Building Services Design
Consulting Engineers

27th April 2017
Revision 2

Energy and Renewables Statement

For Proposed Hotel Development at

Wild Court

London

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ISSUE & REVISION RECORD

Issue	Document prepared			Document checked		
	Name	Signature	Date	Name	Signature	Date
0	Aleksander Krawczyk	Aleksander Krawczyk	26/01/17	Eoin Hickey	Eoin Hickey	27/01/17
1*	Aleksander Krawczyk	Aleksander Krawczyk	03/03/17	Eoin Hickey	Eoin Hickey	10/03/17
2**	Aleksander Krawczyk	Aleksander Krawczyk	27/04/17	Eoin Hickey	Eoin Hickey	27/04/17

* Revised to updated architectural layouts
** Revised to Sustainability Officer's comments (changes/responses highlighted in yellow)

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EXECUTIVE SUMMARY

Building Services Design has carried out an assessment of the low carbon and renewable energy solutions for proposed hotel development at Wild Court in London.

This report demonstrates compliance with the building regulations and local planning conditions.

The existing site comprises of an eight-storey building located on Wild Court. The building is currently in D1 planning category use (Non-residential institution) and is occupied by the Kensington School of Business / Kensington College of Business (KCB) with an internal café area and an area of vacant B1 office space at 1st floor level.

It is proposed to convert the site into a hotel. The proposed hotel will comprise 216 bedrooms and will incorporate ancillary facilities including a small coffee shop. No other facilities such as a spa/gym, meeting rooms or a restaurant/bar are proposed. All bedrooms will include ensuite bathrooms, comfort cooling and other bedroom amenities.

The assessment has been carried out using approved energy modelling software. The energy model provides the energy usage and CO2 emissions for heating, ventilation, cooling, hot water and lighting within the building.

Although the development is a refurbishment and change of use, it has been assessed against a baseline Target Emission Rate calculated for a notional building under Building Regulations Part L2A for new non-domestic buildings.

By adopting the Be Lean, Be Clean and Be Green Strategies the overall energy use and CO2 emissions of the proposed development will be designed to emit far less CO2 than the existing building and to comply with current building regulation and local planning standards.

Firstly, under Be Lean strategy the existing building envelope fabric will be significantly improved. The proposed new development will incorporate the mechanical and electrical elements that are extremely energy efficient. These will include:

- Low energy LED lighting utilized throughout
- Intelligent lighting control (utilizing absence detection, presence detection and daylight controls)
- VRV/VRF Heat recovery (air source heat pumps regarded as renewable energy source) to heat and cool the building.
- Low energy EC fan motors on FCUs
- Variable speed drive fans on the main ventilation plant so that the fresh air ventilation ramps up and down to meet the building occupancy load.
- Variable speed drive controls on all heating pumps so that the pumps ramp up and down speed to meet the building heat load.
- BMS which monitors all energy usage within the building and warns of our of range energy usage.

Under Be Clean strategy a CHP (combine heat and power) solution has been proposed as the most suitable for the site low carbon technology. A CHP unit will be provided to heat to cater for the bulk of the hot water generation load – 65% of the building demand.

Finally, a range of renewable energy and low carbon technologies have been considered for the proposed development. Photovoltaics cells (PV) have been considered as a renewable energy technology and adopted under Be Green strategy to provide additional carbon offset required to comply with London Plan. 90 m2 of PV cells will be incorporated into the scheme.

To summarize, by adopting best practice, following the energy hierarchy of the London Plan and observing the London Borough of Camden Sustainability (CPG 3) Planning Guidance document, a significant carbon reduction has been achieved through sustainable technologies at the site. The table below and figure overleaf summarizes the carbon emissions and savings calculated for the proposed solution. It demonstrates **overall improvement of 35.5% over required by building regulation 2013 emissions, which equates to a saving of 109,300 kg of CO2 per annum**.

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

	Carbon dioxide emissions (Tonnes CO2 per annum)	
	Regulated	Unregulated
Baseline: Building Regulations 2013 Part L Compliant Development	312.3	35.6
After Energy demand reduction	281.4	35.6
After CHP	204.2	35.6
After Renewable	201.4	35.6

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

	Regulated Carbon Dioxide Savings	
	(Tonnes CO2 per annum)	(%)
Savings from energy demand reduction	31.0	9.91%
Savings from CHP	77.2	27.42%
Savings from renewable	3.2	1.36%
Total Cumulative Savings	110.9	35.50%
Total Target Savings	109.3	35%
Annual Surplus	1.6	-

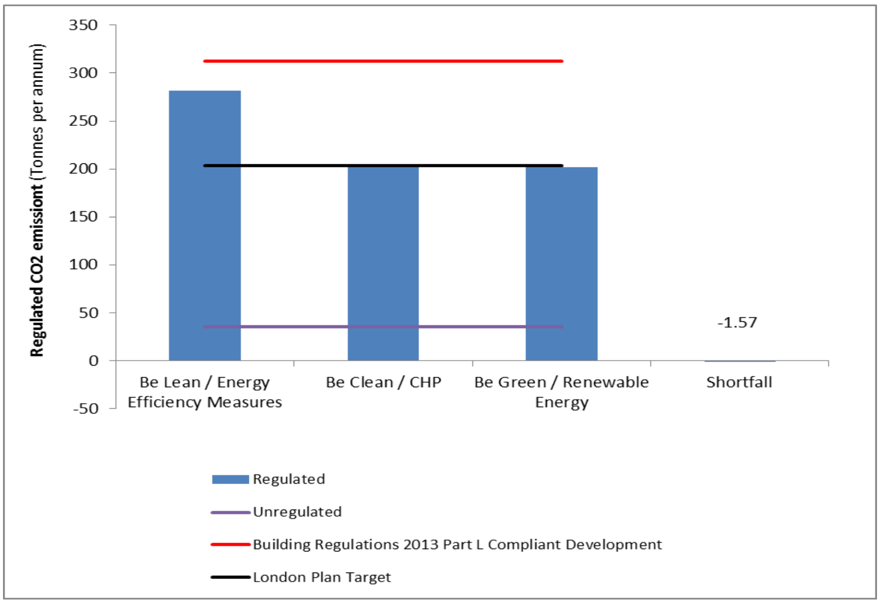


Figure 1. The Energy Hierarchy; CO2 emissions in tonnes per annum

1.0 INTRODUCTION

BSD have been employed by Z Hotel to carry out an energy and renewables report for the proposed hotel development at Wild Court, London.

