Sustainia

Energy and Renewable Energy Statement
FOR
William Goodenough House
Mecklenburgh Square
London WC1N 2AB

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Issue/revision	Issue 1	Issue 2	Issue 3	
Remarks	Draft Issue	Made corrections as requested by D O'Brien Amended table 2-2	Final Issue. Amended floor areas as per Architects brief. Reduced fan power consumption by redefining en-suite showers. Increased PV area and removed solar thermal. Amended all calcs and tables.	
Date	21/02/10	24/02/10	27/02/10	
Prepared by	PP	PP	PP	
Signature				
Checked by	KP	KP	KP	
Signature				

Contents

Executive summary

This energy statement describes the strategy used to reduce the overall carbon emissions within the development at William Goodenough House, London, WC1N 2AB.

William Goodenough House lies on the Northern side of Mecklenburgh Square, which itself is composed of collegiate buildings around the private Mecklenburgh Square Garden. The building itself was constructed in the 1950's with subsequent additions, and is entirely given over to accommodating postgraduate or mature students.

The project involves the constrution of two additional floors at roof level, which will add a further 61 single rooms to the current accommodation.

The buildings will be constructed in keeping with the nature of the historic area, but will have thermal performance specified to a relatively high standard. The new build accomodation will be built to high standards of energy efficiency.

The energy strategy follows three main precepts:

- To reduce energy demand through energy efficient building fabric
- To use an efficient energy supply where possible
- To produce on-site generated energy

The report will show how each of these aspects is addressed by the proposed development.

The energy efficiency of a baseline building built to building regs. is compared to the proposed building.

The report shows that the development achieves a minimum 7.45% CO2 reduction over the baseline building through energy efficiency improvements, and an 11.0% reduction due to renewable energy. The renewable technology selected is Solar Photovoltaic Panels (PV).

INTRODUCTION

This report will review the various options for provision of renewable energy technologies in relation to the new development at William Goodenough House.

This report will summarise the costs associated with installation. The report will be mindful of the end users requirements and the need to minimise maintenance and compare all options with a baseline scenario.

It is to be noted that all data is currently based on benchmark information and CIBSE guidance and that firm calculations can not be achieved until the Part L Building Regulations Calculations including SBEM have been completed during the design period, and as such current figures are only estimates.

Development Details

Development type:	Higher education halls of residence
Development area:	1,550 m2 GIFA
Site description:	Extension of existing building

Energy Hierarchy

There is an energy hierarchy whereby when developing a building, the first step is always to make the building as energy efficient as possible, as a cost effective means of reducing energy demand and as a result reducing the energy demand that is to be provided via the use of renewable energy sources.

It is recommended that as part of the scheme that the passive approach is fully investigated as a means of saving energy.

Part L of the building regulations aims to reduce carbon emissions from new buildings by around 17% when compared with a building designed to 2002 values, this is achieved by improving the building fabric energy efficiency, for example provision of a structure which has been built to a very good standard of air tightness and improving the insulation levels; and heating system of the building itself.

Renewable energy also aids in reducing the carbon emission of the buildings. The principal requirement for renewable provision under the terms of the LB Camden Planning Guidance[1] is that 10% of the energy demand is provided via the use of renewable energy technologies.

The scheme design should abide by the following energy hierarchy:

- Use less energy
- Use renewable energy
- Supply energy more efficiently

Potential areas for consideration when seeking to improve the energy efficiency of buildings and thereby reducing CO2 emissions are:-

- Increased fabric insulation
- Reduced thermal bridging
- Improved air tightness
- Controlled ventilation
- Efficient heating and hot water systems
- Responsive heating and lighting controls
- Efficient lighting and fittings that do not permit the use of non-efficient lighting
- Efficient electrical appliances

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1. London Borough of Camden (2006), Camden Planning Guidance 2006, para 17.15, pp 75. LB Camden

1.0 Energy Supply

The baseline site demand shows what a building built to minimum building regs. standards would require in terms of energy. The proposed site demand is the energy demand of the site as proposed. The renewable energy component is also shown.

The Baseline site demand and the proposed site demand have been calculated using iSBEM Part L assessment software.

