SUSTAINABLE ENERGY STATEMENT

FOR

QUEENS HALL
TWICKENHAM

VERSION 2.0

Issued by:-

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CONTENTS

QUEENS HALL, TWICKENHAM

SUSTAINABLE ENERGY STATEMENT

EXECUTIVE SUMMARY

Silcock Dawson and Partners have been appointed by F&C REIT Asset Management to provide an Energy Statement for the proposed redevelopment of Queens Hall, Twickenham.

The development will maintain the long established D2 use on site and will add 4 new dwellings created on two new floor levels within the refurbished Queens Hall shell and a new extension on the south side of the Hall. The D2 unit will be constructed as a shell by the developer, with the tenant being responsible for the fit out.

The structural shell of the existing building will be utilised, and where parts of the existing structure is being demolished the materials will be re-used if appropriate.

Following a review of the relevant National, Regional and Local planning policies this Sustainable Energy Statement proposes a strategy that positively responds to the policy structure that requires developments to *be lean; be clean; be green*.

The buildings are designed to be energy efficient and incorporate the following key features:

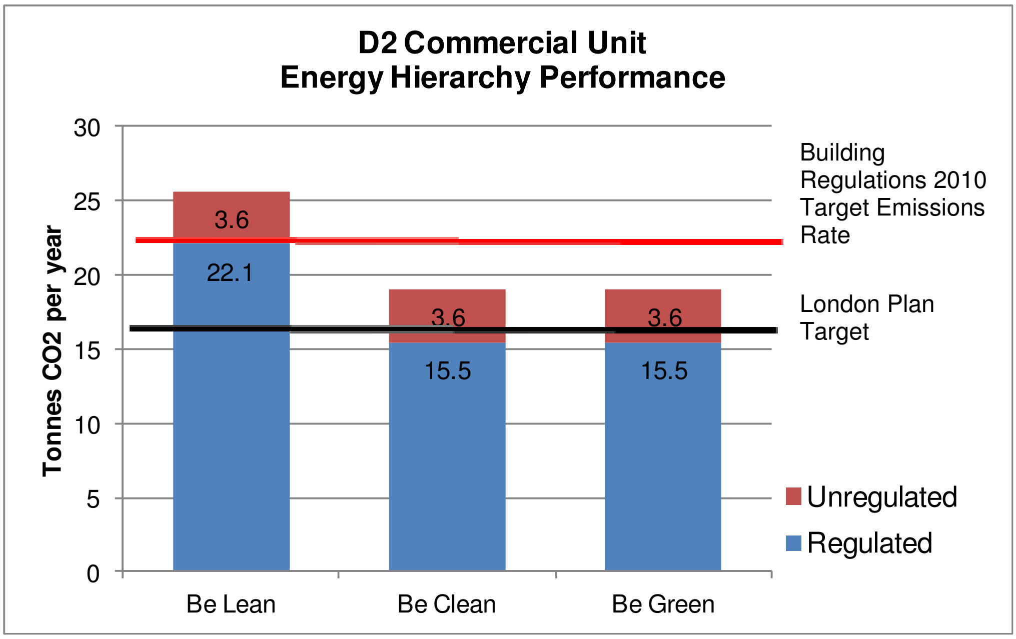
1. The annual heating demand will be reduced by using insulation values better than the limiting standards. The target air permeability is 3 $m^3/hr/m^2$. Approved construction details will be used to reduce heat loss due to thermal bridging.
2. The dwelling will have a whole house ventilation system with a heat recovery efficiency of 90% and a fan power of 0.7 W/l/s or less.
3. The dwellings will be provided with 100% low energy luminaires.
4. Controls and monitoring systems will be provided to each dwelling and commercial unit. The common spaces will also be provided with energy monitoring facilities.

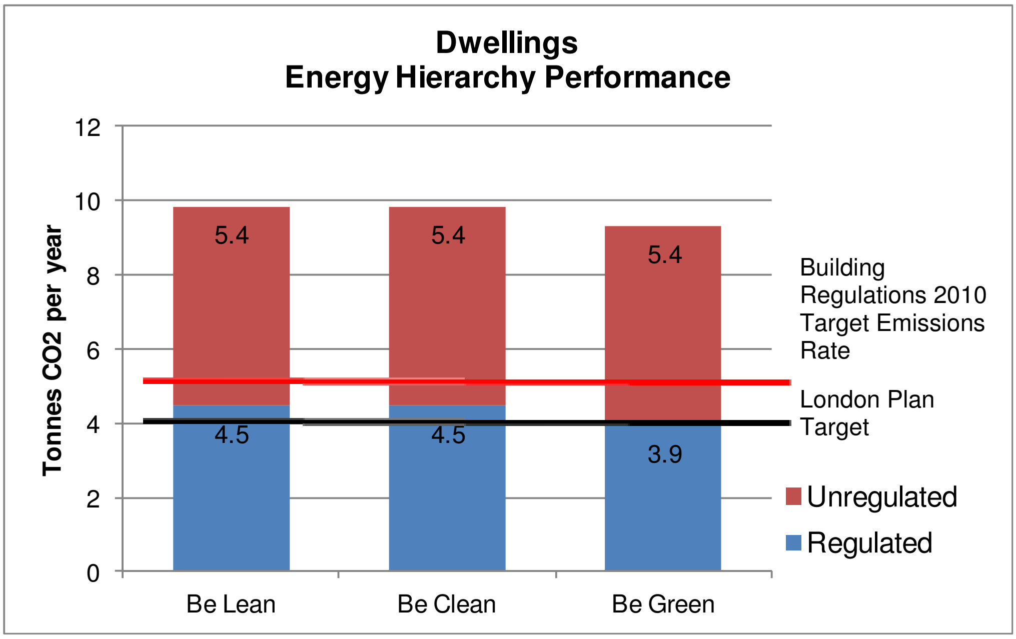
The energy efficiency measures will reduce the regulated carbon emissions for the development by 3.6% relative to the 2010 Building Regulations baseline case. With dwelling emissions reduced by 16.9% and for the D2 unit by 0.4%.

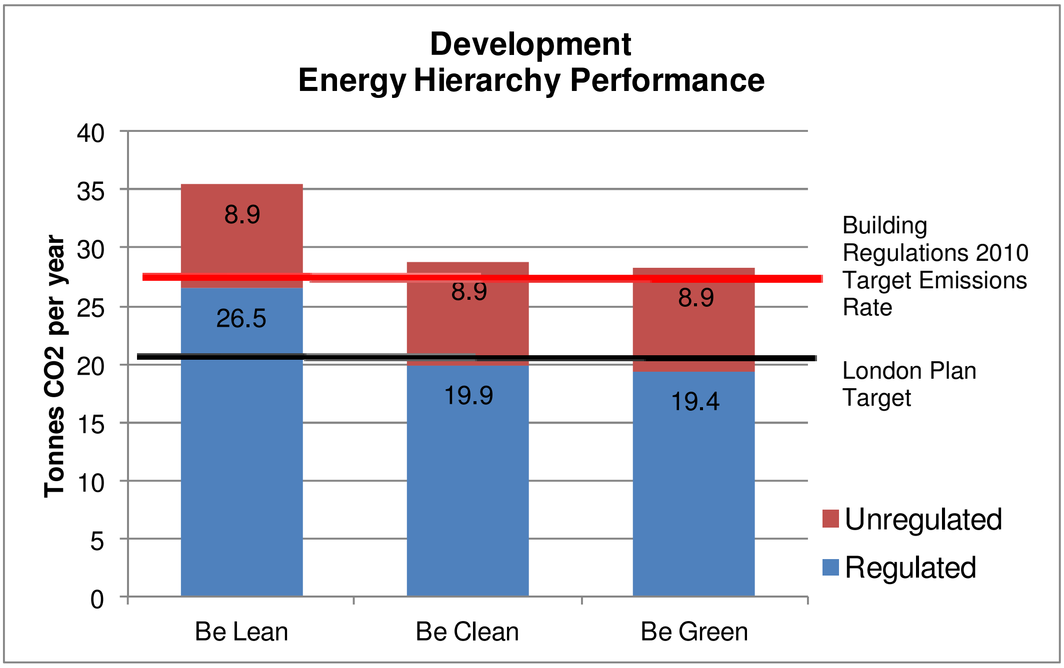
Decentralised energy has been considered in response to London Plan policy 5.6. There are no existing CCHP/CHP (Cooling and Combined Heat and Power) networks in the vicinity of the development. The dwellings are not large enough to justify the installation of a micro-chp boiler. The D2 commercial unit is likely to have a large domestic hot water demand to serve the showers so a mini CHP boiler is viable for this part of the development. A CHP boiler meeting 70% of the domestic hot water demand would save 29.9%. of the regulated carbon emissions. This solution, and the manufacturer and capacity of the CHP boiler, will be subject to change when the detail of the fit out is known. A green lease will require the tenant to provide carbon efficient technology and discharge any planning conditions relating to carbon reduction.

The dwellings will be provided with solar thermal collectors installed on the flat roof area, saving a total of 0.7 tonnes CO^2 for the development. Each dwelling will have an independent collector of 3.5m^2 serving a thermal store to pre-heat the domestic hot water feed to the combi boiler.

The combined impact of the energy efficiency measures and renewable energy technologies on the dwellings is to reduce the regulated carbon emissions by 26.8%.


