Energy Statement

ENERGY STATEMENT- PROPOSED RESIDENTIAL DEVELOPMENT 8 HILL RISE EN6 4EE

Client:

ADL Ltd

Reference:	8 Hill Rise EN6-ES-01/R/1.0/AF
Status:	ISSUE
Date:	10/1/2018

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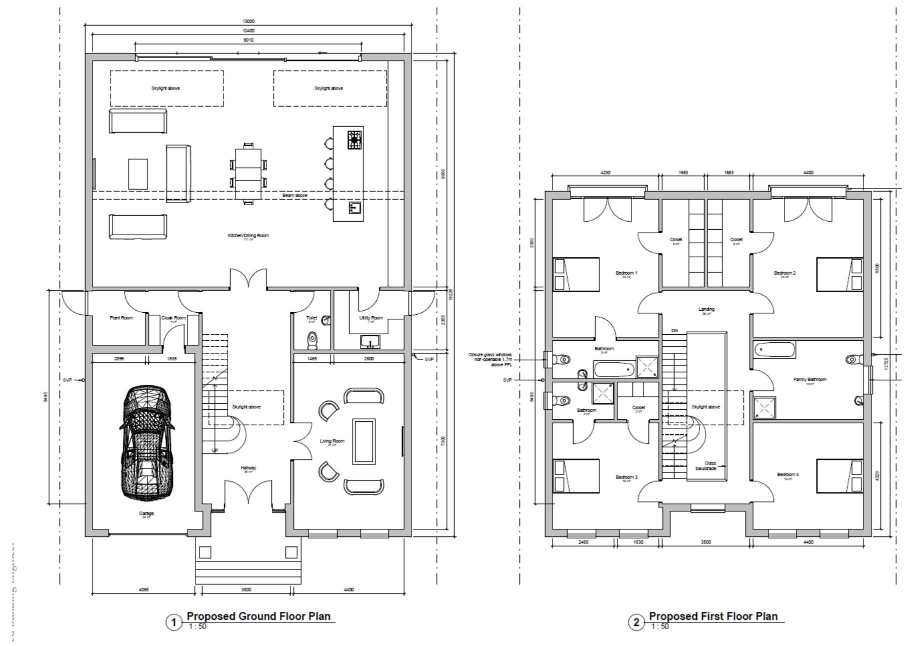
1. Assessment Information

Nature of Assessment:	Energy Statement-Proposed residential development 8 Hill Rise EN6 4EE
Project Name:	New Build
Project Address:	8 Hill Rise EN6 4EE
Client:	ADL Ltd
Project Description	Demolition of existing house and erection of new 5 bedroom house

Figure 1: Proposed Site Plan



2. Executive Summary

In keeping with requirements of planning, this statement comprises:

- A Building Regulation baseline energy assessment for the proposed development.
- Energy conservation measures to be undertaken in the design of the development.
- A calculation of energy savings that are to be achieved as a result of energy efficient measures.
- A calculation of CO_2 savings that are to be achieved as a result of energy efficient measures.

Mr & Mrs Panayiotou have placed considerable emphasis on utilising passive design measures and targeting fabric efficiency in order to mitigate energy use. In conjunction with high levels of air tightness and proposed Accredited Construction Details (ACD) to all wall junctions; energy consumption for heating will be dramatically reduced, providing home owners with a comfortable, efficient and cost effective dwelling. Highly efficient mechanical ventilation will ensure the dwellings will remain well ventilated and provide a comfortable living environment for home owners.

The overall fabric energy efficiency specification significantly improves on the requirements of Part L1A 2013, and shows that the development will reduce CO_2 requirements and supply energy efficiently. The proposal demonstrates that all units will achieve a reduction in Dwelling Emission Rates **3.6 %** better than a Part L 2013 baseline.

The introduction of renewables reduces the CO2 and energy use further. The total reduction is summarised in the table below.

Table 1: Key Figures

Energy and $C0_2$ Savings			
	Description	Amount	Unit
Regs & Improvements (TER's)	Total site CO_2 demand Part L1A 2013 (TER)	3,110	$KGCO_2$/Year
	Total site Energy Demand Part L1A 2013 (TER)	13,139	kWh/Year
	Actual Site CO_2 demand (DER) 2013	**2,998**	$KGCO_2$/Year
	Actual Site CO_2 demand (DER) 2013	12,536	kWh/Year
	Percentage CO_2 improvement through fabric/control	3.6	%
	Percentage energy improvement through fabric/control	4.59	%
Site Summary	Reduction in energy through fabric	1,976	kWh/Year
	Reduction in CO2 through fabric	1,026	$KGCO_2$/Year
	Energy abatement	15.04	%
	CO2 abatement	32.99	%
	Total CO_2 Improvement over baseline	36.59	%

Fabric Energy Efficiency measures reduce CO_2 emissions by **1,026** $KGCO_2$/Year.

