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Planning Statement
Energy Assessment
176 Prince of Wales Road

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About the Scheme:

The proposal comprises the extension of the existing middle and rear gallery buildings to provide additional gallery space for the art gallery. Located within the London Borough of Camden, the development has a total gross internal area of approximately 1,633 m^2.

Please note that only the refurbished side of the building (west side) will be analysed in this report. The east side of the building comprises 100% retained elements, which are not subject to any renovation work. Moreover, the existing building services will essentially be retained. Therefore for the purposes of this energy strategy the building has been subdivided with the existing unrefurbished part of the building excluded.

Planning Policy

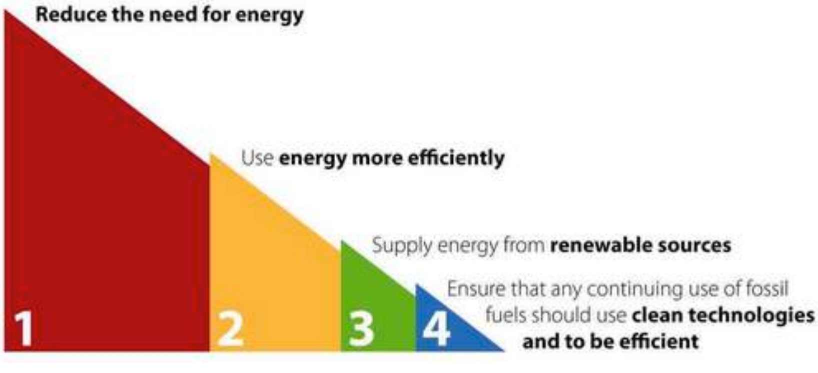
In accordance with the GLA's London Plan Policy 5.2, the London Borough of Camden's Core Strategy Policy, the scheme aspires to achieve a 35% reduction in carbon emissions over minimum building regulations Part L2B.

The scheme complies with the 2013 Building Regulations Part L and the minimum energy efficiency targets in the following documents have been followed:

- Refurbishment (Part L2B) – Consequential improvements to refurbished areas have been made to ensure that the building complies with Part L, to the extent that such improvements are technically, functionally, and economically feasible.

The Energy Hierarchy:

The proposed scheme has followed the energy hierarchy that is illustrated below:



The resulting energy savings are shown below in accordance with the GLA's Energy Hierarchy:

GLA's Energy Hierarchy – Regulated Carbon Emissions				
	Baseline:	Be Lean:	Be Clean:	Be Green:
CO_2 emissions (Tonnes CO_2/yr)	73.32	48.66	-	47.36
CO_2 emissions saving (Tonnes CO_2/yr)	-	24.66	-	1.31
Saving from each stage (%)	-	33.6	-	1.8
Total CO_2 emissions saving (Tonnes CO_2/yr)	25.96			
35.4% Total carbon emissions savings over Part L of the Building Regulations 2013 achieved				

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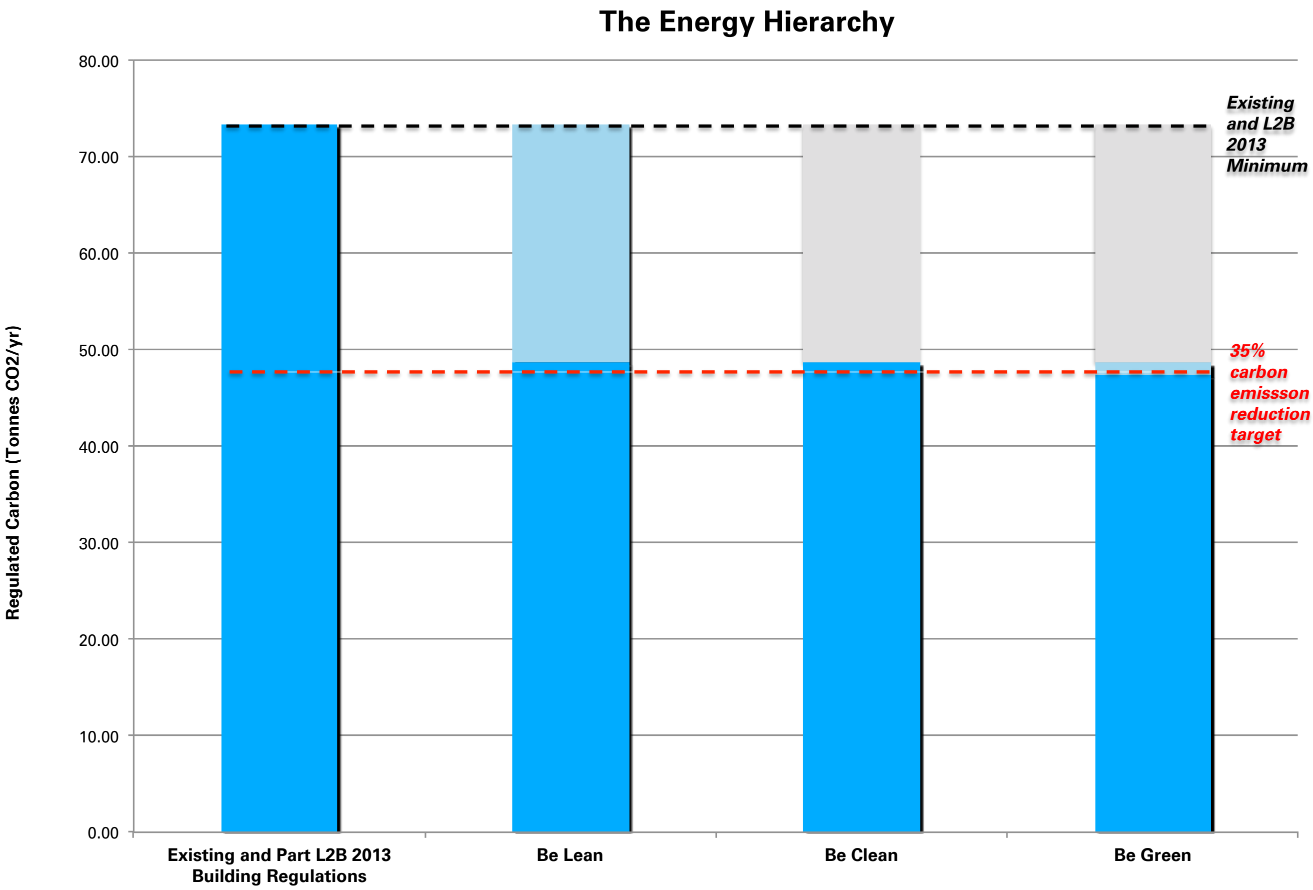
GLA's Energy Hierarchy – Regulated Carbon Emissions:

A graphical illustration of how the scheme performs in relation to Building Regulations and the Energy Hierarchy is shown below.

Figure:



Summary:

As demonstrated above the development will reduce carbon emissions by 33.6% from the fabric energy efficiency measures described in the 'Be Lean' section, and will reduce total carbon emissions by 35.4% over Building Regulations with the further inclusion of low and zero carbon technologies.

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Shortfall in Emissions:

As set out in Policy 5.2 of the London Plan and adopted within Camden's Core Strategy Policy, if the development fails to meet the 35% target, the annual shortfall is determined by subtracting the overall regulated carbon dioxide savings from the target savings. The result is then multiplied by the assumed lifetime of the development's services (e.g. 30 years) to give the cumulative shortfall. The cumulative shortfall is multiplied by the carbon dioxide off-set price to determine the required cash-in-lieu contribution, as shown below.

Carbon Dioxide Emissions – Regulated (Tonnes CO_2/yr)		
	(Tonnes CO_2/yr)	%
Savings from 'Be Lean'-After energy demand reduction	24.66	33.6%
Savings from 'Be Clean'-After CHP	0.0	0.0%
Savings from 'Be Green'-After renewable energy	1.31	1.8%
Total Cumulative Savings	25.96	35.4%
Total Target Savings	25.66	35%
Annual Surplus	0.30	-
Cumulative Shortfall	0	

Total Carbon Emissions:

As required by the GLA both the regulated and unregulated emissions of the development must be quantified and demonstrated. The total emissions for the scheme are shown below.

Carbon Dioxide Emissions – Regulated and Unregulated (Tonnes CO_2/yr)			
	Regulated Emissions	Unregulated Emissions	Total Emissions
Baseline: Part L 2013	73.32	45.58	118.90
Be Lean: After demand reduction	48.66	45.58	94.24
Be Clean: After CHP	-	-	-
Be Green: After Renewable energy	47.36	45.58	92.94

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Introduction
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Aim of this study:

The purpose of an energy assessment is to demonstrate that climate change mitigation measures comply with London Plan energy policies, including the energy hierarchy. It also ensures energy remains an integral part of the development's design and evolution.

Methodology:

The methodology followed in this report follows the guidance set out by the Greater London Authority (GLA) for developing energy strategies as detailed in the document "ENERGY PLANNING: Greater London Authority guidance on preparing energy assessments (2016)"

In accordance with the GLA's London Plan Policy 5.2 and the London borough of Camden's Core Strategy Policy CPG3, applications for major developments should be accompanied by an energy statement. The energy statement should provide information demonstrating how the energy hierarchy has been followed i.e. 'Lean, Clean, Green', including consideration of passive design and decentralised energy options such CHP/Community CHP.

This report has followed these documents and comprises the following components:

- BASELINE: A calculation of the Part L 2013 Building Regulations complaint CO_2 emission baseline using approved software. The baseline assumes a gas boiler would provide heating and any active cooling would be electrically powered.

- Maximise Energy Efficiency (Be LEAN): A calculation of the impact of demand reduction measures. For example, passive design measures, including optimising orientation and site layout, natural ventilation and lighting, thermal mass and solar shading, and active design measures such as high efficacy lighting and efficient mechanical ventilation with heat recovery.

- Supply Energy Efficiently Using Low Carbon Heating and Cooling Systems (Be CLEAN: COOLING HIERARCHY): in accordance with Policy 5.9 of London Plan, measures that are proposed to reduce the demand for cooling have been set out such as minimisation of solar and internal gains and night cooling strategies.

