Energy & Sustainability Statement

Fortess Grove

June 2015

REPORT REF: ESS/FG/20151007 - AT

NRG Consulting— Studio 7, Third Floor, 138-148 Cambridge Heath Road London, E1 5QJ

T:0207 998 6481

TABLE OF CONTENTS

DOCUMENT CONTROL SHEET:

Rev.	Issue Purpose	Author	Signature	Checked	Signature	Date
A	Following developer comments	Alex Timperley		Ryan Thrower		10/07/2015

1. EXECUTIVE SUMMARY

1.1 NRG Consulting has been appointed by The Estate Charity of Eleanor Palmer to undertake an Energy Statement on a proposed development in Camden.

1.2 The scheme comprises of part demolition and part retention of existing warehouse structures to create 1,138m2 of commercial floorpsace over 3 levels, 8no. 3 bedroom and 1no. 2 bedroom dwellings, together with associated landscaping.

1.3 This document has been produced to satisfy:

- Policy 5.2 of the London Plan by providing a 35% improvement in regulated CO_2 over Part L of the Building Regulations 2013.

- Camden Core Strategy Policy CS13

- Camden Council's Planning Guidance

1.4 This document details how the targets are met via:

- Passive Design Measures

- Low U-Values

- Low Air Permeability

- A High efficiency Gas Heating System

- Photovoltaic Panels

1.5 This document has been written in adherence to the GLA Guide to Energy Statements (April 2015)

2. POLICY FRAMEWORK

2.1 With 9 residential units proposed alongside a significant amount of commercial space the development falls within the Government's "major" category of planning applications.

NATIONAL POLICIES

2.2 On 25 March 2015, the Government confirmed its policy to limit local energy requirements and continue to support low carbon infrastructure. The Mayor has considered the Government's intentions regarding energy performance standards and its support for energy infrastructure and considers his energy targets within his energy hierarchy to be in line with this approach. It encourages developers to make carbon savings on-site, firstly through demand reduction. These reductions are in line with the Government's preferred maximum energy requirement (19 per cent reduction beyond Part L 2013 (Code 4) equivalent). The remaining energy savings are met through low carbon infrastructure, either on-site or off-site.

2.3 The Mayor has also commissioned a viability study as part of his Minor Alterations to the London Plan6 which confirms that current and future London Plan targets are viable for development in London. The targets in the London Plan will therefore continue to be applied in line with the energy hierarchy, across both residential and non-domestic development until the implementation of zero carbon policies in 2016.

(Source: Pg.11 *GLA Guide to Energy Statements* – April 2015)

REGIONAL POLICIES

2.4 The London Plan was updated in March 2015. A link to the new version can be found here:

https://www.london.gov.uk/priorities/planning/london-plan/further-alterations-to-the-london-plan

2.5

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

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

B The Mayor will work with boroughs and developers to ensure that major developments meet the following targets for carbon dioxide emissions reduction in buildings. These targets are expressed as minimum improvements over the Target Emission Rate (TER) outlined in the national Building Regulations leading to zero carbon residential buildings from 2016: Improvement on 2013 Building Regulations: 2013 - 2016 - **35 percent** (as of 6th April 2014).

C Development proposals should include a detailed energy assessment to demonstrate how the targets for carbon dioxide emissions reduction outlined above are to be met within the framework of the energy hierarchy.

D As a minimum, Energy Assessments should include the following details:

i. Calculation of the energy demand and carbon dioxide emissions covered by the Building Regulations and, separately, the energy demand and carbon dioxide emissions from any other part of the development, including plant or equipment, that are not covered by the Building Regulations.

ii. Proposals to reduce carbon dioxide emissions through the energy efficient design of the site, buildings and services.

iii. Proposals to further reduce carbon dioxide emissions through the use of decentralised energy where feasible, such as district heating and cooling and combined heat and power (CHP).

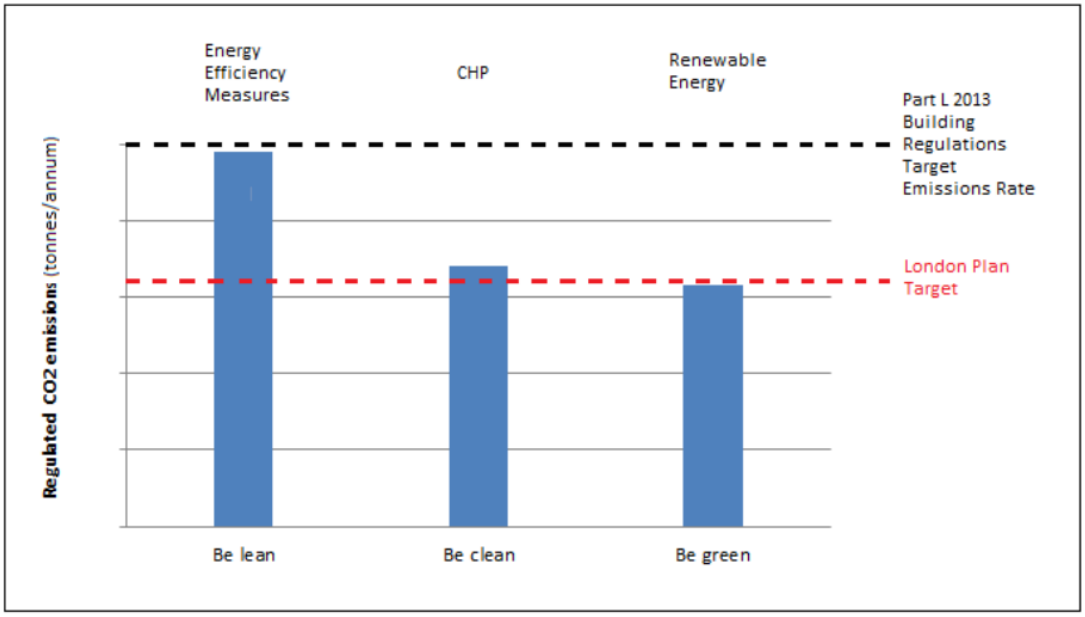
iv. Proposals to further reduce carbon dioxide emissions through the use of on-site renewable energy technologies.

2.6 As of 6th April 2014, The London Plan changed the targets required for major developments from 40% reduction in CO_2 emissions over the Part L 2010 baseline to 35% reduction in CO_2 emissions over the Part L 2013 baseline. Text from the GLA Website confirms this:

The GLA provides guidance for developers and their advisers on preparing energy assessments to accompany strategic planning applications. Each assessment is required to demonstrate how the targets for regulated CO_2 emission reductions over and above 2013 Building Regulations will be met using the Mayor's energy hierarchy. As outlined in the Sustainable Design and Construction SPG, since 6 April 2014, the Mayor has applied a 35 per cent carbon reduction target beyond Part L 2013 of the Building Regulations - this is deemed to be broadly equivalent to the 40 per cent target beyond Part L 2010 of the Building Regulations, as set out in London Plan Policy 5.2 for 2013-2016.

(Source: GLA. 2015. *Energy Planning - GLA Guidance on preparing energy assessments*. [ONLINE] Available at: https://www.london.gov.uk/priorities/planning/strategic-planning-applications/preplanning-application-meeting-service/energy-planning-gla-guidance-on-preparing-energy-assessments) [Accessed April 15].

2.7 A visual representation of the GLA Target in relation to Building Regulations where feasible is:



(Source GLA. 2015. Pg.13 *ENERGY PLANNING Greater London Authority guidance on preparing energy assessments (April 2015)*. [ONLINE] Available at: https://www.london.gov.uk/sites/default/files/GLA%20guidance%20on%20preparing%20energy%20assessments%20April%202015.pdf. [Accessed April 15].

LOCAL POLICIES

2.8 The **Camden Core Strategy** is to be followed. Policy **CS13** states that:

> **CS13 - Tackling climate change through promoting higher environmental standards**
>
> ***Reducing the effects of and adapting to climate change***
> The Council will require all development to take measures to minimise the effects of, and adapt to, climate change and encourage all development to meet the highest feasible environmental standards that are financially viable during construction and occupation by:
> a) ensuring patterns of land use that minimise the need to travel by car and help support local energy networks;
> b) promoting the efficient use of land and buildings;
> c) minimising carbon emissions from the redevelopment, construction and occupation of buildings by implementing, in order, all of the elements of the following energy hierarchy:
> - ensuring developments use less energy,
> - making use of energy from efficient sources, such as the King's Cross, Gower Street, Bloomsbury and proposed Euston Road decentralised energy networks;
> - generating renewable energy on-site; and
> d) ensuring buildings and spaces are designed to cope with, and minimise the effects of, climate change.
> The Council will have regard to the cost of installing measures to tackle climate change as well as the cumulative future costs of delaying reductions in carbon dioxide emissions

Therefore this report will lay out how the highest feasible environmental standards, taking into account financial factors, will be met on this development.

2.9 **Camden Council's Planning Guidance** is also to be followed on this development. It is in line with the Energy Hierarchy contained within the GLA Guidance for Energy Statements and the London Plan.

Therefore, a 35% reduction in carbon emissions will be achieved on this development.