This represents a **3.6** % saving over a 2013 baseline unit.

The total CO_2 reduction including fabric and renewables is **3.6 %**.

The reduction in Carbon Dioxide and energy meets the requirements of London Borough of Enfield.

3. Policy

3.1 National Policy

3.2 National Planning Policy Framework (NPPF) March 2012

The NPPF sets out the Government's planning policies for England and how these are expected to be applied. It sets out the Government's requirements for the planning system only to the extent that it is relevant, proportionate and necessary to do so. It provides a framework within which local people and their accountable councils can produce their own distinctive local and neighbourhood plans, which reflect the needs and priorities of their communities.

Chapter 10 Meeting the challenge of climate change, flooding and coastal change

The following paragraphs set out the Government's position in response to reducing carbon emissions:

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

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

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

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

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

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

Planning update March 2015

Written statement to Parliament

On 25th March 2015 The Rt Hon Eric Pickles delivered a statement on Energy efficiency in buildings, Planning system, Climate change, Environment and Planning and building.

It outlined the steps the government are taking to streamline the planning system, protect the environment, support economic growth and assist locally-led decision-making. The following areas were highlighted as areas requiring change.

Zero Carbon Homes: supporting small builders

The government highlighted their commitment to implementing the zero carbon homes standard in 2016 and in addition to the future strengthening of minimum on-site energy performance requirements introduced in the Infrastructure Act 2015 the powers needed to enable off-site carbon abatement measures (Allowable Solutions) to contribute to achieving the zero carbon standards. However they recognised achieving the zero carbon standards would be a challenge for home builders and in particular smaller home builders and consulted on how an exemption for small sites could operate.

It was decided there would be an exemption for small housing sites of 10 units or fewer, which are most commonly developed by small scale home builders and can be more expensive to develop irrespective of the size of the builder, from the allowable solutions element of the zero carbon homes target. All new homes will be required to meet the strengthened on-site energy performance standard but those building on small sites will not be required to support any further off-site carbon abatement measures.

Housing standards: streamlining the system

It was agreed that all new homes need to be high quality, accessible and sustainable. To achieve this, the government created a new approach for the setting of technical standards for new housing. This rationalises the many differing existing standards into a simpler, streamlined system which it is hoped would reduce burdens and help bring forward much needed new homes.

The new system comprises new additional optional Building Regulations on water and access, and a new national space standard (hereafter referred to as “the new national technical standards”). This system complements the existing set of Building Regulations.

To implement the new regime a written ministerial statement sets out the government’s new national planning policy on the setting of technical standards for new dwellings. The statement is to be taken into account in applying the National Planning Policy Framework, and in particular the policies on local standards or requirements at paragraphs 95, 174, and 177, in both plan making and decision-taking.

Plan making

From the date the Deregulation Bill 2015 is given Royal Assent, local planning authorities and qualifying bodies preparing neighbourhood plans should not set in their emerging Local Plans, neighbourhood plans, or supplementary planning documents, any additional local technical standards or requirements relating to the construction, internal layout or performance of new dwellings. This includes any policy requiring any level of the Code for Sustainable Homes to be achieved by new development; the government has now withdrawn the code, aside from the management of legacy cases.

Local planning authorities and qualifying bodies preparing neighbourhood plans are to consider their existing plan policies on technical housing standards or requirements and update them as appropriate, for example through a partial Local Plan review, or a full neighbourhood plan replacement in due course. Local planning authorities may also need to review their local information requirements to ensure that technical detail that is no longer necessary is not requested to support planning applications.

The optional new national technical standards should only be required through any new Local Plan policies if they address a clearly evidenced need, and where their impact on viability has been considered, in accordance with the National Planning Policy Framework and Planning Guidance. Neighbourhood plans should not be used to apply the new national technical standards.

For the specific issue of energy performance, local planning authorities will continue to be able to set and apply policies in their Local Plans which require compliance with energy performance standards that exceed the energy requirements of Building Regulations until commencement of amendments to the Planning and Energy Act 2008 in the Deregulation Bill 2015.

This is expected to happen alongside the introduction of zero carbon homes policy in late 2016. The government has stated that, from then, the energy performance requirements in Building Regulations will be set at a level equivalent to the (outgoing) Code for Sustainable Homes Level 4. Until the amendment is commenced, it is expected local planning authorities to take this statement of the government's intention into account in applying existing policies and not set conditions with requirements above a Code level 4 equivalent. This statement does not modify the National Planning Policy Framework policy allowing the connection of new housing development to low carbon infrastructure such as district heating networks.

