Castlehaven Row Ltd

Camden Wharf

Energy Strategy

Issue 1 | 19 August 2016

This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

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Contents

Tables

Figures

Regulated Emissions Unregulated Emissions ---- Part-L 2013 Compliant

Appendices

1 Introduction

The purpose of this report is to present the energy strategy for Camden Wharf project, in accordance with the Greater London Authority guidance on Energy Planning.

The project concerns the extension to an existing commercial building located at 28 Jamestown Road, Camden, known as Camden Wharf. The existing building was built in 2000 and is made of 3 floors, plus a basement and a roof hosting the plants and the staircase, with a total NIA floor area of 4253m^2 (the modelled area is slightly higher at 5550m^2 due to the way the software interprets the building). The ground floor hosts shops, pubs and a hair stylist shop, the 1st, 2nd and 3rd floor are occupied by offices.

The extension concerns the addition of a new restaurant on the 4th floor, extensions to the office levels at 2nd and 3rd floors and removing the existing plant at the 4th floor roof level serving the 3rd floor office and providing new landlord equipment in the South arm of the building at 4th floor and on the Level 1 Plant Shelf. The total uplift in NIA floor area is 587m^2, of which 400m^2 is the NIA floor area of the Level 4 restaurant. The new restaurant area is 9.4% of the existing floor area.

The energy strategy for the building follows the Mayor of London’s energy hierarchy contained within the London Plan 2015 which states that Development proposals should make the fullest contribution to minimising carbon dioxide emissions in accordance with the following energy hierarchy:

- **Be lean:** use less energy
- **Be clean:** supply energy efficiently
- **Be green:** use renewable energy.

Due to the proportion between additional and existing floor area (9.4%), the development is classified as “other extensions” according to Building Regulations 2010 Part L2B (2010 edition incorporating 2010, 2011, 2013 and 2016 amendments). The construction of an extension implies the requirements for *consequential improvements* because the existing building has a total useful floor area greater than 1000m^2.

In accordance with this guidance, the intervention will include passive and energy efficiency measures such as:

- New high efficiency gas fired boilers and LTHW pumps
- New high efficiency air cooled chillers and CHW pumps
- New AHU with heat recovery
- Low Energy LED lighting system with photocell daylight control and PIR sensors

2 Context

2.1 National Policy

The UK national planning system has been amended to make sustainability its underlying principle as outlined in PPS1 (Planning Policy Statement 1). At a national level, the British Government is committed to reduce greenhouse gas emissions by 34% by 2020 and by 80% by 2050 (Climate change Act, 2008).

2.1.1 Climate Change Act 2008

Following this summit's agreement of the EU Climate Change Package, passed by the European Parliament on 17 December, 2008, the UK has a target of a 20% contribution from renewable energy as enshrined in EU law, which translates into a 15% share for renewables for the UK (2008 -2012 EU Burden Sharing Agreement);

Key aspects of this agreement include:

- 20% cut in greenhouse gas emissions by 2020, against 1990 levels;
- 20% increase in use of renewable energy by 2020;
- 20% cut in energy consumption through improved energy efficiency by 2020.

2.1.2 EPC –DEC

The EU Energy Performance of Buildings Directive (EPBD) was introduced in the UK from January 2006 with a three year implementation period ending January 2009.

Its objective is to improve energy efficiency and reduce carbon emissions as part of the government's strategy to achieve a sustainable environment and meet climate change targets agreed under the Kyoto Protocol.

The EPBD introduced higher standards of energy conservation for new and refurbished buildings from April 2006 and requires energy performance certification for all buildings when sold or leased. In addition, it introduced regular inspections for larger air conditioning systems and advice on more efficient boiler operation for commercial property.

Energy Performance Certificates are required on construction, sale or lease of all buildings from October 2008. The certificate includes an energy rating, as well as advice on how to make cost effective improvements to the building to make it more energy efficient. The ratings are similar to those currently used for white goods, ranging from A to G, with A the best and G the worst.

Public buildings over 1000m^2 occupied or part occupied by public authorities or by institutions providing public services and therefore frequently visited by the public, require Display Energy Certificates (DECs). This form of certificate must be publicly displayed within the building and is different in form and content from an Energy Performance Certificate. Display certificates are produced using a different methodology and are based on actual energy usage over a three year period (if available). The building is given an operational rating which assesses how well it has been operated based on actual energy consumption information.

From 2016 a tenant will be entitled to ask the landlord to carry out the measure recommended on the EPC and the landlord will have a legal obligation to do so. The landlord must be prepared to carry out any outstanding measures if the tenant request to do so, and from 2018 it will be illegal to let a property which has an EPC rating below E.

2.1.3 Part-L 2013 Compliance

The current edition of Approved Document Part-L of the UK Building Regulation has been enforceable since April 2013.

The work for the extension falls under L2B, which is associated with conservation of fuel and power in existing buildings other than dwellings. Under L2B, there is no explicit requirement to carry out a virtual compliance model to assess the building's Building Emission Rate (BER). However, to achieve compliance a demonstration of consequential improvements being applied should be followed.

A series of consequential improvements have been adopted. These are explained in detail later in this report.

2.2 Regional Policy

The Mayor's vision for London is that it should be:

"*A city that becomes a world leader in improving the environment locally and globally, taking the lead in tackling climate change, reducing pollution, developing a low carbon economy and consuming fewer resources and using them more effectively*."

The Spatial Development Strategy (SDS) in the form of the London Plan (2015) reflects PPS1 with particular policies related to climate change and carbon dioxide emissions.

- London Plan policy 5.1A states that the Mayor seeks to reduce London's carbon dioxide emissions by 60% below 1990 levels by 2025.
- London Plan policy 5.2A states that 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

- London Plan Policy 5.2B states that major non-domestic developments need to meet the following targets for carbon dioxide emissions reduction in buildings (Figure 2.1). These targets are expressed as minimum improvements over the Target Emission Rate (TER) outlined in the national Building Regulations leading to zero carbon non-domestic buildings from 2019:

Year	Improvement on 2010 Building Regulatons
2010 – 2013	25 per cent
2013 – 2016	40 per cent
2016 – 2019	As per building regulations requirements

Figure 2.1: Targets for non-domestic buildings (London Plan 2015).

- London Plan Policy 5.2C and 5.2D state that major 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.

  a) calculation of the energy demand and carbon dioxide emissions covered by 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 (see paragraph 5.22) at each stage of the energy hierarchy

  b) proposals to reduce carbon dioxide emissions through the energy efficient design of the site, buildings and services

  c) 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)

  d) proposals to further reduce carbon dioxide emissions through the use of on-site renewable energy technologies.

- London Plan policy 5.2E states that the carbon dioxide reduction targets should be met on-site. Where it is clearly demonstrated that the specific targets cannot be fully achieved on-site, any shortfall may be provided off-site or through a cash in lieu contribution to the relevant borough to be ring fenced to secure delivery of carbon dioxide savings elsewhere.

2.3 Local Policy

On the local level, the site falls under the jurisdiction of the Camden Council.

Camden's Local Development Framework contains policies covering energy performance and carbon emissions of proposed developments, in particular through the core strategy policy CS13 and the development policies DP22. Development Policy DP22 is entitled "Promoting Sustainable Design and

Construction" and Core Strategy policy CS13 is entitled "Tackling Climate Change through Promoting Higher Environmental Standards"

- **Policy CS13**

  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:

  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:

  1. ensuring developments use less energy,

  2. making use of energy from efficient sources, such as the King's Cross, Gower Street, Bloomsbury and proposed Euston Road decentralised energy networks;

  3. generating renewable energy on-site;

  d) ensuring buildings and spaces are designed to cope with, and minimise the effects of, climate change.

Camden's Sustainability Planning Guidance (CPG3;2013) contains additional information to support the policies set out in the Camden Local Development Framework with sections 2 to 6 of the CPG3 guidance document specifically covering the energy consumption of developments.

