ENERGY & SUSTAINABILITY STATEMENT

36 REDINGTON ROAD, LONDON NW3 7RT

Irvineering LTD

ASSESSMENT INFORMATION

Prepared for:
Archetype Associates Ltd

Prepared by:
Ondrej Gajdos,
Irvineering Ltd

Date:
21 December 2018

DISCLAIMER

The findings, conclusions and recommendations of this report are based on the information supplied. OG Energy Ltd disclaims responsibility in respect of incorrect information imparted to them or for the actual performance of any of the building services installations.
This Report is prepared for the use of 36 Redington Road; a duty of care is not owed to other parties.

CONTENT

ABOUT THE ENERGY STATEMENT

Irvineering 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.

The target is to comply fully with the Camden Council and London Plan Policies and ensure, that the "Energy Hierarchy" is followed. This document has been prepared in line with the GLA Energy Team Guidance on Planning Energy Assessments.

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

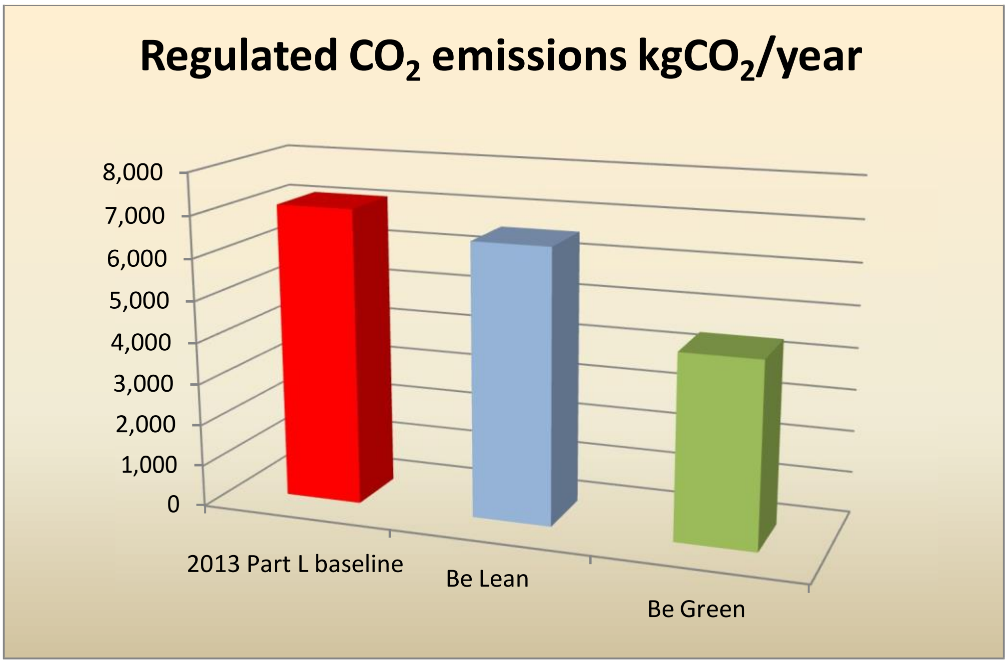
The tables below show a summary of energy requirements for baseline scheme and reduction proposed to be achieved by passive measures, efficient services and on-site renewable energy sources.

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

	Carbon dioxide emissions (Tonnes CO2 per annum)		
	Regulated	Unregulated	Total
Building Regulations 2013 Part L Compliant Development	7.12	3.66	10.78
After energy demand reduction	6.57	3.66	10.23
After PV	4.43	3.66	8.09

Table 2: Carbon Dioxide Savings from each stage of the Energy Hierarchy

	Carbon dioxide savings (Tonnes CO2 per annum)		Carbon dioxide savings (%)	
	Regulated	Total	Regulated	Total
Savings from energy demand reduction	0.55	0.55	7.7%	5.1%
Savings from PV	2.14	2.14	32.5%	20.9%
Total Cumulative Savings	2.69	2.69	**37.7%**	24.9%



Number of passive design measures and energy efficiency measures to reduce CO2 emissions before applying the renewable sources has been included in the design. The table below shows the specification for each stage of the energy hierarchy:

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 & basement wall U-value	0.18	0.18	0.18
Basement floor & ground floor U-value	0.12	0.12	0.12
Exposed floor (soffit) U-value	0.13	0.20	0.20
Roofs and terraces U-value	0.13	0.14	0.14
Windows, doors and rooflights U-value	1.40	0.80	0.80
Thermal bridging	Accredited construction details throughout	Accredited construction details throughout	Accredited construction details throughout
Air Permeability	5	5	5
Space Heating System	Condensing boiler SEDBUK 2009 efficiency 89.5%, radiators, time and temperature zone control, weather compensator	Remeha Quinta Pro 65 (or equivalent, approved by SAP assesor), underfloor heating, time and temperature zone control, delayed start thermostat	Remeha Quinta Pro 65 (or equivalent, approved by SAP assesor), underfloor heating, time and temperature zone control, delayed start thermostat
Secondary Space Heating System	-	Flueless gas fires	Flueless gas fires
DHW System	150 L indirect DHW cylinder	Indirect Cylinder Mikrofill Rapide Extreme 200	Indirect Cylinder Mikrofill Rapide Extreme 200
Ventilation System	Natural with intermittent mechanical extracts	Natural with intermittent mechanical extracts	Natural with intermittent mechanical extracts
Energy Efficient Lighting	100%	100%	100%
Renewable energy sources			PV system with total peak output of 5 kWp with panels facing SE/SW at 15-35 degree pitch
% Improvement in CO2 over Building regulations compliant baseline	**0.0%**	**7.7%**	**37.7%**

Proposed renewable systems include PV system with total peak output of 5 kWp

Table 4: SAP result summary of the proposed development

Residential			Energy Consumption Breakdown						PVs		SAP 2012		% Improvement DER over TER
Unit	Floor area (m2)	FEE (kWh/m2/yr)	Space Heating (kWh/an)	DHW (kWh/an)	Cooling (kWh/a)	Lighting (kWh/an)	Aux (kWh/an)	Un-Reg (kWh/an)	PVs output (kWp)	PVs Energy Offset (kWh/a)	DER	TER	
Proposed House	469.1	52	22,654	2,686	31	954	75	7,054	5.000	-4,117	9.45	15.17	37.7%

The proposed development will achieve:

37.7% overall site regulated CO2 reduction against 2013 Part L compliant baseline.

32.5% reduction in regulated CO2 by renewable sources

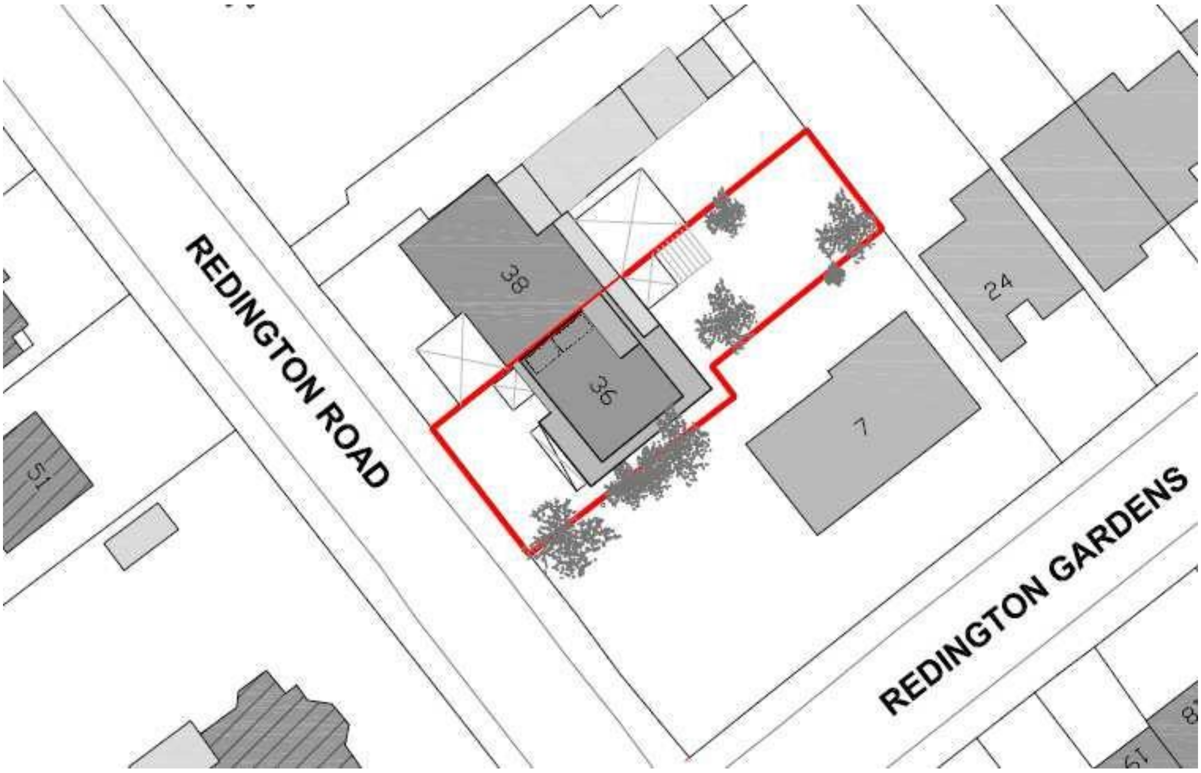
20.9% reduction in total CO2 (regulated and un-regulated) by renewable sources

BACKGROUND

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

DESCRIPTION OF THE SITE

It is proposed to demolish the existing building on the site to make way for a new Erection of a four storey single family dwelling including basement level, ground, first and 2nd floor with solar panels at roof level and associated landscaping.



2.1 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.

2.2 THE LONDON PLAN

The London Plan is the name given to the Mayor's spatial development strategy. The current version of London Plan was published in 2011 with Further Alterations to the London Plan published in March 2015. The aim is to develop London as an exemplary sustainable world city, based on three interwoven themes.

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

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

POLICY 5.2 MINIMISING CO2 EMISSIONS

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

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

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

Residential buildings:

Year	Improvement on 2010 Building Regulations
2010 – 2013	25 per cent (Code for Sustainable Homes level 4)
2013 – 2016	40 per cent
2016 – 2031	Zero carbon

Non-domestic buildings:

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

As this is not a major application according to London Plan definition, policy 5.2 does not apply.

IMPLEMENTATION OF 2013 BUILDING REGULATIONS

Policy 5.2 of the London Plan states that from 2013 to 2016 energy assessments should be produced to meet a target of 40 per cent carbon reduction beyond Part L 2010 of the Building Regulations. The draft SPG on Sustainable Design and Construction confirmed that this requirement would apply for Stage 1 applications received by the Mayor on or after 1 October 2013.

From 6 April 2014 the 2013 changes to Part L of the Building Regulations came into effect. Part L 2013 delivers an overall reduction in CO2 emissions for new residential and new non-domestic buildings, with the targets for individual buildings being differentiated according to building type. This reduction in CO2 emissions affects the percentage reduction necessary above the new Part L 2013 regulations to meet the Mayor's targets in the London Plan.

As outlined in the Sustainable, Design and Construction SPG a 35 per cent carbon reduction target beyond Part L 2013 of the Building Regulations is currently applied - this is deemed to be broadly equivalent to the 40 per cent target beyond Part L 2010 of the Building Regulations, as specified in Policy 5.2 of the London Plan for 2013-2016.

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 this is not a major application according to London Plan definition, this policy does not apply.

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.

As this is not a major application according to London Plan definition, policy 5.7 does not apply.

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)

As this is not a major application according to London Plan definition, policy 5.9 does not apply.

BASELINE ENERGY CONSUMPTION AND CO2 EMISSIONS

An energy assessment using SAP 2012 has been carried out on the actual proposed dwellings using notional baseline specification achieving compliance with 2012 Part L. The specification is set out in Table 3 above.

As a result of the baseline energy calculation, the following values of energy and CO_2 emissions have been obtained. SAP 2012 carbon emission factors have been used for the CO_2 emissions calculation.