- CLEAN: in accordance with Policy 5.6 of London Plan, this report has demonstrated how the scheme has selected heating, cooling and power systems to minimise carbon emissions. This comprises an evaluation of the feasibility of connecting to existing low carbon heat networks, planned networks, site-wide and communal heat networks and CHP.

- Incorporate Renewable Technology (Be GREEN): in accordance with Policy 5.7 of London Plan, this report has conducted a feasibility assessment of renewable energy technologies. This comprised a site-specific analysis of the technologies and if applicable how they would be integrated into the heating and cooling strategy for the scheme.

Please note that these findings are currently subject to a detailed analysis from a building services design engineer and qualified quantity surveyor.

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Establishing Emissions: The Carbon Profile

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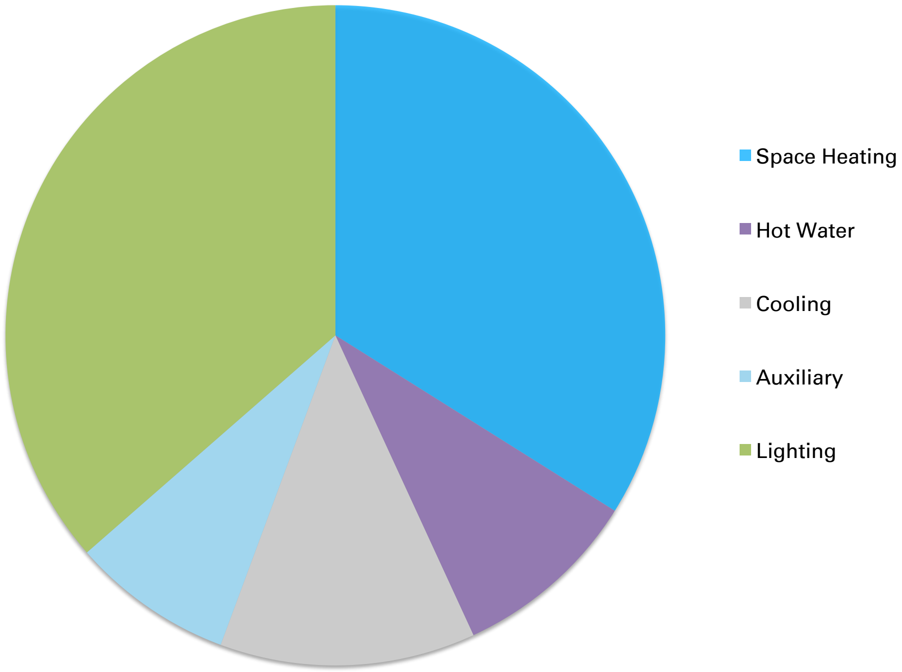
Building Regulations Part L 2013 Minimum Compliance:

The 'baseline' carbon emissions for the development are 73.32 Tonnes CO_2/yr.

The pie chart below provides a breakdown of the scheme's baseline carbon emissions by end use over the course of one year.

Carbon Emissions in Tonnes CO_2/yr	Heating	Hot Water	Cooling	Auxiliary	Lighting
	24.85	6.75	9.18	5.81	26.69

Baseline CO_2 Breakdown



Overview:

The chart above shows that lighting is the primary source of carbon emissions, and space heating is the second largest, across the scheme as a whole. Lighting accounts for approximately 36% of the baseline scenarios energy demand whilst space heating accounts for 34%.

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‘Be Lean’: Demand Reduction Measures

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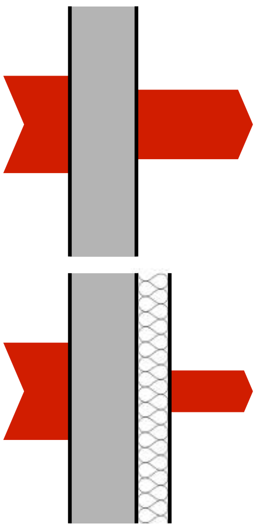
Be Lean - Summary:

Demand reduction measures have reduced the scheme’s carbon emissions by 33.6% over the minimum Part L 2013 Building Regulations baseline.

Building Fabric Passive Design measures:

U Values:

Element	Minimum Building Regulations U value W/m^{2}K	Proposed U value W/m^{2}K
External wall (existing)	1.60	0.30
External wall (new)	0.28	0.24
Ground floor (existing)	-	0.58
Ground floor (new)	0.22	0.18
Roof (new)	0.18	0.18
Glazing (existing)	-	4.96
Glazing (new)	1.8	1.6
Personnel doors (new)	1.8	1.8



Graphic illustrations of the heat flow through a wall and how is it minimized with low u-value (consequence of the additional insulation).

Airtightness:

The target air permeability for the scheme has been modelled as 10 m^3/(hr.m^2) @ 50 pa.

This will require careful attention to two key areas:

- Structural leakage
- Services leakage

Structural leakage occurs at joints in the building fabric and around window and door openings, loft hatches and access openings. There will also be some diffusion through materials such and cracks in masonry walls typically this is caused by poor perpends in blockwork inner leafs. Structural leakage is hard to remedy retrospectively. Good detailing at the design stage is therefore essential.

Services leakage occurs at penetrations from pipes and cables entering the building. These can be sewerage pipes, water pipes and heating pipes. As well as electricity cables there may also be telecommunication cables. Attention therefore, needs to be paid to sealing all penetrations during constriction.

Thermal Bridging:

As a refurbishment project there is limited scope to minimise heat loss via linear junctions. The scheme has therefore been indicatively modelled with the default thermal bridge y-values for all junction types, 0.15W/m^{2}K.

Thermal Mass:

Thermal mass of the scheme has been indicatively modelled as 250 kJ/m^{2}K (medium).

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'Be Lean': Demand Reduction Measures
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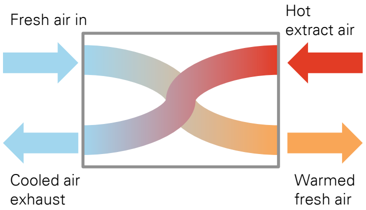
Energy Efficient Services Active Design measures:



Graphic illustration of a heat recovery unit, which exploits the extract hot air of the room to heat the cold supply air.

Heating:
The new heating system in the refurbished west-side part (new extended rear and middle galleries) of the building, for the *Lean scenario only*, will be provided by a condensing gas boilers, featuring time and temperature zone control, delayed thermostat and a weather compensator. The heat will be distributed via radiators. The gas boiler will have a minimum efficiency of 94%.

Ventilation:
Balanced mechanical ventilation with heat recovery (70% seasonal efficiency and 1.8 SFP) will be provided to renovated parts of the scheme, with localised extract ventilation for kitchens and WCs with a with an SFP of 0.3 W/l/s.

Air Conditioning:
Cooling will be provided to the main galleries and associated rooms (including art storage) of the renovated part of the building by 4 x 56kW VRV condensing systems, the systems will have an energy efficiency rating of 3.01.

Lighting:
High efficiency lighting has been specified for the whole development with a minimum luminous efficacy of 75 lumens per circuit watt.

'Be Clean': Heating Infrastructure & CHP

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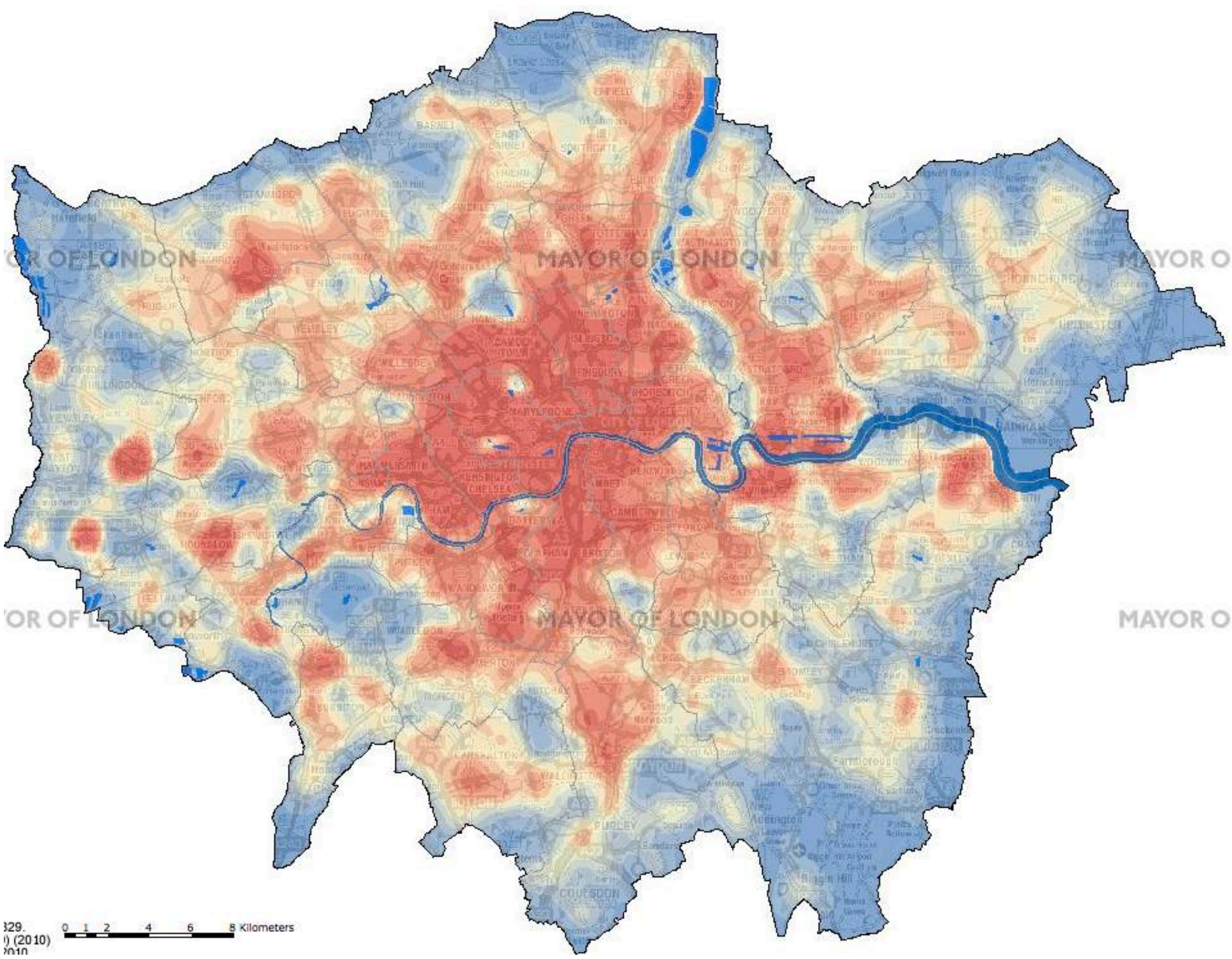
Heating Infrastructure including CHP:

Once demand for energy has been minimised, schemes must demonstrate how their energy systems have been selected in accordance with the order of preference in Policy 5.6B of London Plan. This has involved a systematic appraisal of the potential to connect to existing or planned heating networks and on site communal and CHP systems.