D2 Commercial Unit
Energy Hierarchy Performance
Tonnes CO2 per year
30
25
20
15
10
5
0
3.6
22.1
3.6
15.5
3.6
15.5
Be Lean
Be Clean
Be Green
Building Regulations 2010 Target Emissions Rate
London Plan Target
Unregulated
Regulated


Dwellings
Energy Hierarchy Performance
Tonnes CO2 per year
12
10
8
6
4
2
0
5.4
4.5
5.4
4.5
5.4
3.9
Be Lean
Be Clean
Be Green
Building Regulations 2010 Target Emissions Rate
London Plan Target
Unregulated
Regulated



GLA Table 1: Carbon Dioxide Emissions after each stage of the Energy			
Whole Development	Carbon dioxide emissions (Tonnes CO2 per		
	Regulated	Unregulated	Total
Building Regulations 2010 Part L compliant Dwellings	27.5	8.9	36.4
After energy demand reduction	26.5	8.9	35.4
After CHP	19.9	8.9	28.8
After Renewable Energy	19.4	8.9	28.3

GLA Table 2: Carbon Dioxide Emissions from each stage of the Energy Hierarchy				
Whole Development	Carbon dioxide savings		Carbon dioxide savings (%)	
	Regulated	Total	Regulated	Total
Savings from energy demand reduction	1.0	1.0	3.6%	2.7%
Savings from CHP	6.6	6.6	24.9%	18.6%
Savings from renewable energy	0.5	0.5	2.7%	1.8%
Total cumulative savings	8.1	8.1	29.5%	22.3%

INTRODUCTION

1.1 Background

Silcock Dawson and Partners have been appointed by F&C REIT Asset Management to provide an Energy Statement for the proposed redevelopment of Queens Hall, Twickenham.

The aim of this report is to document the findings of the investigation into energy efficiency measures and the feasibility of on-site decentralised and renewable or low carbon energy sources. The report makes recommendations as to the best means of reducing the development's carbon emissions.

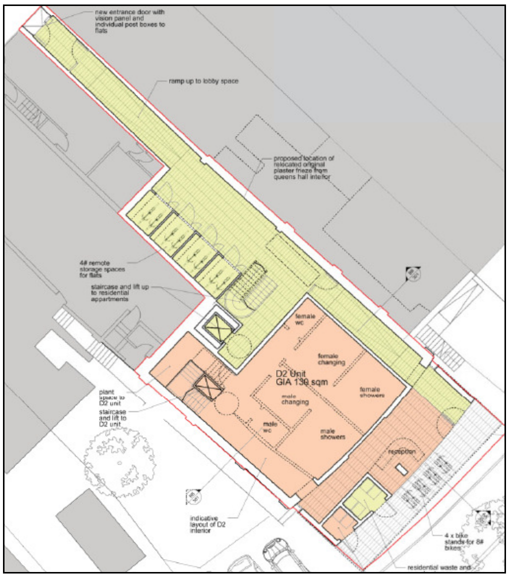
This Energy Statement follows the guidance set out in the London Borough of Richmond Upon Thames Supplementary Planning Document, Sustainable Construction Checklist Guidance Document, August 2011. In addition, the GLA's guidance on the provision of energy assessments, September 2011, is followed.

1.2 Description of the Site and Building

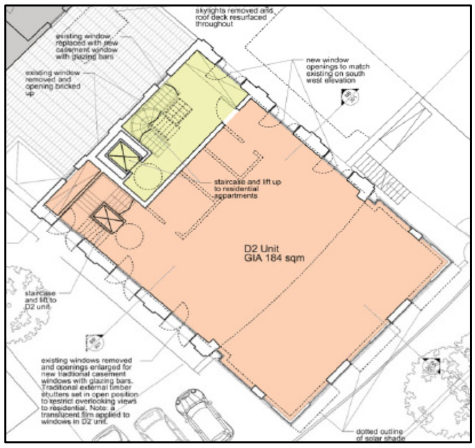
The development will maintain the long established D2 use on site and will add 4 new dwellings created on three new floor levels within the refurbished Queens Hall shell and a new extension on the south side of the Hall. The D2 unit will be constructed as a shell by the developer, with the tenant being responsible for the fit out.

The structural shell of the existing building will be utilised, and where parts of the existing structure is being demolished the materials will be re-used if appropriate.

Floor Plans



Ground Floor



First Floor

Levels 2 and 3

Section and Elevations

South East Elevation

South West Elevation

1.3 Contact Details

Please contact Andrew Sturt of Silcock Dawson & Partners if further details or information is required.

Contact

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2 Relevant Planning Policies

This Sustainable Energy Statement responds to the planning requirements of the London Borough of Richmond upon Thames:

CP2 Reducing Carbon Emissions

2.A The Borough will reduce its carbon dioxide emissions by requiring measures that minimise energy consumption in new development and promoting these measures in existing development, particularly in its own buildings.

2.B The Council will require the evaluation, development and use of decentralised energy in appropriate development.

2.C The Council will increase the use of renewable energy by requiring all new development to achieve a reduction in carbon dioxide emissions of 20% from on-site renewable energy generation unless it can be demonstrated that such provision is not feasible, and by promoting its use in existing development.

This policy is broadly aligned with the regional policies as set out in Chapter 5 of the London Plan, adopted July 2011.

2.1 Regional Policy – The London Plan

Chapter 5 of The London Plan[1] deals with the subject of climate change. The policies that are most relevant to this Energy Statement are:

POLICY 5.2

MINIMISING CARBON DIOXIDE EMISSIONS

Planning decisions

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

1 Be lean: use less energy

2 Be clean: supply energy efficiently

3 Be green: use renewable energy

B The Mayor will work with boroughs and developers to ensure that major developments meet the following targets for carbon dioxide emissions reduction in buildings. These targets are expressed as minimum improvements over the Target Emission Rate (TER) outlined in the national Building Regulations leading to zero carbon residential buildings from 2016 and zero carbon non-domestic buildings from 2019.

Dwellings:

Year	Improvement on 2010 Building Regulations
2010 – 2013	25 per cent
2013 – 2016	40 per cent
2016 – 2031	Zero carbon

[1] The London Plan, Spatial Development Strategy for Greater London, July 2011, Mayor of London.

Non-domestic buildings:

Year	Improvement on 2010 Building Regulations
2010 – 2013	25 per cent
2013 – 2016	40 per cent
2016 – 2019	As per building regulations requirements
2019 – 2031	Zero carbon

C 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.

D As a minimum, energy assessments should include the following details:

a calculation of the energy demand and carbon dioxide emissions covered by the Building Regulations and, separately, the energy demand and carbon dioxide emissions from any other part of the development, including 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.

E 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 deliver y of carbon dioxide savings elsewhere.

Policy 5.2 sets a target reduction of 25% below 2010 Part L requirements.

POLICY 5.6

DECENTRALISED ENERGY IN DEVELOPMENT PROPOSALS

Planning decisions

A Development proposals should evaluate the feasibility of Combined Heat and Power (CHP) systems, and where a new CHP system is appropriate also examine opportunities to extend the system beyond the site boundary to adjacent sites.

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

1 Connection to existing heating or cooling networks

2 Site wide CHP network

3 Communal heating and cooling.

C Potential opportunities to meet the first priority in this hierarchy are outlined in the London Heat Map tool. Where future network opportunities are identified, proposals should be designed to connect to these networks.

The development has been assessed for the feasibility of providing decentralised energy systems. This assessment is in section 5 of this report.

POLICY 5.7 **RENEWABLE ENERGY**
Strategic A The Mayor seeks to increase the proportion of energy generated from renewable sources, and expects that the projections for installed renewable energy capacity outlined in the Climate Change Mitigation and Energy Strategy and in supplementary planning guidance will be achieved in London **Planning decisions** B Within the framework of the energy hierarchy (see Policy 5.2), major development proposals should provide a reduction in expected carbon dioxide emissions through the use of on-site renewable energy generation, where feasible. D All renewable energy systems should be located and designed to minimise any potential adverse impacts on biodiversity, the natural environment and historical assets, and to avoid any adverse impacts on air quality.

The explanatory text relating to Policy 5.7 goes on to say in paragraph 5.42:

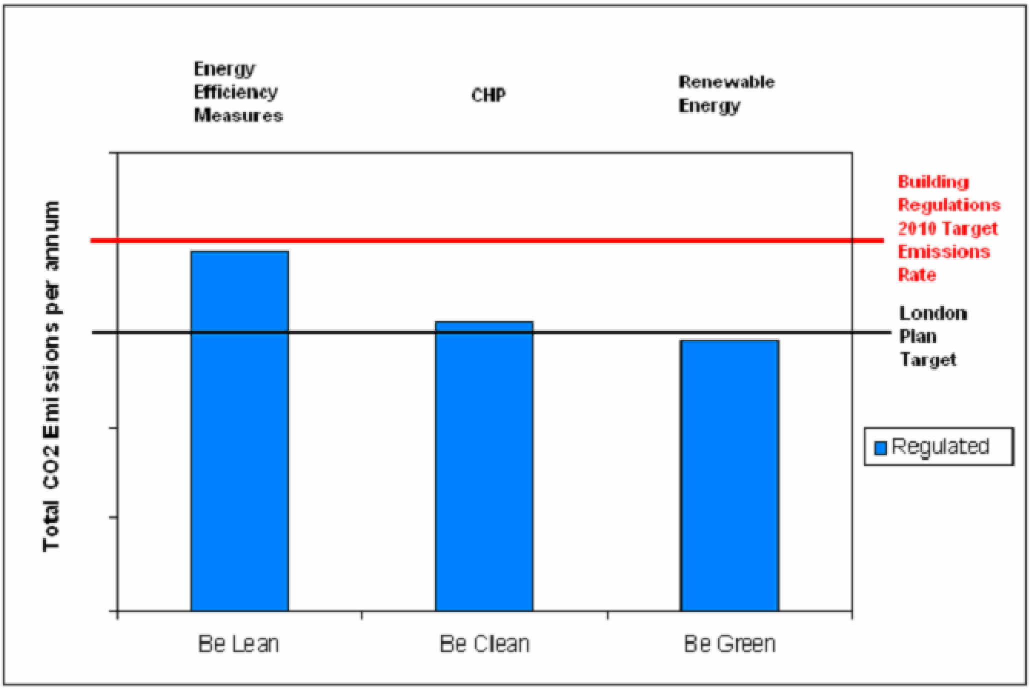
> *Individual development proposals will also help to achieve these targets by applying the energy hierarchy in Policy 5.2. There is a presumption that all major development proposals will seek to reduce carbon dioxide emissions by at least 20 per cent through the use of onsite renewable energy generation wherever feasible. Development proposals should seek to utilise renewable energy technologies such as: biomass heating; cooling and electricity; renewable energy from waste; photovoltaics; solar water heating; wind and heat pumps. The Mayor encourages the use of a full range of renewable energy technologies, which should be incorporated wherever site conditions make them feasible and where they contribute to the highest overall carbon dioxide emissions savings for a development proposal.*

Therefore, whilst Policy 5.7 does not include a specific percentage requirement for on-site renewable energy supply, the explanatory text implies that the on-site renewable technologies should be provided where feasible. An assessment of the feasibility of renewable energy sources to contribute to both regulated and non-regulated energy use is in section 6 of this report.

