3)+ 0.04] =	16.11			(27)
Windows Type 3			16.83	x1/[1/(1.3)+ 0.04] =	20.8			(27)
Windows Type 4			7.19	x1/[1/(1.3)+ 0.04] =	8.88			(27)
Windows Type 5			3.38	x1/[1/(1.3)+ 0.04] =	4.18			(27)
Windows Type 6			2.73	x1/[1/(1.3)+ 0.04] =	3.37			(27)
Windows Type 7			1.96	x1/[1/(1.3)+ 0.04] =	2.42			(27)
Windows Type 8			5.58	x1/[1/(1.3)+ 0.04] =	6.9			(27)
Windows Type 9			3.38	x1/[1/(1.3)+ 0.04] =	4.18			(27)
Windows Type 10			2.73	x1/[1/(1.3)+ 0.04] =	3.37			(27)
Windows Type 11			1.96	x1/[1/(1.3)+ 0.04] =	2.42			(27)
Windows Type 12			11.16	x1/[1/(1.3)+ 0.04] =	13.79			(27)
Windows Type 13			5.58	x1/[1/(1.3)+ 0.04] =	6.9			(27)

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Windows Type 14			2.73	x1/[1/(1.3)+ 0.04] =	3.37				(27)
Windows Type 15			5.4	x1/[1/(1.3)+ 0.04] =	6.67				(27)
Windows Type 16			1.96	x1/[1/(1.3)+ 0.04] =	2.42				(27)
Windows Type 17			4.08	x1/[1/(1.3)+ 0.04] =	5.04				(27)
Windows Type 18			3.38	x1/[1/(1.3)+ 0.04] =	4.18				(27)
Windows Type 19			5.58	x1/[1/(1.3)+ 0.04] =	6.9				(27)
Windows Type 20			2.73	x1/[1/(1.3)+ 0.04] =	3.37				(27)
Windows Type 21			3.9	x1/[1/(1.3)+ 0.04] =	4.82				(27)
Windows Type 22			1.96	x1/[1/(1.3)+ 0.04] =	2.42				(27)
Rooflights			46.34	x1/[1/(1.3) + 0.04] =	60.242				(27b)
Floor Type 1			789.3	x 0.12 =	94.716				(28)
Floor Type 2			29.2	x 0.12 =	3.504				(28)
Walls Type1	350.79	0	350.79	x 0.15 =	52.62				(29)
Walls Type2	1116.81	275.51	841.3	x 0.18 =	151.43				(29)
Walls Type3	123.7	33.48	90.22	x 0.18 =	16.24				(29)
Roof Type1	153.3	0	153.3	x 0.12 =	18.4				(30)
Roof Type2	21.3	0	21.3	x 0.12 =	2.56				(30)
Roof Type3	360.1	46.34	313.76	x 0.12 =	37.65				(30)
Roof Type4	263.8	0	263.8	x 0.12 =	31.66				(30)
Roof Type5	37.6	0	37.6	x 0.12 =	4.51				(30)
Total area of elements, m²			3245.9						(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) =	852.78	(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		74.78	(36)
if details of thermal bridging are not known (36) = 0.05 x (31)			
Total fabric heat loss	(33) + (36) =	927.56	(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=	1801.33	1796.06	1790.9	1766.66	1762.12	1741.01	1741.01	1737.1	1749.14	1762.12	1771.3	1780.89		(38)

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

(39)m=	2728.89	2723.63	2718.46	2694.22	2689.69	2668.57	2668.57	2664.66	2676.71	2689.69	2698.86	2708.45		
									Average = Sum(39)1..12 /12=				2694.2	(39)

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

(40)m=	1.08	1.08	1.08	1.07	1.06	1.06	1.06	1.06	1.06	1.06	1.07	1.07		
									Average = Sum(40)1..12 /12=				1.07	(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)

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4. Water heating energy requirement:	kWh/year:

Assumed occupancy, N — 6.03 (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 — 177.3 (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=	195.03	187.94	180.84	173.75	166.66	159.57	159.57	166.66	173.75	180.84	187.94	195.03		
										Total = Sum(44)$_{1...12}$ =			2127.58	(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=	289.22	252.96	261.03	227.57	218.36	188.43	174.61	200.36	202.75	236.29	257.93	280.1		
										Total = Sum(45)$_{1...12}$ =			2789.6	(45)
If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)														
(46)m=	43.38	37.94	39.15	34.14	32.75	28.26	26.19	30.05	30.41	35.44	38.69	42.01		(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel — 2000 (47)

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

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

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day):		6.67	(48)
Temperature factor from Table 2b		0.54	(49)
Energy lost from water storage, kWh/year	(48) x (49) =	3.6	(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)		3.6	(55)
Water storage loss calculated for each month	((56)m = (55) × (41)m		

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(56)m=	111.66	100.85	111.66	108.05	111.66	108.05	111.66	111.66	108.05	111.66	108.05	111.66	(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=	111.66	100.85	111.66	108.05	111.66	108.05	111.66	111.66	108.05	111.66	108.05	111.66	(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=	424.14	374.82	395.95	358.14	353.28	318.99	309.52	335.28	333.32	371.21	388.5	415.01	(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=	424.14	374.82	395.95	358.14	353.28	318.99	309.52	335.28	333.32	371.21	388.5	415.01	

Output from water heater (annual)$_{1...12}$ 4378.15 (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=	204.1	181.6	194.73	180.12	180.54	167.1	165.99	174.55	171.87	186.5	190.21	201.07	(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=	361.51	361.51	361.51	361.51	361.51	361.51	361.51	361.51	361.51	361.51	361.51	361.51	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m=	406.42	360.98	293.57	222.25	166.13	140.26	151.55	197	264.41	335.73	391.84	417.72	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m=	2541.88	2568.25	2501.78	2360.28	2181.66	2013.78	1901.62	1875.25	1941.71	2083.22	2261.84	2429.72	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m=	77.18	77.18	77.18	77.18	77.18	77.18	77.18	77.18	77.18	77.18	77.18	77.18	(69)
Pumps and fans gains (Table 5a)													
(70)m=	6	6	6	6	6	6	6	6	6	6	6	6	(70)
Losses e.g. evaporation (negative values) (Table 5)													
(71)m=	-241.01	-241.01	-241.01	-241.01	-241.01	-241.01	-241.01	-241.01	-241.01	-241.01	-241.01	-241.01	(71)
Water heating gains (Table 5)													
(72)m=	274.33	270.23	261.73	250.17	242.66	232.09	223.11	234.62	238.71	250.67	264.19	270.25	(72)
Total internal gains =							(66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m						
(73)m=	3426.31	3403.15	3260.76	3036.38	2794.13	2589.81	2479.96	2510.54	2648.51	2873.3	3121.55	3321.37	(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)	
North	0.9x	0.77	x	11.16	x	10.63	x	0.63	x	0.7	=	72.53	(74)
North	0.9x	0.77	x	5.58	x	10.63	x	0.63	x	0.7	=	90.67	(74)
North	0.9x	0.77	x	2.73	x	10.63	x	0.63	x	0.7	=	53.23	(74)
North	0.9x	0.77	x	5.4	x	10.63	x	0.63	x	0.7	=	17.55	(74)
North	0.9x	0.77	x	1.96	x	10.63	x	0.63	x	0.7	=	25.48	(74)
North	0.9x	0.77	x	4.08	x	10.63	x	0.63	x	0.7	=	13.26	(74)
North	0.9x	0.77	x	11.16	x	20.32	x	0.63	x	0.7	=	138.61	(74)
North	0.9x	0.77	x	5.58	x	20.32	x	0.63	x	0.7	=	173.27	(74)
North	0.9x	0.77	x	2.73	x	20.32	x	0.63	x	0.7	=	101.73	(74)
North	0.9x	0.77	x	5.4	x	20.32	x	0.63	x	0.7	=	33.54	(74)
North	0.9x	0.77	x	1.96	x	20.32	x	0.63	x	0.7	=	48.69	(74)
North	0.9x	0.77	x	4.08	x	20.32	x	0.63	x	0.7	=	25.34	(74)

