BrooksDevlin

248 Kilburn High Road, NW6 2BS

Energy Efficiency Strategy

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1 Executive Summary

The proposed development of 14 new flats at 248 Kilburn High Road will be constructed to the exemplary Passivhaus standard. This will deliver carbon dioxide emission reductions of 10.4 tonnes/yr compared to 6 tonnes/yr if the scheme were designed to satisfy the energy hierarchy of the London Plan.

This report defines the proposed energy efficiency strategy for the development and details the following key outcomes of the research and analysis underpinning these proposals:

1. The London Plan Energy Hierarchy encourages the application of fabric and building services efficiency measures (Be Lean) prior to the implementation of local decentralised energy source (Be Clean) and on-site zero carbon energy sources. (Be Green). This report explains why we have chosen to focus on the 'Be Lean' measures.

2. The hierarchy is based on the use of SAP 2009 as the calculation tool for predicting energy consumption. However as detailed in this report, SAP (a compliance tool) is inadequate for predicting actual energy use.

3. UK monitoring and measurement has demonstrated significant differences between SAP predictions and as built performance. This performance gap has shown that it is not uncommon for actual measured heat loss to be at least 50% greater than predicted.

4. It is proposed therefore that SAP is not fit for purpose to accurately assess energy consumption, carbon emissions and the relative benefits of efficiency measures.

5. The result is a calculation methodology, enshrined in planning policy that favours on-site renewable energy technologies prior to the application of best practice efficiency measures. The use of SAP is therefore contrary to the very purpose of the London Plan Energy Hierarchy.

6. Extensive Europe-wide in-use monitoring of performance has demonstrated that due to the rigour of the design, procurement and construction processes required to meet the Passivhaus standard, buildings perform as predicted (within an acceptable margin).

7. The calculations completed for this report conclude that adoption of the Passivhaus standard will deliver significant carbon emission reductions in comparison to a conventional 'Be Lean, Be Clean, Be Green' approach.

8. A conventional Be Lean, Be Clean, Be Green approach, including 10.5KWp of PV delivers a maximum emissions reduction compared to a base case Part L1a compliant scheme of 18% (as calculated by the more accurate Passivhaus Planning Package).

9. In contrast, the scheme as proposed adopts an exemplary fabric first approach and delivers a 32% reduction in total carbon dioxide emissions compared to the same base case Part L1a compliant scheme (as calculated by the more accurate Passivhaus Planning Package).

10. Furthermore, the quality assurance process incorporated into Passivhaus certification will deliver a scheme where the actual space heating consumption will be within an acceptable margin (+/-10%) of that predicted at design stage. This is compared to typical UK practice where actual performance can be at least 50% worse than predicted.

11. It therefore proposed to develop the scheme to meet the Passivhaus certification standard in lieu of the London Plan Energy Hierarchy requirements. It has been demonstrated that this will result in lower annual carbon emissions.

12. Notwithstanding the above, it can also be confirmed (via SAP modelling) that adoption of the Passivhaus standard as detailed in this report will comfortably satisfy the mandatory performance requirements for Code for Sustainable Homes Level 4.

2 Introduction

This Energy Statement has been prepared by Brooks Devlin Ltd on behalf of Studio 246 Media Ltd in support of a full planning application for the proposed development at 248 Kilburn High Road, London NW6 2BS.

Brooks Devlin is an environmental design consultancy based in West Dorset, established in May 2009 by Directors Julian Brooks and Nick Devlin. Together Julian and Nick combine 17 years of industry experience in the environmental building sector. Brooks Devlin offers specialist consultancy services to developers, architects and homeowners that are exploring or committed to the concept of low or zero carbon development.

Brooks Devlin is a member of the Association of Environmentally Conscious Building, The Good Homes Alliance and The Passivhaus Trust.