In support of the London Plan policies the GLA have issued Guidance on Energy Assessments[2] which sets out the information that is expected to be included in Energy Assessments. The Guidance also provides a further explanation of the policies previously summarised. The energy hierarchy, set out in Policy 5.2 is further explained by reference to the following figure copied from the Guidance.

[2] GLA Energy Team Guidance on Planning Energy Assessments, September 2011.

Figure 1: The Energy Hierarchy



3 ENERGY DEMAND ASSESSMENT

3.1 Using National Calculation Methodology (NCM)

The baseline energy use and resulting carbon emission rate of the development has been assessed using:

Dwellings - SAP 2009 for the calculation of the regulated energy use such as the space heating and domestic hot water requirements. The non-regulated emissions are calculated using the Code for Sustainable Home method for domestic appliances.

D2 unit – Part L2A compliant calculations using Design Simulation Modelling (DSM). The software used is EDSL TAS version 9.2.

Based on carbon factors of:

Gas = 0.198 $kgCO_2$/kWhr

Elec = 0.517 $kgCO_2$/kWhr

From SAP 2009.

Due to the nature of the development and the different calculation methods the results for the dwellings and D2 unit are presented separately throughout this document.

3.1.1 Dwellings

For the dwellings the baseline carbon emission rate against which the performance of energy efficiency design and renewable or low carbon energy sources are measured is target emission rate (TER) from SAP 2009 for compliance with Part L1A 2010. The TER will be calculated assuming the space heating and domestic hot water will be provided by a gas fired boiler LTHW heating systems.

The regulated baseline carbon emissions for the dwellings are 18.77 $kgCO_2/m^2$/year, or 5368 $kgCO_2$/year.

The carbon emissions from appliances and cooking have been calculated using the Code for Sustainable Homes tool for credit Ene 7, giving a total of 5367 $kgCO_2$ per year, equivalent to 18.8 $kgCO_2$ per m^2 per year.

GLA Table 1: Carbon Dioxide Emissions after each stage of the Energy Hierarchy			
Dwellings	Carbon dioxide emissions (Tonnes CO2 per annum)		
	Regulated	Unregulated	Total
Building Regulations 2010 Part L compliant Dwellings	5.4	5.4	10.7

3.1.2 D2 Unit

For the D2 unit, due to its likely use as a gym or similar, it is assumed that the fit out will provide air conditioning to the gym areas. In order to arrive at a more realistic estimate of the energy consumption and carbon emissions from the D2 unit it has been assumed that the fit out will include the following spaces; fitness gym/studios, changing rooms, small office, toilets, and circulation areas.

GLA Table 1: Carbon Dioxide Emissions after each stage of the Energy Hierarchy			
D2 Commercial Area	Carbon dioxide emissions (Tonnes CO2 per annum)		
	Regulated	Unregulated	Total
Building Regulations 2010 Part L compliant	22.14	3.56	25.70

4 ENERGY EFFICIENT DESIGN

This section of the report responds to London Plan Policy 5.2. and Richmond's Policy 2A. It outlines how the target emission rate for compliance will be exceeded through energy efficient design.

4.1 Dwellings

4.1.1 Building Fabric

The heating energy consumption will be reduced by insulating the buildings in excess of the minimum requirements of the building regulations.

The design will target best practice air tightness and U-values, beyond those given in the building regulations L1A for the dwellings, as shown in the table below:

	Limiting Standard Building Regulations, Part L1A 2010	Standards to be adopted (Based on Passive House)
Air Tightness	10 m^3/hr per m²	3 m^3/hr per m²
Wall U-Value	0.30 W/m²°C	0.18 W/m²°C
Roof U-Value	0.20 W/m²°C	0.16 W/m²°C
Floor U-Value	0.25 W/m²°C	N/A
Glazing U-Value Side window g value Full height glazed sections g value	2.0 W/m²°C	0.8 W/m²°C 0.6 0.4

Heat loss through thermal bridging will reduced by adopting enhanced approved details, reducing the y-value to 0.08 W/m²/°C.

4.1.2 Heating

According to the calculations, the baseline heating energy consumption is responsible for approximately 13% of the baseline CO_2 emissions of the dwellings. The fabric insulation standards described above will assist in reducing the heating energy consumption of the dwellings.

The dwellings will be provided with a whole house ventilation system with heat recovery. The system will be selected from approved SAP Appendix Q equipment, and will have a minimum heat exchange efficiency of 90% and a specific fan power of 0.7W/l/s. The ductwork serving the MVHR system will be of rigid construction and will be insulated.

As a basis for comparison the energy efficient design assumes that high efficiency gas fired combination boilers will be provided in the dwellings. This assumption is made to allow the energy efficient benchmark to be generated.

4.1.3 Ventilation

The dwelling will be naturally ventilated during the summer to prevent overheating. General ventilation will be provided by whole house mechanical ventilation with heat recovery (MVHR) systems.

4.1.4 Domestic Hot Water

Generation of domestic hot water is responsible for 18% of the baseline CO_2 emissions of the dwellings. In order to reduce these emissions, the following measures will be implemented:

1. High efficiency gas fired combination boiler will be used to generate the domestic hot water. The boiler will have a minimum efficiency of 90%.
2. The boiler will be located very close to the outlets in the bathroom and kitchen, thus reducing the losses due to 'dead legs'.
3. Insulate domestic hot water distribution pipe work in the dwellings.
4. Provide low flow fittings, as required to meet the water use standards set by Part G of the Building Regulations and issue WAT 1 of the Code.

4.1.5 Lighting

Lighting accounts for 7% of the baseline CO_2 emissions of the dwellings.

All fixed light fittings will be for low energy lamps, including storage and infrequently accessed areas. Daylighting in habitable rooms will be targeted to meet Hea 1 Code for Sustainable Homes issue requirements and thereby reduce the lighting energy consumption.

The lighting to common areas will be provided with PIR and daylight control.

4.1.6 Controls and monitoring

All dwellings will be individually metered and will be provided with an energy display device specified to meet the requirements of the Code for Sustainable Home Issue Ene 3. The energy display device will provide the following information for heat and electricity:

- Current energy consumption (kilowatts and kilowatt hours)
- Current emissions (g/kg CO2)
- Current tariff
- Current cost (in pounds and pence). For pre-payment customers this will be 'real time' data and for 'credit' paying customers cost should be displayed on a monthly basis
- Display accurate account balance information (amount in credit or debit)
- Visual presentation of data (i.e. non-numeric) to allow consumers to easily identify high and low level of usage
- Historical consumption data so that consumers can compare their current and previous usage in a meaningful way. This will include cumulative consumption data in any of the following forms day/week/month/billing period.

This information will enable to occupants to understand how their behaviour has a direct effect on their energy consumption in the dwelling, and how modifications to their behaviour can have a beneficial impact on the energy consumption and cost.

The energy use in the common areas will be monitored and metered to allow the energy consumption to be effectively managed.

4.1.7 Equipment

Equipment is responsible for 55% of the CO_2 emissions of the dwellings, making it the largest single contributor. However, since the equipment energy use includes all the appliances, computers, and any electrical device belonging to the users of the development, their energy use is not related to the energy performance of the buildings. It is beyond the scope of this report to include in the analysis measures to decrease the emissions linked with the use of the equipment.

Notwithstanding this, the residents will be provided with a home user guide in accordance with the Code for Sustainable Homes issue Man 1. This user guide will explain the likely primary energy uses in the dwelling and will provide advice on the selection and operation of equipment to reduce energy consumption. If any white goods are provided they will be A rated as a minimum. All dwellings will be provided with drying space to promote a reduced energy means of drying.

4.1.8 Cooling

Cooling will not be provided to the dwellings.

4.1.9 Summary of Carbon Emissions Following Energy Demand Reduction

The annual energy consumption for the development incorporating the energy efficiency measures described above is as shown in the tables below:

Carbon emissions for energy efficient dwelling				
Item	**kgCO2/m²/ Year**	**kg CO_2 /year**	**% CO_2**	**Fuel**
DHW	6.2	1,779	18%	Natural gas
Htg	4.3	1,241	13%	Natural gas
Cooling	0.0	0	0%	Grid electricity
Auxiliary Energy	2.8	798	8%	Grid electricity
Lighting	2.3	645	7%	Grid electricity
Equipment	18.8	5,367	55%	Grid electricity
Total	**34**	**9,831**		

The carbon emissions reduction against the baseline for the dwellings is 8.4%, including non regulated emissions.

