Building Services Design
Consulting Engineers

**12th December 2017**
**Revision 3**

# Energy and Renewables Statement

# For Proposed Hotel Development at

# Wild Court

# London



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## ISSUE & REVISION RECORD

| Issue | Document prepared | | | Document checked | | |
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* Revised to updated architectural layouts
** Revised to Sustainability Officer's comments
*** Revised as per changes in the layouts of the upper three top floors

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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 196 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 $CO_2$ 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 $CO_2$ emissions of the proposed development will be designed to emit far less $CO_2$ 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 $m^2$ 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 35.47% over required by Building Regulation 2013 emissions, which equates to a saving of 102,919 kg of $CO_2$ per annum**.

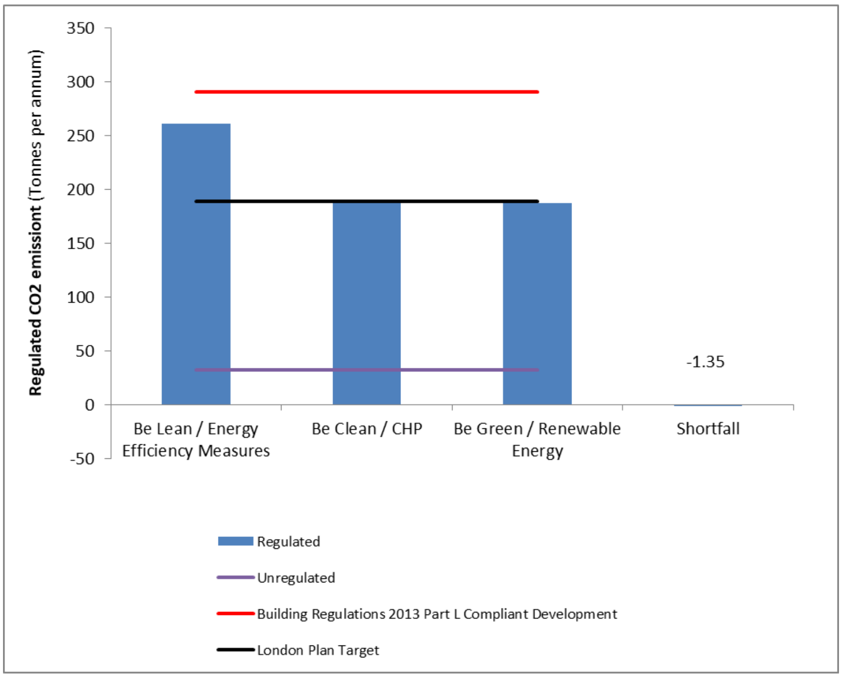
Table 1: Carbon Dioxide Emissions after each stage of the Energy Hierarchy

| | Carbon dioxide emissions (Tonnes $CO_2$ per annum) | |
|---|---|---|
| | Regulated | Unregulated |
| Baseline: Building Regulations 2013 Part L Compliance Development | 290.2 | 32.5 |
| After Energy demand reduction | 261.1 | 32.5 |
| After CHP | 189.8 | 32.5 |
| After Renewable | 187.3 | 32.5 |

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

| | Regulated Carbon Dioxide Savings | |
|---|---|---|
| | (Tonnes $CO_2$ per annum) | (%) |
| Savings from energy demand reduction | 29.1 | 10.03% |
| Savings from CHP | 71.3 | 27.30% |
| Savings from renewable | 2.5 | 1.33% |
| Total Cumulative Savings | 102.9 | 35.47% |
| | | |
| Total Target Savings | 101.6 | 35% |
| Annual Surplus | 1.3 | - |

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 (seven-storey building located on Wild Court) into a hotel. The proposed hotel will comprise 196 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 the ensuite bathrooms, comfort cooling and other bedroom amenities.

The building gross total floor area is approx. 4,218 $m^2$.