Heating Infrastructure:

The London Heat Map (shown below) has been consulted to establish the possibility of connecting to heating infrastructure.



Source: http://www.londonheatmap.org.uk/Mapping

'Be Clean': Connection to Existing and Planned Networks

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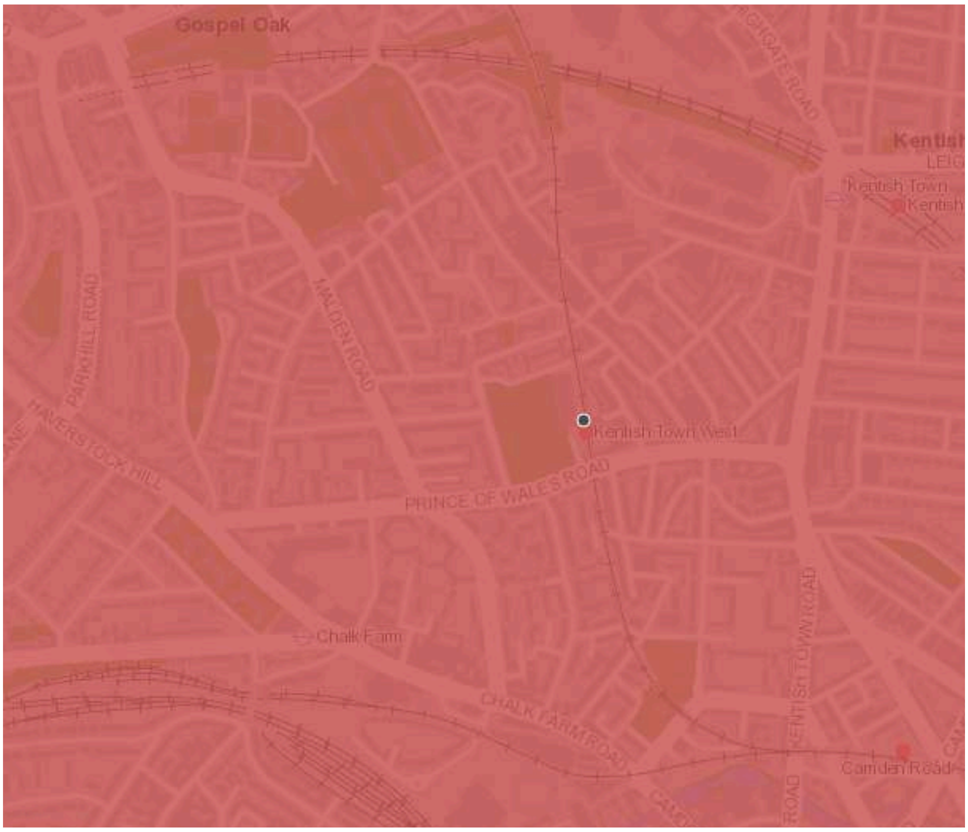
Existing and Planned Networks:

Existing networks:

A review of the London Heat Map demonstrates that there are no existing networks present within connectable range of the scheme. A map of the existing and potential networks in the scheme's location is shown below.

Existing DH Networks

Potential DH Networks



There are no existing or potential networks within (500m) the vicinity of the scheme; therefore a connection is not possible.

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'Be Clean': Site Wide Networks and CHP

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Site-wide Heat Networks:	The scheme comprises one building so a site wide heating network is not relevant.
Combined Heat and Power (CHP)	In accordance with section 8.3 of the GLA guidance for Energy Planning where connection to an area wide heat network will not be available in the foreseeable future i.e. 5 years following completion, or the development is of such a scale that it could be the catalyst for an area wide heat network, applicants should evaluate the feasibility of on-site CHP The heat demand profile of this gallery/office scheme is not suitable to CHP. The implemented fabric improvements from the 'Be Lean' scenario have reduced energy demand from space heating somewhat. However, for CHP systems to be economically viable they need to run for at least 5,000 hours per year. Although the scheme has a reasonable space heating demand it is still not large or consistent for a CHP system, as it would be oversized, and as a result less efficient and economic. The plant room will make allowances to be 'connection ready' should any future connection become available. Capped pipework and plant room allocation for connection to future networks will be made.

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'Be Clean': Cooling
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Policy 5.9 Overheating and Cooling:

The aim of this policy is to reduce the impact of the urban heat island effect in London and encourage the design of spaces to avoid overheating and excessive heat generation, and to mitigate overheating due to the impact of climate change.

Where design measures and the use of natural and/or mechanical ventilation are not enough to guarantee the occupant's comfort, in line with the cooling hierarchy the development's cooling strategy must include details of the active cooling plant being proposed, including efficiencies, and the ability to take advantage of free cooling and/or renewable cooling sources.

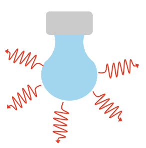
Where appropriate, the cooling strategy should investigate the opportunities to improve cooling efficiencies through the use of locally available sources such as ground cooling and river/dock water-cooling.

The Cooling Hierarchy:

Major developments should reduce potential overheating and reliance on air conditioning systems and demonstrate this with the Cooling Hierarchy:

1) **Minimise internal heat generation through energy efficient design**
2) **Reduce the amount of heat entering the building in summer (e.g. shading and fenestration)**
3) **Manage the heat within the building through thermal mass, room height and green roofs**
4) **Passive ventilation**
5) **Mechanical ventilation**
6) **Active cooling systems (ensuring the lowest carbon option)**

Avoiding Overheating Measures taken:



LED bulbs can emit 80% less heat compared to an incandescent bulb and their life span is up to 41 times more.

The following measures have been taken in accordance with the cooling hierarchy to reduce overheating and the need for cooling:

1) **Minimise internal heat generation through energy efficient design**

Internal heat gains have been minimised where possible. The scheme is a gallery with minimal equipment. Any new appliances such as office equipment will be energy efficient and will help reduce internal heat gain and reduce the cooling requirement.

Energy efficient lighting will also be specified as part of the renovation works. Internal lighting will have a luminous efficacy of 75 lumens per circuit watt and occupancy sensors will also be specified in corridors, WCs and store rooms to reduce unnecessary lighting usage.

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Avoiding Overheating
Measures taken:

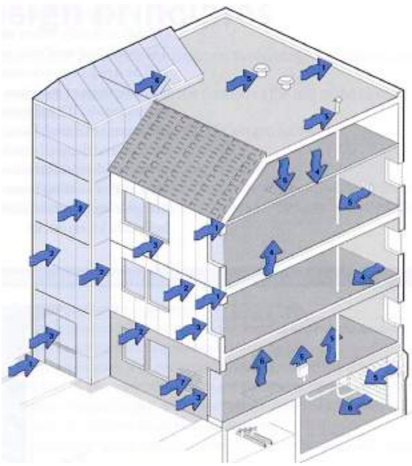
2) Reduce the amount of heat entering the building in summer (e.g. shading and fenestration)

Direct solar gains will be controlled in the following ways:

- Orientation of building – the building's most-glazed façades are orientated east-west which reduces the solar gain and overheating risks.
- Solar control – all methods of controlling solar gain to within tolerable limits have been considered. The design and type of window openings and glazing have been optimised, the new windows will have reduced solar gain factors from low emissivity windows with a G-value of 0.55.
- Internal solar control devices such as blinds will be specified for the offices.

Heat transfer and infiltration has been controlled in the following ways:

- Insulation levels for the new thermal elements have been maximised and the resulting u-values are lower than required by Building Regulations. The build-ups therefore prevent the penetration of heat as much as practically possible. See the 'Be Lean' section of this report for target u values.
- A reduced air permeability rate of 10 $m^3/(hr.m^2)$ @ 50 pa has been targeted to minimise uncontrolled air infiltration. This will require attention to detailing and sealing. See 'Be Lean' section of this report for details of how this will be achieved.


Examples of possible air leakage points in a building

3) Manage the heat within the building through thermal mass, room height and green roofs.

The following measures have been specified to manage heat accumulation within the building:

- High thermal mass – existing building fabric materials such as thick masonry (walls) and concrete (floors) act as 'thermal batteries'; they absorb heat gains during the day when the building is occupied and 'store' it for an extended period, thereby helping to stabilise daytime temperatures. At night this heat can be dissipated, which 'resets' the heating cycle. Ventilation will also be used at night to purge the stored heat within the structure.


Examples of how the thermal mass absorbs heat during day and emits it during night.

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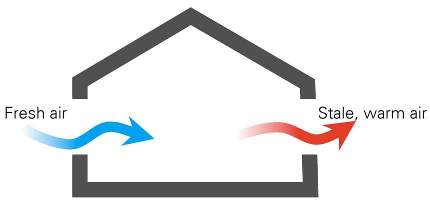
Avoiding Overheating Measures taken:

- Room heights – high ceilings are traditionally used in hot climates to allow thermal stratification so that occupants can inhabit the lower cooler space, and to decrease the transfer of heat gain through the roof. The existing building has varying floor to ceiling heights of approximately 2.7m to 5.9m. As the new roof will be well insulated to achieve a U-value of 0.18 W/m^{2}K, there will be minimal penetration of heat through the roof.

- Due to the listed status of the former Methodist Church, and to integrate the extension with the listed features of the building, the design team have considered a green roof impractical. Brick tiles will be specified which will have a neutral impact to the absorbed heat being transferred into the building.

4) Passive ventilation

Ventilation that does not use fans or mechanical system has been specified to reduce the cooling load.



Typical building section demonstrating passive cross ventilation.