GLA Table 1: Carbon Dioxide Emissions after each stage of the Energy Hierarchy			
Dwellings	Carbon dioxide emissions (Tonnes CO2 per annum)		
	Regulated	Unregulated	Total
Building Regulations 2010 Part L compliant Dwellings	5.4	5.4	10.7
After energy demand reduction	4.5	5.4	9.8

GLA Table 2: Carbon Dioxide Emissions from each stage of the Energy Hierarchy				
Dwellings	Carbon dioxide savings (Tonnes CO2 per annum)		Carbon dioxide savings (%)	
	Regulated	Total	Regulated	Total
Savings from energy demand reduction	0.9	0.9	16.9%	8.4%

4.2 D2 Unit

4.2.1 Building Fabric

The heating energy consumption will be reduced by insulating the buildings in excess of the minimum requirements of the building regulations.

The design will target best practice air tightness and U-values, beyond those given in the building regulations L1A for the dwellings, as shown in the table below:

	Limiting Standard Building Regulations, Part L2A 2010	Standards to be adopted
Air Tightness	10 m^3/hr per m²	5 m^3/hr per m²
Wall U-Value	0.35 W/m²°C	0.18 W/m²°C

Roof U-Value	0.25 W/m²°C	0.18 W/m²°C
Floor U-Value	0.25 W/m²°C	0.25 W/m²°C
Glazing U-Value Translucent glass g value Full height glazed sections g value	2.2 W/m²°C	1.1 W/m²°C 0.5 0.4

4.2.2 Natural Daylight

The size and arrangement of windows is intended to provide a daylight factor of 2%. The luminaires in spaces provided with good daylighting will be provided with daylight dimming controls.

4.2.3 Green lease

The tenancy agreement will set minimum standards for energy efficiency and performance of the building services fit out, including:

Heating and Cooling	It is assumed that the Gym will be heating and cooled by a heat recovery variable refrigerant flow system. This system will be required to recover heat from parts of the Gym that required cooling and use that heat energy to provide space heating in other parts of the Gym.
Ventilation	The Gym and ancillary spaces will be served by ventilation plant that incorporates the following design features: • Specific fan power of 1.6 W/l/second or lower • Heat recovery efficiency of 75% or greater • Summer bypass around heat recovery to assist with summertime cooling • Variable speed controls on air handling unit • Air quality sensors to control the supply air volume and portion of fresh air in order to reduce fan energy consumption and fresh air heating requirement
Domestic Hot Water	Domestic hot water generation will be a major part of the total energy consumption due to the usage resulting from the showers located in the changing rooms. The domestic hot water system will incorporate the following features: • Insulate the hot water storage tanks with a minimum thickness of 80mm of high efficiency insulation. • Boilers to serve the domestic hot water calorifiers will have a seasonal efficiency of at least 88% GCV. • Insulate domestic hot water distribution pipework. • Provide automatic shut off showers and taps to prevent wastage.
Lighting	The lighting design will target 2.6 W/m²/100 lux in the main Gym areas and 3.75 W/m²/100 lux other large spaces such as the changing rooms. The target in smaller rooms will be 5.2 W/m²/100 lux The lighting to areas that are not continuously occupied will be provided with PIR control.
Controls and monitoring	Major energy uses will be individually metered and an energy display device will be provided to allow the management to understand the energy performance of the Gym without expert assistance. As a minimum the following will be sub-metered: • Lighting • Ventilation plant

	• Air condition plant • Domestic hot water plant • Gym equipment
Equipment	Equipment energy use includes all equipment, appliances, computers, etc. The equipment energy use is not related to the energy performance of the buildings. It is beyond the scope of this report to include in the analysis measures to decrease the emissions linked with the use of the equipment.

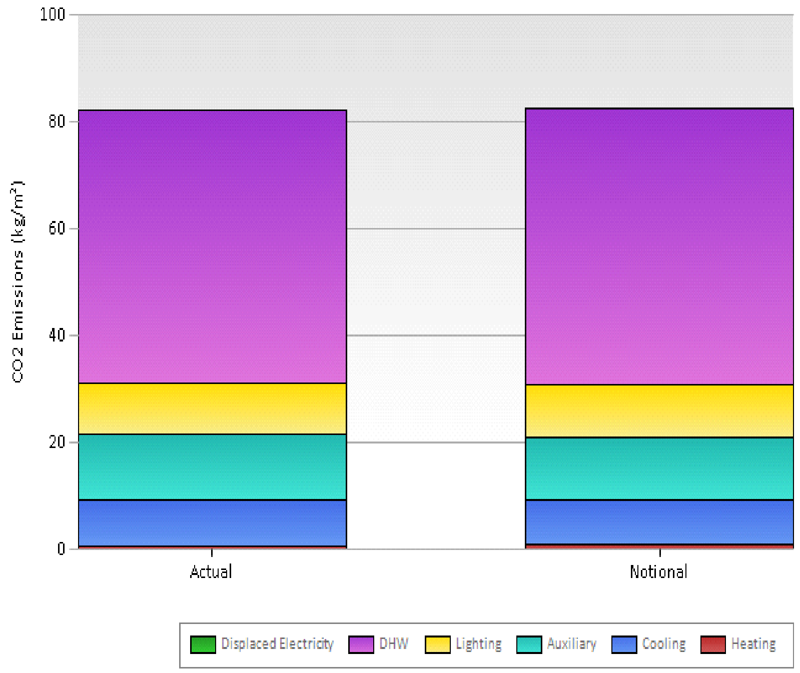
4.2.4 Summary of Carbon Emissions Following Energy Demand Reduction

The annual carbon emissions for the development incorporating the energy efficiency measures described above is as shown in the output from the modelling software below:

queens hall.tplp

Tas UK Building Regulations Studio

Annual CO2 Emissions Comparison



	Actual	Notional
Heating (kgCO2/m²)	0.68	1.01
Cooling (kgCO2/m²)	8.48	8.32
Auxiliary (kgCO2/m²)	12.52	11.68
Lighting (kgCO2/m²)	9.40	9.75
DHW (kgCO2/m²)	51.16	51.80
Displaced Electricity (kgCO2/m²)	0.00	0.00
*Equipment (kgCO2/m²) **	*13.27*	*13.27*
Total (kgCO2/m²)	82.23	82.57
Total Floor Area (m²)	268.20	268.20

** Energy used by equipment does not contribute to total value - it is presented here for comparison only*

GLA Table 1: Carbon Dioxide Emissions after each stage of the Energy Hierarchy			
D2 Commercial Area	Carbon dioxide emissions (Tonnes CO2 per annum)		
	Regulated	Unregulated	Total
Building Regulations 2010 Part L compliant	22.14	3.56	25.70
After energy demand reduction	22.06	3.56	25.62

GLA Table 2: Carbon Dioxide Emissions from each stage of the Energy Hierarchy				
D2 Commercial Area	Carbon dioxide savings (Tonnes CO2 per annum)		Carbon dioxide savings (%)	
	Regulated	Total	Regulated	Total
Savings from energy demand reduction	0.1	0.1	0.4%	0.3%

5 ENERGY SUPPLY

This section of the report responds to London Plan Policy 5.6.

According to the hierarchy of the London Plan, once the building has been designed to be energy efficient (be lean), the energy strategy has to be developed first by considering the possibility of connecting to district heating/cooling schemes or the possibility of implementing CHP/CCHP (be clean), before analysing the use of renewable energies (be green). The table bellows shows the various options as given in Policy 5.6 and their suitability for the present development:

Option	Suitability
Connection to existing CCHP/CHP distribution network	There is no existing district heating scheme local to the development
Site-wide CCHP/CHP powered by renewable energy	Biomass CCHP/CHP are not considered effective in an urban development (see section 6.1)
Gas-fired CCHP/CHP or hydrogen fuel cells, both accompanied by renewables	Gas-fired CCHP/CHP are analysed in further details in section 5.1, and the accompanying renewables in section 6.
Communal heating and cooling fuelled by renewable sources of energy	Will only be considered if gas-fired CCHP/CHP is not viable.
Gas fired communal heating and cooling	Will only be considered if gas-fired CCHP/CHP is not viable

The London Heat Map has been utilised to check if the development can connect into an existing distribution network. Currently there are no existing heat distribution networks in the area.

5.1 Combined Heat and Power (CHP)

5.1.1 Dwellings

Combined heat and power, and micro combined heat and power, are not considered suitable for the dwellings due to the very low energy demand.

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

Dwellings	Carbon dioxide emissions (Tonnes CO2 per annum)		
	Regulated	Unregulated	Total
Building Regulations 2010 Part L compliant Dwellings	5.4	5.4	10.7
After energy demand reduction	4.5	5.4	9.8
After CHP	4.5	5.4	9.8

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

Dwellings	Carbon dioxide savings (Tonnes CO2 per annum)		Carbon dioxide savings (%)	
	Regulated	Total	Regulated	Total
Savings from energy demand reduction	0.9	0.9	16.9%	8.4%
Savings from CHP	0.0	0.0	0.0%	0.0%

5.1.2 D2 Unit

The Part L calculations show that the energy consumption for the generation of domestic hot water, if fitted out as a gym, is the largest single energy use.