3. BASELINE

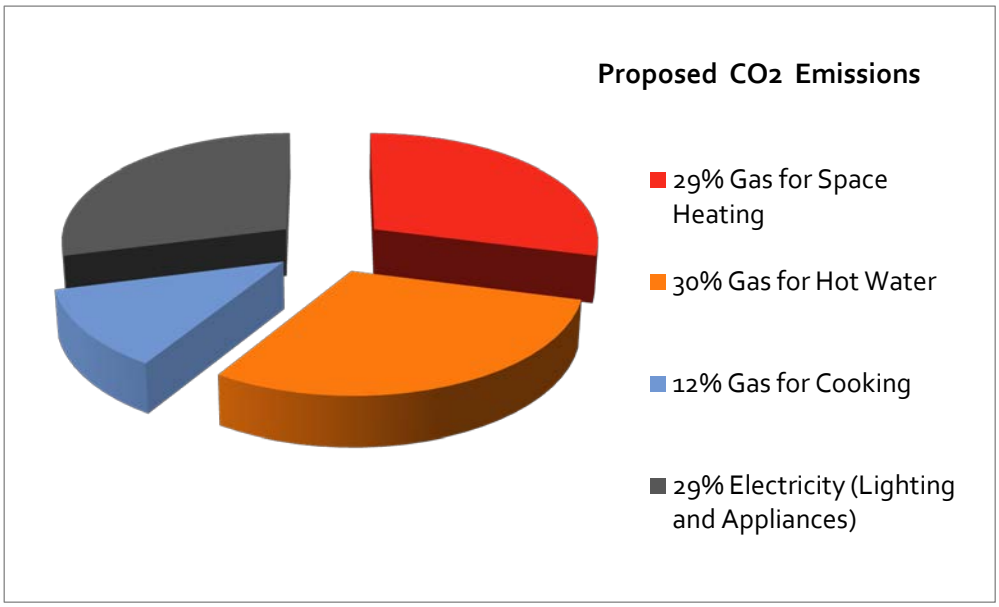
3.1 SAP Calculations have been carried out on a representative sample using the NHER Plan Assessor Version 6.1 (SAP v9.92) to gain the regulated emissions for the site.

Regulated Emissions are the CO_2 emissions covered under Part L of the Building Regulations and comprise of:

a) Space Heating and Cooling
b) Hot Water
c) Lighting
d) Pumps and Fans

A licensed and OCDEA accredited SAP Assessor has carried out the calculations.

3.2 Typical CO_2 emissions for housing developments is broken down as follows:



3.3 In accordance with potential planning requirements, compliance is to be achieved on each unit in order to reach Level 4 of the Code for Sustainable Homes (May 2014).

3.4 A table can be found in the Appendix 1 which:

- Sets out the floor area of each dwelling,

- Shows the Target Emission Rate (TER) and Dwelling Emission Rate (DER) in terms of kg/m²/year

- Highlights the percentage reduction of the DER over the TER.

- Displays the CO_2 saved through the proposed use of energy efficient measures.

3.5 The table in Appendix 1 also sets out the Unregulated Emissions for the development. These are CO_2 emissions that occur in a residential dwelling but are not counted for the purposed of Part L of the Building Regulations and within SAP. These emissions cover the use of:

a) Small Power.

b) Cooking.

This has been calculated using the BREDEM-12 methodology via a spreadsheet issued by NHER which is based on the occupancy rate of the dwellings, derived from the size of the plot.

Due to the nature of the emissions, it is considered extremely difficult/impossible to reduce these emissions through design measures and therefore they remain the same during each stage of the hierarchy.

3.6 For the commercial space the predicted energy consumption has been derived from SBEM Calculations carried out by a qualified and accredited SBEM Assessor.

3.7 Development emissions at this stage of the hierarchy are as follows:

	CO_2 Emissions - (Tonnes per Annum)		
	Regulated	**% improvement on TER**	**Unregulated**
Baseline: Part L 2013 of the Building Regulations Compliant Development (TER)	**54.0**		**17.7**
After energy demand reduction *'Be Lean'*			
After CHP *'Be Clean'*			
After renewable energy *'Be Green'*			

4. BE LEAN

4.1.1 Construction Details have been selected to ensure that all fabric U-Values exceed the requirements of Part L of the Building Regulations (2013) and all Heating, Hot Water and Ventilation elements are in compliance with the Domestic Building Services Compliance Guide (2013). The proposed construction details for the development are as follows:

Elements	U Value	Development Notes
Ground Floor	**0.13 w/m2/k**	
Exposed Upper Floor	**0.25 w/m2/k**	
Main External Walls	**0.20 w/m2/k**	
Party Walls	**0.00 w/m2/k**	**Fully Filled Cavity**
Flat Roof (Lower & Upper Floors)	**0.13 w/m2/k**	
Windows	**1.40 w/m2/k**	
Doors	**1.00 w/m2/k**	
Air Permeability	**5m³/hm²@50Pa**	
Ventilation	**System 1 - Trickle Ventilation**	
Heating	**Gas Heating – Condensing Boiler**	**89 % SEDBUK 2009 efficiency**
Heating Controls	**Full Zone Control**	
Emitters	**Radiators**	
Secondary Heating	**No**	
Thermal Bridging	**ACDS**	**Accredited Details o be followed on all applicable junctions** Link to ACD details
Lighting	**100%**	**Low Energy Bulbs that have a luminous efficacy of over 45 lumens/circuit/watt.**

4.1.2 A full sample SAP Input Data Sheet and SAP L1a Checklist can be found in Appendix 2 to verify the above inputs.

4.2.1 Construction details for the commercial section are as follows:

TABLE 01- PART L2A SBEM SPECIFICATIONS

ELEMENT	PROPOSED / CALCULATED U-VALUES	FURTHER INFORMATION
EXTERNAL WALLS	0.20 W/m^{2}K	U-values recommended to achieve compliance against Criterion 1. Construction element will have exposed thermal mass to reduce risk of overheating in summer Km value > 75 kJ/m2K
INTERNAL PARTITIONS	-	U-values recommended to achieve compliance against Criterion 1.
SEMI EXPOSED WALLS	0.20 W/m^{2}K	TO CYCLE STORE AND BIN STORE As cycle store and bin store are unheated areas, the internal walls adjacent to these rooms will need to be insulated and treated as heat loss walls.
GROUND FLOOR	0.13 W/m^{2}K	U-values recommended to achieve compliance against Criterion 1. Construction element will have exposed thermal mass to reduce risk of overheating in summer Km value > 75 kJ/m2K
INTERNAL FLOORS	-	U-values recommended to achieve compliance against Criterion 1.
SEMI EXPOSED INTERNAL FLOORS	0.13 W/m^{2}K	U-values recommended to achieve compliance against Criterion 1. Construction element will have exposed thermal mass to reduce risk of overheating in summer Km value > 75 kJ/m2K
ROOF	0.13 W/m^{2}K	U-values recommended to achieve compliance against Criterion 1.
GLAZED DOORS	1.4 W/m^{2}K	U-values recommended to achieve compliance against Criterion 1. Glazing specifications in Table 02 below.
WINDOWS	1.4 W/m^{2}K	U-values recommended to achieve compliance against Criterion 1. Glazing specifications in Table 02 below.
AIR PERMEABILITY	5.0 m3/hm2@50Pa	-

***Note: All items highlighted in red are to be confirmed by the client / design team to achieve compliance against Criterion 1.**

TABLE 02 - GLAZING SPECIFICATIONS TO ACHIEVE CRITERION 3 COMPLIANCE & REDUCE THE RISK OF OVERHEATING

ROOM	U value (W/m2K) including frame	G-value	LT Value	Internal blinds required?
GF_ UNIT 1	1.40	<0.60	>0.72	YES
2F_ CIRCULATION 2F_UNIT 4	1.40	<0.28	>0.51	NO
GF_ RECEPTION 1F_ CIRCULATION 2	1.40	<0.35	>0.70	NO
1F_ UNIT 3 1F_ UNIT 2	1.40	<0.28	>0.51	YES
ROOF LIGHTS GF_ MEETING ROOM 2F_UNIT 4 1F_ UNIT 3 1F_ UNIT 2	1.40	<0.28	>0.51	NO
ALL OTHER ROOMS	1.40	<0.60	>0.72	NO

***Note: Glazing details highlighted in red are to be confirmed by the client / design team to achieve compliance against Criterion 3 of Approved Document of Part LA2 of Building Regulations and reduce the risk of overheating in summer.**

4.2.2 Full SBEM Calculations can be found in Appendix 2 to verify the above inputs.

4.3 Following SAP Calculations, CO_2 emissions at this stage of the hierarchy are as follows:

	CO_2 Emissions - (Tonnes per Annum)		
	Regulated	% improvement on TER	Unregulated
Baseline: Part L 2013 of the Building Regulations Compliant Development (TER)	**54.0**		**17.7**
After energy demand reduction *'Be Lean'*	**54.8**	**-1.53%**	**17.7**
After CHP *'Be Clean'*			
After renewable energy *'Be Green'*			

5. BE CLEAN

5.1 Policy 5.6B of the London Plan advises the following:

Major development proposals should select energy systems in accordance with the following hierarchy:

1. Connection to existing heating or cooling networks;

2. Site wide CHP network;

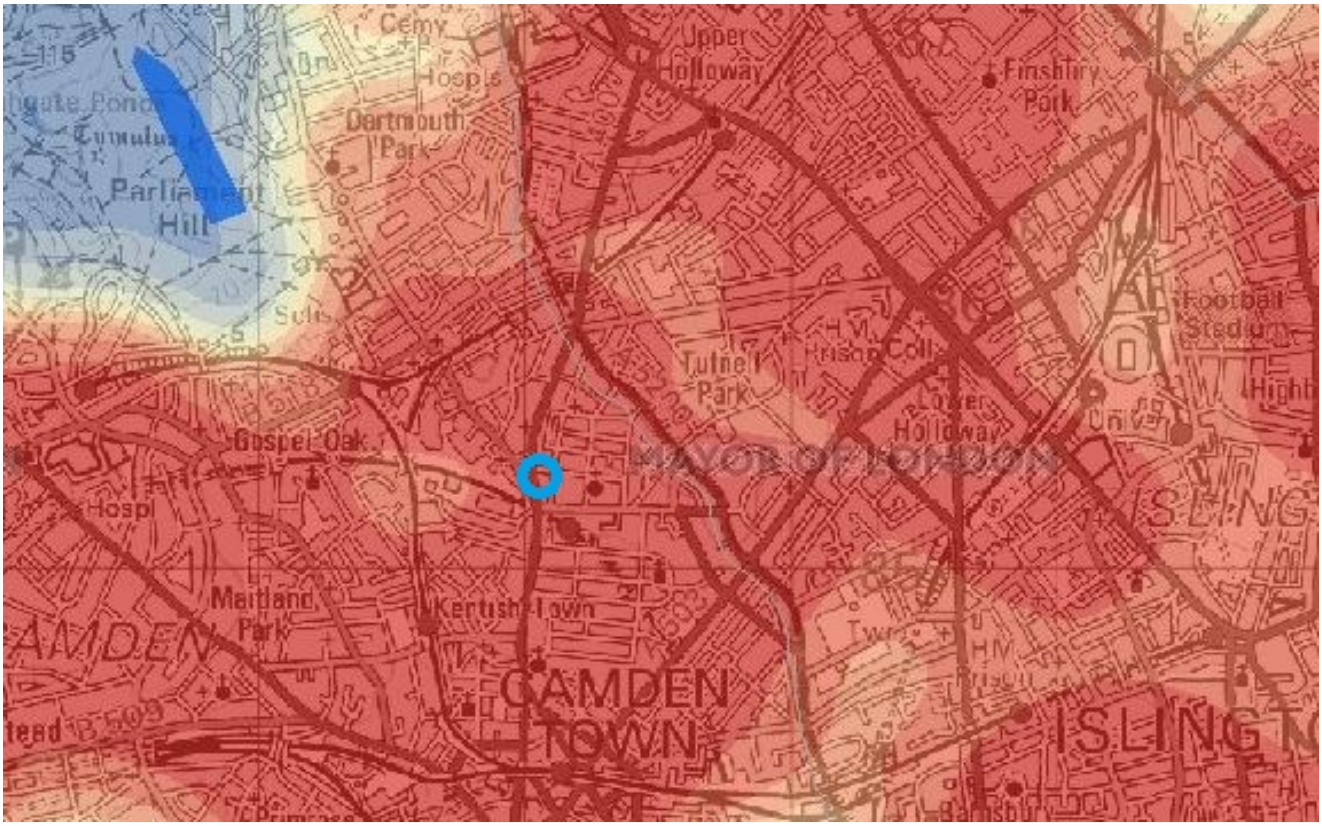
3. Communal heating and cooling.

4. Individual heating

(Source: Mayor of London. 2015. Pg. 197, *The London Plan March 2015*. [ONLINE] Available at: https://www.london.gov.uk/sites/default/files/London%20Plan%20March%202015%20%28FALP%29.pdf) [Accessed April 15].

HEAT MAP

The blue circle in the middle represents the location of the Site. As can be seen, there are no Heat networks either in the immediate area or planned for the future.



CONNECTION TO AREA WIDE LOW CARBON HEAT DISTRIBUTION NETWORKS

EXISTING NETWORKS

5.2 There are no existing heat networks within 1km of the development.

FEASIBILITY OF UTILISING EXISTING AREA WIDE CONNECTION

5.3 Infeasible due to there being no existing Heat Networks.

PLANNED NETWORKS

5.4 There are no planned heat networks within 1km of the development.

FEASIBILITY OF PROVIDING A SITE HEAT NETWORK FOR FUTURE AREA WIDE CONNECTION

5.5 Infeasible due to there being no planned Heat Networks.

5.6 Development emissions at this stage of the hierarchy are as follows:

	CO_2 Emissions - (Tonnes per Annum)		
	Regulated	% improvement on TER	Unregulated
Baseline: Part L 2013 of the Building Regulations Compliant Development (TER)	**54.0**		**17.7**
After energy demand reduction *'Be Lean'*	**54.8**	**-1.53%**	**17.7**
After CHP *'Be Clean'*	**54.8**	**-1.53%**	**17.7**
After renewable energy *'Be Green'*			

6. BE GREEN

6.1 The potential renewable energy applicable to this development and its feasibility is investigated below:

Renewable	Advantages	Disadvantages	Feasibility
Photovoltaic Panels	• Can have significant impact on carbon by offsetting electricity which has a high carbon footprint. • Low maintenance. • No noise issues associated with PV. • No additional land use from the installation of PV panels.	• High capital investment required. • Needs unobstructed space on roof.	• The development incorporates a roof which is perfectly suited to PV. • PV would be feasible as it can contribute to meet the on-site electrical demand and any unused electricity can be sent back to the grid.
Solar Thermal Collectors	• No additional land use from the installation of solar thermal collectors. • Low maintenance and easy to manage. • Low capital cost. • No noise issues associated with Solar thermal collectors.	• Limited CO_2 offset • No Grants or Tariffs for new build installations.	• Solar thermal collectors are feasible for the development, although it is not possible to meet the required carbon saving as the maximum demand that solar thermal collectors can be designed to meet can be no greater than 50% of the hot water demand.
Biomass Heating	• Potential to reduce large component of the total CO_2 . • A biomass boiler would replace a standard gas heating system so some of the cost may be offset through money saved on a traditional boiler.	• Regular maintenance will be required Reliability of fuel may become a problem, therefore limited cost saving for residents. • A plant room and fuel store will be required which may take additional land from the proposed development or surroundings. • The fuel will need to be delivered, which can cause issues with access etc.	• This is a small tight site in an urban area. • Biomass is not considered feasible for such a development due to the need for space to accommodate fuel storages, access for delivery vehicles and local NOx emissions.

Ground Source Heat Pumps	• Low maintenance and easy to manage Optimum efficiency with under- floor heating systems. • As heat pumps would replace standard heating systems, some of the cost may offset through money saved on a traditional boiler.	• The heat pump has a noise level around 45-60dB so some attenuation may be required and it should be sensibly located. • Relatively high capital cost. • Requires electricity to run the pump, therefore limited carbon savings in most cases. • For communal systems plant room required which may take additional land from the proposed development/ surroundings. • High payback.	• Limited Space on site and large communal infrastructure needed would remove and reduce amenity space. • As PV offers a much simpler installation offering equal/greater savings, GSHP has not been investigated further.
Air Source Heat Pumps	• ASHP systems are generally cheaper than ground source as there is no requirement for long lengths of buried piping. • Low maintenance and easy to manage. • Optimum efficiency with under- floor heating systems. • As heat pumps would replace standard heating systems, some of the cost may offset through money saved on a traditional boiler.	• The heat pump has a noise level around 50-60dB so some attenuation may be required and it should be sensibly located. • The potential noise from the external unit may mean there is local opposition to their installation. • Requires electricity to run the pump, therefore limited carbon savings in most cases. • For communal systems plant room required which may take additional land from the proposed development/surroundings Potential noise issues.	• As Gas is available to the Site, the benefit of ASHPs is limited. • Lack of space, capital cost and limited efficiencies of Exhaust Air Heat Pumps means CO_2 savings are too low to make the systems economical when compared to Gas and PV.

6.2.1 For the Commercial Unit, Air Source Heat Pumps are proposed for the heating and cooling (classified as Renewable Technology under EU Directive 2009/28/EC).

Highly efficient units are being proposed as can be seen in the following table:

ELEMENT	DETAILS	FURTHER INFORMATION
ELECTRIC POWER FACTOR	>0.95	
HEATING ALL ROOMS		**Be lean:** Supplied via LTHW boiler Seasonal efficiency 91%. Delivery Efficiency 95% Pumps: Variable speed with differential sensor across the pump. **Be clean:** The proposed Shell and Core units will have a simultaneous demand for heat and power for less than 5,000 hours per annum. Therefore a CHP unit is not feasible. **Be green:** ASHP with cassette units. Fuel type: electricity Seasonal efficiency 4.00 Pumps: Variable speed with differential sensor across the pump.
CONTROLS HEATING	Yes	Central Time Control Local time control (i.e., room by room) Local temperature control (i.e., room by room) Weather compensation control
SUB METERING HVAC	Yes	Yes, but no alarm for out of range values.
HEAT EMITTERS	-	Cassette units.
COOLING ALL ROOMS	Split or multi-split system	Cooling system type: Heat pump Chiller fuel type: Electricity Generator seasonal EER value 4.3 Generator nominal EER value 3.8

		The system have provision for metering Air supply mechanism: Design as zonal supply with remote fan Heat Recovery seasonal efficiency 90% Pumps: Variable speed with differential sensor across the pump. Mixed mode ventilation available.

6.2.2 Following the above feasibility, the chosen technology, Solar PV, will be implemented.

6.3 To achieve the remaining reduction we need to offset **18.0 tonnes of CO_2 /year.**

6.4 Proposed PV details are:

Figure	Unit
PV offset required for emission reduction target	**40.16 kWp**
PV offset proposed	**35.97 kWp**
Proposed Panel Configuration	**110 Panels @ 327 watts based on:** **i. 15 to 35 degree mounting angle** **ii. South Facing orientation** **iii. Less than 20% over-shading of total system.**

6.5 In the Appendices, to illustrate the above is:

1. Manufacturer Datasheet of PV Panel.
2. Drawing showing the PV on the Roof of the Development and that this is the maximum amount which can be installed.

