ATHLONE HOUSE

PLANNING SUBMISSION OF ENERGY STATEMENT

FOR

ATHLONE HOUSE – HIGHGATE

October 2013

PREPARED BY:

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05	D. Vardill	10.10.13		P.Dunk	10.10.13	

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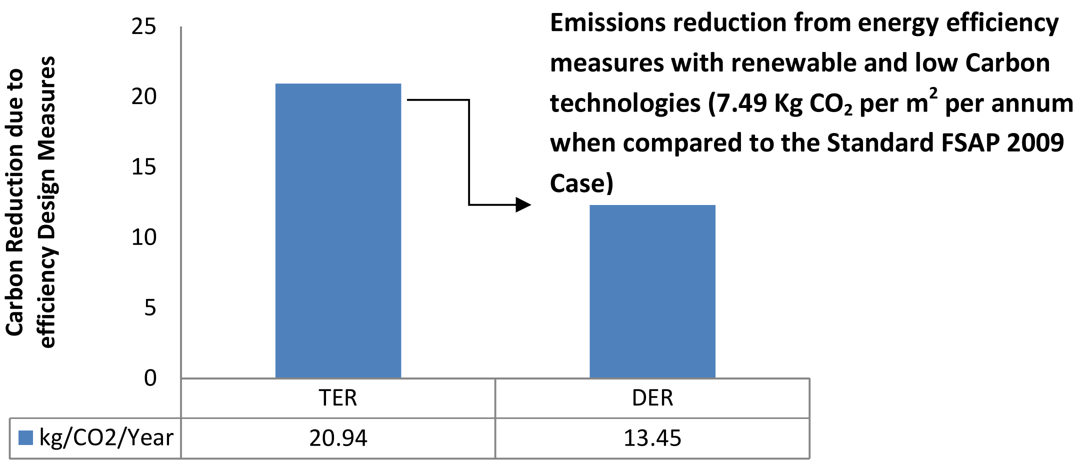
1. EXECUTIVE SUMMARY

This Energy Statement consists of an energy demand assessment showing how selected energy efficiency and renewable energy measures have been incorporated into the Athlone House development. The scheme is subject to the planning policies of the Camden council and the development must comply with London Plan Policy.

The SAP calculations have been prepared (See Appendix C) for a unique building whose areas, controls and building services allow for a single residence which will include the construction of an integrated Pool Room and a separate below ground Garage to the property. And this approach has predicted to achieve **34 tonnes $C0_2$** per annum related to the Part L: 2010 compliant base case of **54 tonnes $C0_2$** per annum**.** The proposed re-development at Highgate is at the cutting edge of sustainable design and expected to reduce its carbon emissions by approximately **36 %** compared to the target emissions rate (TER) set by Building Regulations Part L1A 2010.

The key technologies proposed for the site are:

- It is proposed that the building thermal elements be specified to exceed minimum building regulations 2010 by 25%.
- It is proposed to install a ground source heat pump.
- It is proposed to install a total of 10m^2 solar thermal panels.
- It is proposed to install a total of 60m^2 Photovoltaic panels.



When building CO_2 emissions 20.94 & 13.45 (Kg/m^2) are multiply by useful area of the building (2595.75 m^2) is given by 54 & 34(tonnes) CO_2 per annum respectively.

2. INTRODUCTION

2.1. BACKGROUND TO THE SCHEME

The Statement describes the methodology used in assessing the proposed re-development and the assessment of the predicted energy target and renewable proposals to support the planning application for the re-development of the Athlone House project.

The existing dwelling is proposed to be demolished and replaced with a more contemporary dwelling arranged over four floors from basement to second floor and incorporating an internal swimming pool.

This Energy Statement has been prepared by Slender Winter Partnership Ltd on behalf of Adam Architecture in support of the full planning application for the proposed new building.

3. POLICY GUIDANCE AND CONSTRAINTS

3.1. REGIONAL AND LOCAL POLICY FRAMEWORK

The Proposed development has been influenced by the Camden Council planning guidance, which support the policies in the Local Development framework (LDF) and this guidance consistent with Core Strategy and the development policies which are supported by the Mayor of London's London Plan (including alterations from 2004) and Energy Strategy. In maximizing the sustainability aspects of the development, the Client is committed to delivering appropriate items. In particular:

- Code for Sustainable Homes Level 4 standard "at least 68 credits".
- Maximizing water conversation and recycling.
- Designing the building and services for minimum energy use.
- Offset on-site generated renewable energy sources where feasible "at least 20% of predicted energy requirements".

This new guidance will replace the Camden Planning Guidance 2006, updating advice where appropriate and providing new guidance on matters introduced or strengthened in the LDF.

This guidance provides information on ways to achieve carbon reductions and more sustainable developments. It also highlights the Council's requirements and guidelines which support the relevant Local Development Framework (LDF) policies:

CS13 - *Tackling climate change through promoting higher environmental standards*
DP22 - *Promoting sustainable design and construction*
DP23 - *Water*

3.2. NATIONAL PLANNING GUIDANCE

The UK government published its sustainable development strategy in 1999 and set out in following national planning guidance:

- Planning policy statement 1: "Creating Sustainable Communities" published in 2005.
- Planning policy statement 3: "Housing", published in June 2010.
- Planning policy statement 13: Transport, published in 2001.
- Planning policy statement 22: Renewable Energy.

3.3. RENEWABLE ENERGY POLICY IN THE UK – TARGETS

The UK's Climate Change Act passed into law in November 2008, placing a legal imperative on the government to cut emissions by 80% of their 1990 levels by 2050, with a mid-term target of 34% cuts by 2020.

Government has set targets of 10% electricity to come from renewable sources by 2010 and for this to increase to 20% by 2020.
The Government's Renewable Energy Policy sets the context for determination of planning applications and the statements reviewed within this section of the Planning Statement make it clear that considerable planning weight should be attributed to these policies. Indeed in every statement of government policy since in 1997 the importance which government attaches to an increasing rate of development of renewable sources has been substantial.

3.4. METHODOLOGY ADOPTED IN THE STRATEGY

The following energy hierarchy was used to identify and prioritise the most effective means of reducing carbon emissions where it is feasible and reasonable.

1. **Be Lean-** Energy Efficiency measures through design and use.(use less energy)
2. **Be Clean-** Optimise energy supply infrastructure for efficiency through "Low carbon" strategies. (Supply energy efficiently)
3. **Be Green-** Utilise renewable energy resources, where it is feasible and appropriate.

4. THE PROPOSED DEVELOPMENT

It is the intention of Adam Architecture to create a new house with the re development of building arranged over four floors from basement to second floor with total useful area of 2595.75 m^2. A proposed site plan is included in Appendix A. The proposed development consists of following habitable areas:

Floor	Useful Floor Area / (m^2)
Basement Floor	560
Ground Floor	823
First Floor	811.75
Second Floor	401
TOTAL AREA	**2595.75**

4.1. BASE CASE ENERGY DEMAND AND CARBON EMISSIONS

The baseline energy demand for the proposal has been established using SAP calculations prepared for the building to arrive at an overall site energy demand. The appropriate base case against which to assess potential carbon savings is a new development designed to conform to 2010 PartL2A Building Regulations; effectively "do minimum" case. This base case represents a Part L 2010 compliant notional building of same size, shape and use as proposed building, where the electricity for the development is imported from the grid, the space heating and domestic hot water are provided by a standard individual gas – fired boilers and space cooling, where applicable, is provided by Direct Expansion (DX) cooling and HVAC ventilation.

The development has been modelled by approved energy assessment software (FSAP 2009 program, Version 1.5.0.37). The total heated area of the proposed dwelling is approximately 2596 m^2. The baseline Carbon emissions for the site have been predicted 20.94 kg/m^2CO_2 per annum and the results included in the Appendix C.

The baseline energy demand for the proposed development results in **231 MWhr** of Space heating and hot water (assumed to be Gas fuelled) **4.8 MWhr** of electrical energy usage annually. This equates to site emissions of **54 Tonnes CO_2 per annum.**

5. ENERGY EFFICIENT MEASURES APPLIED TO BASELINE DESIGN

5.1. DESIGN

The energy performance of the building is affected by the design, its construction and its use. Whilst occupant behaviour is beyond the remit of this statement, improved design and construction methods can significantly reduce the cycle emissions of a building and assist the occupant to reduce consumption. Sustainable design is not just incorporating renewable technologies and buildings should be designed at the outset, which provides suitable environmental conditions for the occupant's whist also consuming as little energy as practically achievable.

5.2. BUILDING PERFORMANCE

Buildings in Camden account for 88% of Camden's overall CO_2 emissions * and these emissions result from the energy used within buildings.

Substantial advances have been achieved in terms of reducing the heat demand in new homes in the last few years. The annual heat demand for an existing detached house, for example, is higher than 200 kW/m^2 p.a. By comparison, a new house built to high energy efficiency standards only requires approximately 70 kW/m^2 p.a.

The following energy measures are intended to be incorporated to provide an acceptable energy level usage building.

*Camden Planning Guidance (CPG 3) – Sustainability

5.3. THERMAL ELEMENTS

It is proposed that the building's thermal elements be specified to exceed the minimum AD Part L standards by 20%.

Element	Building Reg. Part L1A (W/m2K)	Proposed (W/m2K)
External Walls	0.30	0.19
Roof	0.20	0.15
Floor	0.25	0.15
Windows	2.0	1.4

5.4. HEATING

The house will have ground source water loop heat pumps that reject all waste heat into the building piles at basement sub level during summer months therefore avoiding the requirement for roof mounted condenser units. Subject to how the space heating will be provided this will be sized to cover load, a provisional allowance for background heating in the region of **55 kW**. The areas within the building shall be suitably zoned for space heating provision.

5.5. POOL VENTILATION PLANT

The pool ventilation unit shall be a purpose built unit and shall incorporate heat recovery technology utilising external air for heating/cooling and dehumidification wherever possible. This unit will receive primary heat from the boiler system for air heating and reclaim dehumidification energy to heat the pool water. In addition the pool ventilation unit shall also be located in the basement plantroom.

5.6. AIR PERMEABILITY

Large amounts of heat are lost in winter through air leakage from a building often through poor sealing of joints and openings in the building.

Air tightness standards will be constructed at the development to the 'Accredited Construction Details' as compiled by the Local Government and this building will be designed to achieve an air permeability of lower than **8 $m^3/hr/m^2$.** This, along with the high thermal mass of the external walls and the terraced nature of the streetscape, will significantly reduce the energy demand for space heating. In order to achieve this low air permeability rate the use of a central ventilation system with heat recovery is proposed for the basement accommodation.

