Appendix A: Energy Strategy

2562 / Gondar Gardens, London Borough of Camden

For

Linden Wates West Hampstead Ltd

November 2013

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Contents

1.0 Executive Summary 4
2.0 Introduction 8
2.1 Document structure 8
2.2 Objectives 9
2.3 Grants and Incentives 10
3.0 Baseline Energy Demands and CO_2 Emissions 11
3.1 Context to Approach 11
3.2 Base specifications 12
3.3 Baseline CO_2 emissions 13
3.4 Setting the targets 14
3.4.1 Code for Sustainable Homes Level 4 14
3.4.2 Policy CS13 target 14
4.0 Overview of LZC Technologies 15
4.1 Discounted technologies 16
4.2 Preferred technologies 17
4.3 Further technologies to consider 17
5.0 Proposed Solution 19
6.0 Conclusion 20
Appendix A: Details of Preferred Technologies 22
A1: Solar Analysis 23
Appendix B: Further Technologies to Consider 24
Appendix C: CHP appraisal 26
B1: CHP feasibility 26
B2: Connection to existing Heat Network 27

1.0 Executive Summary

This document has been prepared for Linden Wates West Hampstead Limited to present the results of an early stage analysis of potential Low and Zero Carbon (LZC) technologies for the proposed new development at Gondar Gardens, in order to satisfy the Local and Regional Planning Policy requirements relating to energy and CO_2 emissions as noted in this document.

The site consists of the redevelopment of the reservoir street frontage to provide 28 residential units (Class C3 use) in two blocks from lower ground to third floors with basement parking, following substantial demolition of the roof and internal structure of the reservoir and its subsequent re-landscaping. The development is situated in the London Borough of Camden and, as such, should comply with the energy requirement of the Camden Core Strategy 2010, London Plan 2011 and Part L1A2010 of Building Regulations.

Therefore, the following objectives have to be achieved for the development:

London Plan 2011 & Camden Core Strategy 2010:

- **Ensure the site complies with Part L1A of the UK Building Regulations 2010**
- **Ensure that the residential units meet the mandatory energy requirements for achieving the Level 4 of the Code for Sustainable Homes i.e. 25% reduction in regulated CO_2 emissions from Part L 2010**
- **The development is to seek to reduce 20% of the sites regulated carbon dioxide emissions from the implementation of Low or Zero Carbon technologies**

This report proposes that this could be achieved by implementing a high performance building fabric and energy efficiency measures, combined with Photovoltaic (PV) Panels. The final strategy however will be confirmed during detailed design and this report outlines other technologies that may be suited to the scheme.

This strategy proposed reflects the Government's trajectory to set future building regulations by the building fabric (Section 3) and follows the energy hierarchy methodology outlined in the Mayor's London Plan.

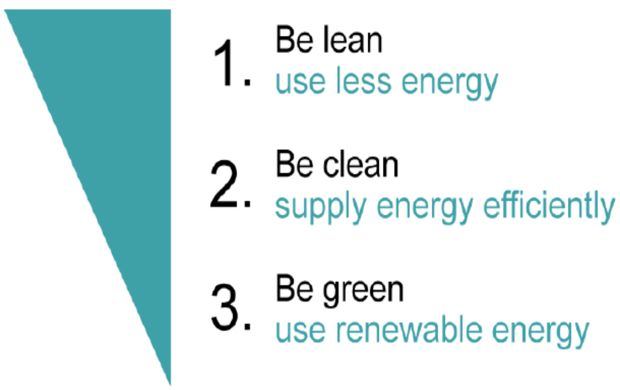


Figure 1: Energy Hierarchy

Step 1 and 2 have been addressed in Section 3 improved insulation, air tightness and accredited construction details have been proposed to improve the energy efficiency of the building fabric.