It is proposed to convert the site (eight-storey building located on Wild Court) into a hotel. The proposed hotel will comprise 216 bedrooms and will incorporate ancillary facilities including a small coffee shop. No other facilities such as a spa/gym, meeting rooms or a restaurant/bar are proposed. All bedrooms will include ensuite bathrooms, comfort cooling and other bedroom amenities.

The building gross total floor area is approx. 4,620m^2.

The purpose of this report is to look at the most appropriate renewable / low /zero carbon energy source to serve the proposed redevelopment and outline the most suitable in line with the policies of the London Borough of Camden and the Greater London Authority, for the proposed hotel development.

In line with Energy Planning, Greater London Authority guidance on preparing energy assessments (March 2016) each application is considered on its merits, taking into account the individual characteristics of the development, energy assessments must:

i. be submitted at the planning application stage, not submitted post planning in response to a condition
ii. commit to reducing regulated CO2 emissions below those of a Part L 2013 of the Building Regulations compliant development through energy efficiency measures alone
iii. include information demonstrating that the risk of overheating has been mitigated through the incorporation of passive design measures
iv. demonstrate that connection to existing or planned district heating networks has been prioritised and provide correspondence to support this
v. commit to a site wide heat network to allow connection to existing or planned district heating networks identified in the area
vi. commit to a single energy centre to supply the site wide heat network
vii. where CHP is applicable, select renewable technologies that are complementary with the optimal operation of the CHP.

For the period 2016 to 2019, London Plan policy 5.2B sets the carbon dioxide emissions target for non-residential development to be in line with Part L of the Building Regulations. This target was intended to align with the then expected improvement to Part L of the Building Regulations. However, as stated above, the Government announced (in July 2015) that it does not intend to proceed with the proposed 2016 increase in on-site energy efficiency standards, but will keep energy efficiency standards under review.

Energy Planning, Greater London Authority guidance on preparing energy assessments (March 2016):

> For applications received by the Mayor on or after 1st October 2016 the regulated carbon dioxide emissions reduction target for domestic development is zero carbon and 35 per cent beyond Part L 2013 of the Building Regulations for non-domestic development.

This report presents the findings of a preliminary energy demand and carbon reduction assessment for the proposed development. A number of fabric improvements, energy efficiency measures, low carbon and renewable energy technologies are explored by which the carbon footprint could be most significantly reduced from that incurred by the building designed simply to be compliant with current building regulations

Camden Planning Guidance Sustainability CPG 3 issued by London Borough of Camden (July 2015) advises as follows:

> An energy statement is to set out how a development has been designed to follow the steps in the energy hierarchy. It should demonstrate how the proposed measures are appropriate and viable to the context of the development.
> **Baseline energy demand and carbon dioxide emissions**
> Calculate the baseline energy demand of the development and the corresponding carbon dioxide emissions arising from the development. You should clearly show the methodology used.
> **Reduce the demand for energy**
> Describe the design measures which are proposed to maximise the energy efficiency of the development.
> Supply energy efficiently
> Describe how your development has considered further reducing carbon dioxide emissions by sourcing energy efficiently e.g. through the use of decentralized energy, such as combined heat and power systems.
> **Use renewable energy**
> Describe how your development has considered using renewable energy technologies to further reduce carbon dioxide emissions.
> Calculate the remaining energy use and the corresponding carbon emissions from the development having applied all three stages of the energy hierarchy.

The following, similar strategy and hierarchy has been used to structure our approach to energy at the Wild Court, which is set out in accordance with Policy 5.2 of the London Plan. The requirements of policy are summarised below:

1. BASELINE. Calculate baseline energy demand & carbon dioxide emissions. The energy assessment shall include a 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 equipment, that are not covered by the Building Regulations (i.e small power loads, cooking loads etc.
2. BE LEAN. Reduce Carbon Dioxide emissions through energy efficient design of site, building and services.
3. BE CLEAN. Reduce Carbon Dioxide emissions through the use of decentralised energy such as CHP where feasible.
4. BE GREEN. Reduce Carbon Dioxide emissions through the use of Low zero carbon technologies.

In addition to the London Plan local policy (Camden Planning Guidance Sustainability) requires that:

> Developments are to target a 20% reduction in carbon dioxide emissions from on-site renewable energy technologies.
> (..)
> Where feasible and viable your development will be required to connect to a decentralized energy network or include CHP.

2.0 ENERGY DEMAND ASSESSMENT

The development has been modeled in Bentley HevaComp V8i software. Energy demand and CO2 emissions have been assessed in HevaComp using approved energy assessment software SBEM v5.5.d.2 Part L2A.

The energy hierarchy considered whilst making emission reductions to the proposed scheme has been applied in the following sequence:

BASELINE – Building Regulations Part L2A 2013 minimum emissions target
BE LEAN – Reduction in energy use
BE CLEAN – Supplying energy efficiently
BE GREEN – Use of renewable energy

2.1 BASELINE (Building Regulations minimum)

Based on the energy calculations, the base case scenario for development is estimated at 312.3 tonnes of CO2 per annum. This equates to 67.6 kgCO2/m2 assessed under PartL 2A Target Emissions Rate (TER) calculation for a Notional Building.

It shall be noted that the baseline for this assessment is calculated as for a new building, rather than existing. This method makes the assessment more transparent, but is quite challenging due to constrain of existing building envelope.

2.2 BE LEAN (Reduction in energy use)

By incorporating energy efficient strategies described below, the entire development will meet the performance required by a Part L2A building regulations for new buildings.

This is due to extensive improvement of the building fabric which has very poor U-values when compared with today's standards. It is not feasible to get an existing building with poor thermal elements to achieve the thermal u-values stipulated in the current building regulations. It is therefore proposed to dramatically improve the buildings fabric to as close as practical to current building regulations minimum standards. In some instances these improvements achieve better than current building regulations minimum standards.

The following low energy design principles will be utilized in the building's refurbishment and the development will incorporate at least the following energy efficiency measures:

- Existing walls U-value will be improved to 0.32 W/m2K by the addition of polyurethane foam boards on the inside of the existing façade.
- The existing roof fabric is to be improved to 0.15 u value by the addition of insulation to the underside of the existing roof.
- Existing windows will be partially replaced with very efficient ones to achieve overall U-value across the building of 1.8 W/m2K.
- Low U-Value walls & roof (to all new elements). New roofs shall have U-Values of 0.15 W/m2K.