5.7. ARTIFICIAL LIGHTING

The provision of natural daylight is considered an important factor in the design in order to minimise the use of artificial light within the building. All habitable rooms have access to natural light with high specification glazing being used to maximise day lighting levels and minimise associated heat loss. High efficiency lamps will be considered in conjunction with the client's preferences and facilities for automatic switching and dimming via the Audio Visual system shall also be incorporated where possible. This will however be subject to the client's and interior designer's agreement.

5.8. SUSTAINABILITY CONSIDERATIONS

The Athlone House development incorporates the following measures to minimise water Consumption:

- Rainwater harvesting system sized to deliver proportion of the toilet flushing requirements and car washing.
- Water leak detection systems linked to central alarm system.
- Taps with automatic shut off or electronic sensors.

6. ON-SITE RENEWABLE ENERGY ASSESSMENT

The energy demand established above has been used to test the viability of various renewable and low carbon technologies as follows and this section determines the appropriateness of each renewable technology and considers the ability of each technology to comply with the planning requirements as set out above in section 1.2.

The Government Renewable Obligation defines renewable energy in the UK and the identified technologies are;

- Geothermal power (ground source and air source heat pumps)
- Solar Power (water or PV panels)
- Tidal and wave power
- Biomass
- Onshore and offshore wind.
- Small hydro-electric
- Landfill and sewage gas.

The use of landfill or sewage gas, offshore wind or any form of hydroelectric power is not suitable for the site due to its location. The remaining technologies are considered below;

6.1. GROUND SOURCE HEAT PUMPS

illustrative images only

Heat pumps use refrigerant gases and an electrical compressor to take heat from a source and deliver it to an output. In this way they can be used to supply heat to a building. The ground acts as a huge solar collector and thermal store, which dampens fluctuations in ground temperature. The fluctuations reduce with depth and stabilise at the annual mean by about 12m below the surface; for the UK this is in the range 9–12°C.

Ground source heat pumps make use of this heat stored in the ground and raise it to a more useful temperature of around 40-50°C. It should be noted that at these temperatures, the heat produced is only useful for low temperature applications such as under floor heating installations; otherwise, a degree of top-up by conventional means is required when used for generating domestic hot water for example.

To accommodate the need for low temperature water for underfloor heating purposes and also relatively medium temperature water for chilling of the underfloor heating mass a ground source heat pump utilising vertical bore hole piles is being considered below the basement car park level.

It is believed a total of 16 boreholes approximately 70m deep can be provided within this area with the correct spacing for maximum heat rejection/extraction, approximately **55 kW.**

With this system employed it is likely that an estimated total of **39,000 kWh/annum** may be produced from the system on an annual basis

6.2. AIR SOURCE HEAT PUMPS

illustrative images only

Air source heat pumps operate using same reverse refrigeration cycle as ground source heat pumps; however the initial heat energy is extracted from the external air rather than ground. These heat pumps can be reversed to provide cooling to an area although this reduces the coefficient of the performance of the pumps.

The heat pump connects a multiple inside unit with a single outside unit. The latter resembles an air conditioning condenser unit and care must be taken to locate the unit where any noise generation is not obtrusive and the location should ensure the unit is not visually obtrusive.

It is not proposed to install Air source heat pumps for heating but instead utilize split system DX units for cooling during peak periods.

6.3. SOLAR WATER HEATING

illustrative images only

There is space at roof level as indicated on the Architect's drawings to provide solar water heating panels that will serve the hot water service demand particularly during the summer months of the property as a whole. It may also be used to feed the swimming pool heating system depending on temperature arrangements and in conjunction with the correctly sized buffer vessel will store heat for maximum demand use in mornings and evenings if sized correctly.

It is anticipated that vacuum black tube units can be employed in an array that will feed a hot water storage buffer vessel within the basement plantroom. These units will be fitted to the rear of the main roof as indicated at a slight incline and will be south facing to absorb sun rays or bright sky where available.

The estimated annual output from a total of 10sq.m of solar panels will constitute approximately **2900 kWh** of solar water heating and this would result in achieving around **4 %** of the annual buildings energy needs.

6.4. PHOTOVOLTAICS

illustrative images only

Photovoltaic panels (PV) provide clean silent electricity and they generate green electricity during most daylight conditions although they are most efficient when expose to direct sunlight or are orientated to face plus or minus 30 degrees of due south.

PV panels typically have an electrical warranty of 20 – 25 years and are eligible for the Government's Feed in Tariff (FITS) incentive scheme for the 25 years after the installation.

Firstly we need to discuss the likely location of solar arrays of this type. Investigating the Architect's plan of the roof construction it is unlikely that there is sufficient space at all at roof level owing to the complexity and sensitive nature of the site and the Architect's desire to duplicate the existing building as much as possible.

An array of photovoltaic panels could be arranged within the grounds of the house but obviously again this would affect the landscaping and current rural plan for the landscape garden and garden heritage.

Subject again to the advice of Planners, Client and the Design Team it is again unlikely a large array of photovoltaic panels can be provided for Athlone House to substantiate any major source of benefit to the 20% renewable energy requirement of this development.

It is important to note that the estimated annual output from **60sq.m** of photovoltaic panels is **7.5kW peak**[1]; therefore PV panels will constitute **10%** of the overall renewable energy requirement making this a feasible option for the development

[1] Figures assume 8m^2 of PV per kilowatt of energy produced

6.5. WIND TURBINES

illustrative images only

The main issues applicable to the selection of wind turbines relate to local wind speeds, planning, and the potential miss-match between energy generation and demand profiles. Generally a minimum of six months worth of specific site weather data is required to provide results that are meaningful than just information obtained from existing data bases.

It is taken within this assessment although it has not been possible to carry out site wind measurements due to the time constraints. The Department of Trade and Industry's wind speed database gives computed wind speeds per sq. km of sites. From this database the average speed at Highgate are 4.8m/second at 10m above ground level.

Taking this information on board and utilising industry standard components for small wind turbines, the most efficient means of providing wind power at these levels can be given from manufacturers such as Proven Ltd, who provide units at 3.5m diameter turbines mounted 5m above roof access or ground level.

These units produce approximately 6kW of electricity at maximum output at the wind speed stipulated, a single unit of this size would generate approx **9,300 kwh/annum**. The practical issues here are obvious particularly relating to the site in question and this is a relatively sensitive site in terms of the overall global environment associated with the Athlone House Estate. It has a fundamentally a rural feel to the Estate at the rear of the property while the front of the property is open to direct public view and has neighbouring properties on both sides at the main Highgate entrance.

Any sitting of wind turbines would need to take on board any acoustic issues of adjoining properties as well as any health and safety issues of either mounting the wind turbines at roof level or at ground level somewhere towards the front access of the building.

Subject to further discussion with the Planning Department and the Client it is unlikely that wind turbines will be practical for this site. For this reason we have not investigated the application of wind turbines further.

6.6. BIOMASS BOILERS

illustrative images only

The biomass system can burn directly to provide heat within the building, although biomass boilers require storage frequent cleaning and a high level of maintenance. The size of the development dictates that a high level of maintenance throughout the services within the building must be available.

To this degree the Client is willing to consider this option as a means of achieving a substantial part of the renewable energy requirement. A secondary source of heating over and above the ground source heat pump option for underfloor heating will be provided in terms of a natural gas fired boiler system for top up and peak demand requirements. The maximum heating demand for the development at Athlone House is 150kW. It is believed that if a biomass boiler were utilised to provide part of the heating/hot water service load then this will be sized in the order of 95kW with a run time of approximately 950 hours.

This would require approximately 45 tonnes/year of wood pellets and an estimate fuel store in the realm of $53m^3$ (6 deliveries/year). Due to fuel storage and logistical issues Biomass has not been considered for this dwelling.

6.7. SUMMARY OF PROPOSED RENEWABLE ENERGY SYSTEMS

	System	Energy/Annum	% of Annual Energy
1)	Photovoltaics	5,766 kWh/year	8 %
2)	Solar Water Panels	2,900 kWh/year	4 %
3)	Ground Source heat pump	39,000 kWh/year	53 %
Total estimated low and zero carbon technology contribution to site energy usage.		**47,666 kWh/year**	**65%**

7. CONCLUSION

7.1. REQUIREMENT FOR THE ON-SITE RENEWABLE ENERGY

Estimated Building Energy demand based on SAP calculations prepared (Appendix C).

	Energy Demand kWh/Year	Total
Space Heating	59162.91	
Hot Water	937.78	
Cooling	342.99	73414.88 kWh/Year
Pumps & Fans	9689.1	
Lighting	3282.1	

The SAP target energy (TER) demand is **235504.79 KWh** with associated CO_2 emissions of **20.94 kg CO_2/m^2**

- To meet the London plan policy (20%) the total required renewable energy output needs to reduce site CO_2 emissions by at least **4.188 kg/m^2**

- The total estimated annual building energy usage including onsite energy produced is **67648.88 KWh** with associated CO_2 emissions of **13.45 kg CO_2/m^2** which is a reduction of **7.49 kg/m^2**

7.2. ACHIEVABLE TOTAL EMISSIONS REDUCTION

By utilising energy efficiency measures and supplying a majority of the development's energy requirements with low carbon technology (ASHP), and renewable technologies (Solar Thermal Panels & PV panels) a total level of emissions of **34 tonnes CO_2** per annum is predicted by SAP2009 (Appendix C). This equates to a saving of **20 tonnes CO_2** per annum or **36 %** over the target level (set within Part L 2010).With these design inclusions the property would also meet the Code for Sustainable Home level 4 target at this initial assessment (Appendix F) and complies with the building regulation 2010 (Appendix E).