The analysis presented in this document is based on the following information provided by the client and design team:

- P1112_P-100 / Site Location Plan
- P1112_P-101 / Site Plan
- P1112_P-200-205 / Floor Plans
- P1112_P-210 / Landscaping Plan
- P1112_P-300-306 / Elevations / Sections

2.1 Planning Policy Context

The scheme is required to satisfy the energy performance standards defined in Chapter 5 of The London Plan 2011. This incorporates a number of policies that seek to mitigate climate change by reducing energy consumption and carbon dioxide emissions arising from new development.

This report specifically aims to address the following policies from The London Plan 2011:

1. Policy 5.2: A minimum 25 per cent improvement over Part L1a 2010 requirements (equal to CfSH Level 4) for the period 2010-2013 inclusive.

2. Policy 5.3(c): Major development proposals should meet the minimum standards outlined in the Mayor's supplementary planning guidance and this

should include measures to achieve other policies in this plan and the following sustainable design principles (in the context of this energy statement):

- Minimising carbon dioxide emissions across the site, including the building services (such as heating and cooling systems).

- Avoiding overheating and contributing to the urban heat island effect.

3. Policy 5.6(a): Development proposals should evaluate the feasibility of Combined Heat and Power (CHP) systems, and where a new CHP system is appropriate also examine opportunities to extend the system beyond the site boundary to adjacent sites.

4. Policy 5.6(b): Major development proposals should select energy systems in accordance with the following hierarchy:

   - Connection to existing heating or cooling networks
   - Site wide CHP
   - Communal heating and cooling

5. Policy 5.7: Para 5.42 There is a presumption that all major development proposals will seek to reduce carbon dioxide emissions by at least 20 per cent through the use of on-site renewable energy generation wherever feasible.

Note that the policy requirement to cut carbon dioxide emissions by 25 per cent over Part L1a 2010, it is important to distinguish between regulated and un-regulated emissions. Policy 5.2 gives the following guidance for the assessment of carbon dioxide emissions:

> *"A calculation of the energy demand and carbon dioxide emissions covered by the Building Regulations (regulated emissions) 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 (un-regulated emissions) (see paragraph 5.22) at each stage of the energy hierarchy"*

2.2 Development Proposals

The development proposals are for 14no. dwellings to be constructed in two separate blocks. Block A will contain 4no. 2bed flats ranging from 61m² to 73m². Block B/C is located at the rear of the site incorporates nine dwellings in total, ranging from 51m² 1 bed flats to 96m² 3 bed flats. The front of Block A faces south west onto Kilburn High Road and is bound by existing adjacent properties.