- Openable sash windows are specified on the front facade of the building. Cross ventilation will be achieved by opening windows and ensuring there is a clear path for airflow.

- Night time cooling can also be utilised via opening windows. This will work in tandem with high thermal mass materials specified. The larger temperature differential that exists between internal and external temperatures at night will allow effective stack ventilation and purging of heat accumulated within the structure during the day.

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Avoiding Overheating Measures taken:

5) Mechanical ventilation

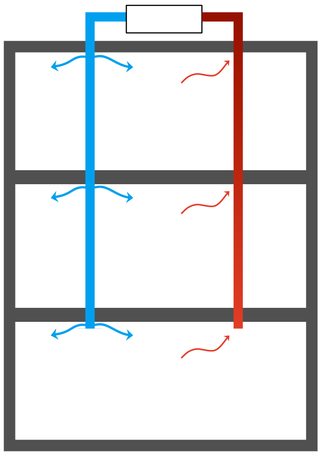
Passive ventilation will not be adequate to cool the building to the required temperature. Mechanical ventilation will be utilised in the following forms:

- A mixed mode system will be implemented in the refurbished building. This will be complimentary to the passive cooling measures taken. During summer months, mechanical ventilation using fans will circulate and remove hot air from the building. The building will also adopt a zoned design to allow natural ventilation where possible and mechanical ventilation where there are increased cooling loads such as gallery and IT rooms and equipment and high-density offices.

- Fan powered ventilation: single point extracts will be used in WCs, bin stores and food preparation areas. The renovated part of the building will use air handling units with separate supply and extract fans. Heat recovery units will also be specified to reduce energy demand, improved performance will be achieved by the reduced air permeability rate of 10 $m^3/(hr.m^2)$ @ 50 pa.

- The mechanical systems will have the following efficiencies which are in compliance with the Non-Domestic Building Services Compliance Guide:
  - ✓ Specific fan power of 0.3 W/l/s for extract fans
  - ✓ Specific fan power of 1.8 W/l/s for whole ventilation systems with heat recovery
  - ✓ Heat recovery efficiency of 70%*

*Variable seasonal efficiency



Typical building section demonstrating a simple method of supply and extract ventilation system.

Overheating Risk:

According to the GLA guidance on preparing energy assessments (2016), Section 11, a dynamic modelling to assess the risk of overheating should be carried out. An overheating risk assessment with dynamic thermal modelling has been conducted and confirms that without active cooling measures there is a risk of overheating. A separate overheating report has been undertaken and accompanies this report.

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Efficiency Measures taken:

6) Active cooling systems (ensuring the lowest carbon option)

Passive design measures and the use of natural and/or mechanical ventilation were not adequate to meet the requirements of a contemporary art gallery and the provision of climatically controlled exhibition and storage spaces. Therefore, air conditioning has been specified for the scheme to provide the required level of comfort. Following the methodology of the cooling hierarchy has progressively reduced the demand for cooling.

To ensure the cooling system is the most carbon efficient possible the following parameters have been selected:

- Location: Indoor cooling units have been specified on a localised basis where internal gains are too high. The units will be fully fitted with local temperature controls for optimal usage.
- The AC systems will have the following efficiencies which are in compliance with the Non-Domestic Building Services Compliance Guide:
  - ✓ Seasonal Energy Efficiency Ratio of 4.39
  - ✓ Energy Efficiency Ratio of 3.01

Renewable Energy Feasibility:

In line with Policy 5.7 of the London Plan the feasibility of renewable energy technologies has been considered. A detailed site-specific analysis and associated carbon saving calculations has also been provided for renewable energy technologies considered feasible.

Renewable Energy Technology Comparison:

Each technology has been assessed under 5 broader categories. There are key criteria for each category on which the technology is evaluated. The key criteria have been given a weighting based on a tick-system, a graphical representation of this is shown below:

✔ ✔ ✔ ✔ ✔ = 1 scored out of a possible 5

The weighting of each of the criteria within the categories is shown below:

- **Local, site-specific impact:** (Maximum score of 4)
  - Local planning criteria = ✔ ✔
  - Land used by all components = ✔
  - Noise impact from operation = ✔
- **Suitability and design impact:** (Maximum score of 4)
  - Interaction on the current building design = ✔ ✔
  - Building orientation suitability = ✔
  - Buildability of installation = ✔
- **Economic viability:** (Maximum score of 5)
  - Capital cost of all components = ✔ ✔
  - Grants and funding available = ✔
  - Payback periods (years) 3-5, 5-10, 10-15 = ✔ ✔ ✔
- **Operation and maintenance:** (Maximum score of 3)
  - Servicing requirements (low or high) = ✔
  - Maintenance costs (low or high) = ✔
  - Resource use from future maintenance (low or high) = ✔
- **CO_2 and sustainability:** (Maximum score of 10)
  - Carbon saving per year = ✔ ✔ ✔ ✔
  - Impact of future grid decarbonisation (gas vs. electric) = ✔ ✔
  - Local air quality/pollution = ✔ ✔
  - Resource use of installation = ✔ ✔

Key comments on each of the criteria and the corresponding score will be provided in a table (example below) for each of the technologies. The score for each of the criteria will be summed and each of the technologies will then be ranked. The assessment of each technology is undertaken on the following pages.

Renewable Technology	Local, site-specific impact	Suitability and design impact	Economic viability	Operation and maintenance	CO_2 and sustainability
	✔✔✔✔	✔✔✔✔	✔✔✔✔✔	✔✔✔	✔✔✔✔✔ ✔✔✔✔✔

Biomass & Biofuel:

Rejected

Biomass is normally considered a carbon 'neutral' fuel, as the carbon dioxide emitted on burning has been recently absorbed from the atmosphere by photosynthesis. Although some form of fossil fuel derived inputs are required in the production and transportation of the fuel.

Wood is seen as a by-product of other industries and the small quantity of energy for drying, sawing, pelleting and delivery are typically discounted. Biomass from coppicing is likely to have external energy inputs from fertiliser, cutting, drying etc. and these may need to be considered. In this toolkit, all biomass fuels are considered to have zero net carbon emissions.

Biomass can be burnt directly to provide heat in buildings. Wood from forests, urban tree pruning, farmed coppices or farm and factory waste, is the most common fuel and is used commercially in the form of wood chips or pellets. Biomass boilers can also be designed to burn smokeless to comply with the Clean Air Acts.

Boilers can be fed automatically by screw drives from fuel hoppers. This typically involves daily addition of bagged fuels. A biomass boiler could be installed on site for supplementary LTHW heating; however, a major factor influencing the suitability of a biomass boiler is the availability of the biomass fuel. A local and reliable fuel source would be essential for the biomass boiler to be an efficient replacement for a conventional boiler system. Therefore, a very comprehensive feasibility assessment needs to be undertaken to understand the practicalities of such a system.

It is estimated that the heating and hot water demand of the site is large enough to allow significant reductions in CO_2 emissions to be achieved if a biomass boiler was installed. However, a biomass boiler would need to be combined with energy demand reduction measures to limit the required number of deliveries to the site. In order to meet a significant CO_2 emissions reduction a 65kW biomass boiler would need to be installed for the renovated part of the scheme. The likely installed cost would be circa £50,000. The additional cost of providing and storing the bio-fuel also needs to be accounted for. The site is likely to be unsuitable for biomass boilers due to site constraints such as limited transport/access issues, and storage of the biomass fuel. For an extensive understanding of the capabilities and feasibility of this technology, a further analysis would be required at the detailed design by an appropriate services engineer.

Renewable Technology	Local, site-specific impact	Suitability and design impact	Economic viability	Operation and maintenance	CO_2 and sustainability
Biomass Boiler	✔✓✓✓ Local air quality impacts, increased transport usage on the restricted site, increased plant space.	✔✔✔✓ Increase in plant space required, orientation fine, slightly increased buildability issues.	✔✔✔✓✓ Increased capital costs of installation, typical payback of 8 years	✔✓✓ Increased maintenance relative to gas boiler, resource use not significantly increased if well serviced.	✔✔✔✔✔ ✔✔✓✓✓ Very low carbon intensity of feedstock if properly procured. Decarbonisation impact not applicable, air quality issues.

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'Be Green': Renewable Energy

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Photovoltaic (PV):

Rejected

Photovoltaic systems convert energy from the sun into electricity through semi conductor cells. Systems consist of semi-conductor cells connected together and mounted into modules. Modules are connected to an inverter to turn the direct current (DC) output into alternating current (AC) electricity for use in buildings.

Photovoltaic systems can be discreet through being designed as an integral part of the roof. An 'invisible' design using slates or shingles as opposed to an architectural statement could be preferable in a sensitive area.

Photovoltaics supply electricity to the building and are connected to the electrical grid or to any other electrical load. Excess electricity can be exported to the National Grid when the generated power exceeds the local need. PV systems require only daylight, not sunlight to generate electricity (although more electricity is produced with more sunlight), so energy can still be produced in overcast or cloudy conditions.

The cost of PV cells is heavily dependent on the size of the array. There are significant cost reductions available for larger installations.

The most suitable location for mounting photovoltaic panels is on roofs as they usually have the greatest exposure to the sun. The proposed site has a large useable roof area and is orientated east-west. However, it is considered unsuitable given the conservation constraints of scheme and its listed status.

Renewable Technology	Local, site-specific impact	Suitability and design impact	Economic viability	Operation and maintenance	CO_2 and sustainability
Photovoltaic	✔✔✓✓ No local air quality impacts, use of unutilised roof space, conservation officer has concerns for part of the site, no noise issues. The historic character of the building will be considered compromised with PVs.	✔✔✔✓ Can be added to the roof, good orientation, and slightly increased buildability issues for wiring and metering.	✔✔✔ ✔✓ Increased capital costs of installation, typical payback of 8 years, Feed in Tariff available.	✔✔✓ Limited servicing and maintenance i.e. 1 visit per year, inverter will require replacement.	✔✔✔✔✔ ✔✔✓✓✓ High carbon saving from electricity, uses minimal grid electricity, no local air impact, high embodied energy of panels.

