energycouncil
engineering sustainable buildings

Sustainability and Energy Statement
Ref: Z22045A

1No. New Build Dwelling

at

Rear of 16 Frognal Gardens,
Camden,
London,
NW3 6UX

for

Holly Walk Developments Ltd



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Contents

Executive Summary

The proposed development is for 1No. dwelling at the rear of 16 Frognal Gardens, London. The proposed development consists of a split level two-storey 3 bedroom dwelling. The development is required to achieve compliance under Building Regulations Approved Document Part L1A (2016).

Supporting information is provided within this report for the proposed sustainability strategy to be considered on site in accordance with the following planning policies:

- Camden Local Plan 2017 Policy CC1 – Climate change mitigation;
- National Planning Policy Framework (2012)

With reference to Pre-application Report 2017/4522/PRE, the extract below on 'Sustainability' sets out the expected requirements for this development. The project is classed as a 'minor development', as dictated within Camden policy and The London Plan (2016).

Policy CC1 states that the Council will require development to incorporate sustainable design and construction measures. All developments are expected to reduce their carbon dioxide emissions by following the steps in the energy hierarchy (be lean, be clean and be green) to reduce energy consumption. All minor residential developments (over 1+ unit) are expected to submit a sustainability statement - the detail of which to be commensurate with the scale of the development showing how the development will:

- *Implement the sustainable design principles as noted in policy CC1. In particular the key energy objective is to meet Code 4 emission standards which equate to an 19% uplift on 2013 building regs part L.*
- *Demonstrate that the development is capable of achieving a maximum internal water use of 105 litres per day (plus an additional 5 litres for external water use). This is equivalent to Code 4 water consumption standards.*
- *Further information regarding the Council's requirements regarding Climate Change mitigation measures are outlined within CPG3 (Sustainability). Guidance relating to the design of living walls and roofs will be issued alongside these notes.*

The following low and zero carbon technologies have been evaluated:

- Biomass
- Wind
- Biogas
- Air Source Heat Pumps & Exhaust Air Heat Pumps
- Geothermal
- Combined Heat & Power (CHP)
- Solar Hot Water
- Solar Photovoltaic

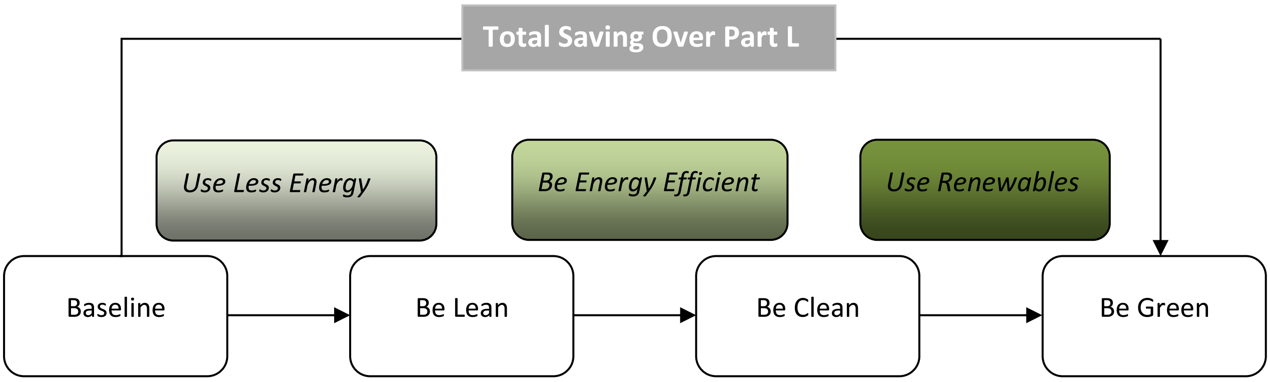
The approach for the Frognal Gardens development is to embed sustainability into the heart of the development through a range of design measures based on the 'Be Lean, Be Clean, Be Green' design hierarchy. Measures will include:

1. Code level 4 CO2 emission.
2. Code level 3 water standards
3. Enhanced building fabric to meet Building Regulation ADL1A 2016
4. Enhanced air tightness and thermal bridging.
5. Efficient extract ventilation system
6. Heating and hot water will be provided a highly efficient gas fired boilers
7. Efficient lighting strategy primarily using CFL or LED type fittings.
8. Photo-voltaic rooftop panel array (totalling 0.75kWp)
9. Reduced water consumption to meet 105l/p/day
10. Green roof to assist with surface run-off attenuation and biodiversity

For the purpose of the assessment we have evaluated the dwelling type in SAP 2012 (Standard Assessment Procedure) to provide an accurate estimate of predicted energy consumption/CO_2 emissions. We have completed SAP calculations for a representative sample of dwelling to provide an estimation of the worst case total energy consumption/emissions on site.

Summary

The development has been provided with energy savings through the use of passive improvement measures such as improved energy efficiency. In line with the energy hierarchy illustrated below, the development complies with ADL1A 2016 through fabric efficiency measures alone, before the application of low and zero carbon technologies. The dwelling will be serviced by gas fired combination boiler for space heating and hot water, with a photovoltaic array totalling 0.75kWp to further reduce emissions.



The principles of a Be Lean, Be Clean, Be Green design philosophy have been applied, which results in a 19% improvement over Building Regulations Part L1A 2016, as indicated in Table 1. A full design specification that confirms inputs used within the SAP calculations is provided within the Appendices of this report.

Table 1 - Proposed development CO_2 emissions against Building Regulations Part L1A 2016

	Total CO_2 Emissions ($KgCO_2$/Yr)
	Total
Baseline Emissions of Development (pre improvement)	**2085**
Be Lean, Be Clean & Be Green	**1683**
Total Reduction in Energy ($KgCO_2$/yr)	**402**
Percentage Improvement in Carbon Emissions (above Bldg Regs ADL1A 2016)	**19%**

Water consumption will be reduced to meet the requirement of less than 105l/person/day using the following parameters:

Table 2 - Proposed sanitary fittings flow rates and capacities

Sanitary fittings	Flow rate or capacity		Consumption (L/person/day)
WC (Full Flush)	4	L/flush	13.53
WC (Half Flush)	2.6	L/flush	
Hand Basin Tap	3	L/min	6.32
Shower	10	L/min	43.7
Bath	140	L/capacity	15.40
Kitchen Tap	4	L/min	12.12
Washing Machine	8.17	L/kg dry load	17.16
Dishwasher	1.25	L/place setting	4.50
Total	Incl. normalization factor 0.91		**104.18**

1. Introduction

The proposed development is for 1No. dwelling at the rear of 16 Frognal Gardens, London. The proposed development consists of a split level two-storey 3 bedroom dwelling and has been subject to a Pre-application Report 2017/4522/PRE. The development is required to achieve compliance under Building Regulations Approved Document Part L1A (2016). Supporting information is provided within this report for the proposed sustainability strategy to be considered on site in accordance with the following planning policies:

- Camden Local Plan 2017 Policy CC1 – Climate change mitigation;
- National Planning Policy Framework (2012)

Throughout this report, passive design techniques, energy efficient equipment and appropriate low carbon technologies will be appraised in line with the 'Be Lean, Be Clean, Be Green' philosophy of relevant planning documents and the Energy Hierarchy.

An assessment of CO_2 emissions will be made based on the calculation methodology dictated by the Standard Assessment Procedure (SAP) and in line with the requirements of London Borough of Camden planning policy.

As this development consists of one residential dwelling, it is classed as a 'minor development', as dictated within Camden policy and The London Plan (2016).