Decision taking, transition and compliance:

Where there is an existing plan policy which references the Code for Sustainable Homes, it was decided authorities may continue to apply a requirement for a water efficiency standard equivalent to the new national technical standard, or in the case of energy a standard consistent with Code Level 4.

3.3 Local Policy

Enfield Core Strategy

Core Policy 20

Sustainable Energy used and Energy Infrastructure

The Council will require all new developments, and where possible via a retrofitting process in existing developments to address the causes and impacts of climate change by: minimising energy use; supplying energy efficiently; and using energy generated from renewable sources in line with London Plan and national policy.

The Council will support appropriate measures to mitigate and adapt to the impacts of climate change and will reduce emissions of carbon dioxide as part of development proposals, in line with the London Plan.

The Council will set local standards and targets, based on an understanding of local potential and opportunities for renewable or low carbon energy and existing or planned decentralised energy infrastructure. Where opportunities are identified, development will be required to contribute towards realising these opportunities subject to the Council and its partners undertaking further work that is required to explore the feasibility and development potential of projects or strategies in order to take them forward.

The Council, working with its partners, will seek to ensure that Enfield's future energy infrastructure needs are managed effectively by ensuring that the necessary infrastructure is in place to accommodate the levels of growth anticipated within the Borough.

Enfield's Development Management Document

DMD 51

Energy Efficiency Standards

All developments will be required to demonstrate how the proposal minimises energy-related CO2emissionsin accordance with the following energy hierarchy:

a. Maximising fabric energy efficiency and the benefits of passive design;

b. Utilising the potential for connection to an existing or proposed decentralised energy network in accordance with DMD 52 'Decentralised Energy Networks';

c. Demonstrating the feasibility and use of low or zero carbon technology in accordance with lDMD 53 'Low and Zero Carbon Technology'; and, where applicable,

d. Financial contributions to on, near or off-site carbon reduction strategies in accordance with DMD 54 'Allowable Solutions'.

Measures to secure energy efficiencies and reduce the emissions of CO2must adhere strictly to the principles of the energy hierarchy with each tier utilised fully before a lower tier is employed. Developers must submit detailed Energy Statements in accordance with DMD 49 'Sustainable Design and Construction Statements' to demonstrate how they have engaged with the energy hierarchy to maximise the energy efficiency of the proposal.

Specific targets for energy efficiency will apply to the following types of development:

Residential Development

The Council will require all major residential developments to achieve as a minimum:

a. 25% reduction in carbon dioxide emissions over Part L1A of Building Regulations (2010) in line with best practice to 2013;

b. 40% improvement from 2013 to 2016; and

c. Moving towards zero carbon from 2016.

Non-residential proposals

The Council will require major non-residential development involving the replacement or creation of new non-residential floorspace or a combination thereof to achieve as a minimum:

a. 25% reduction in Carbon Dioxide emissions over Part L2A of Building Regulation (2010) in line with best practice to 2013;

b. 40% improvement from 2013 to 2016;

c. As per Building Regulations; and

d. Moving towards zero carbon from 2019.

All of the reductions specified for residential and non-residential development above should be provided on-site. Where site constraints preclude attainment of the required reductions and/or the reductions are not technically feasible and this has been evidenced through the Energy Statement, in accordance with DMD 49 'Sustainable Design and Construction Statements' provisions for providing near-site or off-site reductions through a set of agreed allowable solutions or financial contribution will be required to fully off-set the shortfall.

For minor development, the Council will seek to encourage all residential or non-residential developments to achieve the above targets where it is demonstrated that this is technically feasible and economically viable.

Developers will be required to take account of unregulated CO_2 emissions within their energy statements and will be required to reduce energy consumption for these uses so far as practicable.

4. BASELINE ENERGY CALCULATIONS

A baseline total energy demand has been established for the proposed development. Reductions in demand due to energy conservation measures are considered and form the basis of the renewable energy strategy which follows.

Floor plans for the development have been used in conjunction with an outline accommodation schedule and building specifications to prepare initial preliminary SAP Calculations on a sample of unit types. SAP calculations have been carried out to Approved Document Part L1A 2013. The relevant energy loads have been collated from the full SAP calculation sheets and entered into a spread sheet that can be found in the appendices, which calculates the total energy and CO_2 demand.

Regulated Energy Demand is calculated from the energy associated with space heating, hot water and fixed electrical demands (for lights, fans and pumps).

Unregulated energy is the annual electrical energy demand from appliances and would be calculated using the methodology as suggested by SAP2012. SAP calculations are extended to allow for CO2 emissions associated with appliances and cooking, and to allow for site-wide electricity generation technologies.

Total Energy Demand for the development is calculated from the regulated energy demand figures given above and an additional energy demand associated with unregulated energy.