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, the Greater London Authority guidance on preparing the energy assessments (March 2016), each application has been considered by taking into the account the individual characteristics of the development. The 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 $CO_2$ 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 which are complementary with the optimal operation of the CHP.

For the period 2016 to 2019, the London Plan policy 5.2B sets the carbon dioxide emissions target for non-residential development to be in line with Part L Building Regulations. This target was intended to align with the expected improvement of the Part L 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 the 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 the 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 reduced most significantly from that incurred by the building designed simply to comply with the 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 the baseline energy demand & carbon dioxide emissions. The energy assessment shall include the calculation of 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 the 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 $CO_2$ emissions have been assessed in HevaComp using approved energy assessment software SBEM v5.5.d.2 Part L2A.

The energy hierarchy considered whilst reducing emission to the proposed scheme has been applied into 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 290.2 tonnes of $CO_2$ per annum. This equates to 68.8 $kgCO_2/m^2$ assessed under Part L2A 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 the constraint 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 Part L2A Building Regulations for the new buildings.

This is due to an extensive improvement of the building fabric which has very poor U-values when compared with the present 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 dramatically to improve the building's fabric to as much close as practical to the current Building Regulations minimum standards. In some instances, these improvements achieve better than the current Building Regulations minimum standards.

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

- Existing walls U-value will be improved to 0.32 $W/m^2K$ 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 $W/m^2K$.
- Low U-Value walls & roof (to all new elements). New roofs shall have U-Values of 0.15 $W/m^2K$.

- The building shall achieve an air permeability of 5.0 $m^3$/h/m2 at 50 Pa or better upon completion of the works.
- Low energy lighting such as metal halide and high efficient LED lighting will be introduced to the development to minimize emissions.
- All circulation and public areas shall be fitted with the 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 enters the building.

Based on the energy calculations, $CO_2$ emissions have been estimated for the development under Be Lean scenario at 261.1 tonnes of $CO_2$ per annum providing 10.03 % savings over minimum standard required by the Building Regulations for the new buildings. This equates to 61.9 $kgCO_2/m^2$ assessed under Part L2A 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 have been significantly reduced. The use of air source heating through the VRF/VRV systems enables seasonal efficiencies of extremely high figures to be attained which means the heating system produces significantly less $CO_2$ ( 2.3 times less $CO_2$ per kWh) than the modern condensing boilers. In addition to this, VRF / VRV is one of the most efficient comfort cooling systems on the marketplace at present and has seasonal efficiencies (6.75) far greater than the standard water cooled chillers, which are generally between 2.7 and 3.5.

These systems are also able to be utilized under the heat recovery technology. For instance, if the north façade of a building requires heating whilst the south façade requires cooling, the heat can be moved from one façade to the other without any compressor power, rather than being discharged into the atmosphere and get wasted. This ability to utilized excess heat enables much greater savings to be achieved during spring and autumn periods of the year.

Incorporation of 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 an energy efficient renewable source, it fulfills the heating and cooling demand by the building, in accordance with the energy hierarchy. This system had to be incorporated under Be Lean strategy rather than Be Green.

## 2.3 BE CLEAN (Supplying Energy Efficiently)

The London Plan Local Policy (Camden Planning Guidance Sustainability) also states that, where feasible and viable, the developments will be required to connect with a decentralized energy network or include CHP.

The London Plan requires that proposals for further reduction of carbon dioxide emissions shall be considered. Further reductions can be achieved by 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 the 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, therefore there is no opportunity to connect to them.