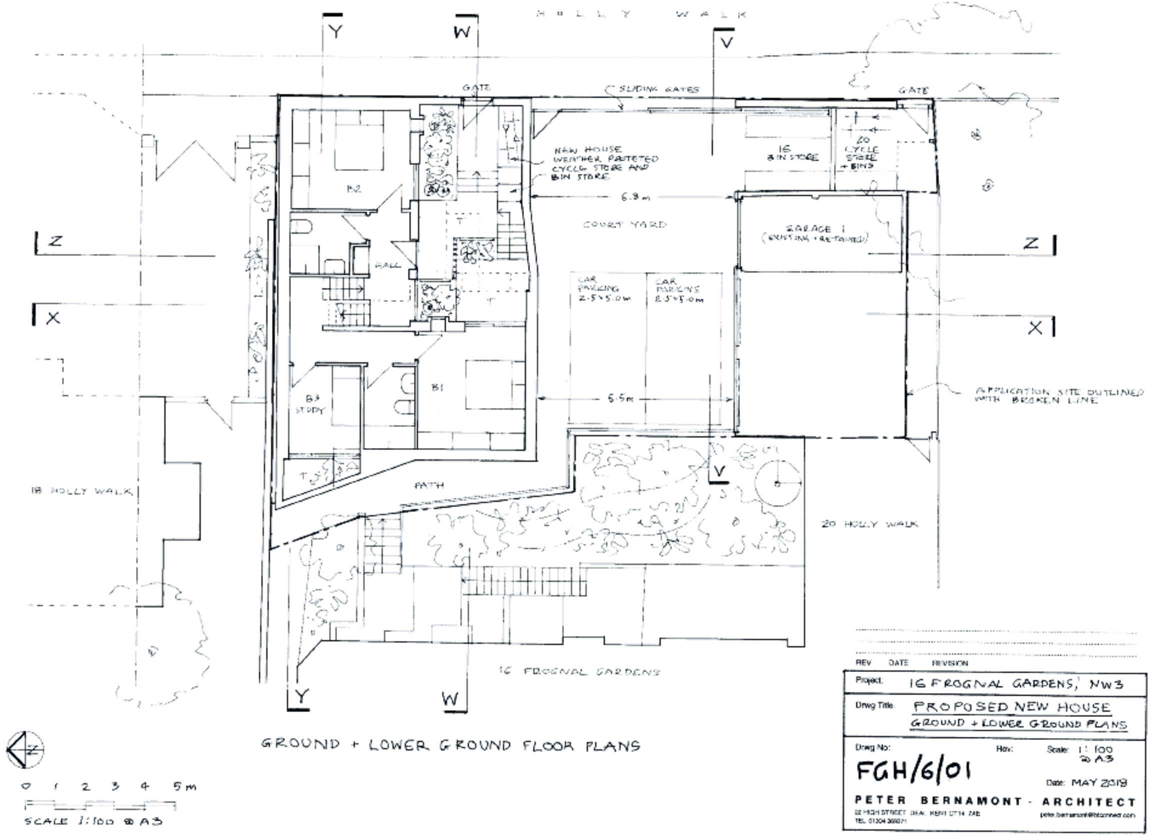
1.1. Location

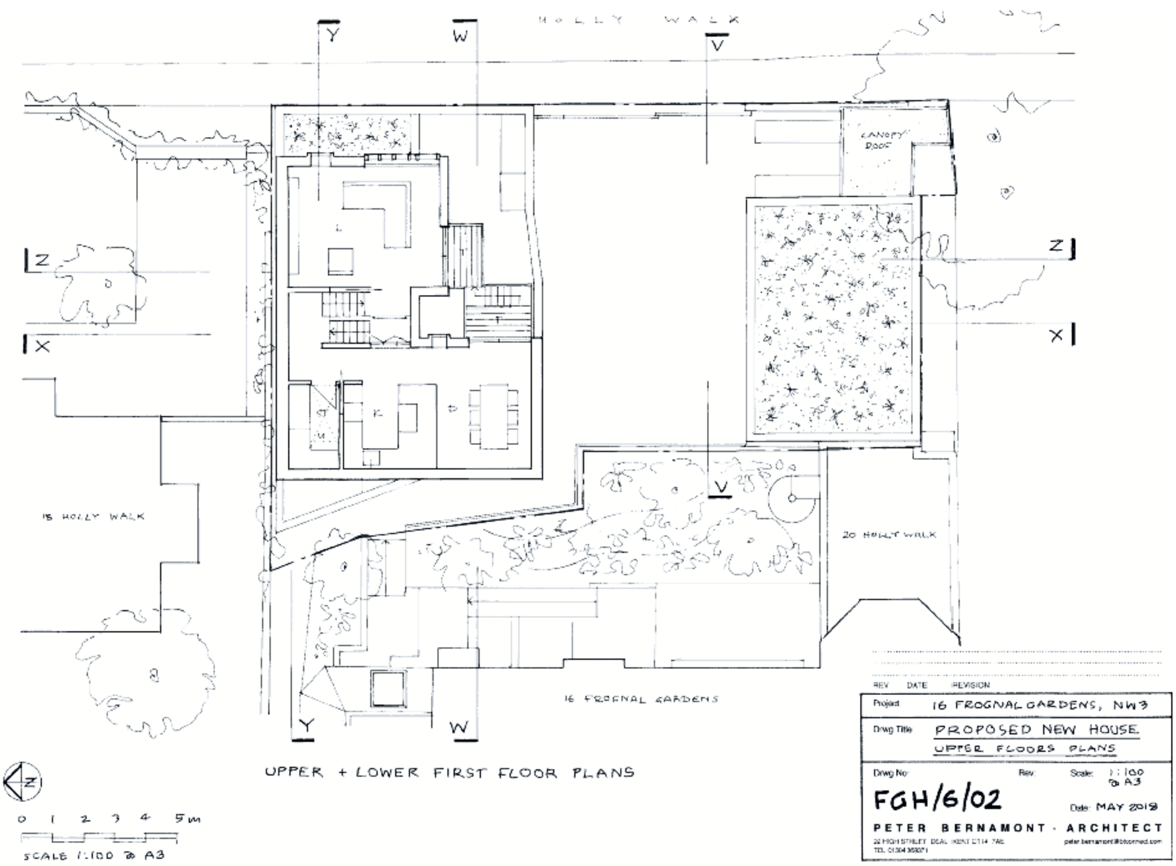
The area of land for the proposed development at 16 Frognal Gardens, NW3 6UX, is highlighted below in Figure 1.

Figure 1 - Location and surrounding area of proposed Frognal Gardens residential development

The site is located at the rear of 16 Frognal Gardens, with existing developments to either side. The site is considered to be located in a dense urban area. The proposed development consists of a single split level two-storey residential block.

1.2. Floor Plans





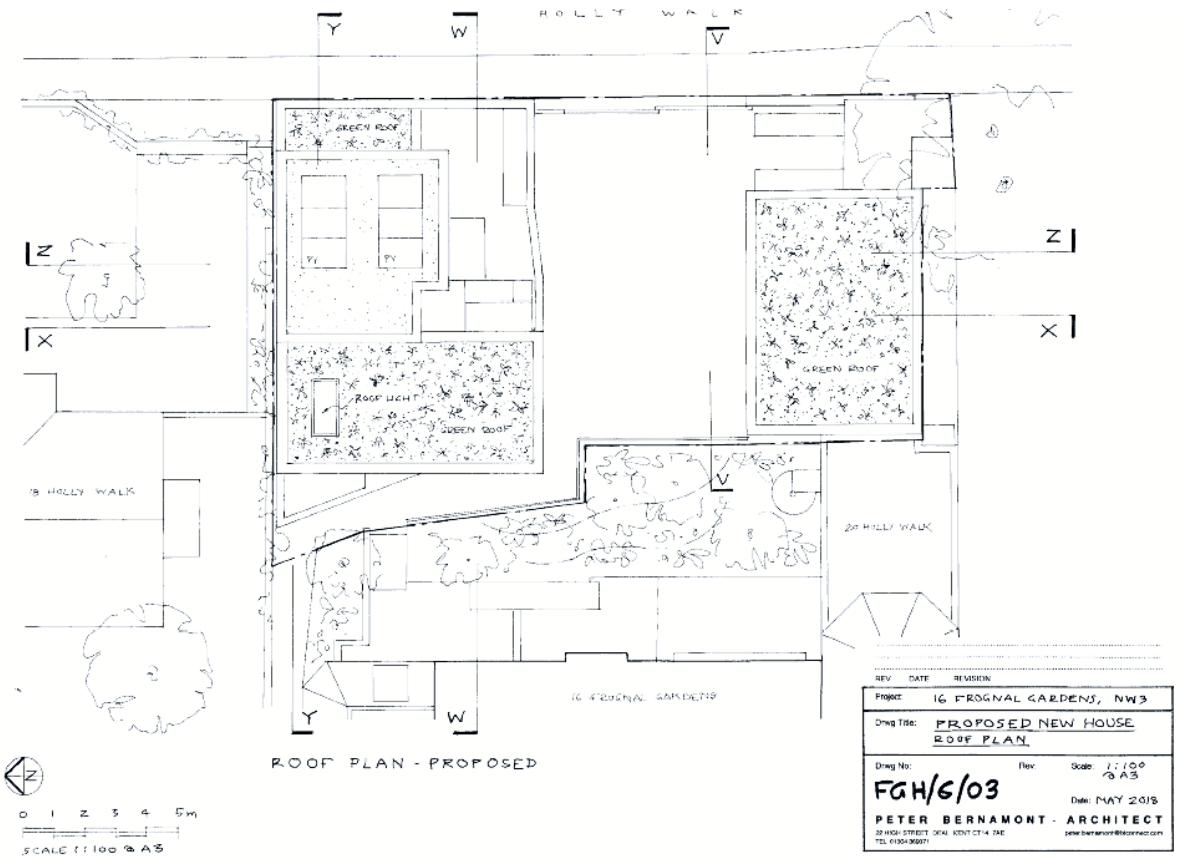


Figure 2 – Floor Plans of the proposed Frognal Gardens residential development

2. Policy Drivers for Energy Efficiency and Renewable Energy

This section presents a range of planning policy that is applicable to the proposed 16 Frognal Gardens development, at both a national and a local level.

