18a Frognal Gardens

Energy & Sustainability Assessment

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ENVIRONMENTAL ENGINEERING PARTNERSHIP

CONSULTING ENGINEERS

The Chapel House,
High Street, West Wycombe,
Buckinghamshire.
HP14 3AG
Telephone: 01494 464544
Facsimile: 01494 464282
e-mail: consulting@eep.co.uk
Website: eep.co.uk

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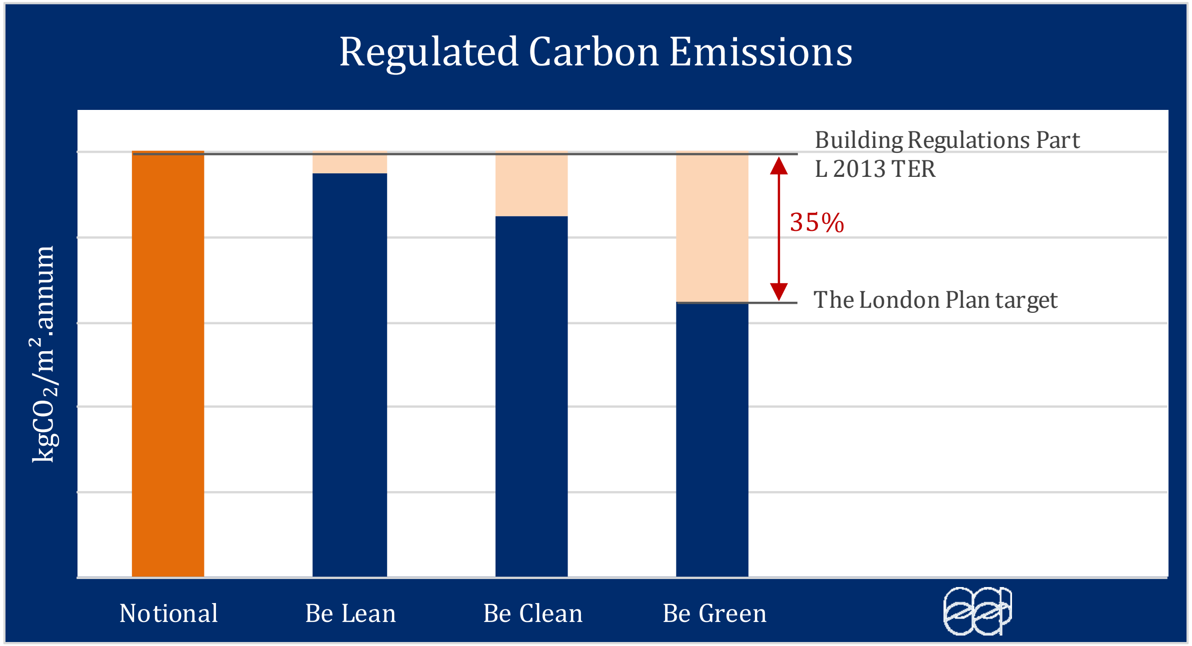

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INTRODUCTION

The Mayor is committed to making London a zero carbon city and with almost 80% of the city's emissions coming from buildings, therefore, there is a big drive to tackle emissions starting with new build and major refurbishment projects.

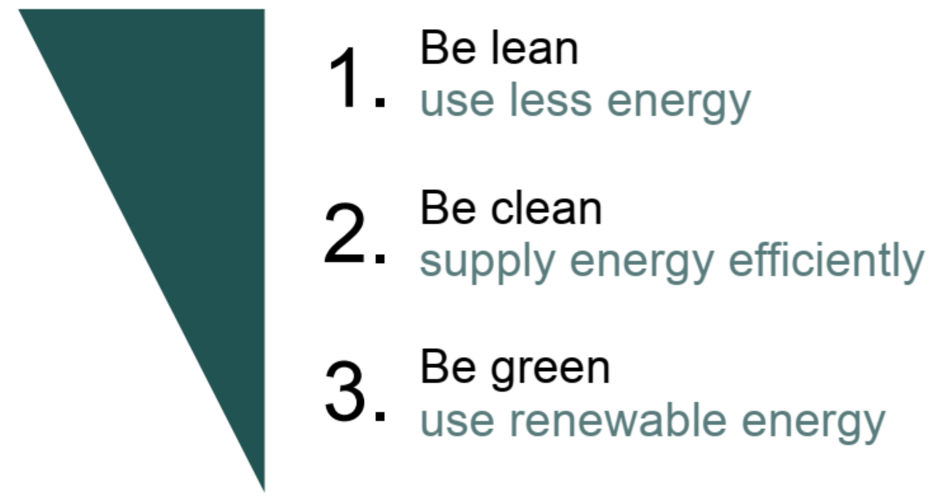
The Camden Local Plan sets out the local council's planning policies which set out the various energy and sustainability targets for project's requiring planning consent. The Camden Local Plan is the name given to a group of policies that together form the development plan for Camden.

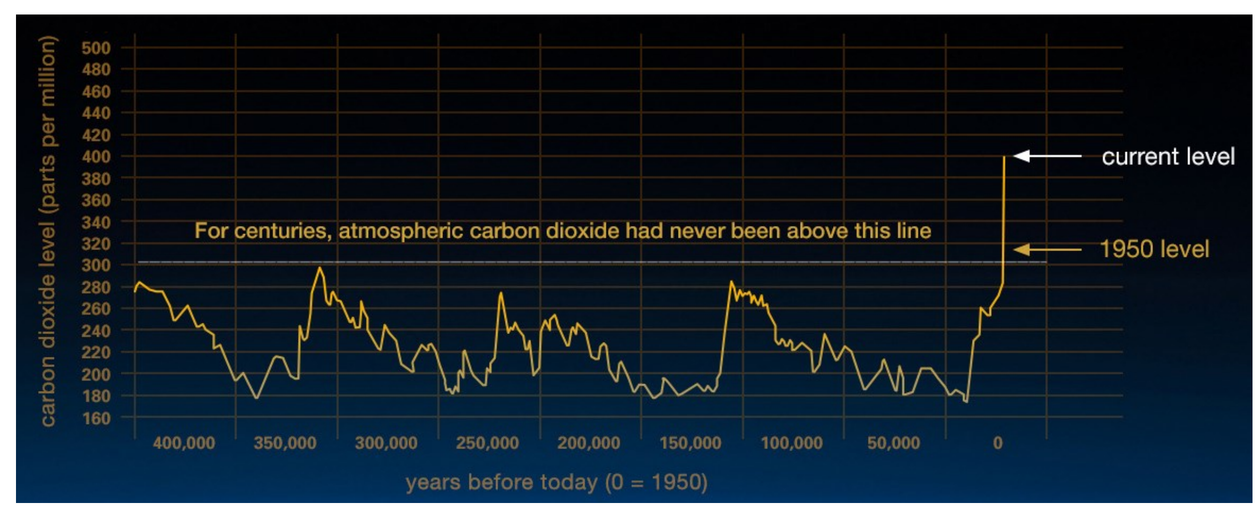
This energy assessment will look at the relevant policies within the Plan and shall demonstrate how this development plans to apply the principles of each policy in both the architectural and building services design.

The relevant sections in The Camden Local Plan are:

Policy CC1: Climate change Mitigation

1. The Energy Hierarchy
2. Sustainable Patterns of Development
3. Resource efficiency, demolition and retrofitting existing buildings
4. Decentralised Energy Generation





Building Regulations Approved Document L1A 2013 – Conservation of fuel and power in new dwellings

The Regulations place a legal requirement for the Building CO_2 Emission Rate (calculated using an approved software package) must be less than the Target Emission Rate for which there is prescribed method for calculating.

The intention of the Government is to reduce the regulated carbon emissions from buildings and in each amendment to the Regulations the requirement for CO_2 reductions increases. The latest update came in 2013 and requires a c.a. 9% improvement from the previous Regulations set in 2010.

The London Plan

The Mayor's London Plan sets targets and provides guidance to the 32 London boroughs and the Corporation of the City of London for the spatial development of London to 2036. The current version was published in March 2015. First published in 2004 with revisions being made in line with the revised energy performance targets set out in the updated Building Regulations.

Policy and Context

The Camden Local Plan, Policy CC1: Climate Change Mitigation

- The Council aims to tackle the causes of climate change in the borough by ensuring developments use less energy and assess the feasibility of decentralised energy and renewable energy technologies

- Green Action for Change: Camden's environmental sustainability plan (2011-2020) commits Camden to a 27% borough wide Carbon Dioxide (CO_2) reduction by 2017 and a 40% borough wide CO_2 reduction by 2020 (London carbon reduction target). Over 90% of Camden's carbon dioxide emissions are produced by the operation of buildings.

- Camden Council commissioned two borough wide carbon reduction studies to ensure that local planning policy appropriately responds to the carbon emissions reduction challenge. The first study, 'Delivering a low carbon Camden', considered carbon reduction scenarios to 2050 to align with the long-term national 80% carbon dioxide reduction target within the Climate Change Act 2008. The 2010 study focused specifically on the challenges of achieving a carbon dioxide reduction target of 40% by 2020.

Both studies concluded that meeting borough carbon dioxide reduction targets depends on the growth of Combined Heat and Power (CHP) led decentralised energy networks; the extensive thermal improvement of existing housing stock; behavior change; the significant deployment of appropriate renewable technologies; and the steady decarbonisation of the national electricity grid.