Buiding regulation assessment

	kg/m²/year
TER	20.94
DER	13.45

The following code calculations are taken from the Code for Sustainable Homes Technical Guide (Nov 10)

Ene 1 Assessment - Dwelling Emission Rate

Total Energy Type CO2 Emissions for Codes Levels 1 - 5

	%	kg/m²/year	
DER from SAP 2009 DER Worksheet		13.45	*(ZC1)*
TER		20.94	
Residual CO2 emissions offset from biofuel CHP		0	*(ZC5)*
CO2 emissions offset from additional allowable electricty generation		0	*(ZC7)*
Total CO2 emissions offset from SAP Section 16 allowances		0	
DER accounting for SAP Section 16 allowances		13.45	
% improvement DER/TER	35.8		

Total Energy Type CO2 Emissions for Codes Levels 6

	kg/m²/year	
DER accounting for SAP Section 16 allowances	13.45	*(ZC1)*
CO2 emissions from appliances, equation (L14)	3.95	*(ZC2)*
CO2 emissions from cooking, equation (L16)	0.1	*(ZC3)*
Net CO2 emissions	17.5	*(ZC8)*

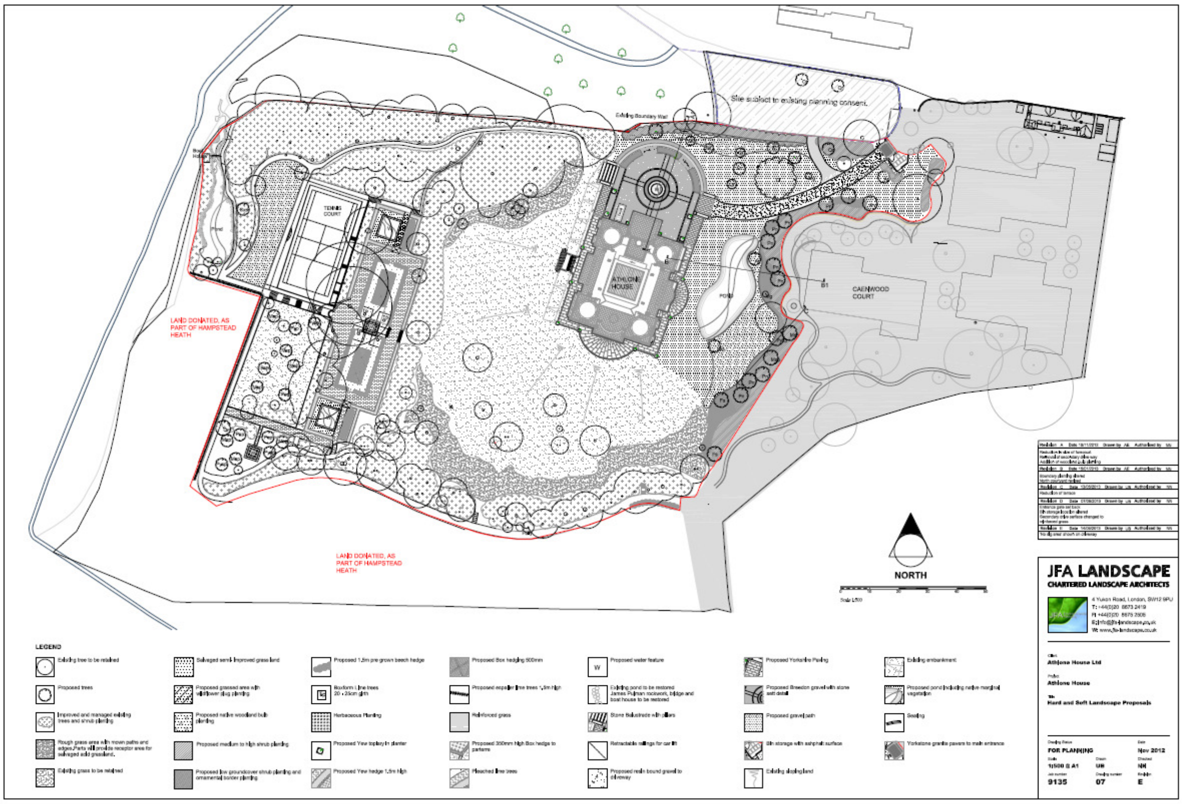
Result:

Credits awarded for Ene 1 = 4

Code Level = 4

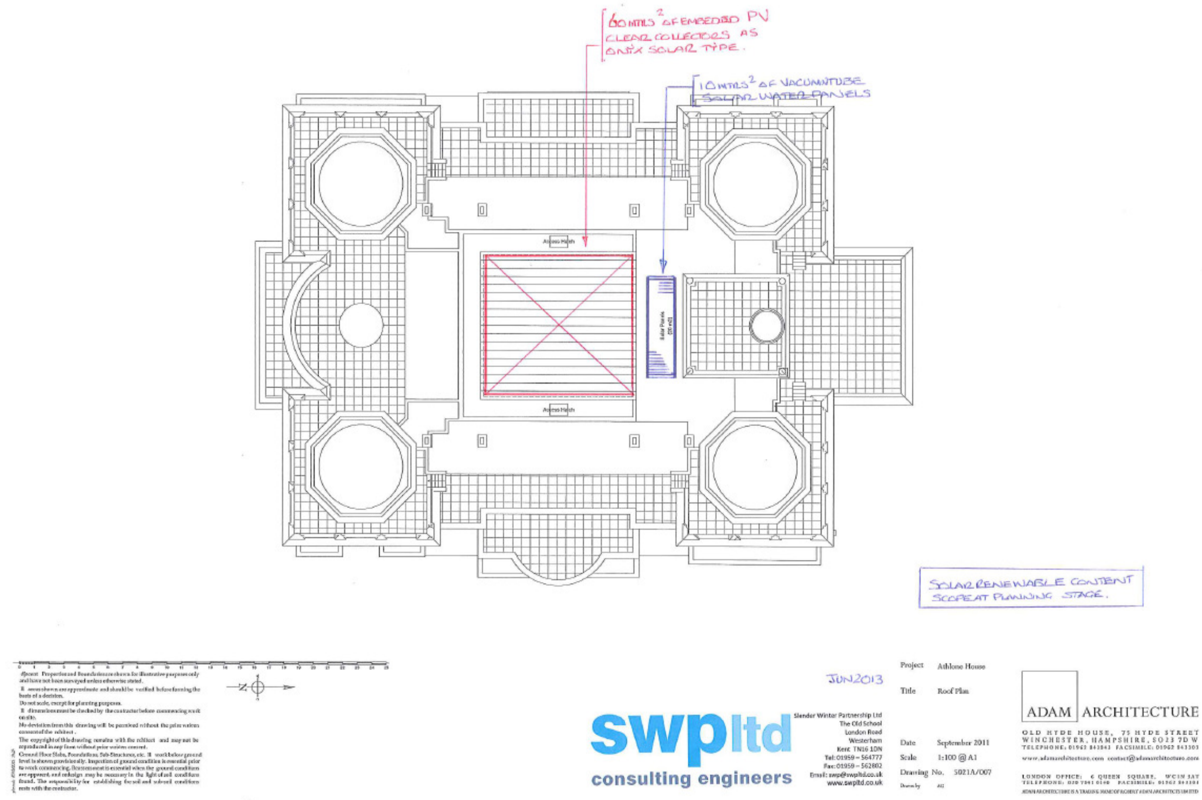
APPENDIX A

SITE PLAN



APPENDIX B

PROPOSED ROOF PLANT



APPENDIX C

SAP WORKSHEET

METHODOLOGY BY SAP2009

SAP WorkSheet: New dwelling design stage

User Details:

Assessor Name:		**Stroma Number:**	
Software Name:	Stroma FSAP 2009	**Software Version:**	Version: 1.5.0.37

Property Address: Athlone House

Address : Athlone House, Hampstead Lane, LONDON, N6 4RU

1. Overall dwelling dimensions:

	Area(m²)			Ave Height(m)			Volume(m³)	
Basement	560	(1a)	x	3	(2a)	=	1680	(3a)
Ground floor	823	(1b)	x	4	(2b)	=	3292	(3b)
First floor	811.75	(1c)	x	3	(2c)	=	2435.25	(3c)
Second floor	401	(1d)	x	3	(2d)	=	1203	(3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	2595.75	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =			8610.25	(5)

2. Ventilation rate:

	main heating		Secondary heating		other		total		m³ per hour	
Number of chimneys	4	+	0	+	0	=	4	x 40 =	160	(6a)
Number of open flues	0	+	0	+	0	=	0	x 20 =	0	(6b)
Number of intermittent fans							0	x 10 =	0	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

			Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	160	÷ (5) =	0.02	(8)

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

Number of storeys in the dwelling (ns)		0	(9)
Additional infiltration	[(9)-1]x0.1 =	0	(10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction		0	(11)

if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35

If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0	(12)
If no draught lobby, enter 0.05, else enter 0		0	(13)
Percentage of windows and doors draught stripped		0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		5	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.27	(18)

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

Number of sides on which sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.23	(21)

Infiltration rate modified for monthly wind speed

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

SAP WorkSheet: New dwelling design stage

Monthly average wind speed from Table 7

(22)m=	5.4	5.1	5.1	4.5	4.1	3.9	3.7	3.7	4.2	4.5	4.8	5.1

Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.2	1.27

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

	0.31	0.29	0.29	0.26	0.23	0.22	0.21	0.21	0.24	0.26	0.27	0.29

Calculate effective air change rate for the applicable case

If mechanical ventilation:	0.5	(23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a)	0.5	(23b)
If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =	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=	0.56	0.54	0.54	0.51	0.5	0.5	0.5	0.5	0.5	0.51	0.52	0.54	(24c)

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

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

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

(25)m=	0.56	0.54	0.54	0.51	0.5	0.5	0.5	0.5	0.5	0.51	0.52	0.54	(25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors Type 1			6	x	1.8	=	10.8			(26)
Doors Type 2			4	x	1.8	=	7.2			(26)
Doors Type 3			4	x	1.8	=	7.2			(26)
Windows Type 1			122	x1/[1/(1.4)+ 0.04]		=	161.74			(27)
Windows Type 2			122.36	x1/[1/(1.4)+ 0.04]		=	162.22			(27)
Windows Type 3			121.32	x1/[1/(1.4)+ 0.04]		=	160.84			(27)
Windows Type 4			122.36	x1/[1/(1.4)+ 0.04]		=	162.22			(27)
Rooflights			60	x 1/[1/(2) + 0.04]		=	120			(27b)
Floor			551	x	0.15	=	82.65	110	60610	(28)
Walls Type1	501.14	0	501.14	x	0.19	=	95.22	190	95216.6	(29)
Walls Type2	501.14	0	501.14	x	0.19	=	95.22	190	95216.6	(29)
Walls Type3	224.5	0	224.5	x	0.19	=	42.65	190	42655	(29)
Walls Type4	173.68	0	173.68	x	0.19	=	33	190	32999.2	(29)
Walls Type5	300	0	300	x	0.19	=	57	190	57000	(29)