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North	0.9x	0.77	x	11.16	x	34.53	x	0.63	x	0.7	=	235.54	(74)
North	0.9x	0.77	x	5.58	x	34.53	x	0.63	x	0.7	=	294.43	(74)
North	0.9x	0.77	x	2.73	x	34.53	x	0.63	x	0.7	=	172.86	(74)
North	0.9x	0.77	x	5.4	x	34.53	x	0.63	x	0.7	=	56.99	(74)
North	0.9x	0.77	x	1.96	x	34.53	x	0.63	x	0.7	=	82.73	(74)
North	0.9x	0.77	x	4.08	x	34.53	x	0.63	x	0.7	=	43.06	(74)
North	0.9x	0.77	x	11.16	x	55.46	x	0.63	x	0.7	=	378.34	(74)
North	0.9x	0.77	x	5.58	x	55.46	x	0.63	x	0.7	=	472.92	(74)
North	0.9x	0.77	x	2.73	x	55.46	x	0.63	x	0.7	=	277.65	(74)
North	0.9x	0.77	x	5.4	x	55.46	x	0.63	x	0.7	=	91.53	(74)
North	0.9x	0.77	x	1.96	x	55.46	x	0.63	x	0.7	=	132.89	(74)
North	0.9x	0.77	x	4.08	x	55.46	x	0.63	x	0.7	=	69.16	(74)
North	0.9x	0.77	x	11.16	x	74.72	x	0.63	x	0.7	=	509.66	(74)
North	0.9x	0.77	x	5.58	x	74.72	x	0.63	x	0.7	=	637.07	(74)
North	0.9x	0.77	x	2.73	x	74.72	x	0.63	x	0.7	=	374.02	(74)
North	0.9x	0.77	x	5.4	x	74.72	x	0.63	x	0.7	=	123.3	(74)
North	0.9x	0.77	x	1.96	x	74.72	x	0.63	x	0.7	=	179.02	(74)
North	0.9x	0.77	x	4.08	x	74.72	x	0.63	x	0.7	=	93.16	(74)
North	0.9x	0.77	x	11.16	x	79.99	x	0.63	x	0.7	=	545.6	(74)
North	0.9x	0.77	x	5.58	x	79.99	x	0.63	x	0.7	=	682	(74)
North	0.9x	0.77	x	2.73	x	79.99	x	0.63	x	0.7	=	400.4	(74)
North	0.9x	0.77	x	5.4	x	79.99	x	0.63	x	0.7	=	132	(74)
North	0.9x	0.77	x	1.96	x	79.99	x	0.63	x	0.7	=	191.65	(74)
North	0.9x	0.77	x	4.08	x	79.99	x	0.63	x	0.7	=	99.73	(74)
North	0.9x	0.77	x	11.16	x	74.68	x	0.63	x	0.7	=	509.39	(74)
North	0.9x	0.77	x	5.58	x	74.68	x	0.63	x	0.7	=	636.74	(74)
North	0.9x	0.77	x	2.73	x	74.68	x	0.63	x	0.7	=	373.83	(74)
North	0.9x	0.77	x	5.4	x	74.68	x	0.63	x	0.7	=	123.24	(74)
North	0.9x	0.77	x	1.96	x	74.68	x	0.63	x	0.7	=	178.93	(74)
North	0.9x	0.77	x	4.08	x	74.68	x	0.63	x	0.7	=	93.11	(74)
North	0.9x	0.77	x	11.16	x	59.25	x	0.63	x	0.7	=	404.14	(74)
North	0.9x	0.77	x	5.58	x	59.25	x	0.63	x	0.7	=	505.17	(74)
North	0.9x	0.77	x	2.73	x	59.25	x	0.63	x	0.7	=	296.58	(74)
North	0.9x	0.77	x	5.4	x	59.25	x	0.63	x	0.7	=	97.77	(74)
North	0.9x	0.77	x	1.96	x	59.25	x	0.63	x	0.7	=	141.95	(74)
North	0.9x	0.77	x	4.08	x	59.25	x	0.63	x	0.7	=	73.87	(74)
North	0.9x	0.77	x	11.16	x	41.52	x	0.63	x	0.7	=	283.2	(74)
North	0.9x	0.77	x	5.58	x	41.52	x	0.63	x	0.7	=	354	(74)
North	0.9x	0.77	x	2.73	x	41.52	x	0.63	x	0.7	=	207.83	(74)
North	0.9x	0.77	x	5.4	x	41.52	x	0.63	x	0.7	=	68.52	(74)
North	0.9x	0.77	x	1.96	x	41.52	x	0.63	x	0.7	=	99.47	(74)