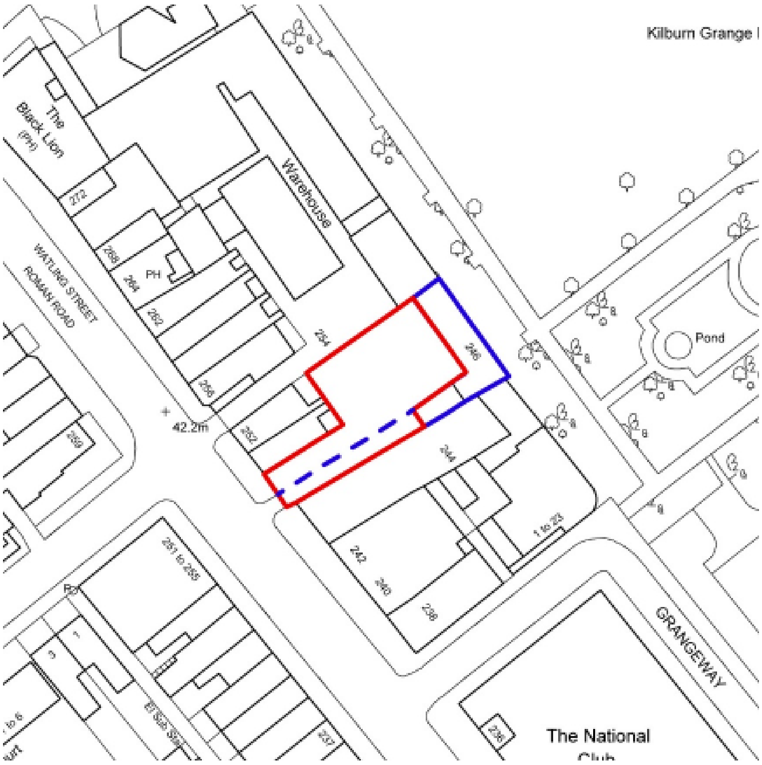

Figure 1: Site Location Plan

3 Performance Gap

Constructed buildings should function and perform as originally designed. However, there is a well-recognised disparity between designed and as-built performance, known as 'the performance gap' (Zero Carbon Hub, 2010). This describes the difference in measured performance compared to that anticipated at the design stage. There are a number of key factors influencing the performance gap in residential buildings:

- Inaccuracy of SAP (Standard Assessment Procedure)
- Procurement methods
- Construction quality control (thermal bypass)
- Post-construction verification

The report 'Closing the Gap between Designed & Built Performance' (Zero Carbon Hub, 2010) summarises extensive monitoring results of 16 dwellings completed between 2008 and 2010. Each of the dwellings was subjected to a co-heating test to determine the actual heat loss for comparison to the design heat loss. A co-heating test involves continuously heating an unoccupied dwelling to a set temperature and simultaneously monitoring the external temperature. By recording the energy required to maintain the internal temperature, it is possible to determine the actual heat loss in W/K (Watts/Kelvin) compared to the design value predicted by SAP. (Wingfield, 2010).

The houses monitored represented a range of dwelling types typical of current UK construction design and practice, but with particular emphasis on schemes/dwellings aiming for improved levels of energy efficiency (i.e. generally Code for Sustainable Homes Level 4 & 5).

The results demonstrated the following key results:

- In all cases, the measured heat loss was greater than the predicted.
- Only 5 out 16 dwellings had measured results within a reasonable range (10-15%) of the predicted performance
- A further 6 dwellings had measured performance between 45-80% worse than predicted
- 5 dwellings had measured performance of between 80-125% worse than predicted.

The discrepancy between the design standards and as-built performance results in a number of significant issues:

- Occupant energy costs are significantly higher than predicted
- The resultant carbon emissions are much greater than predicted
- Failures in construction quality control can result in localised thermal bridging and condensation / mould issues.

3.1 Summary of SAP Performance Failures

SAP was developed as a compliance tool and not a design tool. Many of the assumptions used within the calculations does not incentivise the adoption of a fabric first energy efficiency approach. Whilst issues of construction defects could fill entire books, the key SAP calculation issues can be summarised as follows

1. SAP is based on the BREDEM (Building Research Establishment Domestic Energy Model) which has been validated against a small sample of dwellings in a single geographic location. (Kelly, et al., 2012)

2. SAP uses a single climate file for all locations within the country. Whilst this remains appropriate for assessing compliance with national Building Regulations, these results are not representative of actual energy consumption.

3. SAP calculations are independent of actual occupancy levels, user behaviour and regional weather data.

4. Current Building Regulations compare the proposed building against a notional building of exactly the same floor area and external surface areas. This does not reward any efficiency of built form.

It is therefore contended that whilst SAP remains the appropriate tool for demonstrating compliance with UK Building Regulations, it significantly underestimates space heating energy use. This results in a false perception that reductions in carbon emissions from fabric efficiency measures are significantly lower than reality. The outcome is energy efficiency strategies that underestimate the carbon emissions from buildings and a subsequent optimistic assumption of the relative emissions reductions from on-site low or zero carbon technologies.

4 What is Passivhaus?

Passivhaus is a low energy building standard developed by the Passivhaus Institut in Darmstadt, Germany. The first buildings were constructed in 1991 and over the last 20 years, more than 20,000 buildings have been constructed to the standard and approximately a quarter of these have been formally certified.

The standard defines a maximum space heating or cooling demand whilst maintaining excellent indoor air quality and comfort levels. The maximum space heating demand is 15kWh/m².yr and represents approximately a 75% reduction compared to 2010 UK Building Regulations compliance for dwellings.