The baseline energy demands for the site have been calculated using indicative SAP 2009 calculations from similar schemes with the chosen SAPs from dwellings of a similar form and size to provide an estimation of the energy demands at this stage of the project. However, actual SAP modelling will be carried out when full detailed design is completed. The SAP analysis has provided the following targets for the development:

London Plan 2011 target from Part L 2010

Target	Measured as...	Target from Part L	Unit
London Plan 2011 Target (25% reduction)	Emissions calculated by SAP 2009	**11.91**	tCO_2/yr

Remaining targets set for site after fabric improvements

Target type	Percent	Measured as...	Target	Unit
London Plan 2011	**25%**	Regulated Emissions	**6.36**	tCO_2/yr
Camden Council Policy CS13	**20%**	Regulated Emissions	**8.42**	tCO_2/yr

As such, the analysis has shown that that the overall reduction required from Low and Zero Carbon technologies (LZC) to satisfy the London Plan 2011 target will be approximately **11.91 Tonnes of Carbon Dioxide Emitted per year across the residential units.** To satisfy this target the following solution is proposed as the preferred options at this early stage:

Proposed solution

Technology	Details	tCO_2 Saved	Meets Both targets?
Enhanced Building Fabric	Highly energy efficient building fabric and services with additional energy saving devices	5.55	NO
Photovoltaic Panels (PV)	Circa 15.9 kWp PV System* (e.g. 60 x 265 Wp PV panels)	8.48*	NO
TOTAL		**14.03**	**YES**

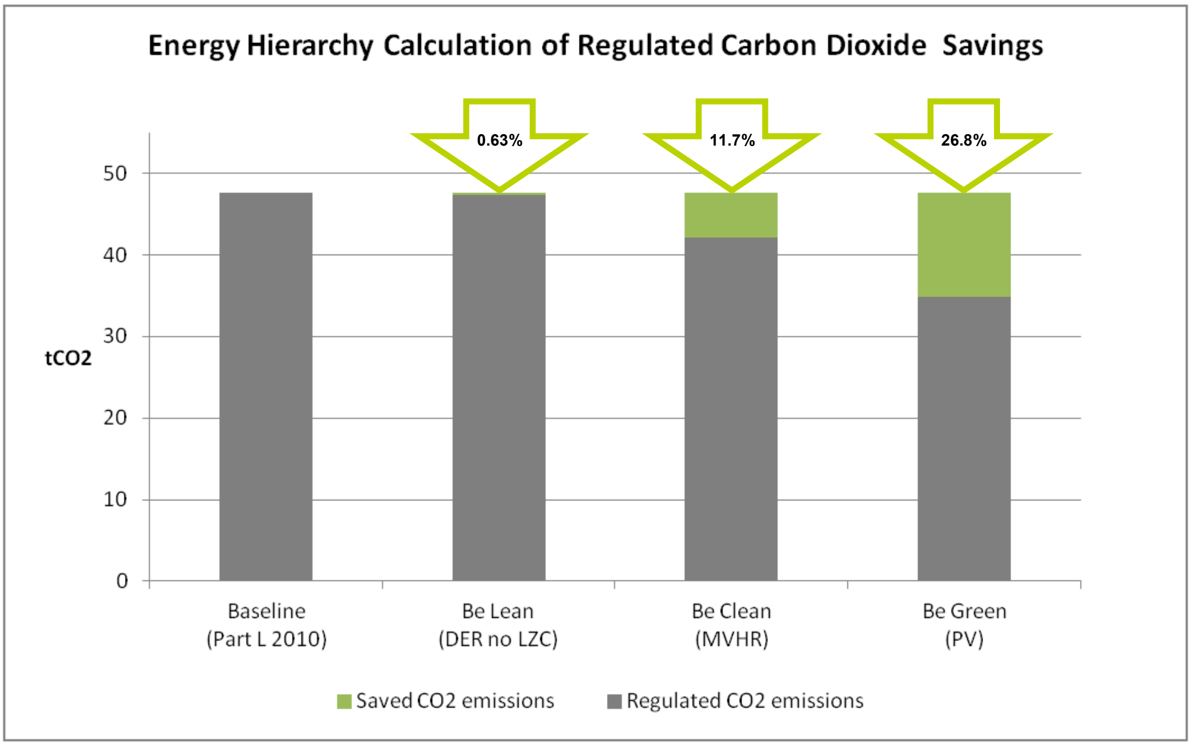
*Note that the PV requirements are given for indicative purposes and should be reviewed once the final specifications have been agreed. SAP 2009 methodology accounting for actual orientation, pitch and local irradiance.

Modelling the scenario presented in the table above with the indicative SAP calculations shows that this solution will satisfy the London Plan target.