- Improving air-tightness beyond minimum standards to all areas. The building shall achieve an air permeability of 5.0 m3/h/m2 at 50 Pa or better upon completion of the works.
- Low energy lighting. 100% of all lighting shall be low energy lighting such as metal halide and high efficient LED lighting to minimize emissions.
- Automatic lighting control and daylight dimming. All circulation areas and public areas shall be fitted with microwave presence detectors and daylight sensors to minimize lighting use when not required. Every room shall be fitted with a room card holder which shall turn off all small power and lighting within the room 30 sec after the room card is removed from the card holder.
- High efficiency Heat recovery VRF/VRV air source heat pump systems are planned to heat and cool the hotel.
- Low energy fan coil motors will be provided.
- Demand control fresh air ventilation to all bedrooms. This will consist of a shut off damper on the supply to every room which shall shut of the fresh air to the room when it is not occupied. The supply fan shall be fitted with variable speed drive motors and sensors and shall speed up / slow down to match the occupancy. This considerably reducing the amount of air that needs to be heated / cooled as it enter the building.

Based on the energy calculations, CO2 emissions have been estimated for development under Be Lean scenario at 281.4 tonnes of CO2 per annum providing 9.91% savings over minimum standard required by building regulations for new buildings. This equates to 60.9 kgCO2/m2 assessed under PartL 2A Building Emissions Rate (BER) calculation for an actual building (as designed).

A review of the energy demand for the building revealed that due to the fabric improvements the heating and cooling loads had been significantly reduced. The use of air source heating through VRF/VRV enables seasonal efficiencies of extremely high figures to be attained which means the heating system produces significantly less CO2 (2.3 times less CO2 per kWh) than even modern condensing boilers. In addition to this VRF / VRV is one of the most efficient comfort cooling systems on the marketplace at the moment, and has seasonal efficiencies (6.75) far greater than standard water cooled chillers which are generally between 2.7 and 3.5.

These systems are also able to utilized heat recovery technology. So for instance if one façade of a building (north) required heating whilst the south façade required cooling then the heat can be moved from one façade to the other without having to utilize compressor power or being discharged to atmosphere and wasted. This ability to utilized heat recover enable even much greater saving to be achieved during spring and autumn times of the year.

Incorporation of these heat pump VRV units under the “be lean” strategy in the hierarchy means substantial energy reductions are possible over conventional chillers and boiler.

Air source heat pumps are regarded by Camden Planning Guidance on Sustainability as a renewable source of energy and therefore contribute greatly towards the policy target of a 20% reduction in carbon dioxide emissions from on-site renewable energy technologies. Being energy efficient renewable source and providing most of the building space heat and the whole cooling demand, in accordance with energy hierarchy, this system had to be incorporated under Be Lean strategy rather than Be green.

2.3 BE CLEAN (Supplying energy efficiently)

In addition to the London Plan local policy (Camden Planning Guidance Sustainability) requires that where feasible and viable development will be required to connect to a decentralized energy network or include CHP.

The London Plan requires that proposals for further reduce of carbon dioxide emissions shall be considered. Further reductions can be achieved by through the use of decentralised energy where feasible, such as district heating and cooling and combined heat and power (CHP).

The London Heat Map is an interactive tool that allows users to identify opportunities for decentralised energy projects in London. The map has been checked and it revealed that there are no existing decentralised energy networks in vicinity of the site and therefore there is no opportunity to connect to one.

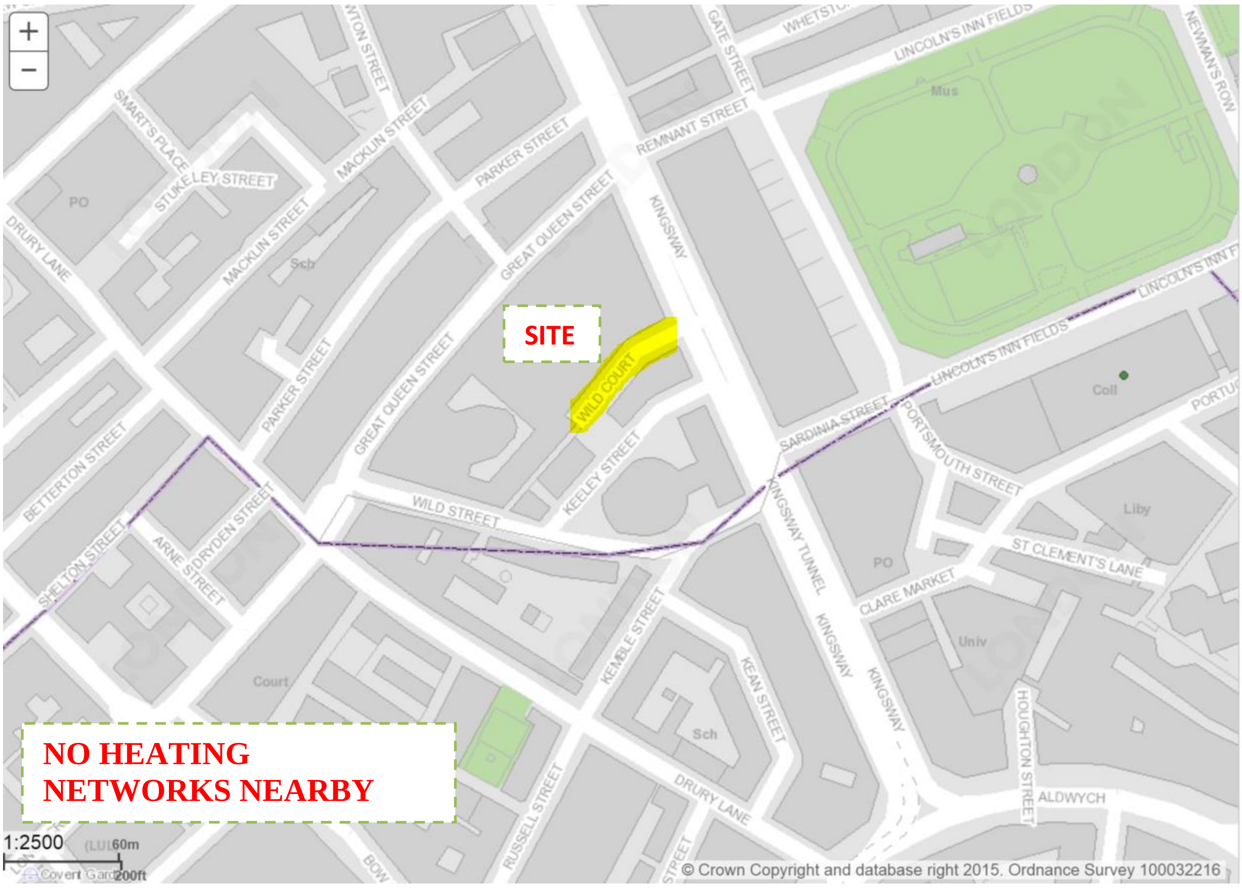


Image show no heating network in the vicinity of the site.