Policy CC1 Climate change mitigation

The Council will require all development to minimise the effects of climate change and encourage all developments to meet the highest feasible environmental standards that are financially viable during construction and occupation.

We will:

a. promote zero carbon development and require all development to reduce carbon dioxide emissions through following the steps in the energy hierarchy;
b. require all major development to demonstrate how London Plan targets for carbon dioxide emissions have been met;
c. ensure that the location of development and mix of land uses minimise the need to travel by car and help to support decentralised energy networks;
d. support and encourage sensitive energy efficiency improvements to existing buildings;
e. require all proposals that involve substantial demolition to demonstrate that it is not possible to retain and improve the existing building; and
f. expect all developments to optimise resource efficiency.

For decentralised energy networks, we will promote decentralised energy by:

g. working with local organisations and developers to implement decentralised energy networks in the parts of Camden most likely to support them;
h. protecting existing decentralised energy networks (e.g. at Gower Street, Bloomsbury, King's Cross, Gospel Oak and Somers Town) and safeguarding potential network routes; and
i. requiring all major developments to assess the feasibility of connecting to an existing decentralised energy network, or where this is not possible establishing a new network.

To ensure that the Council can monitor the effectiveness of renewable and low carbon technologies, major developments will be required to install appropriate monitoring equipment.

Policy and Context

The Camden Local Plan, Policy CC1: The Energy Hierarchy

The energy hierarchy is a sequence of steps that minimise the energy consumption of a building. Buildings designed in line with the energy hierarchy priorities lower cost passive design measures, such as improved fabric performance over higher cost active systems such as renewable energy technologies. The following diagram shows a simplified schematic of the energy hierarchy, which is explained further in supplementary planning document Camden Planning Guidance on sustainability.

Section 8.8 requires all developments involving five or more dwellings and/or more than 500 sqm of (gross internal) any floorspace will be required to submit an energy statement demonstrating how the energy hierarchy has been applied to make the fullest contribution to CO_2 reduction. All new residential development will also be required to demonstrate a 19% CO_2 reduction below Part L 2013 Building Regulations (in addition to any requirements for renewable energy).

Note: The London plan references a 35% CO_2 reduction below Part L 2013 Building regulations, Camden Local Authority require a 19% carbon reduction target, but for the purposes of this report a 35% reduction has been targeted.

Be Lean

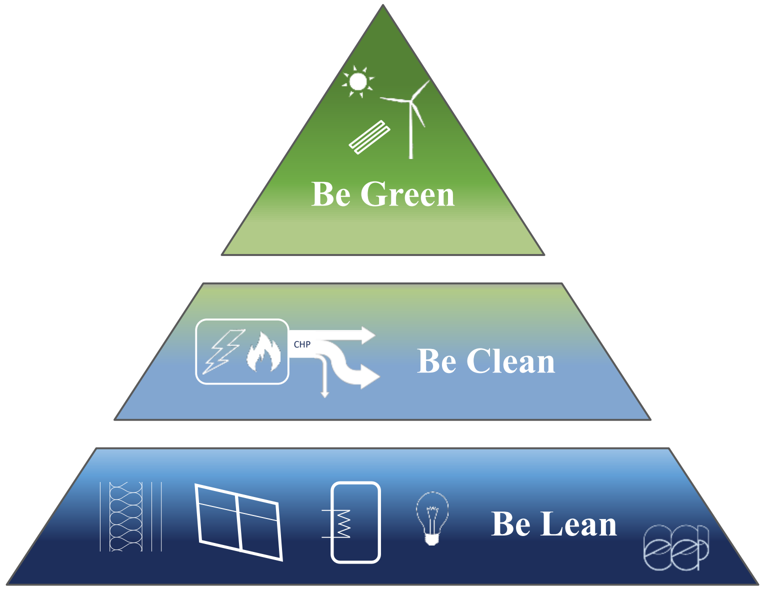
Proposals should demonstrate how passive design measures including the development orientation, form, mass, and window sizes and positions have been taken into consideration to reduce energy demand, demonstrating that the minimum energy efficiency requirements required under building regulations will be met and where possible exceeded.

Be Clean

The second stage of the energy hierarchy 'be clean' should demonstrate how the development will supply energy efficiently through clean energy systems such as CHP or decentralised energy.

Be Green

The "be green" stage of the energy hierarchy requires that developments make use of renewable technologies to achieve the sites overall carbon dioxide emissions target.



Policy and Context

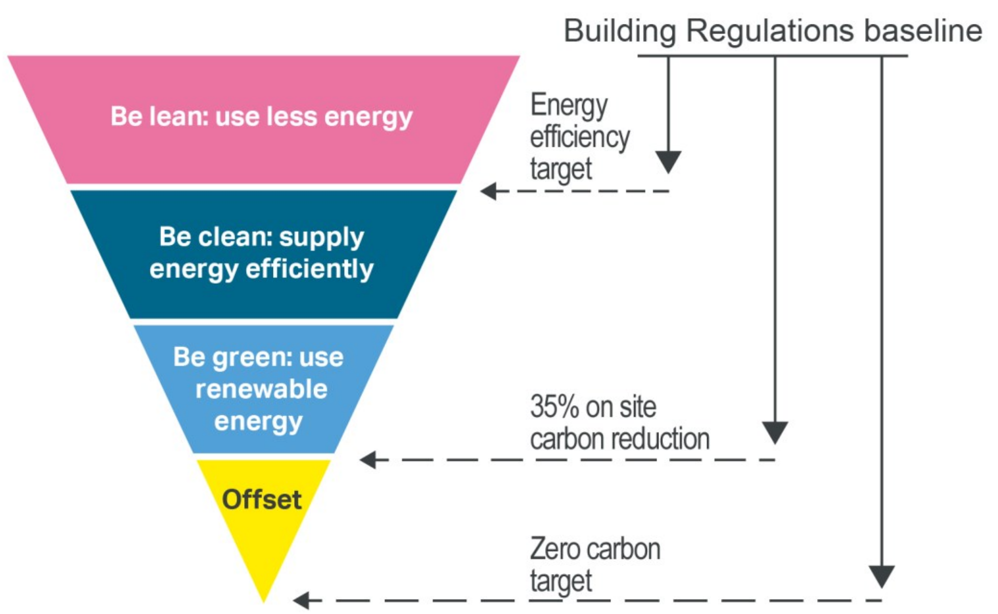
The Camden Local Plan, Policy CC1: The Energy Hierarchy

Section 8.41 requires all new developments to submit a statement describing how the project has applied The London Plan's cooling hierarchy and shall demonstrate how the risk of overheating has been mitigated.

The cooling hierarchy includes:

1. Minimise internal heat gains
2. Reduce external heat gains through consideration of; orientation, shading, fenestration, insulation etc.
3. Manage internal heat through exposed thermal mass and high ceilings
4. Passive ventilation
5. Mechanical ventilation
6. Active cooling

The Energy Hierarchy in the upcoming London Plan 2019



Source: Greater London Authority

Policy and Context

The London Plan 2016 – Policy 5.2: Minimising Carbon Dioxide

The policy states that all major developments are to produce and issue an energy strategy that must follow the principles of "be lean", "be clean", and "be green" and as minimum must achieve an onsite carbon emission reduction of 35% beyond the current Building Regulations (2013).

The listed requirements are:

- Carbon emissions are to be minimised in accordance with the energy hierarchy
- Domestic buildings are to achieve a 40% carbon emission improvement over the 2010 Building Regulations (35% the 2013 Building Regulations)
- Strategy for achieving carbon dioxide emission reductions to be presented in a detailed energy assessment
- Energy assessments to include calculation results, proposed reductions through energy efficient designs, proposals to use decentralised energy where feasible (including CHP), proposal to include on-site renewable technologies
- Where carbon dioxide emission targets cannot be achieved on-site shortfalls are to be made-up off-site or through a cash in lieu contribution

The intention is to achieve 35% carbon emission savings on-site through the application of the energy hierarchy. Detailed information to be provided further in this report.

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.

Residential buildings:

Year	Improvement on 2010 Building Regulatons
2010 – 2013	25 per cent (Code for Sustainable Homes level 4)t
2013 – 2016	40 per cent
2016 – 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 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 delivery of carbon dioxide savings elsewhere.

Policy and Context

The London Plan 2016 – Policy 5.7: Renewable Energy

The policy outlines the expectation to increase the amount of energy provided by on-site renewable technologies.

New developments will be expected to provide substantial carbon dioxide emission reductions through the use of on-site renewable energy generation.

The ambition for this project shall be to achieve a 10% carbon dioxide emission reduction through the installation of a photovoltaic system to be installed on the roof.

Details and results to be presented further in 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

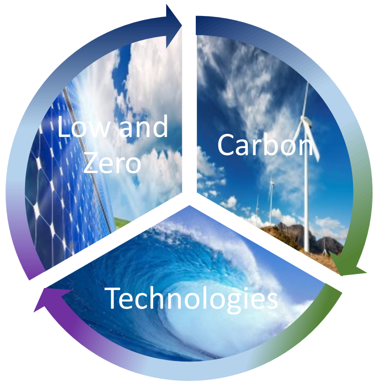
B Within the framework of the energy hierarchy (see Policy 5.2), major development proposals should provide a reduction in expected carbon dioxide emissions through the use of on-site renewable energy generation, where feasible.

LDF preparation

C Within LDFs boroughs should, and other agencies may wish to, develop more detailed policies and proposals to support the development of renewable energy in London – in particular, to identify broad areas where specific renewable energy technologies, including large scale systems and the large scale deployment of small scale systems, are appropriate. The identification of areas should be consistent with any guidelines and criteria outlined by the Mayor.