The total predicted domestic hot water energy demand is around 75MWhrs. Based on the rule of thumb of 5000 running hours a 10kWth CHP boiler would meet 70% of the annual domestic hot water demand. The remainder of the domestic hot water demand will be met by a high efficiency gas fired boiler. A CHP unit of this size falls into the micro-CHP or mini-CHP product class. There are a number of products available today, and it is anticipated that as demand increases so will the number of alternative products. For the purpose of demonstrating the potential carbon savings from a CHP boiler the Baxi Dachs has be used in the Part L calculation.

Electrical output(3-phase)	5.5 kW
Thermal output (min.)	12.5 kW
With condenser (max.)	15.5 kW
Efficency gross (nett)	79% (88%)
Max. with condenser	92% (102%)

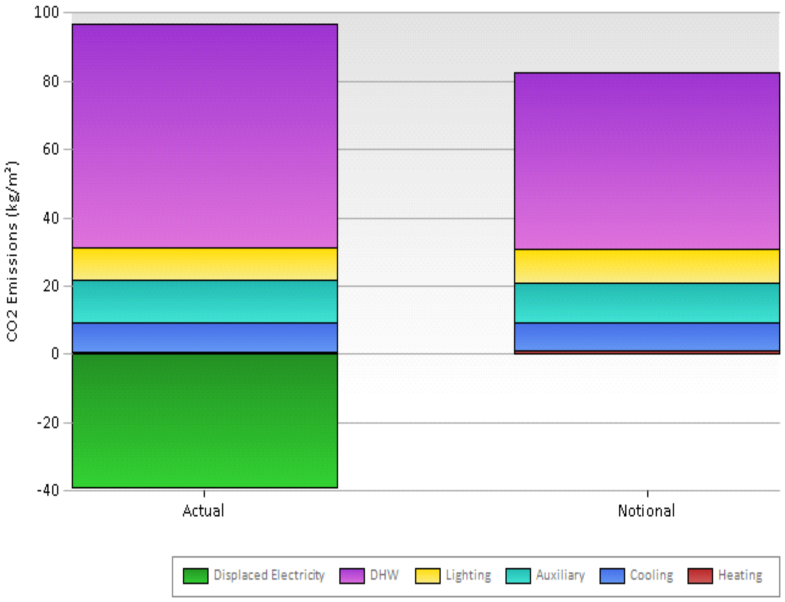
This solution, and the manufacturer and capacity of the CHP boiler, will be subject to change when the detail of the fit out is known.

The annual carbon emissions from the D2 commercial unit incorporating the energy efficiency measures and a CHP boiler are shown in the output from the modelling software below:

queens hall.tplp

Tas UK Building Regulations Studio

Annual CO2 Emissions Comparison



	Actual	*Notional*
Heating (kgCO2/m²)	0.71	1.01
Cooling (kgCO2/m²)	8.48	8.32
Auxiliary (kgCO2/m²)	12.52	11.68
Lighting (kgCO2/m²)	9.40	9.75
DHW (kgCO2/m²)	65.49	51.80
Displaced Electricity (kgCO2/m²)	-38.96	0.00
Equipment (kgCO2/m²) *	*13.27*	*13.27*
Total (kgCO2/m²)	57.62	82.57
Total Floor Area (m²)	268.20	268.20

** Energy used by equipment does not contribute to total value - it is presented here for comparison only*

GLA Table 1: Carbon Dioxide Emissions after each stage of the Energy Hierarchy			
D2 Commercial Area	Carbon dioxide emissions (Tonnes CO2 per annum)		
	Regulated	Unregulated	Total
Building Regulations 2010 Part L compliant	22.14	3.56	25.70
After energy demand reduction	22.06	3.56	25.62
After CHP	15.45	3.56	19.02

GLA Table 2: Carbon Dioxide Emissions from each stage of the Energy Hierarchy				
D2 Commercial Area	Carbon dioxide savings (Tonnes CO2 per annum)		Carbon dioxide savings (%)	
	Regulated	Total	Regulated	Total
Savings from energy demand reduction	0.1	0.1	0.4%	0.3%
Savings from CHP	6.6	6.6	29.9%	25.8%

6 LOW AND ZERO CARBON TECHNOLOGIES FOR ENERGY PRODUCTION

This section of the report responds to London Plan Policy 5.7 and Richmond's requirement to achieve a reduction in carbon dioxide emissions from on-site renewable energy generation unless it can be demonstrated that such provision is not feasible.

The use of energy conversion technologies using renewable energies has to be analyzed. The main technologies available for on-site renewable energy generation are:

- Biomass
- Ground Source Heat Pump (GSHP)
- Exhaust Air Heat Pump
- Photovoltaics
- Solar thermal hot water generation
- Wind

Refer to appendix A2 for the more details and a brief explanation of renewable energy technologies.

6.1 Biofuel

Refer to appendix A2.1, for a discussion on the broader sustainability aspects of biofuels. The appendix explains why biofuels are not favoured for this project.

6.2 Ground Source Heat Pumps

Ground source heat pumps are not technically viable for the development because the existing ground floor slab is to be retained. In addition to this, the major heat energy use for the dwellings and the D2 unit is domestic hot water, and when used to generate domestic hot water the ground source heat pumps will operate with a poor coefficient of performance.

Conclusion

Not viable for this development

6.3 Exhaust Air Heat Pump

Exhaust air heat pumps take energy that would normally be exhausted from the dwelling by the ventilation system and re-use this energy to provide space heating and domestic hot water. Small dwellings such as this are an ideal application for this technology.

The SAP calculations have been undertaken using a Nibe air source heat pump as the means of providing heating and hot water; the dwelling emission rate (DER) for this solution is worse than the baseline carbon emission rate for gas fired combi boilers.

6.4 Solar Water Heating Systems

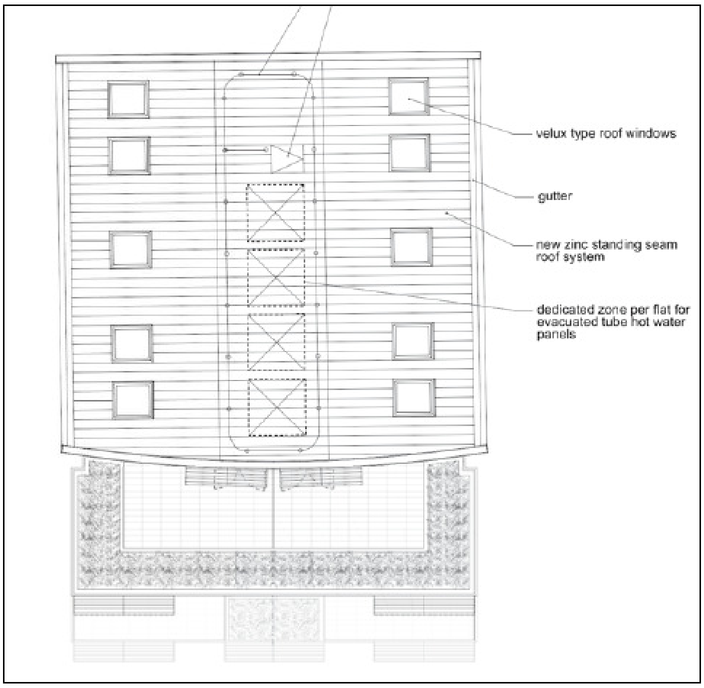
Solar thermal collectors are technically viable for the dwellings. The horizontal roof is sufficiently large to allow the installation of approximately 3.5 to 4m^2 of evacuated tube collectors per dwelling. Evacuated tubes are the favoured type of collector because they will be installed horizontal in order to minimise the visual impact.

Each dwelling will be provided with an independent domestic hot water system, with the solar thermal energy used to pre-heat the domestic hot water in a 100 litre dedicated tank. The combi boiler will be used to meet the domestic hot water demand not met by the solar thermal collectors.

The SAP calculations have been undertaken using 3.5m^2 of solar thermal collectors and a 100 litres solar store to contribute to the generation of domestic hot water. This resulted in a saving of 172 kg CO^2 per year per dwelling, a total of 0.7 tonnes CO^2 for the development.

Solar thermal collectors would also be technically viable for the D2 unit, however, there is insufficient space on the flat roof area for additional solar collectors and it is felt that the general benefit of solar thermal to the dwellings, including factors such as operating cost and fuel poverty, will be greater than for the commercial unit.

The roof plan, below, shows the location of the solar thermal collectors.



6.5 Photovoltaics

The use of roof mount photovoltaic panels is not applicable for the dwellings because the flat roof area is used for solar thermal collectors.

Solar PV is not viable for the D2 area as there are no suitable locations for the installation of collectors.

6.6 Wind Energy

The urban environment and the close proximity of dwellings are not favourable conditions for the installation of wind turbines. The uneven air flow caused by surrounding buildings and the potential negative impact on the visual and noise amenity of the area militate against the use of wind turbines for this development.

Therefore, wind turbines are not favoured for this development.

7 SUMMARY

The table below summarises the costs, pay-back periods and equipment sizes to achieve CO_2 emission savings by decentralised energy plant and on-site renewable energy source. The technical viability of the technologies using the renewable energy sources is also considered. The technical viability is intended to include aspects such as maintenance, constructability, and planning issues.

7.1 Dwellings

Option	Carbon Saving, Tonnes	Investment costs [£]	Technical Viability (0=not viable, 10=very viable)	Comments
Gas fired CHP	Not viable			
Ground source heat pumps	Not viable			
Exhaust air heat pumps	Not viable - emissions increase relative to base case			
PV Cells	Not viable			
Solar thermal hot water heating.	0.7	£15,000	8	Collectors installed horizontal on flat part of roof.
Biomass heating	Not favored due to broader sustainability issues			
Wind Turbines	Not favored due to proximity to dwellings and urban location.			