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Roof Type1	200	0	200	x	0.15	=	30	9	1800	(30)
Roof Type2	660	60	600	x	0.2	=	120	9	5400	(30)
Total area of elements, m²			3613.5							(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) =	1339.07	(33)
Heat capacity Cm = S(A x k)	((28)...(30) + (32) + (32a)...(32e) =	390897.4	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	= (34) ÷ (4) =	150.59	(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		542.03	(36)

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

Total fabric heat loss	(33) + (36) =	1881.1	(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=	1586.06	1537.4	1537.4	1440.1	1420.69	1420.69	1420.69	1420.69	1420.69	1440.1	1488.75	1537.4	(38)

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

(39)m=	3467.15	3418.5	3418.5	3321.2	3301.79	3301.79	3301.79	3301.79	3301.79	3321.2	3369.85	3418.5	

Average = Sum(39)1...12 /12= 3353.65 (39)

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

(40)m=	1.34	1.32	1.32	1.28	1.27	1.27	1.27	1.27	1.27	1.28	1.3	1.32

Average = Sum(40)1...12 /12= 1.29 (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 6.12 (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) + 36 188.91 (43)

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

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

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

(44)m=	207.8	200.24	192.69	185.13	177.58	170.02	170.02	177.58	185.13	192.69	200.24	207.8

Total = Sum(44)1...12 = 2266.92 (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=	308.9	270.17	278.79	243.05	233.22	201.25	186.49	213.99	216.55	252.37	275.48	299.15

Total = Sum(45)1...12 = 2979.4 (45)

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

(46)m=	46.34	40.52	41.82	36.46	34.98	30.19	27.97	32.1	32.48	37.86	41.32	44.87	(46)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day):		2.5	(47)
Temperature factor from Table 2b		0.54	(48)
Energy lost from water storage, kWh/year	(47) x (48) =	1.35	(49)
If manufacturer's declared cylinder loss factor is not known:			
Cylinder volume (litres) including any solar storage within same		0	(50)

If community heating and no tank in dwelling, enter 110 litres in box (50)
Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in box (50)

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Hot water storage loss factor from Table 2 (kWh/litre/day)		0	(51)
Volume factor from Table 2a		0	(52)
Temperature factor from Table 2b		0	(53)
Energy lost from water storage, kWh/year	((50) x (51) x (52) x (53) =	0	(54)
Enter (49) or (54) in (55)		1.35	(55)

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

(56)m=	41.85	37.8	41.85	40.5	41.85	40.5	41.85	41.85	40.5	41.85	40.5	41.85	(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=	41.85	37.8	41.85	40.5	41.85	40.5	41.85	41.85	40.5	41.85	40.5	41.85	(57)

Primary circuit loss (annual) from Table 3 — 360 (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=	30.58	27.62	28.74	20.71	13.76	13.02	13.45	14.68	22.49	28.74	29.59	30.58	(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=	381.33	335.58	349.38	304.27	288.82	254.77	241.79	270.52	279.54	322.96	345.57	371.58	(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=	-48.79	-79.32	-128.25	-175.37	-220.25	-226.63	-225.82	-193.76	-145.69	-103.15	-58.01	-40.43	(63)

Output from water heater

(64)m=	332.54	256.26	221.13	128.89	68.58	28.13	15.96	76.76	133.85	219.81	287.56	331.15	

Output from water heater (annual)1…12 — 2100.62 (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=	160.65	142.16	149.17	129.79	122.03	109.73	106.25	116.37	122.39	140.39	147.67	157.41	(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=	366.98	366.98	366.98	366.98	366.98	366.98	366.98	366.98	366.98	366.98	366.98	366.98	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m=	464.62	412.67	335.6	254.07	189.92	160.34	173.25	225.2	302.27	383.8	447.95	477.53	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m=	2593.21	2620.12	2552.31	2407.95	2225.72	2054.45	1940.03	1913.12	1980.93	2125.29	2307.52	2478.8	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m=	77.81	77.81	77.81	77.81	77.81	77.81	77.81	77.81	77.81	77.81	77.81	77.81	(69)
Pumps and fans gains (Table 5a)													
(70)m=	10	10	10	10	10	10	10	10	10	10	10	10	(70)
Losses e.g. evaporation (negative values) (Table 5)													
(71)m=	-244.66	-244.66	-244.66	-244.66	-244.66	-244.66	-244.66	-244.66	-244.66	-244.66	-244.66	-244.66	(71)
Water heating gains (Table 5)													
(72)m=	215.93	211.55	200.5	180.26	164.02	152.4	142.81	156.42	169.99	188.69	205.09	211.57	(72)
Total internal gains = (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
(73)m=	3483.9	3454.49	3298.56	3052.43	2789.81	2577.34	2466.24	2504.88	2663.33	2907.92	3170.71	3378.04	(73)

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6. Solar gains:

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

Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
North	0.9x	0.77	x	122	x	10.73	x	0.68	x	0.7	=	431.67	(74)
North	0.9x	0.77	x	122	x	20.36	x	0.68	x	0.7	=	819.32	(74)
North	0.9x	0.77	x	122	x	33.31	x	0.68	x	0.7	=	1340.47	(74)
North	0.9x	0.77	x	122	x	54.64	x	0.68	x	0.7	=	2198.91	(74)
North	0.9x	0.77	x	122	x	75.22	x	0.68	x	0.7	=	3026.98	(74)
North	0.9x	0.77	x	122	x	84.09	x	0.68	x	0.7	=	3384.07	(74)
North	0.9x	0.77	x	122	x	79.12	x	0.68	x	0.7	=	3184.08	(74)
North	0.9x	0.77	x	122	x	61.56	x	0.68	x	0.7	=	2477.61	(74)
North	0.9x	0.77	x	122	x	41.09	x	0.68	x	0.7	=	1653.43	(74)
North	0.9x	0.77	x	122	x	24.81	x	0.68	x	0.7	=	998.63	(74)
North	0.9x	0.77	x	122	x	13.22	x	0.68	x	0.7	=	531.94	(74)
North	0.9x	0.77	x	122	x	8.94	x	0.68	x	0.7	=	359.96	(74)
East	0.9x	1	x	122.36	x	19.87	x	0.68	x	0.7	=	802.11	(76)
East	0.9x	1	x	122.36	x	38.52	x	0.68	x	0.7	=	1554.72	(76)
East	0.9x	1	x	122.36	x	61.57	x	0.68	x	0.7	=	2484.94	(76)
East	0.9x	1	x	122.36	x	91.41	x	0.68	x	0.7	=	3689.54	(76)
East	0.9x	1	x	122.36	x	111.22	x	0.68	x	0.7	=	4489.12	(76)
East	0.9x	1	x	122.36	x	116.05	x	0.68	x	0.7	=	4684.17	(76)
East	0.9x	1	x	122.36	x	112.64	x	0.68	x	0.7	=	4546.52	(76)
East	0.9x	1	x	122.36	x	98.03	x	0.68	x	0.7	=	3956.93	(76)
East	0.9x	1	x	122.36	x	73.6	x	0.68	x	0.7	=	2970.84	(76)
East	0.9x	1	x	122.36	x	46.91	x	0.68	x	0.7	=	1893.35	(76)
East	0.9x	1	x	122.36	x	24.71	x	0.68	x	0.7	=	997.23	(76)
East	0.9x	1	x	122.36	x	16.39	x	0.68	x	0.7	=	661.66	(76)
South	0.9x	0.77	x	121.32	x	47.32	x	0.68	x	0.7	=	1893.86	(78)
South	0.9x	0.77	x	121.32	x	77.18	x	0.68	x	0.7	=	3088.84	(78)
South	0.9x	0.77	x	121.32	x	94.25	x	0.68	x	0.7	=	3771.69	(78)
South	0.9x	0.77	x	121.32	x	105.11	x	0.68	x	0.7	=	4206.63	(78)
South	0.9x	0.77	x	121.32	x	108.55	x	0.68	x	0.7	=	4344.12	(78)
South	0.9x	0.77	x	121.32	x	108.9	x	0.68	x	0.7	=	4358.05	(78)
South	0.9x	0.77	x	121.32	x	107.14	x	0.68	x	0.7	=	4287.59	(78)
South	0.9x	0.77	x	121.32	x	103.88	x	0.68	x	0.7	=	4157.34	(78)
South	0.9x	0.77	x	121.32	x	99.99	x	0.68	x	0.7	=	4001.6	(78)
South	0.9x	0.77	x	121.32	x	85.29	x	0.68	x	0.7	=	3413.34	(78)
South	0.9x	0.77	x	121.32	x	56.07	x	0.68	x	0.7	=	2243.87	(78)
South	0.9x	0.77	x	121.32	x	40.89	x	0.68	x	0.7	=	1636.42	(78)

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West	0.9x	0.77	x	122.36	x	19.87	x	0.68	x	0.7	=	802.11	(80)
West	0.9x	0.77	x	122.36	x	38.52	x	0.68	x	0.7	=	1554.72	(80)
West	0.9x	0.77	x	122.36	x	61.57	x	0.68	x	0.7	=	2484.94	(80)
West	0.9x	0.77	x	122.36	x	91.41	x	0.68	x	0.7	=	3689.54	(80)
West	0.9x	0.77	x	122.36	x	111.22	x	0.68	x	0.7	=	4489.12	(80)
West	0.9x	0.77	x	122.36	x	116.05	x	0.68	x	0.7	=	4684.17	(80)
West	0.9x	0.77	x	122.36	x	112.64	x	0.68	x	0.7	=	4546.52	(80)
West	0.9x	0.77	x	122.36	x	98.03	x	0.68	x	0.7	=	3956.93	(80)
West	0.9x	0.77	x	122.36	x	73.6	x	0.68	x	0.7	=	2970.84	(80)
West	0.9x	0.77	x	122.36	x	46.91	x	0.68	x	0.7	=	1893.35	(80)
West	0.9x	0.77	x	122.36	x	24.71	x	0.68	x	0.7	=	997.23	(80)
West	0.9x	0.77	x	122.36	x	16.39	x	0.68	x	0.7	=	661.66	(80)
Rooflights	0.9x	1	x	60	x	26	x	0.76	x	0.8	=	853.63	(82)
Rooflights	0.9x	1	x	60	x	54	x	0.76	x	0.8	=	1772.93	(82)
Rooflights	0.9x	1	x	60	x	94	x	0.76	x	0.8	=	3086.21	(82)
Rooflights	0.9x	1	x	60	x	150	x	0.76	x	0.8	=	4924.8	(82)
Rooflights	0.9x	1	x	60	x	190	x	0.76	x	0.8	=	6238.08	(82)
Rooflights	0.9x	1	x	60	x	201	x	0.76	x	0.8	=	6599.23	(82)
Rooflights	0.9x	1	x	60	x	194	x	0.76	x	0.8	=	6369.41	(82)
Rooflights	0.9x	1	x	60	x	164	x	0.76	x	0.8	=	5384.45	(82)
Rooflights	0.9x	1	x	60	x	116	x	0.76	x	0.8	=	3808.51	(82)
Rooflights	0.9x	1	x	60	x	68	x	0.76	x	0.8	=	2232.58	(82)
Rooflights	0.9x	1	x	60	x	33	x	0.76	x	0.8	=	1083.46	(82)
Rooflights	0.9x	1	x	60	x	21	x	0.76	x	0.8	=	689.47	(82)