3 Energy Hierarchy

The performance of the redevelopment has been assessed following the procedure laid out by the document titled "*Energy Planning – Greater London Authority guidance on preparing energy assessments (April 2015)*", following the Mayor's Energy hierarchy:

- **Priority 1 – Energy Conservation & Energy Efficiency (Be Lean)**
- **Priority 2 – Exploitation of Low Carbon Technologies (Be Clean)**
- **Priority 3 – Exploitation of renewables, sustainable sources of energy (Be Green)**

The Energy Hierarchy offers an effective framework to guide energy policy and decision making. By prioritising demand-side activities to reduce wastage and improve efficiency, the hierarchy links closely to the principles of sustainable development and offers an integrated, easy to use approach to the management of energy demand and supply.

Priority 1 – Energy Conservation & Energy Efficiency (Be Lean)

The reduction or elimination of unnecessary energy use: conservation is often achieved through behavioural changes such as switching appliances off when they are not being used, or the introduction of passive design features, an example of which would be to implement shading devices in order to reduce the need for cooling in summer etc.

Energy efficiency improvements are usually achieved through the application of engineering principles.

Priority 2 – Exploitation of low carbon technologies (Be Clean)

Finite natural resources such as oil, coal, gas and uranium provide the vast majority of global and UK energy supply. The current transport systems, buildings and power generation infrastructure have been built such that they are all largely dependent on the continued supply of these resources. Examples of low carbon technologies are Heat Pumps, Combined Heat & Power and District Heating/Cooling, etc.

Priority 3 – Exploitation of Renewables, Sustainable Sources of Energy (Be Green)

Having taken all reasonable steps to minimise energy demand and improve efficiency, this next priority is to supply that demand from clean energy sources that are effectively infinite. Effective, sustainable energy provision, though, is not just about resource availability, it must also embrace wider issues such as affordability, societal acceptability and environmental impact.

4 Baseline energy demand and carbon emissions

4.1 Methodology

The extension of Camden Wharf falls under Part-L2B (Conservation of fuel and power in existing buildings other than dwellings) of the current UK Building Regulation 2013 edition. Because the existing useful floor area is over 1000m^2 and the additional floor area is 9.4% of the existing, the development needs to follow the consequential improvements and is classified as "other extension" (large extensions are those where the proposed extension has a total useful floor area that is both greater than 100m^2 and greater than 25% of the total useful floor area of the existing building).

L2B does not explicitly require a virtual compliance model to demonstrate the building's Building Emission Rate (BER) improvement factor over the Target Emission Rate (TER). However, in order to assess the impact and consequential improvements of the building modifications, a virtual compliance model has been created nonetheless and analysis undertaken.

According to the GLA *Guidance on Preparing Energy Assessments,* for developments consisting of a refurbishment with a new build extension, the CO_2 savings for the new and refurbished elements should be presented separately, and the new build elements should be assessed in line with the methodology used for new buildings. Also, the new elements will be expected to comply with London Plan energy policy.

4.2 Software

In order to give separate results for the existing and the new elements, three thermal models have been constructed:

1. Before the extension (existing building)
2. After the extension (whole new building)
3. New restaurant (new extension only).

The thermal models have been created using dynamic thermal simulation approach with a software package known as EDSL TAS. The version of the tool used for this analysis was Version 9.3.3b, which was the most recent release at the time of performing the calculations.

Calculations are based on first-principle methods of heat transfer and are driven by real weather data. EDSL TAS is also an accredited software and can be used to demonstrate UK Building Regulation Part-L Compliance.

4.3 Building Geometry

The geometry of the thermal model is based on architectural general arrangement layout drawings dated 8th April 2016. Figures Figure 4.1 and Figure 4.2 show the compliance thermal model for the whole building after the extension. In particular, Figure 4.2 shows the external shading devices designed for the solar gains reduction.

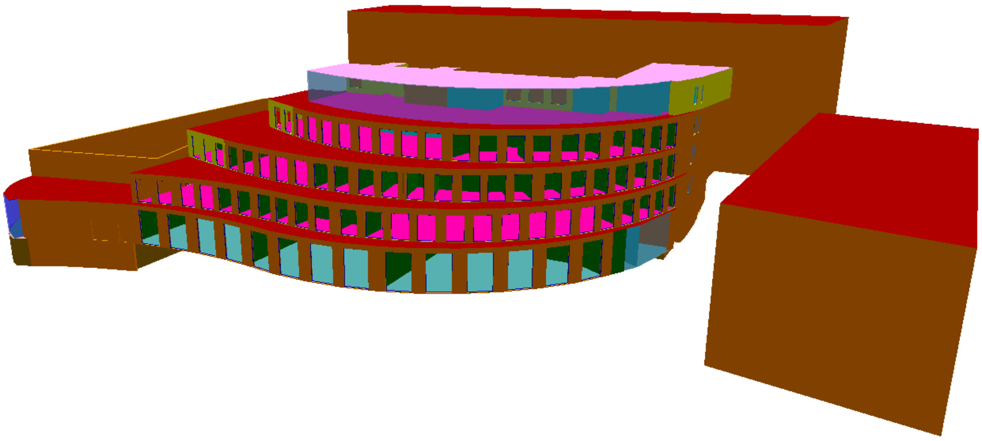


Figure 4.1: View of the compliance thermal model in EDSL TAS.

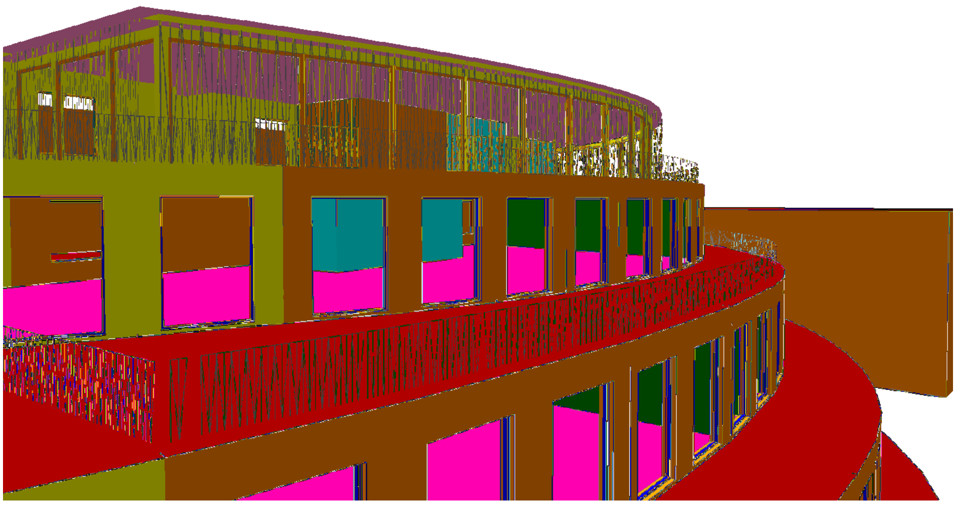


Figure 4.2: Detail view of the shading devices in the compliance thermal model in EDSL TAS.