Combined Heat and Power (CHP) technology is the simultaneous generation of usable heat and power (usually electricity) in a single process. The heat and power generation is achieved by burning the fossil fuels, usually natural gas.

A review of the heating demand for the site revealed that the heating load of the site is well suited for the incorporation of CHP due to the large amounts of HWS generation which will give an all year round heat load. It is proposed to utilise the CHP for the entire building resulting in a considerable reductions in CO_2 emissions across the site.

The CHP plant shall be sized so that 65% of the hot waters annual load is carried out by the CHP plant. In order to achieve such high usage figure for the CHP we have selected two smaller machines which will enable the CHP installation to modulate better with the building load.

Detailed calculation were undertaken to ensure good annual usage of the CHP machines could be achieve.

Based on the energy calculations, Be Clean CO_2 emissions for development are estimated at 204.2 tonnes of CO_2 per annum providing further 27.42% savings over emissions calculated under Be Lean strategy. This equates to 44.2 $kgCO_2/m^2$ assessed under PartL 2A Building Emissions Rate (BER) calculation for an actual building (as designed).

2.4 BE GREEN (Use renewable energy)

A range of renewable energy and low carbon technologies have been considered for the proposed development and their feasibility has been considered in line with London plan policy 5.7 for renewable energy which states:-

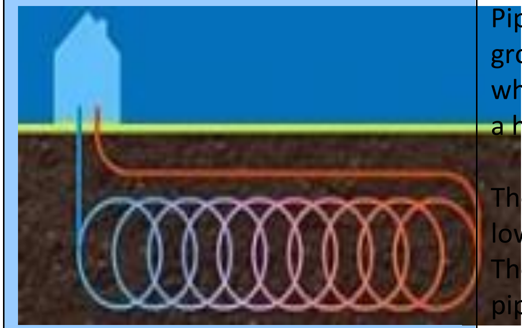
"Within the framework of the energy hierarchy (see Policy 5.2), major development proposals should provide a reduction in expected carbon dioxide emissions through the use of on-site renewable energy generation, where feasible."

Table below presents a summary of the technologies considered. It is clear that some are not well suited for the development.

Table appraisal of renewable technologies options

TECHNOLOGY	COMMENTS
 **WIND TURBINES**	Micro wind turbines can be fitted to the roof of a building. This technology is not considered suitable due to the relatively low (and turbulent) wind speed prevailing in an urban areas such as Camden. A report by Building Research Establishment highlighted inherent problems and the poor performance to date of urban micro wind installations. Turbines can also generate a reasonably high degree of noise during their operation. This noise could create nuisance to the surrounding neighbours. Whilst turbines give a strong visual representation of renewable energy, it would significantly detract from the visual amenity of the area, this combined with their insignificant output in this location means that this technology will not be considered further for this redevelopment. **No Viability - Not Suitable**

 **BIOMASS HEATING**	The combustion of wood chip or pellets creates heat for space heating and hot water loads. However, in a city centre location, access for biomass delivery lorries is very difficult and allocating adequate storage space is a major issue. Typically a biomass boiler would need a huge space be set aside as fuel store which take up most of the basement area. Emissions are also tightly regulated (clean air act) in this part of the city which precludes the use of biomass. For the above reason we believe this option is not suitable. **Low Viability**
 **PHOTO VOLTAIC CELLS**	Photovoltaic (PV) Cell technology involves the conversion of the sun's energy into electricity. The roof of the building is large enough to accommodate a small amount of PV panels. The incorporation of PV is definitely viable and would make an excellent choice of renewable however PV alone would fall far short of the required CO2 savings and will need to be utilized in conjunction with Low carbon technologies such as CHP and air source heat pumps. However whatever amount of PV which can sensibly be incorporate onto the roof should be included. **Good Viability - Suitable**
 **SOLAR THERMAL – HOT WATER**	Solar Thermal panels could be utilized to generate a small proportion of the buildings energy. However solar thermal panels utilize their energy to generate hot water and would compete for heat with CHP. CHP is a much better option as it will provide heat all year round and also during the night. Furthermore since PV is proposed these technologies would compete for available roof space and PV represents a better option since it will not compete with the CHP plant. It is for these reasons we believe solar thermal is not suitable. **No Viability - Not Suitable**



GROUND SOURCE HEAT PUMPS

GSHP technologies exploit seasonal temperature differences between ground and air temperatures. Pipe work is placed either horizontally or vertically in the ground. Fluid pumped through the pipes takes up heat which is then extracted by the heat pump and released at a higher temperature to drive a space heating system.

The basement area slab is not being disturbed and the lower floors of the building are generally being retained. Therefore there will be no way to physically provide a pipework array in the ground under the building.

It is for the above reason that we believe this form of renewable technology is unsuitable for incorporation into the scheme.

No Viability - Not Suitable

Energy usage has been further reduced by the incorporation of the Photo Voltaics (90m² High efficiency PV panels has been incorporated into the scheme) as a renewable technology under be Green.

The image below show proposed PV installation, which is all that the existing roof area can accommodate while still facilitating maintenance access to the roof and around the panels.

Image above indicates the proposed location for the new PV panels at 8th and 9th floors

Based on the energy calculations, Be Green CO2 emissions for development are estimated at 201.4 tonnes of CO2 per annum providing further 1.36% savings over emissions calculated under Be Clean strategy. This equates to 43.6 kgCO2/m2 assessed under PartL 2A Building Emissions Rate (BER) calculation for an actual building (as designed) and 35.50% savings over minimum standard required by building regulations for new buildings.