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

(83)m=	4783.38	8790.52	13168.24	18709.43	22587.43	23709.69	22934.11	19933.27	15405.22	10431.25	5853.73	4009.17	(83)

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

(84)m=	8267.28	12245	16466.8	21761.85	25377.24	26287.03	25400.35	22438.15	18068.55	13339.17	9024.44	7387.21	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	1	0.99	0.98	0.93	0.83	0.67	0.5	0.55	0.83	0.97	1	1	(86)

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

(87)m=	18.54	18.85	19.36	19.95	20.51	20.82	20.95	20.94	20.64	19.93	19.06	18.59	(87)

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

(88)m=	19.82	19.83	19.83	19.86	19.87	19.87	19.87	19.87	19.87	19.86	19.85	19.83	(88)

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

(89)m=	1	0.99	0.97	0.91	0.78	0.59	0.37	0.42	0.77	0.96	0.99	1	(89)

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

(90)m=	16.51	16.98	17.72	18.58	19.34	19.72	19.84	19.84	19.53	18.56	17.29	16.6	(90)

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fLA = Living area ÷ (4) = 0.04 (91)

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

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

(92)m=	16.6	17.05	17.78	18.63	19.38	19.77	19.89	19.88	19.57	18.62	17.37	16.68	(92)
(93)m=	16.6	17.05	17.78	18.63	19.38	19.77	19.89	19.88	19.57	18.62	17.37	16.68	(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	0.89	0.76	0.58	0.38	0.42	0.75	0.94	0.99	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	8223.13	12047.83	15734.59	19368.89	19322.34	15261.65	9568.67	9430.36	13501.38	12508.21	8929.66	7356.68	(95)
Monthly average external temperature from Table 8													
(96)m=	4.5	5	6.8	8.7	11.7	14.6	16.9	16.9	14.3	10.8	7	4.9	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	41935.51	41204.54	37551.65	32993.56	25372.65	17062.55	9869.53	9841.09	17413.58	25974.98	34932.01	40271.86	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	25082.01	19593.31	16231.89	9809.76	4501.43	0	0	0	0	10019.27	18721.69	24488.89	

Total per year (kWh/year) = Sum(98)1...5,10...12 = 128448.26 (98)

Space heating requirement in kWh/m²/year 49.48 (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	28395.37	20471.09	20471.09	0	0	0	0	(100)
Utilisation factor for loss hm													
(101)m=	0	0	0	0	0	0.79	0.88	0.85	0	0	0	0	(101)
Useful loss, hmLm (Watts) = (100)m x (101)m													
(102)m=	0	0	0	0	0	22499.97	17972.9	17361.28	0	0	0	0	(102)
Gains (solar gains calculated for applicable weather region, see Table 10)													
(103)m=	0	0	0	0	0	30880.58	29451.7	26412.8	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	6034.04	8540.23	6734.34	0	0	0	0	

Total = Sum(104) = 21308.6 (104)

Cooled fraction — f C = cooled area ÷ (4) = 0.28 (105)

Intermittency factor (Table 10b)

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

Total = Sum(104) = 0 (106)

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

(107)m=	0	0	0	0	0	419.59	593.86	468.28	0	0	0	0

Total = Sum(107) = 1481.73 (107)

Space cooling requirement in kWh/m²/year (107) ÷ (4) = 0.57 (108)

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

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		224	(206)
Efficiency of secondary/supplementary heating system, %		0	(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)	25082.01	19593.31	16231.89	9809.76	4501.43	0	0	0	0	10019.27	18721.69	24488.89		
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206)	11197.33	8747.01	7246.38	4379.36	2009.57	0	0	0	0	4472.89	8357.9	10932.54		(211)
Total (kWh/year) =Sum(211)1...5,10...12=													57342.97	(211)
Space heating fuel (secondary), kWh/month = {[(98)m x (201)] + (214) m } x 100 ÷ (208) (215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
Total (kWh/year) =Sum(215)1...5,10...12=													0	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Output from water heater (calculated above)	332.54	256.26	221.13	128.89	68.58	28.13	15.96	76.76	133.85	219.81	287.56	331.15		
Efficiency of water heater													224	(216)
(217)m=	224	224	224	224	224	224	224	224	224	224	224	224		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m (219)m=	148.45	114.4	98.72	57.54	30.61	12.56	7.13	34.27	59.75	98.13	128.38	147.84		
Total = Sum(219a)1...12 =													937.78	(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	97.13	137.47	108.4	0	0	0	0		
Total = Sum(221)6...8 =													342.99	(221)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			57342.97	
Water heating fuel used			937.78	
Space cooling fuel used			342.99	
Electricity for pumps, fans and electric keep-hot				
mechanical ventilation - balanced, extract or positive input from outside		9559.1		(230a)
central heating pump:		130		(230c)
Total electricity for the above, kWh/year	sum of (230a)...(230g) =		9689.1	(231)
Electricity for lighting			3282.1	(232)
Electricity generated by PVs			-5766	(233)

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10a. Fuel costs - individual heating systems:

	Fuel kWh/year		Fuel Price (Table 12)		Fuel Cost £/year	
Space heating - main system 1	(211) x		11.46	x 0.01 =	6571.5	(240)
Space heating - main system 2	(213) x		0	x 0.01 =	0	(241)
Space heating - secondary	(215) x		0	x 0.01 =	0	(242)
Water heating cost (other fuel)	(219)		11.46	x 0.01 =	107.47	(247)
Space cooling	(221)		11.46	x 0.01 =	39.31	(248)
Pumps, fans and electric keep-hot	(231)		11.46	x 0.01 =	1110.37	(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)		11.46	x 0.01 =	376.13	(250)
Additional standing charges (Table 12)					0	(251)
	one of (233) to (235) x)		11.46	x 0.01 =	-660.78	(252)
Appendix Q items: repeat lines (253) and (254) as needed						
Total energy cost	(245)...(247) + (250)...(254) =				7544	(255)

11a. SAP rating - individual heating systems

Energy cost deflator (Table 12)		0.47	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	1.34	(257)
SAP rating (Section 12)		81.27	(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		0.517	=	29646.32	(261)
Space heating (secondary)	(215) x		0	=	0	(263)
Water heating	(219) x		0.517	=	484.83	(264)
Space and water heating	(261) + (262) + (263) + (264) =				30131.15	(265)
Space cooling	(221) x		0.517	=	177.33	(266)
Electricity for pumps, fans and electric keep-hot	(231) x		0.517	=	5009.26	(267)
Electricity for lighting	(232) x		0.517	=	1696.85	(268)
Energy saving/generation technologies						
Item 1			0.529	=	-3050.21	(269)
Total CO2, kg/year			sum of (265)...(271) =		33964.37	(272)
CO2 emissions per m²			(272) ÷ (4) =		13.08	(273)
EI rating (section 14)					83	(274)

13a. Primary Energy

	Energy kWh/year		Primary factor		P. Energy kWh/year	
Space heating (main system 1)	(211) x		2.92	=	167441.49	(261)

SAP WorkSheet: New dwelling design stage

Space heating (secondary)	(215) x	0	=	0	(263)
Energy for water heating	(219) x	2.92	=	2738.31	(264)
Space and water heating	(261) + (262) + (263) + (264) =			170179.8	(265)
Space cooling	(221) x	2.92	=	1001.54	(266)
Electricity for pumps, fans and electric keep-hot	(231) x	2.92	=	28292.17	(267)
Electricity for lighting	(232) x	0	=	9583.73	(268)
Energy saving/generation technologies Item 1		2.92	=	-16836.72	(269)
'Total Primary Energy	sum of (265)...(271) =			192220.52	(272)
Primary energy kWh/m²/year	(272) ÷ (4) =			74.05	(273)

APPENDIX D

PROPOSED BUILDING CO_2 EMISSIONS RATE ASSESSMENT METHODOLOGY

WITH ENERGY EFFICIENCY MEASURES , LOW CARBON TECHNOLOGY

AND RENEWABLE TECHNOLOGIES BY SAP 2009

DER WorkSheet: New dwelling design stage

User Details:

Assessor Name:
Stroma Number:
Software Name: Stroma FSAP 2009
Software Version: Version: 1.5.0.37

Property Address: Athlone House

Address : Athlone House, Hampstead Lane, LONDON, N6 4RU

1. Overall dwelling dimensions:

	Area(m²)		Ave Height(m)		Volume(m³)	
Basement	560	(1a) x	3	(2a) =	1680	(3a)
Ground floor	823	(1b) x	4	(2b) =	3292	(3b)
First floor	811.75	(1c) x	3	(2c) =	2435.25	(3c)
Second floor	401	(1d) x	3	(2d) =	1203	(3d)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	2595.75	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	8610.25	(5)

2. Ventilation rate:

	main heating		Secondary heating		other		total		m³ per hour	
Number of chimneys	4	+	0	+	0	=	4	x 40 =	160	(6a)
Number of open flues	0	+	0	+	0	=	0	x 20 =	0	(6b)
Number of intermittent fans							0	x 10 =	0	(7a)
Number of passive vents							0	x 10 =	0	(7b)
Number of flueless gas fires							0	x 40 =	0	(7c)

			Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	160	÷ (5) =	0.02	(8)

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

Number of storeys in the dwelling (ns)		0	(9)
Additional infiltration	[(9)-1]x0.1 =	0	(10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction *if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35*		0	(11)
If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0	(12)
If no draught lobby, enter 0.05, else enter 0		0	(13)
Percentage of windows and doors draught stripped		0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		5	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.27	(18)

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

Number of sides on which sheltered		2	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.23	(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=	5.4	5.1	5.1	4.5	4.1	3.9	3.7	3.7	4.2	4.5	4.8	5.1

Wind Factor (22a)m = (22)m ÷ 4

(22a)m=	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.2	1.27

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

0.31	0.29	0.29	0.26	0.23	0.22	0.21	0.21	0.24	0.26	0.27	0.29

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0.5 (23a)