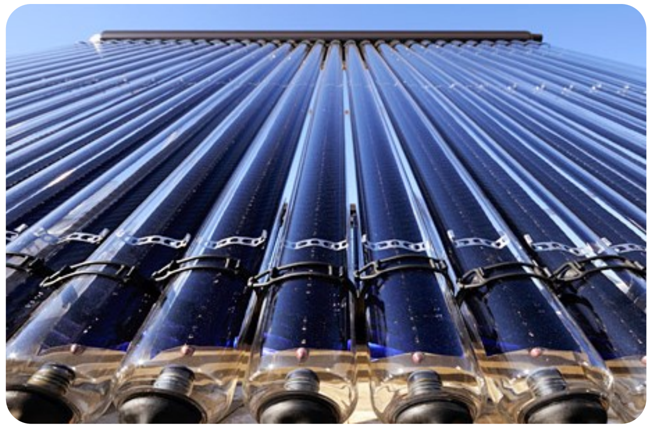
D All renewable energy systems should be located and designed to minimise any potential adverse impacts on biodiversity, the natural environment and historical assets, and to avoid any adverse impacts on air quality.

Low and Zero Carbon Technologies



Before undertaking any energy assessment it is important to review the Low and Zero Carbon (LZC) technologies available and their suitability to the project. There are a number of factors influencing the decision to pursue any LZC installation and these include; location, local environment, political drivers, feasibility (financial and technical), and marketability. In the following sections various available LZC technologies will be reviewed before presenting a decision matrix that will define which technologies will be pursued and tested.

Solar Thermal Collectors



Solar water heating (SWH) using solar thermal collectors is a well proven technology and payback periods are relatively short. There are two main types of collector technology – flat plate collectors and evacuated tube collectors. Evacuated tubes are more efficient, around 20% (including better operation on cloudy days), and can produce higher temperature waters up to around 150°C for processes that may be useful for kitchens. Annual outputs of around 450 – 600+ kWh/yr per m^2 of collector (flat plate – evacuated) could be possible for a fully optimised installation.

SWH collection panels can achieve net efficiencies around 50%, which is much higher than that of PVs. On the negative side they are slightly more maintenance intensive as PVs benefit from not having any moving parts nor any wet services (i.e. pipework).

Photovoltaics

PVs are one of the few true zero carbon energy technologies available on the market. There are no moving parts they require very low maintenance. Systems can be easily integrated into almost any surface at any point in building's life (including fit-out) without major intervention.
The annual solar availability in London is around 1000 kWh/m^2 cumulative solar radiation incident on an unobstructed (unshaded) horizontal surface. Photovoltaic cells (PV) convert that solar energy (sunlight) into electricity. They are commonly manufactured into glazed collectors which can be ground mounted, roof mounted or building-integrated. The performance of PVs is heavily influenced by over-shadowing. 10% shading could result in 80% loss in electrical performance.

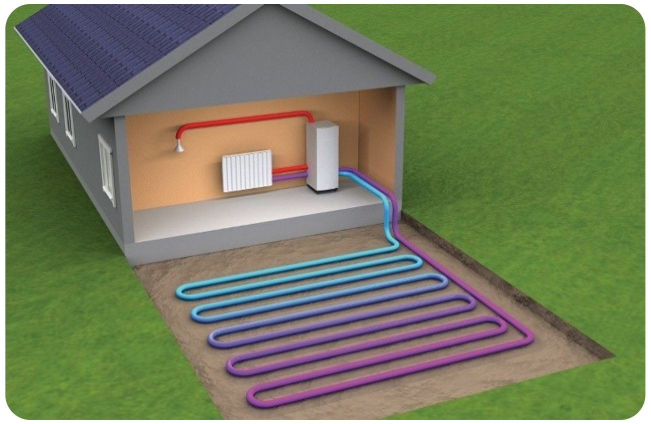
Wind Turbines

Wind turbines convert the kinetic energy contained in a flowing air/wind mass into electrical energy using an electrical generator.

The following criteria pertaining to this technology have been taken into account for the preliminary viability assessment–visual impacts, noise, intermittent power production, local planning such as height restrictions, impacts on migratory paths of birds, interference with radio and/or TV signals and so on.

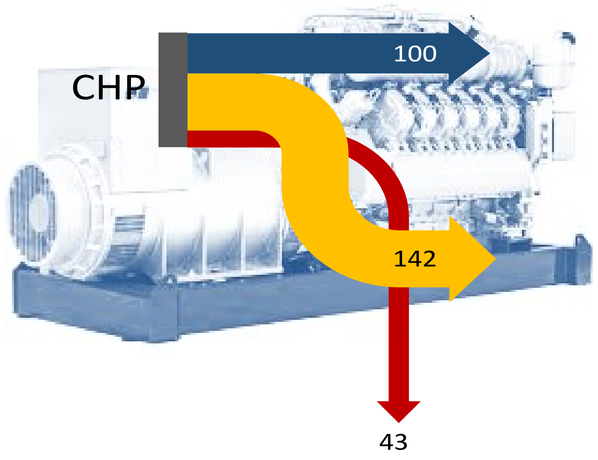
The amount of energy which can be extracted is proportional to the square of the turbine diameter and the cube of the wind speed hence the size of the turbine is critical for the viability of an installation. Wind turbines are also known to be quite loud during operation as the mechanically driven generator can be quite loud.

Heat Pumps



Properly designed and installed heat pumps offer very low carbon space heating and can also provide low carbon cooling. The pumps are powered by electricity although there are variants such as gas-fired absorption units available - albeit with lower efficiencies. Heat pumps take low temperature heat and upgrade it to a higher more useful temperature. The heat source can be from the external ambient air, a nearby water source or the ground. Ambient air and ground as the source of renewable energy have been considered in this assessment.

Combined Heat and Power



There are various types of co-generation (i.e. CHP/CCHP) prime movers, typically gas turbines, gas engines and fuel cells - or a mix thereof. It is possible that in a modular system some co-generation units could run on biomass (e.g. wood pellets), biofuels, bio-methane from anaerobic digestion of organic wastes, or syngas generated from wastes (e.g. cooking oils, municipal solid waste).

A key requisite for good practice co-generation is that the plant should operate for at least 5,000 hours per annum, i.e. that there is a significant base load for heat all year round - both day and night. Any scheme should as a minimum conform to the CHPQA Good Quality CO-GENERATION Standards (which will also ensure compliance with the EC CO-GENERATION Directive).

Low and Zero Carbon Technology Decision Matrix

	Technology	Lifecycle Carbon Saving Potential	Grants	Lifecycle Costs	Space Requirements	Planning Restrictions	Noise	Appropriate for the site	Reason for exclusion
Solar Energy	**Solar Hot Water**	Low	Renewable Heat Incentive	Medium	Low	Suitable	Suitable	Suitable	SHW tested but found to compromise effectiveness of CHP whilst reducing PV area.
	Photovoltaics	Low-Medium	Feed-In Tariff	High	Low	Suitable	Suitable	Suitable	Tested and shown to provide substantial CO_2 savings.
Wind Energy	**Wind Turbines**	Low-Medium	Feed-In Tariff	Medium	Medium-High	Not acceptable	Noise from gears and generator	Not suitable for urban areas	Noisy and not suitable in urban areas (due to turbulence coming from surrounding buildings).
Heat Pumps	**Ground Source Heat Pumps**	Medium	Renewable Heat Incentive	Medium-High	Low	Suitable	Suitable	Not suitable	Limited ground space due to tree root protection zone
	Air Source Heat Pumps	Low-Medium	Renewable Heat Incentive	Low	Low	Suitable	Fan & compressor noise	Suitable	ASHP tested and found to provide substantial savings during heating and cooling.
Co-generation and alternative fuds	**Biomass Boilers**	Medium	Renewable Heat Incentive	Medium-Low	Medium	PM 10 particulate	Consideration for vehicle noise during regular fuel deliveries to be considered	Not suitable	Discounted due to concerns over emissions, air quality, noise from deliveries and concerns over fuel supplies.
	Biomass CHP	High	Renewable Heat Incentive	Medium	Medium	PM 10 particulate		Not suitable	
	Gas-fired CHP	Medium	Feed-In Tariff	Medium-Low	Low	Suitable	Located in acoustically treated plnatrooms	Not suitable	Discounted due to conserns over noise and required emand being too low to be cost effective
	Gas-fired CCHP	Medium	Feed-In Tariff	Medium-High	Low	Suitable		Not suitable	
	Fuel Cell CHP/CCHP	Medium	Feed-In Tariff	High	Low	Suitable	Suitable	Not suitable	
	District Heating/cooling	Medium-High	Renewable Heat Incentive	Medium	Low	Suitable	Suitable	sn	No networks or future networks planned for the area.
Hydro Power	**Small Scale Hydro Power**	Low	Feed-In Tariff	Low	N/A	N/A	N/A	N/A	Not applicable due geographical restrictions.
	Tidal Power	Low	Feed-In Tariff	Low	N/A	N/A	N/A	N/A	
	Wave Power	Low	Feed-In Tariff	Low	N/A	N/A	N/A	N/A	

Technology to be considered (green)
Technology unfeasible or non-applicable (pink)

Cooling Hierarchy

Several measures have been adopted to reduce the risk of overheating and mitigating the need for cooling, whilst at the same time trying to maximise the views to the North and South.