CO_2 emissions from appliances use equation L14

L14= E_A x $El_{ectricity}$/TFA

Where $El_{ectricity}$ is the emission factor for electricity (SAP 2012 Table 12)

CO_2 emissions from cooking uses equation L16

L16= (119 +24N)/TFA

Where N= 1+1.76x {1-exp (-0.000349x $(TFA-13.9)^2$} +0.0013x (TFA-13.9)

Total Energy Demand is used in the final analysis to determine the contribution which renewable energy technology makes to total energy requirements for the development once energy conservation measures have been considered.

Energy savings are measured in terms of a reduction in CO_2 emissions and kWh, which are calculated from their association with a particular fuel source. CO_2 Conversion Factors have been taken from Table 2, Building Regulations Part L1A (2013):

Table 2: Fuel Conversion factors

Fuel Source	CO_2 Conversion Factor (Kg/kWh)
Electricity	**0.519 (Displaced 0.519)**
Gas	**0.216**

4.1 CALCULATION OF BASELINE ENERGY AND CO2 EMISSIONS

Thermal insulation levels and air tightness standards for the baseline case are assumed to just meet the requirements of Part L (2013) of Building Regulations. The unit is assumed to have conventional gas boilers with efficiency of 88.6% to provide space heating and hot water.

Table 3: Predicted Carbon Emissions: Part L1A (2013) Compliant Unit (TER) including Non domestic

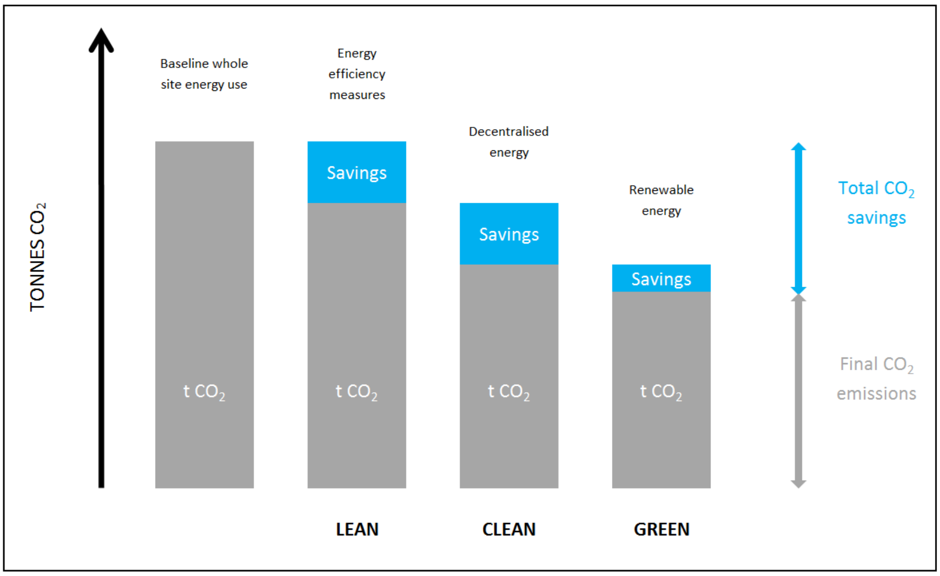
	Space Heating Demand (kWh/a)	Secondary Heating Demand (kWh/a)	Hot Water demand (kWh/a)	Energy from pumps and fans (kWh/a)	Energy from Lighting (kWh/a)	Energy from Appliances (kWh/a)	Totals
Part L1A 2013 Compliant Units	7,381	0	4,863	150	745	0	**13,139**
CO_2 Associated with total Energy Demand (kg/a)	1,594	0	1,051	78	387	0	**3,110**

5. Energy Hierarchy

The accepted standard approach to reducing carbon dioxide emissions in the built environment is as follows;

1. Reduce energy demand (be lean)
2. Supply energy efficiently (be clean)
3. Use renewable energy (be green)

Figure 2: Energy Hierarchy



5.1 Be Lean – Use Less Energy

Energy demand reduction provides the greatest opportunity for minimising a building's potential CO_2 emissions. Design strategies typically include building form and fabric measures (passive design) and energy efficient building services (active design). Focusing on form and fabric, in particular at an early stage in the building process, is often the most cost effective way to reduce energy and consequently CO_2 emissions.

As required by the energy hierarchy, the overall energy demand for the development will be reduced by implementing energy efficiency measures as far as practically and economically possible.

5.2 Regulated Energy

To reduce demand for space heating, emphasis has been placed on providing a very high standard of fabric and reducing heat loss through the building envelope. Approved Document Part L1A 2013 sets out the limiting fabric parameters for each of the building elements. Each stated value represents the area-weighted average U-value. Table 1 details the proposed U-values for the development along with anticipated percentage improvements over the maximum allowable average weighted U-values in Part L1A 2013. A strong emphasis has been placed on improving the building fabric with the minimum improvement over the average weighted U value being at least 25% to ensure the development's heating and cooling demands are reduced.