2.1. National Policy

The National Planning Policy Framework was published in March 2012 and sets out the governments' planning policies for England and they should be applied. Table 3 sets out the relevant energy standards for new developments and provides an indication of the design response to be provided.

Table 3 – Key National Planning Policy Requirements and Design Responses

Section	Policy Requirements	Design Response
10. Meeting the challenge of climate change, flooding and coastal change	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.	This development will follow the principles set out in Camden Local Plan 2017 Policy CC1 – Climate change mitigation using a 'Be Lean, Be Clean, Be Green' approach in reducing operational carbon emissions.
	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.	An overview of current decentralised energy schemes in Camden and an assessment on the potential for future schemes in relation to this development is provided in Section 6 of this report.
	Take account of landform, layout, building orientation, massing and landscaping to minimise energy consumption.	This Sustainability Statement appraises site specific information to determine the most appropriate approach to minimise energy consumption.

2.2. Local Policy

The Camden Local Plan 2017 Policy CC1 – Climate change mitigation provides a set of guidelines for new development. All relevant energy policy within this document is provided within this section together with a design response.

As the development consists of one unit, it is considered a minor development by the Greater London Authority and therefore the requirements of the London Plan (2016) are not applicable.

Table 4 – Key Local Planning Policy Requirements and Design Responses

Camden Local Plan 2017 Policy CC1 – Climate change mitigation;		
Section	**Policy Requirements**	**Design Response**
CC1 – Climate change mitigation	All minor and major development, including major refurbishment, will be required to demonstrate the following unless developers can robustly justify why full compliance with the policy requirements is not viable: a. How it makes effective use of resources and materials, minimises water use and CO_2 emissions; b. How development proposals are making 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 c. How it is sited and designed to withstand the long term impacts of climate change, particularly the effect of rising temperatures on mechanical cooling requirements; d. Regeneration plan in town centre are an excellent opportunity to implement District Heat and Power networks, and all major development would be strongly encourage to be 'Multi Utility Services Company (MUSCo) ready where viable and actively contribute to the networks where possible; e. We will require all new development comprising the creation of new dwellings to achieve Code for Sustainable Homes Level 4;	The development will achieve a water consumption rate of less than 105 litres/person/year in line with the Pre-application Report 2017/4522/PRE The Frognal Gardens development will follow the principles of the 'Be Lean, Be Clean, Be Green' approach to energy, by ensuring high levels of efficiency before the use of low and zero carbon technologies. In line with Section CC1 of the Camden Local Plan (2017), the development will provide a CO_2 reduction of at least 19% against Part L1A 2013 of the Building Regulations. This is assessed using the SAP methodology in Section 8 of this report. The development will achieve a 19% reduction in carbon emissions from on-site renewable energy generation though a rooftop photovoltaic array. This is confirmed in Section 8.1 of this report. An overview of decentralised energy

	f. All non-domestic development over 500m^2 which does not qualify for assessment under Code for Sustainable Homes will be expected to be built to a minimum of BREEAM (Building Research Establishment Assessment Method) Very Good standard, and meet CO2 reduction targets in line with the requirements of the London Plan or national policy, whichever is the greater.	opportunities is also provided in Section 6 of this report.

With reference to Pre-application Report 2017/4522/PRE, Following the Deregulation Bill 2015 receiving Royal Ascent, it is no longer possible to set conditions with requirements above a Code Level 4 equivalent. However it is still possible to secure energy efficiency reduction as part of new residential schemes in the interests of minimising the environmental impact of the development. We therefore propose a compliant solution to meet Code 4 emission targets for the new dwellings which requires a minimum Dwelling Emission Rate of 19% above 2013 Building Regulations.

3. Methodology

The first step of the full energy strategy assessment has been to undertake a baseline energy assessment. The baseline energy assessment consists of calculating the total CO_2 emissions of the development to meet Building Regulations and then compare the proposed improvement measures against this baseline. Building Regulations Part L1A 2016 (SAP) applies to both of the proposed dwellings and provides carbon emissions from regulated energy.

The building can then be benchmarked/thermally modelled using the energy hierarchy:

1. Be Lean *A reduction in energy use as a result of passive design and energy efficiency*
Thermal performance of envelope (U-values) Glazing design Airtight construction Efficient mechanical ventilation and heat recovery Variable speed fans and pumps Energy Efficient lighting
2. Be Clean *A focus on supplying energy to the development through efficient means*
Connect to low carbon heat networks Develop site wide heat network from single energy centre On site CHP Provide energy efficient individual heating
3. Be Green *The installation of renewable technologies to meet energy demand where possible*
Consider the feasibility of renewable energy technologies Assess the integration of renewable technologies based on the above measures

The development must be provided with energy savings through the use of thermal improvements to fabric (a 'fabric first' approach), followed by other clean energy solutions (energy efficiency improvements, district heating, etc.) and finally the use of renewable energy technologies, where practical. This hierarchy complements the integrated approach to the sustainable energy objectives of the Camden Local Plan (2017).

The planning policies require a full review of the technical and economic feasibility of the following renewable technologies:

- Biomass heating
- Biomass combined heat and power
- Solar hot water
- Solar photovoltaic
- Ground source heat pumps
- Air source heat pumps / exhaust air heat pumps
- Wind power

To achieve the targets set the development must achieve a balance between fabric, heating and control, ventilation and air leakage improvements, the amount of zero or low carbon technology installed and the capital, life cycle and running costs, maintenance and operation, etc.

Feasible renewable energy technologies have been considered during the assessment to ensure the most suitable renewable energy is chosen for the demands of this scheme. The pros and cons of each technology with respect to this site are considered as part of this statement.

4. Baseline Energy Assessment

Energy Council have based the analysis on current Building Regulations ADL1A 2016 (SAP 2012), taking into account solutions that must not only be energy efficient but also practical, reliable and user friendly.

Energy Council have carried out preliminary SAP 2012 calculations for the dwellings. To meet compliance with Building Regulations Part L1 2013, the Dwelling Emissions Rate (DER) must be lower than or equal to the Target Emissions Rate (TER). SAP 2012 is the Governments Standard Assessment Procedure (SAP) for calculating the energy aspects of a dwelling. SAP is a measure of fuel costs for heating, hot water and lighting for a dwelling. SAP 2012 can also be used to ascertain the energy requirements of a development.

To assess the baseline energy we must make an estimation of the energy demands based on current Building Regulations in order to set a target upon which the actual development can be compared.

4.1. Predicted Baseline Energy Requirements

The predicted baseline CO_2 emission demands for the development:

Table 5 - Baseline dwelling carbon emissions

Ref	Dwelling Type	Area	No. of Type	TER	Total Carbon Emissions (kg CO_2/yr)
Z22045	3 bed Dwelling	115.8m^2	1	18.00	2085
Total			**1**		**2085**

The baseline carbon emissions are **2085 kgCO_2/yr**.