6.6 Final CO_2 emissions based on this installation are:

	CO_2 Emissions - (Tonnes per Annum)		
	Regulated	% improvement on TER	Unregulated
Baseline: Part L 2013 of the Building Regulations Compliant Development (TER)	**54.0**		**17.7**
After energy demand reduction *'Be Lean'*	**54.8**	**-1.53%**	**17.7**
After CHP *'Be Clean'*	**54.8**	**-1.53%**	**17.7**
After renewable energy *'Be Green'*	**37.0**	**31.52%**	**17.7**

7. COOLING AND OVERHEATING

THE COOLING HIERARCHY

7.1 Pursuant with Policy 5.9 of the London Plan the following measures have been investigated:

Cooling Hierarchy	Measures Undertaken
1. Minimising internal heat generation through energy efficient design	• Heat distribution infrastructure within buildings should be designed to minimise pipe lengths, particularly lateral pipework in corridors of apartment blocks. • Adopting pipe configurations which minimise heat loss e.g. twin pipes.
2. Reducing the amount of heat entering the building in summer	• Carefully designed shading measures have been considered, including: i. Balconies, iii. Specification of Internal blinds
3. Use of thermal mass and high ceilings to manage the heat within the building	• Level of exposed thermal mass has been maximised to help to absorb excess heat within the building.
4. Passive Ventilation	• The use of: i. Openable windows, ii. Dual aspect units, iii. Designing in the 'stack effect.
5. Mechanical ventilation	• MVHR is not to be installed

OVERHEATING RISK ANALYSIS

7.2 Criterion 3 of Part L 2013 of the Building Regulations relates to limiting the effects of heat gains in summer - this is implemented for new dwellings as set out in Appendix P of SAP 2012.

All dwellings pass this Criterion.

However, the Building Regulations recognises that Criterion 3 does not cover all factors influencing overheating and that there is no guarantee that buildings will not overheat.

7.3 CIBSE Guide A – Environmental Design (2015) is the reference standard for overheating in the GLA SPG on Sustainability and the current industry standard amongst other CIBSE guides such as CIBSE TM52 "The Limits of Thermal Comfort: Avoiding Overheating in European Buildings" (2013). These set out guidelines on the number of hours a dwelling should not exceed a certain temperature.

7.4 This development should have no issues with overheating due to all stages of the cooling hierarchy being followed, with the lack of communal heat distribution being major factors in minimising any potential risks.

ACTIVE COOLING

7.5 There is no active cooling for the project.

8. CARBON OFFSETTING

8.1 In April 2015, the Greater London Authority (GLA) published:

- *GLA Energy Team Guidance on Planning Energy Assessments* - April 2015.

- *Sustainable Design and Construction – Supplementary Planning Guidance.*

These documents contain updated guidance on Sustainability Guidance for major scheme and also set formal guidance for Carbon Offsetting for the first time. Carbon Offsetting was introduced to reflect that on tight urban sites, meeting the mayor's CO_2 reduction targets were becoming increasingly difficult despite more energy efficient buildings being designed. In lieu of being able to feasibly meet the targets on-site, an off-site payment would be made to the Local Authority to be spent elsewhere in the borough to reduce CO_2 emissions.

8.2 The SPG states:

2.5.6 - *London Plan Policy 5.2 sets out that where the target percentage improvements beyond Part L of the Building Regulations, also set in this policy, cannot be met on-site, any short fall should be provided off-site or through a cash in lieu contribution to the relevant borough. This is to be ring fenced to secure delivery of carbon dioxide savings elsewhere*.

8.3 In terms of the cost of the contribution, London Borough's can either set their own price, based on the actual cost of offsetting Carbon in the borough or, use the "national standard" as set by the Zero Carbon Hub.

Contact has been attempted with the local council to establish whether they have such a report but an answer could not be found and there are no documents mentioning Carbon Offsetting on the website so the "national standard" shall be followed. According to the SPG (page 47), this should be calculated as:

i. Nationally recognised prices for carbon dioxide include:

- **The Zero Carbon Hub price, currently £60 per tonne, and**
- **The non-trading price of carbon.**

2.5.13 The overall contribution should be calculated over 30 years. For example, using the Zero Carbon Hub price equates to £60 x 30 years = £1,800 per tonne of carbon dioxide to be off-set.

Using methodology above, the Carbon Offsetting payment for the scheme should be £3,240.

8.4 Therefore, while the above follows the exact guidance in regards to Planning Policy targets, it is in by no way a legally binding commitment or absolute requirement, only a starting point for discussion with the Local Authority in terms of S106 contributions.

8.5 Final CO_2 emissions therefore are:

	CO_2 Emissions - (Tonnes per Annum)		
	Regulated	**% improvement on TER**	**Unregulated**
Baseline: Part L 2013 of the Building Regulations Compliant Development (TER)	**54.0**		**17.7**
After energy demand reduction *'Be Lean'*	**54.8**	**-1.53%**	**17.7**
After CHP *'Be Clean'*	**54.8**	**-1.53%**	**17.7**
After renewable energy *'Be Green'*	**37.0**	**31.52%**	**17.7**
After Carbon Offsetting	**35.1**	**35.00%**	**17.7**

9. CONCLUSION

9.1 This document is written in accordance with the guidelines and requirements of:

i. GLA Guide to Energy Statements (April 2015)

ii. The London Plan (March 2015) – Section 5

iii. The Core Strategy of the Local Borough.

9.2 The development has CO_2 baseline emissions that are Part L compliant via passive Energy Efficiency Measures alone as highlighted in Section 4.

9.3 In addition to the passive measures, **35.97** kWp amount of PV is being installed in order to achieve a 31.52% reduction in CO_2 emissions.

9.4 The remainder of the required 35% reduction will be achieved through Carbon Offsetting to the value of £3,240. It is expected that at Construction Stage full SAP Calculations and the associated Revised Energy Report will confirm this amount through means of a Planning Condition.

9.5 Combining the on site and off site reductions, the 35% target is met and the. This consists of a 31.52% reduction through on site measures and the remaining 3.48% coming under the umbrella of Carbon Offsetting.

Appendix 1

Fortess Grove
Reduction of Carbon Emissions by 35%

1	2	3		4	5	6
PLOT	AREA	TER	UNREGULATED	Regulated Part L	DER	Total
TYPE			Emissions	Baseline		$kg/CO_2/yr$
			(Appliances & Cooking)			Regulated Only
		$kg/CO_2/m2/yr$		$kg/CO_2/yr$	$kg/CO_2/m2/yr$	
1	130.83	18.10	15.07	2,368	19.51	2,552
2	130.83	16.70	15.07	2,185	18.04	2,360
3	129.37	16.07	15.15	2,079	17.12	2,215
4	91.20	20.65	17.82	1,883	21.59	1,969
Total	**482.23**			**8,515**		**9,096**
Total Residential	1132			**1m2 TER**		**1m2 DER**
		UNREGULATED TOTAL	17,672	***17.66***		***18.86***
Commercial	*1078.9*	**Commercial Baseline TER**	**31.5**	**Commercial "Be Lean" BER**	**31**	
		Commercial Baseline Emissions (TER x TFA)	**33985.35**	**Commercial "Be Lean" Emissions (BER x TFA)**	**33445.9**	
Total Site (m2)	**2,211**		**TOTAL TER CO2**	**53,974**	**TOTAL DER CO2**	**54,799**

Multiple TER	**53,974**	$kg/CO_2/yr$
Multiple DER	**54,799**	$kg/CO_2/yr$
CO2 Offset Required for 35% Reduction	**19,716**	$kg/CO_2/yr$
Commercial ASHP "BE Green" Offset	**1,726**	
Final CO2 Offset Required for 35% reduction	**17,990**	
PV orientation	**South**	
1kWP PV	**448.00**	$kg/CO_2/yr$
PV	**40.16**	**kWp**
Maximum PV on Roof	**35.97**	**kWp**
PV CO2 Offset	**16,115**	$kg/CO_2/yr$
On-Site CO2 Total	**36,958**	$kg/CO_2/yr$
Off-Site CO2 Offset Required for 35% reduction	**1,875**	$kg/CO_2/yr$
Carbon Offset Payment (£60 per tonne per annum x 30 years)	**£3,240**	

Appendix 2

Data Input Report
Design - Draft

This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Mr Neil Rothon	Assessor number	4282
Client		Last modified	11/06/2015
Address	House Type A m/t Fortess Grove, London, NW5		

Dwelling

Development:	N/A	House type:	
Property type:	House		
Built form:	Mid-terrace	Year built:	2015
Tariff:	Standard	Assess summer overheating:	Yes
Thermal mass:	Medium	Thermal mass parameter:	250.00
Separated heated conservatory:	No	Degree day region:	Thames
Sheltered sides:	2	Terrain:	Dense Urban

Storeys:

Name	Area (m²)	Height (m)
Lowest occupied	57.38	2.40
+1	49.91	2.60
+2	23.54	2.60

Floors

Ref - Name	Type	Construction	Storey Location	Living Area (m²)	Area (m²)	U-value (W/m²K)
Floor 1 - Floor 1	Ground	Solid	Lowest occupied	15.90	57.38	0.13

Living area that has no heat loss: 0.00

Walls

Ref - Name	Type	Construction	Gross Area (m²)	U-value (W/m²K)
Wall 1 - external	External	Cavity	141.26	0.20
Wall 2 - party	Party	Fully filled cavity with sealed edges	127.48	0.00

Roofs

Ref - Name	Construction	Gross Area (m²)	U-value (W/m²K)
Roof 1 - lower floors	Flat	33.84	0.13
Roof 2 - main flat	Flat	23.54	0.13

Openings

Opening Ref: 1 Half glazed door, Double glazed (low-E), ' N/A', master: Yes, linked to: 0

Location:	Wall 1	Source:	From Manufacturer	Orientation:	N/A
Overshading:	N/A	Width (m):	0.90	Height (m):	2.10
Frame:	u-PVC	Transmittance factor:	0.63	U-value (W/m²K):	1.00