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

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 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=	0.56	0.54	0.54	0.51	0.5	0.5	0.5	0.5	0.5	0.51	0.52	0.54	(24c)

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

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

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

(25)m=	0.56	0.54	0.54	0.51	0.5	0.5	0.5	0.5	0.5	0.51	0.52	0.54	(25)

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3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors Type 1			6	x	1.8	=	10.8			(26)
Doors Type 2			4	x	1.8	=	7.2			(26)
Doors Type 3			4	x	1.8	=	7.2			(26)
Windows Type 1			122	x1/[1/(1.4)+ 0.04]		=	161.74			(27)
Windows Type 2			122.36	x1/[1/(1.4)+ 0.04]		=	162.22			(27)
Windows Type 3			121.32	x1/[1/(1.4)+ 0.04]		=	160.84			(27)
Windows Type 4			122.36	x1/[1/(1.4)+ 0.04]		=	162.22			(27)
Rooflights			60	x 1/[1/(2) + 0.04]		=	120			(27b)
Floor			551	x	0.15	=	82.65	110	60610	(28)
Walls Type1	501.14	0	501.14	x	0.19	=	95.22	190	95216.6	(29)
Walls Type2	501.14	0	501.14	x	0.19	=	95.22	190	95216.6	(29)
Walls Type3	224.5	0	224.5	x	0.19	=	42.65	190	42655	(29)
Walls Type4	173.68	0	173.68	x	0.19	=	33	190	32999.2	(29)
Walls Type5	300	0	300	x	0.19	=	57	190	57000	(29)

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Roof Type1	200	0	200	x	0.15	=	30	9	1800 (30)
Roof Type2	660	60	600	x	0.2	=	120	9	5400 (30)
Total area of elements, m²			3613.5						(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) = 1339.07 (33)

Heat capacity Cm = S(A x k) ((28)...(30) + (32) + (32a)...(32e) = 390897.4 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K = (34) ÷ (4) = 150.59 (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 542.03 (36)

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

Total fabric heat loss (33) + (36) = 1881.1 (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=	1586.06	1537.4	1537.4	1440.1	1420.69	1420.69	1420.69	1420.69	1420.69	1440.1	1488.75	1537.4	(38)

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

(39)m=	3467.15	3418.5	3418.5	3321.2	3301.79	3301.79	3301.79	3301.79	3301.79	3321.2	3369.85	3418.5	

Average = Sum(39)$_{1...12}$ /12= 3353.65 (39)

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

(40)m=	1.34	1.32	1.32	1.28	1.27	1.27	1.27	1.27	1.27	1.28	1.3	1.32	

Average = Sum(40)$_{1...12}$ /12= 1.29 (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 6.12 (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) + 36 188.91 (43)

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

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

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

(44)m=	207.8	200.24	192.69	185.13	177.58	170.02	170.02	177.58	185.13	192.69	200.24	207.8	

Total = Sum(44)$_{1...12}$ = 2266.92 (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=	308.9	270.17	278.79	243.05	233.22	201.25	186.49	213.99	216.55	252.37	275.48	299.15	

Total = Sum(45)$_{1...12}$ = 2979.4 (45)

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

(46)m=	46.34	40.52	41.82	36.46	34.98	30.19	27.97	32.1	32.48	37.86	41.32	44.87	(46)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): 2.5 (47)

Temperature factor from Table 2b 0.54 (48)

Energy lost from water storage, kWh/year (47) x (48) = 1.35 (49)

If manufacturer's declared cylinder loss factor is not known:

Cylinder volume (litres) including any solar storage within same 0 (50)

If community heating and no tank in dwelling, enter 110 litres in box (50)
Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in box (50)

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Hot water storage loss factor from Table 2 (kWh/litre/day)		0	(51)
Volume factor from Table 2a		0	(52)
Temperature factor from Table 2b		0	(53)
Energy lost from water storage, kWh/year	((50) x (51) x (52) x (53) =	0	(54)
Enter (49) or (54) in (55)		1.35	(55)

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

(56)m=	41.85	37.8	41.85	40.5	41.85	40.5	41.85	41.85	40.5	41.85	40.5	41.85	(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=	41.85	37.8	41.85	40.5	41.85	40.5	41.85	41.85	40.5	41.85	40.5	41.85	(57)

Primary circuit loss (annual) from Table 3 — 360 (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=	30.58	27.62	28.74	20.71	13.76	13.02	13.45	14.68	22.49	28.74	29.59	30.58	(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=	381.33	335.58	349.38	304.27	288.82	254.77	241.79	270.52	279.54	322.96	345.57	371.58	(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=	-48.79	-79.32	-128.25	-175.37	-220.25	-226.63	-225.82	-193.76	-145.69	-103.15	-58.01	-40.43	(63)

Output from water heater

(64)m=	332.54	256.26	221.13	128.89	68.58	28.13	15.96	76.76	133.85	219.81	287.56	331.15	

Output from water heater (annual)1…12 — 2100.62 (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=	160.65	142.16	149.17	129.79	122.03	109.73	106.25	116.37	122.39	140.39	147.67	157.41	(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=	305.82	305.82	305.82	305.82	305.82	305.82	305.82	305.82	305.82	305.82	305.82	305.82	(66)

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

(67)m=	185.85	165.07	134.24	101.63	75.97	64.14	69.3	90.08	120.91	153.52	179.18	191.01	(67)

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

(68)m=	1737.45	1755.48	1710.05	1613.33	1491.23	1376.48	1299.82	1281.79	1327.22	1423.95	1546.04	1660.79	(68)

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

(69)m=	53.58	53.58	53.58	53.58	53.58	53.58	53.58	53.58	53.58	53.58	53.58	53.58	(69)

Pumps and fans gains (Table 5a)

(70)m=	10	10	10	10	10	10	10	10	10	10	10	10	(70)

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

(71)m=	-244.66	-244.66	-244.66	-244.66	-244.66	-244.66	-244.66	-244.66	-244.66	-244.66	-244.66	-244.66	(71)

Water heating gains (Table 5)

(72)m=	215.93	211.55	200.5	180.26	164.02	152.4	142.81	156.42	169.99	188.69	205.09	211.57	(72)

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

(73)m=	2263.97	2256.85	2169.53	2019.96	1855.97	1717.77	1636.68	1653.04	1742.87	1890.9	2055.06	2188.12	(73)

DER WorkSheet: New dwelling design stage

6. Solar gains:

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

Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
North	0.9x	0.77	x	122	x	10.73	x	0.68	x	0.7	=	431.67	(74)
North	0.9x	0.77	x	122	x	20.36	x	0.68	x	0.7	=	819.32	(74)
North	0.9x	0.77	x	122	x	33.31	x	0.68	x	0.7	=	1340.47	(74)
North	0.9x	0.77	x	122	x	54.64	x	0.68	x	0.7	=	2198.91	(74)
North	0.9x	0.77	x	122	x	75.22	x	0.68	x	0.7	=	3026.98	(74)
North	0.9x	0.77	x	122	x	84.09	x	0.68	x	0.7	=	3384.07	(74)
North	0.9x	0.77	x	122	x	79.12	x	0.68	x	0.7	=	3184.08	(74)
North	0.9x	0.77	x	122	x	61.56	x	0.68	x	0.7	=	2477.61	(74)
North	0.9x	0.77	x	122	x	41.09	x	0.68	x	0.7	=	1653.43	(74)
North	0.9x	0.77	x	122	x	24.81	x	0.68	x	0.7	=	998.63	(74)
North	0.9x	0.77	x	122	x	13.22	x	0.68	x	0.7	=	531.94	(74)
North	0.9x	0.77	x	122	x	8.94	x	0.68	x	0.7	=	359.96	(74)
East	0.9x	1	x	122.36	x	19.87	x	0.68	x	0.7	=	802.11	(76)
East	0.9x	1	x	122.36	x	38.52	x	0.68	x	0.7	=	1554.72	(76)
East	0.9x	1	x	122.36	x	61.57	x	0.68	x	0.7	=	2484.94	(76)
East	0.9x	1	x	122.36	x	91.41	x	0.68	x	0.7	=	3689.54	(76)
East	0.9x	1	x	122.36	x	111.22	x	0.68	x	0.7	=	4489.12	(76)
East	0.9x	1	x	122.36	x	116.05	x	0.68	x	0.7	=	4684.17	(76)
East	0.9x	1	x	122.36	x	112.64	x	0.68	x	0.7	=	4546.52	(76)
East	0.9x	1	x	122.36	x	98.03	x	0.68	x	0.7	=	3956.93	(76)
East	0.9x	1	x	122.36	x	73.6	x	0.68	x	0.7	=	2970.84	(76)
East	0.9x	1	x	122.36	x	46.91	x	0.68	x	0.7	=	1893.35	(76)
East	0.9x	1	x	122.36	x	24.71	x	0.68	x	0.7	=	997.23	(76)
East	0.9x	1	x	122.36	x	16.39	x	0.68	x	0.7	=	661.66	(76)
South	0.9x	0.77	x	121.32	x	47.32	x	0.68	x	0.7	=	1893.86	(78)
South	0.9x	0.77	x	121.32	x	77.18	x	0.68	x	0.7	=	3088.84	(78)
South	0.9x	0.77	x	121.32	x	94.25	x	0.68	x	0.7	=	3771.69	(78)
South	0.9x	0.77	x	121.32	x	105.11	x	0.68	x	0.7	=	4206.63	(78)
South	0.9x	0.77	x	121.32	x	108.55	x	0.68	x	0.7	=	4344.12	(78)
South	0.9x	0.77	x	121.32	x	108.9	x	0.68	x	0.7	=	4358.05	(78)
South	0.9x	0.77	x	121.32	x	107.14	x	0.68	x	0.7	=	4287.59	(78)
South	0.9x	0.77	x	121.32	x	103.88	x	0.68	x	0.7	=	4157.34	(78)
South	0.9x	0.77	x	121.32	x	99.99	x	0.68	x	0.7	=	4001.6	(78)
South	0.9x	0.77	x	121.32	x	85.29	x	0.68	x	0.7	=	3413.34	(78)
South	0.9x	0.77	x	121.32	x	56.07	x	0.68	x	0.7	=	2243.87	(78)
South	0.9x	0.77	x	121.32	x	40.89	x	0.68	x	0.7	=	1636.42	(78)