	Heating	*Cooling*	*Electricity*	*Heating*	*Cooling*	*Electricity*
	kWh / yr	*kWh / yr*	*kWh / yr*	*% of site*	*% of site*	*% of site*
Baseline Site Demand	342,148	0	38,504	90%	0%	10%
Proposed Site Demand	309,008	0	38,394	89%	0%	11%
Renewable Energy Contribution	0	0	20,607	0%	0%	6%

Table 1-1. Total site energy demand and proportions provided by Efficient Supply and renewable Energy technologies.

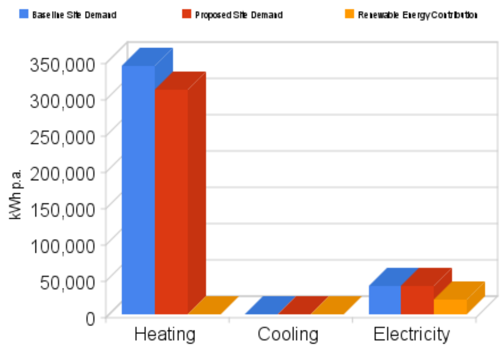


Figure 1-1. Proposed site energy supply breakdown

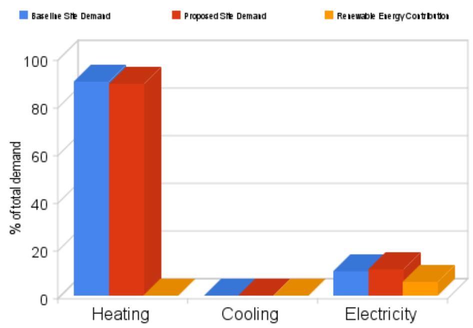


Figure 1-2. Proposed site energy supply breakdown as percentages.

1.1 CO_2 Emissions

The table below shows both the CO_2 savings as a result of energy efficiency improvements, and through the use of renewable energy.

Table 1-2. Total site CO2 emissions and savings due to the inclusion of Efficient Supply and Renewable Energy technologies.

	kWh	CO2 (kg/yr)	CO2 (%)
Baseline Emissions	308,652	87,053	100%
Savings from energy efficiency	33,250	6,488	7%
Savings from renewable energy on baseline energy demand	20,607	8,861	10%

Savings from renewables energy on proposed scheme energy demand	11%

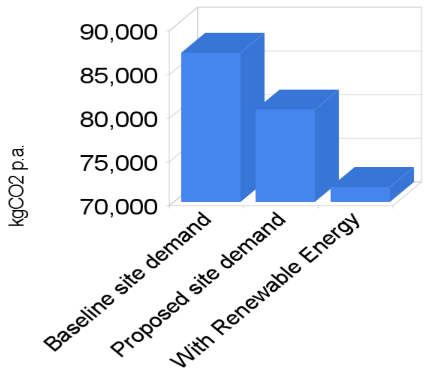


Figure 1-3. CO2 emissions from the site at each stage of analysis

2.0 Energy Demand

Table 2-1. Total site CO_2 emissions and savings by end use.

	Baseline scheme (see assumptions and benchmarks below		Proposed scheme (including energy efficient design and technology)		Change	
	kWh/yr	CO2(kg/yr)	kWh/yr	CO2(kg/yr)	kWh/yr	CO2(kg/yr)
Heating	342,148	66,377	309,008	59,948	33,140	6,429
Cooling	0	-	0	-	0	0
Electricity	38,504	20,676	38,394	20,617	110	59

Benchmarks have been calculated in the following way:
The energy demands of the commercial areas were quantified using the National Calculation Methodology (NCM) using iSBEM v3.4a calculation software

The baseline figure is the target emission rate (TER) derived from SBEM. To develop the TER figures for heating, hot water etc the standard approach was used i.e. the notional building figures were reduced by 15% to account for the required improvement factor, and then by 10% to account for the Low or Zero Carbon Technology factor.

The building emission rate (BER) provides the proposed scheme figures. The calculated energy consumption figures (kWh/m2) were extrapolated to match the gross internal floor area provided by the architect.