Opening Ref: 2 Window, Double glazed (low-E), ' N/A', master: Yes, linked to: 0

Location:	Wall 1	Source:	From Manufacturer	Orientation:	West
Overshading:	Average / Unknown	Width (m):	2.50	Height (m):	2.10
Frame:	u-PVC	Transmittance factor:	0.63	U-value (W/m²K):	1.40

Opening Ref: 3 Window, Double glazed (low-E), ' N/A', master: No, linked to: 2

Location:	Wall 1	Source:	From Manufacturer	Orientation:	East
Overshading:	Average / Unknown	Width (m):	3.25	Height (m):	2.10

Frame:	u-PVC	Transmittance factor:	0.63	U-value (W/m²K):	1.40

Opening Ref: 4 Window, Double glazed (low-E), ' N/A', master: No, linked to: 2

Location:	Wall 1	Source:	From Manufacturer	Orientation:	West
Overshading:	Average / Unknown	Width (m):	3.25	Height (m):	2.10
Frame:	u-PVC	Transmittance factor:	0.63	U-value (W/m²K):	1.40

Opening Ref: 5 Window, Double glazed (low-E), ' N/A', master: No, linked to: 2

Location:	Wall 1	Source:	From Manufacturer	Orientation:	South
Overshading:	Average / Unknown	Width (m):	2.00	Height (m):	2.10
Frame:	u-PVC	Transmittance factor:	0.63	U-value (W/m²K):	1.40

Opening Ref: 6 Window, Double glazed (low-E), ' N/A', master: No, linked to: 2

Location:	Wall 1	Source:	From Manufacturer	Orientation:	West
Overshading:	Average / Unknown	Width (m):	1.80	Height (m):	2.20
Frame:	u-PVC	Transmittance factor:	0.63	U-value (W/m²K):	1.40

Opening Ref: 7 Window, Double glazed (low-E), ' N/A', master: No, linked to: 2

Location:	Wall 1	Source:	From Manufacturer	Orientation:	West
Overshading:	Average / Unknown	Width (m):	0.75	Height (m):	2.20
Frame:	u-PVC	Transmittance factor:	0.63	U-value (W/m²K):	1.40

Opening Ref: 8 Window, Double glazed (low-E), ' N/A', master: No, linked to: 2

Location:	Wall 1	Source:	From Manufacturer	Orientation:	West
Overshading:	Average / Unknown	Width (m):	1.20	Height (m):	1.20
Frame:	u-PVC	Transmittance factor:	0.63	U-value (W/m²K):	1.40

Opening Ref: 9 Window, Double glazed (low-E), ' N/A', master: No, linked to: 2

Location:	Wall 1	Source:	From Manufacturer	Orientation:	East
Overshading:	Average / Unknown	Width (m):	2.70	Height (m):	2.10
Frame:	u-PVC	Transmittance factor:	0.63	U-value (W/m²K):	1.40

Opening Ref: 10 Window, Double glazed (low-E), ' N/A', master: No, linked to: 2

Location:	Wall 1	Source:	From Manufacturer	Orientation:	West
Overshading:	Average / Unknown	Width (m):	2.50	Height (m):	1.20
Frame:	u-PVC	Transmittance factor:	0.63	U-value (W/m²K):	1.40

Opening Ref: 11 Window, Double glazed (low-E), ' N/A', master: No, linked to: 2

Location:	Wall 1	Source:	From Manufacturer	Orientation:	South
Overshading:	Average / Unknown	Width (m):	3.00	Height (m):	2.10
Frame:	u-PVC	Transmittance factor:	0.63	U-value (W/m²K):	1.40

Opening Ref: 12 Window, Double glazed (low-E), ' N/A', master: No, linked to: 2

Location:	Wall 1	Source:	From Manufacturer	Orientation:	West
Overshading:	Average / Unknown	Width (m):	2.40	Height (m):	1.80
Frame:	u-PVC	Transmittance factor:	0.63	U-value (W/m²K):	1.40

Opening Ref: 13 Window, Double glazed (low-E), ' N/A', master: No, linked to: 2

Location:	Wall 1	Source:	From Manufacturer	Orientation:	South
Overshading:	Average / Unknown	Width (m):	1.40	Height (m):	2.10
Frame:	u-PVC	Transmittance factor:	0.63	U-value (W/m²K):	1.40

Opening Ref: 14 Window, Double glazed (low-E), ' N/A', master: No, linked to: 2

Location:	Wall 1	Source:	From Manufacturer	Orientation:	West
Overshading:	Average / Unknown	Width (m):	1.30	Height (m):	2.10
Frame:	u-PVC	Transmittance factor:	0.63	U-value (W/m²K):	1.40

Opening Ref: 15 Window, Double glazed (low-E), ' N/A', master: No, linked to: 2

Location:	Wall 1	Source:	From Manufacturer	Orientation:	East
Overshading:	Average / Unknown	Width (m):	0.70	Height (m):	1.05
Frame:	u-PVC	Transmittance factor:	0.63	U-value (W/m²K):	1.40

Opening Ref: 16 Window, Double glazed (low-E), ' N/A', master: No, linked to: 2

Location:	Wall 1	Source:	From Manufacturer	Orientation:	South
Overshading:	Average / Unknown	Width (m):	1.50	Height (m):	1.05
Frame:	u-PVC	Transmittance factor:	0.63	U-value (W/m²K):	1.40

Opening Ref: 17 Rooflight, Double glazed (low-E), ' N/A', master: Yes, linked to: 0

Location:	Roof 1	Source:	From Manufacturer	Orientation:	Horizontal
Overshading:	None / Very little	Width (m):	0.90	Height (m):	0.90
Frame:	u-PVC	Transmittance factor:	0.63	U-value (W/m²K):	1.40

Opening Ref: 18 Rooflight, Double glazed (low-E), ' N/A', master: Yes, linked to: 0

Location:	Roof 1	Source:	From Manufacturer	Orientation:	Horizontal
Overshading:	None / Very little	Width (m):	1.00	Height (m):	2.55
Frame:	u-PVC	Transmittance factor:	0.63	U-value (W/m²K):	1.40

Opening Ref: 19 Rooflight, Double glazed (low-E), ' N/A', master: Yes, linked to: 0

Location:	Roof 1	Source:	From Manufacturer	Orientation:	Horizontal
Overshading:	None / Very little	Width (m):	1.00	Height (m):	3.20
Frame:	u-PVC	Transmittance factor:	0.63	U-value (W/m²K):	1.40

Thermal Bridging

Ref	Description	Length (m)	Source	ψ (W/m·K)	Result
E1	Steel lintel with perforated steel	0	Default Value	N/A	0
E2	Other lintels (including other stee	31.15	Approved	0.3	9.345
E3	Sill	30.25	Approved	0.04	1.21
E4	Jamb	59.2	Approved	0.05	2.96
E5	Ground floor (normal)	12.6	Approved	0.16	2.016
E5	Ground floor (normal)	8.5	Approved	0.16	1.36
E19	Ground floor (inverted)	N/A	Default Value	N/A	0
E20	Exposed floor (normal)	N/A	Default Value	N/A	0
E21	Exposed floor (inverted)	N/A	Default Value	N/A	0
E22	Basement floor	N/A	Default Value	N/A	0
E6	Intermediate floor within a dwellin	12.35	Approved	0.07	0.8645
E6	Intermediate floor within a dwellin	10.5	Default Value	0.14	1.47
E7	Party floor between dwellings (in b	N/A	Default Value	N/A	0
E8	Balcony within a dwelling, wall ins	N/A	Default Value	N/A	0
E9	Balcony between dwellings, wall ins	N/A	Default Value	N/A	0
E23	Balcony within or between dwellings	N/A	Default Value	N/A	0
E10	Eaves (insulation at ceiling level)	N/A	Default Value	N/A	0
E24	Eaves (insulation at ceiling level	12.1	Default Value	0.24	2.904
E11	Eaves (insulation at rafter level)	N/A	Default Value	N/A	0
E12	Gable (insulation at ceiling level)	N/A	Default Value	N/A	0
E13	Gable (insulation at rafter level)	N/A	Default Value	N/A	0
E14	Flat roof	4.8	Default Value	0.08	0.384
E15	Flat roof with parapet	21.6	Approved	0.28	6.048
E16	Corner (normal)	10	Approved	0.09	0.9
E17	Corner (inverted - internal area gr	5.2	Default Value	0	0
E18	Party wall between dwellings	27.8	Approved	0.06	1.668
E25	Staggered party wall between dwelli	N/A	Default Value	N/A	0
P1	Ground floor	21.7	Default Value	0.16	3.472
P6	Ground floor (inverted)	N/A	Default Value	N/A	0
P2	Intermediate floor within a dwellin	29	Default Value	0	0
P3	Intermediate floor between dwelling	N/A	Default Value	N/A	0
P7	Exposed floor (normal)	N/A	Default Value	N/A	0
P8	Exposed floor (inverted)	N/A	Default Value	N/A	0
P4	Roof (insulation at ceiling level)	17.3	Default Value	0.24	4.152

P5	Roof (insulation at rafter level)	N/A	Default Value	N/A	0
R1	Head	2.9	Default Value	0.08	0.232
R2	Sill	2.9	Default Value	0.06	0.174
R3	Jamb	13.3	Default Value	0.08	1.064
R4	Ridge (vaulted ceiling)	N/A	Default Value	N/A	0
R5	Ridge (inverted)	N/A	Default Value	N/A	0
R6	Flat ceiling	N/A	Default Value	N/A	0
R7	Flat ceiling (inverted)	N/A	Default Value	N/A	0
R8	Roof wall (rafter)	N/A	Default Value	N/A	0
R9	Roof wall (flat ceiling)	N/A	Default Value	N/A	0