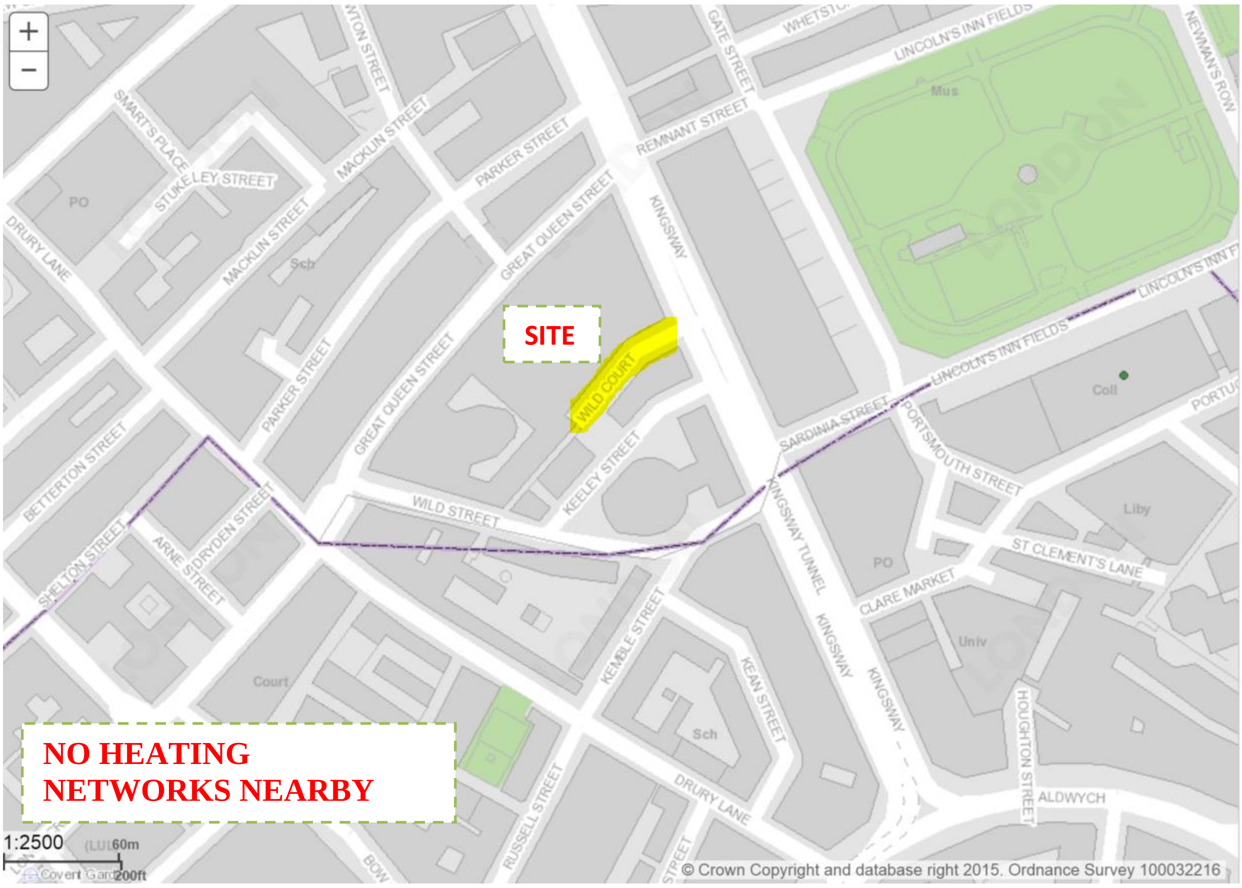



*Image show no heating network in the vicinity of the site*

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 Hot Water System (HWS) generation, which provide heating load all over the year. It is proposed to utilise the CHP for the entire building, which result in a considerable $CO_2$ emissions reductions across the site.

The CHP plant shall be sized in such a way that it can cover 65% of the hot water demand annually. To achieve this high demand target, we have selected two smaller machines which would enable the CHP installation to modulate better with the building load.

Detailed calculations were carried out to select the correctly sized CHP machines for achieving the full demand target on annual basis.

Based on the energy calculations, Be Clean $CO_2$ emissions for the development are estimated at 189.8 tonnes of $CO_2$ per annum providing further 27.30% savings over emissions calculated under Be Lean strategy. This equates to 45 $kgCO_2/m^2$ assessed under the Part L2A Building Emissions Rate (BER) calculation for an actual building (as designed).