Passive design measures to prevent solar gains entering the building:

- Glazing ratios have been reduced following initial energy modelling
- Double glazing has been specified with very low g-values and u-value
- Adjustable external shading devices have been proposed – this will provide seasonal flexibility i.e. maximise solar gain in winter and limit solar gains in summer.

Passive design measures that have been implemented to mitigate heat gain within the building:

- Internal heat gains will be reduced through the specification of low heat emitting LED light fittings
- Exposed thermal mass
- Naturally ventilated living quarters with mechanical ventilation on Lower and Upper Ground Floors
- Green roofs on terraces

Due to the installation of the pool to the Lower Ground floor, and because the building will be utilising an air source heat pump system for heating, the building will require active cooling to ensure temperature and humidity levels can be controlled (due to heating requirements for the pool). **Cooling provision will be limited to the areas where dynamic thermal modelling proves that passive measures alone are not enough to maintain thermal comfort levels.**

The proposed cooling system shall utilise the underfloor heating pipework installation that will provide either heating or cooling according to the rooms demands and controlled via valves at the plantroom manifold.

Benefits of this design are; no ancillary fans are needed, silent operation, and good thermal comfort can be achieved as radiant temperatures are used.

Also, because the cooling system utilises medium flow and return temperatures the efficiency of the air source heat pump will be maximised.

Motorised external blinds to the south façade.

Annual CO_2 Emission Calculation – Be Lean

Modelling Inputs

Scenario : Be Lean

	Value	Unit	Notes
External Wall - U-value	0.11 - 0.18	$W/m^2.K$	Below ground and exposed
Ground Floor - U-value	0.11	$W/m^2.K$	
Roof - U-value	0.11 - 0.20	$W/m^2.K$	Varying terrace constructions
Window - U-value	1.20	$W/m^2.K$	Double glazed unit - centre pane u-value
Window - g-value	0.40		
Air permeability	3.00	$m^3/hr/m^2$	
Electricity power factor	> 0.95		
Lighting efficacies	90 - 100	lm/cW	
Lighting occupancy controls	Yes		
Lighting daylight controls	Yes		
Ventilation SFPs	0.5 - 1.5	W/l/s	MVHR & toilet extract fans
Heat Exchanger Efficiency	> 80%		
Heating Boiler efficiency	90%		Condensing boiler
DHW boiler efficiency	90%		Condensing boiler

The "be lean" scenario is used to identify the building's demand reduction measures that are to be incorporated as;

- Fabric insulation and glazing specification

To maximise the passive energy savings that become inherent to the building, following its form and construction, high levels of insulation have been targeted to all exposed surfaces. There is a cost in terms of installation and loss of net internal area (high levels of insulation require larger construction dimensions) but benefit is gained through operational savings and smaller capital costs for heating and cooling equipment.

Also, the notional building against which the proposed design is compared features a specified glazing ratio which penalises designs with curtain walled facades or full height glazing. To overcome this windows have been shown to be double glazed with very low u-values, this is to ensure that when the external wall is evaluated as a whole the overall insulation level between actual and notional designs will be comparable.

- Lighting efficacy and controls

Through the use of low energy LED light fittings we can provide a 10 fold improvement on the old tungsten and fluorescent fittings meaning significant energy savings can be achieved by optimising the lighting design. Lighting can account for as much as 25% of the building's energy consumption and through design can be reduced by 75%.

- Efficient mechanical services design strategy

The Building Regulations set a minimum standard for system efficiencies and there are several approaches that can be used and selection will depend on the building environment that include factors such as; size, location, use, local authorities. To meet the building's proposed ventilation requirements the proposed design shall include a mechanical ventilation system with heat recovery as well as natural ventilation provided via trickle vents at windows.

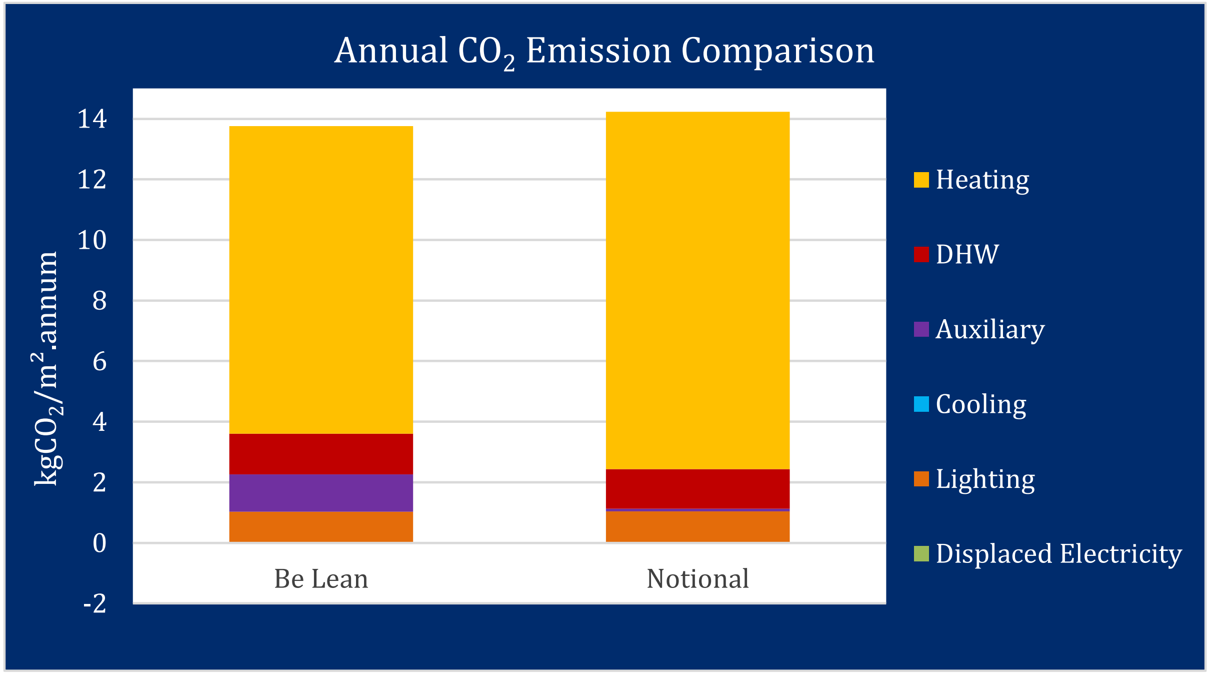
Overall, by maximising the benefits of the various elements the "be lean" scenario achieves a **0.3%** reduction in annual carbon dioxide emissions when compared to the notional building.

ANNUAL CO_2 EMISSION CALCULATION – BE LEAN

As illustrated in the results, the building sees favourable energy and carbon dioxide emission savings in all areas apart from “Auxiliary” which accounts from emissions associated with fan and pump operations.

The “be lean” scenario shows a 3.3% reduction in carbon dioxide emissions compared with the Notional building design.

CO_2 Emissions $kgCO_2/m^2$.annum	Be Lean	Notional
Heating	10.16	11.80
Cooling	0.00	0.00
Auxiliary	1.23	0.09
Lighting	1.02	1.04
DHW	1.35	1.30
Displaced Electricity	0.00	0.00
	13.76	14.23
Total Floor Area (m^2)	457	457



Annual CO_2 Emission Calculation – Be Clean

Modelling Inputs **Scenario : Be Clean**

	Value	Unit	Notes
External Wall - U-value	0.11 - 0.18	$W/m^2.K$	Below ground and exposed
Ground Floor - U-value	0.11	$W/m^2.K$	
Roof - U-value	0.11 - 0.20	$W/m^2.K$	Varying terrace constructions
Window - U-value	1.20	$W/m^2.K$	Double glazed unit - centre pane u-value
Window - g-value	0.40		
Air permeability	3	$m^3/hr/m^2$	
Electricity power factor	> 0.95		
Lighting efficacies	90 - 100	lm/cW	
Lighting occupancy controls	Yes		
Lighting daylight controls	Yes		
Ventilation SFPs	0.5 - 1.5	W/l/s	MVHR & toilet extract fans
Heat Exchanger Efficiency	> 80%		
Heating efficiency	3.9	SCOP	Heat Pump - Daikin Altherma EBLQ
Cooling efficiency	3.9	EER	Heat Pump - Daikin Altherma EBLQ
DHW boiler efficiency	90%		Condensing boiler

The "be clean" scenario is used to identify further carbon dioxide emission savings to be achieved through the application of low carbon technologies;

- Air Source Heat Pump

To ensure that an Air Source Heat Pump runs efficiently the system needs to be accurately sized. The size of a heat pump depends on factors, including outdoor design temperature, desired room temperature and the system flow and return temperatures.

The proposed system shall be an air to water system utlising the R32 refrigerant gas which has a Global Warming Potential 68% lower than the conventional R410a refrigerant (675 vs 2,088). The system will be a monobloc system meaning the refrigerant will not extend beyond the external unit thereby reducing the amount of refrigerant needed as well as eliminating the risk of refrigerant leaks within the building.

The heat pump will be used to supply the heating and hot water, with a secondary boiler used for additional hot water support and for the heating provision to maintain the indoor pool.

The system will also be designed to incorporate additional supplies from the solar thermal panels to be installed on the roof and shall be detailed in the "be green" section of this report.

With the inclusion of the air to water heat pump the SAP modelling results show a **25.9%** annual carbon dioxide emission saving when compared with the notional building.