Equivalent y value: 0.157

Ventilation

Air permeability entered: Yes
Seek exemption (<3 dwellings): No
Design air permeability rate: 5.00

Number of...	Open fireplaces	Open flues	Flueless gas fires	Extract fans	Passive vents
	0	0	0	4	0

Mechanical ventilation: Not present (natural)

Space heating

Main heating category: Individual system/s
Number of systems: 1
Secondary heating: No
Open flue or chimney: No
Unconnected gas point: N/A
Smoke control area: Not Known
Type: Boiler
Efficiency source: Manufacturer declared
Product index: N/A
Product details: N/A N/A N/A
Boiler type: N/A
Fuel: Mains gas
Condensing: Yes
Flue type: Balanced
Fan assisted flue: Yes
System: Condensing with automatic ignition (1998 or later)
Controls: Time and temperature zone control - plumbing circuit
Interlock: Yes
Delayed start thermostat: No
Compensation: None
Burner control: Modulating
Emitter: Radiators
Pump in heated space: Yes
Flow Temp: Unknown
Installed 2013 or later: Yes
Efficiency Type: 2009 SEDBUK
Efficiency (%): 89.00
Manufacturer efficiency description: a
FGHRS: No

Water heating

Type: From main
Fuel: Mains gas
Water separately timed: Yes
Water use ≤125 litres/person/day: Yes
Heat pump uses immersion: N/A
Summer immersion: N/A
Thermal store type: None

Store details:

Cylinder volume (litres): 210.00
Insulation type: Spray foam
Insulation thickness (mm): 65
Thermostat: Yes
In heated space: Yes
Primary pipework insulated: N/A

WWHRS:

WWHRS: N/A

Renewables

No renewables present

Other

Internal lighting

Standard fittings:	0	Low energy fittings:	12	Total fittings:	12

Summer overheating

Thermal mass parameter (TMP):	250.00		
User defined air change rate:	No	Air change rate (ach):	N/A
Cross ventilation on most floors:	No	Window ventilation:	Fully open
Source of user defined values:	N/A		
Curtains closed in daylight hours:	No	Fraction curtains closed:	N/A
Blind/curtain type:	N/A		

Special features (Appendix Q)

No Appendix Q special features present

Cooling details

No space cooling present

L1A 2013 - Regulations Compliance Report
Design - Draft

This design draft submission provides evidence towards compliance with Part L of the Building Regulations, in accordance with Appendix C of AD L1A. It has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the 'as built' property. This report covers only items included within the SAP and is not a complete report of regulations compliance.

Assessor name	Mr Neil Rothon	Assessor number	4282
Client		Last modified	11/06/2015
Address	House Type A m/t Fortess Grove, London, NW5		

Check	Evidence	Produced by	OK?
Criterion 1: predicted carbon dioxide emission from proposed dwelling does not exceed the target			
TER (kg $CO_2/m^2.a$)	Fuel = N/A Fuel factor = 1.00 TER = 16.70	Authorised SAP Assessor	
DER for dwelling as designed (kg $CO_2/m^2.a$)	DER = 18.04	Authorised SAP Assessor	
Are emissions from dwelling as designed less than or equal to the target?	DER 18.04 > TER 16.70 Excess emissions = 1.34 kg/m² (8.02%)	Authorised SAP Assessor	Failed
Is the fabric energy efficiency of the dwellling as designed less than or equal to the target?	DFEE 58.88 < TFEE 59.29	Authorised SAP Assessor	Passed
Criterion 2: the performance of the building fabric and the heating, hot water and fixed lighting systems should be no worse than the design limits			
Fabric U-values			
Are all U-values better than the design limits in Table 2?	**Element** — **Weighted average** — **Highest** Wall — 0.20 (max 0.30) — 0.20 (max 0.70) Party wall — 0.00 (max 0.20) — N/A Floor — 0.13 (max 0.25) — 0.13 (max 0.70) Roof — 0.13 (max 0.20) — 0.13 (max 0.35) Openings — 1.39 (max 2.00) — 1.40 (max 3.30)	Authorised SAP Assessor	Passed
Thermal bridging			
How has the loss from thermal bridges been calculated?	Thermal bridging calculated from linear thermal transmittances for each junction	Authorised SAP Assessor	
Heating and hot water systems			
Does the efficiency of the heating systems meet the minimum value set out in the Domestic Heating Compliance Guide?	Main heating system: Mains gas, Regular boiler a Data from manufacturer Efficiency = 89.00% 2009 SEDBUK Minimum = 88.00% Secondary heating system: None	Authorised SAP Assessor	Passed
Does the insulation of the hot water cylinder meet the standards set out in the Domestic Heating Compliance Guide?	Cylinder volume = 210.00 litres Nominal cylinder loss = 2.26kWh/day Maximum permitted cylinder loss = 2.30kWh/day Primary hot water pipes are insulated	Authorised SAP Assessor	Passed
Do controls meet the minimum controls provision set out in the Domestic Heating Compliance Guide?	Space heating control: Time and temperature zone control - plumbing circuit Hot water control: Boiler interlock (main system 1) Cylinder thermostat Separate water control	Authorised SAP Assessor	Passed

Check	Evidence	Produced by	OK?
Fixed internal lighting			
Does fixed internal lighting comply with paragraphs 42 to 44?	Schedule of installed fixed internal lighting Standard lights = 0 Low energy lights = 12 Percentage of low energy lights = 100% Minimum = 75 %	Authorised SAP Assessor	Passed
Criterion 3: the dwelling has appropriate passive control measures to limit solar gains			
Does the dwelling have a strong tendency to high summertime temperatures?	Overheating risk (June) = Slight Overheating risk (July) = Medium Overheating risk (August) = Medium Region = Thames Thermal mass parameter = 250.00 Ventilation rate in hot weather = 5.00 ach Blinds/curtains = None	Authorised SAP Assessor	Passed
Criterion 4: the performance of the dwelling, as designed, is consistent with the DER			
Design air permeability ($m^3/(h.m^2)$ at 50Pa)	Design air permeability = 5.00 Max air permeability = 10.00	Authorised SAP Assessor	Passed
Mechanical ventilation system Specific fan power (SFP)	Not applicable	Authorised SAP Assessor	
Have the key features of the design been included (or bettered) in practice?	The following party walls have a U-value less than $0.2W/m^2K$: • party (0.00) The following openings have a U-value less than $1.2W/m^2K$: • Half glazed door reference 1 (1.00)	Authorised SAP Assessor	

Appendix 3

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name **Shell and Core**

404 Fortess Grove BE LEAN

As designed

Date: Thu Jun 11 17:48:54 2015

Administrative information

Building Details

Address: 36-52 & 20 Fortess Grove, London, NW5

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.2

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.2

BRUKL compliance check version: v5.2.b.1

Owner Details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Certifier details

Name: Xavier Valladares

Telephone number: 01245 500 566

Address: NRG Consulting, Studio 7 3rd Floor, 138-148 Cambridge, Heath Road, London, E1 5QJ

Criterion 1: The calculated CO_2 emission rate for the building should not exceed the target

1.1	CO_2 emission rate from the notional building, $kgCO_2/m^2.annum$	31.5
1.2	Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	31.5
1.3	Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	31
1.4	Are emissions from the building less than or equal to the target?	BER =< TER
1.5	Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and the building services should achieve reasonable overall standards of energy efficiency

Values which do not meet standards in the 2013 Non-Domestic Building Services Compliance Guide are displayed in red.

2.a Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.2	0.29	GF000007:Surf[10]
Floor	0.25	0.14	0.18	1F000000:Surf[8]
Roof	0.25	0.13	0.13	1F000000:Surf[0]
Windows***, roof windows, and rooflights	2.2	1.17	1.4	GF000006:Surf[1]
Personnel doors	2.2	-	-	No Personnel doors in building
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [$W/(m^2K)$]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [$W/(m^2K)$] $U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [$W/(m^2K)$]

* There might be more than one surface where the maximum U-value occurs.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
*** Display windows and similar glazing are excluded from the U-value check.
N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	5

2.b Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs. Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	NO
Whole building electric power factor achieved by power factor correction	>0.95

1- Split or Multi Split

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.91	3.8	0	0	0.9
Standard value	0.91*	3.2	N/A	N/A	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO
* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.					

1- DHW

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	0.91	-
Standard value	0.9*	N/A
* Standard shown is for gas boilers >30 kW output. For boilers <=30 kW output, limiting efficiency is 0.73.		