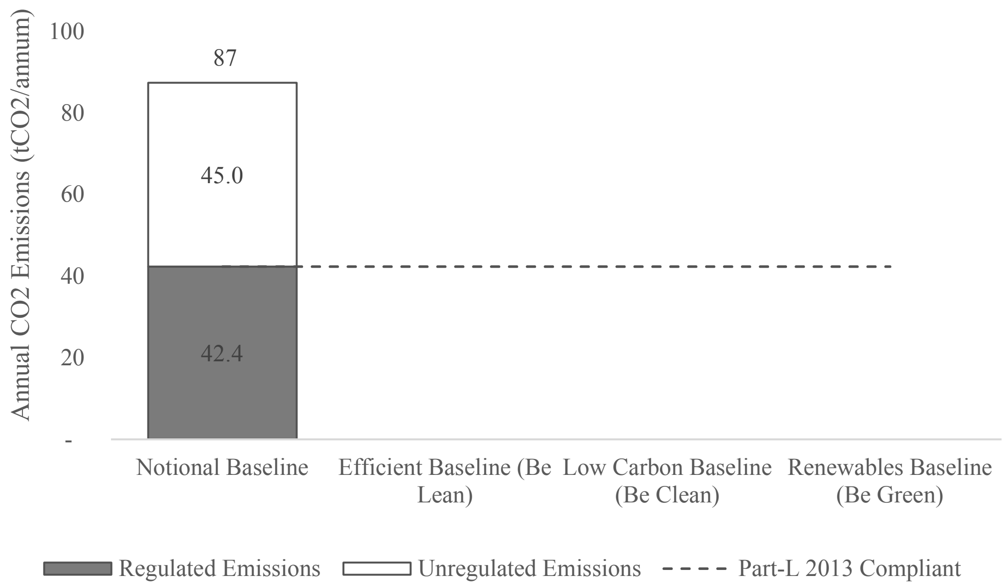
4.4 Notional Baseline

The Notional Baseline represent the energy consumption and carbon dioxide emissions baseline associated with a typical office building built to 2013 standards. The Notional Baseline in this case represents the new extension with typical 2013 controlled services efficiencies:

- Typical Gas fired boilers seasonal efficiency of 82%;
- Typical Water Cooled Chillers SEER of 3.6;
- Average luminaire efficacy of 60 lm/cW;
- Manual lighting controls;
- Air Handling Units Specific Fan Power (SFP) of 1.1 W/l/s;
- Mechanical Ventilation Heat Recovery (MVHR) of 50%;
- Power Factor Correction within [0.90; 0.95].

According to the compliance thermal model, the *Notional Baseline* has been estimated as follows:

Figure 4.3: Building emissions for the notional baseline.



The results indicate that the extension, with typical MEP services, would yield a *'Regulated'* baseline carbon dioxide emission of 42.4 tCO_2/annum, based on a Target Emission Rate (TER) of 75.1kgCO_2/m^2annum.

5 Energy Conservation & Energy Efficiency (Be Lean)

The second stage of the Mayor's Energy Hierarchy approach focus on Energy Efficiency, to reduce energy losses and eliminate waste

5.1 Thermal envelope

5.1.1 Existing building

For the existing building, no detailed information were available regarding the thermal envelope; therefore, typical construction elements compliant with Building Regulations 1995 have been selected, according to the year of construction (2000). On this basis, the U-values of the existing elements have been estimated as follow:

Table 5.1: U-values for the existing elements

Thermal Element	**U-value (W/(m^2.K))**
External walls	0.41
Curtain walls	2.85
Flat roof – concrete deck	0.45
Ground floor	0.46
Windows	3.28

BR Part L2B requires that in case of an extension work, the retained elements respect some threshold values, otherwise they need to be upgraded. Table 5.2 summarises the U-values for the assumed existing elements:

Table 5.2: U-values compliance with BR Part L2B for retained elements

Thermal Element	Actual U-value (W/m^{2}K)	Threshold U-value (W/m^{2}K)	Required U-value (W/m^{2}K)
Existing external walls	0.42	0.7	no improvements required
Existing ground floor	0.46	0.7	no improvements required
Existing roof	0.45	0.35	0.18

Therefore, the existing walls and ground floor wouldn't need any improvement; on the contrary, the roof will need to be improved, presumably with the addition of some insulation, unless surveys on site proof that the existing roof has a U-value below 0.35 W/(m^{2}K). However, it is worth underlining that part of the actual roof will become the internal floor of the new restaurant.

The air permeability for the existing building has been considered 10m^3/hr.m^2, according to Non Domestic EPC Conventions for England & Wales Issue 5.0.

5.1.2 New extension

For new thermal elements, lower U-values are required. The required values are reported in Table 5.3 and have been used for thermal modelling.

Table 5.3: U-values compliance with BR Part L2B for new elements.

Thermal Element	Required U-value (W/m^2K)	Assumed U-value (W/m^2K)
New external walls	0.28	0.24
New ground floor	0.22	No new ground floor
New roof	0.18	0.16
New curtain walls	1.8	1.05 (with G-value 0.42)

In order to reduce the heating and cooling loads of the new restaurant, the restaurant curtain walling system should have a target U-value of 1.05 to limit fabric conductive heat loss in winter. Additionally, solar control glazing are to be considered to limit solar gain in summer, alternatively shading devices or features are to be incorporated to obtain an effective G-value of 0.42.

5.2 Controlled Services

Minimising energy consumption for Camden Wharf project can be accommodated by driving down energy consumption through energy efficient plant and controls.

Therefore, a list of design considerations has been applied to the thermal model:

- Gas fired boiler(s) with seasonal efficiency ⩾ 96%;
- High efficiency water cooled chiller(s) with SEER ⩾ 4.0;
- Low energy lighting i.e. T5 Fluorescent and LEDs with average luminaire efficacy of 60 lm/cW for all the areas;
- Auto Presence Detection for lighting control in the service areas;
- Efficient heat recovery on all new/replaced air handling units targeting 60% as a minimum;
- Low Specific Fan Power (SFP) for air handling units and air distribution systems, targeting 1.6 W/l/s for central balanced mechanical ventilation system with heating and cooling, or 1.1 W/l/s for all other central or zonal ventilation system only.
- BMS system with automatic meter reading, energy monitoring and targeting facilities;
- Power factor correction within [0.90; 0.95].

5.3 Efficient Baseline (Be Lean)

According to the compliance thermal model, the Efficient Baseline has been estimated as shown in Figure 5.1.

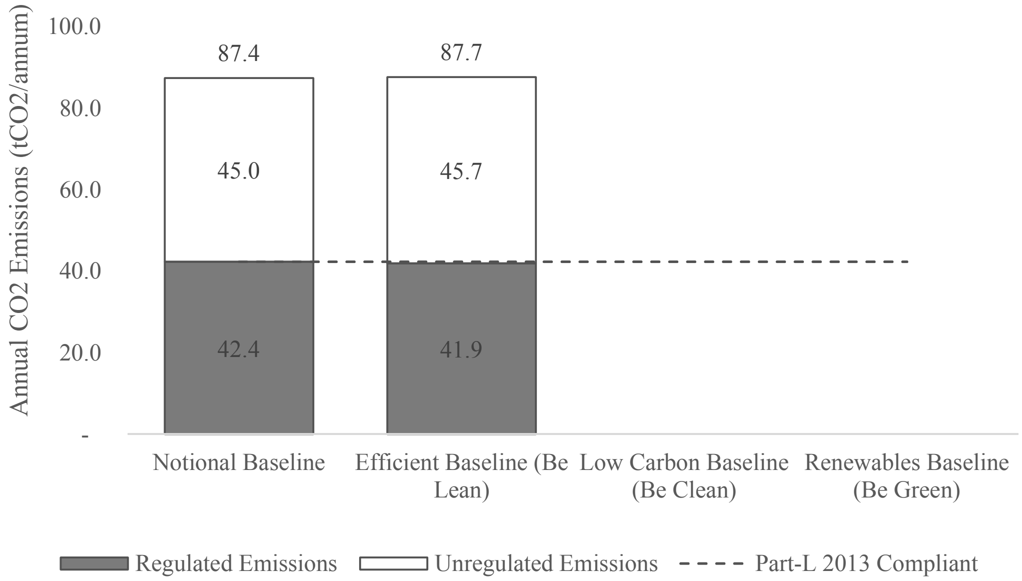


Figure 5.1: Building emissions for the notional building and the efficient baseline.

The results indicate that Camden Wharf project, with energy efficient MEP services, would yield a '*Regulated*' carbon dioxide emission of 41.9tCO_2/annum, based on a Building Emission Rate (BER) of 74.4kgCO_2/m^2annum.

6 Exploitation of Low Carbon Technologies (Be Clean)

6.1 District Heat Network

The most common form of local area energy network is community or district heating. This is where space heating and hot water is delivered to multiple occupants from a local plant via a network of insulated pipes buried in the ground. The pipe network can be installed at the same time as other services (water, drainage and other below ground services) to minimise costs in new development.