		Be Lean	Be Clean	Be Green	
Regulated CO_2 Emissions	Baseline (Part L 2010 TER)	Proposed Gas Baseline (DER) no LZC or Energy Efficiency Measures	Proposed Building (DER) With MVHR	Proposed Building (DER) With MVHR & PV	Final %age Reduction over Part L 2010 Baseline
Total Regulated (tCO_2/yr)	47.64	47.34	42.09	34.87	**26.81%**
%age Reduction over Part L 2010	N/A	**0.63%**	**11.65%**	**26.81%**	N/A
% age Reduction from Energy Efficiency Services & LZC	N/A	N/A	**11.09%**	**20.14%***	N/A

*SAP 2009 methodology accounting for actual orientation, pitch and local irradiance.

As shown in the table above, the implementation of enhanced building fabric specification and energy efficiency measures in conjunction with a Photovoltaic system will ensure the London Plan 2011 and the CS13 target are met for the development. All of the unshaded PV space has been utilised.



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In summary, the presented strategy offers the following savings from enhanced building fabric specifications and Low and Zero Carbon Technologies:

- A 26.81% reduction in regulated CO_2 emissions over the Part L compliant baseline (TER) from fabric specifications, energy efficiency measures and the implementation of Low & Zero Carbon technologies (LZC).
- A 20.14% reduction in regulated CO_2 emissions from Low & Zero Carbon technologies (LZC)
- A 15.79% reduction in all site CO_2 emissions from the Part L compliance baseline (TER) from enhanced building fabric specifications, energy efficient services and Low & Zero Carbon technologies (LZC). This includes both regulated CO_2 emissions (measured for Part L) and the unregulated CO_2 emissions (attributed to cooking & appliances as calculated by SAP)
- An 11.25% reduction in all site CO_2 emissions from Low & Zero Carbon technologies (LZC) compared to the proposed total dwelling emission rates (regulated & unregulated).

As this analysis is based on indicative SAP calculations the outcomes should be confirmed at later stage, once the detailed design has been finalised, by actual SAP calculations. As such, the findings should be taken as indicative and are presented for illustrative purposes to show how the scheme can satisfy the planning requirements.

Additionally, the implementation of the proposed PV system is subject to a detailed roof design analysis to ensure there is enough space to fit the system.

2.0 Introduction

This report presents the energy strategy for the development at Gondar Gardens, London Borough of Camden, NW6 1EP. The site consists of 28 dwellings include houses, apartments and duplexes. The site will be assessed under Part L 2010 of the building regulations. In addition to Part L 2010 compliance, the development must comply with Policy 5.2 of the London Plan 2011 which requires dwellings to achieve the mandatory energy requirement of Code for Sustainable Homes Level 4.

Therefore, the regulated CO_2 emissions of the dwellings (Dwelling Emission Rate DER) must be reduced by at least 25% compared to the Part L 2010 baseline (Target Emission Rate, TER). Further to this, Camden council ask for developments to satisfy the following target where possible:

"Developments are to target a 20% reduction in carbon dioxide emissions from on-site renewable energy technologies." ***Core Strategy policy CS13, Paragraph 13.11***

At this early stage a number of technologies have been outlined as suitable to satisfy the CO_2 reduction planning targets. As detailed design has not yet occurred, there may be scope for implementing some alternative technologies that do not conflict with other drivers (please see Appendix for details on technologies).

However, in line with the Mayoral Energy Hierarchy, this report explores, in detail, the feasibility of implementing enhanced building fabric specifications and photovoltaic panels to satisfy the planning energy targets.

2.1 Document structure

The first section provides the executive summary for this report and sets out what the objectives are.

This second section sets out the structure of the report, discusses the objectives and details any financial incentives available.

The third section sets out the base specifications for the site and details the further LZC requirements needed to comply with Part L 2010, as well as the local planning requirement.

Section four gives information regarding the recommended LZC technologies, as well as giving information on why other technologies were discounted.

Section five goes into more detail regarding the recommended LZC technologies for the development.

Section six sets out the findings of the analysis.