"No zones in project where local mechanical ventilation, exhaust, or terminal unit is applicable"

Shell and core configuration

Zone	Assumed shell?
GF_WC	NO
GF_WC1	NO
GF_Reception	NO
GF_Stairs	NO
GF_Meeting Room	NO
1F_Unit 3	NO
1F_Stairs	NO
1F_Circulation 2	NO
1F_WC	NO
1F_WC1	NO
1F_Unit 2	NO
GF_Unit 1	NO
GF_Circulation 2	NO
2F_WC	NO
2F_WC1	NO
2F_Circulation	NO
2F_Unit 4	NO
2F_Stairs	NO

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
GF_WC	-	70	-	41
GF_WC1	-	70	-	37
GF_Reception	-	70	-	63

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
GF_Stairs	-	70	-	34
GF_Meeting Room	70	-	-	179
1F_Unit 3	-	70	22	817
1F_Stairs	-	70	-	30
1F_Circulation 2	-	70	-	58
1F_WC	-	70	-	34
1F_WC1	-	70	-	30
1F_Unit 2	-	70	22	3838
GF_Unit 1	-	70	22	4516
GF_Circulation 2	-	70	-	142
2F_WC	-	70	-	44
2F_WC1	-	70	-	43
2F_Circulation	-	70	-	44
2F_Unit 4	-	70	22	2928
2F_Stairs	-	70	-	46

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
GF_WC	N/A	N/A
GF_WC1	N/A	N/A
GF_Reception	NO (-0.9%)	NO
GF_Stairs	N/A	N/A
GF_Meeting Room	NO (-17.2%)	NO
1F_Unit 3	NO (-20.8%)	YES
1F_Stairs	N/A	N/A
1F_Circulation 2	NO (-9.9%)	NO
1F_WC	N/A	N/A
1F_WC1	N/A	N/A
1F_Unit 2	NO (-6.6%)	YES
GF_Unit 1	NO (-2.1%)	YES
GF_Circulation 2	NO (-15%)	NO
2F_WC	N/A	N/A
2F_WC1	N/A	N/A
2F_Circulation	NO (-13.4%)	NO
2F_Unit 4	NO (-14.1%)	NO
2F_Stairs	NO (-28.2%)	NO

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

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	NO
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	NO

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m^2]	1078.9	1078.9
External area [m^2]	1777.6	1777.6
Weather	LON	LON
Infiltration [m^3/hm^2@ 50Pa]	5	3
Average conductance [W/K]	675.22	791.06
Average U-value [W/m^2K]	0.38	0.45
Alpha value* [%]	10.35	10

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
100	**A1/A2 Retail/Financial and Professional services**
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
	B1 Offices and Workshop businesses
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Inst.: Hospitals and Care Homes
	C2 Residential Inst.: Residential schools
	C2 Residential Inst.: Universities and colleges
	C2A Secure Residential Inst.
	Residential spaces
	D1 Non-residential Inst.: Community/Day Centre
	D1 Non-residential Inst.: Libraries, Museums, and Galleries
	D1 Non-residential Inst.: Education
	D1 Non-residential Inst.: Primary Health Care Building
	D1 Non-residential Inst.: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others - Stand alone utility block

Energy Consumption by End Use [kWh/m^2]

	Actual	Notional
Heating	14.35	17.89
Cooling	15.55	9.52
Auxiliary	0.06	0.06
Lighting	38.87	44.29
Hot water	1.75	1.66
Equipment*	19.25	19.25
TOTAL**	**70.56**	**73.41**

* Energy used by equipment does not count towards the total for calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m^2]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m^2]	215.53	185.36
Primary energy* [kWh/m^2]	182.68	185.07
Total emissions [kg/m^2]	31	31.5

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

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] Split or multi-split system, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity									
Actual	44.7	170.9	14.3	15.5	0.1	0.87	3.05	0.91	4.3
Notional	55.5	129.8	17.9	9.5	0.1	0.86	3.79	----	----

Key to terms

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 (for notional building, value depends on activity glazing class)
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

Key Features

The BCO can give particular attention to items with specifications that are better than typically expected.

Building fabric

Element	$U_{i\text{-}Typ}$	$U_{i\text{-}Min}$	Surface where the minimum value occurs*
Wall	0.23	0.2	GF000006:Surf[2]
Floor	0.2	0.13	GF000002:Surf[0]
Roof	0.15	0.13	1F000000:Surf[0]
Windows, roof windows, and rooflights	1.5	0.9	GF00000E:Surf[8]
Personnel doors	1.5	-	No Personnel doors in building
Vehicle access & similar large doors	1.5	-	No Vehicle access doors in building
High usage entrance doors	1.5	-	No High usage entrance doors in building

$U_{i\text{-}Typ}$ = Typical individual element U-values [W/(m²K)] $U_{i\text{-}Min}$ = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	Typical value	This building
m³/(h.m²) at 50 Pa	5	5

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name **Shell and Core**

404 Fortess Grove BE GREEN

As designed

Date: Thu Jun 11 17:58:24 2015

Administrative information

Building Details

Address: 36-52 & 20 Fortess Grove, London, NW5

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.2

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.2

BRUKL compliance check version: v5.2.b.1

Owner Details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Certifier details

Name: Xavier Valladares

Telephone number: 01245 500 566

Address: NRG Consulting, Studio 7 3rd Floor, 138-148 Cambridge, Heath Road, London, E1 5QJ

Criterion 1: The calculated CO_2 emission rate for the building should not exceed the target

1.1	CO_2 emission rate from the notional building, $kgCO_2/m^2.annum$	30.6
1.2	Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	30.6
1.3	Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	29.4
1.4	Are emissions from the building less than or equal to the target?	BER =< TER
1.5	Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and the building services should achieve reasonable overall standards of energy efficiency

Values which do not meet standards in the 2013 Non-Domestic Building Services Compliance Guide are displayed in red.

2.a Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.2	0.29	GF000007:Surf[10]
Floor	0.25	0.14	0.18	1F000000:Surf[8]
Roof	0.25	0.13	0.13	1F000000:Surf[0]
Windows***, roof windows, and rooflights	2.2	1.17	1.4	GF000006:Surf[1]
Personnel doors	2.2	-	-	No Personnel doors in building
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [$W/(m^2K)$]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [$W/(m^2K)$]
$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [$W/(m^2K)$]

* There might be more than one surface where the maximum U-value occurs.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
*** Display windows and similar glazing are excluded from the U-value check.
N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	5

2.b Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs. Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	NO
Whole building electric power factor achieved by power factor correction	>0.95

1- Split or Multi Split

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4	3.8	0	0	0.9
Standard value	2.5*	3.2	N/A	N/A	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

1- DHW

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	4	-
Standard value	1	N/A

"No zones in project where local mechanical ventilation, exhaust, or terminal unit is applicable"

Shell and core configuration

Zone	Assumed shell?
GF_WC	NO
GF_WC1	NO
GF_Reception	NO
GF_Stairs	NO
GF_Meeting Room	NO
1F_Unit 3	NO
1F_Stairs	NO
1F_Circulation 2	NO
1F_WC	NO
1F_WC1	NO
1F_Unit 2	NO
GF_Unit 1	NO
GF_Circulation 2	NO
2F_WC	NO
2F_WC1	NO
2F_Circulation	NO
2F_Unit 4	NO
2F_Stairs	NO

General lighting and display lighting

	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
GF_WC	-	70	-	41
GF_WC1	-	70	-	37
GF_Reception	-	70	-	63
GF_Stairs	-	70	-	34

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
GF_Meeting Room	70	-	-	179
1F_Unit 3	-	70	22	817
1F_Stairs	-	70	-	30
1F_Circulation 2	-	70	-	58
1F_WC	-	70	-	34
1F_WC1	-	70	-	30
1F_Unit 2	-	70	22	3838
GF_Unit 1	-	70	22	4516
GF_Circulation 2	-	70	-	142
2F_WC	-	70	-	44
2F_WC1	-	70	-	43
2F_Circulation	-	70	-	44
2F_Unit 4	-	70	22	2928
2F_Stairs	-	70	-	46

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
GF_WC	N/A	N/A
GF_WC1	N/A	N/A
GF_Reception	NO (-0.9%)	NO
GF_Stairs	N/A	N/A
GF_Meeting Room	NO (-17.2%)	NO
1F_Unit 3	NO (-20.8%)	YES
1F_Stairs	N/A	N/A
1F_Circulation 2	NO (-9.9%)	NO
1F_WC	N/A	N/A
1F_WC1	N/A	N/A
1F_Unit 2	NO (-6.6%)	YES
GF_Unit 1	NO (-2.1%)	YES
GF_Circulation 2	NO (-15%)	NO
2F_WC	N/A	N/A
2F_WC1	N/A	N/A
2F_Circulation	NO (-13.4%)	NO
2F_Unit 4	NO (-14.1%)	NO
2F_Stairs	NO (-28.2%)	NO

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

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	NO
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	NO

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m^2]	1078.9	1078.9
External area [m^2]	1777.6	1777.6
Weather	LON	LON
Infiltration [m^3/hm^2@ 50Pa]	5	3
Average conductance [W/K]	675.22	791.06
Average U-value [W/m^2K]	0.38	0.45
Alpha value* [%]	10.35	10

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
100	**A1/A2 Retail/Financial and Professional services**
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
	B1 Offices and Workshop businesses
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Inst.: Hospitals and Care Homes
	C2 Residential Inst.: Residential schools
	C2 Residential Inst.: Universities and colleges
	C2A Secure Residential Inst.
	Residential spaces
	D1 Non-residential Inst.: Community/Day Centre
	D1 Non-residential Inst.: Libraries, Museums, and Galleries
	D1 Non-residential Inst.: Education
	D1 Non-residential Inst.: Primary Health Care Building
	D1 Non-residential Inst.: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others - Stand alone utility block

Energy Consumption by End Use [kWh/m^2]

	Actual	Notional
Heating	3.27	6.03
Cooling	15.55	9.52
Auxiliary	0.06	0.06
Lighting	38.87	44.29
Hot water	0.4	0.56
Equipment*	19.25	19.25
TOTAL**	**58.13**	**60.45**

* Energy used by equipment does not count towards the total for calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m^2]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m^2]	215.53	185.36
Primary energy* [kWh/m^2]	184.98	200.67
Total emissions [kg/m^2]	29.4	30.6

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

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] Split or multi-split system, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	44.7	170.9	3.3	15.5	0.1	3.8	3.05	4	4.3
	Notional	55.5	129.8	6	9.5	0.1	2.56	3.79	----	----

Key to terms

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 (for notional building, value depends on activity glazing class)
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

Key Features

The BCO can give particular attention to items with specifications that are better than typically expected.