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North	0.9x	0.77	x	4.08	x	41.52	x	0.63	x	0.7	=	51.77	(74)
North	0.9x	0.77	x	11.16	x	24.19	x	0.63	x	0.7	=	165	(74)
North	0.9x	0.77	x	5.58	x	24.19	x	0.63	x	0.7	=	206.25	(74)
North	0.9x	0.77	x	2.73	x	24.19	x	0.63	x	0.7	=	121.09	(74)
North	0.9x	0.77	x	5.4	x	24.19	x	0.63	x	0.7	=	39.92	(74)
North	0.9x	0.77	x	1.96	x	24.19	x	0.63	x	0.7	=	57.96	(74)
North	0.9x	0.77	x	4.08	x	24.19	x	0.63	x	0.7	=	30.16	(74)
North	0.9x	0.77	x	11.16	x	13.12	x	0.63	x	0.7	=	89.48	(74)
North	0.9x	0.77	x	5.58	x	13.12	x	0.63	x	0.7	=	111.85	(74)
North	0.9x	0.77	x	2.73	x	13.12	x	0.63	x	0.7	=	65.67	(74)
North	0.9x	0.77	x	5.4	x	13.12	x	0.63	x	0.7	=	21.65	(74)
North	0.9x	0.77	x	1.96	x	13.12	x	0.63	x	0.7	=	31.43	(74)
North	0.9x	0.77	x	4.08	x	13.12	x	0.63	x	0.7	=	16.36	(74)
North	0.9x	0.77	x	11.16	x	8.86	x	0.63	x	0.7	=	60.47	(74)
North	0.9x	0.77	x	5.58	x	8.86	x	0.63	x	0.7	=	75.58	(74)
North	0.9x	0.77	x	2.73	x	8.86	x	0.63	x	0.7	=	44.38	(74)
North	0.9x	0.77	x	5.4	x	8.86	x	0.63	x	0.7	=	14.63	(74)
North	0.9x	0.77	x	1.96	x	8.86	x	0.63	x	0.7	=	21.24	(74)
North	0.9x	0.77	x	4.08	x	8.86	x	0.63	x	0.7	=	11.05	(74)
East	0.9x	0.54	x	4.79	x	19.64	x	0.63	x	0.7	=	20.16	(76)
East	0.9x	0.54	x	13.04	x	19.64	x	0.63	x	0.7	=	54.89	(76)
East	0.9x	0.54	x	16.83	x	19.64	x	0.63	x	0.7	=	70.84	(76)
East	0.9x	0.54	x	7.19	x	19.64	x	0.63	x	0.7	=	30.27	(76)
East	0.9x	0.77	x	3.38	x	19.64	x	0.63	x	0.7	=	20.29	(76)
East	0.9x	0.77	x	5.58	x	19.64	x	0.63	x	0.7	=	200.96	(76)
East	0.9x	0.77	x	2.73	x	19.64	x	0.63	x	0.7	=	81.93	(76)
East	0.9x	0.77	x	3.9	x	19.64	x	0.63	x	0.7	=	46.82	(76)
East	0.9x	0.77	x	1.96	x	19.64	x	0.63	x	0.7	=	35.29	(76)
East	0.9x	0.54	x	4.79	x	38.42	x	0.63	x	0.7	=	39.44	(76)
East	0.9x	0.54	x	13.04	x	38.42	x	0.63	x	0.7	=	107.38	(76)
East	0.9x	0.54	x	16.83	x	38.42	x	0.63	x	0.7	=	138.59	(76)
East	0.9x	0.54	x	7.19	x	38.42	x	0.63	x	0.7	=	59.21	(76)
East	0.9x	0.77	x	3.38	x	38.42	x	0.63	x	0.7	=	39.69	(76)
East	0.9x	0.77	x	5.58	x	38.42	x	0.63	x	0.7	=	393.12	(76)
East	0.9x	0.77	x	2.73	x	38.42	x	0.63	x	0.7	=	160.28	(76)
East	0.9x	0.77	x	3.9	x	38.42	x	0.63	x	0.7	=	91.59	(76)
East	0.9x	0.77	x	1.96	x	38.42	x	0.63	x	0.7	=	69.04	(76)
East	0.9x	0.54	x	4.79	x	63.27	x	0.63	x	0.7	=	64.96	(76)
East	0.9x	0.54	x	13.04	x	63.27	x	0.63	x	0.7	=	176.84	(76)
East	0.9x	0.54	x	16.83	x	63.27	x	0.63	x	0.7	=	228.23	(76)
East	0.9x	0.54	x	7.19	x	63.27	x	0.63	x	0.7	=	97.5	(76)

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East	0.9x	0.77	x	3.38	x	63.27	x	0.63	x	0.7	=	65.36	(76)
East	0.9x	0.77	x	5.58	x	63.27	x	0.63	x	0.7	=	647.41	(76)
East	0.9x	0.77	x	2.73	x	63.27	x	0.63	x	0.7	=	263.95	(76)
East	0.9x	0.77	x	3.9	x	63.27	x	0.63	x	0.7	=	150.83	(76)
East	0.9x	0.77	x	1.96	x	63.27	x	0.63	x	0.7	=	113.7	(76)
East	0.9x	0.54	x	4.79	x	92.28	x	0.63	x	0.7	=	94.74	(76)
East	0.9x	0.54	x	13.04	x	92.28	x	0.63	x	0.7	=	257.91	(76)
East	0.9x	0.54	x	16.83	x	92.28	x	0.63	x	0.7	=	332.86	(76)
East	0.9x	0.54	x	7.19	x	92.28	x	0.63	x	0.7	=	142.2	(76)
East	0.9x	0.77	x	3.38	x	92.28	x	0.63	x	0.7	=	95.32	(76)
East	0.9x	0.77	x	5.58	x	92.28	x	0.63	x	0.7	=	944.2	(76)
East	0.9x	0.77	x	2.73	x	92.28	x	0.63	x	0.7	=	384.96	(76)
East	0.9x	0.77	x	3.9	x	92.28	x	0.63	x	0.7	=	219.98	(76)
East	0.9x	0.77	x	1.96	x	92.28	x	0.63	x	0.7	=	165.83	(76)
East	0.9x	0.54	x	4.79	x	113.09	x	0.63	x	0.7	=	116.1	(76)
East	0.9x	0.54	x	13.04	x	113.09	x	0.63	x	0.7	=	316.07	(76)
East	0.9x	0.54	x	16.83	x	113.09	x	0.63	x	0.7	=	407.94	(76)
East	0.9x	0.54	x	7.19	x	113.09	x	0.63	x	0.7	=	174.28	(76)
East	0.9x	0.77	x	3.38	x	113.09	x	0.63	x	0.7	=	116.82	(76)
East	0.9x	0.77	x	5.58	x	113.09	x	0.63	x	0.7	=	1157.16	(76)
East	0.9x	0.77	x	2.73	x	113.09	x	0.63	x	0.7	=	471.78	(76)
East	0.9x	0.77	x	3.9	x	113.09	x	0.63	x	0.7	=	269.59	(76)
East	0.9x	0.77	x	1.96	x	113.09	x	0.63	x	0.7	=	203.23	(76)
East	0.9x	0.54	x	4.79	x	115.77	x	0.63	x	0.7	=	118.85	(76)
East	0.9x	0.54	x	13.04	x	115.77	x	0.63	x	0.7	=	323.56	(76)
East	0.9x	0.54	x	16.83	x	115.77	x	0.63	x	0.7	=	417.6	(76)
East	0.9x	0.54	x	7.19	x	115.77	x	0.63	x	0.7	=	178.4	(76)
East	0.9x	0.77	x	3.38	x	115.77	x	0.63	x	0.7	=	119.59	(76)
East	0.9x	0.77	x	5.58	x	115.77	x	0.63	x	0.7	=	1184.56	(76)
East	0.9x	0.77	x	2.73	x	115.77	x	0.63	x	0.7	=	482.95	(76)
East	0.9x	0.77	x	3.9	x	115.77	x	0.63	x	0.7	=	275.97	(76)
East	0.9x	0.77	x	1.96	x	115.77	x	0.63	x	0.7	=	208.04	(76)
East	0.9x	0.54	x	4.79	x	110.22	x	0.63	x	0.7	=	113.15	(76)
East	0.9x	0.54	x	13.04	x	110.22	x	0.63	x	0.7	=	308.04	(76)
East	0.9x	0.54	x	16.83	x	110.22	x	0.63	x	0.7	=	397.57	(76)
East	0.9x	0.54	x	7.19	x	110.22	x	0.63	x	0.7	=	169.85	(76)
East	0.9x	0.77	x	3.38	x	110.22	x	0.63	x	0.7	=	113.85	(76)
East	0.9x	0.77	x	5.58	x	110.22	x	0.63	x	0.7	=	1127.74	(76)
East	0.9x	0.77	x	2.73	x	110.22	x	0.63	x	0.7	=	459.79	(76)
East	0.9x	0.77	x	3.9	x	110.22	x	0.63	x	0.7	=	262.74	(76)
East	0.9x	0.77	x	1.96	x	110.22	x	0.63	x	0.7	=	198.06	(76)