ANNUAL CO_2 EMISSION CALCULATION – BE CLEAN

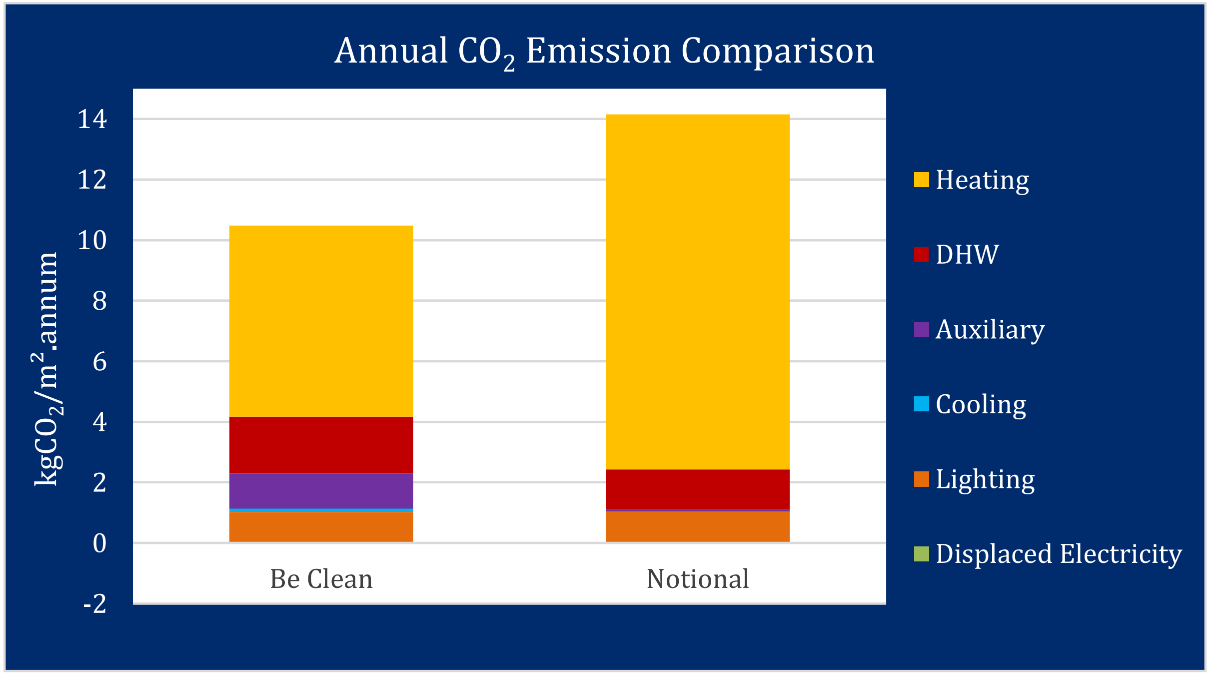
The "be clean" scenario shows an impressive 25.9% reduction in carbon dioxide emissions compared with the Notional building design.

This includes the provision of cooling to the building.

The major carbon emission savings can be attributed to the efficiency gains in using the air source heat pump (electrical) in place of a conventional gas-fired boiler. The efficiency of the air source heat pumps is four times greater than the specified boiler (390% vs 90%), but the carbon emission factor for electricity versus gas is 0.519 $kgCO_2$/kWh vs 0.216 $kgCO_2$/kWh (more than two times greater.

The other major difference is attributed to "Auxiliary" which accounts from emissions associated with fan and pump operations.

CO_2 Emissions $kgCO_2/m^2$.annum	Be Clean	Notional
Heating	6.32	11.72
Cooling	0.11	0.00
Auxiliary	1.15	0.09
Lighting	1.03	1.04
DHW	1.88	1.30
Displaced Electricity	0.00	0.00
	10.49	14.15
Total Floor Area (m^2)	457	457



ANNUAL CO_2 EMISSION CALCULATION – BE GREEN

Modelling Inputs

Scenario : Be Green

	Value	Unit	Notes
External Wall - U-value	0.11 - 0.18	W/m².K	Below ground and exposed
Ground Floor - U-value	0.11	W/m².K	
Roof - U-value	0.11 - 0.20	W/m².K	Varying terrace constructions
Window - U-value	1.20	W/m².K	Double glazed unit - centre pane u-value
Window - g-value	0.40		
Air permeability	3	m³/hr/m²	
Electricity power factor	> 0.95		
Lighting efficacies	90 - 100	lm/cW	
Lighting occupancy controls	Yes		
Lighting daylight controls	Yes		
Ventilation SFPs	0.5 - 1.5	W/l/s	MVHR & toilet extract fans
Heat Exchanger Efficiency	> 80%		
Heating efficiency	3.9	SCOP	Heat Pump - Daikin Altherma EBLQ
Cooling efficiency	3.9	EER	Heat Pump - Daikin Altherma EBLQ
DHW boiler efficiency	92%		Condensing boiler
PV efficiency	20.8%		LG LNeonR - LG360Q1C-A5
PV solar conversion factor	95.0%		Easily accessible for maintenance
Solar thermal collector	95%		Easily accessible for maintenance

The "be green" stage of the energy hierarchy requires that developments make use of renewable technologies to achieve the sites overall carbon dioxide emissions target.

In this instance and within the context of the buildings form and location the most suitable renewable technology has been found to be photovoltaics and solar thermal panels (according to the LZC decision matrix) producing zero carbon electricity and hot water.

The overall carbon dioxide emissions reduction of **41.4%** exceeds The London Plan's target of 35%.

The photovoltaics are to be installed to the roof of the building. The panels are to be south facing and installed to an angle of 45°. The panels are required to have a peak power of 1.08 kWp, this equates to 3No. LG360Q1C-A5 panels.

Similarly, the solar thermal panel design has been based on the flat plate Lochinvar LSP20+ solar collector with an active area of 1.79m² with 3No. panels providing a total area of 5.37m².

The panel layout shall ensure that overshading is minimised and kept away from the perimeter parapet wall.

The roof will be freely accessible to allow easy maintenance and cleaning of the panels to ensure continued performance of the panels.

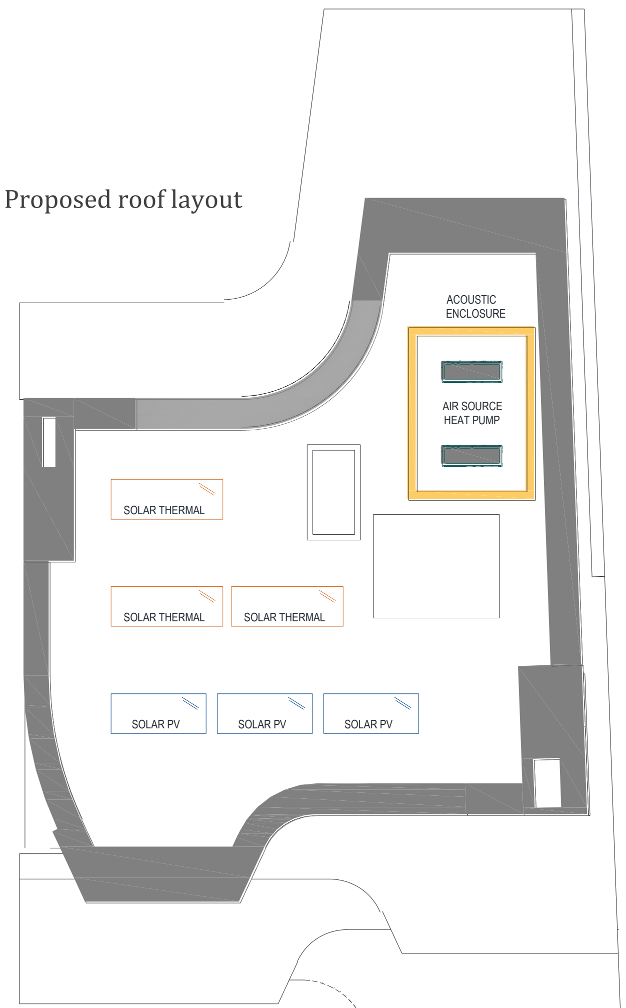
ANNUAL CO_2 EMISSION CALCULATION – BE GREEN

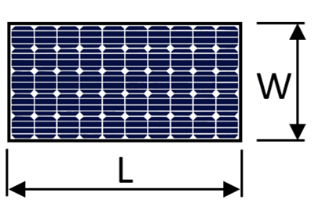
The individual category emissions rates are relatively unchanged from those shown in the "be clean" calculation apart from the additional displaced heating, DHW, and electricity being supplied by the 3No. solar thermal, and 3No. PV panels.

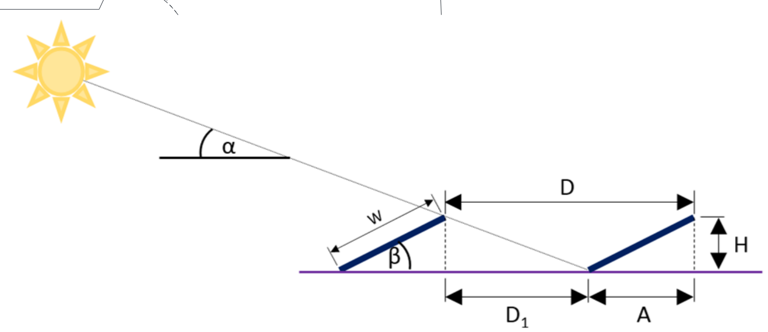
Overall the results show the development achieving The London Plan's target by showing a **41.4%** carbon dioxide emission reduction.