## 2.4 BE GREEN (Use of 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 the London Plan Policy 5.7 for the renewable energy which states that:-

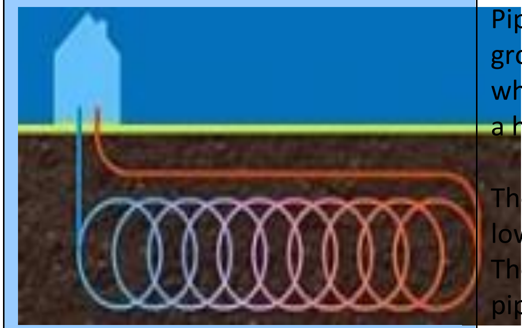
"Within the framework of the energy hierarchy (see Policy 5.2), major development proposals should provide a reduction in expected carbon dioxide emissions through the use of on-site renewable energy generation, where feasible."

Table given below presents a summary of the technologies that were being considered against the project. It is clear that some of them 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.<br>A report by Building Research Establishment highlighted inherent problems and the poor performance to date of urban micro wind installations.<br>Turbines can also generate a reasonably high degree of noise during their operation. This noise could create nuisance to the surrounding neighbours.<br>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.<br>**No Viability - Not Suitable** |

| | |
|---|---|
| <br>**BIOMASS HEATING** | The combustion of wood chip or pellets creates heat for space heating and hot water loads.<br><br>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.<br><br>Emissions are also tightly regulated (clean air act) in this part of the city which precludes the use of biomass.<br><br>For the above reason we believe this option is not suitable.<br><br>**Low Viability** |
| <br>**PHOTO VOLTAIC CELLS** | Photovoltaic (PV) Cell technology involves the conversion of the sun's energy into electricity.<br><br>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.<br><br>However whatever amount of PV which can sensibly be incorporate onto the roof should be included.<br><br>**Good Viability - Suitable** |
| <br>**SOLAR THERMAL – HOT WATER** | Solar Thermal panels could be utilized to generate a small proportion of the buildings energy.<br><br>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.<br><br>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.<br><br>**No Viability - Not Suitable** |

| | |
|---|---|
| <br>**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.<br><br>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.<br><br>It is for the above reason that we believe this form of renewable technology is unsuitable for incorporation into the scheme.<br><br>**No Viability - Not Suitable** |

$CO_2$ emissions have been further reduced by the incorporation of the Photovoltaic cells (90m² high efficiency PV panels has been incorporated into the scheme) as a renewable technology under the Be Green strategy.

The image below shows the proposed PV installation, which shows that the existing roof area can accommodate the PV panels while facilitating maintenance access to the roof and around the panels at the same time.


*Image above indicates the proposed location for the new PV panels at 8th floor.*

Based on the energy calculations, Be Green $CO_2$ emissions for the development are estimated at 187.3 tonnes of CO2 per annum providing further 1.33% savings over emissions calculated under Be Clean strategy. This equates to 44.40 kgCO2/m2 assessed under Part L2A Building Emissions Rate (BER) calculation for an actual building (as designed) and 35.47% savings over the minimum standard required by the Building Regulations for the 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 principle guidance in selecting the most appropriate technology.

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

The tables and the graph below indicate that the $CO_2$ emissions reduction target is achievable through this preferred solution**.**

This report has considered the best practice principles to propose the best sustainable energy solution, saving 35.47% total CO2 over Building Regulations 2013 for the development and demonstrating compliance with the local planning requirements.