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Solar Thermal:

Rejected

Solar water heating systems use the energy from the sun to heat water for domestic hot water needs. The systems use a heat collector, generally mounted on the roof in which a fluid is heated by the sun. This fluid is used to heat up water that is stored in either a separate hot water cylinder or a twin coil hot water cylinder inside the building. The systems work very successfully in all parts of the UK, as they can work in diffuse light conditions.

Like photovoltaic panels the most suitable location for mounting solar hot water panels is on roofs as they usually have the greatest exposure to the sun. The proposed site has a large useable roof area and is orientated east-west. However, it is considered unsuitable given the conservation constraints of scheme and its listed status.

It is estimated that the CO_2 emissions reduction that would be produced by solar hot water as a standalone system would not be adequate to achieve the required CO_2 emissions reduction target. Therefore a solar hot water system would need to be combined with more energy efficiency strategies, a CHP or additional renewable technologies to achieve the carbon reduction target.

Renewable Technology	Local, site-specific impact	Suitability and design impact	Economic viability	Operation and maintenance	CO_2 and sustainability
Solar Thermal	✔✔ (✔✔) No local air quality impacts, use of unutilised roof space, conservation officer has concerns for part of the site, no noise issues. The historic character of the building will be considered compromised with solar panels.	✔✔✔ (✔) Can be added to the roof, good orientation, and slightly increased buildability issues for piping and cylinders.	✔✔✔✔ (✔) Increased capital costs of installation, typical payback of 8 years, Renewable Heat Incentive available.	✔✔✔ Limited servicing and maintenance i.e. 1 visit every two years, heat transfer fluid requires replacing every 10 years.	✔✔✔✔✔ (✔✔✔✔✔) Lower carbon saving as primarily displacing gas, uses minimal grid electricity, no local air impact, medium embodied energy of panels.

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Wind Energy:

Rejected

Wind energy is a cost effective method of renewable power generation. Wind turbines can produce electricity without carbon dioxide emissions in ranges from watts to megawatt outputs. The most common design is for three blades mounted on a horizontal axis, which is free to rotate into the wind on a tall tower.

The blades drive a generator either directly or via a gearbox to produce electricity. The electricity can either be linked to the grid or charge batteries. An inverter is required to convert the electricity from direct current (DC) to alternating current (AC) for feeding into the grid.

Modern quiet wind turbines are becoming viable in low density areas where ease of maintenance and immediate connection to the grid or direct use of the electricity in a building, may make them cost effective, despite lower wind speeds than open areas.

Wind turbines are generally less suited to dense urban areas as their output will be affected by potentially lower and more disrupted wind speeds, and their use of much more cost effective machines may be prohibited by their proximity to some building types. Small turbines can be used in inner city areas mounted on buildings, although there are relatively few installations.

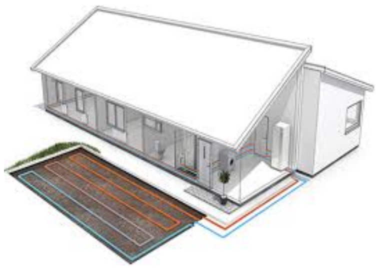
Typically a 1.5 kW turbine can provide 4,000 kWh of electrical power annually. To achieve the required CO_2 emissions reduction target approximately 1 turbine would be required as a standalone solution. The indicative cost of a smaller roof mounted turbine is £2,000/kW so achieving the required CO_2 emissions reduction would cost approximately £4,000 for installation and maintenance costs.

A detailed wind resource evaluation would be required for the site to fully understand the generation potential and payback period. Also, it is certain that planning restrictions and resistance from small groups within the local community would mean the viability of wind energy is nil for the project.

Renewable Technology	Local, site-specific impact	Suitability and design impact	Economic viability	Operation and maintenance	CO_2 and sustainability
Wind Energy	✔ (1 of 4) No local air quality impacts, use of unutilised roof space, conservation officer will have concerns for the site, minor noise issues. The historic character of the building will be compromised with wind turbines	✔ (1 of 4) Can be added to the roof, relatively limited wind speeds in local area, increased buildability issues for wiring and metering.	✔✔✔✔ (4 of 5) Medium capital costs of installation, typical payback < 5 years, Feed in Tariff available.	✔✔✔ Very limited servicing and maintenance, costs of 2-3% typical.	✔✔✔✔✔✔✔ (7 of 10) High carbon saving from electricity, output limited from urban installation, consumes little grid electricity, no local air impact, low embodied energy of panels.

Ground Source Heat Pump (GSHP):

Rejected



Geo-thermal energy is essentially heat collected from the ground. Heat obtained from the ground may be considered it as a source of heating and cooling within the UK by the use of a geo-thermal heat pump or ground source heat pumps.

A ground source heat pump is a device for converting energy in the form of low level heat to heat at a usable temperature. The heat pump consists of five main parts; ground collector loop/or bores, heat exchanger, compressor, condenser heat exchanger and expansion valve.

At approximately 1.2-1.5 metres down below ground level the temperature is a constant 10 to 12ºC. Any bores would need to be sunk to an effective depth of 50 – 120m and a ground feasibility report would be required to ascertain if this method of heat source was viable.

From the bores pre-insulated pipework is laid in the ground to the heat exchanger device. The system is filled with water and antifreeze. The cooled water is pumped around the loop / bore gathering energy as it circulates. The water that has been heated to 10-12ºC is returned to the ground source heat exchanger where the energy is transferred to the refrigerant gas. For every 1kW of energy used to compress the refrigerant, the process 'gives up' 4 kW of energy for use in the system being used to heat the building.

Typical costs for an installation this are in the region of £250,000 for a commercial installation, with general installation costs at £1200 /kW of energy produced.

Renewable Technology	Local, site-specific impact	Suitability and design impact	Economic viability	Operation and maintenance	CO_2 and sustainability
GSHP	✔✔✓✓ No local air quality impacts, not visible so conservation friendly, no noise issues, however the constrained site may prohibit its installation.	✔✔✔✓ Can be added to the roof, good air-flow on roof, increased buildability issues for pipework and heating emitters internally.	✔✓✓✓✓ High capital costs of installation, typical payback of 15 years where gas is displaced, Renewable Heat Incentive available.	✔✔✓ Limited servicing and maintenance i.e. 1 visit per year, mechanical parts may require replacement over lifespan.	✔✔✔✔✔ ✔✔✓✓✓ Limited carbon saving from gas displacement, consumes some electricity so benefits from decarbonisation, no local air impact, high embodied energy of equipment.

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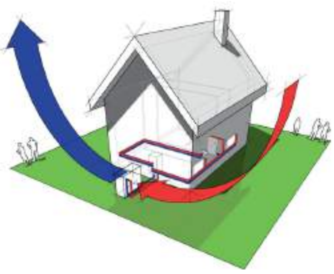
Air Source Heat Pump (ASHP):

Accepted



Air source heat pump systems work on the same principle as a ground source heat pump although they use the outside air as the heat source.

The coefficients of performance given by air source heat pump systems are inferior to that of ground source systems due to varying air temperatures. In the depth of winter the energy efficiency of an air source system will be lower than that of a ground source system, and it is likely that more back-up heat will be required if an air source unit is fitted. This back-up heat often comes from a direct electric heater. They operate over a varying temperatures range of -15°C to +25°C, however, the performance will reduce to below the required 3 to 1 carbon saving ratio in winter, and the also require a defrosting mechanism to melt ice that forms on the air heat exchanger.

ASHPs are cheaper to install than ground source heat pumps but are only available on a relatively small scale. If applied across a larger site a number of plant zones would be required for generation of heat, leading to increased plant space requirements. Typical costs for an installation this are in the region of £60,000 for medium sized commercial spaces.

Carbon dioxide emissions savings will typically be less than that of the ground source heat pump. Air source heat pumps may be more suitable as a HVAC solution.

Renewable Technology	Local, site-specific impact	Suitability and design impact	Economic viability	Operation and maintenance	CO_2 and sustainability
ASHP	✔✔✔✓ No local air quality impacts, use of unutilised roof space, conservation officer may have minor concerns over visual impact, no noise issues.	✔✔✔✓ Can be added to the roof, good air-flow on roof, increased buildability issues for pipework and heating emitters internally.	✔✔✔✓✓ Medium- high capital costs of installation, typical payback >15 years where gas is displaced, Renewable Heat Incentive available.	✔✔✓ Limited servicing and maintenance i.e. 1 visit per year, mechanical parts may require replacement over lifespan.	✔✔✔✔✔✔✓✓✓✓ Limited carbon saving from gas displacement, less efficient in winter, consumes electricity so benefits from decarbonisation, no local air impact, high embodied energy of equipment.

'Be Green': Summary of Renewable Technologies

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Summary Comparison Matrix:

An assessment of the feasibility of each of the technologies is shown below.

Renewable Technology	Local, site-specific impact	Suitability and design impact	Economic viability	Operation and maintenance	CO_2 and sustainability	Total Score
Biomass Boiler	✔✓✓✓	✔✔✔✓	✔✔✔✓✓	✔✓✓	✔✔✔✔✔ ✔✔✓✓✓	15 out of 26
Photovoltaic	✔✔✓✓	✔✔✔✓	✔✔✔✔✓	✔✔✓	✔✔✔✔✔ ✔✔✓✓✓	18 out of 26
Solar Thermal	✔✔✓✓	✔✔✓✓	✔✔✔✔✓	✔✔✔	✔✔✔✔✔ ✓✓✓✓✓	16 out of 26
Wind Energy	✔✓✓✓	✔✓✓✓	✔✔✔✔✓	✔✔✔	✔✔✔✔✔ ✔✔✓✓✓	16 out of 26
GSHP	✔✔✓✓	✔✔✔✓	✔✓✓✓✓	✔✔✓	✔✔✔✔✔ ✔✔✓✓✓	15 out of 26
ASHP	✔✔✔✓	✔✔✔✓	✔✔✔✓✓	✔✔✓	✔✔✔✔✔ ✔✓✓✓✓	17 out of 26

Renewable Technology Conclusion & Specification:

Photovoltaic panels, and an air source heat pump have scored the best. Wind energy would be considered unsuitable for the area by conservation criteria and that the local residents would raise concerns over potential noise and turbulence.

The capital costs of a ground source heat pump combined with the constraints of the site make this unviable. Therefore, an air source heat pump is considered to be the optimum balance of sustainable and economic objectives.