East	0.9x	0.54	x	4.79	x	94.68	x	0.63	x	0.7	=	97.2	(76)
East	0.9x	0.54	x	13.04	x	94.68	x	0.63	x	0.7	=	264.6	(76)
East	0.9x	0.54	x	16.83	x	94.68	x	0.63	x	0.7	=	341.51	(76)
East	0.9x	0.54	x	7.19	x	94.68	x	0.63	x	0.7	=	145.9	(76)
East	0.9x	0.77	x	3.38	x	94.68	x	0.63	x	0.7	=	97.8	(76)
East	0.9x	0.77	x	5.58	x	94.68	x	0.63	x	0.7	=	968.72	(76)
East	0.9x	0.77	x	2.73	x	94.68	x	0.63	x	0.7	=	394.95	(76)
East	0.9x	0.77	x	3.9	x	94.68	x	0.63	x	0.7	=	225.69	(76)
East	0.9x	0.77	x	1.96	x	94.68	x	0.63	x	0.7	=	170.13	(76)
East	0.9x	0.54	x	4.79	x	73.59	x	0.63	x	0.7	=	75.55	(76)
East	0.9x	0.54	x	13.04	x	73.59	x	0.63	x	0.7	=	205.67	(76)
East	0.9x	0.54	x	16.83	x	73.59	x	0.63	x	0.7	=	265.44	(76)
East	0.9x	0.54	x	7.19	x	73.59	x	0.63	x	0.7	=	113.4	(76)
East	0.9x	0.77	x	3.38	x	73.59	x	0.63	x	0.7	=	76.02	(76)
East	0.9x	0.77	x	5.58	x	73.59	x	0.63	x	0.7	=	752.96	(76)
East	0.9x	0.77	x	2.73	x	73.59	x	0.63	x	0.7	=	306.99	(76)
East	0.9x	0.77	x	3.9	x	73.59	x	0.63	x	0.7	=	175.42	(76)
East	0.9x	0.77	x	1.96	x	73.59	x	0.63	x	0.7	=	132.24	(76)
East	0.9x	0.54	x	4.79	x	45.59	x	0.63	x	0.7	=	46.8	(76)
East	0.9x	0.54	x	13.04	x	45.59	x	0.63	x	0.7	=	127.41	(76)
East	0.9x	0.54	x	16.83	x	45.59	x	0.63	x	0.7	=	164.45	(76)
East	0.9x	0.54	x	7.19	x	45.59	x	0.63	x	0.7	=	70.25	(76)
East	0.9x	0.77	x	3.38	x	45.59	x	0.63	x	0.7	=	47.09	(76)
East	0.9x	0.77	x	5.58	x	45.59	x	0.63	x	0.7	=	466.47	(76)
East	0.9x	0.77	x	2.73	x	45.59	x	0.63	x	0.7	=	190.18	(76)
East	0.9x	0.77	x	3.9	x	45.59	x	0.63	x	0.7	=	108.67	(76)
East	0.9x	0.77	x	1.96	x	45.59	x	0.63	x	0.7	=	81.92	(76)
East	0.9x	0.54	x	4.79	x	24.49	x	0.63	x	0.7	=	25.14	(76)
East	0.9x	0.54	x	13.04	x	24.49	x	0.63	x	0.7	=	68.44	(76)
East	0.9x	0.54	x	16.83	x	24.49	x	0.63	x	0.7	=	88.33	(76)
East	0.9x	0.54	x	7.19	x	24.49	x	0.63	x	0.7	=	37.74	(76)
East	0.9x	0.77	x	3.38	x	24.49	x	0.63	x	0.7	=	25.3	(76)
East	0.9x	0.77	x	5.58	x	24.49	x	0.63	x	0.7	=	250.57	(76)
East	0.9x	0.77	x	2.73	x	24.49	x	0.63	x	0.7	=	102.16	(76)
East	0.9x	0.77	x	3.9	x	24.49	x	0.63	x	0.7	=	58.38	(76)
East	0.9x	0.77	x	1.96	x	24.49	x	0.63	x	0.7	=	44.01	(76)
East	0.9x	0.54	x	4.79	x	16.15	x	0.63	x	0.7	=	16.58	(76)
East	0.9x	0.54	x	13.04	x	16.15	x	0.63	x	0.7	=	45.14	(76)
East	0.9x	0.54	x	16.83	x	16.15	x	0.63	x	0.7	=	58.26	(76)
East	0.9x	0.54	x	7.19	x	16.15	x	0.63	x	0.7	=	24.89	(76)
East	0.9x	0.77	x	3.38	x	16.15	x	0.63	x	0.7	=	16.68	(76)