DER WorkSheet: New dwelling design stage

West	0.9x	0.77	x	122.36	x	19.87	x	0.68	x	0.7	=	802.11	(80)
West	0.9x	0.77	x	122.36	x	38.52	x	0.68	x	0.7	=	1554.72	(80)
West	0.9x	0.77	x	122.36	x	61.57	x	0.68	x	0.7	=	2484.94	(80)
West	0.9x	0.77	x	122.36	x	91.41	x	0.68	x	0.7	=	3689.54	(80)
West	0.9x	0.77	x	122.36	x	111.22	x	0.68	x	0.7	=	4489.12	(80)
West	0.9x	0.77	x	122.36	x	116.05	x	0.68	x	0.7	=	4684.17	(80)
West	0.9x	0.77	x	122.36	x	112.64	x	0.68	x	0.7	=	4546.52	(80)
West	0.9x	0.77	x	122.36	x	98.03	x	0.68	x	0.7	=	3956.93	(80)
West	0.9x	0.77	x	122.36	x	73.6	x	0.68	x	0.7	=	2970.84	(80)
West	0.9x	0.77	x	122.36	x	46.91	x	0.68	x	0.7	=	1893.35	(80)
West	0.9x	0.77	x	122.36	x	24.71	x	0.68	x	0.7	=	997.23	(80)
West	0.9x	0.77	x	122.36	x	16.39	x	0.68	x	0.7	=	661.66	(80)
Rooflights	0.9x	1	x	60	x	26	x	0.76	x	0.8	=	853.63	(82)
Rooflights	0.9x	1	x	60	x	54	x	0.76	x	0.8	=	1772.93	(82)
Rooflights	0.9x	1	x	60	x	94	x	0.76	x	0.8	=	3086.21	(82)
Rooflights	0.9x	1	x	60	x	150	x	0.76	x	0.8	=	4924.8	(82)
Rooflights	0.9x	1	x	60	x	190	x	0.76	x	0.8	=	6238.08	(82)
Rooflights	0.9x	1	x	60	x	201	x	0.76	x	0.8	=	6599.23	(82)
Rooflights	0.9x	1	x	60	x	194	x	0.76	x	0.8	=	6369.41	(82)
Rooflights	0.9x	1	x	60	x	164	x	0.76	x	0.8	=	5384.45	(82)
Rooflights	0.9x	1	x	60	x	116	x	0.76	x	0.8	=	3808.51	(82)
Rooflights	0.9x	1	x	60	x	68	x	0.76	x	0.8	=	2232.58	(82)
Rooflights	0.9x	1	x	60	x	33	x	0.76	x	0.8	=	1083.46	(82)
Rooflights	0.9x	1	x	60	x	21	x	0.76	x	0.8	=	689.47	(82)

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

(83)m=	4783.38	8790.52	13168.24	18709.43	22587.43	23709.69	22934.11	19933.27	15405.22	10431.25	5853.73	4009.17	(83)

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

(84)m=	7047.36	11047.37	15337.78	20729.39	24443.4	25427.46	24570.79	21586.3	17148.09	12322.15	7908.79	6197.29	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	1	0.99	0.98	0.94	0.84	0.69	0.51	0.57	0.85	0.97	1	1	(86)

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

(87)m=	18.48	18.79	19.31	19.91	20.48	20.81	20.95	20.93	20.61	19.88	19.01	18.53	(87)

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

(88)m=	19.82	19.83	19.83	19.86	19.87	19.87	19.87	19.87	19.87	19.86	19.85	19.83	(88)

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

(89)m=	1	0.99	0.98	0.92	0.8	0.6	0.39	0.43	0.79	0.96	1	1	(89)

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

(90)m=	16.42	16.89	17.64	18.52	19.31	19.71	19.84	19.83	19.5	18.5	17.21	16.51	(90)

DER WorkSheet: New dwelling design stage

fLA = Living area ÷ (4) = 0.04 (91)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(92)m=	16.51	16.97	17.71	18.58	19.35	19.76	19.89	19.88	19.55	18.56	17.29	16.59	(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=	16.51	16.97	17.71	18.58	19.35	19.76	19.89	19.88	19.55	18.56	17.29	16.59	(93)

8. Space heating requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, hm:													
(94)m=	1	0.99	0.96	0.9	0.77	0.59	0.39	0.43	0.77	0.95	0.99	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	7023.04	10910.64	14757.07	18651.68	18919.82	15106.38	9535.23	9379.16	13123.03	11676.28	7850.41	6181.62	(95)
Monthly average external temperature from Table 8													
(96)m=	4.5	5	6.8	8.7	11.7	14.6	16.9	16.9	14.3	10.8	7	4.9	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	41630.65	40914.48	37296.46	32807.4	25273.26	17027.96	9862.69	9830.47	17320.88	25760.47	34661.18	39976.65	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	25748.06	20162.58	16769.31	10192.12	4726.95	0	0	0	0	10478.64	19303.76	25143.5	

Total per year (kWh/year) = Sum(98)$_{1...5,10...12}$ = 132524.92 (98)

Space heating requirement in kWh/m²/year 51.05 (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	28395.37	20471.09	20471.09	0	0	0	0	(100)
Utilisation factor for loss hm													
(101)m=	0	0	0	0	0	0.79	0.88	0.85	0	0	0	0	(101)
Useful loss, hmLm (Watts) = (100)m x (101)m													
(102)m=	0	0	0	0	0	22499.97	17972.9	17361.28	0	0	0	0	(102)
Gains (solar gains calculated for applicable weather region, see Table 10)													
(103)m=	0	0	0	0	0	30880.58	29451.7	26412.8	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	6034.04	8540.23	6734.34	0	0	0	0	

Total = Sum(104) = 21308.6 (104)

Cooled fraction — f C = cooled area ÷ (4) = 0.28 (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) = 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	419.59	593.86	468.28	0	0	0	0

Total = Sum(107) = 1481.73 (107)

Space cooling requirement in kWh/m²/year — (107) ÷ (4) = 0.57 (108)

DER WorkSheet: New dwelling design stage

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

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		224	(206)
Efficiency of secondary/supplementary heating system, %		0	(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)	25748.06	20162.58	16769.31	10192.12	4726.95	0	0	0	0	10478.64	19303.76	25143.5		
(211)m = {[(98)m x (204)] + (210)m } x 100 ÷ (206)	11494.67	9001.15	7486.3	4550.05	2110.25	0	0	0	0	4677.96	8617.75	11224.78		(211)
Total (kWh/year) =Sum(211)$_{1...5,10...12}$=													59162.91	(211)
Space heating fuel (secondary), kWh/month = {[(98)m x (201)] + (214) m } x 100 ÷ (208)														
(215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
Total (kWh/year) =Sum(215)$_{1...5,10...12}$=													0	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Output from water heater (calculated above)	332.54	256.26	221.13	128.89	68.58	28.13	15.96	76.76	133.85	219.81	287.56	331.15		
Efficiency of water heater													224	(216)
(217)m=	224	224	224	224	224	224	224	224	224	224	224	224		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	148.45	114.4	98.72	57.54	30.61	12.56	7.13	34.27	59.75	98.13	128.38	147.84		
Total = Sum(219a)$_{1...12}$ =													937.78	(219)

Space cooling fuel, kWh/month.

(221)m = (107)m÷ (209)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
(221)m=	0	0	0	0	0	97.13	137.47	108.4	0	0	0	0		
Total = Sum(221)$_{6...8}$ =													342.99	(221)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			59162.91	
Water heating fuel used			937.78	
Space cooling fuel used			342.99	
Electricity for pumps, fans and electric keep-hot				
mechanical ventilation - balanced, extract or positive input from outside		9559.1		(230a)
central heating pump:		130		(230c)
Total electricity for the above, kWh/year	sum of (230a)...(230g) =		9689.1	(231)
Electricity for lighting			3282.1	(232)
Electricity generated by PVs			-5766	(233)

DER WorkSheet: New dwelling design stage

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	0.517	=	30587.23	(261)
Space heating (secondary)	(215)	x	0	=	0	(263)
Water heating	(219)	x	0.517	=	484.83	(264)
Space and water heating	(261) + (262) + (263) + (264) =				31072.06	(265)
Space cooling	(221)	x	0.517	=	177.33	(266)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.517	=	5009.26	(267)
Electricity for lighting	(232)	x	0.517	=	1696.85	(268)
Energy saving/generation technologies Item 1			0.529	=	-3050.21	(269)
Total CO2, kg/year			sum of (265)...(271) =		34905.28	(272)
Dwelling CO2 Emission Rate			(272) ÷ (4) =		13.45	(273)
EI rating (section 14)					82	(274)

APPENDIX E

SAP INPUT

SAP Input

Property Details: Athlone House

Address:	Athlone House, Hampstead Lane, LONDON, N6 4RU
Located in:	England
Region:	Thames valley
UPRN:	7404741078
Date of assessment:	19 November 2012
Date of certificate:	29 May 2013
Assessment type:	New dwelling design stage
Transaction type:	New dwelling
Tenure type:	Unknown
Related party disclosure:	No related party
Thermal Mass Parameter:	Calculated 150.5913
Dwelling designed to use less than 125 litres per Person per day:	False

Property description:

Dwelling type:	House
Detachment:	Detached
Year Completed:	2012

Floor Location:	Floor area:	Storey height:
Basement floor	560 m²	3 m
Floor 1	823 m²	4 m
Floor 2	811.75 m²	3 m
Floor 3	401 m²	3 m

Living area:	106.43 m² (fraction 0.041)
Front of dwelling faces:	North

Opening types:

Name:	Source:	Type:	Glazing:	Argon:	Frame:
N/door	Manufacturer	Half glazed	low-E, En = 0.1, soft coat	Yes	Wood
W/door	Manufacturer	Half glazed	low-E, En = 0.1, soft coat	Yes	Wood
E/door	Manufacturer	Half glazed	low-E, En = 0.1, soft coat	Yes	Wood
N/window	Manufacturer	Windows	double-glazed	Yes	
E/window	Manufacturer	Windows	low-E, En = 0.1, soft coat	Yes	
S/window	Manufacturer	Windows	low-E, En = 0.1, soft coat	Yes	
W/window	Manufacturer	Windows	low-E, En = 0.1, soft coat	Yes	
Atrium Rooflight	Manufacturer	Roof Windows	double-glazed	Yes	Metal, thermal break