SBEM does not provide CO2 emission data for appliances and as this should be included in the demand calculations we have calculated the appliance CO2 emissions based on benchmarks taken from CIBSE Guide F. This 'auxiliary energy' has been calculated based on the floor area of the development, and are assumed equal for the proposed and baseline schemes. The rate for use in 'hotels' is 10kWh/m2, we have used this as the basis for auxiliary power consumption in William Goodenough Hall.

For reference CIBSE Guide F gives the following figures for energy consumption in halls of residence:

Table 2-2. Energy consumption in halls of residence

	kWh/m2		
	Typical	Good	Proposed extension
Fossil fuels	240	290	199
Electricity	100	85	25

Table 2-3. Summary of Energy Efficiency for all site loads.

Load number			All	
Development description:			Commercial	
Number of loads			1	
Building type:			Halls of residence	
Floor area (m2):			1,550	
Loads - totals		**Baseline**	**Proposed**	**Saving**
Space heating	kWh / yr	88,528	54,018	38.98%
	kg CO2/ yr	17,174	10,479	38.98%
Hot water	kWh / yr	253,620	254,991	0.00%
	kg CO2/ yr	49,202	49,468	0.00%
Cooling	kWh / yr	-	-	0.00%
	kg CO2/ yr	-	-	0.00%
Lighting	kWh / yr	19,363	15,252	21.23%
	kg CO2/ yr	10,398	8,190	21.23%
Building Electrical	kWh / yr	3,640	7,642	0.00%
	kg CO2/ yr	1,955	4,103	0.00%
Auxiliary Electrical	kWh / yr	15,500	15,500	0.00%
	kg CO2/ yr	8,324	8,324	0.00%
Loads - by floor area		**Baseline**	**Proposed**	**Saving**
Fossil fuel	kWh/m²/yr	221	199	21
Electricity	kWh/m²/yr	25	25	0
CO2 emissions		**Baseline**	**Proposed**	**Saving**
Total CO2 emissions	kg CO2 / yr	87,053	80,565	6,488
CO2 saving				**7.45%**
Energy Efficiency				
Energy Efficiency (kWh) Improvement Factor:				**9%**

3.0 Energy efficient design

3.1 Passive solar design

As this is an extension of an existing site with certain heritage aspects to consider, the potential for passive solar design is limited, both by restrictions on orientation, and design constraints.

3.2 Lighting

Energy efficiency will be better than the sample benchmarks in practice, with the use of state of the art LED and HF Fluorescent lighting.

3.3 Insulation

The development will exceed the Part L2A building regulations requirements in terms of the performance of the thermal elements.

The exact construction of the building elements is not yet known but the client has agreed to work to the minimum specifications below.

The infiltration and thermal performance will be to a high standard. The following table shows the required vs. proposed u-values. A sample SBEM report is included in the appendices.

Table 3-1. Comparison of recommended u-values with part-L maximums

Element	$U_{a\text{-Limit}}$	$U_{a\text{-Calc}}$	$U_{i\text{-Limit}}$	$U_{i\text{-Calc}}$	Surface where this maximum value occurs*
Wall**	0.35	0.17	0.7	0.2	z0/01 Room 3-21/s
Floor	0.25	0	0.7	0	"No Floors in project"
Roof	0.25	0.15	0.35	0.15	z1/02 Kitchen adj 4-19/c
Windows***, roof windows, and rooflights	2.2	1.6	3.3	1.6	z0/01 Room 3-21/w/g
Personnel doors	2.2	0	3	0	"No Personnel doors in project"
Vehicle access & similar large doors	1.5	0	4	0	"No Vehicle access doors in project"
High usage entrance doors	6	0	6	0	"No High usage entrance doors in project"

$U_{a\text{-Limit}}$ = Limiting area-weighted average U-values [W/(m2K)]
$U_{a\text{-Calc}}$ = Calculated area-weighted average U-values [W/(m2K)]
$U_{i\text{-Limit}}$ = Limiting individual element U-values [W/(m2K)]
$U_{i\text{-Calc}}$ = Calculated individual element U-values [W/(m2K)]

* There might be more than one surface exceeding the limiting standards.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standards are similar to those for windows.
*** Display windows and similar glazing are not required to meet the standard given in this table.