Table 5:

Residential		Energy Consumption Breakdown						SAP 2012	
Unit	Floor area (m2)	Space Heating (Main 1) (kWh/an)	DHW (kWh/an)	Cooling (kWh/a)	Lighting (kWh/an)	Aux (kWh/an)	Un-Reg (kWh/an)	DER	TER
Proposed House	882	51,419	3,641		1,328	75	10,042	14.31	14.31

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

Table 6:

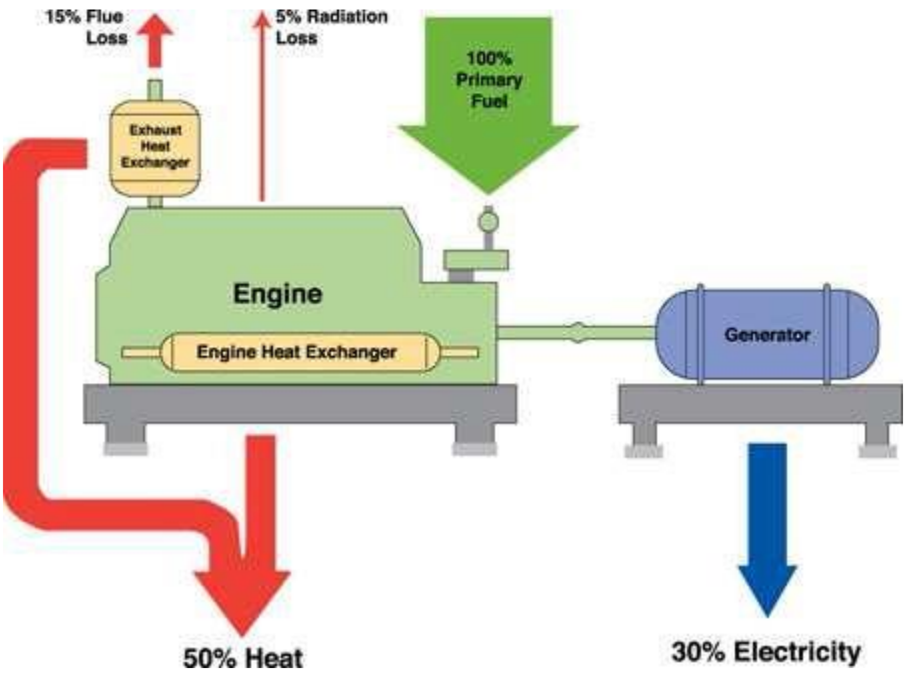
Residential		Energy Consumption Breakdown						SAP 2012		% Improvement DER over TER
Unit	Floor area (m2)	Space Heating (kWh/an)	DHW (kWh/an)	Cooling (kWh/a)	Lighting (kWh/an)	Aux (kWh/an)	Un-Reg (kWh/an)	DER	TER	
Proposed Hous	469.1	22,654	2,686	31	954	75	7,054	14.00	15.17	7.7%

OVERHEATING AND COOLING

The house modelled in SAP has also been assessed against overheating criteria set out in SAP Appendix P.
The proposed house complies with the criteria using passive measures - openable windows and light coloured internal blinds. The house achieves “slight” risk of overheating.

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

Heat demand of the proposed development is considered too low to make a CHP installation feasible.

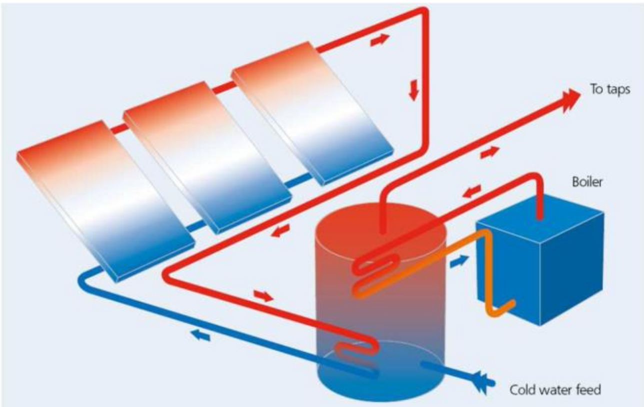
BE GREEN: ON-SITE RENEWABLE ENERGY SOURCE - SOLAR HOT WATER (SHW)

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 may be feasible, however, photovoltaic panels are preferable due to higher CO_2 emission offset, lower installation and maintenance cost.

Be Green: On-site renewable energy source - Air source heat pump (ASHP)

36 Redington Road, London NW3 7RT

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.

Be Green: On-site renewable energy source - Air source heat pump (ASHP)

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 are not proposed due to higher installation, maintenance and running cost compared to gas boilers. Noise from outdoor condensing units could also represent a potential problem.

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

36 REDINGTON ROAD, LONDON NW3 7RT

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 8 and 20 m2.

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

The cost per tonne of CO2 saved would be between £550 and £1,100,

RECOMMENDATIONS SPECIFIC TO THIS DEVELOPMENT

A PV system with total peak output of 5 kWp is proposed for roof installation. The panels are proposed to be installed at a 15-35 degree angle facing South-East or South-West to alighn with the building orientation. The proposed PV system will produce 4,117 kWh of electricity per year, which represents an offset of 2.13 tonnes of CO2.

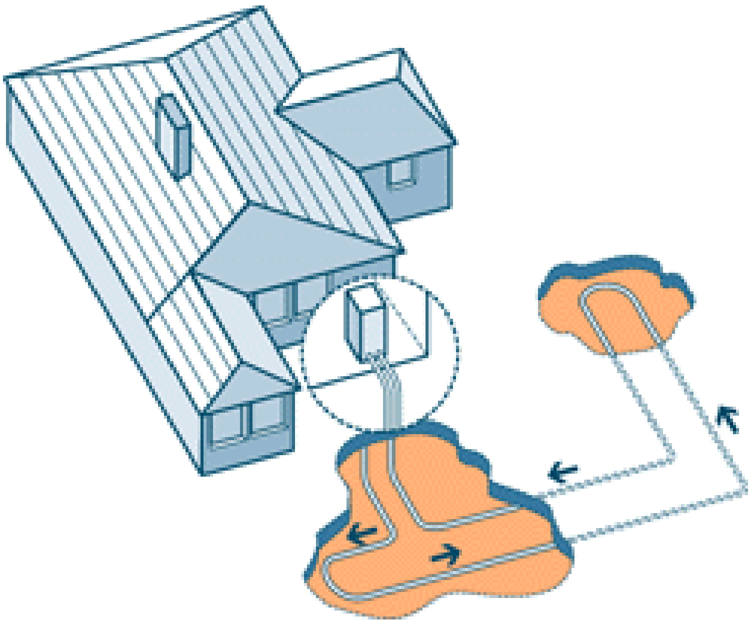
Be Green: On-site renewable energy source – Ground source heat pump (GSHP)

36 Redington Road, London NW3 7RT

General information

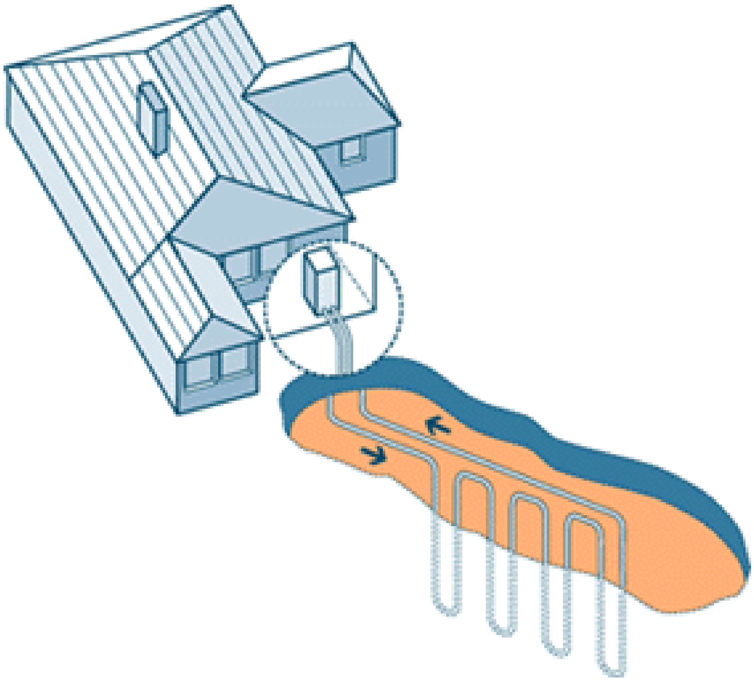
Ground source heat pumps use a buried ground loop which transfers heat from the ground into the building through heating distribution system. GSHP technology can be used both for heating and cooling. Two main types of GSHP are available:

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



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

- 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

Ground source heat pumps have been ruled out due to high capital cost and relatively small savings in CO2 emissions compared to other recommended technologies.

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.

BE GREEN: ON-SITE RENEWABLE ENERGY SOURCE – WIND ENERGY

36 REDINGTON ROAD, LONDON NW3 7RT

GENERAL INFORMATION

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

RECOMMENDATIONS SPECIFIC TO THIS DEVELOPMENT

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

WATER

Internal water consumption will be reduced to 105 litres/person/day by specification of water efficient fittings:

Dual flush WC with 4/6 l flush volume
Kitchen tap: 8 litres/min
Other taps: 6 litres/min
Showers: 8 litres/min
Bath capacity to overflow: 140 litres
Washing machines: 6 litres/kg dry load
Dishwashers: 1.3 litres pre place setting

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

Appendix A

SAP Calculation of the proposed house

Regulations Compliance Report

Approved Document L1A, 2013 Edition, England assessed by Stroma FSAP 2012 program, Version: 1.0.4.16
Printed on 21 December 2018 at 09:26:50

Project Information:

Assessed By: Ondrej Gajdos (STRO006629) **Building Type:** Semi-detached House

Dwelling Details:

NEW DWELLING DESIGN STAGE Total Floor Area: 469.14m²

Site Reference : 36 Redington Road **Plot Reference:** Proposed House

Address : 36 Redington Road, London, NW3 7RT

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: Mains gas
Fuel factor: 1.00 (mains gas)

Target Carbon Dioxide Emission Rate (TER)	15.17 kg/m²	
Dwelling Carbon Dioxide Emission Rate (DER)	9.44 kg/m²	**OK**

1b TFEE and DFEE

Target Fabric Energy Efficiency (TFEE)	68.9 kWh/m²	
Dwelling Fabric Energy Efficiency (DFEE)	52.0 kWh/m²	
		OK

2 Fabric U-values

Element	Average	Highest	
External wall	0.18 (max. 0.30)	0.18 (max. 0.70)	**OK**
Floor	0.12 (max. 0.25)	0.20 (max. 0.70)	**OK**
Roof	0.14 (max. 0.20)	0.14 (max. 0.35)	**OK**
Openings	0.80 (max. 2.00)	0.80 (max. 3.30)	**OK**

2a Thermal bridging

Thermal bridging calculated from linear thermal transmittances for each junction

3 Air permeability

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

4 Heating efficiency

Main Heating system:
Database: (rev 436, product index 016567):
Boiler systems with radiators or underfloor heating - mains gas
Brand name: Remeha
Model: Quinta Pro 45
Model qualifier:
(Regular)
Efficiency 88.7 % SEDBUK2009
Minimum 88.0 % **OK**

Secondary heating system:
Room heaters - gas
Flueless gas fire, secondary heating only

Regulations Compliance Report

5 Cylinder insulation

Hot water Storage:	Measured cylinder loss: 1.20 kWh/day	
	Permitted by DBSCG: 2.24 kWh/day	**OK**
Primary pipework insulated:	Yes	**OK**

6 Controls

Space heating controls	TTZC by plumbing and electrical services	**OK**
Hot water controls:	Cylinderstat	**OK**
	Independent timer for DHW	**OK**
Boiler interlock:	Yes	**OK**

7 Low energy lights

Percentage of fixed lights with low-energy fittings	100.0%	
Minimum	75.0%	**OK**

8 Mechanical ventilation

Not applicable

9 Summertime temperature

Overheating risk (Thames valley):	Slight	**OK**

Based on:

Overshading:	Average or unknown
Windows facing: South West	4.16m²
Windows facing: South West	3.41m²
Windows facing: South West	6.81m²
Windows facing: South West	2.3m²
Windows facing: South West	4.26m²
Windows facing: South West	8.1m²
Windows facing: South West	4.05m²
Windows facing: South East	2.16m²
Windows facing: North East	5.24m²
Windows facing: North East	6.34m²
Windows facing: North East	4.45m²
Windows facing: North East	13.06m²
Windows facing: North East	12.7m²
Windows facing: North East	11.02m²
Windows facing: North West	4.59m²
Roof windows facing: Unspecified	3.49m²
Roof windows facing: Unspecified	4.33m²
Ventilation rate:	3.00
Blinds/curtains:	Light-coloured curtain or roller blind Closed 100% of daylight hours

10 Key features

Windows U-value	0.8 W/m²K
Doors U-value	0.8 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)	

Regulations Compliance Report

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Ondrej Gajdos	**Stroma Number:**	STRO006629
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.16