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

Table 3.1 Building Emissions Summary

| | TER $(kgCO_2)/m^2$ | BER $(kgCO_2)/m^2$ | Total Target Emissions $(kgCO_2)$ | Total Actual Building Emissions $(kgCO_2)$ | Total $CO_2$ Saving $(kgCO_2)$ | Total % $CO_2$ Saving |
|---|---|---|---|---|---|---|
| Total Development | 68.8 | 44.40 | 290,198 | 187,279 | 102,919 | 35.47% |

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

| | Carbon dioxide emissions (Tonnes $CO_2$ per annum) | |
|---|---|---|
| | Regulated | Unregulated |
| Baseline: Building Regulations 2013 Part L Compliance Development | 290.2 | 32.5 |
| After Energy demand reduction | 261.1 | 32.5 |
| After CHP | 189.8 | 32.5 |
| After Renewable | 187.3 | 32.5 |

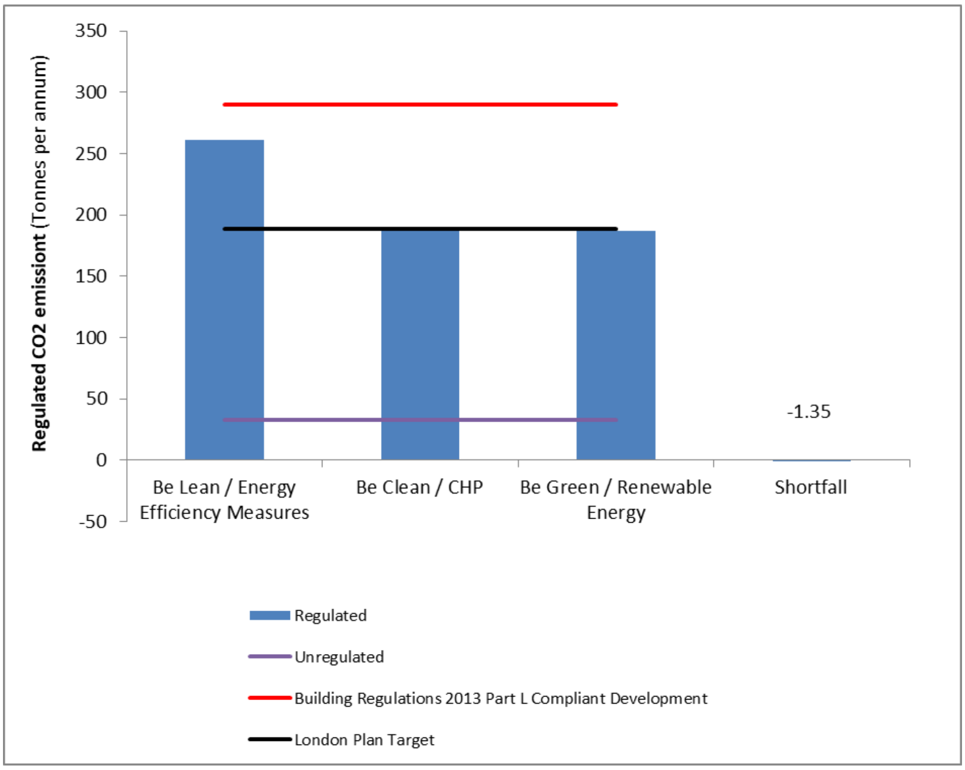
Table 3.3: Carbon Dioxide savings from each stage of the Energy Hierarchy

| | Regulated Carbon Dioxide Savings | |
|---|---|---|
| | (Tonnes $CO_2$ per annum) | (%) |
| Savings from energy demand reduction | 29.1 | 10.03% |
| Savings from CHP | 71.3 | 27.30% |
| Savings from renewable | 2.5 | 1.33% |
| Total Cumulative Savings | 102.9 | 35.47% |
| | | |
| Total Target Savings | 101.6 | 35% |
| Annual Surplus | 1.3 | - |

Table 3.3: Shortfall in regulated carbon dioxide savings

| | Annual Shortfall (Tonnes $CO_2$) | Cumulative Shortfall (Tonnes $CO_2$) |
|---|---|---|
| | | |
| Shortfall | -1.35 | -40.49 |