To further minimise heat loss through the building envelope, air leakage will be made a priority. The airtightness of the dwellings will be set to a level of $5m^3/h/m^2$. Such a level of airtightness, along with the proposed enhanced fabric measures, will increase comfort and warmth as well as save future residents money on energy bills.

Repeated thermal bridges such as timber studs or mortar joints are already covered by U value calculations. Non-repeating thermal bridges are intermittent and occur at specific points in the construction. They are often caused by discontinuities in the thermal envelope. They commonly occur around openings and other instances where materials of different thermal conductivities form part of the external envelope, as illustrated in Figure 3.

Accredited construction details for all wall junctions will be specified to minimise the effects of non-repeating thermal bridging and reduce heat loss further. By specifying and ensuring that ACDs are designed into the build, CO_2 emissions can be reduced by up to 5%.

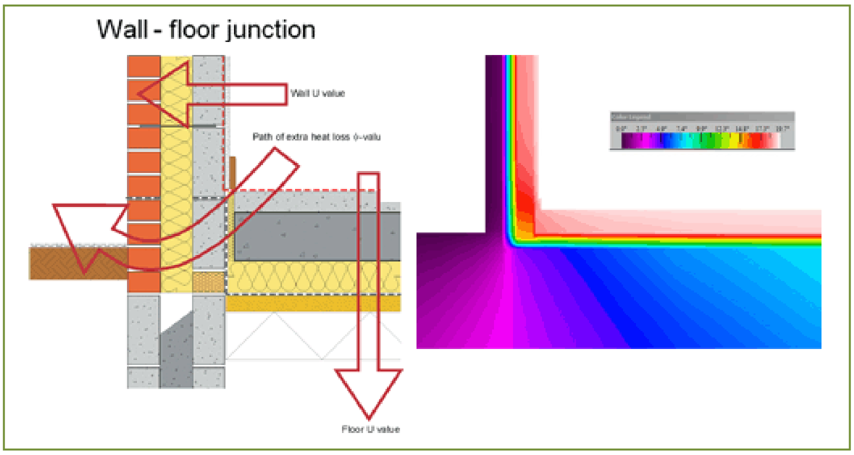
The use of ACDs will provide a continuous ‘blanket’ around the dwellings, minimising gaps in the insulation.

All dwellings will be specified to have 100% of their lighting outlets classed as low energy, thus reducing the future homeowner’s electricity bill. Orientation and layout have also been given consideration to help limit heat loss in winter and maximise the potential for free cooling in summer, to limit the risk of overheating.

Overall the proposed passive design measures for this development will provide households with a resource to reduce their energy demand and heat their homes to a satisfactory standard at an affordable cost.

The proposed specification will provide a robust long term solution, future proofing the dwelling for years to come.

Figure 3: Wall-Floor Junction Detail



This image, alongside showing the temperature distribution for the same junction, is taken directly from thermal modelling software

5.3 Fabric Specification

The indicative U Values for the scheme are shown in the table below along with the anticipated percentage improvement over the maximum allowable average area weighted U Value in Part L1A 2013.

Table 4: Proposed U Values - Houses

Element	Average Weighted U Value as Part L1A 2013	Proposed U Value/other	Improvement
External Walls	0.30	0.24	20.00%
Party Wall	0.20	0	100.00%
Floor	0.25	0.12	52.00%
Cold Roof	0.20	0.11	45.00%
Warm/Flat Roof	0.20	-	100.00%
Windows	2.0	1.2	40.00%
Air Tightness	10	5	50.00%
Average Y Value	0.15	0.07	53.33%

5.4 Supply energy efficiently - Be Green – Decentralised Energy

Options for heat supply have been considered below:

Combined Heat and Power

There are many benefits of decentralised heat generation and Combined Heat and Power (CHP) in terms of cost and CO_2 emissions savings. However, technology such as this is more significant for larger developments, ideally complimented with some non-residential use of heat and electricity. The proposed development size of 2 dwellings is at the low end of what the industry tends to view as viable for such systems. The development is for residential dwellings only and this will result in 'peaky' thermal demands with little anchor load to enable efficient operation of gas fired CHP. This option also risks the potential to increase costs to residents.

The site is neither sufficiently dense nor large enough to warrant investment from 3rd party managing agents or Energy Supply Companies (ESCos). The proposed development would need to be run by an independent agent/company and there would be very little if any interest among existing ESCos in servicing such a small-scale system. Even if it was possible, the cost of managing fuel procurement, customer billing, operation and maintenance would lead to disproportionally and unnecessary high service charges to residents compared to the provision of heat from individual gas boilers.