Property Address: Proposed House

Address : 36 Redington Road, London, NW3 7RT

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	150.84	(1a)	x	2.6	(2a)	=	392.18	(3a)
First floor	125.3	(1b)	x	3.3	(2b)	=	413.49	(3b)
Second floor	121.9	(1c)	x	3	(2c)	=	365.7	(3c)
Third floor	71.1	(1d)	x	3	(2d)	=	213.3	(3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	469.14	(4)						
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =					1384.67	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total			m³ per hour	
Number of chimneys	0	+	0	+	0	=	0	x 40 =		0	(6a)
Number of open flues	0	+	0	+	0	=	0	x 20 =		0	(6b)
Number of intermittent fans							7	x 10 =		70	(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) =	70	÷ (5) =	0.05	(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		5	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.3	(18)

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

Number of sides sheltered		1	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.92	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.28	(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

0.35	0.35	0.34	0.31	0.3	0.26	0.26	0.26	0.28	0.3	0.31	0.33

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=	0.56	0.56	0.56	0.55	0.54	0.53	0.53	0.53	0.54	0.54	0.55	0.55	(24d)

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

(25)m=	0.56	0.56	0.56	0.55	0.54	0.53	0.53	0.53	0.54	0.54	0.55	0.55	(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			4.08	x	0.8	=	3.264			(26)
Windows Type 1			4.16		x1/[1/(0.8)+ 0.04]	=	3.22			(27)
Windows Type 2			3.41		x1/[1/(0.8)+ 0.04]	=	2.64			(27)
Windows Type 3			6.81		x1/[1/(0.8)+ 0.04]	=	5.28			(27)
Windows Type 4			2.3		x1/[1/(0.8)+ 0.04]	=	1.78			(27)
Windows Type 5			4.26		x1/[1/(0.8)+ 0.04]	=	3.3			(27)
Windows Type 6			8.1		x1/[1/(0.8)+ 0.04]	=	6.28			(27)
Windows Type 7			4.05		x1/[1/(0.8)+ 0.04]	=	3.14			(27)
Windows Type 8			2.16		x1/[1/(0.8)+ 0.04]	=	1.67			(27)
Windows Type 9			5.24		x1/[1/(0.8)+ 0.04]	=	4.06			(27)
Windows Type 10			6.34		x1/[1/(0.8)+ 0.04]	=	4.91			(27)
Windows Type 11			4.45		x1/[1/(0.8)+ 0.04]	=	3.45			(27)
Windows Type 12			6.53		x1/[1/(0.8)+ 0.04]	=	5.06			(27)
Windows Type 13			6.35		x1/[1/(0.8)+ 0.04]	=	4.92			(27)

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Floor Type 1			150.84	x	0.12	=	18.1008	(28)
Floor Type 2			3.6	x	0.2	=	0.72	(28)
Floor Type 3			16.5	x	0.12	=	1.98	(28)
Walls Type1	419.64	96.73	322.91	x	0.18	=	58.12	(29)
Walls Type2	147.94	0	147.94	x	0.18	=	26.63	(29)
Roof Type1	71.1	7.82	63.28	x	0.14	=	8.86	(30)
Roof Type2	7	0	7	x	0.14	=	0.98	(30)
Roof Type3	50.8	0	50.8	x	0.14	=	7.11	(30)
Roof Type4	39.6	0	39.6	x	0.14	=	5.54	(30)
Total area of elements, m²			907.02					(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) =	209.2	(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: Low	100	(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		69.93	(36)

if details of thermal bridging are not known (36) = 0.15 x (31)

Total fabric heat loss	(33) + (36) =	279.13	(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=	257.18	256.06	254.97	249.84	248.88	244.41	244.41	243.58	246.13	248.88	250.82	252.85	(38)

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

(39)m=	536.3	535.19	534.1	528.96	528	523.53	523.53	522.71	525.26	528	529.95	531.98	

Average = Sum(39)$_{1…12}$ /12= 528.96 (39)

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

(40)m=	1.14	1.14	1.14	1.13	1.13	1.12	1.12	1.11	1.12	1.13	1.13	1.13	

Average = Sum(40)$_{1…12}$ /12= 1.13 (40)

Number of days in month (Table 1a)

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

4. Water heating energy requirement: kWh/year:

Assumed occupancy, N 3.35 (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) + 36 113.81 (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)

DER WorkSheet: New dwelling design stage

(44)m	125.19	120.63	116.08	111.53	106.98	102.42	102.42	106.98	111.53	116.08	120.63	125.19

Total = Sum(44) = 1365.67 (44)

DER WorkSheet: New dwelling design stage

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=	185.65	162.37	167.55	146.07	140.16	120.95	112.08	128.61	130.15	151.67	165.56	179.79	

Total = Sum(45)$_{1...12}$ = 1790.6 (45)

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

(46)m=	27.85	24.36	25.13	21.91	21.02	18.14	16.81	19.29	19.52	22.75	24.83	26.97	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 200 (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): 1.2 (48)

Temperature factor from Table 2b 0.54 (49)

Energy lost from water storage, kWh/year (48) x (49) = 0.65 (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) 0.65 (55)

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

(56)m=	20.09	18.14	20.09	19.44	20.09	19.44	20.09	20.09	19.44	20.09	19.44	20.09	(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=	20.09	18.14	20.09	19.44	20.09	19.44	20.09	20.09	19.44	20.09	19.44	20.09	(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=	229	201.52	210.9	188.03	183.51	162.9	155.43	171.96	172.1	195.02	207.51	223.14	(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=	229	201.52	210.9	188.03	183.51	162.9	155.43	171.96	172.1	195.02	207.51	223.14

Output from water heater (annual)$_{1...12}$ 2301.02 (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=	96.41	85.31	90.39	82.13	81.28	73.78	71.95	77.44	76.83	85.11	88.61	94.46	(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

DER WorkSheet: New dwelling design stage

(66)m=	167.59	167.59	167.59	167.59	167.59	167.59	167.59	167.59	167.59	167.59	167.59	167.59	(66)

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

(67)m=	54.03	47.99	39.03	29.55	22.09	18.65	20.15	26.19	35.15	44.64	52.1	55.54	(67)

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

(68)m=	584.18	590.24	574.96	542.44	501.39	462.81	437.03	430.97	446.25	478.77	519.82	558.4	(68)

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

(69)m=	39.76	39.76	39.76	39.76	39.76	39.76	39.76	39.76	39.76	39.76	39.76	39.76	(69)

Pumps and fans gains (Table 5a)

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

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

(71)m=	-134.07	-134.07	-134.07	-134.07	-134.07	-134.07	-134.07	-134.07	-134.07	-134.07	-134.07	-134.07	(71)

Water heating gains (Table 5)

(72)m=	129.58	126.95	121.49	114.07	109.25	102.47	96.7	104.09	106.72	114.4	123.07	126.96	(72)

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

(73)m=	844.07	841.46	811.76	762.34	709.01	660.2	630.16	637.53	664.39	714.08	771.26	817.18	(73)

6. Solar gains:

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

Orientation:	Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Northeast 0.9x	0.54	x	5.24	x	11.28	x	0.63	x	0.7	=	12.67	(75)
Northeast 0.9x	0.54	x	6.34	x	11.28	x	0.63	x	0.7	=	15.33	(75)
Northeast 0.9x	0.54	x	4.45	x	11.28	x	0.63	x	0.7	=	10.76	(75)
Northeast 0.9x	0.54	x	6.53	x	11.28	x	0.63	x	0.7	=	31.58	(75)
Northeast 0.9x	0.54	x	6.35	x	11.28	x	0.63	x	0.7	=	30.71	(75)
Northeast 0.9x	0.54	x	11.02	x	11.28	x	0.63	x	0.7	=	26.65	(75)
Northeast 0.9x	0.54	x	5.24	x	22.97	x	0.63	x	0.7	=	25.79	(75)
Northeast 0.9x	0.54	x	6.34	x	22.97	x	0.63	x	0.7	=	31.21	(75)
Northeast 0.9x	0.54	x	4.45	x	22.97	x	0.63	x	0.7	=	21.9	(75)
Northeast 0.9x	0.54	x	6.53	x	22.97	x	0.63	x	0.7	=	64.29	(75)
Northeast 0.9x	0.54	x	6.35	x	22.97	x	0.63	x	0.7	=	62.51	(75)
Northeast 0.9x	0.54	x	11.02	x	22.97	x	0.63	x	0.7	=	54.24	(75)
Northeast 0.9x	0.54	x	5.24	x	41.38	x	0.63	x	0.7	=	46.47	(75)
Northeast 0.9x	0.54	x	6.34	x	41.38	x	0.63	x	0.7	=	56.23	(75)
Northeast 0.9x	0.54	x	4.45	x	41.38	x	0.63	x	0.7	=	39.47	(75)
Northeast 0.9x	0.54	x	6.53	x	41.38	x	0.63	x	0.7	=	115.82	(75)
Northeast 0.9x	0.54	x	6.35	x	41.38	x	0.63	x	0.7	=	112.63	(75)
Northeast 0.9x	0.54	x	11.02	x	41.38	x	0.63	x	0.7	=	97.73	(75)
Northeast 0.9x	0.54	x	5.24	x	67.96	x	0.63	x	0.7	=	76.32	(75)
Northeast 0.9x	0.54	x	6.34	x	67.96	x	0.63	x	0.7	=	92.34	(75)
Northeast 0.9x	0.54	x	4.45	x	67.96	x	0.63	x	0.7	=	64.81	(75)

DER WorkSheet: New dwelling design stage

Northeast	0.9x	0.54	x	6.53	x	67.96	x	0.63	x	0.7	=	190.21	(75)
Northeast	0.9x	0.54	x	6.35	x	67.96	x	0.63	x	0.7	=	184.97	(75)
Northeast	0.9x	0.54	x	11.02	x	67.96	x	0.63	x	0.7	=	160.5	(75)
Northeast	0.9x	0.54	x	5.24	x	91.35	x	0.63	x	0.7	=	102.59	(75)
Northeast	0.9x	0.54	x	6.34	x	91.35	x	0.63	x	0.7	=	124.12	(75)
Northeast	0.9x	0.54	x	4.45	x	91.35	x	0.63	x	0.7	=	87.12	(75)
Northeast	0.9x	0.54	x	6.53	x	91.35	x	0.63	x	0.7	=	255.69	(75)
Northeast	0.9x	0.54	x	6.35	x	91.35	x	0.63	x	0.7	=	248.64	(75)
Northeast	0.9x	0.54	x	11.02	x	91.35	x	0.63	x	0.7	=	215.75	(75)
Northeast	0.9x	0.54	x	5.24	x	97.38	x	0.63	x	0.7	=	109.37	(75)
Northeast	0.9x	0.54	x	6.34	x	97.38	x	0.63	x	0.7	=	132.33	(75)
Northeast	0.9x	0.54	x	4.45	x	97.38	x	0.63	x	0.7	=	92.88	(75)
Northeast	0.9x	0.54	x	6.53	x	97.38	x	0.63	x	0.7	=	272.59	(75)
Northeast	0.9x	0.54	x	6.35	x	97.38	x	0.63	x	0.7	=	265.07	(75)
Northeast	0.9x	0.54	x	11.02	x	97.38	x	0.63	x	0.7	=	230.01	(75)
Northeast	0.9x	0.54	x	5.24	x	91.1	x	0.63	x	0.7	=	102.31	(75)
Northeast	0.9x	0.54	x	6.34	x	91.1	x	0.63	x	0.7	=	123.79	(75)
Northeast	0.9x	0.54	x	4.45	x	91.1	x	0.63	x	0.7	=	86.89	(75)
Northeast	0.9x	0.54	x	6.53	x	91.1	x	0.63	x	0.7	=	255	(75)
Northeast	0.9x	0.54	x	6.35	x	91.1	x	0.63	x	0.7	=	247.97	(75)
Northeast	0.9x	0.54	x	11.02	x	91.1	x	0.63	x	0.7	=	215.17	(75)
Northeast	0.9x	0.54	x	5.24	x	72.63	x	0.63	x	0.7	=	81.56	(75)
Northeast	0.9x	0.54	x	6.34	x	72.63	x	0.63	x	0.7	=	98.69	(75)
Northeast	0.9x	0.54	x	4.45	x	72.63	x	0.63	x	0.7	=	69.27	(75)
Northeast	0.9x	0.54	x	6.53	x	72.63	x	0.63	x	0.7	=	203.29	(75)
Northeast	0.9x	0.54	x	6.35	x	72.63	x	0.63	x	0.7	=	197.69	(75)
Northeast	0.9x	0.54	x	11.02	x	72.63	x	0.63	x	0.7	=	171.54	(75)
Northeast	0.9x	0.54	x	5.24	x	50.42	x	0.63	x	0.7	=	56.63	(75)
Northeast	0.9x	0.54	x	6.34	x	50.42	x	0.63	x	0.7	=	68.51	(75)
Northeast	0.9x	0.54	x	4.45	x	50.42	x	0.63	x	0.7	=	48.09	(75)
Northeast	0.9x	0.54	x	6.53	x	50.42	x	0.63	x	0.7	=	141.13	(75)
Northeast	0.9x	0.54	x	6.35	x	50.42	x	0.63	x	0.7	=	137.24	(75)
Northeast	0.9x	0.54	x	11.02	x	50.42	x	0.63	x	0.7	=	119.09	(75)
Northeast	0.9x	0.54	x	5.24	x	28.07	x	0.63	x	0.7	=	31.52	(75)
Northeast	0.9x	0.54	x	6.34	x	28.07	x	0.63	x	0.7	=	38.14	(75)
Northeast	0.9x	0.54	x	4.45	x	28.07	x	0.63	x	0.7	=	26.77	(75)
Northeast	0.9x	0.54	x	6.53	x	28.07	x	0.63	x	0.7	=	78.56	(75)
Northeast	0.9x	0.54	x	6.35	x	28.07	x	0.63	x	0.7	=	76.4	(75)
Northeast	0.9x	0.54	x	11.02	x	28.07	x	0.63	x	0.7	=	66.29	(75)
Northeast	0.9x	0.54	x	5.24	x	14.2	x	0.63	x	0.7	=	15.94	(75)
Northeast	0.9x	0.54	x	6.34	x	14.2	x	0.63	x	0.7	=	19.29	(75)