3.0 SUMMARY

Building Services Design has carried out an assessment of the low carbon and renewable technology options. The energy hierarchy, advising to be lean, be clean and then be green, has been used as a guiding principle in selecting the most appropriate technology.

The proposed option incorporates energy efficiency measures – improved fabric and glazing, efficient lighting, low carbon energy technologies (CHP) and renewable energy sources (air source heat pump and PV panels).

The tables and figure below indicates the carbon savings achievable through this preferred solution.

This report has used best practice principles to create a sustainable energy solution, saving 35.6% total CO_2 over Building Regulations 2013 for the development and demonstrating compliance with local planning requirements.

Proposed development will not create a shortfall that would need to be compensated by developer.

Table 3.1 Building Emissions Summary

	TER (kgCO_2)/m²	BER (kgCO_2)/m²	Total Target Emissions (kgCO_2)	Total Actual Building Emissions (kgCO_2)	Total CO_2 Saving (kgCO_2)	Total % CO_2 Saving
Total Development	67.6	43.6	312,312	201,432	110,880	35.50

Table 3.2: Carbon Dioxide Emissions after each stage of the Energy Hierarchy

	Carbon dioxide emissions (Tonnes CO2 per annum)	
	Regulated	Unregulated
Baseline: Building Regulations 2013 Part L Compliant Development	312.3	35.6
After Energy demand reduction	281.4	35.6
After CHP	204.2	35.6
After Renewable	201.4	35.6

Table 3.3: Carbon Dioxide savings from each stage of the Energy Hierarchy

	Regulated Carbon Dioxide Savings	
	(Tonnes CO2 per annum)	(%)
Savings from energy demand reduction	31.0	9.91%
Savings from CHP	77.2	27.42%
Savings from renewable	3.2	1.36%
Total Cumulative Savings	110.9	35.50%
Total Target Savings	109.3	35%
Annual Surplus	2.0	-

Table 3.3: Shortfall in regulated carbon dioxide savings

	Annual Shortfall (Tonnes CO2)	Cumulative Shortfall (Tonnes CO2)
Shortfall	-1.57	-47.12

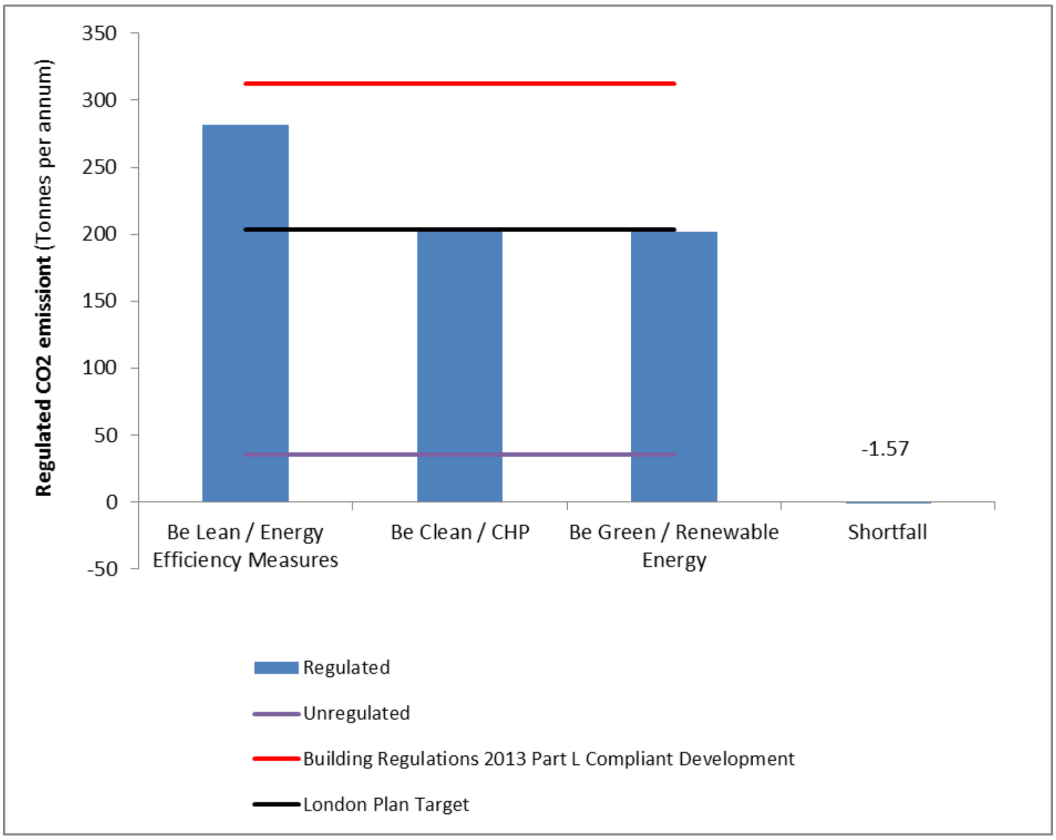


Figure 3.1. The Energy Hierarchy; CO2 emissions in tonnes per annum

APPENDIX 1 ENERGY CALCULATIONS (BE GREEN BRUKL REPORT)

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

Wild Court - Z Hotel

As designed

Date: Fri Mar 10 12:04:03 2017

Administrative information

Building Details

Address: ,

Certification tool

Calculation engine: SBEM

Calculation engine version: v5.2.d.2

Interface to calculation engine: Design Database

Interface to calculation engine version: v26.05

BRUKL compliance check version: v5.2.d.2

Owner 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: Building Services Design

Telephone number: 02073779007

Address: 87A Worship Street, London, EC2A 2BE

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

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	67.6
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	67.6
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	43.6
Are emissions from the building less than or equal to the target?	BER =< TER
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 not achieving standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.32	0.35	01.27 Wall 1
Floor	0.25	0.2	0.2	GF.22 Exposed Floor 1
Roof	0.25	0.15	0.15	01.27 Exposed Roof 1
Windows***, roof windows, and rooflights	2.2	1.71	2.19	REC.UG.01 Door 1
Personnel doors	2.2	-	-	"No external personnel doors"
Vehicle access & similar large doors	1.5	-	-	"No external vehicle access doors"
High usage entrance doors	3.5	-	-	"No external high usage entrance doors"

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

* 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
m³/(h.m²) at 50 Pa	10	5

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	4619.9	4619.9
External area [m²]	3452.6	3452.6
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	5	3
Average conductance [W/K]	1566.73	2255.61
Average U-value [W/m²K]	0.45	0.65
Alpha value* [%]	19.98	17.8