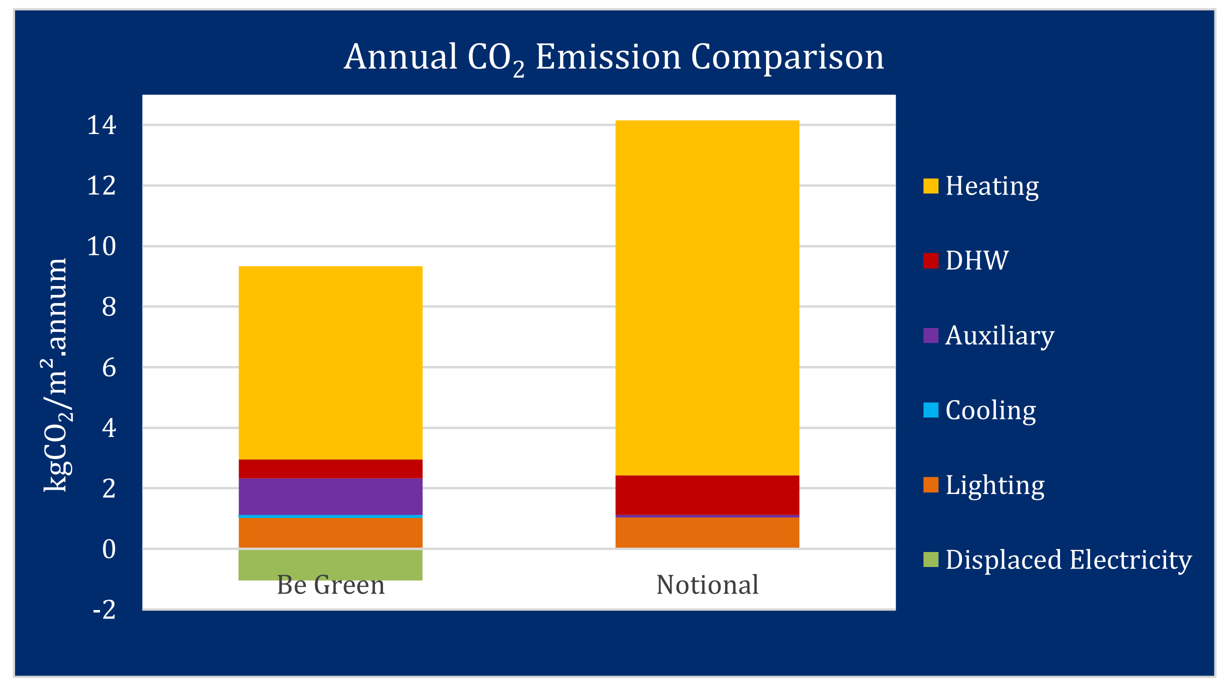
CO_2 Emissions $kgCO_2/m^2$.annum	Be Green	Notional
Heating	6.39	11.72
Cooling	0.10	0.00
Auxiliary	1.20	0.09
Lighting	1.03	1.04
DHW	0.62	1.30
Displaced Electricity	-1.05	0.00
	8.29	14.15
Total Floor Area (m^2)	457	457

Proposed roof layout









Sustainability Statement

The client and returning occupiers of 18A Frognal Gardens have set an ambitious target for sustainability where the design team have been tasked with maximising energy savings through passive and active designs, as well measures looking at water savings and ecology.

In response the following measures can be directly attributed to the sustainability design of the building;

Passive architectural designs:

- High insulation levels exceeding minimum Building Regulation requirements.
- High performance double glazing units with low u-values and g-values.
- Exposed thermal mass designed to reduce heating and cooling demands.
- External shading to windows to control external solar gains entering the building.

Active services designs:

- Installation of solar photovoltaics and solar thermal panels for the production of renewable electricity and hot water.
- Installation of on site electrical storage through batteries to maximise output from PV panels.
- Space heating and cooling provided by highly efficient air source heat pumps.
- Specification of low energy LED lighting with occupancy controls and dimming.
- Use of mechanical ventilation with heat recovery to capture energy otherwise lost.
- Provision of electrical charge points to promote use of electrical bikes and cars.

Water saving measures:

- Rainwater attenuation tanks to capture and control the release of surface water to the local sewer.
- Rainwater harvesting to be used for irrigation.
- Flow restrictors to water outlets to limit over consumption of water.

Ecological features:

- Green roofs have been included to some terrace areas to be used to promote; species biodiversity, local wildlife, and improve air quality.
- Green roofs will also provide rainwater attenuation to limit the impact to the local sewers.

With all of these measures in place the buildings has shown an impressive annual carbon dioxide emission reduction of **41.4%** when compared with the notional building and exceeds the Camden target of 19%, and also exceeds The London Plan target of 35%.

Conclusions

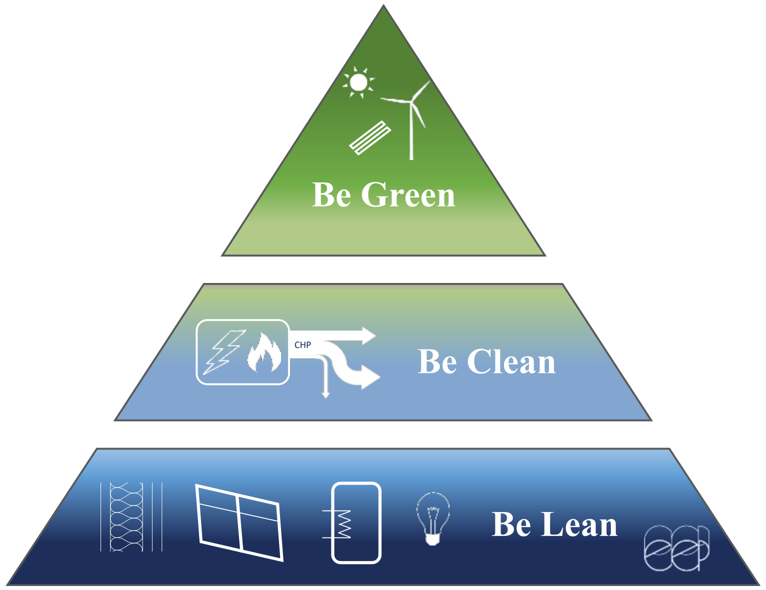
Every effort has been made to prioritise energy savings and carbon dioxide emission reductions through early engagement with the design team during concept development and extensive energy modelling.

Ambitious levels of thermal performance have been set for the building fabric with triple glazing specified for all new windows and the target u-values for all external elements have been set well below the limits set by The Building Regulations.

With this strategy the thermal modelling exercise demonstrating the three levels of The Energy Hierarchy show the following progressing reductions in annual carbon dioxide emissions:

- Be Lean – **3.3%**
- Be Clean – **25.9%**
- Be Green – **41.4%**

This demonstrates that the building will achieve the 35% carbon dioxide reductions targets as set by The Camden Local Plan and The London Plan.



ENVIRONMENTAL
ENGINEERING
PARTNERSHIP

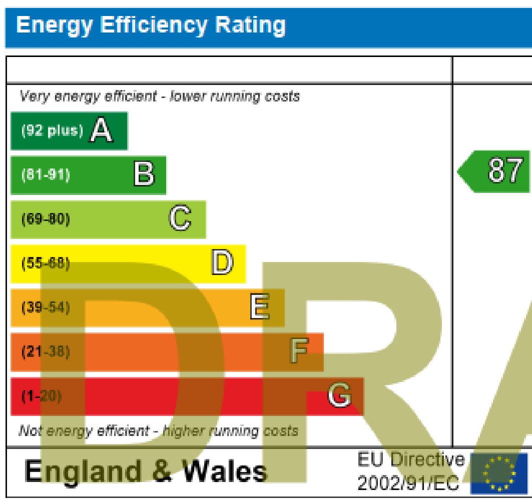
CONSULTING ENGINEERS

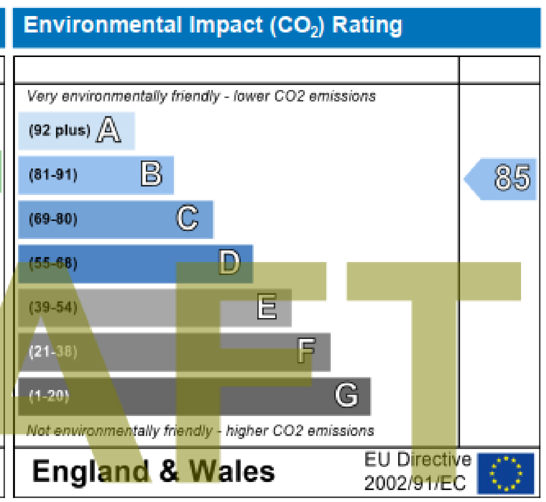
Predicted Energy Assessment

Dwelling type:	Semi-detached House
Date of assessment:	27 October 2020
Produced by:	Stroma Certification
Total floor area:	457.3 m²

This is a Predicted Energy Assessment for a property which is not yet complete. It includes a predicted energy rating which might not represent the final energy rating of the property on completion. Once the property is completed, an Energy Performance Certificate is required providing information about the energy performance of the completed property.

Energy performance has been assessed using the SAP 2012 methodology and is rated in terms of the energy use per square metre of floor area, energy efficiency based on fuel costs and environmental impact based on carbon dioxide (CO2) emissions.