DER WorkSheet: New dwelling design stage

Northeast 0.9x	0.54	x	4.45	x	14.2	x	0.63	x	0.7	=	13.54	(75)
Northeast 0.9x	0.54	x	6.53	x	14.2	x	0.63	x	0.7	=	39.74	(75)
Northeast 0.9x	0.54	x	6.35	x	14.2	x	0.63	x	0.7	=	38.64	(75)
Northeast 0.9x	0.54	x	11.02	x	14.2	x	0.63	x	0.7	=	33.53	(75)
Northeast 0.9x	0.54	x	5.24	x	9.21	x	0.63	x	0.7	=	10.35	(75)
Northeast 0.9x	0.54	x	6.34	x	9.21	x	0.63	x	0.7	=	12.52	(75)
Northeast 0.9x	0.54	x	4.45	x	9.21	x	0.63	x	0.7	=	8.79	(75)
Northeast 0.9x	0.54	x	6.53	x	9.21	x	0.63	x	0.7	=	25.79	(75)
Northeast 0.9x	0.54	x	6.35	x	9.21	x	0.63	x	0.7	=	25.08	(75)
Northeast 0.9x	0.54	x	11.02	x	9.21	x	0.63	x	0.7	=	21.76	(75)
Southeast 0.9x	0.54	x	2.16	x	36.79	x	0.63	x	0.7	=	17.03	(77)
Southeast 0.9x	0.54	x	2.16	x	62.67	x	0.63	x	0.7	=	29.01	(77)
Southeast 0.9x	0.54	x	2.16	x	85.75	x	0.63	x	0.7	=	39.7	(77)
Southeast 0.9x	0.54	x	2.16	x	106.25	x	0.63	x	0.7	=	49.19	(77)
Southeast 0.9x	0.54	x	2.16	x	119.01	x	0.63	x	0.7	=	55.1	(77)
Southeast 0.9x	0.54	x	2.16	x	118.15	x	0.63	x	0.7	=	54.7	(77)
Southeast 0.9x	0.54	x	2.16	x	113.91	x	0.63	x	0.7	=	52.73	(77)
Southeast 0.9x	0.54	x	2.16	x	104.39	x	0.63	x	0.7	=	48.33	(77)
Southeast 0.9x	0.54	x	2.16	x	92.85	x	0.63	x	0.7	=	42.99	(77)
Southeast 0.9x	0.54	x	2.16	x	69.27	x	0.63	x	0.7	=	32.07	(77)
Southeast 0.9x	0.54	x	2.16	x	44.07	x	0.63	x	0.7	=	20.4	(77)
Southeast 0.9x	0.54	x	2.16	x	31.49	x	0.63	x	0.7	=	14.58	(77)
Southwest 0.9x	0.54	x	4.16	x	36.79		0.63	x	0.7	=	32.81	(79)
Southwest 0.9x	0.54	x	3.41	x	36.79		0.63	x	0.7	=	26.89	(79)
Southwest 0.9x	0.54	x	6.81	x	36.79		0.63	x	0.7	=	53.7	(79)
Southwest 0.9x	0.54	x	2.3	x	36.79		0.63	x	0.7	=	18.14	(79)
Southwest 0.9x	0.54	x	4.26	x	36.79		0.63	x	0.7	=	33.59	(79)
Southwest 0.9x	0.54	x	8.1	x	36.79		0.63	x	0.7	=	63.88	(79)
Southwest 0.9x	0.54	x	4.05	x	36.79		0.63	x	0.7	=	31.94	(79)
Southwest 0.9x	0.54	x	4.16	x	62.67		0.63	x	0.7	=	55.88	(79)
Southwest 0.9x	0.54	x	3.41	x	62.67		0.63	x	0.7	=	45.81	(79)
Southwest 0.9x	0.54	x	6.81	x	62.67		0.63	x	0.7	=	91.48	(79)
Southwest 0.9x	0.54	x	2.3	x	62.67		0.63	x	0.7	=	30.89	(79)
Southwest 0.9x	0.54	x	4.26	x	62.67		0.63	x	0.7	=	57.22	(79)
Southwest 0.9x	0.54	x	8.1	x	62.67		0.63	x	0.7	=	108.8	(79)
Southwest 0.9x	0.54	x	4.05	x	62.67		0.63	x	0.7	=	54.4	(79)
Southwest 0.9x	0.54	x	4.16	x	85.75		0.63	x	0.7	=	76.46	(79)
Southwest 0.9x	0.54	x	3.41	x	85.75		0.63	x	0.7	=	62.67	(79)
Southwest 0.9x	0.54	x	6.81	x	85.75		0.63	x	0.7	=	125.16	(79)
Southwest 0.9x	0.54	x	2.3	x	85.75		0.63	x	0.7	=	42.27	(79)
Southwest 0.9x	0.54	x	4.26	x	85.75		0.63	x	0.7	=	78.29	(79)

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Southwest	0.9x	0.54	x	8.1	x	85.75	0.63	x	0.7	=	148.87	(79)
Southwest	0.9x	0.54	x	4.05	x	85.75	0.63	x	0.7	=	74.44	(79)
Southwest	0.9x	0.54	x	4.16	x	106.25	0.63	x	0.7	=	94.73	(79)
Southwest	0.9x	0.54	x	3.41	x	106.25	0.63	x	0.7	=	77.65	(79)
Southwest	0.9x	0.54	x	6.81	x	106.25	0.63	x	0.7	=	155.08	(79)
Southwest	0.9x	0.54	x	2.3	x	106.25	0.63	x	0.7	=	52.38	(79)
Southwest	0.9x	0.54	x	4.26	x	106.25	0.63	x	0.7	=	97.01	(79)
Southwest	0.9x	0.54	x	8.1	x	106.25	0.63	x	0.7	=	184.46	(79)
Southwest	0.9x	0.54	x	4.05	x	106.25	0.63	x	0.7	=	92.23	(79)
Southwest	0.9x	0.54	x	4.16	x	119.01	0.63	x	0.7	=	106.11	(79)
Southwest	0.9x	0.54	x	3.41	x	119.01	0.63	x	0.7	=	86.98	(79)
Southwest	0.9x	0.54	x	6.81	x	119.01	0.63	x	0.7	=	173.7	(79)
Southwest	0.9x	0.54	x	2.3	x	119.01	0.63	x	0.7	=	58.67	(79)
Southwest	0.9x	0.54	x	4.26	x	119.01	0.63	x	0.7	=	108.66	(79)
Southwest	0.9x	0.54	x	8.1	x	119.01	0.63	x	0.7	=	206.61	(79)
Southwest	0.9x	0.54	x	4.05	x	119.01	0.63	x	0.7	=	103.3	(79)
Southwest	0.9x	0.54	x	4.16	x	118.15	0.63	x	0.7	=	105.34	(79)
Southwest	0.9x	0.54	x	3.41	x	118.15	0.63	x	0.7	=	86.35	(79)
Southwest	0.9x	0.54	x	6.81	x	118.15	0.63	x	0.7	=	172.45	(79)
Southwest	0.9x	0.54	x	2.3	x	118.15	0.63	x	0.7	=	58.24	(79)
Southwest	0.9x	0.54	x	4.26	x	118.15	0.63	x	0.7	=	107.87	(79)
Southwest	0.9x	0.54	x	8.1	x	118.15	0.63	x	0.7	=	205.11	(79)
Southwest	0.9x	0.54	x	4.05	x	118.15	0.63	x	0.7	=	102.56	(79)
Southwest	0.9x	0.54	x	4.16	x	113.91	0.63	x	0.7	=	101.56	(79)
Southwest	0.9x	0.54	x	3.41	x	113.91	0.63	x	0.7	=	83.25	(79)
Southwest	0.9x	0.54	x	6.81	x	113.91	0.63	x	0.7	=	166.26	(79)
Southwest	0.9x	0.54	x	2.3	x	113.91	0.63	x	0.7	=	56.15	(79)
Southwest	0.9x	0.54	x	4.26	x	113.91	0.63	x	0.7	=	104	(79)
Southwest	0.9x	0.54	x	8.1	x	113.91	0.63	x	0.7	=	197.75	(79)
Southwest	0.9x	0.54	x	4.05	x	113.91	0.63	x	0.7	=	98.88	(79)
Southwest	0.9x	0.54	x	4.16	x	104.39	0.63	x	0.7	=	93.07	(79)
Southwest	0.9x	0.54	x	3.41	x	104.39	0.63	x	0.7	=	76.29	(79)
Southwest	0.9x	0.54	x	6.81	x	104.39	0.63	x	0.7	=	152.36	(79)
Southwest	0.9x	0.54	x	2.3	x	104.39	0.63	x	0.7	=	51.46	(79)
Southwest	0.9x	0.54	x	4.26	x	104.39	0.63	x	0.7	=	95.31	(79)
Southwest	0.9x	0.54	x	8.1	x	104.39	0.63	x	0.7	=	181.23	(79)
Southwest	0.9x	0.54	x	4.05	x	104.39	0.63	x	0.7	=	90.61	(79)
Southwest	0.9x	0.54	x	4.16	x	92.85	0.63	x	0.7	=	82.79	(79)
Southwest	0.9x	0.54	x	3.41	x	92.85	0.63	x	0.7	=	67.86	(79)
Southwest	0.9x	0.54	x	6.81	x	92.85	0.63	x	0.7	=	135.52	(79)
Southwest	0.9x	0.54	x	2.3	x	92.85	0.63	x	0.7	=	45.77	(79)