Connecting to a local area energy network is also preferable to the City of London, eligibility of a scheme to connect into a heat network are to be assessed as part of planning requirement. This forms part of GLA's Energy Hierarchy of 'Lean', 'Clean' and 'Green'. The 'Clean' requirements suggests forming or making future provision for connection into a local district heat network or CHP network, or if not suitable, install a local standalone CHP system.

According to the London Heat Map (http://www.londonheatmap.org.uk/Mapping/), there are currently no existing or proposed district heat network available for Camden Wharf to connect into. Therefore, District Heat Network is not a viable option.

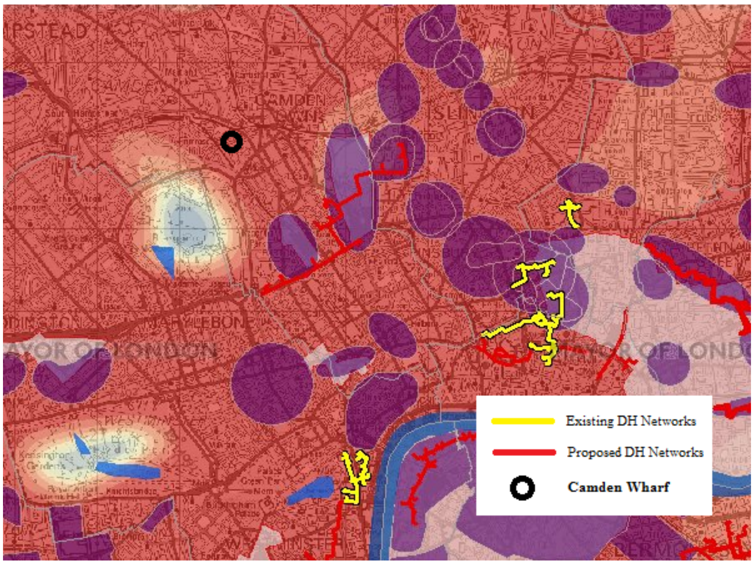


Figure 6.1: Existing and proposed district heat networks in proximity to Camden Wharf.

6.2 Combined Heat & Power

The successful integration of low carbon technologies with buildings depends on a number of technical, economic and social factors.

Combined Heat & Power (CHP) Plants, also known as cogeneration, uses conventional stationary internal combustion engines or turbines to generate both electricity and heat, using large proportion of waste heat.

Assuming the CHP plant is well-designed, the system is usually significantly more efficient than typical conventional engine.

Although they can provide energy with very high efficiency, CHP plants rely on matched building electrical and heat demands. If these do not follow a similar trend over the course of the day, and throughout the year, then the CHP plant may frequently be generating large proportions of heat when it is not required. If there is no demand then this heat is essentially wasted, or ‘dumped’, implying a significant decrease in the seasonal efficiency and therefore in the carbon emissions reduction.

In addition, CHP plants are typically economically feasible only if they operate for at least 3,000 hours per year. To ensure steady operation of the CHP plant, and to prevent heat being dumped, it is recommended that CHP plants are designed to meet the building’s base heating demand, exporting electricity to the grid when electrical demand is lower than the CHP electrical output.

In the case of Camden Wharf, the heating is managed separately for each tenant, and the tenant of the new addition will have his own DHW system. Therefore, the CHP might be used only for space heating of the office area, which would not assure a constant load and wouldn't be sufficient to justify the use of a CHP engine. Also, the CHP plant would require additional space which is not available according to the architectural layout.

For these reasons, the CHP technology is considered NOT viable.

6.3 Low Carbon Baseline

Because a low carbon system cannot be utilised, as explained in the previous paragraph, the Low Carbon Baseline will have same figures as the Efficient Baseline, as shown in Figure 6.2.

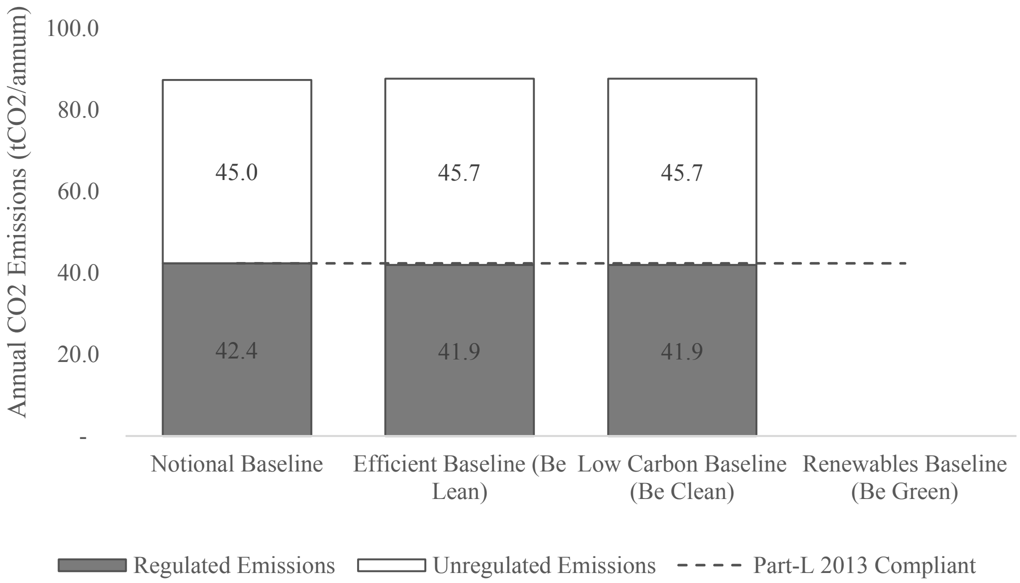


Figure 6.2: Building emissions for the notional building, the efficient baseline and the low carbon baseline.

7 Exploitation of renewable, sustainable resources (Be Green)

The successful integration of renewable energy technologies with buildings depends on a number of technical, economic and social factors.

The key technologies are summarised below and show the findings from this feasibility study that only photovoltaic panels are suitable technology for the Development.

Table 7.1: Summary of Renewable Energy Technologies investigated

Technology	Feasible?	Practical Solution?	Comments
Small Scale Hydro	NO	NO	No hydro source
Tidal/ Wave Power	NO	NO	No tidal/ wave source
Solar Water Heating	YES	NO	No base load assured
Wind Turbines	YES	NO	Insufficient capacity or contribution / urban environment
Biomass Boilers	YES	NO	High NOx emissions, delivery issues
Heat Pumps	YES	NO	High fuel cost, additional roof plant space requirement, free ground floor area required.
Photovoltaic	YES	YES	Complimentary to other technologies

7.1 Unviable Technologies

The following technologies have been analysed, and have been determined to be unfeasible or unviable. They are, therefore, NOT recommended to be implemented for this development.

7.1.1 Hydro and wave power

This site is not located near the coast or any rivers which could provide a source of moving water for hydro power generation, and therefore these technologies are not considered.

7.1.2 Solar Water Heating

Solar Thermal technology can provide hot water to buildings by pumping incoming cold water supply through collectors, typically located on the building roof or façade.

Solar Thermal technology is a proven technology, is silent in operation (does not cause any noise pollution) and does not require frequent access or maintenance. It is therefore considered to be a feasible option on technical and practical grounds.

However, solar water heating is not considered effective for the case because of the different DHW systems present in different parts of the building, as reported in paragraph 6.2.

7.1.3 Wind Turbines

Due to the city centre location, the historic facade of this building and the close proximity of residential properties, wind turbines are not considered an effective renewable technology for this project.

7.1.4 Biomass Heating

Biomass boilers could be used to provide hot water heating to the buildings. Carbon emissions associated with biomass boilers are low compared to a gas, oil or electric heating system. However, they present significant technical challenges and also require many additional components, such as a storage facility, handling, delivery access, ash removal, thermal storage etc.

Fuel can be delivered via trucks; the wood pellets can be pumped directly into the Storage facility via blowers. Therefore, careful consideration must be given to space requirements on site, vehicle turning radius and location of fuel store.