The analysis in the energy supply section of this report has demonstrated the carbon dioxide savings possible with various low-carbon technologies and renewable energy sources. The greatest saving in carbon dioxide would be achieved by the provision of a combination of solar thermal collectors and thin film PV embedded onto the south east facing glass balustrades.

GLA Table 1: Carbon Dioxide Emissions after each stage of the Energy Hierarchy			
Dwellings	Carbon dioxide emissions (Tonnes CO2 per annum)		
	Regulated	Unregulated	Total
Building Regulations 2010 Part L compliant Dwellings	5.4	5.4	10.7
After energy demand reduction	4.5	5.4	9.8
After CHP	4.5	5.4	9.8
After Renewable Energy	3.9	5.4	9.3

GLA Table 2: Carbon Dioxide Emissions from each stage of the Energy Hierarchy				
Dwellings	Carbon dioxide savings (Tonnes CO2 per annum)		Carbon dioxide savings (%)	
	Regulated	Total	Regulated	Total
Savings from energy demand reduction	0.9	0.9	16.9%	8.4%
Savings from CHP	0.0	0.0	0.0%	0.0%
Savings from renewable energy	0.5	0.5	11.9%	5.4%
Total cumulative savings	1.4	1.4	26.8%	13.4%

7.2 D2 unit

Option	Carbon Saving, Tonnes	Investment costs [£]	Technical Viability (0=not viable, 10=very viable)	Comments
Gas fired CHP	4.3	£6,000	7	To be confirmed during fit out design.
Ground source heat pumps	Not viable due to retention of ground floor slab.			
PV Cells	Not viable as no space available for installation			
Solar thermal hot water heating.	Not viable as no space available for installation and CHP boiler meets much of the domestic hot water load.			
Biomass heating	Not favored due to broader sustainability issues			
Wind Turbines	Not favored due to proximity to dwellings and urban location.			

GLA Table 1: Carbon Dioxide Emissions after each stage of the Energy Hierarchy			
D2 Commercial Area	Carbon dioxide emissions (Tonnes CO2 per annum)		
	Regulated	Unregulated	Total
Building Regulations 2010 Part L compliant	22.14	3.56	25.70
After energy demand reduction	22.06	3.56	25.62
After CHP	15.45	3.56	19.02
After Renewable Energy	15.45	3.56	19.02

GLA Table 2: Carbon Dioxide Emissions from each stage of the Energy Hierarchy				
D2 Commercial Area	Carbon dioxide savings (Tonnes CO2 per annum)		Carbon dioxide savings (%)	
	Regulated	Total	Regulated	Total
Savings from energy demand reduction	0.1	0.1	0.4%	0.3%
Savings from CHP	6.6	6.6	29.9%	25.8%
Savings from renewable energy	0.0	0.0	0.0%	0.0%
Total cumulative savings	6.7	6.7	30.2%	26.0%

8 RECOMMENDATION

Following a review of the relevant National, Regional and Local planning policies this proposed Sustainable Energy Statement proposes a strategy that positively responds to the policy structure that requires developments to *be lean; be clean; be green*.

The buildings are designed to be energy efficient and incorporate the following key features:

1. The annual heating demand will be reduced by using insulation values better than the limiting standards. The target air permeability is 3 $m^3/hr/m^2$. Approved construction details will be used to reduce heat loss due to thermal bridging.
2. The dwelling will have a whole house ventilation system with a heat recovery efficiency of 90% and a fan power of 0.7 W/l/s or less.
3. The dwellings will be provided with 100% low energy luminaires and the occupied spaces benefit from southerly facing windows.
4. Controls and monitoring systems will be provided to each dwelling and commercial unit. The common spaces will also be provided with energy monitoring facilities.

The energy efficiency measures will reduce the regulated carbon emissions for the dwellings by 16.9% and for the D2 unit by 0.4% relative to the 2010 Building Regulations baseline case.

Decentralised energy has been considered in response to London Plan policy 5.6. There are no existing CCHP/CHP (Cooling and Combined Heat and Power) networks in the vicinity of the development. The dwellings are not large enough to justify the installation of a micro-chp boiler. The D2 commercial unit is likely to have a large domestic hot water demand to serve the showers so a mini CHP boiler is viable for this part of the development. A CHP boiler meeting 70% of the domestic hot water and changing area heating demand would provide a saving of 29.9% in regulated carbon emissions. This solution, and the manufacturer and capacity of the CHP boiler, will be subject to change when the detail of the fit out is known. The tenant will be required by the green lease to provide carbon efficient technology and discharge any planning conditions relating to carbon reduction.

The dwellings will be provided with solar thermal collectors installed on flat roof area, saving a total of 1.0 tonnes CO^2. Each dwelling will have an independent collector of 3.5m^2 serving a thermal store to pre-heat the domestic hot water feed to the combi boiler.

The combined impact of the energy efficiency measures and renewable energy technologies on the dwellings is to reduce the regulated carbon emissions by 26.8%.

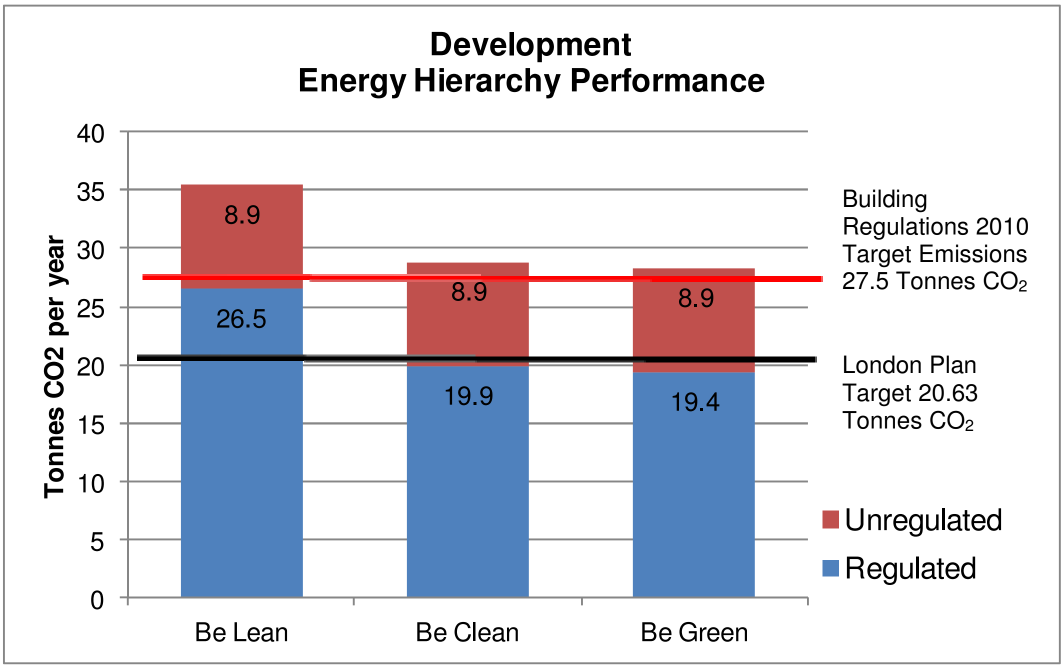
The combined impact of the energy efficiency measures and provision of a CHP boiler on the D2 commercial unit is to reduce the regulated carbon emissions by 30.2%. A green lease will be developed for the unit to ensure that the tenant implements the carbon saving measures, along with other sustainable features, as part of the fit out works and day to day operation.

8.1 Summary Tables

Whole Development

GLA Table 1: Carbon Dioxide Emissions after each stage of the Energy			
Whole Development	Carbon dioxide emissions (Tonnes CO2 per		
	Regulated	Unregulated	Total
Building Regulations 2010 Part L compliant Dwellings	27.5	8.9	36.4
After energy demand reduction	26.5	8.9	35.4
After CHP	19.9	8.9	28.8
After Renewable Energy	19.4	8.9	28.3

GLA Table 2: Carbon Dioxide Emissions from each stage of the Energy Hierarchy				
Whole Development	Carbon dioxide savings		Carbon dioxide savings (%)	
	Regulated	Total	Regulated	Total
Savings from energy demand reduction	1.0	1.0	3.6%	2.7%
Savings from CHP	6.6	6.6	24.9%	18.6%
Savings from renewable energy	0.5	0.5	2.7%	1.8%
Total cumulative savings	8.1	8.1	29.5%	22.3%



A1 APPENDIX 1 – National Planning Policy

A1.1 10 - Meeting the challenge of climate change, flooding and coastal change

93. Planning plays a key role in helping shape places to secure radical reductions in greenhouse gas emissions, minimising vulnerability and providing resilience to the impacts of climate change, and supporting the delivery of renewable and low carbon energy and associated infrastructure. This is central to the economic, social and environmental dimensions of sustainable development.

94. Local planning authorities should adopt proactive strategies to mitigate and adapt to climate change, taking full account of flood risk, coastal change and water supply and demand considerations.

95. To support the move to a low carbon future, local planning authorities should:

- plan for new development in locations and ways which reduce greenhouse gas emissions;
- actively support energy efficiency improvements to existing buildings; and
- when setting any local requirement for a building's sustainability, do so in a way consistent with the Government's zero carbon buildings policy and adopt nationally described standards.

96. In determining planning applications, local planning authorities should expect new development to:

- comply with adopted Local Plan policies on local requirements for decentralised energy supply unless it can be demonstrated by the applicant, having regard to the type of development involved and its design, that this is not feasible or viable; and
- take account of landform, layout, building orientation, massing and landscaping to minimise energy consumption.