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Southwest 0.9x	0.54	x	4.26	x	92.85		0.63	x	0.7	=	84.78	(79)
Southwest 0.9x	0.54	x	8.1	x	92.85		0.63	x	0.7	=	161.19	(79)
Southwest 0.9x	0.54	x	4.05	x	92.85		0.63	x	0.7	=	80.6	(79)
Southwest 0.9x	0.54	x	4.16	x	69.27		0.63	x	0.7	=	61.76	(79)
Southwest 0.9x	0.54	x	3.41	x	69.27		0.63	x	0.7	=	50.62	(79)
Southwest 0.9x	0.54	x	6.81	x	69.27		0.63	x	0.7	=	101.1	(79)
Southwest 0.9x	0.54	x	2.3	x	69.27		0.63	x	0.7	=	34.15	(79)
Southwest 0.9x	0.54	x	4.26	x	69.27		0.63	x	0.7	=	63.24	(79)
Southwest 0.9x	0.54	x	8.1	x	69.27		0.63	x	0.7	=	120.25	(79)
Southwest 0.9x	0.54	x	4.05	x	69.27		0.63	x	0.7	=	60.13	(79)
Southwest 0.9x	0.54	x	4.16	x	44.07		0.63	x	0.7	=	39.29	(79)
Southwest 0.9x	0.54	x	3.41	x	44.07		0.63	x	0.7	=	32.21	(79)
Southwest 0.9x	0.54	x	6.81	x	44.07		0.63	x	0.7	=	64.32	(79)
Southwest 0.9x	0.54	x	2.3	x	44.07		0.63	x	0.7	=	21.72	(79)
Southwest 0.9x	0.54	x	4.26	x	44.07		0.63	x	0.7	=	40.24	(79)
Southwest 0.9x	0.54	x	8.1	x	44.07		0.63	x	0.7	=	76.51	(79)
Southwest 0.9x	0.54	x	4.05	x	44.07		0.63	x	0.7	=	38.25	(79)
Southwest 0.9x	0.54	x	4.16	x	31.49		0.63	x	0.7	=	28.07	(79)
Southwest 0.9x	0.54	x	3.41	x	31.49		0.63	x	0.7	=	23.01	(79)
Southwest 0.9x	0.54	x	6.81	x	31.49		0.63	x	0.7	=	45.96	(79)
Southwest 0.9x	0.54	x	2.3	x	31.49		0.63	x	0.7	=	15.52	(79)
Southwest 0.9x	0.54	x	4.26	x	31.49		0.63	x	0.7	=	28.75	(79)
Southwest 0.9x	0.54	x	8.1	x	31.49		0.63	x	0.7	=	54.66	(79)
Southwest 0.9x	0.54	x	4.05	x	31.49		0.63	x	0.7	=	27.33	(79)
Northwest 0.9x	0.54	x	4.59	x	11.28	x	0.63	x	0.7	=	11.1	(81)
Northwest 0.9x	0.54	x	4.59	x	22.97	x	0.63	x	0.7	=	22.59	(81)
Northwest 0.9x	0.54	x	4.59	x	41.38	x	0.63	x	0.7	=	40.71	(81)
Northwest 0.9x	0.54	x	4.59	x	67.96	x	0.63	x	0.7	=	66.85	(81)
Northwest 0.9x	0.54	x	4.59	x	91.35	x	0.63	x	0.7	=	89.86	(81)
Northwest 0.9x	0.54	x	4.59	x	97.38	x	0.63	x	0.7	=	95.8	(81)
Northwest 0.9x	0.54	x	4.59	x	91.1	x	0.63	x	0.7	=	89.62	(81)
Northwest 0.9x	0.54	x	4.59	x	72.63	x	0.63	x	0.7	=	71.45	(81)
Northwest 0.9x	0.54	x	4.59	x	50.42	x	0.63	x	0.7	=	49.6	(81)
Northwest 0.9x	0.54	x	4.59	x	28.07	x	0.63	x	0.7	=	27.61	(81)
Northwest 0.9x	0.54	x	4.59	x	14.2	x	0.63	x	0.7	=	13.97	(81)
Northwest 0.9x	0.54	x	4.59	x	9.21	x	0.63	x	0.7	=	9.06	(81)
Rooflights 0.9x	1	x	3.49	x	26	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	4.33	x	26	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	3.49	x	54	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	4.33	x	54	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	3.49	x	96	x	0	x	0.8	=	0	(82)

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Rooflights 0.9x	1	x	4.33	x	96	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	3.49	x	150	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	4.33	x	150	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	3.49	x	192	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	4.33	x	192	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	3.49	x	200	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	4.33	x	200	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	3.49	x	189	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	4.33	x	189	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	3.49	x	157	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	4.33	x	157	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	3.49	x	115	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	4.33	x	115	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	3.49	x	66	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	4.33	x	66	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	3.49	x	33	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	4.33	x	33	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	3.49	x	21	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	4.33	x	21	x	0	x	0.8	=	0	(82)

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

(83)m=	416.78	756.04	1156.91	1638.74	2022.89	2090.68	1981.34	1682.15	1321.79	868.61	507.61	351.25	(83)

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

(84)m=	1260.85	1597.5	1968.68	2401.08	2731.9	2750.88	2611.5	2319.68	1986.18	1582.68	1278.87	1168.42	(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=	0.99	0.99	0.98	0.95	0.89	0.79	0.68	0.74	0.9	0.97	0.99	1	(86)

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

(87)m=	18.69	18.88	19.23	19.71	20.19	20.56	20.75	20.7	20.37	19.76	19.14	18.67	(87)

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

(88)m=	19.97	19.97	19.97	19.98	19.98	19.99	19.99	19.99	19.98	19.98	19.98	19.97	(88)

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

(89)m=	0.99	0.99	0.98	0.94	0.87	0.74	0.58	0.65	0.86	0.97	0.99	1	(89)

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

(90)m=	16.82	17.1	17.61	18.31	18.99	19.5	19.73	19.68	19.25	18.39	17.49	16.78	(90)

fLA = Living area ÷ (4) = 0.07 (91)

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

(92)m=	16.95	17.22	17.72	18.41	19.07	19.58	19.8	19.75	19.33	18.49	17.61	16.92	(92)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(93)m=	16.8	17.07	17.57	18.26	18.92	19.43	19.65	19.6	19.18	18.34	17.46	16.77	(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=	0.99	0.98	0.96	0.92	0.83	0.7	0.53	0.6	0.82	0.95	0.98	0.99	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	1247.98	1567.14	1894.23	2204.4	2276.29	1912.86	1395.7	1394.18	1635.17	1501.17	1257.77	1158.65	(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=	6705.24	6515.58	5913.28	4952.66	3814.05	2527.99	1596.49	1675.14	2670.2	4084.38	5487.7	6685.99	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	4060.21	3325.35	2990.17	1978.75	1144.09	0	0	0	0	1921.91	3045.55	4112.35	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 22578.38 (98)

Space heating requirement in kWh/m²/year 48.13 (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	4921.23	3874.16	3972.57	0	0	0	0	(100)
Utilisation factor for loss hm													
(101)m=	0	0	0	0	0	0.61	0.69	0.63	0	0	0	0	(101)
Useful loss, hmLm (Watts) = (100)m x (101)m													
(102)m=	0	0	0	0	0	3023.2	2665.99	2519.97	0	0	0	0	(102)
Gains (solar gains calculated for applicable weather region, see Table 10)													
(103)m=	0	0	0	0	0	3675.48	3493.26	3118.87	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	0	615.5	445.58	0	0	0	0	

Total = Sum(104)$_{6...8}$ = 1061.08 (104)

Cooled fraction f C = cooled area ÷ (4) = 0.51 (105)

Intermittency factor (Table 10b)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(106)m=	0	0	0	0	0	0.25	0.25	0.25	0	0	0	0

Total = Sum(104)$_{6...8}$ = 0 (106)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(107)m=	0	0	0	0	0	0	78.72	56.99	0	0	0	0

Total = Sum(107)$_{6...8}$ = 135.71 (107)

Space cooling requirement in kWh/m²/year (107) ÷ (4) = 0.29 (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 total heating from main system 1	(204) = (202) × [1 – (203)] =	0.9	(204)

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Efficiency of main space heating system 1	89.7	(206)
Efficiency of secondary/supplementary heating system, %	90	(208)
Cooling System Energy Efficiency Ratio	4.32	(209)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Space heating requirement (calculated above)														
	4060.21	3325.35	2990.17	1978.75	1144.09	0	0	0	0	1921.91	3045.55	4112.35		
(211)m = {[(98)m x (204)] } x 100 ÷ (206)														(211)
	4073.79	3336.47	3000.17	1985.37	1147.92	0	0	0	0	1928.34	3055.73	4126.1		
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													22653.89	(211)
Space heating fuel (secondary), kWh/month = {[(98)m x (201)] } x 100 ÷ (208)														
(215)m=	451.13	369.48	332.24	219.86	127.12	0	0	0	0	213.55	338.39	456.93		
Total (kWh/year) =Sum(215)$_{1...5,10....12}$=													2508.71	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Output from water heater (calculated above)	229	201.52	210.9	188.03	183.51	162.9	155.43	171.96	172.1	195.02	207.51	223.14		
Efficiency of water heater													79	(216)
(217)m=	88.99	88.94	88.83	88.55	87.9	79	79	79	79	88.49	88.85	89.01		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	257.33	226.58	237.43	212.33	208.78	206.2	196.74	217.67	217.84	220.4	233.55	250.68		
Total = Sum(219a)$_{1...12}$ =													2685.54	(219)

Space cooling fuel, kWh/month.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
(221)m = (107)m÷ (209)														
(221)m=	0	0	0	0	0	0	18.22	13.19	0	0	0	0		
Total = Sum(221)$_{6...8}$ =													31.41	(221)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		22653.89	
Space heating fuel used, secondary		2508.71	
Water heating fuel used		2685.54	
Space cooling fuel used		31.41	
Electricity for pumps, fans and electric keep-hot			
central heating pump:	30		(230c)
boiler with a fan-assisted flue	45		(230e)
Total electricity for the above, kWh/year — sum of (230a)…(230g) =		75	(231)
Electricity for lighting		954.27	(232)
Electricity generated by PVs		-4116.75	(233)

12a. CO_2 emissions – Individual heating systems including micro-CHP

	Energy kWh/year		Emission factor kg CO_2/kWh		Emissions kg CO_2/year	
Space heating (main system 1)	(211)	x	0.216	=	4893.24	(261)

DER WorkSheet: New dwelling design stage

Space heating (secondary)	(215) x	0.216	=	541.88	(263)
Water heating	(219) x	0.216	=	580.08	(264)
Space and water heating	(261) + (262) + (263) + (264) =			6015.2	(265)
Space cooling	(221) x	0.519	=	16.3	(266)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	38.93	(267)
Electricity for lighting	(232) x	0.519	=	495.27	(268)
Energy saving/generation technologies Item 1		0.519	=	-2136.59	(269)
Total CO2, kg/year	sum of (265)…(271) =			4429.1	(272)
Dwelling CO2 Emission Rate	(272) ÷ (4) =			9.44	(273)
EI rating (section 14)				88	(274)

Predicted Energy Assessment

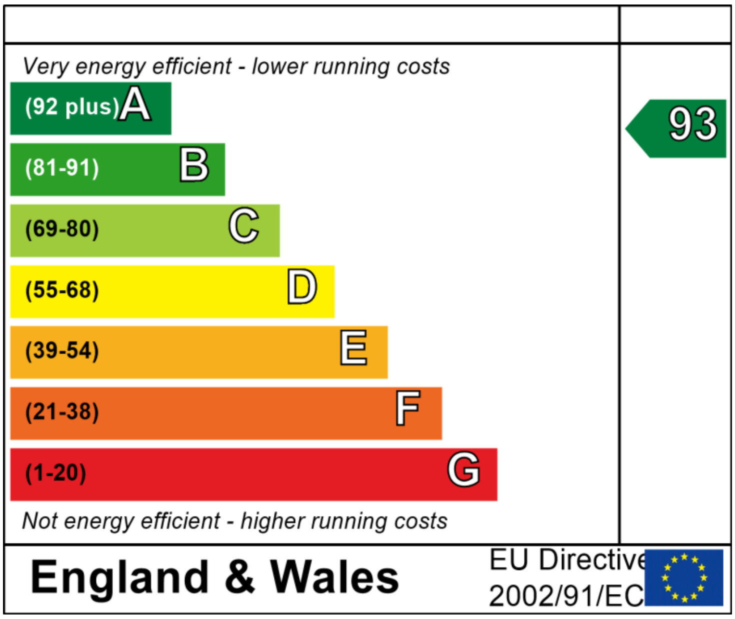
36 Redington Road
London
NW3 7RT

Dwelling type:	Semi-detached House
Date of assessment:	21 December 2018
Produced by:	Ondrej Gajdos
Total floor area:	469.14 m²

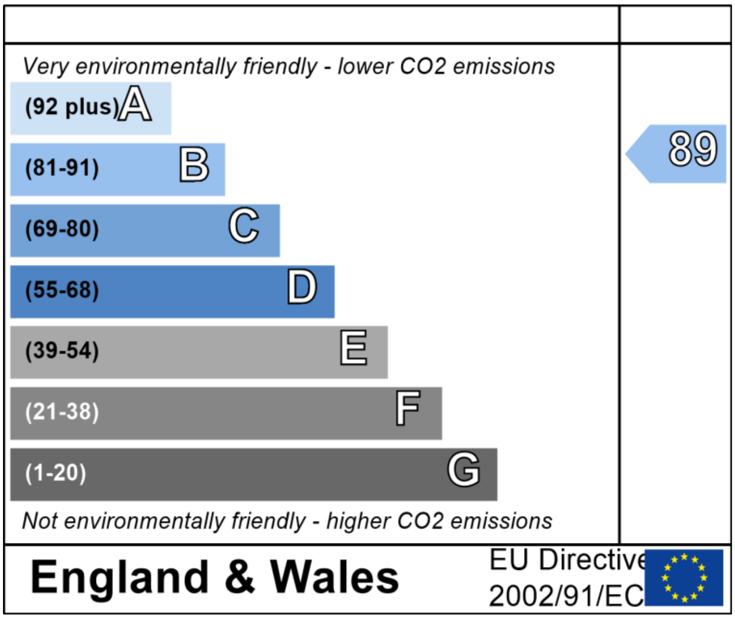
This is a Predicted Energy Assessment for a property which is not yet complete. It includes a predicted energy rating which might not represent the final energy rating of the property on completion. Once the property is completed, an Energy Performance Certificate is required providing information about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