The standard can be applied to nearly all building types including residential developments, retail, care-homes, hospitals, offices, schools and swimming pools.

The standard requires the adoption of high levels of insulation, exemplary airtightness, triple glazing and mechanical ventilation with heat recovery.

Unlike SAP, Passivhaus measures and assesses the actual energy efficiency of the building, rather than running costs or carbon efficiency of the fuels used. Therefore, it is more suited for use as a design tool. The calculations are completed in the Passivhaus Planning Package (PHPP) and this tool facilitates the completion of both certification and predicted actual fuel consumption. The former is based on standardised assumptions for occupancy levels and behaviour and the latter is based on the actual design values.

4.1 Minimum Performance Specification

The Passivhaus standard rewards the design of efficient massing and forms by recognising the energy savings achieved from both compact buildings and orientation. The minimum performance standards required to achieve Passivhaus are:

- Maximum U-values of 0.15W/m².k for opaque fabric
- Thermal bridge free construction
- Maximum U-values of 0.85W/m².k for windows (installed)
- Maximum air leakage rate of 0.6 air changes/hour (ACH^{-1}) @ 50Pa.
- Minimum installed efficiency for MVHR of 75%

Passivhaus buildings are engineered in relation to their specific location and climate. The result is a contextually appropriate fabric specification that reflects both the location and the built form of the building. Therefore, a specification that it appropriate to Cornwall is unlikely to be adequate for

Scotland or indeed Germany. It is on this basis that the specification detailed above defines maximum acceptable U-values and not absolute values.

4.2 Advantages of Passivhaus

A formally certified Passivhaus building requires exemplary attention to detail through all planning, design, procurement and implementation stages. The calculations are completed by the designer / PH consultant during design and construction and then must be re-calculated and verified by the certifying body. The certification process also requires the completed pressure test certificates, detailed commissioning information for the MVHR systems and extensive site photos to demonstrate it has been constructed as per the drawings. These photos are of particular importance in determining that insulation has been installed correctly thus reducing the risk of thermal bypass.

In short, the quality assurance process is more exacting than typical practice in the UK, resulting in greater confidence that the as designed performance will be achieved. This provides confidence that the carbon savings proposed during the planning application are more likely to be realised in operation.

Furthermore, occupants also benefit from:

- Reduced heating use – lower bills and lower emissions
- Enhanced thermal comfort standards for occupants
- Reduced risk of poor internal air quality and associated health issues.

4.3 Passivhaus Performance in Use

In contrast to the limited validation of SAP within the UK, there are numerous monitored studies of Passivhaus projects in use across Europe (Schnieders, 2003) and a growing number from within the UK (Siddall & Trinick, 2013) (Ingham, 2013). Whilst the number of monitored dwellings remains less than is statistically significant, it is suggested that nonetheless the PH methodology and PHPP calculation tool have undergone a greater level of validation testing and monitoring than current version of SAP.

The results of co-heating tests (Siddall & Trinick, 2013) detail measured heat loss in 5no. Passivhaus dwellings in the range of 4-10% greater than predicted via calculation compared to the 10-125% margin described in Section 3. However, it must be noted that because the predicted heat loss in the Passivhaus dwellings is so low, the actual (as opposed to relative) difference between predicted and actual performance is less than 5W/K in all cases.

It is therefore contended that adoption of the Passivhaus methodology not only provides exemplary energy efficiency targets but also a reliable quality assurance methodology to ensure that performance in use is close to the predicted standards.

5 Methodology

The following methodology has been adopted in order to determine the predicted energy consumption and associated carbon emissions reduction arising from the development. This follows the established methodology for demonstrating compliance within the London Plan with the exception that, in order to provide a more detailed and accurate assessment of energy usage, SAP 2009 has been replaced with PHPP 2012 as the modelling tool.

The methodology adopted is as detailed below:

1. Complete PHPP assessments for the development as proposed to determine total predicted energy consumption, including unregulated energy use (appliances and cooking).