In addition, wood chips/pellets are usually housed indoor in order to avoid decay due to humidity and rain; therefore storage facilities would have to be built inside the energy centre, thereby increasing the cost and reducing the useful floor area.

Whilst Biomass Heating systems can result in a significant carbon mitigation, they can produce a large amount of NOx, typically around 200kg/kWh of delivered heating energy, and so they have a negative impact on the local air quality and may cause problems with obtaining planning consent. In addition to air quality issues, in an urban environment, logistics and security of fuel delivery can also be an issue, as well as fuel storage.

For these reasons, it is determined that Biomass Heating cannot be practically implemented as part of the refurbishment of Camden Wharf.

7.1.5 Heat Pumps

A heat pump is a refrigerant based system which uses a medium such as air, water, or the ground as an energy source for heating (or/and cooling). Generally, the efficiency of the system is higher when the difference between the required temperature and the medium temperature is lower, as the ASHP needs to work a harder to extract the desired amount of heat.

In many instances, they are considered a ‘Low Carbon’ technology, as the heat supplied to the buildings comes from a renewable source and not from combustion of non-renewable energy sources such as gas or oil. However, this heat is only being ‘moved’ from one space (outdoor) to another (indoor) and to do so requires a compressor in the refrigerant circuit, which consumes electricity, and therefore leads to carbon emission based on the carbon emission factor of the electricity supplied.

Air Source Heat Pumps (ASHPs)

ASHPs system use the ambient air as the medium from which heat is extracted. In general, ASHPs have a lower seasonal coefficient of performance than ground source heat pumps (GSHPs) as they are affected by significant variations in the temperature of the ambient air. At peak heating conditions, the ambient air is at its coldest, meaning that the system is not very efficient and the carbon emissions increase.

As with everything involving moving parts, the fans associated with external condensing units may cause noise pollution; considerations will have to be put in for positioning of the external condensing units.

Ground Source Heat Pumps (GSHPs)

Similar to ASHPs system, a GSHPs system is a low carbon technology rather than a renewable energy technology as GSHPs do not generate any electrical power such solar PVs or Wind Turbines would. The system consumes electrical energy in pumping fluids through the building and the ground and in compressing refrigerant in the heat pumps vapour compression cycle.

The ground is a very effective heat sink because it has a high thermal mass. Soil temperature is mainly influenced by the temperature of the atmosphere at ground level and solar radiation. At around 5m below ground level, the soil temperature varies very little over the course of a year for a given location and will typically be roughly equal to the average annual ambient air temperature at that location. The relatively constant temperature of the ground can be exploited to provide heating and cooling using GSHPs.

GSHPs should operate much quieter than ASHPs as they do not involve any fans. GSHPs can achieve CoP of 3-4 in heating and 4-5 in cooling model. The CoP of a GSHPS system is inversely related to the temperature difference required by the heating and cooling system, hence low temperature large surface area distribution technologies such as underfloor heating/cooling, chilled beams, displacement ventilation etc. are preferred, which is not the case of Camden Wharf building, where fan coils and radiators are mainly used for heating.

The drawback in using GSHPs is that it can be very expensive to install, with an indicative cost of £1,400 to £2,000 per installed kW of GSHP capacity. However, the sum of the trenching, pipework, electro-fusion welded couplings, pressure testing, flushing, fluids, biocides etc. can easily add £1,000 to £1,500 per borehole to the cost of the total system, depending on borehole spacing, pipe runs, distance to heat pump etc.

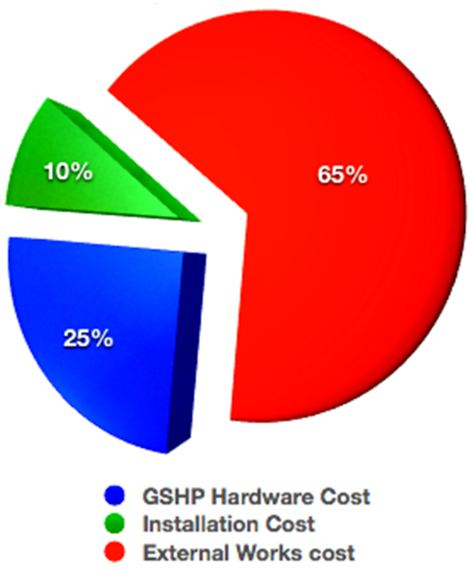


Figure 7.1: GSHP project cost breakdown with GSHPs.

Heat Pumps Conclusion

As mentioned for the CHP, in the case of Camden Wharf, the heat demand is managed separately for each tenant. This means that the installation of a heat pump system wouldn't be cost effective because the heat demand to cover would be only the one of the office.

In addition, the ASHP system is not considered effective due to primarily to noise pollution, which can be a significant issue in a dense area such as Camden, and the decrease in seasonal efficiency due to local climate conditions - indeed, the winter temperatures in London don't allow the system to work at high efficiency.

For GSHPs, the project is an addition to the an existing building within a very dense area, meaning that no space is available at the ground floor to install the system. Minimal substructure works are proposed meaning that there is no opportunity to add an array of boreholes.

Overall, the analysis conclude that ASHP and GSHP systems are not practically viable.

7.2 Feasible Technology – Photovoltaic

Photovoltaic (PV) systems work by converting solar energy directly into electricity. PV panels generate Direct Current (DC) electricity and are arranged in modules that include inverters to convert electricity into Alternating Current (AC) that can be used by the building systems. The panels should be mounted in a location that receives good access to the sun and is not overshadowed by surrounding parts of the building, adjacent buildings or other PV Panels. As such, they are typically either installed on the roof or integrated into the building facade.

PV panels can generate electricity by either direct or diffuse radiation (i.e. sunlight that has been scattered/ reflected by the atmosphere or surrounding objects). The amount of power that can be generated varies depending on a number of factors, including type of cell, orientation, sunlight conditions, etc. Typically, peak outputs in the UK may be achieved by panels which are orientated around 30-40 degrees above the horizontal southerly direction. Alternate orientations are possible, but relative output of the PV arrays will decrease.

PV panels are proven technology, are silent in operation (do not cause any noise pollution) and do not require frequent access or maintenance. However they are still a relatively expensive renewable technology.

A central roof terrace has been proposed for Camden Wharf building and thus only the roof of the south wing can accommodate photovoltaic panels, the roof of the north wing is reserved for plant equipment. A preliminary layout has been defined, based on the rules of thumb to avoid overshadowing of the panels by the opposite rows.

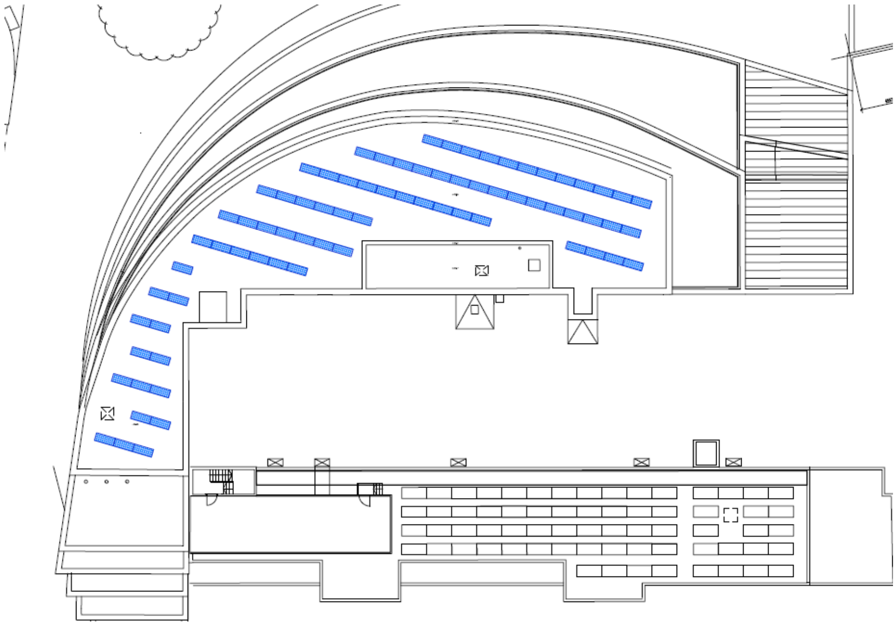


Figure 7.2: Visualisation of the roof terrace showing PV panels.