3.4 Thermal Mass

The likelihood is that thermal mass will have to be sacrificed due to weight considerations due to the structural loadings on the building.

3.5 Infiltration

The infiltration rate for the new build has been assumed to be close to best practice, 5.0 m^3 / (h.m^2) will be the target.

The accepted advice on the matter is to 'build tight – ventilate right' in order to implement an effective ventilation strategy.

Better infiltration rates are achievable through good practice the Energy Saving Trust document: GPG 224 'Improving airtightness in dwellings' which is aimed at residential development and is a useful reference on achieving low infiltration rates.

3.6 Additional measures

All appliances will be specified to A or AAA energy standards. WC's and other fittings will be low flow/low flush for water conservation.

4.0 Building Services

4.1 Heating

Space heating and DHW will be delivered by efficient gas fired boilers. This will be part of a general replacement programme with the new plant serving the entire building including the extension.

4.2 Direct Hot Water

How water in the rooms will be supplied by the central heating system. The proposal at present is that this be via flat plate heat exchangers within the plant room, i.e. no DHW storage. The design team considers that this makes inclusion of Solar Hot Water problematic as there is no high temperature hot water delivery to the upper floors.

4.3 Cooling

There is no comfort cooling requirement

4.4 Ventilation

All areas are to be naturally ventilated with opening windows. Bathrooms and kitchens will have a mechanical exhaust.

5.0 Renewable Energy

5.1 Renewable Energy – Summary

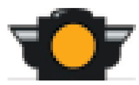
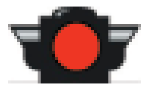
The following table lists all the systems analysed. Their contribution to the remainder of the site energy demands not met by Efficient Supply is expressed as a percentage.

Table 5-1. Summary of all Renewable Energy systems analysed showing energy outputs as a proportion of the site demands. The final column indicates if the system has been selected for inclusion on the site.

System type	System name	Energy generated (% of total)			Capital Cost £	Energy produced kWh/y	CO_2 Saved kg CO_2/yr)	CO_2 Saved (% of proposed site demands)
		Heating	Cooling	Electricity				
Wind	Wind 1	0%	0%	0%	£0.00	0	0	0.0%
PV	Solar PV 1	0%	0%	53.7%	£105,000.00	20,607	8,867	11.0%
Solar water heating (SWH)	Solar thermal 1	0%	0%	0%	£0.00	0	0	0.0%
Biomass heating systems	Biomass 1	0%	0%	0%	£0.00	0	0	0.0%
Ground source heat pumps (GSHP)	GSHP 1	0%	0%	0%	£0.00	0	0	0.0%
Ground cooling	N/A	0%	0%	0%	£0.00	0	0	0.0%
Total (included systems)		0%	0%	53.7%	£105,000.00	20,607	8,867	11.0%

5.2 Renewable Energy – Analysed Systems

Below is a brief overview of the available renewables technologies which are commonly used. A traffic light system is used to denote whether the systems are technically appropriate for the development at William Goodenough House.

Description	Traffic Light
Technology is technically and economically feasible with few barriers to implementation	
Technology is technically and economically feasible, but there are barriers to implementation	
Technology is technically or economically unfeasible and has been discounted	

Only those systems that are Amber or Green will be considered further.

N.B Micro hydro has not been considered as there is no potential at this site

5.2.1 Solar photovoltaic cells

Solar photovoltaic (PV) systems use energy from the sun to convert solar radiation into electricity, which can be used directly to run appliances and lighting, sold to the national grid, or stored in batteries, in off-grid locations.

PV systems perform best in direct sunlight, but continue to perform well in reduced light conditions. Systems come in various forms including solar tiles, roof-integrated panels, and on-roof panels. PV systems are also available for cladding buildings and covering walkways.