2. Prepare 'base case' PHPP assessment, assuming typical thermal performance standards and associated building services if built to current Part L1a standards.

3. Assess the predicted carbon emissions for the proposed and base case scenarios using SAP 2009 carbon intensity values for mains gas and electricity.

4. Ascertain maximum carbon reductions available to base case scenario through on-site low or zero carbon technologies.

5. Compare predicted total Passivhaus carbon emissions to those for base case including on-site renewable energy technologies.

For consistency, the electricity consumption calculations for cooking and appliances have adopted the same efficiencies for both the PH compliant and base case models. It is recognised however, that if constructed to meet current Part L standards, the plug loads for the base case option may be higher than for Passivhaus. However, the level of uncertainty surrounding this means that it is simpler to assume the same performance for both scenarios. An allowance for lift energy consumption, in accordance with the draft ISO 25745-1 standard has been included in the calculations.

6 Development Specification

The following sections details the specifications used for the comparative modelling of the Passivhaus proposals and the base case scenario.

6.1 Be Lean - External Fabric Standards

Table 1 below details the thermal performance standards adopted for the modelling and energy comparison. A basic, enhanced and Passivhaus specification were assessed. Note that an air change rate of 4.5 under the base case is equal to a pressure test result of c. $4m^3/m^2$@50Pa and represents good practice for conventional non-Passivhaus developments. The U-values adopted are not based on a specific build system but can be accommodated within the envelope thicknesses included in the planning drawings. An appropriate allowance for thermal bridging has been included in both calculation. The scheme also incorporates green roof finishes as detailed on the plans.

Item	Part L1a Minimum	London Plan 'Be Lean'	Proposed Passivhaus	Metric
Ground Floor	0.18	0.15	0.12	W/m².k
Upper Floors	0.18	0.15	0.12	W/m².k
External Walls	0.25	0.21	0.11	W/m².k
Party Walls	0.00	0	0.00	W/m².k
Roof	0.16	0.12	0.10	W/m².k
Airtightness	3.00 *	3.00 *	0.60	ACH

Table 1: Modelling Thermal Performance Standards

Table 2 below details the glazing performance adopted for the assessment. Note that where two values are provided in a single cell, these represent the values for the fixed light / opening windows.

Item	Base Case	Proposed Passivhaus	Metric
Frame U-value	1.08 / 1.17	1.08 / 1.17	W/m².k
Frame width	78 / 94	78 / 94	mm
Glass U-value	1.10	0.53	W/m².k
Glass g-value	0.71	0.5	-
Glass Ψ Value	0.037	0.037	W/m.k
Installation Ψ Value	0.04	0.04	W/m.k

Table 2: Glazing Specifications

6.2 Be Lean - Building Services

The following building services are proposed for the scheme:

- High efficiency combi-gas boilers with radiators
- Heat recovery ventilation (Zehnder Comfoair 200)
- Natural ventilation adopted for the base case scheme
- 100% Low-energy lighting
- Lift energy consumption from manufacturers data

The MVHR is only proposed for the Passivhaus scenario.

The PH space heating demand calculation is independent of the specified heating system and fuel source. These only impact the Primary Energy (PE) calculation within the PHPP. Formal PH certification requires a PE compliance value of no greater than $120kWh/m^2.yr$. Each unit of energy consumed by the development is multiplied by the fuel source Primary Energy Factor. The PE Factor for electricity and mains gas are 2.6 and 1.1 respectively. Therefore $10kWh/m^2.yr$ space heating demand equals $26kWh/m^2.yr$ Primary Energy if provided by electricity and $11kWh/m^2.yr$ if delivered by gas.

6.3 Be Clean

As per Policy 5.6(b): Major development proposals should select energy systems in accordance with the following hierarchy:

- Connection to existing heating or cooling networks
- Site wide CHP
- Communal heating and cooling

There are currently no district heat networks within a suitable connection distance of the development proposals. Furthermore, the limited thermal demand from Passivhaus buildings also limits the financial viability and associated emissions reduction that are available from such schemes. Therefore, connection to a communal or district system has been discounted at this stage.