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

Building Use

% Area	Building Type
	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
100	**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/m²]

	Actual	Notional
Heating	1.6	5.26
Cooling	4.13	5.38
Auxiliary	21.11	24.26
Lighting	13.86	16.65
Hot water	270.76	192.04
Equipment*	14.47	14.47
TOTAL**	**244.28**	**243.58**

* 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/m²]

	Actual	Notional
Photovoltaic systems	1.19	0
Wind turbines	0	0
CHP generators	67.19	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	201.72	205.41
Primary energy* [kWh/m²]	245.89	388.58
Total emissions [kg/m²]	43.6	67.6

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

APPENDIX 3 CHP SELECTION, DETAILS AND CALCULATIONS

According to CIBSE AM12: 2013 (Combined heat and power for buildings) CHP hotels are 'buildings that have historically proved suitable' for Hotel applications due to 'long operating hours, need to maintain customer comfort (…) and high demand for domestic hot water'.

CIBSE advises further that 'In general it is better to undersize CHP than oversize, as heat demands are often overestimated and can reduce over time as a result of energy efficiency improvements.'

Estimated for the development annual and peak energy demands for heating, hot water and electricity are shown in the table below:

	Heating Demand		Hot Water Demand		Electricity Demand (incl. Unregulated)	
	kWh/year	kWt	kWh/year	kWt	kWh/year	kWe
Jan	1441	141	106219	622	18914	92
Feb	1219	119	95940	622	17084	92
Mar	1035	102	106219	622	18914	88
Apr	554	54	102792	622	18304	83
May	185	18	102792	622	20338	79
Jun	37	7	106219	622	25219	74
Jul	0	0	106219	622	26269	79
Aug	0	0	106219	622	26269	79
Sept	111	10	102792	622	20338	83
Oct	406	43	106219	622	18914	83
Nov	961	93	102792	622	18304	88
Dec	1441	141	106219	622	18914	92
Total/Peak	**7390**	**141**	**1250640**	**622**	**247440**	**92**

As per table above estimated for the site heat peak load demand is 763kWt. Electricity base load shall be no less than 20% of estimated above peak of 92 kWe. It is proposed to size the CHP to be capable of providing an electrical base load at minimum load and approx. 15% of peak heat demand.

It is proposed to provide two ENER-G E35M units to deliver up to 70kWe (electrically) and 124kWt (thermally). Each unit can modulate down to 50% providing wide range of demands they can cover.

CHP details and estimates (based on two ENER-G E35M units or equivalent):

Thermal output	124	kWth
Electric output	70	kWe
Fuel input	250	kWg (natural gas)
Thermal efficiency	54.9	%
Electrical efficiency	30.9	%
Total efficiency	85.8	%
Heat generated	814,680	kWh (unit running 18h/day)
Heat generated	65	% of annual hot water demand

Heat generated	16	% of site peak demand
Electricity generated	459,900	kWh (unit running 18h/day)
Electricity generated	186	% of annual electricity demand (see paragraph below)
Electricity generated	76	% of site peak demand
Thermal storage	1000	Litres (1.0 m3)
Boilers	750	kW

Technical Datasheet

E35M (Low NOx) Natural Gas CHP Unit

ENER-G

Energy Balance and Load Data at Power Factor 1		Units	100%	75%	50%
Electrical Output	(+/-3%)	kW	35	26	17
Electrical Efficiency (Net)	(+/-5%)	%	30.9%	27.6%	22.6%
Heat Output	(+/-10%)	kW	62	53	44
Thermal Efficiency (Net)	(+/-8%)	%	54.9%	56.2%	58.1%
Fuel Input (Net / Gross)*	(+/-5%)	kW	113 / 125	95 / 105	77 / 86
Total Efficiency (Net)	(+/-8%)	%	85.8%	83.9%	80.7%
Heat Output from Jacket Water	(+/-8%)	kW	39	35	31
Heat Output from Exhaust Gas @ Outlet Temp.	(+/-8%)	kW	22	17	13
Aftercooler Heat Output	(+/-8%)	kW	N/A	N/A	N/A
Radiated Heat Output	(+/-8%)	kW	8	6	4
Combustion Air Flow (30 C, 100 kPa, 30% RH)	(+/-5%)	m^3/h	119	100	82
Fuel Mass Flow (ρ = 0.75kg/Nm³)	(+/-5%)	kg/h	8.5	7.1	5.8
Fuel Volume Flow (LHV = 10kWh/Nm³)	(+/-5%)	Nm3/h	11.3	9.5	7.7
Exhaust Mass Flow (Wet)	(+/-5%)	kg/h	148	124	101
Exhaust Volume Flow @ Outlet Temp.	(+/-5%)	m^3/h	164	138	112

*Natural gas Net and Gross fuel input figures are based on 36MJ/Nm3 and 39.8MJ/Nm3 respectively. The Gross figure is used when establishing UK fuel costs. Net figures are provided for ease of performance comparison with other technologies.

Engine Details

Manufacturer		MAN
Model		E 0834 E 302
Fuel Type		Natural Gas
Min. Methane Number		80
Cylinders		4
Aspiration		Natural
Speed	rpm	1500
Aftercooler		No

Hot Water Details

Max. Water In/Out Temp.	°C	80/90°C
Max. Water Flow Rate*	l/s	1.53
Max. Glycol Content	%	30
Connection Size	mm	50
Flange Type		PN16
Pressure Loss**	kPa	4.66
Max. Test Pressure	Bar	9.75

* Assuming Cp = 4.2 kJ/kg·K and ρ = 968.55 kg/m³

** Pressure loss figures stated are at max. water flow rate. Internal unit only.

Exhaust Details

Connection Size	mm	100
Flange Type		PN6
Outlet Temp.	°C	120
Allowable Backpressure	Pa	1810
Allowable Backpressure with Catalyst	Pa	910

Ventilation Details

Connection Size	mm	500
Ventilation Rate***	m^3/s	0.79
Max. Air Inlet Temp.	°C	30
Max. Air Outlet Temp.	°C	45
Enclosure Pressure Drop	Pa	25

*** Vent rate is stated at max. air outlet temp, 100kPa

Generator Details

Manufacturer		Stamford
Model		UCI224G-311
Type		Synchronous
Rating	kVA	85
Voltage	V	400
Phase	Ph	3
Frequency	Hz	50
Protection Class		IP23
Rated Power Factor	PF	0.8
Xd Dir. Axis Synchronous		2.2
X'd Dir. Axis Transient		0.17
X"d Dir. Axis Sub-Transient		0.12
T" Sub-Transient Time Const.		0.008
T'do O.C Field Time Const.		0.75
CHP Protection Device	A/Ph	80
Indicative Client Protection Device	A/Ph	80 (Adjustable)
Current Per Phase @ 0.8PF	A	63
Current Per Phase @ 0.95PF	A	53
Efficiency @ 0.8PF	%	91.3%
Efficiency @ 0.95PF	%	92.8%
Indicative Main Cable Size [a] †	mm^2	TBC
Indicative Earth Cable Size [b] †	mm^2	TBC

[a] 4-Core XLPE/SWA/PVC to BS5467, Max 50 meters.