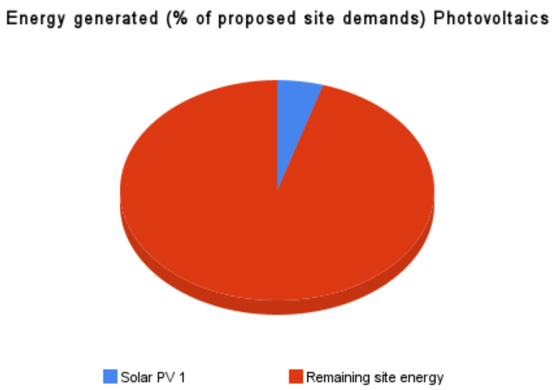
A PV array would yield both energy and CO2 savings, while providing long term revenue via the feed in tariff, therefore a PV system is **recommended** for this site.

Competition for grant funding for PV is extremely high and therefore the economic feasibility is an issue. With the Feed-in-Tariff simple payback can be between 10-20 years however this can be excessive for independent funding. As a not-for-profit organisation however grant funding is still a possibility for Goodenough College, interest free Carbon Trust loans are also available.

As an indication the feed-in tariff would be expected to provide around **£6,470 p.a.** (based on a tariff of 31.4p per kWh). In addition energy generated will displace an equivalent amount of purchased power at a rate of say £0.10 per kWh. This means the total benefit based on 20,607 kWh generated would be £8,531 p.a.

At the time of writing this report, the estimated installed cost of a PV array is in the region of £5,000/KWp of array, so 147m2 would accommodate an array with a peak power of around 21kW at a cost of around £105k. The energy yield from a 21kW system is around 20.6 MWh/year.

Description			
System number:	1		
System name:	PV-system-1		
Make and model number:	Sharp mono-Si - NT-185U1		
System description:	Stand off frames - mounted on the roof		
Number panels:	113		
Selected:	Yes		
Inputs			
Installed system Capital cost per m2:	5,000 £ / kWp		
System Lifetime:	25 Years		
PV technology:	Mono-si		
PV area:	147 m^2		
Maximum annual output from panel:	137 kWh / m^2		
Power capacity:	20.91kWp		
Panel efficiency:	14.2%		
Inverter efficiency:	90%		
Misc losses:	2%		
Weather data:	London Heathrow		
Capacity factor:	11.3%		
Outputs	Heating	Cooling	Electricity
Energy generated kWh	-	-	20,607
Proportion of total site energy demand %	-	-	6%



CO_2saving	
Net CO_2 saving:	8,861 kg
CO_2 saving as a proportion of the site demand:	11.0%
Costs	
Total capital cost of systems:	**£** 105,000

5.2.2 Small scale wind

A wind turbine harnesses energy from the wind to produce electricity. The most common design is of three blades mounted on a horizontal axis (HAWT), which is free to rotate into the wind on a tall tower or mast. The blades drive a generator either directly or via a gearbox (generally for larger machines) to produce electricity. Wind turbines can be mounted on masts that are freestanding or tethered with wires, or on buildings. Vertical axis wind turbines (VAWT) can be up to 30% more efficient than HAWT's although the overall energy yield is lower than an 'equivalent' HAWT. The electricity can either link to the grid or, in the case of off-grid systems, charge batteries. Modern designs can be very quiet in operation.

The NOABL wind speed database gives a figure of 5.6 m/s at 25 m height for the area of the college, which could make a small wind turbine viable. However, the national database gives an average figure over a square kilometre of area, thus it is a very generic figure. If a wind turbine is to be considered, we recommend that the site be monitored over a period of at least 6 months to establish the actual wind speed. This period is likely to take this project beyond the programme and timelines available regarding the grant funding deadlines and other constraints.

The probability of resistance to a wind turbine from local stakeholders is high.

Therefore we do not recommend wind as part of this feasibility study, however it should not be ruled out in the future and should be subject to a period of wind monitoring for at least 6 months.

5.2.3 Ground source or Air source heat pump (GSHP / ASHP)

Heat pumps can be used effectively for space and water heating. Heat pumps take heat energy from a source such as the ground; a body of water (e.g. river, lake or well) or simply the outside air and transfer it to the building.

The heat is upgraded by using a pump and compressor, which removes heat from one side of the circuit and ejects it to the other side. Heat pumps require electricity for their operation and users may consider buying this through a green tariff scheme, which promotes the use of renewable energy sources by power generators.