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

Energy Efficiency Rating



Environmental Impact (CO_2) Rating



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

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

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name:	Ondrej Gajdos	**Stroma Number:**	STRO006629
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.16

Property Address: Proposed House

Address : 36 Redington Road, London, NW3 7RT

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	150.84	(1a)	x	2.6	(2a)	=	392.18	(3a)
First floor	125.3	(1b)	x	3.3	(2b)	=	413.49	(3b)
Second floor	121.9	(1c)	x	3	(2c)	=	365.7	(3c)
Third floor	71.1	(1d)	x	3	(2d)	=	213.3	(3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	469.14	(4)						
Dwelling volume		(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =					1384.67	(5)

2. Ventilation rate:

	main heating		secondary heating		other		total			m³ per hour	
Number of chimneys	0	+	0	+	0	=	0	x 40	=	0	(6a)
Number of open flues	0	+	0	+	0	=	0	x 20	=	0	(6b)
Number of intermittent fans							7	x 10	=	70	(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) =	70	÷ (5) =	0.05	(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		5	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.3	(18)

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

Number of sides sheltered		1	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.92	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.28	(21)

Infiltration rate modified for monthly wind speed

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

Monthly average wind speed from Table 7

(22)m=	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7

Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.27	1.25	1.23	1.1	1.08	0.95	0.95	0.92	1	1.08	1.12	1.18

Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m

0.35	0.35	0.34	0.31	0.3	0.26	0.26	0.26	0.28	0.3	0.31	0.33

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=	0.56	0.56	0.56	0.55	0.54	0.53	0.53	0.53	0.54	0.54	0.55	0.55	(24d)

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

(25)m=	0.56	0.56	0.56	0.55	0.54	0.53	0.53	0.53	0.54	0.54	0.55	0.55	(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			4.08	x	0.8	=	3.264			(26)
Windows Type 1			4.16	x1/[1/(0.8)+ 0.04]		=	3.22			(27)
Windows Type 2			3.41	x1/[1/(0.8)+ 0.04]		=	2.64			(27)
Windows Type 3			6.81	x1/[1/(0.8)+ 0.04]		=	5.28			(27)
Windows Type 4			2.3	x1/[1/(0.8)+ 0.04]		=	1.78			(27)
Windows Type 5			4.26	x1/[1/(0.8)+ 0.04]		=	3.3			(27)
Windows Type 6			8.1	x1/[1/(0.8)+ 0.04]		=	6.28			(27)
Windows Type 7			4.05	x1/[1/(0.8)+ 0.04]		=	3.14			(27)
Windows Type 8			2.16	x1/[1/(0.8)+ 0.04]		=	1.67			(27)
Windows Type 9			5.24	x1/[1/(0.8)+ 0.04]		=	4.06			(27)
Windows Type 10			6.34	x1/[1/(0.8)+ 0.04]		=	4.91			(27)
Windows Type 11			4.45	x1/[1/(0.8)+ 0.04]		=	3.45			(27)
Windows Type 12			6.53	x1/[1/(0.8)+ 0.04]		=	5.06			(27)
Windows Type 13			6.35	x1/[1/(0.8)+ 0.04]		=	4.92			(27)

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Floor Type 1			150.84	x	0.12	=	18.1008	(28)
Floor Type 2			3.6	x	0.2	=	0.72	(28)
Floor Type 3			16.5	x	0.12	=	1.98	(28)
Walls Type1	419.64	96.73	322.91	x	0.18	=	58.12	(29)
Walls Type2	147.94	0	147.94	x	0.18	=	26.63	(29)
Roof Type1	71.1	7.82	63.28	x	0.14	=	8.86	(30)
Roof Type2	7	0	7	x	0.14	=	0.98	(30)
Roof Type3	50.8	0	50.8	x	0.14	=	7.11	(30)
Roof Type4	39.6	0	39.6	x	0.14	=	5.54	(30)
Total area of elements, m²			907.02					(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) =	209.2	(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: Low	100	(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 — 69.93 (36)

if details of thermal bridging are not known (36) = 0.15 x (31)

Total fabric heat loss — (33) + (36) = 279.13 (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=	257.18	256.06	254.97	249.84	248.88	244.41	244.41	243.58	246.13	248.88	250.82	252.85	(38)

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

(39)m=	536.3	535.19	534.1	528.96	528	523.53	523.53	522.71	525.26	528	529.95	531.98	

Average = Sum(39)1…12 /12= 528.96 (39)

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

(40)m=	1.14	1.14	1.14	1.13	1.13	1.12	1.12	1.11	1.12	1.13	1.13	1.13

Average = Sum(40)1…12 /12= 1.13 (40)

Number of days in month (Table 1a)

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

4. Water heating energy requirement: kWh/year:

Assumed occupancy, N — 3.35 (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 — 113.81 (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)

SAP WorkSheet: New dwelling design stage

(44)m	125.19	120.63	116.08	111.53	106.98	102.42	102.42	106.98	111.53	116.08	120.63	125.19

Total = Sum(44) = 1365.67 (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=	185.65	162.37	167.55	146.07	140.16	120.95	112.08	128.61	130.15	151.67	165.56	179.79

Total = Sum(45)$_{1...12}$ = 1790.6 (45)

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

(46)m=	27.85	24.36	25.13	21.91	21.02	18.14	16.81	19.29	19.52	22.75	24.83	26.97	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 200 (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): 1.2 (48)

Temperature factor from Table 2b 0.54 (49)

Energy lost from water storage, kWh/year (48) x (49) = 0.65 (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) 0.65 (55)

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

(56)m=	20.09	18.14	20.09	19.44	20.09	19.44	20.09	20.09	19.44	20.09	19.44	20.09	(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=	20.09	18.14	20.09	19.44	20.09	19.44	20.09	20.09	19.44	20.09	19.44	20.09	(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=	229	201.52	210.9	188.03	183.51	162.9	155.43	171.96	172.1	195.02	207.51	223.14	(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=	229	201.52	210.9	188.03	183.51	162.9	155.43	171.96	172.1	195.02	207.51	223.14

Output from water heater (annual)$_{1...12}$ 2301.02 (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=	96.41	85.31	90.39	82.13	81.28	73.78	71.95	77.44	76.83	85.11	88.61	94.46	(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=	201.11	201.11	201.11	201.11	201.11	201.11	201.11	201.11	201.11	201.11	201.11	201.11	(66)

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

(67)m=	135.09	119.98	97.58	73.87	55.22	46.62	50.37	65.48	87.88	111.59	130.24	138.84	(67)

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

(68)m=	871.91	880.95	858.15	809.62	748.34	690.76	652.29	643.24	666.04	714.58	775.85	833.43	(68)

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

(69)m=	58.46	58.46	58.46	58.46	58.46	58.46	58.46	58.46	58.46	58.46	58.46	58.46	(69)

Pumps and fans gains (Table 5a)

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

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

(71)m=	-134.07	-134.07	-134.07	-134.07	-134.07	-134.07	-134.07	-134.07	-134.07	-134.07	-134.07	-134.07	(71)

Water heating gains (Table 5)

(72)m=	129.58	126.95	121.49	114.07	109.25	102.47	96.7	104.09	106.72	114.4	123.07	126.96	(72)

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

(73)m=	1265.07	1256.39	1205.72	1126.06	1041.32	968.35	927.86	941.31	989.14	1069.06	1157.66	1227.74	(73)

6. Solar gains:

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

Orientation:	Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
Northeast 0.9x	0.54	x	5.24	x	11.28	x	0.63	x	0.7	=	12.67	(75)
Northeast 0.9x	0.54	x	6.34	x	11.28	x	0.63	x	0.7	=	15.33	(75)
Northeast 0.9x	0.54	x	4.45	x	11.28	x	0.63	x	0.7	=	10.76	(75)
Northeast 0.9x	0.54	x	6.53	x	11.28	x	0.63	x	0.7	=	31.58	(75)
Northeast 0.9x	0.54	x	6.35	x	11.28	x	0.63	x	0.7	=	30.71	(75)
Northeast 0.9x	0.54	x	11.02	x	11.28	x	0.63	x	0.7	=	26.65	(75)
Northeast 0.9x	0.54	x	5.24	x	22.97	x	0.63	x	0.7	=	25.79	(75)
Northeast 0.9x	0.54	x	6.34	x	22.97	x	0.63	x	0.7	=	31.21	(75)
Northeast 0.9x	0.54	x	4.45	x	22.97	x	0.63	x	0.7	=	21.9	(75)
Northeast 0.9x	0.54	x	6.53	x	22.97	x	0.63	x	0.7	=	64.29	(75)
Northeast 0.9x	0.54	x	6.35	x	22.97	x	0.63	x	0.7	=	62.51	(75)
Northeast 0.9x	0.54	x	11.02	x	22.97	x	0.63	x	0.7	=	54.24	(75)
Northeast 0.9x	0.54	x	5.24	x	41.38	x	0.63	x	0.7	=	46.47	(75)
Northeast 0.9x	0.54	x	6.34	x	41.38	x	0.63	x	0.7	=	56.23	(75)
Northeast 0.9x	0.54	x	4.45	x	41.38	x	0.63	x	0.7	=	39.47	(75)
Northeast 0.9x	0.54	x	6.53	x	41.38	x	0.63	x	0.7	=	115.82	(75)
Northeast 0.9x	0.54	x	6.35	x	41.38	x	0.63	x	0.7	=	112.63	(75)
Northeast 0.9x	0.54	x	11.02	x	41.38	x	0.63	x	0.7	=	97.73	(75)
Northeast 0.9x	0.54	x	5.24	x	67.96	x	0.63	x	0.7	=	76.32	(75)
Northeast 0.9x	0.54	x	6.34	x	67.96	x	0.63	x	0.7	=	92.34	(75)
Northeast 0.9x	0.54	x	4.45	x	67.96	x	0.63	x	0.7	=	64.81	(75)