The energy efficiency rating is a measure of the overall efficiency of a home. The higher the rating the more energy efficient the home is and the lower the fuel bills are likely to be.

The environmental impact rating is a measure of a home's impact on the environment in terms of carbon dioxide (CO2) emissions. The higher the rating the less impact it has on the environment.

Block Compliance WorkSheet: Lean

User Details

Assessor Name:		**Stroma Number:**	
Software Name:	Stroma FSAP	**Software Version:**	Version: 1.0.5.9

Calculation Details

Dwelling	DER	TER	DFEE	TFEE	TFA
18A Frognal Gardens - Lean	13.77	14.24	57.6	62.6	457.3

Calculation Summary

Total Floor Area	457.30
Average TER	14.24
Average DER	13.77
Average DFEE	57.60
Average TFEE	62.60
Compliance	Pass
% Improvement DER|TER	3.3
% Improvement DFEE|TFEE	7.99

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Regulations Compliance Report

Approved Document L1A, 2013 Edition, England assessed by Stroma FSAP 2012 program, Version: 1.0.5.9
Printed on 27 October 2020 at 12:40:33

Project Information:

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

Dwelling Details:

NEW DWELLING DESIGN STAGE Total Floor Area: 457.3m²
Site Reference : 18A Frognal Gardens **Plot Reference:** 18A Frognal Gardens - Lean
Address :

Client Details:

Name:
Address :

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

1a TER and DER

Fuel for main heating system: Mains gas		
Fuel factor: 1.00 (mains gas)		
Target Carbon Dioxide Emission Rate (TER)	14.24 kg/m²	
Dwelling Carbon Dioxide Emission Rate (DER)	13.77 kg/m²	OK

1b TFEE and DFEE

Target Fabric Energy Efficiency (TFEE)	62.6 kWh/m²	
Dwelling Fabric Energy Efficiency (DFEE)	57.6 kWh/m²	
		OK

2 Fabric U-values

Element	Average	Highest	
External wall	0.16 (max. 0.30)	0.18 (max. 0.70)	OK
Party wall	0.00 (max. 0.20)	-	OK
Floor	0.11 (max. 0.25)	0.11 (max. 0.70)	OK
Roof	0.16 (max. 0.20)	0.20 (max. 0.35)	OK
Openings	1.21 (max. 2.00)	1.60 (max. 3.30)	OK

2a Thermal bridging

Thermal bridging calculated using user-specified y-value of 0.15

3 Air permeability

Air permeability at 50 pascals	3.00 (design value)	
Maximum	10.0	OK

4 Heating efficiency

Main Heating system:	Database: (rev 466, product index 010263): Boiler systems with radiators or underfloor heating - mains gas Brand name: Worcester Model: Greenstar CDi Model qualifier: 25 Cdi (Combi) Efficiency 90.0 % SEDBUK2009 Minimum 88.0 %	OK
Secondary heating system:	None	

Regulations Compliance Report

5 Cylinder insulation

Hot water Storage:	No cylinder	

6 Controls

Space heating controls	TTZC by plumbing and electrical services	OK
Hot water controls:	No cylinder thermostat No cylinder	
Boiler interlock:	Yes	OK

7 Low energy lights

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

8 Mechanical ventilation

Continuous supply and extract system		
Specific fan power:	0.46	
Maximum	1.5	OK
MVHR efficiency:	92%	
Minimum	70%	OK

9 Summertime temperature

Overheating risk (South East England):	Not significant	OK
Based on:		
Overshading:	Heavy	
Windows facing: South	3m²	
Windows facing: South	10.8m²	
Windows facing: West	6.78m²	
Windows facing: East	0.8m²	
Windows facing: South	6.07m²	
Windows facing: South	6.07m²	
Windows facing: East	6.92m²	
Windows facing: North	16.7m²	
Windows facing: North West	6.21m²	
Windows facing: West	8.04m²	
Windows facing: South	5.5m²	
Windows facing: South	3.96m²	
Windows facing: East	4.93m²	
Windows facing: North	10.4m²	
Windows facing: North West	7.14m²	
Windows facing: West	1.98m²	
Windows facing: South	2.8m²	
Windows facing: South	4.6m²	
Windows facing: East	2.8m²	
Windows facing: North	8.4m²	
Windows facing: North West	3.99m²	
Roof windows facing: Horizontal	1.9m²	
Ventilation rate:	4.00	
Blinds/curtains:	None Closed 100% of daylight hours	

Regulations Compliance Report

10 Key features	
Air permeablility	3.0 m³/m²h
Roofs U-value	0.11 W/m²K
External Walls U-value	0.11 W/m²K
Party Walls U-value	0 W/m²K
Floors U-value	0.11 W/m²K

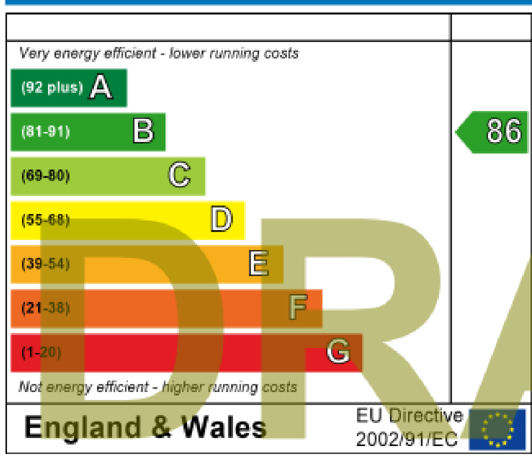
Predicted Energy Assessment

Dwelling type:	Semi-detached House
Date of assessment:	27 October 2020
Produced by:	Stroma Certification
Total floor area:	457.3 m²

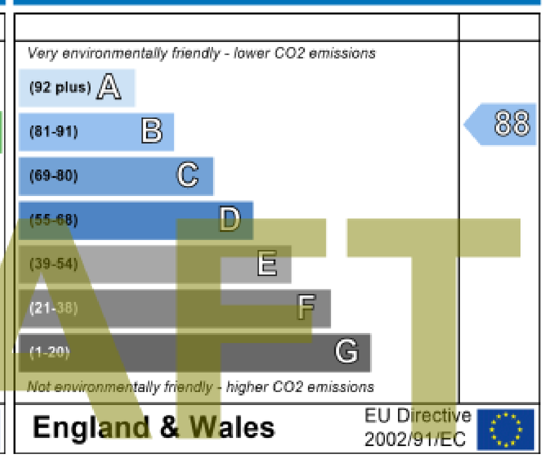
This is a Predicted Energy Assessment for a property which is not yet complete. It includes a predicted energy rating which might not represent the final energy rating of the property on completion. Once the property is completed, an Energy Performance Certificate is required providing information about the energy performance of the completed property.

Energy performance has been assessed using the SAP 2012 methodology and is rated in terms of the energy use per square metre of floor area, energy efficiency based on fuel costs and environmental impact based on carbon dioxide (CO2) emissions.

Energy Efficiency Rating



Environmental Impact (CO_2) Rating



The energy efficiency rating is a measure of the overall efficiency of a home. The higher the rating the more energy efficient the home is and the lower the fuel bills are likely to be.

The environmental impact rating is a measure of a home's impact on the environment in terms of carbon dioxide (CO2) emissions. The higher the rating the less impact it has on the environment.

Block Compliance WorkSheet: Clean

User Details

Assessor Name:		**Stroma Number:**	
Software Name:	Stroma FSAP	**Software Version:**	Version: 1.0.5.9

Calculation Details

Dwelling	DER	TER	DFEE	TFEE	TFA
18A Frognal Gardens - Clean	10.48	14.14	57.6	62.6	457.3

Calculation Summary

Total Floor Area	457.30
Average TER	14.14
Average DER	10.48
Average DFEE	57.60
Average TFEE	62.60
Compliance	Pass
% Improvement DER|TER	25.88
% Improvement DFEE|TFEE	7.99

Stroma FSAP 2012 Version: 1.0.5.9 (SAP 9.92) - http://www.stroma.com

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Regulations Compliance Report

Approved Document L1A, 2013 Edition, England assessed by Stroma FSAP 2012 program, Version: 1.0.5.9
Printed on 27 October 2020 at 12:43:04

Project Information:

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

Dwelling Details:

NEW DWELLING DESIGN STAGE Total Floor Area: 457.3m²
Site Reference : 18A Frognal Gardens **Plot Reference:** 18A Frognal Gardens - Clean
Address :

Client Details:

Name:
Address :

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

1a TER and DER

Fuel for main heating system: Electricity		
Fuel factor: 1.55 (electricity)		
Target Carbon Dioxide Emission Rate (TER)	14.14 kg/m²	
Dwelling Carbon Dioxide Emission Rate (DER)	10.48 kg/m²	OK

1b TFEE and DFEE

Target Fabric Energy Efficiency (TFEE)	62.6 kWh/m²	
Dwelling Fabric Energy Efficiency (DFEE)	57.6 kWh/m²	
		OK

2 Fabric U-values

Element	Average	Highest	
External wall	0.16 (max. 0.30)	0.18 (max. 0.70)	OK
Party wall	0.00 (max. 0.20)	-	OK
Floor	0.11 (max. 0.25)	0.11 (max. 0.70)	OK
Roof	0.16 (max. 0.20)	0.20 (max. 0.35)	OK
Openings	1.21 (max. 2.00)	1.60 (max. 3.30)	OK