A problem with heat pumps is that electricity produces around three times more carbon per kWh than natural gas. Therefore the use of electricity to generate heat has immediate carbon credibility issues, even if there are economic benefits (for example by running the heat pump at night for cheaper electricity). This situation is avoided if local renewable power is available from wind or PV, so that the electricity required to drive the pump is carbon neutral.

The most expensive element under normal circumstances in heat pump installation is the provision of horizontal or vertical collectors.

Furthermore either extensive horizontal ground area or deep boreholes are required.

As there are limited opportunities for boreholes or horizontal collectors on this site the technology is rejected on technical grounds

5.2.4 Biomass heating system

Wood burning systems, unlike other renewable energy sources emit carbon dioxide. However, as the tree is growing, it absorbs the same amount of carbon dioxide as is released when burnt. As such, it does not add to the carbon dioxide in the atmosphere and is therefore deemed carbon neutral.

Biomass heating has been rejected due to the fact that the emissions from biomass within the London area are usually a basis for rejection by local authorities. There would also be supply chain, delivery and storage issues to contend with.

5.2.5 Solar thermal hot water systems

Solar panels, also known as "collectors", can be fitted onto or integrated into a building's roof. They use the sun's energy to heat water, or a heat-transfer fluid, which passes through the panel.

The fluid is fed to a heat store (for example, a hot water tank) to provide part of the hot water demand for the building. Usually another heat source will be needed to supplement collectors in winter months.

There is clearly a very high hot water demand within the building, accounting for over 50% of the total energy use. There is also the issue of hot water delivery from the basement plant room to the upper two floors.

Potentially solar hot water can help on both these two fronts by

1. Providing solar heated water to supplement the heating system
2. Creating hot water storage on the upper floors and therefore reducing heat loss due to piping the hot water from the plant room to the roof.

It is not usually possible cover to the whole hot water demand with solar thermal, however between 40% and 60% could be achieved with a large scale installation.

However in William Goodenough House there are a large number of bedrooms and a large volume of water storage would be needed to maximise the solar water percentage to these levels. A thermal store of 3,000-5,000l would probably be required and the current M&E proposals do not include hot water storage, using flat plate heat exchangers instead.

The vertical distance to the plant room does cause difficulties in integrating a solar thermal array.

This is a technical issue that would need to be addressed but is not insurmountable, although from a finanancial perspective the vertical distance may make this option uneconomical.

NB There are plans to introduce a renewable heat 'Feed in tariff' in April 2011 which will provide revenue based on renewable heat produced. Further details are expected in summer 2010

6.0 Conclusions

The scheme benefits from a number of energy efficiency measures, the most notable being:

- Levels of insulation exceeding building regulations minimums for new construction and refurbishment
- Low hot water use
- Good airtightness performance
- Use of advanced lighting systems

It can therefore be demonstrated that the scheme follows the energy hierarchy set out in Energy Statement guidance notes provided by both the LB of Camden and by the GLA, by using less energy, supplying energy efficiently and then using renewable energy.

The renewable systems chosen are a 147m2 array of mono-si Solar PV.

The renewable energy technology has been chosen in terms of effectiveness, cost and suitability for the scheme, and there is an upgrade route identified for future improvement if there is adequate roof space available and technical difficulties can be overcome (solar hot water).

The large solar PV array could provide up to 53% of the projected power demand of the building, and will also by virtue of the feed in tariff provide a revenue stream of up to £6,470 per year, which together with the purchased energy displaced could provide a financial benefit of up to £8,531 per year.

This system achieves a CO_2 reduction of 11% against a renewable target of 10% set by the local authority.

Other renewable technologies have been considered but the most appropriate option is for solar PV. With all available roof space being used in this way, it is our opinion that the 11% reduction achieved should be considered appropriate for the development.

We do however suggest that the option to include a wind turbine post construction is factored into the building services designs, and that wind monitoring is carried out post construction to measure both available wind and the effects of turbulence. Should the M&E specs. develop in such a way during the design stage to overcome the technical obstacles to Solar Hot Water, then the inclusion of this technology could be reviewed.

In total 8,861 kgCO2 per year are removed from the site emissions, at an estimated cost of £105,000 for the renewable technology aspects.