Multiple Connections from the primary heat main to each house would increase the distribution losses on the heat network as well as increase capital costs for the energy infrastructure. The Installation of a communal heating system would also risk the site becoming isolated limiting any potential connection to a larger district network in the near future to deliver low carbon heat more cost effectively.

Overall this option has been discounted because communal gas boilers do not offer any efficiency gains over individual gas condensing boilers once distribution losses are accounted for.

Individual Gas Boilers

Individual gas condensing boilers have many advantages. They can be highly efficient, have much lower NOx emissions and lower installation costs. Reliability and maintenance requirements are well understood ensuring low costs of installation, operation and maintenance. Homeowners are also very familiar with the concept of gas central heating.

It is proposed that highly efficient mains gas condensing boilers with efficiencies of circa 88.9% SEDBUK2009 are to be installed. The boilers will incorporate optimum start, weather compensation and full zone controls to ensure efficient operation. The cylinders will be highly insulated to ensure that the heat loss per day is kept to a minimum.

5.5 Proposed Heating and ventilation systems

The following specification for the heating and ventilation is proposed:

Houses

Heating:	Condensing combi gas boiler- Ideal Logic System Efficiency 88.9% SEDBUK 2009
Secondary Heating:	None
Heating Hot Water Controls:	Programmer, room thermostat and TRVs Weather compensation
Flue Gas Heat Recovery:	No
Cylinder:	N/A
Heat Loss:	N/A
Ventilation:	System 3 fans Decentralised MEV Titon Solitude
Waste Water Heat Recovery:	None

Unregulated energy

Unregulated energy will be reduced across the site by ensuring:

- All white goods, where supplied by Mr & Mrs Panayiotou will conform to EU energy labelling scheme.
- All external lighting will be low energy and will have daylight and/or PIR sensors to avoid wastage.

5.6 PROPOSED HEATING AND VENTILATION SYSTEMS

Using the energy efficiency improvement measures as indicated, a revised predicted energy demand can be calculated to show:

Table 5: Predicted Total Energy Demand: Improved building fabric, controls, and gas boilers

	Space Heating Demand (kWh/a)	Secondary Heating Demand (kWh/a)	Hot Water demand (kWh/a)	Energy from pumps and fans (kWh/a)	Energy from Lighting (kWh/a)	Energy from Appliances (kWh/a)	Totals
Part L1A 2013 Compliant Units (TER)	7,381	0	4,863	150	745	0	**13,139**
CO_2 Associated with total Energy Demand (kg/a)	1,594	0	1,051	78	387	0	**3,110**
Part L1A 2013 Actual Unit (DER)	7,510	-	4,072	209	745	0	**12,536**
CO_2 Associated with total Energy Demand (kg/a)	1,622	-	880	109	387	0	**2,998**

When compared against Part L1A 2013 Building Regulations not including unregulated energy:

- Total CO_2 demand for the residential units is calculated to be 2,998 kg per annum. This represents a saving of **3.60** % over the part L1A 2013 compliant figure of **3,110** kg per annum.

- Total Energy demand for the residential units is calculated to be 12,536 kWh per annum. This represents a saving of **4.59 %** over the part L1A 2013 compliant figure of **13,139** kWh per annum.

5.7 Be Green – Low Carbon and Renewable Energy Generation Options

The following options to supply low carbon and renewable energy generation have been explored and discounted based on the following reasons:

Wind Turbines
Wind turbines have been discounted due to concerns over reliable wind resources. The use of wind turbines are likely to present aesthetic as well as nuisance issues.

Biomass Boilers
Unsuitable for this development due to fuel storage issues and increased traffic of heavy vehicles supplying biomass. Individual biomass boilers in the houses are be technically feasible, but would be commercially unviable when compared to alternative solutions at the required level of energy abatement.

Air Source Heat Pumps (ASHP)
Air source heat pumps could be utilised but would require outdoor space for the fan-coil units to each dwelling. These outdoor units would be difficult to conceal without affecting the aesthetics of the building facades.

Ground Source Heat Pumps (GSHP)
Discounted on the grounds of costs and available space. Incompatible with individual gas boilers and blocks of apartments.

Solar Thermal
Unsuitable for blocks of flats and low carbon reduction efficiency compared to photovoltaic systems. Solar hot water systems for flatted blocks are only suitable where a central boiler plant room is provided to accommodate a central thermal store. Solar hot water systems are ideally suited to houses; however as mentioned, this technology is less cost-effective than Solar PV technology.

Solar Photovoltaics (PV)
Solar energy could be a solution to reduce CO_2 emissions to satisfy building regulations, however the building fabric has been improved to ensure compliance is met without the need for renewables.