Furthermore, the application of CHP to small scale residential only developments is known to deliver limited carbon reductions. This is due to the low summertime thermal base-load associated with residential only schemes. This situation is exacerbated in Passivhaus schemes where the winter thermal base-load is not significantly higher.

Emission reductions from CHP are achieved by generating electricity simultaneously to meeting a minimum thermal base-load. It is contended that the thermal base-load for the scheme shall be so low as to provide negligible carbon savings. Therfore CHP has been discounted for the scheme.

6.4 Be Green

The following technologies have been considered for on-site energy generation:

Biomass Boilers

A biomass boiler would be unsuitable for the site since there is no space for a large fuel store and plant room. Furthermore, current research is demonstrating that biomass boilers result in carbon dioxide emissions greater than coal at point of use. (Pelsmakers & de Selincourt, 2013). Therefore, they are not considered appropriate for the scheme.

Solar Water Collectors

The proposed design presents a number of challenges for the integration of solar thermal collectors, specifically the distance between the potential collector locations and the conflict with the desire to use some roof areas as terraces. The length of pipe-runs will result in significant pumping energy and is therefore not currently considered suitable for the scheme.

Ground Source Heat Pumps

There is insufficient space on the site to accommodate either horizontal or vertical boreholes due to the minimum spacing required from foundations. Therefore ground source heat pumps are not considered viable.

Wind Turbines

Urban wind turbines are not considered a viable option due to limited wind speeds and associated potential noise issues.

Photovoltaics

Photovoltaics are considered a viable option for the scheme and will be considered further.

7 Modelling Results

The following Sections detail the results of the comparative energy modelling completed for the scheme. This will identify the predicted energy consumption and associated carbon emissions under the following scenarios:

- Part L1a statutory minimum requirements
- London Plan 'Be Lean, Be Clean, Be Green'
- The proposed Passivhaus standard

The thermal performance standards required to meet Part L1a of the Building Regulations were determined using SAP modelling software. These thermal performance standards were then transferred to the PHPP calculations.

For the purpose of simplicity, it has been assumed that the DHW and electricity (plug loads) for all three modelled scenarios will be identical. This allows for a direct comparison of the impact of improved thermal performance standards alone. In the first instance, energy consumption is reported in kWh/m².yr for both Blocks A & B/C. Subsequent calculations will convert these figure into total development carbon dioxide emissions.

7.1 Part L1a Energy Demand

The initial modelling results, to Part L1a minimum standards are detailed below in Table 3. The results indicate that Blocks A & B/C would require 51 & 54 kWh/m².yr respectively for space heating.

	Block A Part L	Block B/C Part L
Electricity	27.0	25.5
Space Heating	51.0	54.0
DHW	16.6	21.7

Table 3: Part L1a Energy Demand

7.2 Be Lean Be Green Energy Demand

The adoption of the higher thermal specification as detailed in Section 6.1 delivers the following results (The Part L1a results are repeated for comparison). The results predict a 12-16% reduction in space heating demand compared to the Part L1a minimum requirements.

	Block A Part L	Block B/C Part L	Block A Be Lean	Block B/C Be Lean
Electricity	27.0	25.5	27.0	25.5
Space Heating	51.0	54.0	43.0	48.0
DHW	16.6	21.7	16.6	21.7

Table 4: Be Lean Energy Demand

7.3 Passivhaus Energy Demand

The adoption of the Passivhaus specification as detailed in Section 6.1 delivers the results presented in the Table below. These predict a 75-78% reduction in space heating demand compared to the Part L1a minimum requirements.

	Block A Part L	Block B/C Part L	Block A Be Lean	Block B/C Be Lean	Block A Passivhaus	Block B/C Passivhaus
Electricity	27.0	25.5	27.0	25.5	27.0	25.5
Space Heating	51.0	54.0	43.0	48.0	12.5	12.2
DHW	16.6	21.7	16.6	21.7	16.6	21.7

Table 5: Passivhaus Energy Demand

7.4 Predicted Combined Energy Consumption

As previously stated, the net energy demand figures presented above do not include an allowance for boiler efficiency. Table 6 summarises the 'Net Thermal Demand' as the combined space heating and DHW energy demand under each of the three options.