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Northeast 0.9x	0.54	x	6.53	x	67.96	x	0.63	x	0.7	=	190.21	(75)
Northeast 0.9x	0.54	x	6.35	x	67.96	x	0.63	x	0.7	=	184.97	(75)
Northeast 0.9x	0.54	x	11.02	x	67.96	x	0.63	x	0.7	=	160.5	(75)
Northeast 0.9x	0.54	x	5.24	x	91.35	x	0.63	x	0.7	=	102.59	(75)
Northeast 0.9x	0.54	x	6.34	x	91.35	x	0.63	x	0.7	=	124.12	(75)
Northeast 0.9x	0.54	x	4.45	x	91.35	x	0.63	x	0.7	=	87.12	(75)
Northeast 0.9x	0.54	x	6.53	x	91.35	x	0.63	x	0.7	=	255.69	(75)
Northeast 0.9x	0.54	x	6.35	x	91.35	x	0.63	x	0.7	=	248.64	(75)
Northeast 0.9x	0.54	x	11.02	x	91.35	x	0.63	x	0.7	=	215.75	(75)
Northeast 0.9x	0.54	x	5.24	x	97.38	x	0.63	x	0.7	=	109.37	(75)
Northeast 0.9x	0.54	x	6.34	x	97.38	x	0.63	x	0.7	=	132.33	(75)
Northeast 0.9x	0.54	x	4.45	x	97.38	x	0.63	x	0.7	=	92.88	(75)
Northeast 0.9x	0.54	x	6.53	x	97.38	x	0.63	x	0.7	=	272.59	(75)
Northeast 0.9x	0.54	x	6.35	x	97.38	x	0.63	x	0.7	=	265.07	(75)
Northeast 0.9x	0.54	x	11.02	x	97.38	x	0.63	x	0.7	=	230.01	(75)
Northeast 0.9x	0.54	x	5.24	x	91.1	x	0.63	x	0.7	=	102.31	(75)
Northeast 0.9x	0.54	x	6.34	x	91.1	x	0.63	x	0.7	=	123.79	(75)
Northeast 0.9x	0.54	x	4.45	x	91.1	x	0.63	x	0.7	=	86.89	(75)
Northeast 0.9x	0.54	x	6.53	x	91.1	x	0.63	x	0.7	=	255	(75)
Northeast 0.9x	0.54	x	6.35	x	91.1	x	0.63	x	0.7	=	247.97	(75)
Northeast 0.9x	0.54	x	11.02	x	91.1	x	0.63	x	0.7	=	215.17	(75)
Northeast 0.9x	0.54	x	5.24	x	72.63	x	0.63	x	0.7	=	81.56	(75)
Northeast 0.9x	0.54	x	6.34	x	72.63	x	0.63	x	0.7	=	98.69	(75)
Northeast 0.9x	0.54	x	4.45	x	72.63	x	0.63	x	0.7	=	69.27	(75)
Northeast 0.9x	0.54	x	6.53	x	72.63	x	0.63	x	0.7	=	203.29	(75)
Northeast 0.9x	0.54	x	6.35	x	72.63	x	0.63	x	0.7	=	197.69	(75)
Northeast 0.9x	0.54	x	11.02	x	72.63	x	0.63	x	0.7	=	171.54	(75)
Northeast 0.9x	0.54	x	5.24	x	50.42	x	0.63	x	0.7	=	56.63	(75)
Northeast 0.9x	0.54	x	6.34	x	50.42	x	0.63	x	0.7	=	68.51	(75)
Northeast 0.9x	0.54	x	4.45	x	50.42	x	0.63	x	0.7	=	48.09	(75)
Northeast 0.9x	0.54	x	6.53	x	50.42	x	0.63	x	0.7	=	141.13	(75)
Northeast 0.9x	0.54	x	6.35	x	50.42	x	0.63	x	0.7	=	137.24	(75)
Northeast 0.9x	0.54	x	11.02	x	50.42	x	0.63	x	0.7	=	119.09	(75)
Northeast 0.9x	0.54	x	5.24	x	28.07	x	0.63	x	0.7	=	31.52	(75)
Northeast 0.9x	0.54	x	6.34	x	28.07	x	0.63	x	0.7	=	38.14	(75)
Northeast 0.9x	0.54	x	4.45	x	28.07	x	0.63	x	0.7	=	26.77	(75)
Northeast 0.9x	0.54	x	6.53	x	28.07	x	0.63	x	0.7	=	78.56	(75)
Northeast 0.9x	0.54	x	6.35	x	28.07	x	0.63	x	0.7	=	76.4	(75)
Northeast 0.9x	0.54	x	11.02	x	28.07	x	0.63	x	0.7	=	66.29	(75)
Northeast 0.9x	0.54	x	5.24	x	14.2	x	0.63	x	0.7	=	15.94	(75)
Northeast 0.9x	0.54	x	6.34	x	14.2	x	0.63	x	0.7	=	19.29	(75)

Northeast 0.9x	0.54	x	4.45	x	14.2	x	0.63	x	0.7	=	13.54	(75)
Northeast 0.9x	0.54	x	6.53	x	14.2	x	0.63	x	0.7	=	39.74	(75)
Northeast 0.9x	0.54	x	6.35	x	14.2	x	0.63	x	0.7	=	38.64	(75)
Northeast 0.9x	0.54	x	11.02	x	14.2	x	0.63	x	0.7	=	33.53	(75)
Northeast 0.9x	0.54	x	5.24	x	9.21	x	0.63	x	0.7	=	10.35	(75)
Northeast 0.9x	0.54	x	6.34	x	9.21	x	0.63	x	0.7	=	12.52	(75)
Northeast 0.9x	0.54	x	4.45	x	9.21	x	0.63	x	0.7	=	8.79	(75)
Northeast 0.9x	0.54	x	6.53	x	9.21	x	0.63	x	0.7	=	25.79	(75)
Northeast 0.9x	0.54	x	6.35	x	9.21	x	0.63	x	0.7	=	25.08	(75)
Northeast 0.9x	0.54	x	11.02	x	9.21	x	0.63	x	0.7	=	21.76	(75)
Southeast 0.9x	0.54	x	2.16	x	36.79	x	0.63	x	0.7	=	17.03	(77)
Southeast 0.9x	0.54	x	2.16	x	62.67	x	0.63	x	0.7	=	29.01	(77)
Southeast 0.9x	0.54	x	2.16	x	85.75	x	0.63	x	0.7	=	39.7	(77)
Southeast 0.9x	0.54	x	2.16	x	106.25	x	0.63	x	0.7	=	49.19	(77)
Southeast 0.9x	0.54	x	2.16	x	119.01	x	0.63	x	0.7	=	55.1	(77)
Southeast 0.9x	0.54	x	2.16	x	118.15	x	0.63	x	0.7	=	54.7	(77)
Southeast 0.9x	0.54	x	2.16	x	113.91	x	0.63	x	0.7	=	52.73	(77)
Southeast 0.9x	0.54	x	2.16	x	104.39	x	0.63	x	0.7	=	48.33	(77)
Southeast 0.9x	0.54	x	2.16	x	92.85	x	0.63	x	0.7	=	42.99	(77)
Southeast 0.9x	0.54	x	2.16	x	69.27	x	0.63	x	0.7	=	32.07	(77)
Southeast 0.9x	0.54	x	2.16	x	44.07	x	0.63	x	0.7	=	20.4	(77)
Southeast 0.9x	0.54	x	2.16	x	31.49	x	0.63	x	0.7	=	14.58	(77)
Southwest0.9x	0.54	x	4.16	x	36.79		0.63	x	0.7	=	32.81	(79)
Southwest0.9x	0.54	x	3.41	x	36.79		0.63	x	0.7	=	26.89	(79)
Southwest0.9x	0.54	x	6.81	x	36.79		0.63	x	0.7	=	53.7	(79)
Southwest0.9x	0.54	x	2.3	x	36.79		0.63	x	0.7	=	18.14	(79)
Southwest0.9x	0.54	x	4.26	x	36.79		0.63	x	0.7	=	33.59	(79)
Southwest0.9x	0.54	x	8.1	x	36.79		0.63	x	0.7	=	63.88	(79)
Southwest0.9x	0.54	x	4.05	x	36.79		0.63	x	0.7	=	31.94	(79)
Southwest0.9x	0.54	x	4.16	x	62.67		0.63	x	0.7	=	55.88	(79)
Southwest0.9x	0.54	x	3.41	x	62.67		0.63	x	0.7	=	45.81	(79)
Southwest0.9x	0.54	x	6.81	x	62.67		0.63	x	0.7	=	91.48	(79)
Southwest0.9x	0.54	x	2.3	x	62.67		0.63	x	0.7	=	30.89	(79)
Southwest0.9x	0.54	x	4.26	x	62.67		0.63	x	0.7	=	57.22	(79)
Southwest0.9x	0.54	x	8.1	x	62.67		0.63	x	0.7	=	108.8	(79)
Southwest0.9x	0.54	x	4.05	x	62.67		0.63	x	0.7	=	54.4	(79)
Southwest0.9x	0.54	x	4.16	x	85.75		0.63	x	0.7	=	76.46	(79)
Southwest0.9x	0.54	x	3.41	x	85.75		0.63	x	0.7	=	62.67	(79)
Southwest0.9x	0.54	x	6.81	x	85.75		0.63	x	0.7	=	125.16	(79)
Southwest0.9x	0.54	x	2.3	x	85.75		0.63	x	0.7	=	42.27	(79)
Southwest0.9x	0.54	x	4.26	x	85.75		0.63	x	0.7	=	78.29	(79)

Southwest	0.9x	0.54	x	8.1	x	85.75	0.63	x	0.7	=	148.87	(79)
Southwest	0.9x	0.54	x	4.05	x	85.75	0.63	x	0.7	=	74.44	(79)
Southwest	0.9x	0.54	x	4.16	x	106.25	0.63	x	0.7	=	94.73	(79)
Southwest	0.9x	0.54	x	3.41	x	106.25	0.63	x	0.7	=	77.65	(79)
Southwest	0.9x	0.54	x	6.81	x	106.25	0.63	x	0.7	=	155.08	(79)
Southwest	0.9x	0.54	x	2.3	x	106.25	0.63	x	0.7	=	52.38	(79)
Southwest	0.9x	0.54	x	4.26	x	106.25	0.63	x	0.7	=	97.01	(79)
Southwest	0.9x	0.54	x	8.1	x	106.25	0.63	x	0.7	=	184.46	(79)
Southwest	0.9x	0.54	x	4.05	x	106.25	0.63	x	0.7	=	92.23	(79)
Southwest	0.9x	0.54	x	4.16	x	119.01	0.63	x	0.7	=	106.11	(79)
Southwest	0.9x	0.54	x	3.41	x	119.01	0.63	x	0.7	=	86.98	(79)
Southwest	0.9x	0.54	x	6.81	x	119.01	0.63	x	0.7	=	173.7	(79)
Southwest	0.9x	0.54	x	2.3	x	119.01	0.63	x	0.7	=	58.67	(79)
Southwest	0.9x	0.54	x	4.26	x	119.01	0.63	x	0.7	=	108.66	(79)
Southwest	0.9x	0.54	x	8.1	x	119.01	0.63	x	0.7	=	206.61	(79)
Southwest	0.9x	0.54	x	4.05	x	119.01	0.63	x	0.7	=	103.3	(79)
Southwest	0.9x	0.54	x	4.16	x	118.15	0.63	x	0.7	=	105.34	(79)
Southwest	0.9x	0.54	x	3.41	x	118.15	0.63	x	0.7	=	86.35	(79)
Southwest	0.9x	0.54	x	6.81	x	118.15	0.63	x	0.7	=	172.45	(79)
Southwest	0.9x	0.54	x	2.3	x	118.15	0.63	x	0.7	=	58.24	(79)
Southwest	0.9x	0.54	x	4.26	x	118.15	0.63	x	0.7	=	107.87	(79)
Southwest	0.9x	0.54	x	8.1	x	118.15	0.63	x	0.7	=	205.11	(79)
Southwest	0.9x	0.54	x	4.05	x	118.15	0.63	x	0.7	=	102.56	(79)
Southwest	0.9x	0.54	x	4.16	x	113.91	0.63	x	0.7	=	101.56	(79)
Southwest	0.9x	0.54	x	3.41	x	113.91	0.63	x	0.7	=	83.25	(79)
Southwest	0.9x	0.54	x	6.81	x	113.91	0.63	x	0.7	=	166.26	(79)
Southwest	0.9x	0.54	x	2.3	x	113.91	0.63	x	0.7	=	56.15	(79)
Southwest	0.9x	0.54	x	4.26	x	113.91	0.63	x	0.7	=	104	(79)
Southwest	0.9x	0.54	x	8.1	x	113.91	0.63	x	0.7	=	197.75	(79)
Southwest	0.9x	0.54	x	4.05	x	113.91	0.63	x	0.7	=	98.88	(79)
Southwest	0.9x	0.54	x	4.16	x	104.39	0.63	x	0.7	=	93.07	(79)
Southwest	0.9x	0.54	x	3.41	x	104.39	0.63	x	0.7	=	76.29	(79)
Southwest	0.9x	0.54	x	6.81	x	104.39	0.63	x	0.7	=	152.36	(79)
Southwest	0.9x	0.54	x	2.3	x	104.39	0.63	x	0.7	=	51.46	(79)
Southwest	0.9x	0.54	x	4.26	x	104.39	0.63	x	0.7	=	95.31	(79)
Southwest	0.9x	0.54	x	8.1	x	104.39	0.63	x	0.7	=	181.23	(79)
Southwest	0.9x	0.54	x	4.05	x	104.39	0.63	x	0.7	=	90.61	(79)
Southwest	0.9x	0.54	x	4.16	x	92.85	0.63	x	0.7	=	82.79	(79)
Southwest	0.9x	0.54	x	3.41	x	92.85	0.63	x	0.7	=	67.86	(79)
Southwest	0.9x	0.54	x	6.81	x	92.85	0.63	x	0.7	=	135.52	(79)
Southwest	0.9x	0.54	x	2.3	x	92.85	0.63	x	0.7	=	45.77	(79)