East	0.9x	0.77	x	5.58	x	16.15	x	0.63	x	0.7	=	165.26	(76)
East	0.9x	0.77	x	2.73	x	16.15	x	0.63	x	0.7	=	67.38	(76)
East	0.9x	0.77	x	3.9	x	16.15	x	0.63	x	0.7	=	38.5	(76)
East	0.9x	0.77	x	1.96	x	16.15	x	0.63	x	0.7	=	29.02	(76)
South	0.9x	0.77	x	3.38	x	46.75	x	0.63	x	0.7	=	386.35	(78)
South	0.9x	0.77	x	2.73	x	46.75	x	0.63	x	0.7	=	351.06	(78)
South	0.9x	0.77	x	1.96	x	46.75	x	0.63	x	0.7	=	140.02	(78)
South	0.9x	0.77	x	3.38	x	76.57	x	0.63	x	0.7	=	632.74	(78)
South	0.9x	0.77	x	2.73	x	76.57	x	0.63	x	0.7	=	574.94	(78)
South	0.9x	0.77	x	1.96	x	76.57	x	0.63	x	0.7	=	229.32	(78)
South	0.9x	0.77	x	3.38	x	97.53	x	0.63	x	0.7	=	806	(78)
South	0.9x	0.77	x	2.73	x	97.53	x	0.63	x	0.7	=	732.37	(78)
South	0.9x	0.77	x	1.96	x	97.53	x	0.63	x	0.7	=	292.11	(78)
South	0.9x	0.77	x	3.38	x	110.23	x	0.63	x	0.7	=	910.95	(78)
South	0.9x	0.77	x	2.73	x	110.23	x	0.63	x	0.7	=	827.74	(78)
South	0.9x	0.77	x	1.96	x	110.23	x	0.63	x	0.7	=	330.15	(78)
South	0.9x	0.77	x	3.38	x	114.87	x	0.63	x	0.7	=	949.27	(78)
South	0.9x	0.77	x	2.73	x	114.87	x	0.63	x	0.7	=	862.56	(78)
South	0.9x	0.77	x	1.96	x	114.87	x	0.63	x	0.7	=	344.04	(78)
South	0.9x	0.77	x	3.38	x	110.55	x	0.63	x	0.7	=	913.54	(78)
South	0.9x	0.77	x	2.73	x	110.55	x	0.63	x	0.7	=	830.09	(78)
South	0.9x	0.77	x	1.96	x	110.55	x	0.63	x	0.7	=	331.09	(78)
South	0.9x	0.77	x	3.38	x	108.01	x	0.63	x	0.7	=	892.59	(78)
South	0.9x	0.77	x	2.73	x	108.01	x	0.63	x	0.7	=	811.05	(78)
South	0.9x	0.77	x	1.96	x	108.01	x	0.63	x	0.7	=	323.5	(78)
South	0.9x	0.77	x	3.38	x	104.89	x	0.63	x	0.7	=	866.82	(78)
South	0.9x	0.77	x	2.73	x	104.89	x	0.63	x	0.7	=	787.64	(78)
South	0.9x	0.77	x	1.96	x	104.89	x	0.63	x	0.7	=	314.16	(78)
South	0.9x	0.77	x	3.38	x	101.89	x	0.63	x	0.7	=	841.96	(78)
South	0.9x	0.77	x	2.73	x	101.89	x	0.63	x	0.7	=	765.05	(78)
South	0.9x	0.77	x	1.96	x	101.89	x	0.63	x	0.7	=	305.15	(78)
South	0.9x	0.77	x	3.38	x	82.59	x	0.63	x	0.7	=	682.47	(78)
South	0.9x	0.77	x	2.73	x	82.59	x	0.63	x	0.7	=	620.13	(78)
South	0.9x	0.77	x	1.96	x	82.59	x	0.63	x	0.7	=	247.34	(78)
South	0.9x	0.77	x	3.38	x	55.42	x	0.63	x	0.7	=	457.95	(78)
South	0.9x	0.77	x	2.73	x	55.42	x	0.63	x	0.7	=	416.12	(78)
South	0.9x	0.77	x	1.96	x	55.42	x	0.63	x	0.7	=	165.97	(78)
South	0.9x	0.77	x	3.38	x	40.4	x	0.63	x	0.7	=	333.84	(78)
South	0.9x	0.77	x	2.73	x	40.4	x	0.63	x	0.7	=	303.35	(78)
South	0.9x	0.77	x	1.96	x	40.4	x	0.63	x	0.7	=	120.99	(78)
West	0.9x	0.77	x	5.58	x	19.64	x	0.63	x	0.7	=	133.97	(80)

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West	0.9x	0.77	x	3.38	x	19.64	x	0.63	x	0.7	=	40.58	(80)
West	0.9x	0.77	x	2.73	x	19.64	x	0.63	x	0.7	=	98.32	(80)
West	0.9x	0.77	x	1.96	x	19.64	x	0.63	x	0.7	=	35.29	(80)
West	0.9x	0.77	x	5.58	x	38.42	x	0.63	x	0.7	=	262.08	(80)
West	0.9x	0.77	x	3.38	x	38.42	x	0.63	x	0.7	=	79.37	(80)
West	0.9x	0.77	x	2.73	x	38.42	x	0.63	x	0.7	=	192.33	(80)
West	0.9x	0.77	x	1.96	x	38.42	x	0.63	x	0.7	=	69.04	(80)
West	0.9x	0.77	x	5.58	x	63.27	x	0.63	x	0.7	=	431.6	(80)
West	0.9x	0.77	x	3.38	x	63.27	x	0.63	x	0.7	=	130.72	(80)
West	0.9x	0.77	x	2.73	x	63.27	x	0.63	x	0.7	=	316.74	(80)
West	0.9x	0.77	x	1.96	x	63.27	x	0.63	x	0.7	=	113.7	(80)
West	0.9x	0.77	x	5.58	x	92.28	x	0.63	x	0.7	=	629.47	(80)
West	0.9x	0.77	x	3.38	x	92.28	x	0.63	x	0.7	=	190.65	(80)
West	0.9x	0.77	x	2.73	x	92.28	x	0.63	x	0.7	=	461.95	(80)
West	0.9x	0.77	x	1.96	x	92.28	x	0.63	x	0.7	=	165.83	(80)
West	0.9x	0.77	x	5.58	x	113.09	x	0.63	x	0.7	=	771.44	(80)
West	0.9x	0.77	x	3.38	x	113.09	x	0.63	x	0.7	=	233.64	(80)
West	0.9x	0.77	x	2.73	x	113.09	x	0.63	x	0.7	=	566.14	(80)
West	0.9x	0.77	x	1.96	x	113.09	x	0.63	x	0.7	=	203.23	(80)
West	0.9x	0.77	x	5.58	x	115.77	x	0.63	x	0.7	=	789.7	(80)
West	0.9x	0.77	x	3.38	x	115.77	x	0.63	x	0.7	=	239.18	(80)
West	0.9x	0.77	x	2.73	x	115.77	x	0.63	x	0.7	=	579.54	(80)
West	0.9x	0.77	x	1.96	x	115.77	x	0.63	x	0.7	=	208.04	(80)
West	0.9x	0.77	x	5.58	x	110.22	x	0.63	x	0.7	=	751.83	(80)
West	0.9x	0.77	x	3.38	x	110.22	x	0.63	x	0.7	=	227.7	(80)
West	0.9x	0.77	x	2.73	x	110.22	x	0.63	x	0.7	=	551.75	(80)
West	0.9x	0.77	x	1.96	x	110.22	x	0.63	x	0.7	=	198.06	(80)
West	0.9x	0.77	x	5.58	x	94.68	x	0.63	x	0.7	=	645.81	(80)
West	0.9x	0.77	x	3.38	x	94.68	x	0.63	x	0.7	=	195.59	(80)
West	0.9x	0.77	x	2.73	x	94.68	x	0.63	x	0.7	=	473.94	(80)
West	0.9x	0.77	x	1.96	x	94.68	x	0.63	x	0.7	=	170.13	(80)
West	0.9x	0.77	x	5.58	x	73.59	x	0.63	x	0.7	=	501.97	(80)
West	0.9x	0.77	x	3.38	x	73.59	x	0.63	x	0.7	=	152.03	(80)
West	0.9x	0.77	x	2.73	x	73.59	x	0.63	x	0.7	=	368.38	(80)
West	0.9x	0.77	x	1.96	x	73.59	x	0.63	x	0.7	=	132.24	(80)
West	0.9x	0.77	x	5.58	x	45.59	x	0.63	x	0.7	=	310.98	(80)
West	0.9x	0.77	x	3.38	x	45.59	x	0.63	x	0.7	=	94.18	(80)
West	0.9x	0.77	x	2.73	x	45.59	x	0.63	x	0.7	=	228.22	(80)
West	0.9x	0.77	x	1.96	x	45.59	x	0.63	x	0.7	=	81.92	(80)
West	0.9x	0.77	x	5.58	x	24.49	x	0.63	x	0.7	=	167.05	(80)
West	0.9x	0.77	x	3.38	x	24.49	x	0.63	x	0.7	=	50.59	(80)