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'Be Green': ASHP
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ASHP:

A summary of the lifecycle cost, revenue and payback for an ASHP is given below. Whilst this proposed system has higher associated operational costs it reduces carbon emissions relative to a gas boiler.

Lifecycle Cost:

The lifecycle of the proposed system is 25 years. To calculate the lifecycle cost of the panels, the maintenance of the system and cost of electricity to run the pumps will be included.

The total costs for the proposed systems lifetime is:

- Capital Cost = £60,000
- Maintenance Cost = £6,000
- Operation Cost = £21,825
- Total Costs = £87,825

Revenue and Payback Parameters:

With the Non-Domestic Renewable Heat Incentive a tariff of 2.57/kWh will be received for applications processed after Oct 2016, which gives an annual saving of £226.

Summary Performance Calculations:

The following tables summarise the reduction in carbon emissions and the life cycle cost of the ASHP system.

Energy and Carbon Performance Criteria at 2016 carbon intensity	Value
Predicted Annual Energy Saved (kWh/yr)	12.355
Annual Carbon Emissions Reductions (kg CO_2/yr)	1.361
% CO_2 Emissions Reduction	2.7%

Cost Performance Criteria	Value
Extra over total cost over life cycle (£)	-6,099 (saving)
Predicted Annual Savings (£)	524
Initial extra over cost saving of installing an air source heat pump over a gas heating system	Circa £7,000
Payback Period (years)	13

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Conclusion
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Summary

The baseline carbon emissions for the scheme are 73.32 Tonnes CO_2/yr.

As demonstrated above the development will reduce carbon emissions by 33.6% from the fabric energy efficiency measures described in the 'Be Lean' section, and will reduce total carbon emissions by 35.49% over Building Regulations with the further inclusion of low and zero carbon technologies.

GLA's Energy Hierarchy – Regulated Carbon Emissions				
	Baseline:	Be Lean:	Be Clean:	Be Green:
CO_2 emissions (Tonnes CO_2/yr)	73.32	48.66	-	47.36
CO_2 emissions saving (Tonnes CO_2/yr)	-	24.66	-	1.31
Saving from each stage (%)	-	33.6	-	1.8
Total CO_2 emissions saving (Tonnes CO_2/yr)	25.96			
35.4% Total carbon emissions savings over Part L of the Building Regulations 2013 achieved				

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Further Information:

As required by the GLA, the emission figures and details of the calculations and methodology used to determine the figures provided within the report can be found in the following pages:

Baseline – BER from the Baseline & Part L2B BRUKL
Lean – BER from the Lean BRUKL
Green – BER from the Green BRUKL

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Baseline and Part L2B Scenario

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

176 Prince of Wales Rd

As designed

Date: Tue Dec 06 13:45:43 2016

Administrative information

Building Details

Address: ,

Certification tool

Calculation engine: SBEM

Calculation engine version: v5.2.g.3

Interface to calculation engine: DesignBuilder SBEM

Interface to calculation engine version: v4.7.0

BRUKL compliance check version: v5.2.g.3

Owner Details

Name:

Telephone number:

Address: , ,

Certifier details

Name: Niccolo Vicarelli

Telephone number: 02070430418

Address: 57A Great Suffolk Street, London, SE1 0BB

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

The building does not comply with England Building Regulations Part L 2013

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	28.1
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	28.1
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	44.9
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	0.96	1.6	01-Ground - New - Circulation_P_11
Floor	0.25	0.23	0.58	00-Basement - New - Circulation_F_5
Roof	0.25	0.23	0.68	00-Basement - New - Gallery Storage_R_5
Windows***, roof windows, and rooflights	2.2	3.5	4.96	01-Ground - New - Circulation_G_18
Personnel doors	2.2	1.8	1.8	01-Ground - New - Circulation_D_17
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	25

Building services

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

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	NO
Whole building electric power factor achieved by power factor correction	<0.9

1- BOH HVAC

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	0.88	-	-	-	-
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO
* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.					

2- FOH HVAC

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	0.88	2.5	-	-	-
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO
* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.					

1- New DHW

	Water heating efficiency	**Storage loss factor [kWh/litre per day]**
This building	0.88	-
Standard value	0.9*	N/A
* Standard shown is for gas boilers >30 kW output. For boilers <=30 kW output, limiting efficiency is 0.73.		

Local mechanical ventilation, exhaust, and terminal units

ID	**System type in Non-domestic Building Services Compliance Guide**
A	Local supply or extract ventilation units serving a single area
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal supply and extract ventilation units serving a single room or zone with heating and heat recovery
E	Local supply and extract ventilation system serving a single area with heating and heat recovery
F	Other local ventilation units
G	Fan-assisted terminal VAV unit
H	Fan coil units
I	Zonal extract system where the fan is remote from the zone with grease filter

Zone name	**SFP [W/(l/s)]**									**HR efficiency**	
ID of system type	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	**Zone**	**Standard**
00-Basement - New - Plant Rooms	-	-	-	-	-	-	-	-	-	-	N/A
00-Basement - New - AHU Plant	0.4	-	-	-	-	-	-	-	-	-	N/A
01-Ground - New - Risers	-	-	-	-	-	-	-	-	-	-	N/A
03- Second Floor New - Condensers	-	-	-	-	-	-	-	-	-	-	N/A
02 - First Floor New N - Risers	-	-	-	-	-	-	-	-	-	-	N/A
00-Basement - New - Gallery Storage	-	-	-	-	-	-	-	-	-	-	N/A
00-Basement - New - Circulation	-	-	-	-	-	-	-	-	-	-	N/A

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
00-Basement - New - Shower	0.4	-	-	-	-	-	-	-	-	-	N/A
00-Basement - New - WC	0.4	-	-	-	-	-	-	-	-	-	N/A
00-Basement - New - Kitchenette	0.4	-	-	-	-	-	-	-	-	-	N/A
01-Ground - New - Circulation	-	-	-	-	-	-	-	-	-	-	N/A
01-Ground - New - Stairwell	-	-	-	-	-	-	-	-	-	-	N/A
01-Ground - New - Care Taker	-	-	-	-	-	-	-	-	-	-	N/A
01-Ground - New - Bin Store	0.4	-	-	-	-	-	-	-	-	-	N/A
01-Ground - New - Toilets	0.4	-	-	-	-	-	-	-	-	-	N/A
03- Second Floor New - Circulation	-	-	-	-	-	-	-	-	-	-	N/A
03- Second Floor New - Toilets	0.4	-	-	-	-	-	-	-	-	-	N/A
02 - First Floor New S - Classroom	-	-	-	-	-	-	-	-	-	-	N/A
02 - First Floor New S - Void	-	-	-	-	-	-	-	-	-	-	N/A
02 - First Floor New N - Circulation	-	-	-	-	-	-	-	-	-	-	N/A
01-Ground - New - Rear Gallery	-	-	-	2.2	-	-	-	-	-	0.5	0.5
01-Ground - New - Library	-	-	-	2.2	-	-	-	-	-	0.5	0.5
03- Second Floor New - Performance	-	-	-	2.2	-	-	-	-	-	0.5	0.5
02 - First Floor New N - Void	-	-	-	2.2	-	-	-	-	-	0.5	0.5
02 - First Floor New N - Middle Gallery	-	-	-	2.2	-	-	-	-	-	0.5	0.5
02 - First Floor New N - Front Gallery	-	-	-	2.2	-	-	-	-	-	0.5	0.5
02 - First Floor New N - A.V.	-	-	-	2.2	-	-	-	-	-	0.5	0.5

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
00-Basement - New - Plant Rooms	60	-	-	333
00-Basement - New - AHU Plant	60	-	-	225
01-Ground - New - Risers	60	-	-	110
03- Second Floor New - Condensers	60	-	-	244
02 - First Floor New N - Risers	60	-	-	288
00-Basement - New - Gallery Storage	60	-	-	274
00-Basement - New - Circulation	-	60	-	208
00-Basement - New - Shower	-	60	-	35
00-Basement - New - WC	-	60	-	100
00-Basement - New - Kitchenette	-	60	-	209
01-Ground - New - Circulation	-	60	-	363
01-Ground - New - Stairwell	-	60	-	308
01-Ground - New - Care Taker	60	-	-	155
01-Ground - New - Bin Store	60	-	-	22
01-Ground - New - Toilets	-	60	-	171
03- Second Floor New - Circulation	-	60	-	355
03- Second Floor New - Toilets	-	60	-	120
02 - First Floor New S - Classroom	60	-	-	937
02 - First Floor New S - Void	60	-	-	770

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
02 - First Floor New N - Circulation	-	60	-	297
01-Ground - New - Rear Gallery	-	60	-	1426
01-Ground - New - Library	-	60	-	551
03- Second Floor New - Performance	-	60	-	5362
02 - First Floor New N - Void	60	-	-	1709
02 - First Floor New N - Middle Gallery	-	60	-	111
02 - First Floor New N - Front Gallery	-	60	-	90
02 - First Floor New N - A.V.	60	-	-	288

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

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
01-Ground - New - Care Taker	NO (-56.8%)	NO
02 - First Floor New S - Classroom	NO (-0.7%)	NO
02 - First Floor New S - Void	NO (-56.9%)	NO
01-Ground - New - Rear Gallery	NO (-44.8%)	NO
01-Ground - New - Library	NO (-48.6%)	NO
03- Second Floor New - Performance	YES (+18.4%)	NO
02 - First Floor New N - Void	NO (-7.7%)	NO
02 - First Floor New N - Middle Gallery	N/A	N/A
02 - First Floor New N - Front Gallery	N/A	N/A
02 - First Floor New N - A.V.	N/A	N/A

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

Separate submission

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

Separate submission

EPBD (Recast): Consideration of alternative energy systems

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

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m^2]	1633	1633
External area [m^2]	2541.9	2541.9
Weather	LON	LON
Infiltration [m^3/hm^2@ 50Pa]	25	3
Average conductance [W/K]	1951.83	952.87
Average U-value [W/m^2K]	0.77	0.37
Alpha value* [%]	6.32	13.69

* 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
	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
100	**D2 General Assembly and Leisure, Night Clubs and Theatres**
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others - Stand alone utility block