2.2 Objectives

The following objectives have to be met for the development:

- **Ensure the site complies with Part L1A of the UK Building Regulations 2010**
- **Ensure that the residential units meet the mandatory energy requirements for achieving the Level 4 of the Code for Sustainable Homes i.e. 25% reduction in regulated CO_2 emissions from Part L 2010 which is equivalent to the London Plan 2011 target**
- **The development is to seek to reduce 20% of the sites regulated carbon dioxide emissions from the implementation of Low or Zero Carbon technologies**

As noted, the baseline CO_2 emissions of the site have been calculated using sample SAPs from similar developments. Using this data, the target in Table 2.2 was determined:

Table 2.2 Targets for new development from Part L 2010

Target	Measured as...	Target from Part L	Unit
London Plan Target (25% reduction)	Emissions calculated by SAP 2009	**11.91**	tCO_2/yr

Achieving the above objective for the development requires an offset of 11.91 tCO_2/yr above the Part L 2010 Baseline. The table below outlines the remaining targets to be satisfied by the implementation of Low and Zero Carbon technologies after the enhanced building specification has been implemented.

Table 2.2 Remaining targets set for site after fabric improvements

Target type	Percent	Measured as...	Target	Unit
London Plan 2011	**25%**	Regulated Emissions	**6.36**	tCO_2/yr
Camden Council Policy CS13	**20%**	Regulated emissions	**8.42**	tCO_2/yr

2.3 Grants and Incentives

There are a number of grant schemes and other incentive schemes available in the UK. The main incentive available for this development is summarised in the Tables below. However, there may be additional grants available.

Table 2.3 Available funding

Grant / Incentive	Description	Available Financing (p/kWh)**
Feed in Tariff for PV (FiT)*	**Feed in Tariff (FiT)** The FiT rates given in this table are for January to March 2014 for 10-50 kW systems and are provided for indicative purposes only. These should therefore be confirmed at commissioning stage.	**Higher rate: 12.57** **Middle rate: 11.31** **Lower rate: 6.61**

*Note: Installations must comply with MCS standard to be eligible

** The higher, middle, and lower rates for solar PV installations are defined in the Modifications to the Standard Conditions of Electricity Supply Licences (No. 2 of 2012)

3.0 Baseline Energy Demands and CO_2 Emissions

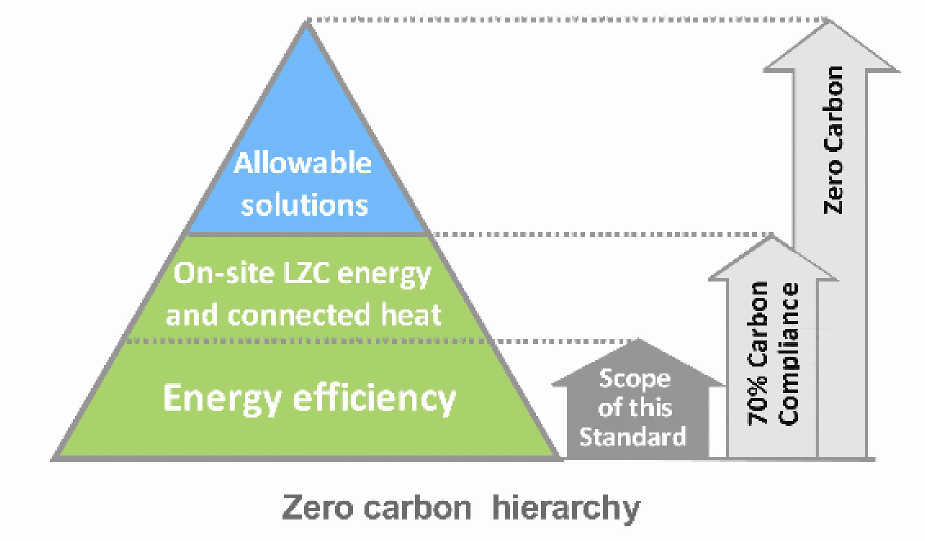
3.1 Context to Approach

The recommendations in this Energy Strategy are proposed as they embrace the themes outlined in the Mayor's energy hierarchy outlined in the London Plan 2011, as well as following the current Zero Carbon trajectory:

- **Be lean:** use less energy
- **Be clean:** supply energy efficiently
- **Be green:** use renewable energy

The Zero Carbon Hub is an independent workgroup that advise the UK Government on optimal solutions with the aim of achieving carbon neutral homes by 2016. As shown in the diagram below, the Zero Carbon Hub identified the "*energy efficiency improvement first"* approach as the most appropriate way to drive the new house toward carbon neutrality.