[b] 1-Core 6491B to BS7211, Max 50 meters.

† Sizes and lengths based on IET 17TH Edition BS7671, Installation method 31.

Fuel Details

Connection Size	mm	40
Flange Type		PN16
Min/Max. Supply Pressure	mbar	20/45

Emissions @ 5% O2

NOx	mg/Nm^3	6500
CO	mg/Nm^3	6500
NOx (With Catalyst)	mg/Nm^3	50
CO (With Catalyst)	mg/Nm^3	150

Weight Details

Enclosure (Dry)	STD/PREM.	See Sales Drawing
Container (Dry)	STD/PREM.	See Sales Drawing

Noise Data

Enclosure SPL @ 1m	SN/LN	dB(A)	70/65
Container SPL @ 1m	SN/LN	dB(A)	75/65

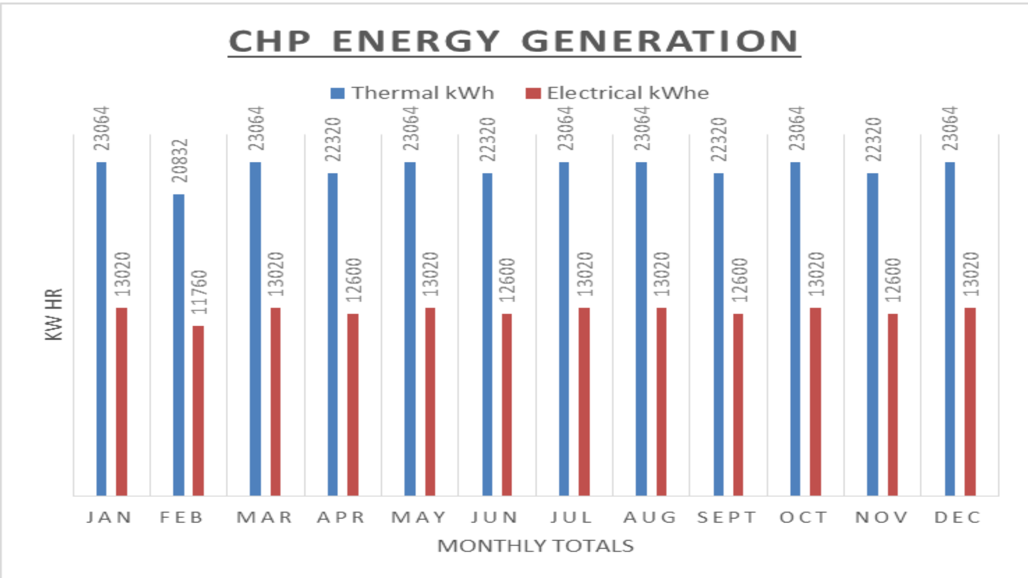
NB: Output figures are based on operation at ISO 3046 conditions with the exception of exhaust output, which is quoted to 120°C, figures are stated from manufacturer's declared performance figures subject to the manufacturer's tolerances and subject to change without notice. Values for de-rated units are estimates only. Energy balance data assumes perfect combustion. All information detailed is for guidance only and is subject to change without notice due to our commitment to continuous improvement - all values should be confirmed with ENER-G Combined Power Ltd on a project specific basis.

Calculated for units running for 18h/day electricity generation exceeds the site requirements. Calculated by SBEM and demonstrated in this report savings from CHP are 77,200 kgCO2. Selected CHP requires to run on average 6h per day in order to achieve this as demonstrated in table below:

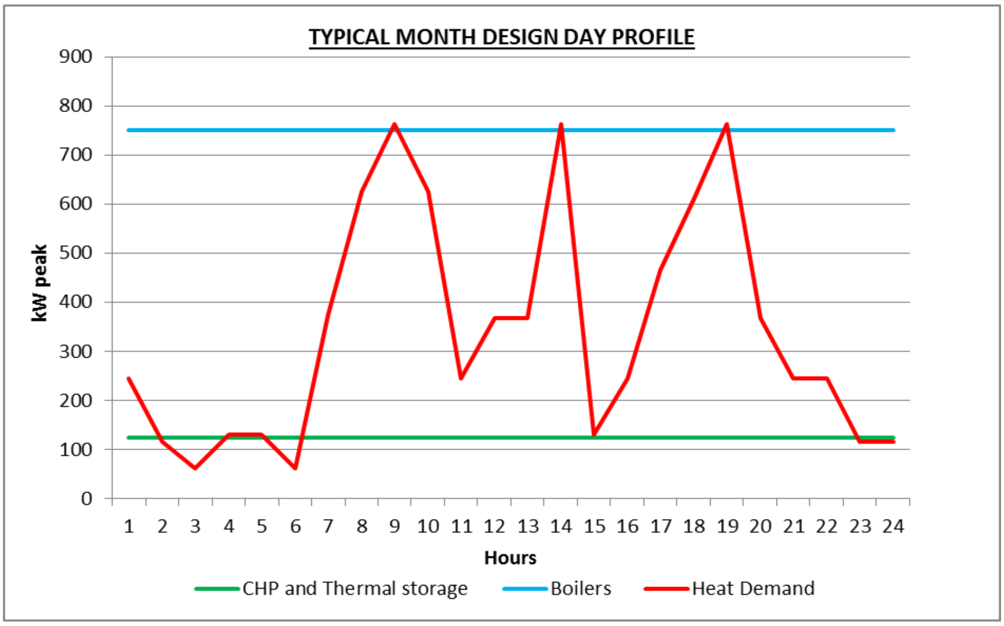
Month	Typical Daily Running Time (hrs)	Thermal Energy (kWth)	Elec Energy (kWe)	Fuel Input (kWg)	Monthly Total (kWth)	Monthly Total (kWhe)	Monthly Fuel Total (kWhg)	Total CHP running time (hrs)	CO2 saving (kg)
Jan	6	124	70	250	23064	13020	46500	186	7284
Feb	6	124	70	250	20832	11760	42000	168	6579
Mar	6	124	70	250	23064	13020	46500	186	7284
Apr	6	124	70	250	22320	12600	45000	180	7049
May	6	124	70	250	23064	13020	46500	186	7284
Jun	6	124	70	250	22320	12600	45000	180	7049
Jul	6	124	70	250	23064	13020	46500	186	7284
Aug	6	124	70	250	23064	13020	46500	186	7284
Sept	6	124	70	250	22320	12600	45000	180	7049
Oct	6	124	70	250	23064	13020	46500	186	7284
Nov	6	124	70	250	22320	12600	45000	180	7049
Dec	6	124	70	250	23064	13020	46500	186	7284
		yearly totals			271560	153300	547500	2190	**85,760**