Name:	Gap:	Frame Factor:	g-value:	U-value:	Area:	No. of Openings:
N/door	6mm mm	0.7	0.68	1.8	6	1
W/door	6mm mm	0.7	0.68	1.8	4	1
E/door	6mm mm	0.7	0.68	1.8	4	1
N/window	6mm	0.7	0.68	1.4	122	1
E/window	6mm	0.7	0.68	1.4	122.36	1
S/window	6mm	0.7	0.68	1.4	121.32	1
W/window	6mm	0.7	0.68	1.4	122.36	1
Atrium Rooflight	12mm	0.8	0.76	2	60	1

Name:	Type-Name:	Location:	Orient:	Width:	Height:
N/door		Wall	North	0	0
W/door		Wall	West	0	0
E/door		Wall	West	0	0
N/window		Wall	North	0	0
E/window		Wall	East	0	0
S/window		Wall	South	0	0
W/window		Wall	West	0	0
Atrium Rooflight		Roof 2	Horizontal	0	0

SAP Input

Overshading: Average or unknown

Opaque Elements:

Type:	Gross area:	Openings:	Net area:	U-value:	Ru value:	Curtain wall:	Kappa:
External Elements							
E/Wall	501.14	0	501.14	0.19	0	False	190
W/Wall	501.14	0	501.14	0.19	0	False	190
N/Wall	224.5	0	224.5	0.19	0	False	190
S/Wall	173.68	0	173.68	0.19	0	False	190
Basement Wall	300	0	300	0.19	0	False	190
Roof	200	0	200	0.15	0		9
Roof 2	660	60	600	0.2	0		9
BF	551			0.15			110
Internal Elements							
Party Elements							

Thermal bridges:

Thermal bridges: No information on thermal bridging (y=0.15) (y =0.15)

Ventilation:

Pressure test: Yes (As designed)
Ventilation: Centralised whole house extract
Number of wet rooms: Kitchen + 10
Ductwork: , Rigid
Approved Installation Scheme: True
Number of chimneys: 4 (main: 4, secondary: 0, other: 0)
Number of open flues: 0
Number of fans: 0
Number of sides sheltered: 2
Pressure test: 5

Main heating system:

Main heating system: Central heating systems with radiators or underfloor heating
Heat pumps
Fuel: Electricity
Info Source: SAP Tables
SAP Table: 201
Ground-to-water heat pump (electric)
Underfloor heating and radiators, pipes in insulated timber floor
Pump in heat space: Yes

Main heating Control:

Main heating Control: Time and temperature zone control
Control code: 2207
Boiler interlock: Yes

Secondary heating system:

Secondary heating system: None

Space cooling system:

Space cooling system: Split/multiple systems
Energy label class: A
Compressor control: Systems with variable speed compressors
Cooled area: 722 (fraction 0.278)

Water heating:

Water heating: From main heating system
Water code: 901
Fuel :Electricity

SAP Input

Hot water cylinder
Cylinder volume: 280 litres
Cylinder insulation: Measured loss, 2.5kWh/day
Primary pipework insulation: True
Cylinderstat: True
Cylinder in heated space: True
Solar panel: True
  aperture area: 10
  Evacuated tube
  default values: True
  collector zero-loss efficiency: 0.6
  collector heat loss coefficient: 3
  orientation: South, 30º pitch
  overshading: Modest (20% - 60%)
  dedicated solar store volume: 250 litres (seperate store)
  solar powered pump: True

Others:	
Electricity tariff:	standard tariff
In Smoke Control Area:	Yes
Conservatory:	No conservatory
Low energy lights:	80%
Terrain type:	Dense urban
EPC language:	English
Wind turbine:	No
Photovoltaics:	Photovoltaic 1 Installed Peak power: 7.5 Tilt of collector: Horizontal Overshading: None or very little Collector Orientation: South
Assess Zero Carbon Home:	No

APPENDIX F

SAP2009 COMPLIANCE REPORT

Regulations Compliance Report

Approved Document L1A 2010 edition assessed by Stroma FSAP 2009 program, Version: 1.5.0.37
Printed on 29 May 2013 at 13:03:04

Project Information:

Assessed By: () **Building Type:** Detached House

Dwelling Details:

NEW DWELLING DESIGN STAGE

Site Reference : Athlone House **Plot Reference:** 2165

Address : Athlone House, Hampstead Lane, LONDON, N6 4RU

Client Details:

Name:

Address :

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

1 TER and DER

Fuel for main heating system: Electricity
Fuel factor: 1.14 x 1.47 (electricity)

Target Carbon Dioxide Emission Rate (TER)	20.94 kg/m²	
Dwelling Carbon Dioxide Emission Rate (DER)	13.45 kg/m²	OK

2 Fabric U-values

Element	Average	Highest	
External wall	0.19 (max. 0.30)	0.19 (max. 0.70)	OK
Floor	0.15 (max. 0.25)	0.15 (max. 0.70)	OK
Roof	0.19 (max. 0.20)	0.20 (max. 0.35)	OK
Openings	1.47 (max. 2.00)	2.00 (max. 3.30)	OK

3 Air permeability

Air permeability at 50 pascals	5.00	
Maximum	10.0	OK

4 Heating efficiency

Main Heating system:	Heat pumps with radiators or underfloor - electric Ground-to-water heat pump (electric) Efficiency 320 % Minimum 320 %
Secondary heating system:	None

5 Cylinder insulation

Hot water Storage:	Nominal cylinder loss: 2.50 kWh/day Permitted by DBSCG: 2.74 kWh/day	
Primary pipework insulated:	Yes	OK
Solar water heating		
Dedicated solar storage volume:	250 litres	
Minimum:	151 litres	OK

6 Controls

Space heating controls	Time and temperature zone control	OK
Hot water controls:	Cylinderstat	OK
	Independent timer for DHW	OK

APPENDIX G

CODE FOR SUSTAINABLE HOMES

Code for Sustainable Homes Report

Assessor and House Details

Assessor Name:

Assessor Number:

Property Address: Athlone House
Hampstead Lane
LONDON
N6 4RU

Buiding regulation assessment

	kg/m²/year
TER	20.94
DER	13.45

The following code calculations are taken from the Code for Sustainable Homes Technical Guide (Nov 10)

Ene 1 Assessment - Dwelling Emission Rate

Total Energy Type CO2 Emissions for Codes Levels 1 - 5

	%	kg/m²/year	
DER from SAP 2009 DER Worksheet		13.45	*(ZC1)*
TER		20.94	
Residual CO2 emissions offset from biofuel CHP		0	*(ZC5)*
CO2 emissions offset from additional allowable electricty generation		0	*(ZC7)*
Total CO2 emissions offset from SAP Section 16 allowances		0	
DER accounting for SAP Section 16 allowances		13.45	
% improvement DER/TER	35.8		

Total Energy Type CO2 Emissions for Codes Levels 6

	kg/m²/year	
DER accounting for SAP Section 16 allowances	13.45	*(ZC1)*
CO2 emissions from appliances, equation (L14)	3.95	*(ZC2)*
CO2 emissions from cooking, equation (L16)	0.1	*(ZC3)*
Net CO2 emissions	17.5	*(ZC8)*

Result:

Credits awarded for Ene 1 = 4

Code Level = 4

Ene 2 - Fabric energy Efficiency

Fabric energy Efficiency: 58.77
Credits awarded for Ene 2 = 3.2

Ene 7 - Low or Zero Carbon (LZC) Technologies

Reduction in CO2 Emissions

	%	kg/m²/year
Standard Case CO2 emissions		19.53
Standard DER		15.48
Actual Case CO2 emissions		17.5
Actual DER		13.45
Reduction in CO2 emissions	10.39	

Credits awarded for Ene 7 = 1

Technologies eligible to contribute to achieving the requirements of this issue must produce energy from renewable sources and meet all other ancillary requirements as defined by Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.

The following requirements must also be met:

- Where not provided by accredited external renewables there must be a direct supply of energy produced to the dwelling under assessment.
- Where covered by the Microgeneration Certification Scheme (MCS), technologies under 50kWe or 300kWth must be certified.
- Combined Heat and Power (CHP) schemes above 50kWe must be certified under the CHPQA standard.
- All technologies must be accounted for by SAP.

CHP schemes fuelled by mains gas are eligible to contribute to performance against this issue. Where these schemes are above 50kWe they must be certified under the CHPQA.
It is the responsibly of the Accredited OCDEA and Code Assessor to ensure all technologies use in the calculation are appropriate before awarding credits.

APPENDIX H

PREDICTED SAP

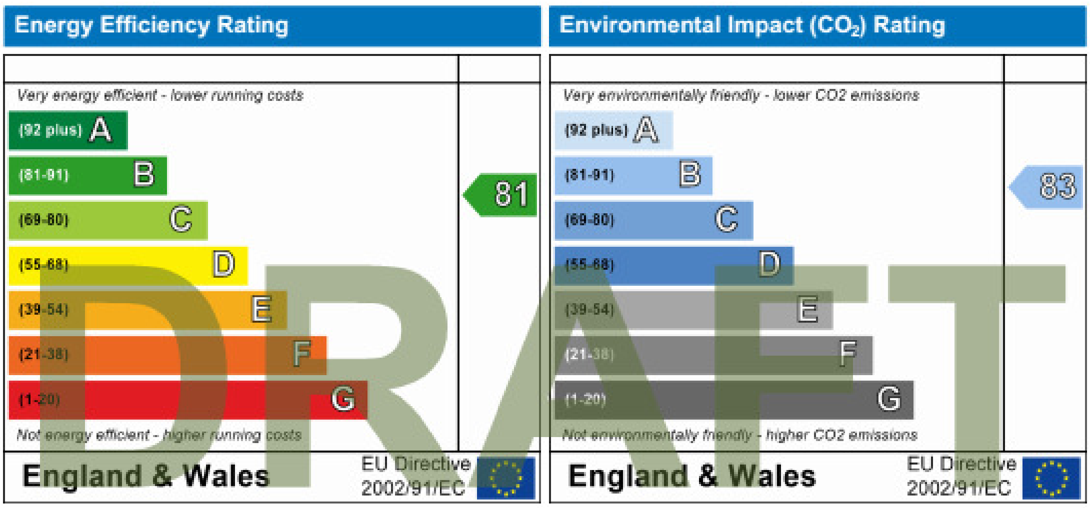
Predicted Energy Assessment

Athlone House
Hampstead Lane
LONDON
N6 4RU

Dwelling type: Detached House
Date of assessment: 19 November 2012
Produced by: Stroma Certification
Total floor area: 2595.75 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 2009 methodology and is rated in terms of the energy use per square metre of floor area, energy efficiency based on fuel costs and environmental impact based on carbon dioxide (CO2) emissions.



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

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