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West	0.9x	0.77	x	2.73	x	24.49	x	0.63	x	0.7	=	122.59	(80)
West	0.9x	0.77	x	1.96	x	24.49	x	0.63	x	0.7	=	44.01	(80)
West	0.9x	0.77	x	5.58	x	16.15	x	0.63	x	0.7	=	110.17	(80)
West	0.9x	0.77	x	3.38	x	16.15	x	0.63	x	0.7	=	33.37	(80)
West	0.9x	0.77	x	2.73	x	16.15	x	0.63	x	0.7	=	80.85	(80)
West	0.9x	0.77	x	1.96	x	16.15	x	0.63	x	0.7	=	29.02	(80)
Rooflights	0.9x	1	x	46.34	x	26	x	0.63	x	0.7	=	478.2	(82)
Rooflights	0.9x	1	x	46.34	x	54	x	0.63	x	0.7	=	993.19	(82)
Rooflights	0.9x	1	x	46.34	x	96	x	0.63	x	0.7	=	1765.67	(82)
Rooflights	0.9x	1	x	46.34	x	150	x	0.63	x	0.7	=	2758.85	(82)
Rooflights	0.9x	1	x	46.34	x	192	x	0.63	x	0.7	=	3531.33	(82)
Rooflights	0.9x	1	x	46.34	x	200	x	0.63	x	0.7	=	3678.47	(82)
Rooflights	0.9x	1	x	46.34	x	189	x	0.63	x	0.7	=	3476.15	(82)
Rooflights	0.9x	1	x	46.34	x	157	x	0.63	x	0.7	=	2887.6	(82)
Rooflights	0.9x	1	x	46.34	x	115	x	0.63	x	0.7	=	2115.12	(82)
Rooflights	0.9x	1	x	46.34	x	66	x	0.63	x	0.7	=	1213.89	(82)
Rooflights	0.9x	1	x	46.34	x	33	x	0.63	x	0.7	=	606.95	(82)
Rooflights	0.9x	1	x	46.34	x	21	x	0.63	x	0.7	=	386.24	(82)

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

(83)m=	2497.96	4652.51	7283.29	10336.08	12610.84	12930.56	12298.66	10567.68	8350.37	5402.78	3067.73	2086.89	(83)

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

(84)m=	5924.26	8055.65	10544.06	13372.46	15404.97	15520.36	14778.62	13078.22	10998.88	8276.07	6189.28	5408.26	(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	0.99	0.97	0.88	0.73	0.81	0.97	1	1	1	(86)

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

(87)m=	19.83	19.94	20.13	20.4	20.66	20.85	20.92	20.9	20.73	20.39	20.06	19.81	(87)

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

(88)m=	20.02	20.02	20.02	20.03	20.03	20.04	20.04	20.04	20.03	20.03	20.03	20.02	(88)

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

(89)m=	1	1	1	0.99	0.95	0.81	0.6	0.7	0.95	1	1	1	(89)

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

(90)m=	18.41	18.57	18.86	19.26	19.64	19.88	19.95	19.94	19.74	19.25	18.76	18.4	(90)

fLA = Living area ÷ (4) = 0.05 (91)

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

(92)m=	18.48	18.64	18.92	19.32	19.69	19.93	20	19.99	19.78	19.3	18.83	18.47	(92)

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

(93)m=	18.48	18.64	18.92	19.32	19.69	19.93	20	19.99	19.78	19.3	18.83	18.47	(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	1	0.99	0.95	0.8	0.6	0.69	0.94	1	1	1	(94)

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

(95)m=	5924.02	8053.79	10528.89	13237.59	14566.72	12485.01	8804.95	9009.13	10387.53	8255.44	6188.45	5408.13	(95)

Monthly average external temperature from Table 8

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

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

(97)m=	38701.08	37421.82	33769.43	28065.16	21479.11	14227.23	9069.88	9558.19	15214.89	23405.81	31647.12	38641.03	(97)

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

(98)m=	24386.14	19735.32	17290.96	10675.85	5142.82	0	0	0	0	11271.88	18330.24	24725.28	

Total per year (kWh/year) = Sum(98)1...5,9...12 = 131558.49 (98)

Space heating requirement in kWh/m²/year 52.09 (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	25084.6	19747.45	20251.45	0	0	0	0	(100)
Utilisation factor for loss hm													
(101)m=	0	0	0	0	0	0.65	0.76	0.68	0	0	0	0	(101)
Useful loss, hmLm (Watts) = (100)m x (101)m													
(102)m=	0	0	0	0	0	16427.14	14919.22	13710.78	0	0	0	0	(102)
Gains (solar gains calculated for applicable weather region, see Table 10)													
(103)m=	0	0	0	0	0	17208.77	16388.15	14477.1	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	562.77	1092.88	0	0	0	0	0

Total = Sum(104) = 1655.65 (104)

Cooled fraction — f C = cooled area ÷ (4) = 0.59 (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	83.56	162.27	0	0	0	0	0

Total = Sum(107) = 245.83 (107)

Space cooling requirement in kWh/m²/year — (107) ÷ (4) = 0.1 (108)

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

Space heating:

Fraction of space heat from secondary/supplementary system		0.1	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	0.9	(202)
Fraction of main heating from main system 2		0.1	(203)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	0.81	(204)
Fraction of total heating from main system 2	(205) = (202) × (203) =	0.09	(205)
Efficiency of main space heating system 1		319.7	(206)

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Efficiency of main space heating system 2	93.3	(207)
Efficiency of secondary/supplementary heating system, %	80	(208)
Cooling System Energy Efficiency Ratio	6.75	(209)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Space heating requirement (calculated above)														
	24386.14	19735.32	17290.96	10675.85	5142.82	0	0	0	0	11271.88	18330.24	24725.28		
(211)m = {[(98)m x (204)] } x 100 ÷ (206)														(211)
	6178.53	5000.19	4380.88	2704.86	1303	0	0	0	0	2855.87	4644.2	6264.46		
Total (kWh/year) =Sum(211)$_{1...5,10...12}$=													33331.99	(211)
(213)m =(98)m x (203) x 100 ÷ (207)														
(213)m=	2352.36	1903.73	1667.94	1029.82	496.09	0	0	0	0	1087.32	1768.19	2385.07		
Total (kWh/year) =Sum(213)$_{1...5,10...12}$=													12690.53	(213)
Space heating fuel (secondary), kWh/month = {[(98)m x (201)] } x 100 ÷ (208)														
(215)m=	3048.27	2466.91	2161.37	1334.48	642.85	0	0	0	0	1408.98	2291.28	3090.66		
Total (kWh/year) =Sum(215)$_{1...5,10...12}$=													16444.81	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Output from water heater (calculated above)	424.14	374.82	395.95	358.14	353.28	318.99	309.52	335.28	333.32	371.21	388.5	415.01		
Efficiency of water heater													79.6	(216)
(217)m=	88.38	88.23	87.9	87.12	85.33	79.6	79.6	79.6	79.6	87.16	88.04	88.43		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	479.93	424.8	450.43	411.08	413.99	400.74	388.85	421.21	418.74	425.89	441.25	469.31		
Total = Sum(219a)$_{1...12}$ =													5146.22	(219)

Space cooling fuel, kWh/month.