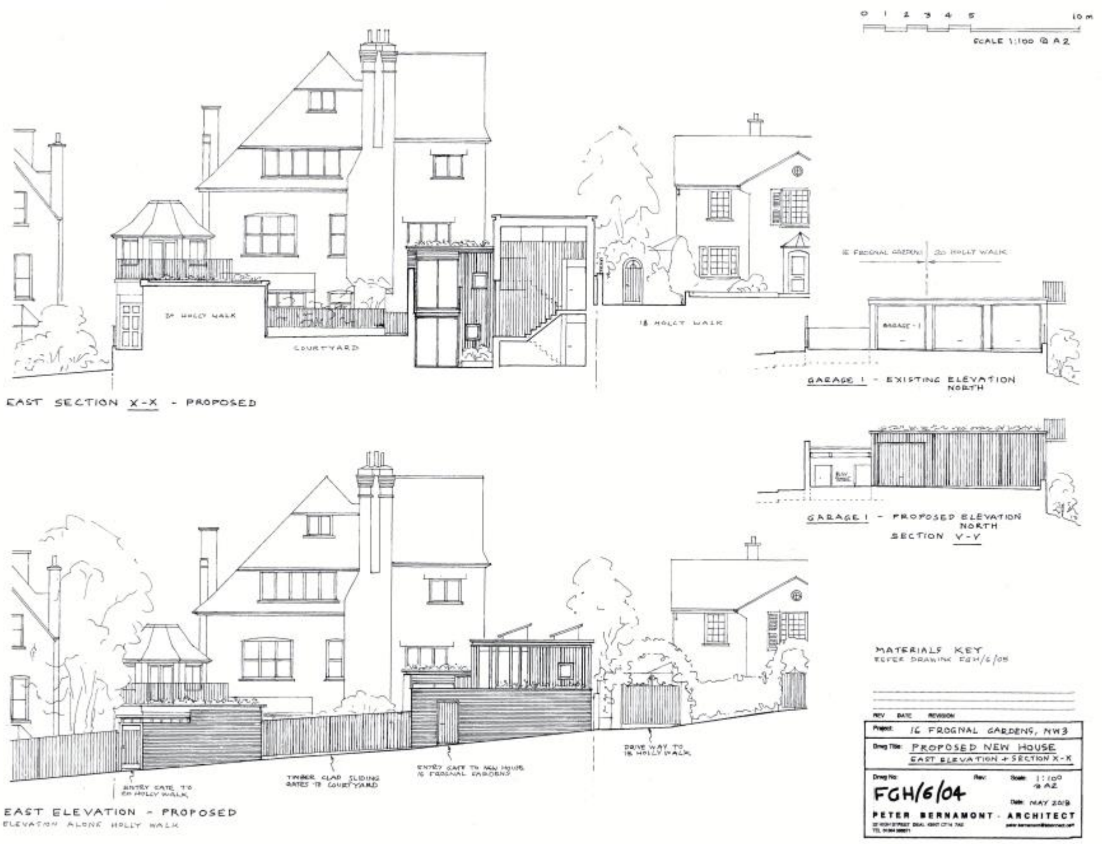
5. Passive Design and Energy Efficiency

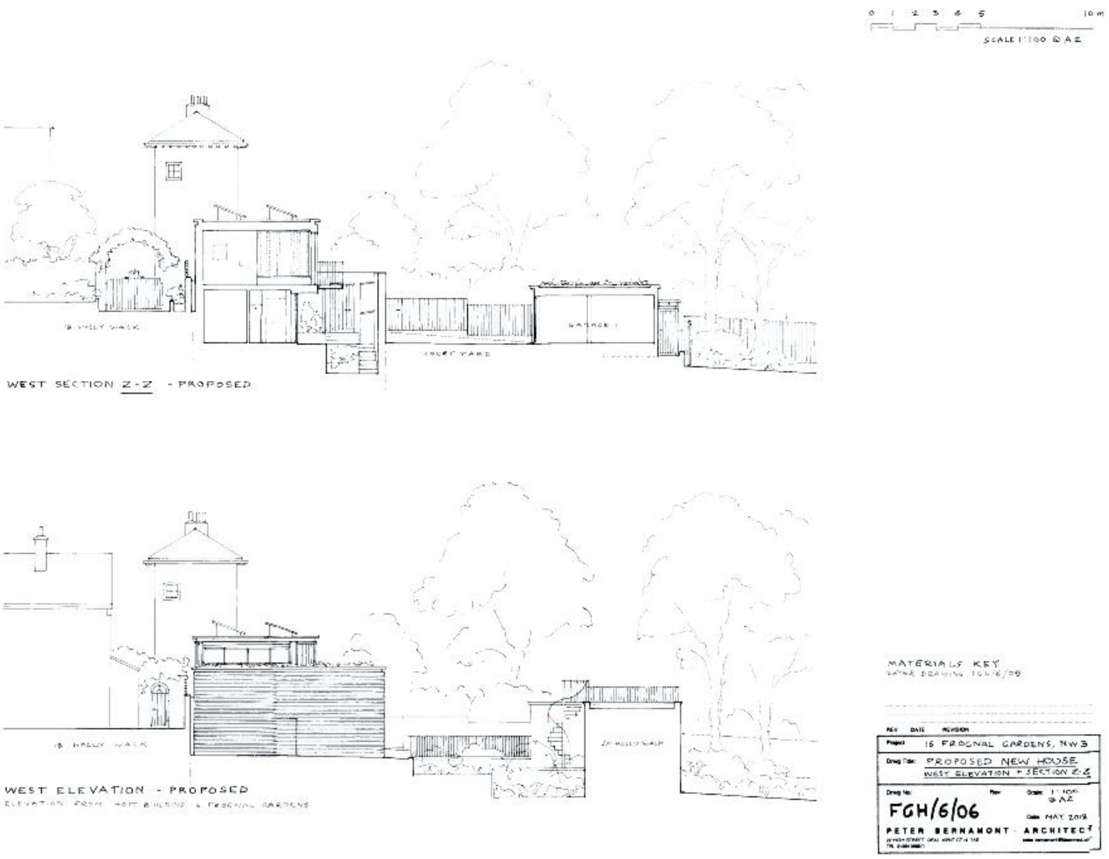
The approach of the development is to embed sustainability into the heart of the design from the outset of the project design process. The design will be developed with sustainable solutions, taking into account the relevant policies and strategies of the Camden Local Plan (2017).

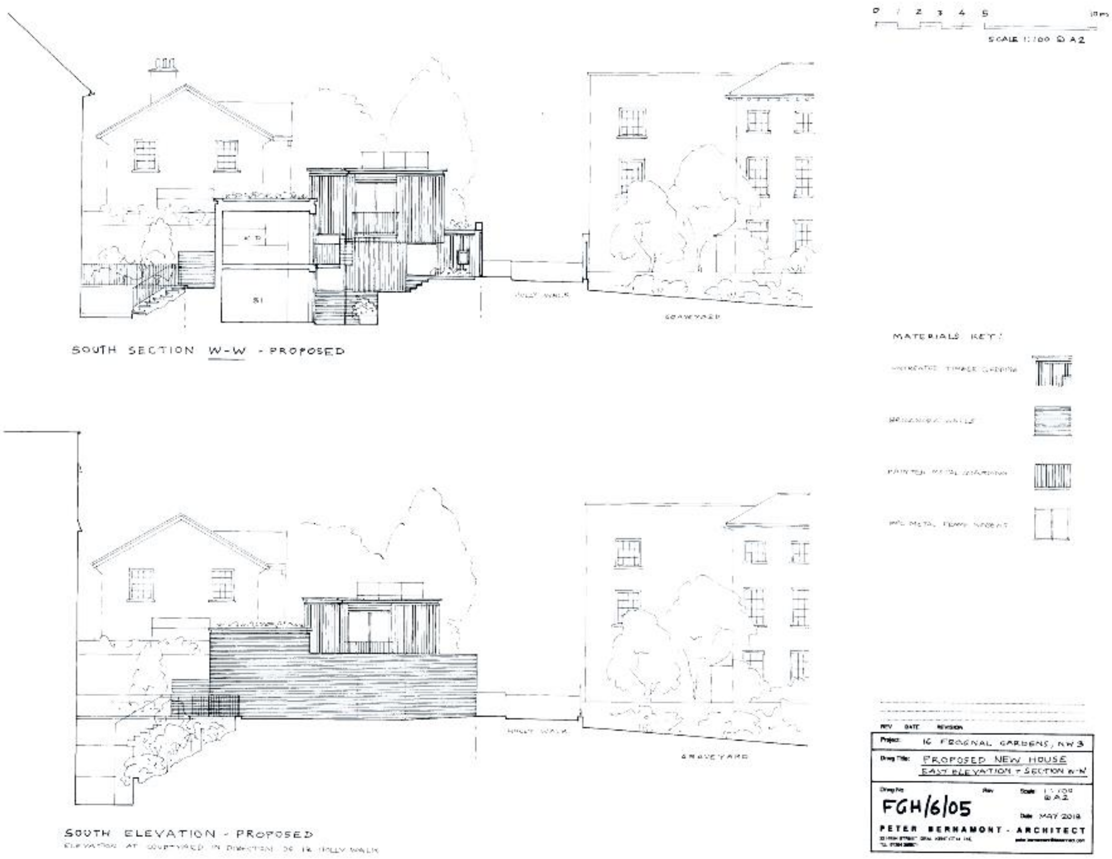
The development will seek to consider all aspects and principles of sustainable development, taking into account environmental, social and economic impacts.