7.0 Appendices

Solar PV RETscreen output

RETScreen Energy Model - Power project

Show alternative units

Proposed case power system | **Incremental initial costs**

Technology		Photovoltaic	
Analysis type		Method 1 / Method 2	
Resource assessment			
Solar tracking mode		Fixed	
Slope	°	30.0	
Azimuth	°	0.0	

Show data

Month	Daily solar radiation - horizontal kWh/m²/d	Daily solar radiation - tilted kWh/m²/d	Electricity export rate £/MWh	Electricity exported to grid MWh
January	0.77	1.32	260.0	0.000
February	1.39	2.03	260.0	0.000
March	2.34	2.89	260.0	0.000
April	3.59	3.98	260.0	0.000
May	4.57	4.64	260.0	0.000
June	4.84	4.75	260.0	0.000
July	4.80	4.78	260.0	0.000
August	4.23	4.52	260.0	0.000
September	2.86	3.39	260.0	0.000
October	1.73	2.42	260.0	0.000
November	0.96	1.60	260.0	0.000
December	0.60	1.07	260.0	0.000
Annual	**2.73**	**3.12**	**0.00**	**0.000**

Annual solar radiation - horizontal	MWh/m²	1.00			
Annual solar radiation - tilted	MWh/m²	1.14			
Photovoltaic					
Type		mono-Si			
Power capacity	kW	20.91		£ 100,000	*See product database*
Manufacturer		Sharp			
Model		mono-Si - NT-185U1	113 unit(s)		
Efficiency	%	14.2%			
Nominal operating cell temperature	°C	45			
Temperature coefficient	% / °C	0.40%			
Solar collector area	m²	147			
Miscellaneous losses	%	2.0%			
Inverter					
Efficiency	%	90.0%			
Capacity	kW	12.5			
Miscellaneous losses	%	0.0%			
Summary					
Capacity factor	%	11.3%			
Electricity delivered to load	MWh	20.607			
Electricity exported to grid	MWh	0.000			

SBEM Output (draft for reference only!)

BRUKL Output Document

HM Government

Compliance with England and Wales Building Regulations Part L

Project name

William Goodenough H

As built

Date: Sat Feb 27 12:47:53 2010

Administrative information

Building Details

Address: ,

Certification tool

Calculation engine: SBEM

Calculation engine version: v3.4.a

Interface to calculation engine: iSBEM

Interface to calculation engine version: v3.4.a

BRUKL compliance check version: v3.4.a

Occupier Details

Name: Information not provided by the user

Telephone number: Information not provided by the user

Address: Information not provided by the user, Information not provided by the user, Information not provided by the user

Certifier details

Name: Paul Parker

Telephone number: 020 8099 6601

Address: 12a Kingfisher Court, Bridge Road, East Molesey, KT8 9HL

Criterion 1: Predicted CO2 emission from proposed building does not exceed the target

1.1	Calculated CO2 emission rate from notional building	64.2 KgCO2/m2.annum
1.2	Improvement factor	0.15
1.3	LZC benchmark	0.1
1.4	Target CO2 Emission Rate (TER)	49 KgCO2/m2.annum
1.5	Building CO2 Emission Rate (BER)	44.9 KgCO2/m2.annum
1.6	Are emissions from building less than or equal to the target?	BER =< TER
1.7	Are as built details the same as used in BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and the building services systems should be no worse than the design limits

2.1 Are the U-values better than the design limits? Better than design limits

Element	$U_{a\text{-Limit}}$	$U_{a\text{-Calc}}$	$U_{i\text{-Limit}}$	$U_{i\text{-Calc}}$	Surface where this maximum value occurs*
Wall**	0.35	0.17	0.7	0.2	z0/01 Room 3-21/s
Floor	0.25	0	0.7	0	"No Floors in project"
Roof	0.25	0.15	0.35	0.15	z1/02 Kitchen adj 4-19/c
Windows***, roof windows, and rooflights	2.2	1.6	3.3	1.6	z0/01 Room 3-21/w/g
Personnel doors	2.2	0	3	0	"No Personnel doors in project"
Vehicle access & similar large doors	1.5	0	4	0	"No Vehicle access doors in project"
High usage entrance doors	6	0	6	0	"No High usage entrance doors in project"