97. To help increase the use and supply of renewable and low carbon energy, local planning authorities should recognise the responsibility on all communities to contribute to energy generation from renewable or low carbon sources. They should:

- have a positive strategy to promote energy from renewable and low carbon sources;
- design their policies to maximise renewable and low carbon energy development while ensuring that adverse impacts are addressed satisfactorily, including cumulative landscape and visual impacts;
- consider identifying suitable areas for renewable and low carbon energy sources, and supporting infrastructure, where this would help secure the development of such sources;
- support community-led initiatives for renewable and low carbon energy, including developments outside such areas being taken forward through neighbourhood planning; and
- identify opportunities where development can draw its energy supply from decentralised, renewable or low carbon energy supply systems and for co-locating potential heat customers and suppliers.

98. When determining planning applications, local planning authorities should:

- not require applicants for energy development to demonstrate the overall need for renewable or low carbon energy and also recognise that even small-scale projects provide a valuable contribution to cutting greenhouse gas emissions; and

- approve the application if its impacts are (or can be made) acceptable. Once suitable areas for renewable and low carbon energy have been identified in plans, local planning authorities should also expect subsequent applications for commercial scale projects outside these areas to demonstrate that the proposed location meets the criteria used in identifying suitable areas.

A2 APPENDIX 2 – RENEWABLE ENERGY OVERVIEW

The information in this appendix is not project specific and is intended to provide an overview of the technologies described.

A2.1 Biofuels

A2.1.1 Background

Biomass is an alternative solid fuel to the conventional fossil fuels and has an impact on carbon emissions that is close to neutral. Various types of biomass fuels are in use, the most common being the woody biomass, which includes forest residues such as tree thinnings, and energy crops such as willow short rotation coppice. The fuel usually takes the form of wood chips, logs and pellets. Supply and storage of the biomass fuel should be carefully considered especially for larger plants. Modern systems can be fed automatically by screw drives from fuel hoppers.

The typical applications are:

a. Biomass boilers replacing standard gas- or oil -fired boilers for space heating and hot water (for individual buildings or district heating systems).

b. Standalone room heaters for space heating.

c. Stoves with back boilers, supplying domestic hot water.

d. Biomass CHP for heat and electricity generation.

Appliances can achieve efficiencies of more than 80%.

The capital cost of automated biomass heating systems is significantly greater than that of conventional heating systems, mainly because of the more complicated feeding mechanisms and the currently smaller market for biomass appliances.

There is an ongoing public debate on the true sustainability of using biofuels. Given the number of differing views expressed by academics and engineers and contradictions in publications issued by the Government the theoretical carbon savings offered by biofuels must be treated with extreme caution. 3.1.2 to 3.1.5 below expands on this.

A2.1.2 Biofuels as a Sustainable Resource

Research undertaken by AEA technology on behalf of the Department for Transport[3] stated that '*Research has shown that biofuels can reduce carbon emissions, yet they are currently a controversial area of science. Insufficient data exists to fully understand the impact of biofuel production on communities and the environment; and, whilst biofuels could be a powerful tool in reducing carbon emissions, they must be produced in a sustainable manner if they are not to do more harm than good' then states that 'biofuels are currently a controversial topic area, and it is difficult to move forward in such circumstances*'. The research paper listed 4 key findings:

- Key finding 1: We need to improve our understanding of the indirect impacts of biofuels, particularly indirect land use change;
- Key finding 2: We need to improve our knowledge of the environmental, socioeconomic and supply-chain impacts of biofuels;
- Key finding 3: There is a need for new research to examine the evolution of the production, infrastructure and vehicle technologies necessary to enable us to meet longer-term biofuels targets for transport and for improving the sustainability of biofuels;
- Key finding 4: There are a number of cross-cutting research gaps that need to be addressed in order to support the development of biofuels policy**.**

[3] Biofuels Research Gap Analysis, Department for Transport, July 2009

According to the Renewable Fuels Agency[4] only 18% of the liquid biofuels consumed in the UK originate in the UK. 30% of liquid biofuels originates in Brazil, and the sustainability of their production and the consequent deforestation are the topic of wider debate.

The carbon emission factor stated in the Standard Assessment Procedure (SAP) 2009 for biodiesel is 0.047kg CO2/kWhr. (The SAP methodology is used to calculate the energy consumption and carbon emissions from dwellings to demonstrate compliance with the Building Regulations and generate Energy Performance Certificates). Data published by the Renewable Fuels Agency[5] shows that the mean carbon emission factor for biodiesel consumed in the UK is 0.148kgCO2/kWhr (41 gCO_2e/MJ), this compares to the carbon emission factor for natural gas of 0.198kgCO2/kWhr. Given that there is a limited supply of biofuel it would be reasonable to use the mean value for the emission factor; this principle is applied to mains electricity where the carbon emissions from all sources of electricity generation are aggregated to arrive at a mean value.

The carbon emission factor stated in the SAP 2009 for wood pellets is 0.028kg CO_2/kWhr. Research by AEA Technology on behalf of the Environment Agency[6] showed that the emissions are actually between 0.050 and 0.140 kg CO_2/kWhr, with 0.1 $kgCO_2$/kWhr being a typical value for good practice. From this it can be concluded that the carbon savings stated when using the SAP values are overstated.

Biodiesel CHP may be technically viable for the development but the lack of certainty over the sustainability of liquid biofuels militates against this. In addition to this, concerns over the future availability of fuel supplies are a consideration. The European Renewable Energy Directive (RED) commits the UK to sourcing 10 percent of its transport energy from renewable sources by 2020[7]. Currently only 3.5% of transport energy is from renewable sources, and 82% of this is imported. It is reasonable to conclude that as the volume of liquid biofuel that is legally required to be used for transport energy increases, the supply of the fuel for other purposes will become more expensive and difficult to procure.

A2.2 Air and Ground Source Heat Pumps

A2.2.1 Background

The technology makes use of the energy available in the ambient air or stored in the Earth's crust, which comes mainly from solar radiation. Essentially, heat pumps take up heat at a certain temperature and release it at a higher temperature. This is achieved by means of a simple heat exchanger in the case of air source heat pumps, or by means of either horizontal or vertical ground collectors, in which a heat exchange fluid circulates and transfers heat via a heat exchanger to the heat pump, in the case of ground source heat pumps. For the latter, when considering buildings with piled foundations, the pipes can be integrated in the design using several piling systems.

The efficiency of any type of heat pump is very much dependent on the temperature level at which it has to provide the heat: the lower the temperature level, the better the coefficient of performance.

Almost all heat pumps in operation are based on the vapour compression cycle, which combines efficiency, safety and reasonable cost. The efficiency of heat pumps is measured by the ratio of the heating capacity to the power input, referred to as the Coefficient of Performance (COP). Generally, a COP of around 2.5-3 for air source heat pumps and around 3.5-4 for ground source heat pumps is achievable for heating,

[4] Renewable Fuels Agency Quarterly Report Apr 2010 to October 2010
[5] Renewable Fuels Agency Quarterly Report Apr 2010 to October 2010
[6] Biomass: Carbon sink or carbon sinner?, Environment Agency, April 2009
[7] Department of Energy and Climate Change website.

assuming low temperature heat emitters such as underfloor heating. When used to generate domestic hot water at 60℃ the COP falls for both types of heat pumps by around 1 point. Therefore, when it comes to domestic hot water, heat pumps can be implemented to pre-heat the water up to a certain temperature, before it enters the boiler, rather than to heat up the domestic hot water entirely up to its final required temperature.

The approximate costs for heat pumps amount to £700 per kW_{th} heat output for an air source heat pump, and £1,200 per kW_{th} heat output for a ground source heat pump with horizontal trenches, and £1,400 per kW_{th} heat output for a ground source heat pump with vertical boreholes (including the cost of bore holes).

A2.3 Solar Water Heating Systems

A2.3.1 Background

Solar thermal and, especially, active Solar Domestic Hot Water (SDHW) heating is a well -established renewable energy system in many countries outside the UK. It can be one of the most cost-effective renewable energy systems available.

It is appropriate for both residential and non-residential applications, and there are currently in the order of 80,000 installations in the UK.

Solar thermal systems in the UK normally operate with a back-up source of heat, such as gas or electricity. The solar system pre-heats the incoming cold water, which is topped up by the back-up heat source when there is insufficient solar energy to reach the chosen target temperature.

Solar collectors are best mounted at an incline with a southerly orientation, although orientations between south-east and south-west are acceptable. The panels can be fixed to the roof or walls.

There are three main types of solar collector that can be used in SDHW systems. These are:

a. Evacuated tubes.

b. Glazed selective surfaced flat plate.

c. Glazed non-selective surfaced flat plate.

Evacuated tube collectors are generally more expensive than flat plate type but offer an improved performance, particularly in the winter.

A2.4 Photovoltaics

A2.4.1 Background

Photovoltaic modules convert daylight directly into DC electricity and can be integrated into buildings. Photovoltaics (PVs) are distinct from other renewable energy technologies since they have no moving parts to be maintained and are silent. PV systems can be incorporated into buildings in various ways: on sloped roofs and flat roofs, in facades, atria and shading devices. Modules can be mounted using frames or they can be fully incorporated into the actual building fabric; for example, PV roof tiles are now available which can be fitted in place of standard tiles. Since PVs generate DC output, an inverter and other equipment is needed to deliver the power to a building or the grid in an acceptable AC form. The cost of the inverter and these components can approach 50% of the total cost of a PV system.

For PV to work effectively it should ideally face south and at an incline of 30º to the horizontal, although orientations within 45º of south are acceptable. It is essential that the system is unshaded, as even a small shadow may significantly reduce output.