5.1. Passive Design Measures

The philosophy for the site is to achieve as much of the necessary reduction in carbon emissions through the use of passive design techniques and energy efficient measures as possible, before resorting to the use of LZCs. This ensures that the highest standards of building fabric and energy efficiency are achieved.




WEST SECTION Z-Z - PROPOSED
WEST ELEVATION - PROPOSED
MATERIALS KEY
16 FROGNAL GARDENS, NW3
PROPOSED NEW HOUSE
WEST ELEVATION + SECTION Z-Z
FGH/6/06
MAY 2018
PETER BERNAMONT - ARCHITECT


SOUTH SECTION W-W - PROPOSED
SOUTH ELEVATION - PROPOSED
MATERIALS KEY
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PROPOSED NEW HOUSE
EAST ELEVATION + SECTION W-W
FGH/6/05
MAY 2018
PETER BERNAMONT - ARCHITECT

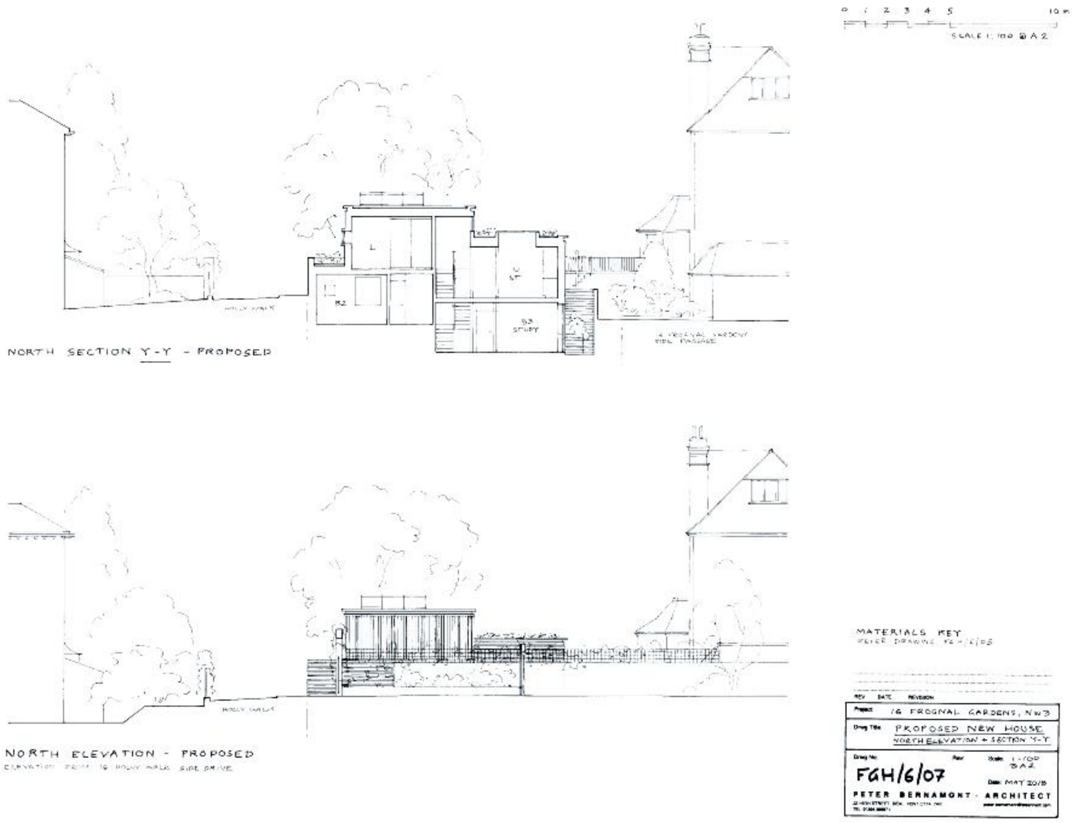

Figure 3 - Elevations of proposed Frognal Gardens residential development

This will be undertaken through a fabric first energy efficient design approach with high levels of thermal efficiency and a reduction in energy demand through efficient lighting design.

5.2. Energy Efficient Systems

Options have been reviewed for improving the energy efficiency of the development by installing an efficient heating system. The scheme will benefit from high efficiency gas fired boilers for heating and hot water.

The dwelling will also be provided with a metering scheme based on their electricity usage.

A low energy, high efficiency, decentralised extract system will serve the kitchen and bathroom, with an overall specific fan power (SPF) of 0.2W/l/s, which improves upon the requirements of Building Regulations Part F (2016). This system operates constantly on low extract and provides a boost when the wet room is in use. Ventilation will be provided throughout the rest of the dwelling by openable windows in all other spaces. Trickle vents will provide background ventilation.

6. District & Communal Heating Networks

This section outlines how consideration of energy supplied efficiently from a district heating network can be provided to the dwellings in line with the Energy Hierarchy.

6.1. Decentralised Heating Networks

The energy policy reaffirms the view that energy generated by centralised power stations and transmitted through the national grid is highly inefficient and wasteful.

One of priorities for reducing CO_2 emissions is to reduce reliance on centralised power stations. This means increasing the use of local, low-carbon energy supplies through de-centralised energy systems.

De-centralised plant generally means any heating and hot water and/or electricity generation provided on a district wide (DHN) or site wide (CHN) basis. DHN and CHN can typically include combined heat and power equipment (CHP). CHP is an engine which, when running, generates electricity and heats water which can then be distributed around a development.

Benefits of district heating networks can include:

- Provision of low carbon / lower cost heat to domestic and commercial customers
- Diversification of the energy mix
- Reductions in region-wide carbon emissions
- Targeting and reduction of fuel poverty
- Potential long term revenue streams for local authorities
- Alignment with regeneration programmes
- Driving the growth of the low carbon services sector

The development is an area defined as high heat load however it is not in close proximity to an existing district heating networks, as shown in Figure 4 below. The development of a decentralised system would not be feasible or beneficial for a singular dwelling.

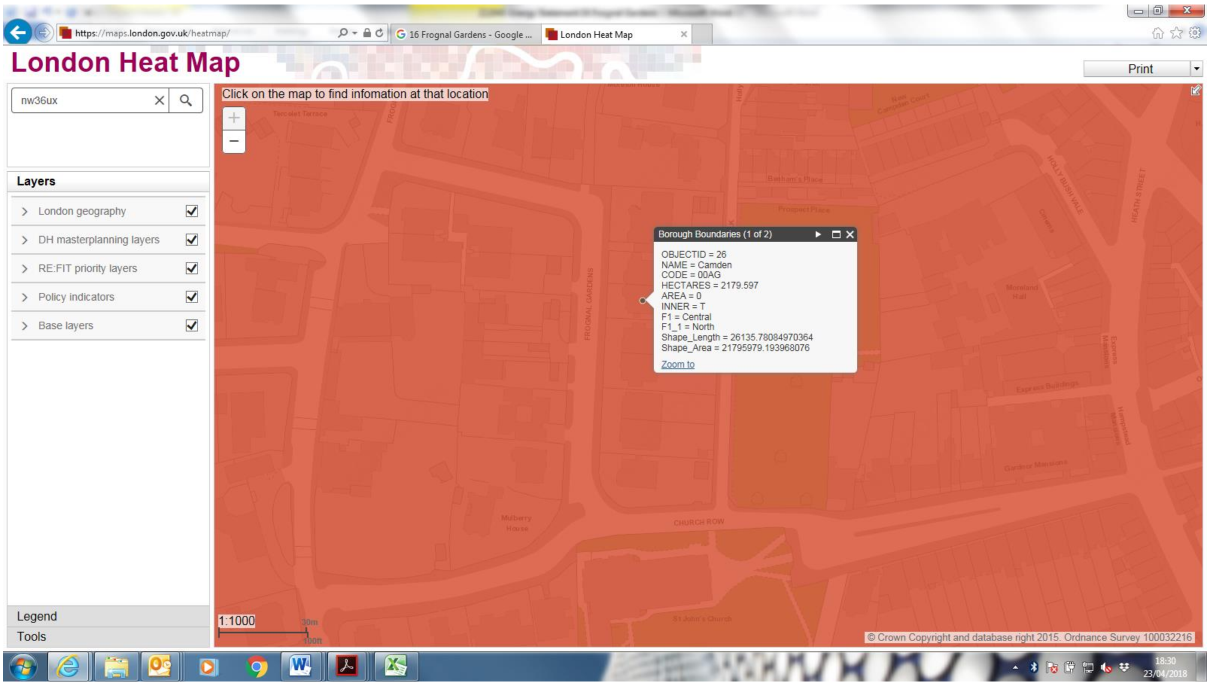

Figure 4 - Local existing and proposed heat networks map. Source: https://maps.london.gov.uk/heatmap/

7. Renewable Energy Technologies

Energy Council have reviewed options for the use of on-site renewable energy/Low or Zero Carbon Technology (LZT) in line with the policy aspirations of the Camden Local Plan (2017).