Zero carbon Hub recommended approach to carbon neutral housing



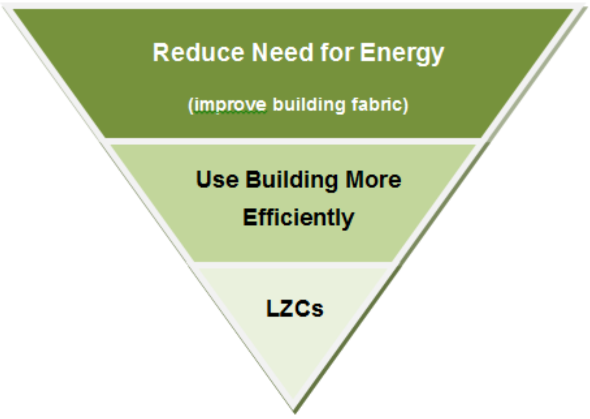
This approach consists of reducing the energy demand and CO_2 emissions by improving the energy efficiency of the building envelope and the mechanical and electrical services first.

Once the energy demand of the building has been reduced from energy efficiency improvements then Low and Zero Carbon (LZC) technologies can be considered. It is widely accepted that the most effective way to reduce energy consumption (and therefore carbon emissions) is to follow the energy hierarchy (shown overleaf).

This approach is the most appropriate because energy efficiency improvements are more cost effective than LZC systems and can provide significant energy and CO_2 savings. In addition, energy efficiency improvements reduce the energy demand of the building and therefore contribute to reducing the size of LZC systems required to achieve low carbon buildings.

The energy efficiency of the dwellings can be improved by adopting low cost passive design measures, such as enhancing the building fabric or designing the dwellings so as to improve passive solar gains through windows.

Energy Hierarchy:



Therefore, improving the energy efficiency of the development before implementing Low or Zero Carbon technologies is considered a preferred strategy as this follows the Mayor's energy hierarchy.

3.2 Base specifications

As the design for the development has not been finalised at this early stage, the baseline energy demands for the site have been modelled using sample SAPs from similar developments. When permission has been granted, the findings in this report will be confirmed by actual calculations at a later stage once detailed design is undertaken.

This early stage energy modelling is based on the following specifications which may be subject to change during detailed design and is therefore provided to show that compliance is achievable.

The enhanced specifications below are those that have been modelled for the site and are shown to illustrate that the scheme can satisfy the Energy Planning requirements:

- Highly efficient gas-fired boilers
- Air permeability standard of 3-5 $m^3/hr/m^2$
- Accredited Construction details
- 100% Low Energy Light fittings
- Mechanical ventilation with space heat recovery (MVHR)

Table 3.2: U-Values of building elements

Element	Modelled U-Values (W/m^2K)	Part L1A 2010 Limiting U-Values (W/m^2K)	%age improvement	Implementation Risk
Walls	**0.20**	0.30	33%	Low
Floors	**0.15**	0.25	40%	Low
Roof	**0.15**	0.20	25%	Low
Windows/Doors	**1.50**	2.00	25%	Low

Achieving Part L 2010 specification in the apartments through Building Fabric Specifications and Energy Efficiency Measures alone follows the Energy Hierarchy of ***"being lean"***.

One of the primary aims of Part L1A 2010 was to reduce the resultant CO_2 emissions of a dwelling by 25% compared to Part L1A 2006, as depicted in the target levels set for the Code for Sustainable Homes Level 3 and was expected to roughly reflect a 40% improvement over dwellings built to 2002 standards. Achieving this requirement through an enhanced specification without the reliance on Low or Zero Carbon Technologies will ensure that the dwellings have low energy demands, helping towards the protection of occupants in the future from energy price rises.

Additionally, MVHR is being implemented in order to re-use heat that would otherwise be lost. This follows the Energy Hierarchy of ***"being clean"*** and increases the overall efficiency of the building.