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

	Actual	Notional
Heating	70.46	31.48
Cooling	10.83	5.5
Auxiliary	6.85	2.98
Lighting	31.49	25.38
Hot water	19.13	19.47
Equipment*	53.78	53.78
TOTAL**	**138.76**	**84.81**

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

Energy Production by Technology [kWh/m^2]

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

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m^2]	296.15	215.92
Primary energy* [kWh/m^2]	260.25	163.51
Total emissions [kg/m^2]	44.9	28.1

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

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] No Heating or Cooling										
	Actual	0	0	0	0	0.9	0	0	0	0
	Notional	0	0	0	0	0.9	0	0	----	----
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Natural Gas										
	Actual	298.1	56.1	105.5	0	4.9	0.79	0	0.88	0
	Notional	192.1	117.1	65.1	0	3.1	0.82	0	----	----
[ST] Split or multi-split system, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	153.2	151.1	51.9	23.6	10	0.82	1.78	0.88	2.5
	Notional	17.1	155.6	5.8	12	3.3	0.82	3.6	----	----

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

Key Features

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

Building fabric

Element	U_{i-Typ}	U_{i-Min}	Surface where the minimum value occurs*
Wall	0.23	0.28	00-Basement - New - Gallery Storage_W_7
Floor	0.2	0.11	01-Ground - New - Rear Gallery_S_5
Roof	0.15	0.18	03- Second Floor New - Circulation_R_13
Windows, roof windows, and rooflights	1.5	1.8	00-Basement - New - Gallery Storage_G_11
Personnel doors	1.5	1.8	01-Ground - New - Circulation_D_17
Vehicle access & similar large doors	1.5	-	"No external vehicle access doors"
High usage entrance doors	1.5	-	"No external high usage entrance doors"

U_{i-Typ} = Typical individual element U-values [W/(m²K)]

U_{i-Min} = Minimum individual element U-values [W/(m²K)]

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

Air Permeability	Typical value	This building
m³/(h.m²) at 50 Pa	5	25

Appendix
Energy Assessment
176 Prince of Wales Road

LEAN Scenario

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

176 Prince of Wales Rd

As designed

Date: Tue Dec 06 13:53:34 2016

Administrative information

Building Details

Address: ,

Certification tool

Calculation engine: SBEM

Calculation engine version: v5.2.g.3

Interface to calculation engine: DesignBuilder SBEM

Interface to calculation engine version: v4.7.0

BRUKL compliance check version: v5.2.g.3

Owner Details

Name:

Telephone number:

Address: , ,

Certifier details

Name: Niccolo Vicarelli

Telephone number: 02070430418

Address: 57A Great Suffolk Street, London, SE1 0BB

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

The building does not comply with England Building Regulations Part L 2013

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	28.1
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	28.1
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	29.8
Are emissions from the building less than or equal to the target?	BER > TER
Are as built details the same as used in the BER calculations?	Separate submission

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

Values not achieving standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.27	0.3	01-Ground - New - Circulation_P_11
Floor	0.25	0.22	0.58	00-Basement - New - Circulation_F_5
Roof	0.25	0.23	0.68	00-Basement - New - Gallery Storage_R_5
Windows***, roof windows, and rooflights	2.2	3.48	4.96	01-Ground - New - Circulation_G_18
Personnel doors	2.2	1.8	1.8	01-Ground - New - Circulation_D_17
Vehicle access & similar large doors	1.5	-	-	"No external vehicle access doors"
High usage entrance doors	3.5	-	-	"No external high usage entrance doors"

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

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

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

Building services

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

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	NO
Whole building electric power factor achieved by power factor correction	<0.9

1- New BOH HVAC

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.94	-	-	-	-
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO
* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.					

2- New FOH HVAC

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.94	3.01	-	-	-
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO
* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.					

1- New DHW

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	0.94	-
Standard value	0.9*	N/A
* Standard shown is for gas boilers >30 kW output. For boilers <=30 kW output, limiting efficiency is 0.73.		

Local mechanical ventilation, exhaust, and terminal units

ID	System type in Non-domestic Building Services Compliance Guide
A	Local supply or extract ventilation units serving a single area
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal supply and extract ventilation units serving a single room or zone with heating and heat recovery
E	Local supply and extract ventilation system serving a single area with heating and heat recovery
F	Other local ventilation units
G	Fan-assisted terminal VAV unit
H	Fan coil units
I	Zonal extract system where the fan is remote from the zone with grease filter

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	**Zone**	**Standard**
00-Basement - New - Plant Rooms	-	-	-	-	-	-	-	-	-	-	N/A
00-Basement - New - AHU Plant	0.4	-	-	-	-	-	-	-	-	-	N/A
01-Ground - New - Risers	-	-	-	-	-	-	-	-	-	-	N/A
03- Second Floor New - Condensers	-	-	-	-	-	-	-	-	-	-	N/A
02 - First Floor New N - Risers	-	-	-	-	-	-	-	-	-	-	N/A
00-Basement - New - Gallery Storage	-	-	-	-	-	-	-	-	-	-	N/A
00-Basement - New - Circulation	-	-	-	-	-	-	-	-	-	-	N/A

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
00-Basement - New - Shower	0.4	-	-	-	-	-	-	-	-	-	N/A
00-Basement - New - WC	0.4	-	-	-	-	-	-	-	-	-	N/A
00-Basement - New - Kitchenette	0.4	-	-	-	-	-	-	-	-	-	N/A
01-Ground - New - Circulation	-	-	-	-	-	-	-	-	-	-	N/A
01-Ground - New - Stairwell	-	-	-	-	-	-	-	-	-	-	N/A
01-Ground - New - Care Taker	-	-	-	-	-	-	-	-	-	-	N/A
01-Ground - New - Bin Store	0.4	-	-	-	-	-	-	-	-	-	N/A
01-Ground - New - Toilets	0.4	-	-	-	-	-	-	-	-	-	N/A
03- Second Floor New - Circulation	-	-	-	-	-	-	-	-	-	-	N/A
03- Second Floor New - Toilets	0.4	-	-	-	-	-	-	-	-	-	N/A
02 - First Floor New S - Classroom	-	-	-	-	-	-	-	-	-	-	N/A
02 - First Floor New S - Void	-	-	-	-	-	-	-	-	-	-	N/A
02 - First Floor New N - Circulation	-	-	-	-	-	-	-	-	-	-	N/A
01-Ground - New - Rear Gallery	-	-	-	1.6	-	-	-	-	-	0.5	0.5
01-Ground - New - Library	-	-	-	1.6	-	-	-	-	-	0.5	0.5
03- Second Floor New - Performance	-	-	-	1.6	-	-	-	-	-	0.5	0.5
02 - First Floor New N - Void	-	-	-	1.6	-	-	-	-	-	0.5	0.5
02 - First Floor New N - Middle Gallery	-	-	-	1.6	-	-	-	-	-	0.5	0.5
02 - First Floor New N - Front Gallery	-	-	-	1.6	-	-	-	-	-	0.5	0.5
02 - First Floor New N - A.V.	-	-	-	1.6	-	-	-	-	-	0.5	0.5

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
00-Basement - New - Plant Rooms	90	-	-	222
00-Basement - New - AHU Plant	90	-	-	150
01-Ground - New - Risers	90	-	-	73
03- Second Floor New - Condensers	90	-	-	163
02 - First Floor New N - Risers	90	-	-	192
00-Basement - New - Gallery Storage	90	-	-	183
00-Basement - New - Circulation	-	90	-	138
00-Basement - New - Shower	-	90	-	24
00-Basement - New - WC	-	90	-	67
00-Basement - New - Kitchenette	-	90	-	139
01-Ground - New - Circulation	-	90	-	242
01-Ground - New - Stairwell	-	90	-	206
01-Ground - New - Care Taker	90	-	-	104
01-Ground - New - Bin Store	90	-	-	15
01-Ground - New - Toilets	-	90	-	114
03- Second Floor New - Circulation	-	90	-	237
03- Second Floor New - Toilets	-	90	-	80
02 - First Floor New S - Classroom	90	-	-	624
02 - First Floor New S - Void	90	-	-	514

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
02 - First Floor New N - Circulation	-	90	-	198
01-Ground - New - Rear Gallery	-	90	-	951
01-Ground - New - Library	-	90	-	367
03- Second Floor New - Performance	-	90	-	3574
02 - First Floor New N - Void	90	-	-	1139
02 - First Floor New N - Middle Gallery	-	90	-	74
02 - First Floor New N - Front Gallery	-	90	-	60
02 - First Floor New N - A.V.	90	-	-	192

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

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
01-Ground - New - Care Taker	NO (-56.8%)	NO
02 - First Floor New S - Classroom	NO (-0.7%)	NO
02 - First Floor New S - Void	NO (-56.9%)	NO
01-Ground - New - Rear Gallery	NO (-44.8%)	NO
01-Ground - New - Library	NO (-48.6%)	NO
03- Second Floor New - Performance	YES (+18.4%)	NO
02 - First Floor New N - Void	NO (-7.7%)	NO
02 - First Floor New N - Middle Gallery	N/A	N/A
02 - First Floor New N - Front Gallery	N/A	N/A
02 - First Floor New N - A.V.	N/A	N/A

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

Separate submission

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

Separate submission

EPBD (Recast): Consideration of alternative energy systems

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

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	1633	1633
External area [m²]	2541.9	2541.9
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	10	3
Average conductance [W/K]	1177.48	952.87
Average U-value [W/m²K]	0.46	0.37
Alpha value* [%]	10.48	13.69

* 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
	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
100	**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	39.14	31.48
Cooling	6.6	5.5
Auxiliary	5.6	2.98
Lighting	21.49	25.38
Hot water	17.91	19.47
Equipment*	53.78	53.78
TOTAL**	**90.73**	**84.81**

* 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	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	220.6	215.92
Primary energy* [kWh/m²]	173	163.51
Total emissions [kg/m²]	29.8	28.1

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

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] No Heating or Cooling										
	Actual	0	0	0	0	0.9	0	0	0	0
	Notional	0	0	0	0	0.9	0	0	----	----
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Natural Gas										
	Actual	197.3	61	65.3	0	4.9	0.84	0	0.94	0
	Notional	192.1	117.1	65.1	0	3.1	0.82	0	----	----
[ST] Split or multi-split system, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	70.5	161.6	22.4	14.4	7.3	0.88	3.12	0.94	4.39
	Notional	17.1	155.6	5.8	12	3.3	0.82	3.6	----	----