2a Thermal bridging

Thermal bridging calculated using user-specified y-value of 0.15

3 Air permeability

Air permeability at 50 pascals	3.00 (design value)	
Maximum	10.0	OK

4 Heating efficiency

Main Heating system:
Heat pumps with radiators or underfloor heating - electric
Daikin Altherma EBLQ016CAV3

Secondary heating system: None

5 Cylinder insulation

Hot water Storage:	Measured cylinder loss: 2.19 kWh/day	
	Permitted by DBSCG: 2.24 kWh/day	OK

Regulations Compliance Report

Primary pipework insulated:	Yes	OK

6 Controls

Space heating controls	Programmer and room thermostat	OK
Hot water controls:	Cylinderstat	OK
	Independent timer for DHW	OK
Boiler interlock:	Yes	OK

7 Low energy lights

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

8 Mechanical ventilation

Continuous supply and extract system		
Specific fan power:	0.46	
Maximum	1.5	OK
MVHR efficiency:	92%	
Minimum	70%	OK

9 Summertime temperature

Overheating risk (South East England):	Not significant	OK
Based on:		
Overshading:	Heavy	
Windows facing: South	3m²	
Windows facing: South	10.8m²	
Windows facing: West	6.78m²	
Windows facing: East	0.8m²	
Windows facing: South	6.07m²	
Windows facing: South	6.07m²	
Windows facing: East	6.92m²	
Windows facing: North	16.7m²	
Windows facing: North West	6.21m²	
Windows facing: West	8.04m²	
Windows facing: South	5.5m²	
Windows facing: South	3.96m²	
Windows facing: East	4.93m²	
Windows facing: North	10.4m²	
Windows facing: North West	7.14m²	
Windows facing: West	1.98m²	
Windows facing: South	2.8m²	
Windows facing: South	4.6m²	
Windows facing: East	2.8m²	
Windows facing: North	8.4m²	
Windows facing: North West	3.99m²	
Roof windows facing: Horizontal	1.9m²	
Ventilation rate:	4.00	
Blinds/curtains:	None	
	Closed 100% of daylight hours	

10 Key features

Air permeablility	3.0 m³/m²h
Roofs U-value	0.11 W/m²K

Regulations Compliance Report

External Walls U-value	0.11 W/m²K
Party Walls U-value	0 W/m²K
Floors U-value	0.11 W/m²K
Fixed cooling system	

DRAFT

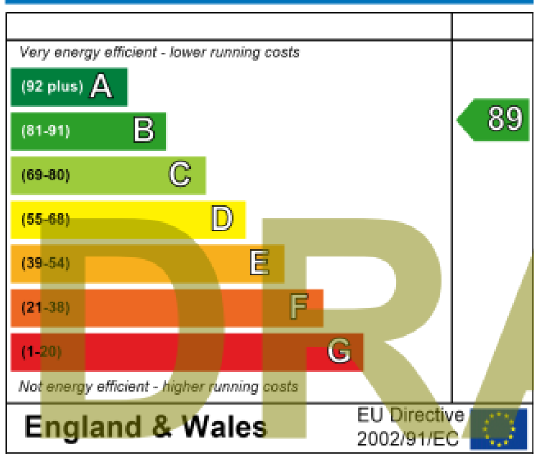
Predicted Energy Assessment

Dwelling type:	Semi-detached House
Date of assessment:	27 October 2020
Produced by:	Stroma Certification
Total floor area:	456.3 m²

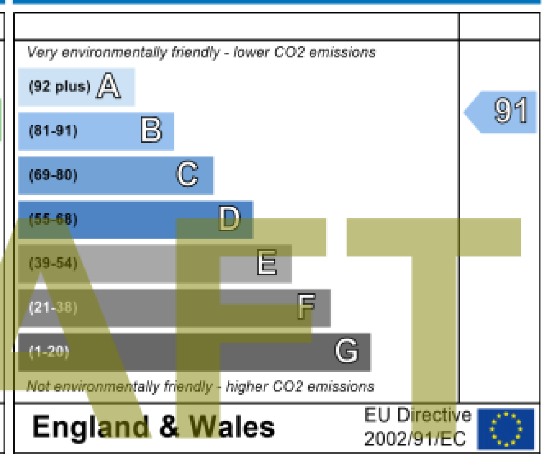
This is a Predicted Energy Assessment for a property which is not yet complete. It includes a predicted energy rating which might not represent the final energy rating of the property on completion. Once the property is completed, an Energy Performance Certificate is required providing information about the energy performance of the completed property.

Energy performance has been assessed using the SAP 2012 methodology and is rated in terms of the energy use per square metre of floor area, energy efficiency based on fuel costs and environmental impact based on carbon dioxide (CO_2) emissions.

Energy Efficiency Rating



Environmental Impact (CO_2) Rating



The energy efficiency rating is a measure of the overall efficiency of a home. The higher the rating the more energy efficient the home is and the lower the fuel bills are likely to be.

The environmental impact rating is a measure of a home's impact on the environment in terms of carbon dioxide (CO_2) emissions. The higher the rating the less impact it has on the environment.

Block Compliance WorkSheet: Green

User Details

Assessor Name:
Stroma Number:
Software Name: Stroma FSAP
Software Version: Version: 1.0.5.9

Calculation Details

Dwelling	DER	TER	DFEE	TFEE	TFA
18A Frognal Gardens - Green	8.3	14.16	57.7	62.6	456.3

Calculation Summary

Total Floor Area	456.30
Average TER	14.16
Average DER	8.30
Average DFEE	57.70
Average TFEE	62.60
Compliance	Pass
% Improvement DER|TER	41.38
% Improvement DFEE|TFEE	7.83

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Page 1 of 1

Regulations Compliance Report

Approved Document L1A, 2013 Edition, England assessed by Stroma FSAP 2012 program, Version: 1.0.5.9
Printed on 28 October 2020 at 11:08:05

Project Information:

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

Dwelling Details:

NEW DWELLING DESIGN STAGE Total Floor Area: 456.3m²
Site Reference : 18A Frognal Gardens **Plot Reference:** 18A Frognal Gardens - Green
Address :

Client Details:

Name:
Address :

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

1a TER and DER

Fuel for main heating system: Electricity
Fuel factor: 1.55 (electricity)

Target Carbon Dioxide Emission Rate (TER)	14.16 kg/m²	
Dwelling Carbon Dioxide Emission Rate (DER)	8.30 kg/m²	OK

1b TFEE and DFEE

Target Fabric Energy Efficiency (TFEE)	62.6 kWh/m²	
Dwelling Fabric Energy Efficiency (DFEE)	57.7 kWh/m²	
		OK

2 Fabric U-values

Element	Average	Highest	
External wall	0.16 (max. 0.30)	0.18 (max. 0.70)	OK
Party wall	0.00 (max. 0.20)	-	OK
Floor	0.11 (max. 0.25)	0.11 (max. 0.70)	OK
Roof	0.16 (max. 0.20)	0.20 (max. 0.35)	OK
Openings	1.21 (max. 2.00)	1.60 (max. 3.30)	OK

2a Thermal bridging

Thermal bridging calculated using user-specified y-value of 0.15

3 Air permeability

Air permeability at 50 pascals	3.00 (design value)	
Maximum	10.0	OK

4 Heating efficiency

Main Heating system: Heat pumps with radiators or underfloor heating - electric
Daikin Altherma EBLQ016CAV3

Secondary heating system: None

5 Cylinder insulation

Hot water Storage: Measured cylinder loss: 2.19 kWh/day
Permitted by DBSCG: 2.24 kWh/day OK

Regulations Compliance Report

Primary pipework insulated:	Yes	OK
Solar water heating		
Dedicated solar storage volume:	200 litres	
Minimum:	96 litres	OK

6 Controls

Space heating controls	Programmer and room thermostat	OK
Hot water controls:	Cylinderstat	OK
	Independent timer for DHW	OK
Boiler interlock:	Yes	OK

7 Low energy lights

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

8 Mechanical ventilation

Continuous supply and extract system		
Specific fan power:	0.46	
Maximum	1.5	OK
MVHR efficiency:	92%	
Minimum	70%	OK

9 Summertime temperature

Overheating risk (South East England):	Not significant	OK
Based on:		
Overshading:	Heavy	
Windows facing: South	3m²	
Windows facing: South	10.8m²	
Windows facing: West	6.78m²	
Windows facing: East	0.8m²	
Windows facing: South	6.07m²	
Windows facing: South	6.07m²	
Windows facing: East	6.92m²	
Windows facing: North	16.7m²	
Windows facing: North West	6.21m²	
Windows facing: West	8.04m²	
Windows facing: South	5.5m²	
Windows facing: South	3.96m²	
Windows facing: East	4.93m²	
Windows facing: North	10.4m²	
Windows facing: North West	7.14m²	
Windows facing: West	1.98m²	
Windows facing: South	2.8m²	
Windows facing: South	4.6m²	
Windows facing: East	2.8m²	
Windows facing: North	8.4m²	
Windows facing: North West	3.99m²	
Roof windows facing: Horizontal	1.9m²	
Ventilation rate:	4.00	
Blinds/curtains:	None	

Regulations Compliance Report

Closed 100% of daylight hours

10 Key features	
Air permeablility	3.0 m³/m²h
Roofs U-value	0.11 W/m²K
External Walls U-value	0.11 W/m²K
Party Walls U-value	0 W/m²K
Floors U-value	0.11 W/m²K
Photovoltaic array	
Fixed cooling system	
Solar water heating	

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