A preliminary assessment indicate that a 17.5kWp PV system size can be implemented based on the indicative roof layout. This system size, equates to 73 panels of 19.4% efficiency, when coupled with energy efficiency measures, can deliver a total of around 24% improvement over Notional Baseline annual emissions.

An assessment need to be carried out at detailed design stage in order to determine the proper layout arrangement of panels and the expected energy output of the photovoltaic system.

7.3 Renewable Baseline

According to the compliance thermal model, the Renewable Baseline has been estimated as shown in Figure 7.3.

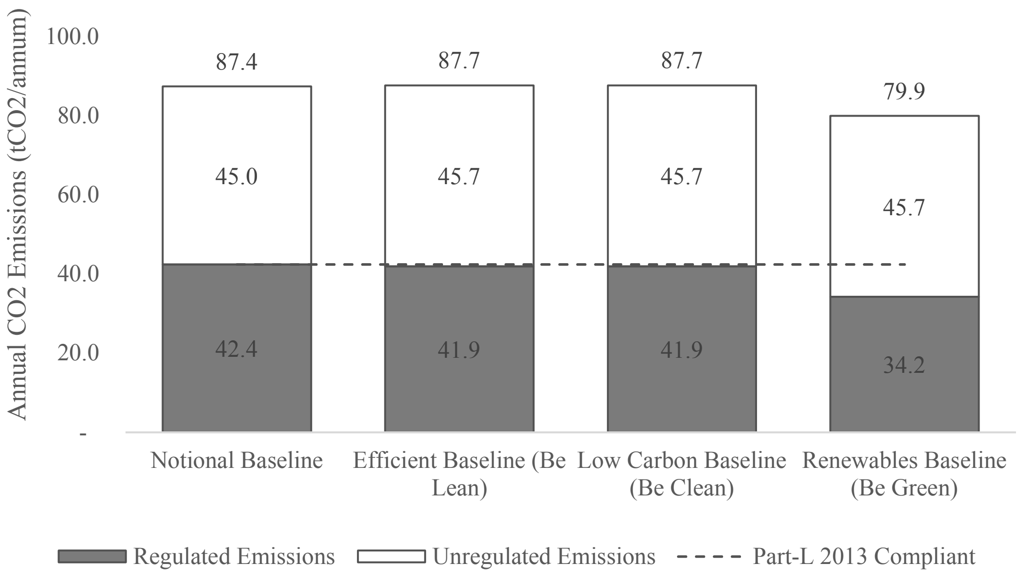


Figure 7.3: Building emissions for the notional building, the efficient baseline, the low carbon baseline and the renewable baseline.

The results indicate that Camden Wharf new addition, with energy efficient MEP services and a 17.5kWp photovoltaic system added, would yield a *'Regulated'* carbon dioxide emission of 34.2tCO_2/annum, based on a Building Emission Rate (BER) of 60.7kgCO_2/m^2annum.

8 Emissions reduction for the whole building

An analysis on the CO_2 emissions reduction related to the impact of the new extension to the entire existing building has been additionally carried out.

Figure 8.1 illustrates comparison of estimated *Regulated* CO_2 emission between the existing Camden Wharf building and the post-refurbishment Camden Wharf building with the new roof top restaurant added.

The results indicate that the post-refurbishment total *Regulated* CO_2 emission to be lower than the existing building even with the new restaurant extension. It is expected that proposed M&E design is able to bring about 11.3% CO_2 reduction to the building, however this is offset by addition of 34.2 tCO_2/annum associated with the new restaurant extension. Overall, an estimated 2.2% carbon reduction is still achievable post refurbishment.

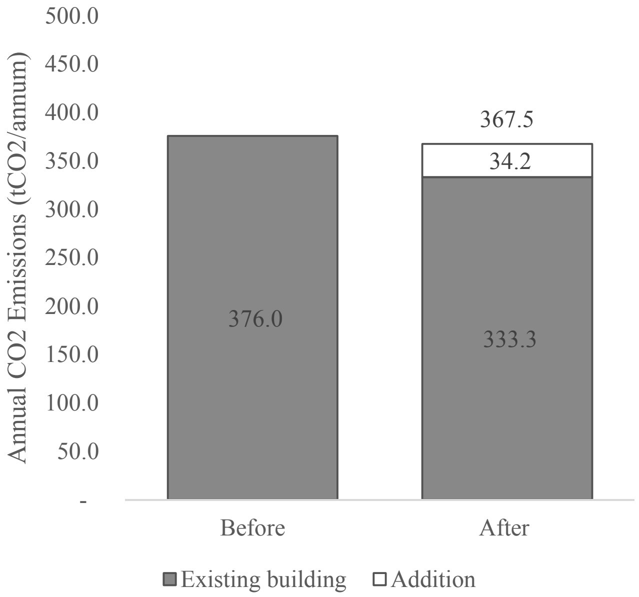


Figure 8.1: Building emissions for the whole building (existing building and new extension).

9 Consequential improvements

The compliance with the *consequential improvements* requirements is summarised in Table 9.1.

Table 9.1: Consequential improvements summary.

No.	Improvement Measure	Undertaken?
1	Upgrade heating systems more than 15 years old by the provision of new plant or improved controls	Yes. Existing heating plant upgrade is part of the project.
2	Upgrading cooling systems more than 15 years old by the provision of new plant or improved controls	Yes. Existing cooling plant upgrade is part of the project.
3	Upgrading air-handling systems more than 15 years old by the provision of new plant or improved controls	Yes. Some existing AHU plant upgrade is part of the project.
4	Upgrading general lighting systems that have an average lamp efficacy of less than 40 lamp-lumens per circuit-watt and that serve areas greater than 100 m^2 by the provision of new luminaires or improved controls	No. The existing lighting systems are assumed to have efficacy of 60 lamp-lumens per circuit-watt.
5	Installing energy metering following the guidance given in CIBSE TM39	Yes. Metering strategy in accordance to CIBSE TM39.
6	Upgrading thermal elements which have U-values worse than those set out in AD L2B 2016 column (a) of Table 5 following the guidance in AD L2B 2016 paragraphs 5.12 and 5.13	Yes. The roof will be upgraded with insulation. Other elements have good U-values (see Par.5.1).
7	Replacing existing windows, roof windows or roof lights (but excluding display windows) or doors (but excluding high-usage entrance doors) which have a U-value worse than 3.3 $W/m^2.K$ following the guidance in AD L2B 2016 paragraphs 4.23 to 4.28	No. existing windows are assumed to have good U-values (see Par.5.1).
8	Increasing the on-site low and zero carbon (LZC) energy-generating systems if the existing on-site systems provide less than 10% of on-site energy demand, provided the increase would achieve a simple payback of 7 years or less.	Yes. PV panels have been proposed in the design.
9	Measures specified in the Recommendations Report produced in parallel with a valid Energy Performance Certificate (EPC)	Yes. Current design stage draft EPC indicate an AR of 27 is achievable.

10 Summary

An energy assessment has been undertaken for the extension of Camden Wharf following the procedure laid out by the document titled "*Energy Planning – Greater London Authority guidance on preparing energy assessments (April 2015)*".

The emission baselines for the proposed redevelopment (Be Lean, Be Clean & Be Green) have been estimated on a '*Regulated Energy'* approach.

Following the Energy Hierarchy approach:

Priority 1	Energy conservation & efficiency
Priority 2	Exploitation of non-sustainable resources using low carbon technologies
Priority 3	Exploitation of renewable, sustainable resources & technologies

The implementation of Energy Efficiency measures in the form of fabric performance improvements, energy efficient building services and intelligent monitoring and controls etc. can result in a 1.2% reduction in '*Regulated Energy'* carbon dioxide emissions, from 42.4tCO_2/annum down to 41.9tCO_2/annum.