This renewable Sustainability Statement/strategy reviews the technical and economic feasibility of the following technologies –

- Solar Photo-voltaic
- Solar Hot Water
- Ground Source Heat Pumps
- Air Source Heat Pumps / Exhaust Air Heat Pumps
- Micro Wind Power
- Biomass

7.1. Photovoltaics (PV)

Photovoltaic panels convert sunlight into electricity to run lights and appliances. Photovoltaic panels use cells to convert light into electricity. A PV cell normally consists of 1 or 2 layers of a semi conducting material such as silicon. When light shines on a cell it generates energy causing electricity to flow, the higher the light intensity is, the more electricity flows.

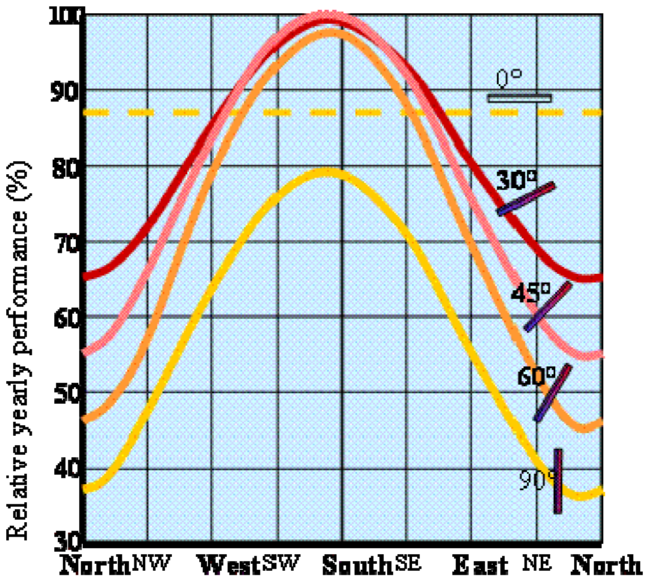

Figure 5 - Performance of photovoltaic panel orientation

The amount of energy PV cells generate is referred to as Kilowatt Peak (KWp). PV arrays now come in a variety of shapes and colours, ranging from grey 'solar tiles' that look like roof tiles to panels and transparent cells that you can use on conservatories and glass to provide shading as well as generating electricity. Solar panels are not light and the roof must be strong enough to take their weight, especially if the panel is placed on top of existing tiles. For flat roofs the panels can be mounted on A-frames to give the optimum angle.

The optimum panel inclination for solar collection is 35°, oriented due south; however panels that are inclined between 35° and 45° and oriented south of west or east are generally suitable. If solar collectors are oriented away from due south then a larger surface area will be required to generate a set amount of energy. The effect of non-optimal orientation is illustrated by the graph in Fig 5 above.

The cost to install PV is typically £1,000 - £1,500 per kWp for 'on-roof' panel systems.

The green roof could support the addition of photo-voltaic panels and this would be the most suitable renewable technology option. An array totalling 0.75kWp has been proposed in the preliminary SAP calculations to demonstrate compliance with local policy.

Figure 6 - Photovoltaic array on roof

7.2. Solar Thermal HW Panel

Solar panel heating uses the radiant energy from the sun to heat hot water, most commonly for domestic hot water needs. There are two types of collectors used for solar water heating – flat plate collectors and evacuated tubes collectors. The systems function successfully in all parts of the UK, as they can work in diffuse light conditions. The collector should be mounted on a 10-60 degrees pitch facing south, although other variations can be used, south is the most efficient.

The cost of installing the system is dependent on the distance between the solar collector and the hot water storage and therefore costs vary. The closer the collectors are to the hot water storage, the less pipe work is required. Annual maintenance checks are recommended.

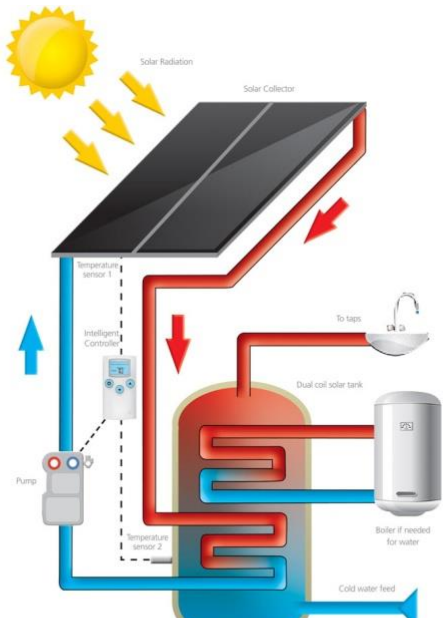

Figure 7 - The principles of a solar thermal system

The solar collectors are connected to a condensing boiler via a HW cylinder with twin coil.

A typical installation in the UK has a panel size of 3-5m^2 which is used in conjunction with a HW storage tank of 180-300litres, of which a minimum of 90-150 litres must be dedicated to solar hot water storage.

They are a 'simple' and guaranteed technology which will act as a pre-heat for the Hot Water and Heating usage. Payback between capital cost and energy saving can normally be achieved within 12 – 20 years, subject to usage and dwelling type.

The use of solar thermal panels, work best in conjunction with individual heating systems for each dwelling. The orientation of the development is fine for the utilisation of solar water heating to provide domestic hot water however it will not achieve significant carbon savings. Carbon savings of approximately 4-5% are achievable with this technology. The dwellings are unlikely to require sufficient hot water storage to deem solar thermal a feasible technology for this site. For the reasons aforementioned this is not an appropriate option for this scheme.

7.3. Ground Source Heat Pump (GSHP)

GSHPs have been developed specifically for the housing market and are now considered to be an established reliable technology. The GSHP would be sized to cater for the heating and domestic hot water requirements. Typically, they are more suited to dwelling as a centralised system would be installed with multiple bore holes to a depth of up to 125 metres depending on the ground conditions. GSHPs use a heat exchanger to extract heat from the earth.

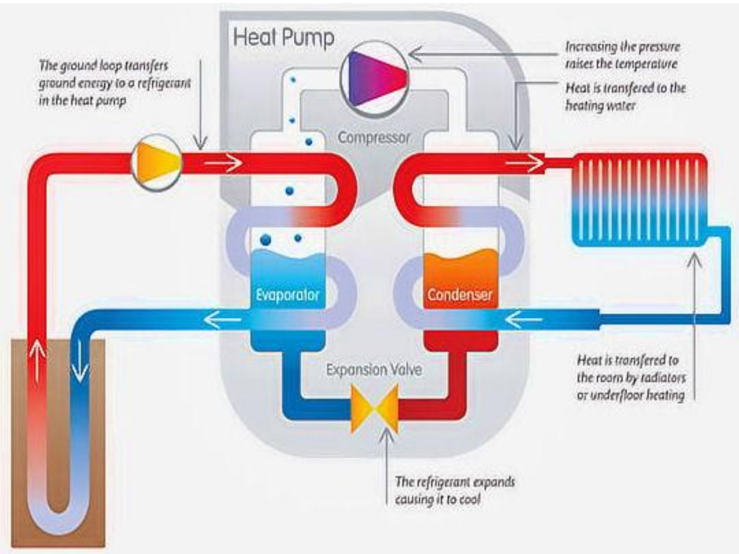

Figure 8 - Principles of a GSHP system

The efficiency of ground source heat pumps is measured by Co-efficient of Performance (CoP), this is the ratio of units of heat output for each unit of electricity used to drive the compressor and pump for the ground loop. Average CoP is around 2-4 although some systems may produce a greater rate of efficiency. This means that for every unit of electricity used to pump the heat, 2-4 units of heat are produced, making it an efficient way of heating a building. If grid electricity is used for the compressor and pump, then there is the opportunity to consider a range of energy suppliers to benefit from the lowest running costs, for example by choosing an economy 10 or economy 7 tariff.

Due to the small scale of this development, GSHPs are not considered an appropriate design solution.