Building fabric

Element	$U_{i\text{-}Typ}$	$U_{i\text{-}Min}$	Surface where the minimum value occurs*
Wall	0.23	0.2	GF000006:Surf[2]
Floor	0.2	0.13	GF000002:Surf[0]
Roof	0.15	0.13	1F000000:Surf[0]
Windows, roof windows, and rooflights	1.5	0.9	GF00000E:Surf[8]
Personnel doors	1.5	-	No Personnel doors in building
Vehicle access & similar large doors	1.5	-	No Vehicle access doors in building
High usage entrance doors	1.5	-	No High usage entrance doors in building

$U_{i\text{-}Typ}$ = Typical individual element U-values [W/(m²K)] $U_{i\text{-}Min}$ = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	Typical value	This building
m³/(h.m²) at 50 Pa	5	5

Appendix 4

SUNPOWER

E20/333 and E20/327 SOLAR PANELS

20% EFFICIENCY

SunPower E20 panels are the highest efficiency panels on the market today, providing more power in the same amount of space

TRANSFORMERLESS INVERTER COMPATIBILITY

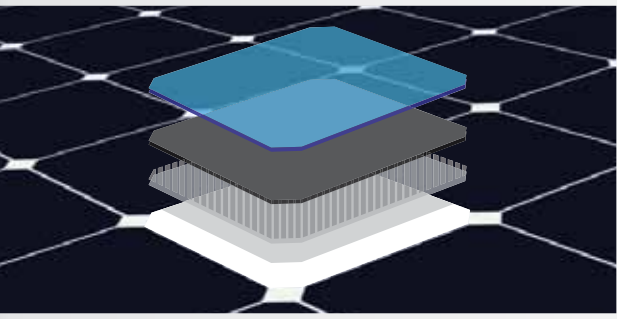
Comprehensive inverter compatibility ensures that customers can pair the highest-efficiency panels with the highest-efficiency inverters, maximizing system output

POSITIVE POWER TOLERANCE

Positive tolerance ensures customers receive the rated power or higher for every panel

RELIABLE AND ROBUST DESIGN

SunPower's unique Maxeon™ cell technology and advanced module design ensure industry-leading reliability



MAXEON™ CELL TECHNOLOGY

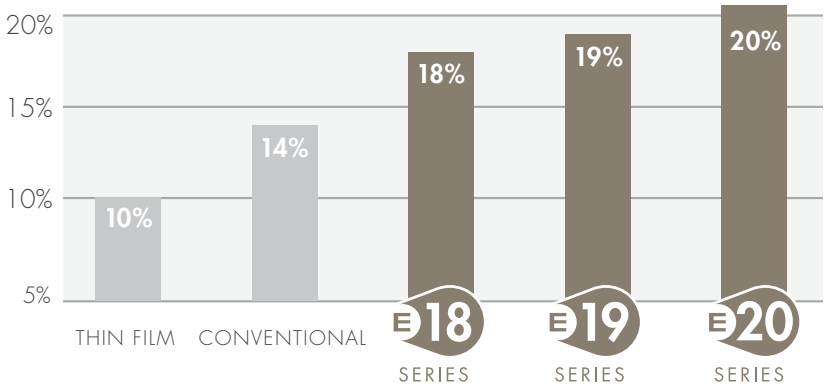
Patented all-back-contact solar cell, providing the industry's highest efficiency and reliability.

E20 SERIES

THE WORLD'S STANDARD FOR SOLAR™

SunPower™ E20 Solar Panels provide today's highest efficiency and performance. Powered by SunPower Maxeon™ cell technology, the E20 series provides panel conversion efficiencies of up to 20.4%. The E20's low voltage temperature coefficient, anti-reflective glass and exceptional low-light performance attributes provide outstanding energy delivery per peak power watt.

SUNPOWER'S HIGH EFFICIENCY ADVANTAGE



www.sunpowercorp.co.uk

SUNPOWER

E20/333 and E20/327 SOLAR PANELS

MODELS: SPR-333NE-WHT-D, SPR-327NE-WHT-D

ELECTRICAL DATA

Measured at Standard Test Conditions (STC): Irradiance 1000W/m², AM 1.5, and cell temperature 25° C

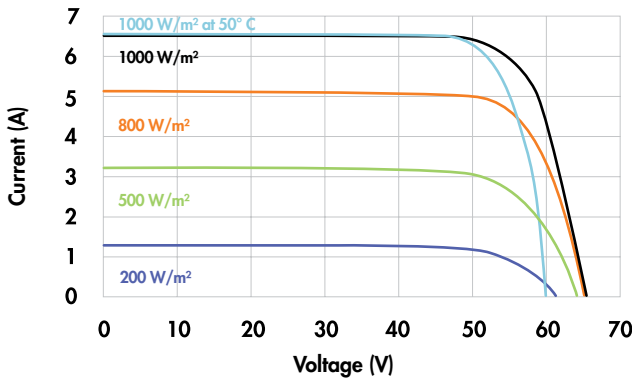
Nominal Power (+5/-0%)	P_{nom}	333 W	327 W
Cell Efficiency	η	22.9 %	22.5 %
Panel Efficiency	η	20.4 %	20.1 %
Rated Voltage	V_{mpp}	54.7 V	54.7 V
Rated Current	I_{mpp}	6.09 A	5.98 A
Open-Circuit Voltage	V_{oc}	65.3 V	64.9 V
Short-Circuit Current	I_{sc}	6.46 A	6.46 A
Maximum System Voltage	IEC	1000 V	
Temperature Coefficients	Power (P)	– 0.38 %/K	
	Voltage (V_{oc})	– 176.6 mV/K	
	Current (I_{sc})	3.5 mA /K	
NOCT		45° C +/– 2° C	
Series Fuse Rating		20 A	
Limiting Reverse Current (3 strings)	I_R	16.2 A	
Grounding		Positive grounding not required	

ELECTRICAL DATA

Measured at Nominal Operating Cell Temperature (NOCT): Irradiance 800W/m², 20° C, wind 1 m/s

Nominal Power	P_{nom}	247 W	243 W
Rated Voltage	V_{mpp}	50.4 V	50.4 V
Rated Current	I_{mpp}	4.91 A	4.82 A
Open-Circuit Voltage	V_{oc}	61.2 V	60.8 V
Short-Circuit Voltage	I_{sc}	5.22 A	5.22 A

I-V CURVE



Current/voltage characteristics with dependence on irradiance and module temperature.

TESTED OPERATING CONDITIONS

Temperature	– 40° C to +85° C
Max load	550 kg/m² (5400 Pa), front (e.g. snow) w/specified mounting configurations
	245 kg/m² (2400 Pa) front and back (e.g. wind)
Impact Resistance	Hail: 25 mm at 23 m/s

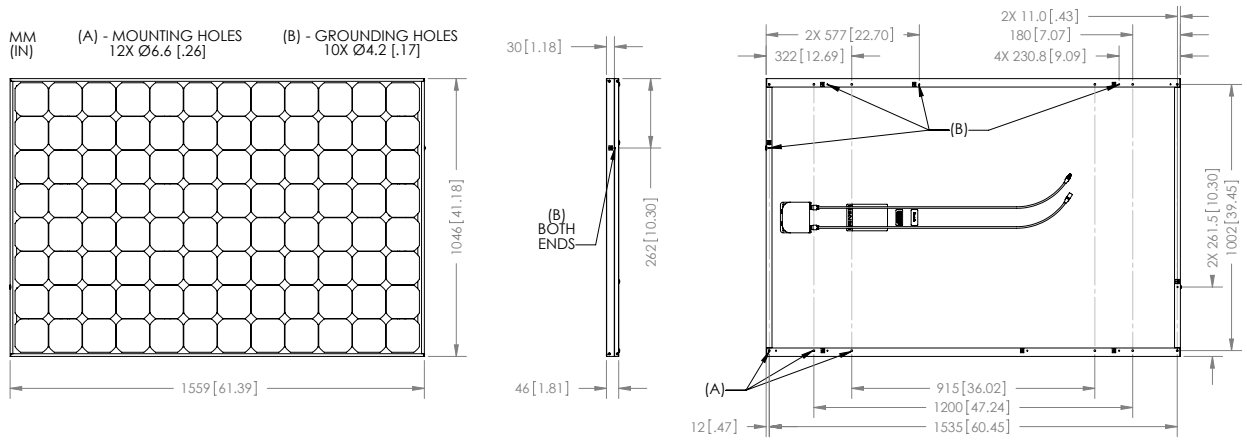
WARRANTIES AND CERTIFICATIONS

Warranties	25-year limited power warranty
	10-year limited product warranty
Certifications	IEC 61215 Ed. 2, IEC 61730 (SCII)

MECHANICAL DATA

Cells	96 SunPower Maxeon™ cells
Front Glass	High-transmission tempered glass with anti-reflective (AR) coating
Junction Box	IP-65 rated with 3 bypass diodes
	32 x 155 x 128 mm
Output Cables	1000 mm cables / Multi-Contact (MC4) connectors
Frame	Anodised aluminium alloy type 6063 (black)
Weight	18.6 kg

DIMENSIONS



Please read safety and installation instructions before using this product, visit sunpowercorp.com for more details.

sunpowercorp.com
Document #001-65483 Rev*B / A4_EN
CS 11_263

PRELIMINARY

110NO. 327W MODULES
35.97kWp

REV	DESCRIPTION	DATE

Architect:

Client: NRG CONSULTING

PROJECT: FORTESS GROVE

Title: PV SYSTEM PRELIMINARY LAYOUT

South-facing
THE PEOPLE WHO KNOW PV

The Despatch House, Noake Mill Lane, Water End
Hemel Hempstead, Hertfordshire, HP1 3BG
Tel: 01442 264514 Fax: 01442 502120
www.south-facing.co.uk

Engineer: PN
Date: 23-06-15
SCALE: NTS
Checked: RS
PM: GR
Drawn: LH

Project No: 10113

DRAWING No: PRE-01

REVISION