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Southwest	0.9x	0.54	x	4.26	x	92.85		0.63	x	0.7	=	84.78	(79)
Southwest	0.9x	0.54	x	8.1	x	92.85		0.63	x	0.7	=	161.19	(79)
Southwest	0.9x	0.54	x	4.05	x	92.85		0.63	x	0.7	=	80.6	(79)
Southwest	0.9x	0.54	x	4.16	x	69.27		0.63	x	0.7	=	61.76	(79)
Southwest	0.9x	0.54	x	3.41	x	69.27		0.63	x	0.7	=	50.62	(79)
Southwest	0.9x	0.54	x	6.81	x	69.27		0.63	x	0.7	=	101.1	(79)
Southwest	0.9x	0.54	x	2.3	x	69.27		0.63	x	0.7	=	34.15	(79)
Southwest	0.9x	0.54	x	4.26	x	69.27		0.63	x	0.7	=	63.24	(79)
Southwest	0.9x	0.54	x	8.1	x	69.27		0.63	x	0.7	=	120.25	(79)
Southwest	0.9x	0.54	x	4.05	x	69.27		0.63	x	0.7	=	60.13	(79)
Southwest	0.9x	0.54	x	4.16	x	44.07		0.63	x	0.7	=	39.29	(79)
Southwest	0.9x	0.54	x	3.41	x	44.07		0.63	x	0.7	=	32.21	(79)
Southwest	0.9x	0.54	x	6.81	x	44.07		0.63	x	0.7	=	64.32	(79)
Southwest	0.9x	0.54	x	2.3	x	44.07		0.63	x	0.7	=	21.72	(79)
Southwest	0.9x	0.54	x	4.26	x	44.07		0.63	x	0.7	=	40.24	(79)
Southwest	0.9x	0.54	x	8.1	x	44.07		0.63	x	0.7	=	76.51	(79)
Southwest	0.9x	0.54	x	4.05	x	44.07		0.63	x	0.7	=	38.25	(79)
Southwest	0.9x	0.54	x	4.16	x	31.49		0.63	x	0.7	=	28.07	(79)
Southwest	0.9x	0.54	x	3.41	x	31.49		0.63	x	0.7	=	23.01	(79)
Southwest	0.9x	0.54	x	6.81	x	31.49		0.63	x	0.7	=	45.96	(79)
Southwest	0.9x	0.54	x	2.3	x	31.49		0.63	x	0.7	=	15.52	(79)
Southwest	0.9x	0.54	x	4.26	x	31.49		0.63	x	0.7	=	28.75	(79)
Southwest	0.9x	0.54	x	8.1	x	31.49		0.63	x	0.7	=	54.66	(79)
Southwest	0.9x	0.54	x	4.05	x	31.49		0.63	x	0.7	=	27.33	(79)
Northwest	0.9x	0.54	x	4.59	x	11.28	x	0.63	x	0.7	=	11.1	(81)
Northwest	0.9x	0.54	x	4.59	x	22.97	x	0.63	x	0.7	=	22.59	(81)
Northwest	0.9x	0.54	x	4.59	x	41.38	x	0.63	x	0.7	=	40.71	(81)
Northwest	0.9x	0.54	x	4.59	x	67.96	x	0.63	x	0.7	=	66.85	(81)
Northwest	0.9x	0.54	x	4.59	x	91.35	x	0.63	x	0.7	=	89.86	(81)
Northwest	0.9x	0.54	x	4.59	x	97.38	x	0.63	x	0.7	=	95.8	(81)
Northwest	0.9x	0.54	x	4.59	x	91.1	x	0.63	x	0.7	=	89.62	(81)
Northwest	0.9x	0.54	x	4.59	x	72.63	x	0.63	x	0.7	=	71.45	(81)
Northwest	0.9x	0.54	x	4.59	x	50.42	x	0.63	x	0.7	=	49.6	(81)
Northwest	0.9x	0.54	x	4.59	x	28.07	x	0.63	x	0.7	=	27.61	(81)
Northwest	0.9x	0.54	x	4.59	x	14.2	x	0.63	x	0.7	=	13.97	(81)
Northwest	0.9x	0.54	x	4.59	x	9.21	x	0.63	x	0.7	=	9.06	(81)
Rooflights	0.9x	1	x	3.49	x	26	x	0	x	0.8	=	0	(82)
Rooflights	0.9x	1	x	4.33	x	26	x	0	x	0.8	=	0	(82)
Rooflights	0.9x	1	x	3.49	x	54	x	0	x	0.8	=	0	(82)
Rooflights	0.9x	1	x	4.33	x	54	x	0	x	0.8	=	0	(82)
Rooflights	0.9x	1	x	3.49	x	96	x	0	x	0.8	=	0	(82)

Rooflights 0.9x	1	x	4.33	x	96	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	3.49	x	150	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	4.33	x	150	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	3.49	x	192	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	4.33	x	192	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	3.49	x	200	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	4.33	x	200	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	3.49	x	189	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	4.33	x	189	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	3.49	x	157	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	4.33	x	157	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	3.49	x	115	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	4.33	x	115	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	3.49	x	66	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	4.33	x	66	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	3.49	x	33	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	4.33	x	33	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	3.49	x	21	x	0	x	0.8	=	0	(82)
Rooflights 0.9x	1	x	4.33	x	21	x	0	x	0.8	=	0	(82)

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

(83)m=	416.78	756.04	1156.91	1638.74	2022.89	2090.68	1981.34	1682.15	1321.79	868.61	507.61	351.25	(83)

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

(84)m=	1681.86	2012.43	2362.64	2764.8	3064.21	3059.02	2909.2	2623.46	2310.93	1937.67	1665.27	1578.99	(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=	0.99	0.98	0.97	0.94	0.87	0.76	0.64	0.69	0.86	0.96	0.98	0.99	(86)

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

(87)m=	18.81	19	19.33	19.8	20.25	20.6	20.77	20.73	20.43	19.85	19.25	18.78	(87)

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

(88)m=	19.97	19.97	19.97	19.98	19.98	19.99	19.99	19.99	19.98	19.98	19.98	19.97	(88)

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

(89)m=	0.99	0.98	0.96	0.92	0.84	0.7	0.53	0.6	0.82	0.95	0.98	0.99	(89)

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

(90)m=	16.99	17.26	17.75	18.43	19.07	19.55	19.75	19.71	19.33	18.52	17.64	16.95	(90)

fLA = Living area ÷ (4) = | 0.07 | (91)

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

(92)m=	17.12	17.39	17.87	18.53	19.16	19.62	19.82	19.78	19.41	18.61	17.76	17.08	(92)

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

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(93)m=	16.97	17.24	17.72	18.38	19.01	19.47	19.67	19.63	19.26	18.46	17.61	16.93	(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=	0.98	0.97	0.95	0.89	0.8	0.66	0.49	0.56	0.78	0.92	0.97	0.98	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	1649.02	1949.59	2234.03	2474.49	2460.87	2012.9	1439.47	1457.07	1805.91	1790.87	1616.41	1552.68	(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=	6795.04	6601.97	5991.22	5015.71	3857.77	2551.5	1606.94	1690.22	2711.06	4151.24	5568.1	6773.57	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	3828.64	3126.4	2795.35	1829.68	1039.29	0	0	0	0	1756.11	2845.22	3884.34	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 21105.03 (98)

Space heating requirement in kWh/m²/year 44.99 (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	4921.23	3874.16	3972.57	0	0	0	0	(100)
Utilisation factor for loss hm													
(101)m=	0	0	0	0	0	0.61	0.69	0.63	0	0	0	0	(101)
Useful loss, hmLm (Watts) = (100)m x (101)m													
(102)m=	0	0	0	0	0	3023.2	2665.99	2519.97	0	0	0	0	(102)
Gains (solar gains calculated for applicable weather region, see Table 10)													
(103)m=	0	0	0	0	0	3675.48	3493.26	3118.87	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	0	615.5	445.58	0	0	0	0	

Total = Sum(104)$_{6...8}$ = 1061.08 (104)

Cooled fraction — f C = cooled area ÷ (4) = 0.51 (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)$_{6...8}$ = 0 (106)

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

(107)m=	0	0	0	0	0	0	78.72	56.99	0	0	0	0

Total = Sum(107)$_{6...8}$ = 135.71 (107)

Space cooling requirement in kWh/m²/year — (107) ÷ (4) = 0.29 (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 total heating from main system 1	(204) = (202) × [1 – (203)] =	0.9	(204)

Efficiency of main space heating system 1	89.7	(206)
Efficiency of secondary/supplementary heating system, %	90	(208)
Cooling System Energy Efficiency Ratio	4.32	(209)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Space heating requirement (calculated above)	3828.64	3126.4	2795.35	1829.68	1039.29	0	0	0	0	1756.11	2845.22	3884.34		
(211)m = {[(98)m x (204)] } x 100 ÷ (206)	3841.45	3136.85	2804.7	1835.8	1042.77	0	0	0	0	1761.99	2854.73	3897.33		(211)
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													21175.62	(211)
Space heating fuel (secondary), kWh/month = {[(98)m x (201)] } x 100 ÷ (208)														
(215)m=	425.4	347.38	310.59	203.3	115.48	0	0	0	0	195.12	316.14	431.59		
Total (kWh/year) =Sum(215)$_{1...5,10....12}$=													2345	(215)
Water heating														
Output from water heater (calculated above)	229	201.52	210.9	188.03	183.51	162.9	155.43	171.96	172.1	195.02	207.51	223.14		
Efficiency of water heater													79	(216)
(217)m=	88.95	88.9	88.77	88.47	87.75	79	79	79	79	88.39	88.8	88.98		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	257.45	226.7	237.58	212.53	209.13	206.2	196.74	217.67	217.84	220.65	233.69	250.78		
Total = Sum(219a)$_{1...12}$ =													2686.97	(219)
Space cooling fuel, kWh/month. (221)m = (107)m÷ (209)														
(221)m=	0	0	0	0	0	0	18.22	13.19	0	0	0	0		
Total = Sum(221)$_{6...8}$ =													31.41	(221)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		21175.62	
Space heating fuel used, secondary		2345	
Water heating fuel used		2686.97	
Space cooling fuel used		31.41	
Electricity for pumps, fans and electric keep-hot			
central heating pump:	30		(230c)
boiler with a fan-assisted flue	45		(230e)
Total electricity for the above, kWh/year — sum of (230a)…(230g) =		75	(231)
Electricity for lighting		954.27	(232)
Electricity generated by PVs		-4116.75	(233)

10a. Fuel costs - individual heating systems:

	Fuel kWh/year	**Fuel Price** (Table 12)		**Fuel Cost** £/year	
Space heating - main system 1	(211) x	3.48	x 0.01 =	736.91	(240)

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Space heating - main system 2	(213) x	0	x 0.01 =	0	(241)
Space heating - secondary	(215) x	3.48	x 0.01 =	81.61	(242)
Water heating cost (other fuel)	(219)	3.48	x 0.01 =	93.51	(247)
Space cooling	(221)	13.19	x 0.01 =	4.14	(248)
Pumps, fans and electric keep-hot	(231)	13.19	x 0.01 =	9.89	(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 =	125.87	(250)
Additional standing charges (Table 12)				120	(251)
	one of (233) to (235) x)	13.19	x 0.01 =	-543	(252)

Appendix Q items: repeat lines (253) and (254) as needed

Total energy cost	(245)...(247) + (250)…(254) =	628.93	(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] =	0.51	(257)
SAP rating (Section 12)		92.83	(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	0.216	=	4573.93	(261)
Space heating (secondary)	(215) x	0.216	=	506.52	(263)
Water heating	(219) x	0.216	=	580.39	(264)
Space and water heating	(261) + (262) + (263) + (264) =			5660.84	(265)
Space cooling	(221) x	0.519	=	16.3	(266)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	38.93	(267)
Electricity for lighting	(232) x	0.519	=	495.27	(268)
Energy saving/generation technologies Item 1		0.519	=	-2136.59	(269)
Total CO2, kg/year		sum of (265)…(271) =		4074.75	(272)
CO2 emissions per m²		(272) ÷ (4) =		8.69	(273)
EI rating (section 14)				89	(274)

13a. Primary Energy

	Energy kWh/year	**Primary** factor		**P. Energy** kWh/year	
Space heating (main system 1)	(211) x	1.22	=	25834.26	(261)
Space heating (secondary)	(215) x	1.22	=	2860.9	(263)
Energy for water heating	(219) x	1.22	=	3278.1	(264)

Space and water heating	(261) + (262) + (263) + (264) =			31973.26	(265)
Space cooling	(221) x	3.07	=	96.44	(266)
Electricity for pumps, fans and electric keep-hot	(231) x	3.07	=	230.25	(267)
Electricity for lighting	(232) x	0	=	2929.62	(268)
Energy saving/generation technologies Item 1		3.07	=	-12638.41	(269)
'Total Primary Energy		sum of (265)…(271) =		22591.16	(272)
Primary energy kWh/m²/year		(272) ÷ (4) =		48.15	(273)