3.3 Baseline CO_2 emissions

Using these specifications, the following baseline CO_2 emissions have been calculated for the development:

Table 3.3.2: Baseline CO_2 emissions before the implementation of LZC technologies or heat recovery units

Description	Total
Total Regulated emissions (tCO_2/yr)	47.34
Total Part L 2010 Baseline (tCO_2/yr)	47.64
%age Reduction Part L 2010 Baseline	**0.63%**

Table 3.3.2: Baseline CO_2 emissions with Heat recovery units before the implementation of LZC technologies

Description	Total
Total Regulated emissions (tCO_2/yr)	42.09
Total Part L 2010 Baseline (tCO_2/yr)	47.64
%age Reduction Part L 2010 Baseline	**11.65%**

3.4 Setting the targets

3.4.1 Code for Sustainable Homes Level 4

There is a planning requirement that all dwellings on site achieve Level 4 of the Code for Sustainable Homes as a minimum, which requires an improvement in regulated CO_2 emissions of at least 25% over the Part L 2010 Target Emissions Rate (TER) baseline. This improvement can either be achieved by passive design measures, such as building fabric improvement, or through the implementation of on-site Low and Zero Carbon technologies. Table 3.4.1 shows how the calculation is undertaken.

Table 3.4.1: Code for Sustainable Homes target after building fabric improvement and energy efficiency services

Description	tCO_2/yr	Equation
Residential Units – Target Emissions Rate (TER) As measured by SAP 2009	47.64	A
Residential Units – Dwelling Emissions Rate (DER) As measured by SAP 2009	42.09	B
Residential Units - Target DER	35.73	C = (1- 25%) x A
Residential Units – CSH Level 4 target Additional CO_2 offset required from LZC	6.36	D = B - C
Additional CO_2 offset required from LZC	**6.36**	**tCO_2/yr**

Achieving the mandatory energy requirements for the Level 4 of the Code for Sustainable Homes requires an additional offset of 6.36 tCO_2/yr through the implementation of on-site Low and Zero Carbon technologies. As a result, complying with the CSH Level 4 target will ensure the London Plan target is satisfied.

3.4.2 Policy CS13 target

In addition to the London Plan 2011, the development is to aim to satisfy Policy CS13 from the Core Strategy, which states that: *"Developments are to target a 20% reduction in carbon dioxide emissions from on-site renewable energy generation."* ***Core Strategy policy CS13, Paragraph 13.11***

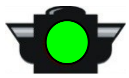
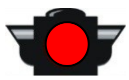
Table 3.3: Setting the Policy CS13 target

Target type & description	tCO_2/yr	Equation
Total Dwelling Emission Rate after energy efficiency measures As measured by SAP2009	**42.09**	A
20% CS13 target	**8.42**	**A x 20%**

Complying with Policy CS13 from the Camden's Core Strategy would require implementation of on-site renewable technologies in order to offset 8.42 tCO_2 per year.

4.0 Overview of LZC Technologies

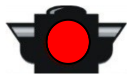
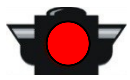
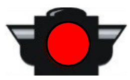
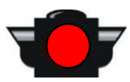
Below is a brief overview of the available LZC Technologies which are commonly used and are accepted as such by DECC and BRE. A traffic light system is used to denote whether the systems are technically appropriate for the development.

Description	Traffic Light
Technology is technically and economically feasible with few barriers to implementation	
Technology is technically and economically feasible, but there are barriers to implementation	
Technology is technically or economically unfeasible and has been discounted	

The table below outlines the justification behind the discounting of technologies. A detailed review of each technology can be found in the Appendices.

4.1 Discounted technologies

Below is the rationale for discounting each technology.

Technology	Description	Traffic Light
Small scale wind	In light of the configuration of the site and the character of the location, there is a risk that this technology will not receive consent from Local Planning Authorities because of potential noise and aesthetics issues. Moreover, field trials have shown that small scale wind turbines often achieve much lower performances than expected in urban areas due to local wind turbulences. There is also a risk that implementing small wind turbines on this development will be economically unviable. Therefore, this technology has been discounted.	
Ground Source Heat Pumps (GSHP)	The implementation of a GSHP is risky with the ground conditions being unknown. Moreover, a vertical ground loop will probably be required for this development which will be very capital intensive due to drilling costs. Additionally, the systems require under-floor heating to be installed in order to work most efficiently because of the applicable operating temperatures. Therefore, this solution has been discounted.	
Biomass	The implementation of a communal biomass heating system requires space for fuel storage and may raise air quality issues. Additionally, fuel delivery requires the plant/storage room to be easily accessible, which will be logistically difficult. Therefore, this solution has been discounted at this stage.	
Combined Heat & Power (CHP)	The implementation of a centralised CHP heating system would necessitate a distribution network with a heat metering/billing system. Moreover, CHP will have to be serviced and maintained by a specialised company. The scale and density of the development does not lend itself well to CHP in this instance, due to costs associated with installation and future maintenance (which would be passed onto future residents) and insufficient base heat demand. Therefore, CHP has been discounted at this stage.	