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

Key Features

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

Building fabric

Element	U_{i-Typ}	U_{i-Min}	Surface where the minimum value occurs*
Wall	0.23	0.24	00-Basement - New - Gallery Storage_W_7
Floor	0.2	0.1	01-Ground - New - Rear Gallery_S_5
Roof	0.15	0.18	03- Second Floor New - Circulation_R_13
Windows, roof windows, and rooflights	1.5	1.6	03- Second Floor New - Performance_G_14
Personnel doors	1.5	1.8	01-Ground - New - Circulation_D_17
Vehicle access & similar large doors	1.5	-	"No external vehicle access doors"
High usage entrance doors	1.5	-	"No external high usage entrance doors"

U_{i-Typ} = Typical individual element U-values [W/(m²K)]

U_{i-Min} = Minimum individual element U-values [W/(m²K)]

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

Air Permeability	Typical value	This building
m³/(h.m²) at 50 Pa	5	10

Appendix
Energy Assessment
176 Prince of Wales Road

GREEN Scenario

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

176 Prince of Wales Rd

As designed

Date: Tue Dec 06 13:47:21 2016

Administrative information

Building Details

Address: ,

Certification tool

Calculation engine: SBEM

Calculation engine version: v5.2.g.3

Interface to calculation engine: DesignBuilder SBEM

Interface to calculation engine version: v4.7.0

BRUKL compliance check version: v5.2.g.3

Owner Details

Name:

Telephone number:

Address: , ,

Certifier details

Name: Niccolo Vicarelli

Telephone number: 02070430418

Address: 57A Great Suffolk Street, London, SE1 0BB

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

The building does not comply with England Building Regulations Part L 2013

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	28
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	28
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	29
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	0.27	0.3	01-Ground - New - Circulation_P_11
Floor	0.25	0.22	0.58	00-Basement - New - Circulation_F_5
Roof	0.25	0.23	0.68	00-Basement - New - Gallery Storage_R_5
Windows***, roof windows, and rooflights	2.2	3.48	4.96	01-Ground - New - Circulation_G_18
Personnel doors	2.2	1.8	1.8	01-Ground - New - Circulation_D_17
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	10

Building services

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

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	NO
Whole building electric power factor achieved by power factor correction	<0.9

1- New BOH HVAC

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.94	-	-	-	-
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

2- New FOH HVAC

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	3.6	3.01	-	-	-
Standard value	2.5*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO

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

1- New DHW

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	0.94	-
Standard value	0.9*	N/A

* Standard shown is for gas boilers >30 kW output. For boilers <=30 kW output, limiting efficiency is 0.73.

Local mechanical ventilation, exhaust, and terminal units

ID	System type in Non-domestic Building Services Compliance Guide
A	Local supply or extract ventilation units serving a single area
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal supply and extract ventilation units serving a single room or zone with heating and heat recovery
E	Local supply and extract ventilation system serving a single area with heating and heat recovery
F	Other local ventilation units
G	Fan-assisted terminal VAV unit
H	Fan coil units
I	Zonal extract system where the fan is remote from the zone with grease filter

Zone name	**SFP [W/(l/s)]**									**HR efficiency**	
ID of system type	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	**Zone**	**Standard**
00-Basement - New - Plant Rooms	-	-	-	-	-	-	-	-	-	-	N/A
00-Basement - New - AHU Plant	0.4	-	-	-	-	-	-	-	-	-	N/A
01-Ground - New - Risers	-	-	-	-	-	-	-	-	-	-	N/A
03- Second Floor New - Condensers	-	-	-	-	-	-	-	-	-	-	N/A
02 - First Floor New N - Risers	-	-	-	-	-	-	-	-	-	-	N/A
00-Basement - New - Gallery Storage	-	-	-	-	-	-	-	-	-	-	N/A
00-Basement - New - Circulation	-	-	-	-	-	-	-	-	-	-	N/A

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
00-Basement - New - Shower	0.4	-	-	-	-	-	-	-	-	-	N/A
00-Basement - New - WC	0.4	-	-	-	-	-	-	-	-	-	N/A
00-Basement - New - Kitchenette	0.4	-	-	-	-	-	-	-	-	-	N/A
01-Ground - New - Circulation	-	-	-	-	-	-	-	-	-	-	N/A
01-Ground - New - Stairwell	-	-	-	-	-	-	-	-	-	-	N/A
01-Ground - New - Care Taker	-	-	-	-	-	-	-	-	-	-	N/A
01-Ground - New - Bin Store	0.4	-	-	-	-	-	-	-	-	-	N/A
01-Ground - New - Toilets	0.4	-	-	-	-	-	-	-	-	-	N/A
03- Second Floor New - Circulation	-	-	-	-	-	-	-	-	-	-	N/A
03- Second Floor New - Toilets	0.4	-	-	-	-	-	-	-	-	-	N/A
02 - First Floor New S - Classroom	-	-	-	-	-	-	-	-	-	-	N/A
02 - First Floor New S - Void	-	-	-	-	-	-	-	-	-	-	N/A
02 - First Floor New N - Circulation	-	-	-	-	-	-	-	-	-	-	N/A
01-Ground - New - Rear Gallery	-	-	-	1.6	-	-	-	-	-	0.5	0.5
01-Ground - New - Library	-	-	-	1.6	-	-	-	-	-	0.5	0.5
03- Second Floor New - Performance	-	-	-	1.6	-	-	-	-	-	0.5	0.5
02 - First Floor New N - Void	-	-	-	1.6	-	-	-	-	-	0.5	0.5
02 - First Floor New N - Middle Gallery	-	-	-	1.6	-	-	-	-	-	0.5	0.5
02 - First Floor New N - Front Gallery	-	-	-	1.6	-	-	-	-	-	0.5	0.5
02 - First Floor New N - A.V.	-	-	-	1.6	-	-	-	-	-	0.5	0.5

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
00-Basement - New - Plant Rooms	90	-	-	222
00-Basement - New - AHU Plant	90	-	-	150
01-Ground - New - Risers	90	-	-	73
03- Second Floor New - Condensers	90	-	-	163
02 - First Floor New N - Risers	90	-	-	192
00-Basement - New - Gallery Storage	90	-	-	183
00-Basement - New - Circulation	-	90	-	138
00-Basement - New - Shower	-	90	-	24
00-Basement - New - WC	-	90	-	67
00-Basement - New - Kitchenette	-	90	-	139
01-Ground - New - Circulation	-	90	-	242
01-Ground - New - Stairwell	-	90	-	206
01-Ground - New - Care Taker	90	-	-	104
01-Ground - New - Bin Store	90	-	-	15
01-Ground - New - Toilets	-	90	-	114
03- Second Floor New - Circulation	-	90	-	237
03- Second Floor New - Toilets	-	90	-	80
02 - First Floor New S - Classroom	90	-	-	624
02 - First Floor New S - Void	90	-	-	514

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
02 - First Floor New N - Circulation	-	90	-	198
01-Ground - New - Rear Gallery	-	90	-	951
01-Ground - New - Library	-	90	-	367
03- Second Floor New - Performance	-	90	-	3574
02 - First Floor New N - Void	90	-	-	1139
02 - First Floor New N - Middle Gallery	-	90	-	74
02 - First Floor New N - Front Gallery	-	90	-	60
02 - First Floor New N - A.V.	90	-	-	192

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

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
01-Ground - New - Care Taker	NO (-56.8%)	NO
02 - First Floor New S - Classroom	NO (-0.7%)	NO
02 - First Floor New S - Void	NO (-56.9%)	NO
01-Ground - New - Rear Gallery	NO (-44.8%)	NO
01-Ground - New - Library	NO (-48.6%)	NO
03- Second Floor New - Performance	YES (+18.4%)	NO
02 - First Floor New N - Void	NO (-7.7%)	NO
02 - First Floor New N - Middle Gallery	N/A	N/A
02 - First Floor New N - Front Gallery	N/A	N/A
02 - First Floor New N - A.V.	N/A	N/A

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

Separate submission

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

Separate submission

EPBD (Recast): Consideration of alternative energy systems

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

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	1633	1633
External area [m²]	2541.9	2541.9
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	10	3
Average conductance [W/K]	1177.48	952.87
Average U-value [W/m²K]	0.46	0.37
Alpha value* [%]	10.48	13.69

* 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
	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
100	**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	31.58	29.72
Cooling	6.6	5.5
Auxiliary	5.6	2.98
Lighting	21.49	25.38
Hot water	17.91	19.47
Equipment*	53.78	53.78
TOTAL**	**83.17**	**83.05**

* 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	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	220.6	215.92
Primary energy* [kWh/m²]	168.72	162.95
Total emissions [kg/m²]	29	28

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

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] No Heating or Cooling										
	Actual	0	0	0	0	0.9	0	0	0	0
	Notional	0	0	0	0	0.9	0	0	----	----
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Natural Gas										
	Actual	197.3	61	65.3	0	4.9	0.84	0	0.94	0
	Notional	192.1	117.1	65.1	0	3.1	0.82	0	----	----
[ST] Split or multi-split system, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	70.5	161.6	5.8	14.4	7.3	3.36	3.12	3.6	4.39
	Notional	17.1	155.6	1.9	12	3.3	2.43	3.6	----	----

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

Key Features

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

Building fabric

Element	U_{i-Typ}	U_{i-Min}	Surface where the minimum value occurs*
Wall	0.23	0.24	00-Basement - New - Gallery Storage_W_7
Floor	0.2	0.1	01-Ground - New - Rear Gallery_S_5
Roof	0.15	0.18	03- Second Floor New - Circulation_R_13
Windows, roof windows, and rooflights	1.5	1.6	03- Second Floor New - Performance_G_14
Personnel doors	1.5	1.8	01-Ground - New - Circulation_D_17
Vehicle access & similar large doors	1.5	-	"No external vehicle access doors"
High usage entrance doors	1.5	-	"No external high usage entrance doors"

U_{i-Typ} = Typical individual element U-values [W/(m²K)]

U_{i-Min} = Minimum individual element U-values [W/(m²K)]

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

Air Permeability	Typical value	This building
m³/(h.m²) at 50 Pa	5	10