$U_{a\text{-Limit}}$ = Limiting area-weighted average U-values [W/(m2K)]
$U_{a\text{-Calc}}$ = Calculated area-weighted average U-values [W/(m2K)]
$U_{i\text{-Limit}}$ = Limiting individual element U-values [W/(m2K)]
$U_{i\text{-Calc}}$ = Calculated individual element U-values [W/(m2K)]

* There might be more than one surface exceeding the limiting standards.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standards are similar to those for windows.
*** Display windows and similar glazing are not required to meet the standard given in this table.

2.2 Is air permeability no greater than the worst acceptable standard? No greater than worst acceptable standard

Air Permeability	Worst acceptable standard	This building (Design value)
m3/(h.m2) at 50 Pa	10	5

2.3 Are all building services standards acceptable?

2.3a-1 Main Heating System HVAC system standard is acceptable

Efficiency check	Limiting heat source seasonal efficiency	This building
Heat source efficiency	0.84	0.91
0.84 is the overall limiting efficiency for a single or a multiple boiler system. For a multiple boiler system the limiting efficiency for any individual boiler is 0.80.		

2.3b- "No HWS in project, or hot water is provided by HVAC system"

2.4	Does fixed internal lighting comply with England and Wales Building Regulations Part L paragraphs 49 to 61?	Separate submission
2.5	Are energy meters installed in accordance with GIL65?	Separate submission

Criterion 3: The spaces in the building without air-conditioning have appropriate passive control measures to limit the effects of solar gains

3.1	Method of showing compliance with England and Wales Building Regulations Part L in paragraph 64?	Separate submission

Criterion 4: The performance of the building, as built, is consistent with the BER

4.1	Have the key features of the design been included (or bettered) in practice?	Separate submission
4.2	Is the level of thermal bridging acceptable?	Separate submission
4.3	Has satisfactory documentary evidence of site inspection checks been produced?	Separate submission

4.4 Design air permeability

Air Permeability	Worst acceptable standard	This building (Design value)
m3/(h.m2) at 50 Pa	10	5

4.5	Has evidence been provided that demonstrates that the design air permeability has been achieved satisfactorily?	Separate submission
4.6	Has commissioning been completed satisfactorily?	Separate submission
4.7	Has evidence been provided that demonstrates that the ductwork is sufficiently airtight?	Separate submission

Criterion 5: Providing information

5.1	Has a suitable building log-book been prepared?	Separate submission

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area (m2)	1244	1244
External area (m2)	772	772
Weather	LON	LON
Infiltration (m3/hm2 @ 50Pa)	5	10
Average conductance (W/K)	511.57	1455.01
Average U-value (W/m2K)	0.66	1.88
Alpha value (%)	14.87	10

Building Use

% area	Building Type
	Office
	Primary school
	Secondary school
100	**Further education universities**
	Primary health care buildings
	Nursing residential homes and hostels
	Hospital
	Hotel
	Restaurant/public house
	Sports centre/leisure centre
	Sports ground arena
	Retail
	Warehouse and storage
	Theatres/cinemas/music halls and auditoria
	Social clubs
	Community/day centre
	Libraries/museums/galleries
	Prisons
	Emergency services
	Crown and county courts
	Airport terminals
	Bus station/train station/seaport terminal
	Workshops/maintenance depot
	Telephone exchanges
	Industrial process building
	Launderette
	Dwelling
	Retail warehouses
	Miscellaneous 24hr activities

HVAC Systems Performance

System Type	Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Grid Supplied Electricity									
Actual	107.3	100.2	34.9	0	4.9	0.86	0	0.91	0
Notional	196.5	214.2	74.7	0	3.1	0.73	0	----	----

Key to terms

Alpha value (%)	= percentage of the building's average heat transfer coefficient which is due to thermal bridging
Heat dem (MJ/m2)	= Heating energy demand
Cool dem (MJ/m2)	= Cooling energy demand
Heat con (kWh/m2)	= Heating energy consumption
Cool con (kWh/m2)	= Cooling energy consumption
Aux con (kWh/m2)	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type