Figure 3.4: The Energy Hierarchy; $CO_2$ 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- Be Green

As designed

Date: Mon Dec 11 10:44:50 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 | 68.8 |
| Target $CO_2$ emission rate (TER), $kgCO_2/m^2$.annum | 68.8 |
| Building $CO_2$ emission rate (BER), $kgCO_2/m^2$.annum | 44.4 |
| 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 | $U_{a-Limit}$ | $U_{a-Calc}$ | $U_{i-Calc}$ | 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 | 1.79 | 5.7 | 6.02 Window 3 |
| 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" |

$U_{a-Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
$U_{a-Calc}$ = Calculated area-weighted average U-values [W/(m²K)]
$U_{i-Calc}$ = 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 |
|---|---|---|
| $m^3/(h.m^2)$ at 50 Pa | 10 | 5 |

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# Technical Data Sheet (Actual vs. Notional Building)

## Building Global Parameters

| | Actual | Notional |
|---|---|---|
| Area [m²] | 4218.1 | 4218.1 |
| External area [m²] | 3511.6 | 3511.6 |
| Weather | LON | LON |
| Infiltration [m³/hm²@ 50Pa] | 5 | 3 |
| Average conductance [W/K] | 1503.97 | 2079.73 |
| Average U-value [W/m²K] | 0.43 | 0.59 |
| Alpha value* [%] | 18.81 | 17.1 |

* 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 | 1.88 | 5.7 |
| Cooling | 4.17 | 5.59 |
| Auxiliary | 21.55 | 24.79 |
| Lighting | 14.08 | 16.86 |
| Hot water | 274.27 | 194.39 |
| Equipment* | 14.72 | 14.72 |
| **TOTAL**** | **247.93** | **247.33** |

* 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 | 1.31 | 0 |
| Wind turbines | 0 | 0 |
| CHP generators | 68.01 | 0 |
| Solar thermal systems | 0 | 0 |

## Energy & $CO_2$ Emissions Summary

| | Actual | Notional |
|---|---|---|
| Heating + cooling demand [MJ/m²] | 205.31 | 205.71 |
| Primary energy* [kWh/m²] | 250.56 | 395.62 |
| Total emissions [kg/m²] | 44.4 | 68.8 |

* 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 |

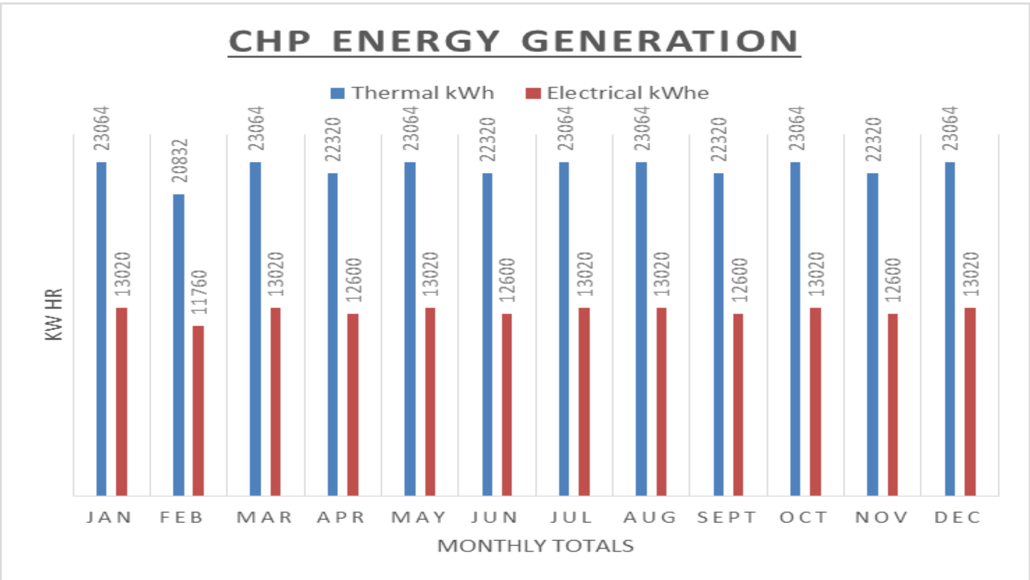
NB: Output figures are based on operation at ISO 3046 conditions with the exception of exhaust output, which is quoted to 120°C, figures are stated from manufacturer's declared performance figures subject to the manufacturer's tolerances and subject to change without notice. Values for de-rated units 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:

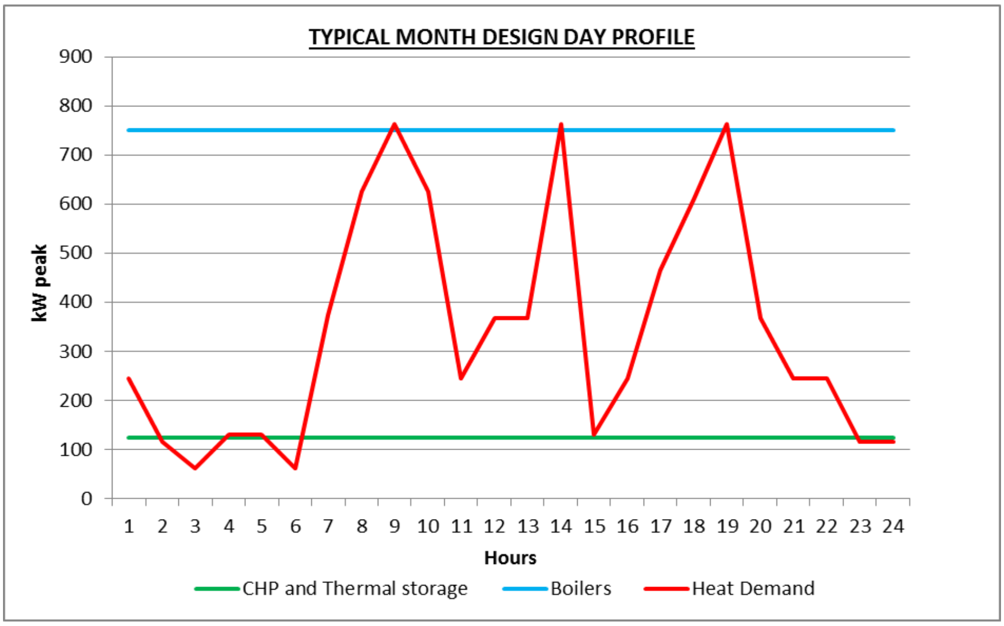
| Month | Typical Daily Running Time (hrs) | Thermal Energy (kWth) | Elec Energy (kWe) | Fuel Input (kWg) | Monthly Total (kWth) | Monthly Total (kWhe) | Monthly Fuel Total (kWhg) | Total CHP running time (hrs) | CO2 saving (kg) |
|---|---|---|---|---|---|---|---|---|---|
| Jan | 6 | 124 | 70 | 250 | 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.