Table above demonstrates that proposed CHP will be capable of saving 85.8 tonnes of CO2 per year. This equates to 1,286 tonnes for a 15 years period, which is estimated lifetime of CHP.

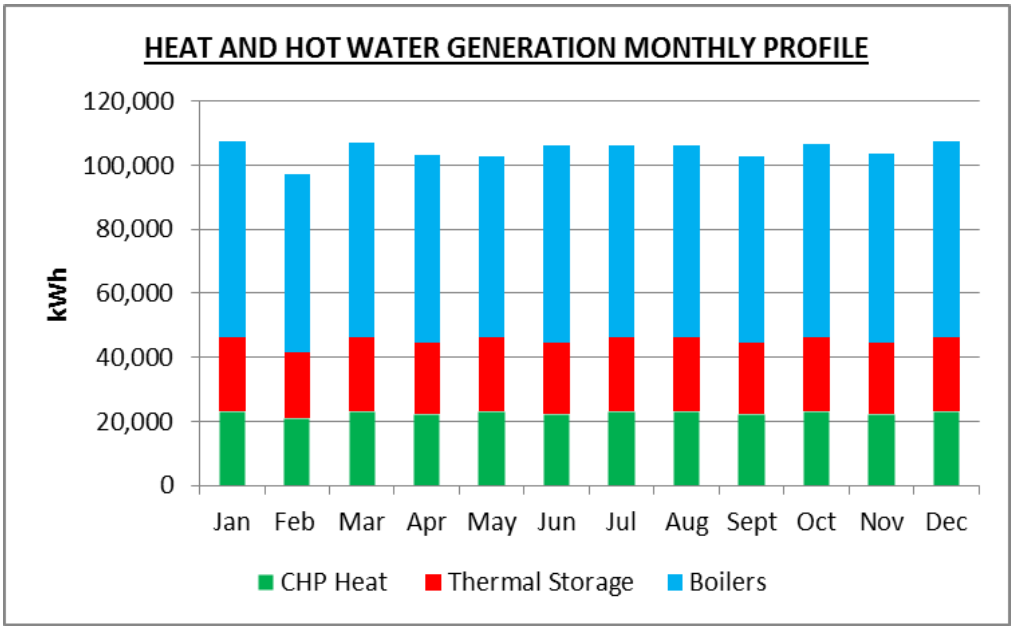
A Graph below shows predicted energy generation expected for CHP units selected for incorporation into the scheme.



A Graph below shows estimated for the development typical day heat demand and CHP potential to provide the base heat load throughout the day. As the unit is sized perfectly for the site, there is no capacity for exporting heat to other sites or supporting local heat network.



A Graph below shows estimated proportional breakdown for thermal energy provided from CHP, Thermal Storage and Boilers for each month of the year.



Notes:

- It is intended to control the unit to site electrical demands and therefore there is no export to the grid envisaged at this stage.
- The Hotel operator shall make all necessary operation, maintenance and monitoring arrangements.

APPENDIX 4 PHOTO VOLTAICS DETAILS AND LOCATION

It is proposed to install 90m2 of Photovoltaic panels – equivalent of at least 61No high efficiency PV panels each capable of peak generation of 345W(peak) giving a total installed power of 21kWpeak.

Image shows the propose locations for the PV panels at 8th and 9th floors

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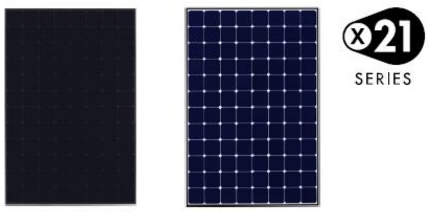

- 21.5% efficiency
  Ideal for roofs where space is at a premium or where future expansion might be needed.
- Maximum performance
  Designed to deliver the most energy in demanding real world conditions, in partial shade and hot rooftop temperatures.[1, 2, 3]

HIGHEST EFFICIENCY[6]

Generate more energy per square foot

ELECTRICAL DATA		
	X21-335-BLK	X21-345
Nominal Power[12] (Pnom)	335 W	345 W
Power Tolerance	+5/–0%	+5/–0%
Avg. Panel Efficiency[13]	21.1%	21.5%
Rated Voltage (Vmpp)	57.3 V	57.3 V
Rated Current (Impp)	5.85 A	6.02 A
Open-Circuit Voltage (Voc)	67.9 V	68.2 V
Short-Circuit Current (Isc)	6.23 A	6.39 A
Maximum System Voltage	600 V UL ; 1000 V IEC	
Maximum Series Fuse	20 A	
Power Temp Coef. (Pmpp)	–0.30% / °C	
Voltage Temp Coef. (Voc)	–167.4 mV / °C	
Current Temp Coef. (Isc)	3.5 mA / °C	

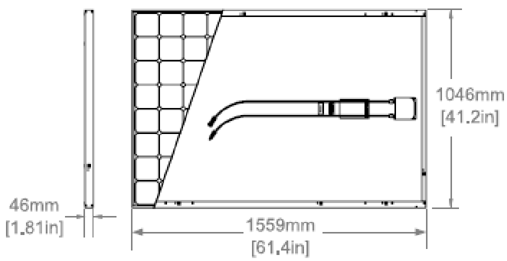

Image shows details of proposed PV panels