The 'Gross Thermal Demand' represents the total gas consumption required to deliver the net thermal energy use. In the absence of detailed performance characteristics, a seasonal boiler efficiency of 80% has been adopted. (Note that this is an assumed average operating efficiency and not the SEDBUK value which would be closer to 89%). It is therefore anticipated that the Passivhaus scheme will require between 36-42kWh/m² for space heating and DHW compared to 75-87kWh/m².yr for the Be Lean, Be Clean scenario and 85-95kWh/m².yr for the Part L1a scenario.

Kwh/m².yr	Block A Part L	Block B/C Part L	Block A Be Lean	Block B/C Be Lean	Block A Passivhaus	Block B/C Passivhaus
Electricity	27.0	25.5	27.0	25.5	27.0	25.5
Net Thermal Demand	67.6	75.7	59.6	69.7	29.1	33.9
Gross Thermal Demand	84.5	94.6	74.5	87.1	36.4	42.4

Table 6: Electric and Thermal Demand Summary per m² of Floor Area

7.5 Predicted Carbon Dioxide Emissions

Table 7 details the combined predicted total energy consumption and associated carbon emissions based on the results presented in Tables 4-6 and the standard UK values for gas and mains electricity carbon intensity.

		Block A Part L	Block B/C Part L	Block A Be Lean	Block B/C Be Lean	Block A Passivhaus	Block B/C Passivhaus
TFA	m²	274	747	274	747	274	747
Electricity	kWh/yr	7,400	19,050	7,400	19,050	7,400	19,050
Gas	kWh/yr	23,160	70,690	20,420	65,090	9,970	31,660
CO2 Elec	Kg/yr	3,830	9,850	3,830	9,850	3,830	9,850
CO2 Gas	Kg/yr	4,590	14,000	4,050	12,890	1,980	6,270
Total CO2	Kg/yr	8,420	23,850	7,880	22,740	5,810	16,120
Total CO2	Kg/Yr		32,270		30,620		21,930
Predicted Emissions Reduction Compared to Part L1a							32%

Table 7: Predicted Energy Consumption and Combined Emissions

The following conclusions can be drawn from the modelling:

1. The total carbon dioxide emissions for the development, if constructed to the proposed Passivhaus standards, is predicted to be in the region of 22 metric tonnes per annum.

2. The Be Lean Be Green specification, prior to reductions from on-site renewable technologies, is predicted to result in CO_2 emissions in the region of 30.6 metric tonnes per annum, a reduction of 5%.

3. The base case emissions, determined by the minimum performance standards required to achieve Part L1a compliance, would result in carbon emissions in the region of 32.3 metric tonnes per annum.

4. The proposed Passivhaus scheme is predicted to deliver a 32% reduction in carbon dioxide emissions compared to Base Case Part L1a scenario.

7.6 Base Case CO_2 Reductions from PV

The next step is to determine the maximum additional carbon dioxide emission reductions that could be achieved by the integration of low or zero carbon technologies.

Analysis of the development proposals indicates that the scheme includes a maximum of 130m2 (assuming 1m perimeter from roof edge for wind loading) of flat roof area capable of accommodating a maximum of 10.5 KWp PV at a 15° pitch. The potential emissions reduction from this are detailed in Table 8 below.

Block	Total KgCO2	Net Roof Area m²	PV KWp	Emission Reduction Kg/yr
A	7,880	56	4.7	1,898
B	22,740	70	5.8	2,375
Total	30,620	126	10.5	4,273
Predicted Reduction from PV				14%

Table 8: Predicted Emissions Reduction from PV

It is estimated that the inclusion of PV could deliver a maximum 14% emissions reduction compared to the Be Lean scenario modelled in PHPP.