7.4. Air Source Heat Pump/Exhaust Air Heat Pump

Air source heat pumps (ASHP) and exhaust air heat pumps (EAHP) work in a similar way to GSHP. Air source heat pumps can be fitted on the external façade or in the roof space. An air source heat pump uses small amounts of electricity to take in large quantities of air and extract heat. The efficiency of ASHP is measured by Coefficient of Performance (CoP); this is the ratio of units of heat output for each unit of electricity used to drive the system. Average CoP is around 2-4 although some systems may produce a greater rate of efficiency.

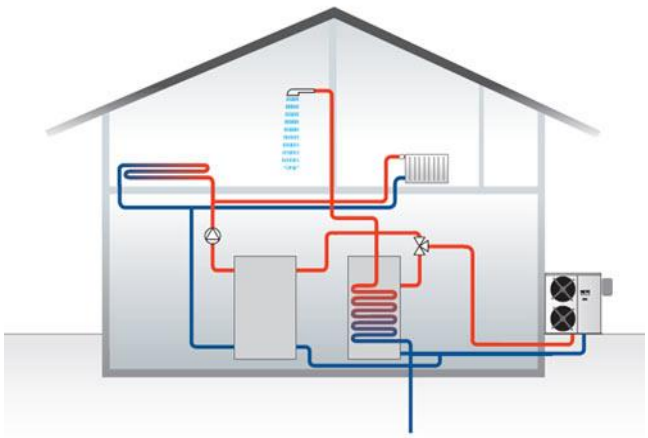

Figure 9 - Principles of an ASHP system

Exhaust air heat pumps such as the NIBE F370 work in a similar manner to ASHP units but have only indoor units (no outdoor compressors) and in addition they also recover heat from their integral exhaust air ventilation system. These units work well on apartment blocks and dwellings where mains gas is unavailable or unsuitable for a development. They are expensive in terms of capital cost of the equipment, installation and the enhanced structural requirements.

ASHPs are feasible for this development but due to the limited external space and associated noise issues they have been discounted.

7.5. Micro Wind Power

Wind power is one of the cleanest and safest methods of generating electricity. However, wind power is unfeasible due to the fact the development is in an urban area and local wind conditions would not be sufficient to provide enough power. Most small wind turbines generate Direct Current (DC) electricity. Systems that are not connected to the national grid require battery storage and an inverter to convert DC electricity into Alternating Current (AC) which is mains electricity.

There are two types of wind turbine available:

- Roof mounted – These are mounted on the roof of dwellings
- Mast mounted – Which are free standing

Figure 10 - Mounted wind turbine

Important issues to consider when using wind turbines are:

- Wind speed increases with height so it's best to have the turbine high on a mast or tower.
- Generally speaking the ideal site is a smooth top hill with a flat, clear exposure, free from excessive turbulence and obstructions such as large trees, dwellings or other buildings.
- Small scale wind power is particularly suitable for remote off grid locations where conventional methods of supply are expensive or impractical.
- Where the local annual average wind speed is 6 m/s or more.
- Where there are no significant nearby obstacles such as buildings, trees or hills that are likely to reduce the wind speed or increase turbulence

As this development is in an urban area there will be obstacles which reduce wind speed. The average wind speed in this area is 4.3 m/s at a height of 10 metres, which is less than the 6 m/s required. Therefore, micro wind is not a viable technology for this development.

7.6. Biomass

Biomass is a generic name for any fuel produced from organic sources and falls into mainly two categories:

- Woody biomass- forest products, untreated wood products, energy crops and wood pellets
- Non-wood biomass – liquid biofuels (such as biodiesel, bioethanol) or animal waste industrial municipal products and high energy crops such as rape seed, sugar cane and maize.

For domestic properties the fuel used is normally wood pellets, wood chips or wood logs. For larger applications, biomass boilers replace conventional fossil fuel boilers and come with an automated feed by screw drives from hoppers.

Biomass systems require more cleaning than gas or oil boilers and they must be capable of being taken out of service for cooling and cleaning whilst maintaining the building heating supply particularly in communal heating systems. Centralised gas boilers are therefore still required to support the biomass boiler, which would be the lead boiler. The size of the dedicated plant rooms is substantial. Fuel availability, delivery and storage are also important issues to consider.

Air quality issues are also an important factor when looking to install biomass. The cost of the fuel depends on the type, delivery distances and whether it is obtained as simple waste product or from another organisation. The cost of wood pellets is currently a little more expensive than mains gas, and woodchip is approx. 30% cheaper, however prices are fluctuating rapidly in the bio-fuel market at the present time creating uncertainty over their take up.

Figure 11 - Biomass boiler and hopper

Biomass CHP is still relatively new to the UK market and is more suitable to large developments where energy demand does not require significant modulation. There are technical issues with small scale Biomass CHP and until these can be resolved and proven the take up of these systems in the UK and Europe has been slow.

Overall carbon savings of 40%+ are achievable with biomass technology. Biomass is more suited to a communal heating system; there is insufficient space to accommodate the equipment and fuel storage to facilitate a biomass boiler. Furthermore, there are noise and air quality issues associated with this type of technology. For this reason biomass is discounted.

8. Energy Assessment of Proposed Scheme

The proposed Frognal Gardens development has adopted the principles of the 'Be Lean, Be Clean, Be Green' approach.

The most practical and economically feasible solution for the development is a good quality thermally insulated fabric, air tight envelope, passive improvements and the use of highly efficient heat pumps supported by efficient ventilation extract system.

Table 6 - Proposed carbon emissions from the Frognal Gardens development

Ref	Dwelling Type	No. of Type	TER	DER	Improvement Factor (%)	Total Carbon Emissions (Kg CO_2/yr)
Z22045	3 bed dwelling	1	18.00	14.53	19	1683
Total		**1**			**19**	**1683**

The carbon emissions are 1683 kg/CO_2/yr. This is a total carbon reduction of 402 kg/CO_2/yr from the baseline emissions of 2085 kg/CO_2/yr this equates to a 19% carbon reduction.

The development proposal meets local policy including energy efficient lighting, efficient ventilation, improved thermal bridging, low air leakage and highly efficient natural space and water heating through gas fired boilers. A 0.75kWp rooftop photo-voltaic array has also been included on the roof of the dwelling.

8.1. Camden Local Plan (2017) Requirements

In line with Policy CC1 of the Camden Local Plan (2017) the development will achieve a 19% reduction in carbon emissions from on-site renewable energy generation. This development provides reductions of 19% on ADL1A (2016) through a combination of efficient gas fired boilers and photovoltaics, therefore is considered to fully accord with policy.

9. Water Consumption Proposals

The Camden Local Plan (2017) requires that the dwellings achieve water consumption figures of no greater than 105 litres per person per day.

Water consumption will be reduced to meet less than 105l/person/day. This compares favourably with the GLA average of 161l/person/day. The design team will provide a schedule of all appliances listed below with manufacturer, type and flow rates all specified and how the flow rate is achieved (flow regulators, limiters, etc...). Suggested water appliance details are as follows and this could be reviewed at detailed design stages:

Table 7 - Proposed sanitary fittings flow rates and capacities

Sanitary fittings	Flow rate or capacity		Consumption (L/person/day)
WC (Full Flush)	4	L/flush	13.53
WC (Half Flush)	2.6	L/flush	
Hand Basin Tap	3	L/min	6.32
Shower	10	L/min	43.7
Bath	140	L/capacity	15.40
Kitchen Tap	4	L/min	12.12
Washing Machine	8.17	L/kg dry load	17.16
Dishwasher	1.25	L/place setting	4.50
Total	Incl. normalization factor 0.91		**104.18**

The dwelling will be fitted with a water meter and will incorporate water saving and efficiency measures that comply with Regulation 36(2)(b) of Part G2 of the Building Regulations to ensure that a maximum of 105 litres of water is consumed per person per day.

10. Conclusion

Following the 'Be Lean, Be Clean, Be Green' hierarchy, the proposed design solutions are predicted to produce carbon emissions of 1683 kg/CO_2/yr which is a reduction in the total carbon emissions of 402 kg/CO_2/yr from the baseline emissions of 2085 kg/CO_2/yr. This equates to a 19% carbon reduction from the calculated baseline regulated energy emissions, confirming compliance with the requirements of the London Borough of Camden's Local Plan (2017).

Water consumption will be reduced to meet less than 105l/person/day.