4.2 Preferred technologies

Photovoltaic panels (PV)

Photovoltaic Cells (PV) generate electricity from sunlight using semiconductor cells linked together to form a module. Electricity can still be generated in cloudy and overcast conditions although more can be generated in direct sunlight. The conditions that provide optimal generation in the UK are with South facing panels with a 30° elevation and no overshadowing.

PV is considered a good solution for the development and follows the "***be green"*** element of the London Plan.

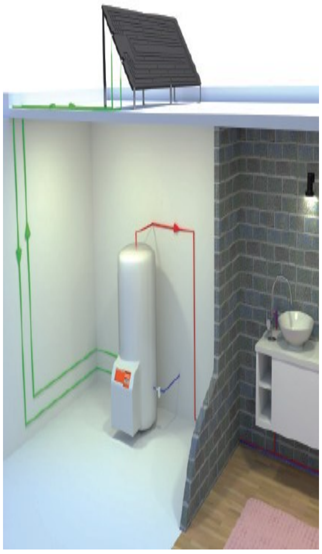
4.3 Further technologies to consider

Photovoltaic thermal panels (PVt)

Hybrid solar systems that combine both photovoltaic cells with solar thermal collectors are an extremely effective technology. A pitfall of dedicated PV units is that they lose efficiency when they get too hot. The integration of a solar thermal element to the unit allows the PV cells to stay cooler, thereby improving efficiency whilst also producing useful hot water. This allows both electrical generation and reduction in heating demand for hot water for a development.

This is an extremely effective technology that offers both gas and electricity savings and as result, has a large carbon offset intensity per m^2. For these reasons PVt is considered a viable secondary solution for the development.

Atmospheric Panels



Atmospheric panels work by absorbing heat energy from the atmosphere into a refrigerant fluid circulating through the capillaries of an aluminium panel. The refrigerant is at a negative temperature that enables a greater collection of solar and environmental energy, which is then released into the water through a heat exchanger.

The panels can be thought of as a hybrid between solar thermal panels and heat pumps. With solar thermal panels, water is pumped around the panel where it is heated up by solar gains and delivered into the home. Atmospheric panels follow the same procedure but instead utilise a refrigerant within the panels.

The panels are currently in the process of being integrated into the SAP methodology so that their full benefit can be claimed. As they are not currently present in the methodology the panels have been given an amber light, but are a possible alternative when construction begins.

Air Source Heat Pumps (ASHP)

ASHPs are usually situated just outside a building and use the surrounding air as the heat source. An electric fan draws the air over an evaporator, cooling the heat stream and providing heat to the pump. The units are capable of delivering all of the space and water heating for dwellings.

ASHP are considered a good solution for the scheme as they can easily satisfy the CSH planning targets.

5.0 Proposed Solution

As described in Section 3.4, an additional offset of 8.42 tCO_2/yr is required through on site LZC technologies to ensure the site meets the targets. The development has a large area of flat roof on which PV panels can be installed.

5.0.1 Assumptions

- **The output of the PV system has been calculated using the SAP2009 methodology to meet the London Plan 2011 target.**
- **Carbon factor from Part L1A 2010 has been used to calculate the CO_2 savings**

5.0.2 PV requirements

Table 5.3: PV requirements

	CO_2 savings shortfall (tCO_2/yr)	Minimum PV kWp required	No. of 265 Wp PV Panels
London Plan 2011	6.36	14.00	53
Policy CS13	8.42	15.79	60

The indicative PV layout in the Appendix shows that the roof can accommodate a total of 60 PV panels which are not in shade, and 10 additional panels in shade. It is to be noted that this layout has been designed using early stage drawings and, therefore, must be considered for indicative purposes only. It is essential that a full solar analysis of the project is carried out at a later stage as there will be some significant changes to the design of the roof, especially once the detailed design of the Mechanical and Electrical Services are carried out.

The implementation of a 15.9 kWp PV system on the development will ensure the London Plan 2011 and policy CS13 target are met; this corresponds to a total of 60 x 265 Wp PV panels.