No low carbon technology system is viable for practical reasons, mainly related to the tenancy of the different areas in the building. Therefore, no improvements are related to the "*Be clean*" stage.

Renewable energy technology such as Photovoltaic is determined to be feasible for the scheme and an initial assessment determined that a total of 17.5kWp PV system can be deployed on the roof of the building, which brings the '*Regulated Energy'* carbon dioxide emissions down from 41.9tCO_2/annum to 34.2tCO_2/annum, a further saving of 18.2%. Ultimately, it results in an overall total carbon dioxide reduction of 19.4%.

Table 10.1: Carbon dioxide emissions after each stage of the Energy Hierarchy.

	Carbon dioxide emissions (Tonnes CO2 per annum)	
	Regulated Emissions	*Unregulated Emissions*
Baseline: Part-L 2013 of the Building Regulations Compliant Development	42.4	45.0
After energy demand reduction	41.9	45.7
After renewable energy	34.2	45.7

Table 10.2: '*Regulated*' carbon dioxide savings from each stage of the Energy Hierarchy.

	***Regulated* Carbon dioxide savings**	
	(Tonnes CO2 per annum)	(%)
Savings from energy demand reduction	0.5	1.2%
Savings from Low Carbon Technology	-	0.0%
Savings from renewables	7.7	18.2%
Total Cumulative Savings	**8.2**	**19.4%**

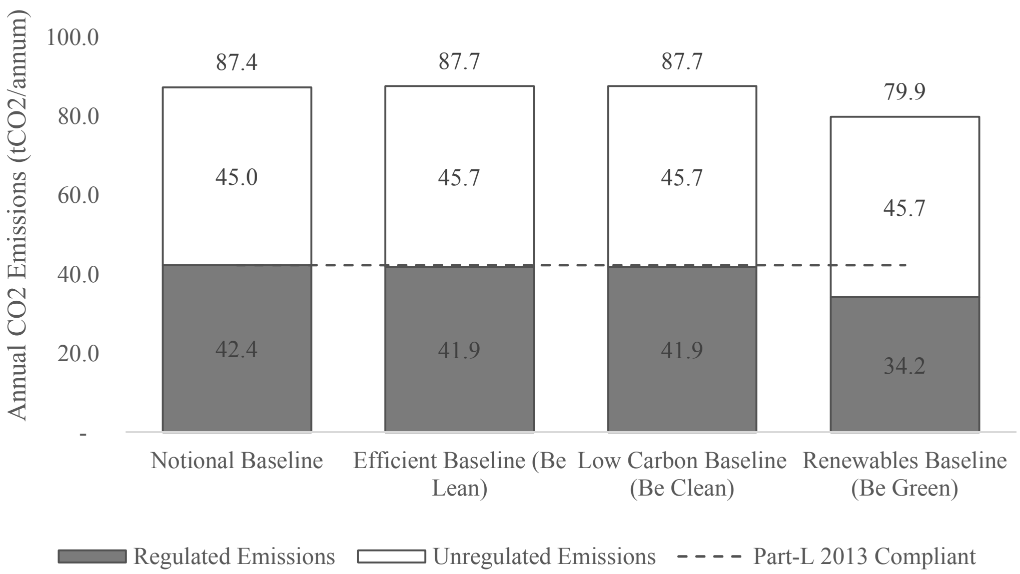


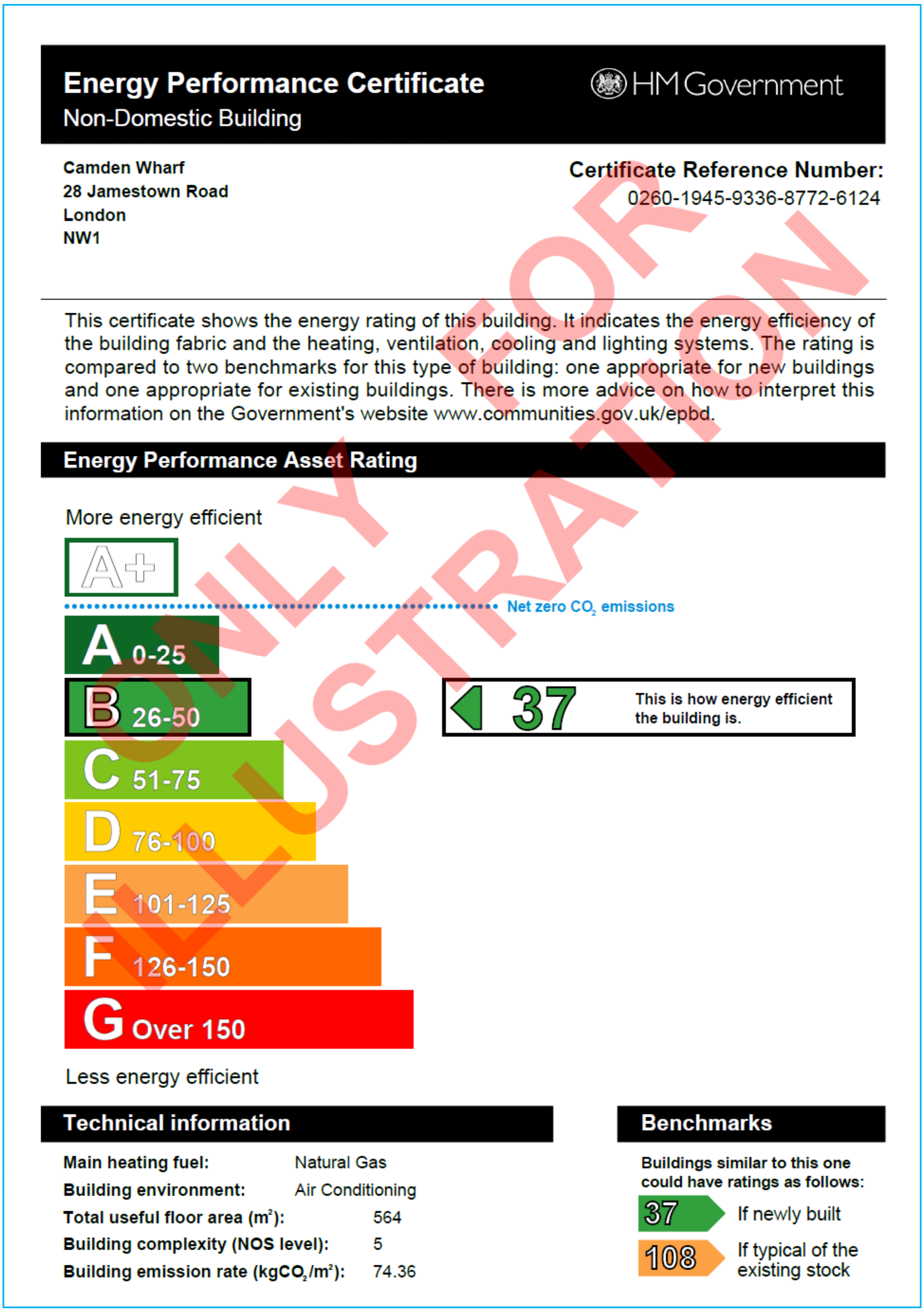
Figure 10.1: Summary chart following the Energy Hierarchy methodology.

To summarize, the new addition complies with Building Regulation Part L2B, and achieves an additional reduction in CO_2 emissions of 19.4%, as shown in Figure 10.1.

In terms of EPC rating, Figure 10.2 illustrates an EPC Asset Rating of 37 (Band B) expected to be achievable with energy efficient Mechanical, Electrical and Public Health services installation.

Figure 10.3 illustrates an EPC Asset Rating of 30 (Band B) expected to be achievable with new energy efficient Mechanical, Electrical and Public Health services installation, and a 17.5kWp Photovoltaic system on the roof level.

In addition, assuming existing thermal elements compliant with Building Regulations Part L 1995, the project respects all the requirements for consequential improvements, thanks to the installation of the new high efficiency systems and renewable technologies.