The approach for the proposed Frognal Gardens development is to embed sustainability into the heart of the development through a range of design measures based on the 'Be Lean, Be Clean, Be Green' design hierarchy. Measures will include:

1) Enhanced building fabric to meet Building Regulation ADL1A 2016
2) Enhanced air tightness and thermal bridging
3) Efficient extract ventilation system
4) Heating and hot water will be provided by highly efficient gas fired boilers
5) Efficient lighting strategy primarily using CFL or LED type fittings
6) Photovoltaic rooftop panel array totalling 0.75kWp

10.1. Low/ Zero Carbon Technologies (LZT) Review

- Photo-voltaic panels have been proposed for the development, which can be integrated into the design to reduce emissions as a result of electricity consumption. The calculations confirm that a 0.75kWp array will provide significant energy reductions to ensure compliance with the requirements of Camden's Local Plan (2017).
- Solar Thermal Hot Water is not considered a suitable option as gas boilers will be utilised for hot water demand, with photovoltaics to provide further carbon reductions on any electrical consumption.
- Biomass has been discounted as it poses problems in terms of air quality, delivery of fuel, storage and transportation for deliveries etc. It would require a centralised larger plant space for storing fuel, which on this constrained site is not viable.
- Micro-wind turbines do not work on this type of development due to problems with wind turbulence and mounting of the units. The wind speeds in the area are not conducive to wind power electricity generation and there would be issues with turbulence, wind shading, noise and air traffic.

- GSHPs are not viable for this site because of spatial and financial costs. There is no room to accommodate a GSHP vertical bore and associated communal plant room, ground conditions are unknown and systems are very costly.
- ASHPs are not included as a gas boiler approach is preferred due to the carbon content of the fuel being lower, meaning less emissions are emitted. There is also limited space for external plant and the associated noise from the condensers could be problematic for existing residents, meaning ASHPs are not viable for this development.

A more detailed overview of LZT technologies is provided in the appendices of this report.

10.2. Summary Headlines

- A passive fabric-first approach has been taken to reduce the energy demand of the proposed 16 Frognal Gardens development below the TER of ADL1A (2016) before the application of low and zero carbon technologies.
- A highly efficient servicing strategy of efficient gas fired boiler and a 0.75kWp rooftop photovoltaic array is proposed, which provides significant reductions on the TER of ADL1A (2016) and confirms compliance with the Camden Core Strategy (2011).
- An overall 19% improvement in CO_2 emissions above the Building Regulations baseline is proposed to support our application and to meet policy requirements.
- Water consumption will be reduced to meet less than 105l/person/day.
- A green roof will be installed to assist with surface water attenuation and to enhance the biodiversity of the site. It also works well with PV panels by providing a cooling effect to increase panel efficiency. .

Table 8 - Summary of Carbon Emissions

	Total CO2 Emissions ($kgCO_2$/Yr)
	Total
Baseline Emissions of Development (pre improvement)	**2085**
Be Lean, Be Clean & Be Green	**1683**
Total Reduction in Energy ($KgCO_2$/yr)	**402**
Percentage Improvement in Carbon Emissions (above Bldg Regs ADL1A 2016)	**19%**

11. Appendices

11.1. LZT Feasibility Table

Technology	Technical Feasibility	Carbon Savings	Estimated Costs	Financial Viability
Solar photovoltaics	South facing aspects of the roof could support a rooftop array totalling 0.75kWp to ensure energy consumption is reduced sufficiently.	A 0.75kWp system could save around 306 kg of CO2 per year per dwelling.	Average cost for such a system is around £1.5-2K per dwelling.	Current potential income generation is around £345 per annum per dwelling, with a fuel cost saving of around £60 per year per dwelling.
Wind	Average wind speeds on the site according to the NOABL Wind Speed Database are 4.9m/s. To be technically feasible a minimum of 6m/s is required, therefore this site is not considered feasible.	N/A	N/A	N/A
Micro Hydro	There is no capacity for micro hydro on this site since there are no local water courses available.	N/A	N/A	N/A
District Heating	There are currently no existing or planned district heating networks to facilitate connection at this stage.	N/A	N/A	N/A
Solar Hot Water	This technology has been discounted as the level of hot water usage in each dwelling does not merit a storage system, which poses space issues.	Around 270 kg of CO2 per year per dwelling.	£3-5K per dwelling	Income generation from RHI in a 4 person household would be in the region of £340 / year (per dwelling) with a fuel saving of around £65 per year per dwelling
Heat Pumps	GSHP: Ground conditions on site are unknown, and installation of coils are likely not economically viable for this project. ASHP: Electric heat pump can provide heating and hot water to dwellings.	GSHP: 2,100 to 3,300 kg CO2 per year per dwelling ASHP: 1,700 to 2,700 kg CO2 per year per dwelling.	GSHP @ £13-20K per dwelling ASHP: £7-11K per dwelling	GSHP: £2,590 minimum annual RHI income generation per dwelling with fuel saving of £440 per year minimum per dwelling ASHP: £920 minimum annual RHI income generation per dwelling with fuel saving of £335 per year minimum per dwelling
Biomass	The small scale of this development would not facilitate the installation of biomass boilers due to the space required for pellet storage.	N/A	N/A	N/A

11.2. Specification for Energy Assessments (ADL1A 2016 - SAP)

energycouncil
engineering sustainable buildings

Appendix I – ADLA 2016 Preliminary
Part L1A 2016
Energy Evaluation Ref: Z22045
Dwellings at Rear of 16 Frognal Gardens
Thermal and Fabric Data

Item	Brief description	Notes.	Confirm
	The following information is required for the design submission (as per requirements of approved doc L1A).	Please note submission is now in two stages. **A) Design,** B) As installed	
1. Dwelling Type			
1.1	Building Regulations Part L1A 2016 apply.		
1.2	Electricity is supplied by standard tariff rather than economy 7, 10 or 24.	*Assumed Standard tariff*	
1.3	Dwellings have a medium thermal mass parameter.	*Masonry construction*	
2. Floor Construction Details			
2.1	Ground floor is insulated with PIR insulation to achieve the U value indicated opposite.	U-Value = 0.12 W/m²K λ of insulation = 0.022 W/mK	
3. Wall Construction Details			
3.1	Main external wall insulated with PIR insulation to achieve the U value indicated opposite.	U-Value = 0.21 W/m²K. λ of insulation = 0.022 W/mK	
3.2	Party walls are fully filled and sealed to achieve the U-value indicated opp	U-Value = 0.00 W/m²K	
3.3	Retaining wall where applicable caused by steps in levels will be insulated to achieve the U-value indicated opposite.	U-Value = 0.25 W/m²K. the above includes soil to one side.	
4. Roof Construction Details			
4.2	All flat roofs are insulated with PIR insulation to achieve the U value indicated opposite.	U-Value = 0.14 W/m²K λ of insulation = 0.022 W/mK	
5. Openings			
5.1	Front External doors have little glazing and are insulated to achieve the U value indicated.	U = 1.2 W/m²K	
5.2	All double glazed windows, rear doors and patio type doors/windows with hard Low-e glass hard coating. Value is manufacturer's declaration.	U=1.4 W/m²K average glass and frame U value.	
5.3	Roof lights have Low-e glass hard coating. Value is manufacturer's declaration.	U=1.3 W/m²K average glass and frame U value.	
5.4	Frame factor, emissivity, and transmission factors are all undefined. Overhang depth/width over window is 0.1.		
6. Ventilation			
6.1	Design stage SAP calculation presumes an air permeability of 5.5m³/m²/hr at 50pa will be achieved.		
6.2	Decentralised Mechanical Ventilation is present in kitchen and all wet areas located through the wall.	*Greenwood 2GV GIP*	
6.3	No open flues or chimneys are present anywhere.		
7. Space Heating			
7.1	Heating is provided by an individual wall mounted fan flued condensing gas boiler with auto ignition.	Logic Code Combi ESP 1 33KW 89.6% efficiency	
7.2	The heating system is to be controlled via programmer, room thermostat and TRVs		
7.3	No weather compensators have been included in the assessment		
7.4	The central heating boiler is inside the main fabric of the dwelling.		
7.5	The boiler has an interlock to switch it off when there is no demand from room thermostat(s).		
8. Water Heating			
8.1	Water usage per person per day is ≤105 Litres.	Exceeds Bldg Regs part G	
8.2	Hot water can be provided independent of central heating.		

Appendix 1 – ADLA 2016 Preliminary
Part L1A 2016
Energy Evaluation Ref: Z22045
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8.3	Hot water storage is not installed to any dwelling.		
9. Renewables			
9.1	PV panels have been installed to help achieve the 19% overall improvement.	South facing panels at a 30° pitch A total of 0.75kWp will be installed.	
10. Other			
10.1	Accredited Construction Details (ACD) for limiting thermal bridging are installed at every junction in the main fabric.		
10.2	Standard Lintels are being used (Psi Value of 0.3)		
10.3	100% Low energy (LE) lights are installed.		

11.3. Index of Tables and Figures