A2.5 Wind Energy

A2.5.1 Background

Most wind turbines are installed in non-urban areas for environmental and technical reasons. However, it has become more common for smaller devices installed at the point of use, i.e. urban settings. The capacity of wind turbines range from 500W to more than 1.5 MW, but, for practical purposes and in built-up areas in particular, machines of more than 1 kW and below 500kW are likely to be considered. Individual building or community wind projects, although smaller, have the advantage of feeding electricity directly into the building's electricity circuit, thus sparing costly distribution network development and avoiding distribution losses. The downside is the still high capital cost per kW installed for smaller turbines, plus location constraints, such as visual intrusion and noise. The wind regime in urban areas is also a concern owing to higher wind turbulence which reduces the potential electricity output.

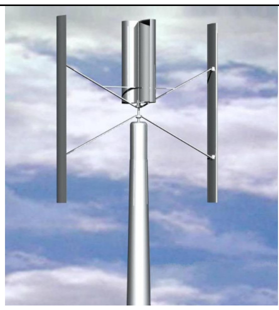
In most cases, wind turbines are connected to the electricity grid and all generated energy is used regardless of the building demand fluctuations. The output largely depends on the wind speed and the correlation between the two is a cube function. This means that in short periods of above-average wind speeds the generation increases exponentially. As a result, it is difficult to make precise calculations of the annual output of a turbine, but average figures can provide useful guidance.

The cost per kW installed varies considerably by manufacturer and size of machine with an indicative bracket of £2,500-£5, 000. With a lifespan of more than 20 years, wind turbines can save money if design and planning are carried out in a robust way.

Wind Turbine Options

Wind turbines can be mounted on horizontal or vertical axes. The horizontal mounted turbines are less expensive (around £ 20,000 for a 6 kW turbine) but generate more vibrations. The vertical mounted turbines are more expensive (around £ 22,000 for a 5 kW turbine), but almost vibration free. The table below shows the most relevant figures for both types of turbines.

	Horizontal mounted turbine	Vertical mounted turbine
Design size taken as reference	6 kW	5 kW
Investment costs of the turbine	£20,000	£22,000

	 http://www.planetenergy.co.uk/windtubines.htm	 http://www.planetenergy.co.uk/windtubines.htm
	Vibrations, accessibility for maintenance and costs for the reinforcement of the masts.	Accessibility for maintenance

Building-integrated wind turbines are starting to be a reality in the UK, but obtaining planning permission may be difficult, and the turbines may suffer reduced efficiency due to the impact of the building on the wind profile.

A3 APPENDIX 3 –Sample Energy Efficient Part L calculations

Regulations Compliance Report

Approved Document L1A 2010 edition assessed by Stroma FSAP 2009 program, Version: 1.5.0.38
Printed on 03 June 2013 at 10:58:53

Project Information:

Assessed By: () **Building Type:** Semi-detached Flat

Dwelling Details:

NEW DWELLING DESIGN STAGE

Site Reference : Queens Hall **Plot Reference:** Typical 1 Bed

Address :

Client Details:

Name:

Address :

This report covers items included within the SAP calculations.
It is not a complete report of regulations compliance.

1 TER and DER

Fuel for main heating system: Natural gas
Fuel factor: 1.00 (natural gas)

Target Carbon Dioxide Emission Rate (TER)	20.25 kg/m²	
Dwelling Carbon Dioxide Emission Rate (DER)	16.48 kg/m²	OK

2 Fabric U-values

Element	Average	Highest	
External wall	0.19 (max. 0.30)	0.19 (max. 0.70)	OK
Floor	(no floor)		
Roof	0.16 (max. 0.20)	0.16 (max. 0.35)	OK
Openings	0.92 (max. 2.00)	2.00 (max. 3.30)	OK

3 Air permeability

Air permeability at 50 pascals	3.00	
Maximum	10.0	OK

4 Heating efficiency

Main Heating system:	Boiler system with radiators or underfloor - mains gas Data from manufacturer Combi boiler Efficiency 90.0 % SEDBUK2009 Minimum 88.0 %	OK
Secondary heating system:	None	

5 Cylinder insulation

Hot water Storage:	No cylinder

6 Controls

Space heating controls	Programmer, room thermostat and TRVs	OK
Hot water controls:	No cylinder	
Boiler interlock:	Yes	OK

7 Low energy lights

Percentage of fixed lights with low-energy fittings	100.0%	
Minimum	75.0%	OK

Regulations Compliance Report

8 Mechanical ventilation

Continuous supply and extract system		
Specific fan power:	0.59	
Maximum	1.5	OK
MVHR efficiency:	92%	
Minimum	70%	OK

9 Summertime temperature

Overheating risk (South East England):	High	Fail
Based on:		
Overshading:	Average or unknown	
Windows facing: South East	$10m^2$, Overhang twice as wide as window, ratio NaN	
Roof windows facing: North East	$8.4m^2$	
Ventilation rate:	3.00	
Blinds/curtains:	None	
	shutter closed 100% of daylight hours	

10 Key features

Air permeablility	3.0 m^3/m^2h
Roof window U-value	0.8 W/m^2K
Windows U-value	0.8 W/m^2K
External Walls U-value	0.18 W/m^2K
External Walls U-value	0.19 W/m^2K

BRUKL Output Document

HM Government

Compliance with England and Wales Building Regulations Part L 2010

Project name

Queens hall

As designed

Date: Thu May 30 15:09:16 2013

Administrative information

Building Details

Address: Twickenham, ,

Certification tool

Calculation engine: TAS

Calculation engine version: "v9.2.1"

Interface to calculation engine: TAS

Interface to calculation engine version: v9.2.1

BRUKL compliance check version: v4.1.e.5

Owner Details

Name:

Telephone number:

Address: , ,

Certifier details

Name:

Telephone number:

Address: , ,

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

1.1	CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	82.6
1.2	Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	82.6
1.3	Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	82.2
1.4	Are emissions from the building less than or equal to the target?	BER =< TER
1.5	Are as built details the same as used in the BER calculations?	Separate submission

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

2.a Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.19	0.19	External Wall
Floor	0.25	0.25	0.25	Ground Floor
Roof	0.25	0.18	0.18	Roof
Windows***, roof windows, and rooflights	2.2	1.85	1.86	Gym window transluscent lower
Personnel doors	2.2	-	-	No personal doors in project
Vehicle access & similar large doors	1.5	-	-	No vehicle doors in project
High usage entrance doors	3.5	-	-	No high usage entrance doors in project

$U_{a\text{-}Limit}$ = 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	5

2.b Building services

The building services parameters listed below are expected to be checked by the BCO against guidance. No automatic checking is performed by the tool.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	>0.95

1- Changing heat and vent

Heating seasonal efficiency	**Cooling nominal efficiency**	**SFP [W/(l/s)]**	**HR seasonal efficiency**
0.9	-	1.6	0.75
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system			NO

2- Gym AC system (4 Zones)

Heating seasonal efficiency	**Cooling nominal efficiency**	**SFP [W/(l/s)]**	**HR seasonal efficiency**
3.8	4.1	1.6	0.75
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system			NO

1- New DHW Circuit

Heating seasonal efficiency	**Hot water storage loss factor [kWh/litre per day]**
0.9	0.01

Local mechanical ventilation and exhaust

Zone	**Supply/extract SFP [W/(l/s)]**	**HR seasonal efficiency**	**Exhaust SFP [W/(l/s)]**
First gym	1.6	-	-
First office	1.6	-	-
Changing rooms	1.6	-	-
Circulation	1.6	-	-
Reception	1.6	-	-

General lighting and display lighting

Zone	**General lighting [W]**	**Display lamps efficacy [lm/W]**
First gym	530	-
First office	60	-
Changing rooms	250	-
Plantroom	40	-
Circulation	300	-
Reception	210	22
Store	10	-

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?**
First gym	NO (-42%)	YES
First office	N/A	N/A
Circulation	NO (-88%)	YES
Reception	NO (-2%)	NO

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

Separate submission

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

Separate submission

EPBD (Recast): Consideration of alternative energy systems

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

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	268	268
External area [m²]	779	779
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	5	5
Average conductance [W/K]	273	294
Average U-value [W/m²K]	0.35	0.38
Alpha value* [%]	10.33	10.33

* 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	2.18	3.05
Cooling	16.81	17.4
Auxiliary	24.83	24.43
Lighting	19.65	20.39
Hot water	258.39	275.4
Equipment*	26.33	26.33
TOTAL**	**321.87**	**340.67**

* 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	Indicative Target
Heating + cooling demand [MJ/m²]	263.56	243
Primary energy* [kWh/m²]	446.33	468.55
Total emissions [kg/m²]	82.2	82.6

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

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Central heating using air distribution, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	23.2	0	7.6	0	14.9	0.86	0	0.9	0
	Notional	24.5	0	8.6	0	22.2	0.79	0	----	----
[ST] Split or multi-split system, [HS] LTHW boiler, [HFT] Electricity, [CFT] Electricity										
	Actual	14.3	316	1	21.4	28.2	3.8	4.1	3.8	4.1
	Notional	16.7	287	1.9	22.2	31.3	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	0.19	External Wall
Floor	0.2	0.25	Ground Floor
Roof	0.15	0.18	Roof
Windows, roof windows, and rooflights	1.5	1.83	Ground floor
Personnel doors	1.5	-	No personal doors in project
Vehicle access & similar large doors	1.5	-	No vehicle doors in project
High usage entrance doors	1.5	-	No high usage entrance doors in project

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
$m^3/(h.m^2)$ at 50 Pa	5	5

Thermal bridges

There is at least one junction in the project whose linear thermal transmittance has been defined as having been calculated following a quality-assured accredited construction details approach in accordance with a scheme approved by the Secretary of State.