(221)m = (107)m÷ (209)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
(221)m=	0	0	0	0	0	12.38	24.04	0	0	0	0	0		
Total = Sum(221)$_{6...8}$ =													36.42	(221)

Annual totals

	kWh/year	kWh/year	
Space heating fuel used, main system 1		33331.99	
Space heating fuel used, main system 2		12690.53	
Space heating fuel used, secondary		16444.81	
Water heating fuel used		5146.22	
Space cooling fuel used		36.42	
Electricity for pumps, fans and electric keep-hot			
central heating pump:	60		(230c)
boiler with a fan-assisted flue	45		(230e)
Total electricity for the above, kWh/year — sum of (230a)...(230g) =		105	(231)
Electricity for lighting		2871.02	(232)
Electricity generated by PVs		-3346.17	(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 =	4396.49	(240)
Space heating - main system 2	(213) x	3.48	x 0.01 =	441.63	(241)
Space heating - secondary	(215) x	3.48	x 0.01 =	572.28	(242)
Water heating cost (other fuel)	(219)	3.48	x 0.01 =	179.09	(247)
Space cooling	(221)	13.19	x 0.01 =	4.8	(248)
Pumps, fans and electric keep-hot	(231)	13.19	x 0.01 =	13.85	(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 =	378.69	(250)
Additional standing charges (Table 12)				120	(251)
	one of (233) to (235) x)	13.19	x 0.01 =	-441.36	(252)
Appendix Q items: repeat lines (253) and (254) as needed					
Total energy cost	(245)...(247) + (250)...(254) =			5665.47	(255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.42	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	0.93	(257)
SAP rating (Section 12)		87.09	(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	=	17299.3	(261)
Space heating (main system 2)	(213) x	0.216	=	2741.15	(262)
Space heating (secondary)	(215) x	0.216	=	3552.08	(263)
Water heating	(219) x	0.216	=	1111.58	(264)
Space and water heating	(261) + (262) + (263) + (264) =			24704.12	(265)
Space cooling	(221) x	0.519	=	18.9	(266)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	54.5	(267)
Electricity for lighting	(232) x	0.519	=	1490.06	(268)
Energy saving/generation technologies					
Item 1		0.519	=	-1736.66	(269)
Total CO2, kg/year		sum of (265)...(271) =		24530.91	(272)
CO2 emissions per m²		(272) ÷ (4) =		9.71	(273)
EI rating (section 14)				87	(274)

13a. Primary Energy

SAP WorkSheet: New dwelling design stage

	Energy kWh/year		Primary factor		P. Energy kWh/year	
Space heating (main system 1)	(211)	x	3.07	=	102329.21	(261)
Space heating (main system 2)	(213)	x	1.22	=	15482.45	(262)
Space heating (secondary)	(215)	x	1.22	=	20062.67	(263)
Energy for water heating	(219)	x	1.22	=	6278.39	(264)
Space and water heating	(261) + (262) + (263) + (264) =				144152.72	(265)
Space cooling	(221)	x	3.07	=	111.81	(266)
Electricity for pumps, fans and electric keep-hot	(231)	x	3.07	=	322.35	(267)
Electricity for lighting	(232)	x	0	=	8814.02	(268)
Energy saving/generation technologies Item 1			3.07	=	-10272.74	(269)
'Total Primary Energy			sum of (265)...(271) =		143128.16	(272)
Primary energy kWh/m²/year			(272) ÷ (4) =		56.67	(273)

APPENDIX (iii)

SAP L1A 2013/16 REGULATION COMPLIANCE REPORT

(SAP Checklist)

Regulations Compliance Report

Approved Document L1A, 2013 Edition, England assessed by Stroma FSAP 2012 program, Version: 1.0.5.7
Printed on 05 October 2020 at 16:29:29

Project Information:

Assessed By:	Ondrej Gajdos (STRO006629)	**Building Type:**	Detached House

Dwelling Details:

NEW DWELLING DESIGN STAGE		Total Floor Area: 2525.6m²	
Site Reference :	28AR	**Plot Reference:**	28, Avenue Road
Address :	28, Avenue Road, LONDON, NW8 6BU		

Client Details:

Name:
Address :

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

1a TER and DER

Fuel for main heating system: Electricity (mains gas used for secondary heating)
Fuel factor: 1.55 (electricity (mains gas used for secondary heating))

Target Carbon Dioxide Emission Rate (TER)	13.6 kg/m²	
Dwelling Carbon Dioxide Emission Rate (DER)	10.09 kg/m²	OK

1b TFEE and DFEE

Target Fabric Energy Efficiency (TFEE)	66.5 kWh/m²	
Dwelling Fabric Energy Efficiency (DFEE)	55.5 kWh/m²	
		OK

2 Fabric U-values

Element	Average	Highest	
External wall	0.17 (max. 0.30)	0.18 (max. 0.70)	OK
Floor	0.12 (max. 0.25)	0.12 (max. 0.70)	OK
Roof	0.12 (max. 0.20)	0.12 (max. 0.35)	OK
Openings	1.30 (max. 2.00)	1.30 (max. 3.30)	OK

2a Thermal bridging

Thermal bridging calculated from linear thermal transmittances for each junction

3 Air permeability

Air permeability at 50 pascals	4.00 (design value)	
Maximum	10.0	OK

4 Heating efficiency

Main Heating system:	Heat pumps with radiators or underfloor heating - electric Ground source heat pump with flow temperature <= 35°C
Main Heating system 2:	Database: (rev 465, product index 016566): Boiler systems with radiators or underfloor heating - mains gas Brand name: Remeha Model: Quinta Pro 65 Model qualifier: (Regular) Efficiency 89.3 % SEDBUK2009