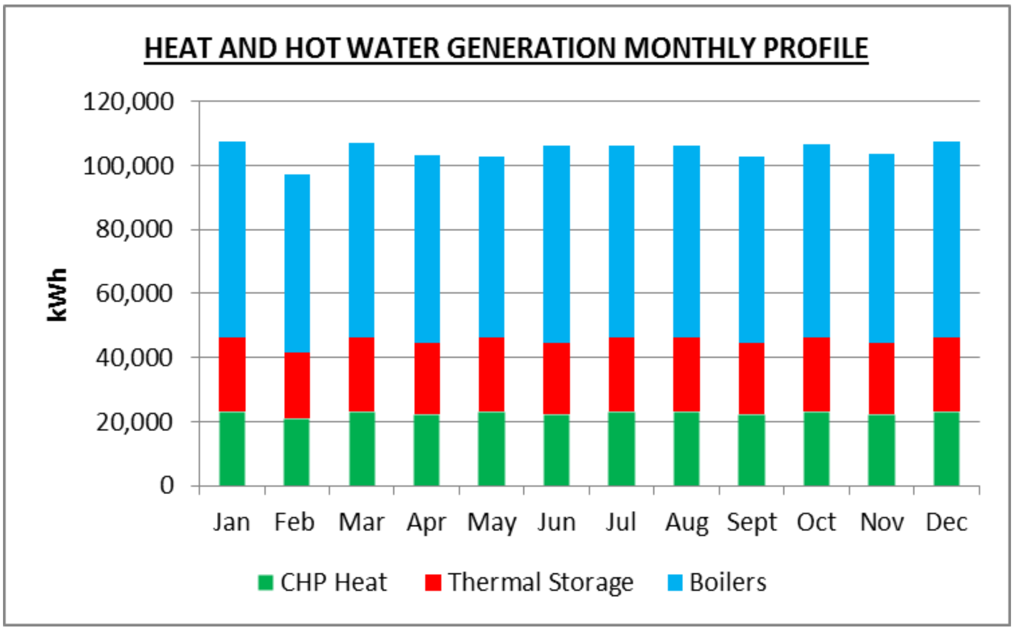
A Graph below shows predicted energy generation expected for CHP units selected for incorporation into the scheme.



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 correctly 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.



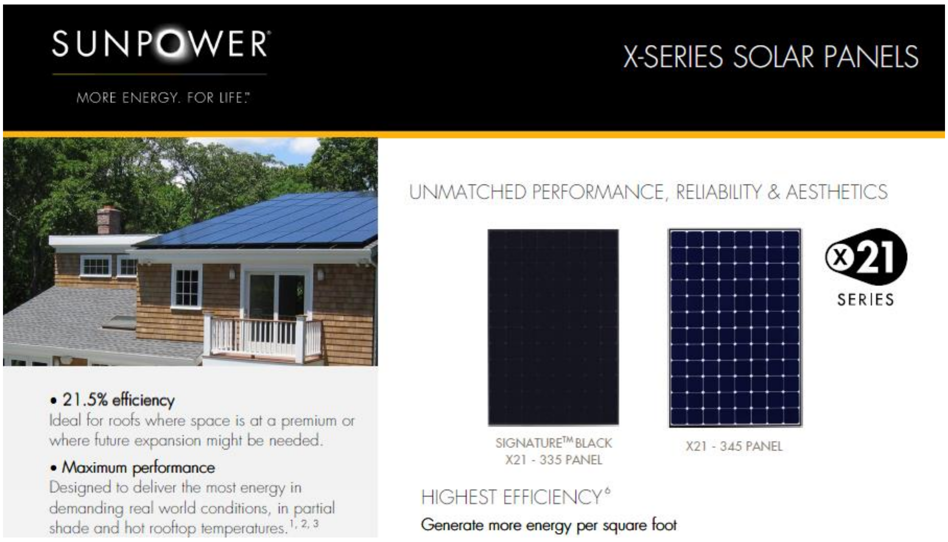

Notes:

- 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 PHOTOVOLTAICS PANELS DETAILS AND LOCATION

It is proposed to install 90m$^2$ of Photovoltaic panels – equivalent of at least 61 number of 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 floor*



| 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 | |

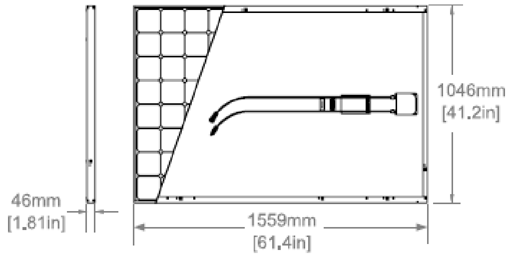



*Image shows details of proposed PV panels*