5.8 PROPOSED LOW CARBON AND RENEWABLE OPTIONS

The Low and Zero carbon energy solution proposed to meet the planning condition is to utilise solar photovoltaic panels.

It is proposed that **2.4 KWp (10No)** Photovoltaics are installed as detailed in the following section.

- Install 5 No 240wp solar photovoltaic panels to each house.
- Total kWp per house 1.2
- Total kWp for development 10

Sanyo 200w Panel

- **Height 1.58m**
- **Width 0.86m**

Solar PV technology offers advantages over other low carbon and renewable energy technologies for the following reasons:

Density/scale

- Solar technologies are modular and can be sized to available space constraints and would easily be integrated into the roofscape of the proposed development.
- Solar PV technologies typically require 2-3 times more space to generate the equivalent energy or abate similar emissions as solar thermal panels, but they can be sized to the maximum available roof space.

Technology Integration

- Solar technologies can be easily integrated into the built environment using available roof space. Since they are modular and easily fixed to buildings they can access solar irradiation in almost any location. The technologies can be integrated on almost any roof structure or vertical façade without compromising structural or aesthetic requirements.
- Solar PV systems are generally connected to the dwelling or block via an inverter and any excess generation not utilised on-site is exported seamlessly to the local grid.

Cost-effectiveness

- Solar PV costs have reduced dramatically in the last 2-3 years in the UK, due to increasing demand for the technology driven by sustainability requirements and the Government's stimulus package known as the Feed-In Tariffs (FiTs) scheme which rewards renewable electricity generation with premium tariffs.

CO_2 Abatement Capacity

- Solar PV generates electricity and abates ~2.5 - 3 times more CO2 than an alternative renewable energy technology that displaces use of gas (e.g. solar hot water technology and/or biomass boilers). Solar PV is well proven with good historical data showing that its performance credentials generally match or exceed manufacturers' claims/modelled generation profiles.

5.9 EFFECTS OF INTRODUCING RENEWABLES/LOW CARBON TECHNOLOGY

SAP12 confirms that the amount of energy produced by solar or PV panels can be calculated based on its orientation, pitch and over shading factor.

The predicted CO_2 and energy savings by the introduction of solar panels are summarised as below:

Table 6: Solar contribution to hot water via SAP12

Solar Contribution to domestic hot water is given by

$$Q_s = S \times Z_{panel} \times A_{ap} \times n_0 \times UF \times f(a_1/n_0) \times f(V_{edd}/V_d)$$

Where:

Qs	=	solar input kWh/year
S	=	total solar radiation on collector, kWh/m2/year
Z_{panel}	=	overshading factor
A_{ap}	=	aperture area of collector m2
n_0	=	zero loss collector efficiency
UF	=	Utilisation factor
a_1	=	linear heat loss
$f(a_1/n_0)$	=	collector performance
V_{edd}	=	effective solar volume litres
V_d	=	daily hot water demand litres
$f(V_{edd}/V_d)$	=	solar storage volume factor

Table 7: Electricity produced by photovoltaic panels

The electricity produced by the PV module in kWh/year is

$$0.8 \times kWp \times S \times Z_{pv}$$

where S is the annual solar radiation from Table H2 (depending on orientation and pitch) and Z_{pv} is the overshading factor from Table H3.

Table 8: Table H2: Annual solar radiation extract from SAP12

Tilt of collector	Orientation of collector				
	South	SE/S	E/W	NE/NW	North
Horizontal	951				
30°	1,080	1,029	908	769	720
45°	1,068	1,004	853	677	597
60°	1,007	939	779	588	393
Vertical	766	719	590	438	364

The predicted CO_2 and energy savings by the introduction of the photovoltaic panels can be summarised as.

The photovoltaic panels to the houses will provide **156.39** kWh/year/m2. See table below.

This will abate the following:

Table 9: Energy and CO2 abatement

Item	Amount	Metric
Energy	1,976	kWh/year
CO_2	1,026	$kgCO_2$/year

Table 10: Energy produced by PV panels to the house

Proposed PV Allocation						
Orientation	No. of Plots	No of Panels per plot	Pitch	Solar Radiation per m2	Total Energy abated kWh	Total CO2 abated kg CO2
South	0	0	45	1068	0	0
SE/SW	2	5	30	1029	1976	1026
E/W	0	0	45	853	0	0
NE/NW	0	0	45	677	0	0
North	0	0	45	597	0	0

PV Summary	
WP Cell	0.240
Size m2	1.43
Total No of PV Cells	10.00
Total M2 (estimated)	14.28
Total KWp Output	**2.40**
Total CO2 Saving Kg CO2	**1,026**
Total Energy Saving Kwh	**1,976**

The predicted CO_2 and energy savings by the introduction of the photovoltaic panels can be summarised as.