Regulations Compliance Report

	Minimum 88.0 %	OK
Secondary heating system:	Room heaters - gas Data from manufacturer - Gas fire or wall heater, balanced flue Efficiency 80.0 % Minimum 63.0 %	OK
5 Cylinder insulation		
Hot water Storage:	Measured cylinder loss: 6.67 kWh/day Permitted by DBSCG: 9.54 kWh/day	OK
Primary pipework insulated:	Yes	OK
6 Controls		
Space heating controls	TTZC by plumbing and electrical services	OK
Space heating controls 2:	Time and temperature zone control by suitable arrangement of plumbing and electrical se	OK
Hot water controls:	Cylinderstat	OK
7 Low energy lights		
Percentage of fixed lights with low-energy fittings	100.0%	
Minimum	75.0%	OK
8 Mechanical ventilation		
Not applicable		
9 Summertime temperature		
Overheating risk (Thames valley):	Not significant	OK
Based on:		
Overshading:	Average or unknown	
Windows facing: East	4.79m²	
Windows facing: East	13.04m²	
Windows facing: East	16.83m²	
Windows facing: East	7.19m²	
Windows facing: South	27.04m²	
Windows facing: South	24.57m²	
Windows facing: South	9.8m²	
Windows facing: West	22.32m²	
Windows facing: West	6.76m²	
Windows facing: West	16.38m²	
Windows facing: West	5.88m²	
Windows facing: North	22.32m²	
Windows facing: North	27.9m²	
Windows facing: North	16.38m²	
Windows facing: North	5.4m²	
Windows facing: North	7.84m²	
Windows facing: North	4.08m²	
Windows facing: East	3.38m²	
Windows facing: East	33.48m²	
Windows facing: East	13.65m²	
Windows facing: East	7.8m²	
Windows facing: East	5.88m²	
Roof windows facing: Horizontal	46.34m²	

Regulations Compliance Report

Ventilation rate:	4.00

10 Key features

Thermal bridging	0.023 W/m²K
Roofs U-value	0.12 W/m²K
Floors U-value	0.12 W/m²K
Floors U-value	0.12 W/m²K
Photovoltaic array	
Fixed cooling system	
Secondary heating (mains gas)	

APPENDIX (iv)

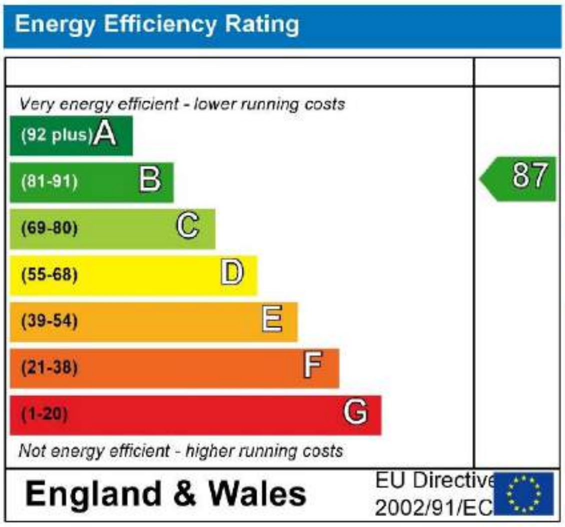
PEA – PREDICTED ENERGY ASSESSMENT (PRE-EPC)

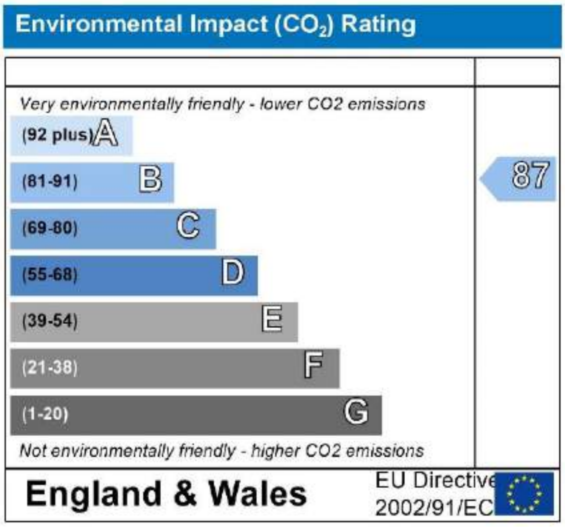
Predicted Energy Assessment

28, Avenue Road LONDON NW8 6BU	Dwelling type: Date of assessment: Produced by: Total floor area:	Detached House 02 October 2020 Ondrej Gajdos 2525.6 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.



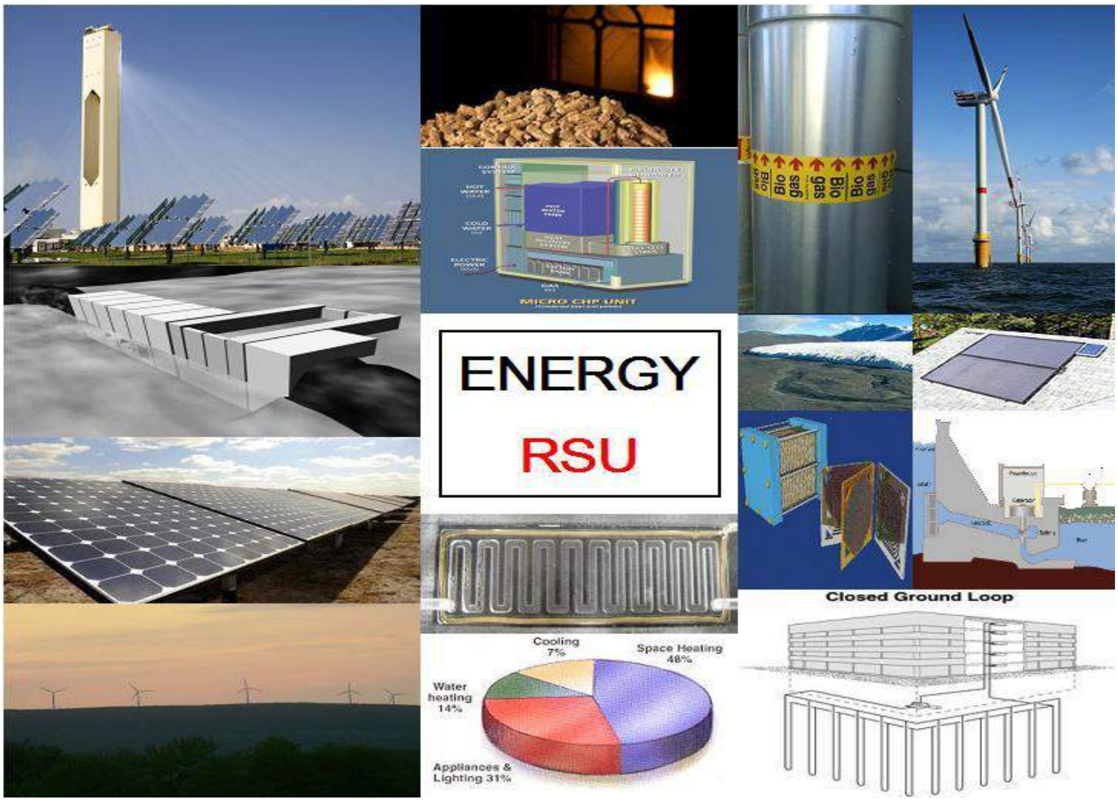


The energy efficiency rating is a measure of the overall efficiency of a home. The higher the rating the more energy efficient the home is and the lower the fuel bills are likely to be.

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 (v)

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)

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