8 Total Scheme Emissions Reductions

The results of the modelling is summarised in Table 9 and the following commentary:

Scenario	CO2 Emissions/yr	% Reduction
Part L Compliance	32.3	-
Be Lean Be Green	26.3	18%
Passivhaus	21.9	32%

Table 9: Predicted Annual Carbon Dioxide Emissions

1. The Base Case scenario, incorporating thermal performance sufficient to meet Part L1a of the Buildings Regulations results in carbon dioxide emissions in the region of 32.2 metric tonnes per annum.

2. A typical enhanced construction specification, developed to meet The London Plan 'Be Lean Be Clean' definition, is predicted to result in 30.6 metric tonnes per annum, a reduction of 5%.

3. The maximum potential for PV within the scheme is predicted to result in emissions reductions in the region of 4.2 metric tonnes. The resulting 'Be Lean, Be Clean, Be Green' emissions are therefore reduced to 26.4 metric tonnes. This represents an 18% reduction compared to the base case minimum Part L1a requirements.

4. By comparison, the modelling presented above predicts that the scheme, if constructed to the Passivhaus standard would result in annual carbon dioxide emissions equal to approximately 22 metric tonnes per annum, a 32% reduction compared to the Base Case scenario and a further 17% improvement compared to the 'Be Lean Be Clean Be Green' approach.

5. Finally, it should be noted that the following calculations are all based on the assumption that as built performance will be as predicted here. However, this report has already demonstrated that for the non-Passivhaus scenarios (which incorporate less thorough quality assurance procedures), it is likely that the actual energy consumption for the Part L and 'Be Lean' options would be higher than predicted here, thus increasing the relative carbon reductions offered by Passivhaus.

It is therefore contended that the proposal to adopt the fabric first Passivhaus standard will result in a scheme with significantly lower annual carbon emissions compared to a scheme developed to satisfy the London Plan energy hierarchy.

9 Code for Sustainable Homes Results

Notwithstanding the proposals detailed above, the scheme remains committed to satisfying the requirement to achieve Level 4 of the Code for Sustainable Homes. SAP modelling has been completed for each of the dwellings based on the proposed Passivhaus specification and the results are detailed in Table 7 below:

The results presented above demonstrate that the Block A and Block B/C will achieve a minimum 29% and 34% improvement respectively compared to the minimum Part L1a. This exceeds the minimum requirements for CSH Level 4. It is also noted that the each of the dwellings would achieve a greater number of credits by adopting the Passivhaus approach compared to a conventional fabric and renewables approach. This is primarily due to the full credits achieved in the ENE2 category. (Note that dwelling sizes are derived from SAP calculations and reflect the measurement conventions)

URN	TFA m²	DER KgCO2.yr	TER KgCO2.yr	FEE kWh/m².yr	ENE1 Credits	ENE2 Credits
Block A - Unit 1	72.8	12.7	18.7	29.5	3.6	9.0
Block A - Unit 2	72.8	11.4	15.6	21.8	3.1	9.0
Block A - Unit 3	72.8	11.4	15.6	21.8	3.1	9.0
Block A - Unit 4	61.6	13.6	19.0	30.0	3.2	9.0
Block B - Unit 1	50.5	13.9	21.2	27.1	3.8	9.0
Block B - Unit 2	50.5	14.0	20.7	27.8	3.6	9.0
Block B - Unit 3	57.1	12.6	18.7	22.0	3.6	9.0
Block B - Unit 4	57.1	12.3	16.7	17.4	3.1	9.0
Block B - Unit 5	68.0	12.2	19.5	26.2	4.1	9.0
Block C - Unit 1	92.6	11.2	18.5	29.9	4.3	9.0
Block C - Unit 2	96.0	10.0	15.3	23.3	3.9	9.0
Block C - Unit 3	96.0	10.0	15.3	23.3	3.9	9.0
Block C - Unit 4	96.0	10.1	15.7	24.6	3.9	9.0
Block C - Unit 5	79.0	12.4	18.7	32.7	3.7	8.7

Table 10: Code for Sustainable Homes Modelling Results

10 References

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