Energy Performance Certificate
Non-Domestic Building

HM Government

Camden Wharf
28 Jamestown Road
London
NW1

Certificate Reference Number:
0260-1945-9336-8772-6124

This certificate shows the energy rating of this building. It indicates the energy efficiency of the building fabric and the heating, ventilation, cooling and lighting systems. The rating is compared to two benchmarks for this type of building: one appropriate for new buildings and one appropriate for existing buildings. There is more advice on how to interpret this information on the Government's website www.communities.gov.uk/epbd.

Energy Performance Asset Rating

More energy efficient

A+

Net zero CO_2 emissions

A 0-25
B 26-50
C 51-75
D 76-100
E 101-125
F 126-150
G Over 150

Less energy efficient

37 This is how energy efficient the building is.

Technical information

Main heating fuel:	Natural Gas
Building environment:	Air Conditioning
Total useful floor area (m^2):	564
Building complexity (NOS level):	5
Building emission rate ($kgCO_2/m^2$):	74.36

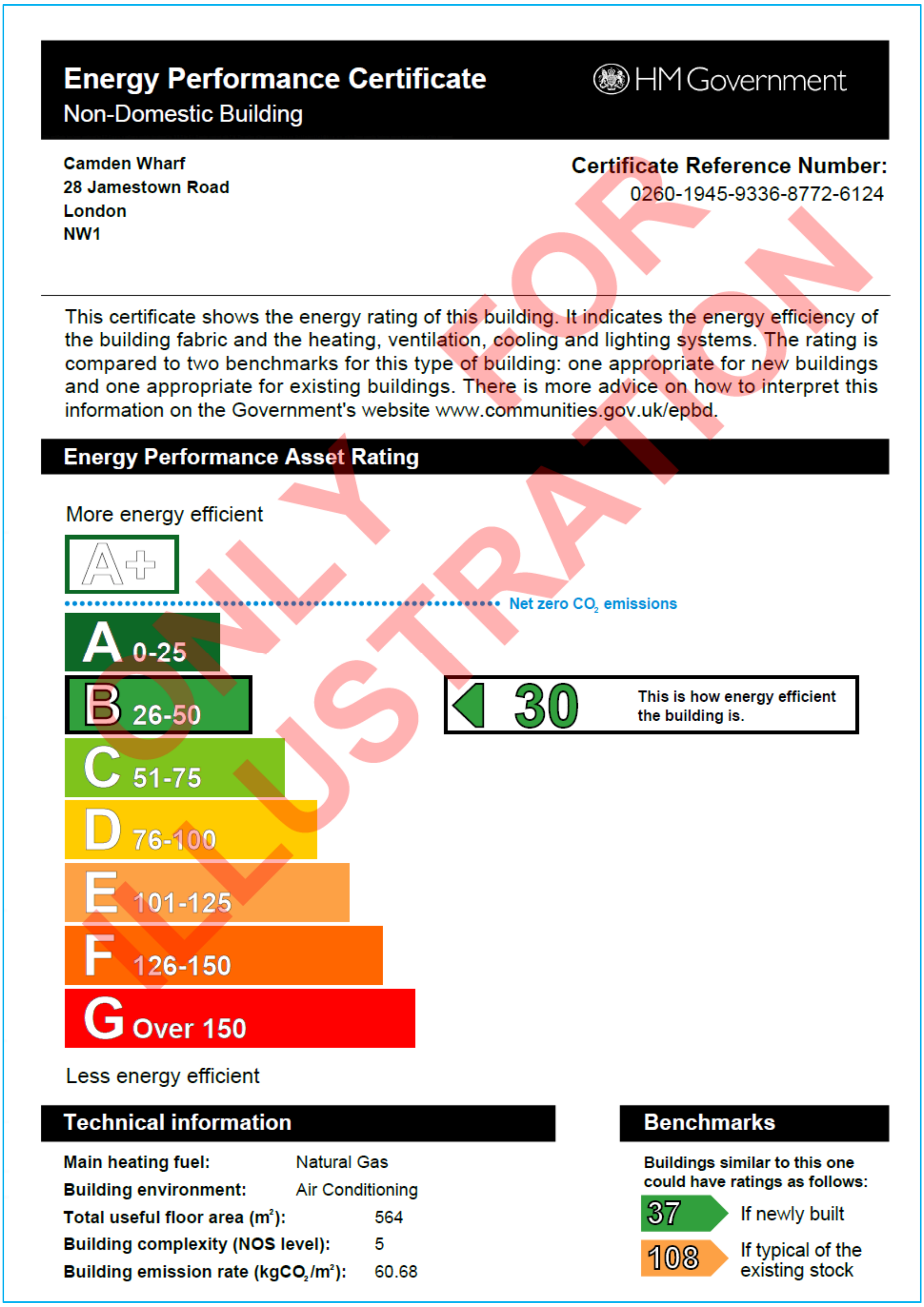
Benchmarks

Buildings similar to this one could have ratings as follows:

37 If newly built

108 If typical of the existing stock

Figure 10.2: Draft EPC rating of Renewable Baseline (with energy efficient MEP system).



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Energy Performance Asset Rating

Technical information

Main heating fuel:	Natural Gas
Building environment:	Air Conditioning
Total useful floor area (m^2):	564
Building complexity (NOS level):	5
Building emission rate ($kgCO_2/m^2$):	60.68

Benchmarks

Buildings similar to this one could have ratings as follows:

37	If newly built
108	If typical of the existing stock

Figure 10.3: Draft EPC rating of Renewable Baseline (with energy efficient MEP system and Photovoltaic system).

Appendix A

Glossary

Glossary

Building Emission Rate (BER) – The building CO_2 emission rate expressed as $kgCO_2/m^2/year$. The BER is calculated in accordance with the National Calculation Methodology (NCM) and the Simplified Buildings Energy Model (SBEM)

Combined heat and power (CHP) – CHP integrates the production of usable heat and power (electricity), in a single, highly efficient process. CHP engine generates electricity whist also capturing usable heat that is produced in this process. This contracts with conventional ways of generating electricity where vast amounts of heat is simply wasted.

District Heating Network (DHN) – DHN is a distribution network of heat generated in a centralised location for residential and commercial heating requirements such as space heating and water heating. The heat is often obtained forma cogeneration plant burning fossil fuels but increasingly biofuel. DHN can provide higher efficiencies and better pollution control than heat generated by localised boilers.

Near-site LZC – a low or zero carbon source of energy generation located near to the site of the assessed building. The source is most likely to be providing energy for all or part of a local community of buildings, including the assessed building e.g. decentralised energy generation linked to a community heat network or renewable connected via private wire.

NOx – a generic term for mono-nitrogen oxides NO and NO2. They are produced from the reaction of nitrogen and oxygen gases in the air during combustion, especially at high temperature in an engine etc.

On-site LZC – a low or zero carbon source of energy generation which is located on the same site as the assessed building.

'Regulated Energy' / 'Regulated'– Building energy consumption resulting from the specification of a 'controlled', fixed building service' i.e. space heating and cooling, water heating, ventilation and lighting, as a result of requirements imposed by Building Regulations.

Target Emission Rate (TER) – The target emission rate is the minimum energy performance requirement (required by Building Regulation) for a new non domestic building ($kgCO_2/m^2/year$). The TER is calculated in accordance with the National Calculation Methodology (NCM) and the Simplified Buildings Energy Model (SBEM).

'Unregulated Energy' / 'Unregulated' – Building energy consumption resulting from a system or process that is not 'controlled' i.e. energy consumption from systems in the building on which the Building Regulations do not impose a requirement. For example, this may include energy consumption from systems integral to the building and its operation e.g. lifts, escalators, refrigeration systems, ducted fume cupboards; or energy consumption from operational related equipment e.g. servers, printers, desktops, mobile fume cupboards, cooking and other appliances etc.

'Whole Energy' – energy consumption covered by the Building Regulation as well as energy consumption from any other part of the development, including plant or equipment that is not covered by the Building Regulations