The photovoltaic panels to the houses will provide **156.39** kWh/year/m2.

6. Conclusions

The fabric specification has been enhanced significantly. Emphasis has been placed on the attention to detail around non repeating thermal bridges to ensure that heat loss is further reduced and that an airtight dwelling is achieved. An efficient mechanical ventilation system is proposed that will introduce fresh air to the building whilst recovering significant heat to ensure the internal comfort of the building is maintained.

The available options for delivery of energy have been appraised and highly efficient individual condensing gas boilers are the optimal method of supplying the homeowners with efficient, cost effective space heating and hot water.

The heating design will be enhanced by specifying full zone and optimum start controls to ensure that the homeowners have an effective, easy to control system. A high percentage of internal lights will be low energy which will reduce energy and CO_2 emissions further.

CO_2 has been reduced on the scheme through the use of renewables and low carbon technolgy.

Total Energy and CO_2 savings across the site - Regulated Energy only, are summarised in the table below as follows:

Table 11: Predicted CO2 and Energy Savings

Energy and $C0_2$ Savings			
	Description	Amount	Unit
Regs & Improvements (TER's)	Total site CO_2 demand Part L1A 2013 (TER)	3,110	$KGCO_2$/Year
	Total site Energy Demand Part L1A 2013 (TER)	13,139	kWh/Year
	Actual Site CO_2 demand 2013 (DER)	2,998	$KGCO_2$/Year
	Actual Site CO_2 demand 2013 (DER)	12,536	kWh/Year
	Percentage CO_2 improvement through fabric/control	3.6	%
	Percentage energy improvement through fabric/control	4.59	%
Site Summary	Reduction in energy through fabric	1,976	kWh/Year
	Reduction in CO2 through fabric	1,026	$KGCO_2$/Year
	Energy abatement	15.04	%
	CO2 abatement	32.99	%
	Total CO_2 Improvement over baseline	36.59	%

Fabric Energy Efficiency measures reduce CO_2 emissions by **1,026** $KGCO_2$/Year.

This represents a **3.6** % saving over a 2013 baseline unit.

The total CO_2 reduction including fabric and renewables is **3.6 %**.

The reduction in Carbon Dioxide and energy meets the requirements of London Borough of Enfield.

7. Appendices

Table 12: Proposed Material Specification

Element			U Value/Note	Specification
Fabric U Values	Roof	Cold Roof	0.11	400 mm mineral wool (λ = 0.043w/mK)
		Sloping (warm)	0.11	195mm of Kingspan thermapitch TP10 between rafters, 40mm of Kingspan thermapitch TP10 fixed across underside face.
		Flat Roof	-	-
	Walls	External Wall	0.24	102.5mm Brick 100mm cavity with fully filled bead (λ = 0.032w/mK) 100mm thermalite 4 or 7 N blocks (λ = 0.11/019w/mK) 12.5mm plasterboard
		Party	0.00	This is a fully filled cavity wall effectively sealed all sides
		Lintels		IG lintels or similar
		Corridors	-	-
		Block and Beam ground floor	0.12	Rackham's beam & block, 175mm deep beams in filled with thermalite 4n floor blocks, (0.16w/mk) 150mm of Kingspan TF70, 70mm floor screed.
	Windows		U Value 1.20 G Figure 0.43	Double Glazed
	Doors		1.20	I.G or similar front doors to houses.
	Thermal Bridging		Y-Value	Measured Lengths by AC - Psi Values as per Constructive Details

7.1 THE PREDICTED ENERGY AND CO2 DEMAND

Table 13: Predicted Energy Demand

Energy	Include Unregulated Energy			No	Building Regs Version		2013	Predicted Energy Demand				
Type	Dwelling Name	TFA	No of Types	Main Heating Fuel Requirement (DER)	Secondary Main Heating Fuel Requirement (DER)	Secondary Heating Fuel Requirement (DER)	Water Fuel Requirement (DER)	Electricity Pumps Fans Requirement (DER)	Electricity Lighting Requirement (DER)	Unit Total	Unregulated Energy Demand	Development Total
1	15	80.4	1	2,873	-	-	1,996	102	360	5,332	0	5,332

Table 14: Predicted CO2 Demand

CO2	Include Unregulated Energy			No	Building Regs Version		2013	Predicted CO2 Demand				
Type	Dwelling Name	TFA	No of Types	Main Heating Fuel Requirement (DER)	Secondary Main Heating Fuel Requirement (DER)	Secondary Heating Fuel Requirement (DER)	Water Fuel Requirement (DER)	Electricity Pumps Fans Requirement (DER)	Electricity Lighting Requirement (DER)	Unit Total	Unregulated Energy Demand	Development Total
1	15	80.4	1	621	-	-	431	53	187	1,292	0 -	1,292