Proposed solution

Technology	Details	tCO_2 Saved	Meets London Plan target?
Enhanced Building Fabric	Highly energy efficient building fabric and services with additional energy saving devices	5.55	NO
Photovoltaic Panels (PV)	Circa 15.9 kWp PV System* (e.g. 60 x 265 Wp PV panels)	8.48	NO
TOTAL		14.03	YES

*Note that the PV requirements are given for indicative purposes and should be reviewed once the final specifications have been agreed. SAP 2009 methodology accounting for actual orientation, pitch and local irradiance.

6.0 Conclusion

The targets set in this document are for illustrative purposes at this early stage as they are based on indicative SAP calculations. Actual SAP calculations will be worked up as detailed design progresses and an energy strategy will be submitted with full planning to show how the development can meet the London Plan 2011 and policy CS13 targets.

In Section 4, a number of technologies were outlined that could be implemented to satisfy the target either individually or combined. The strategy outlined in this document has been conducted to follow the recommendations of the Mayoral Energy Hierarchy discussed in Section 3.

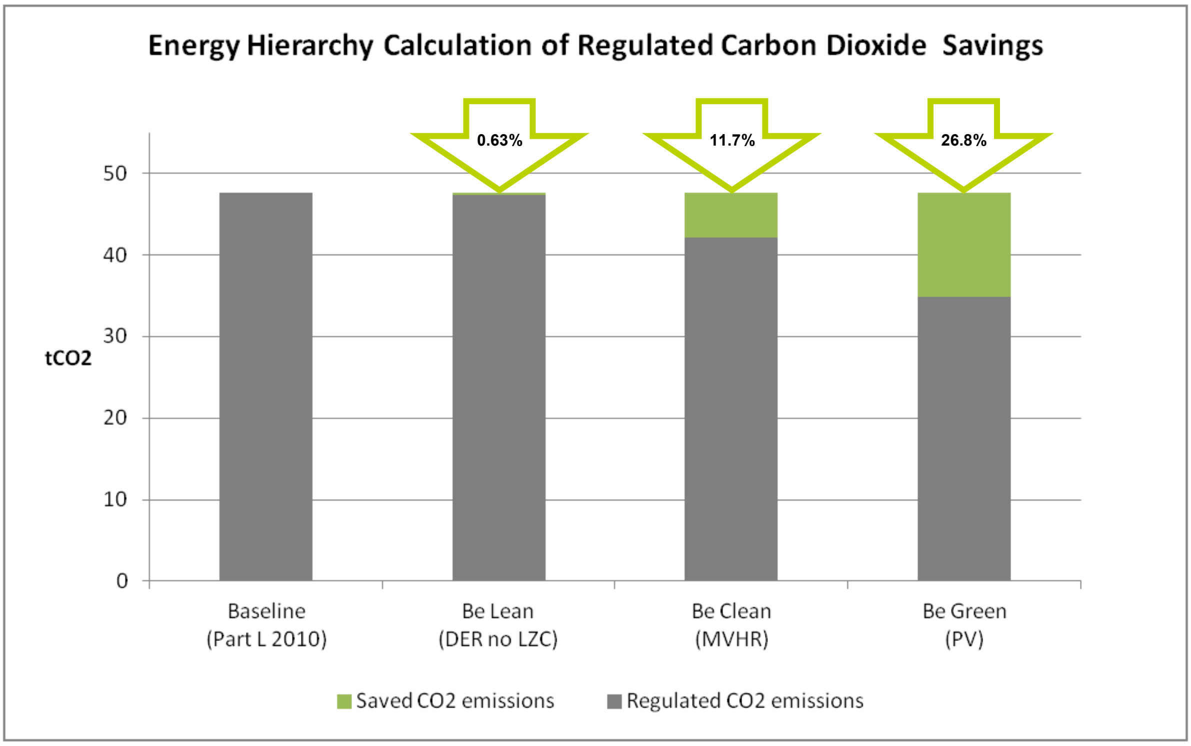
- **Be lean:** use less energy
- **Be clean:** supply energy efficiently
- **Be green:** use renewable energy

Based on the baseline figures used in this report, the implementation of enhanced building fabric specification and energy efficiency measures in conjunction with PV panels have been presented to show how the London Plan and CS13 targets can be achieved. As this is early stage, the specification may be refined at a later date. The analyses undertaken in the report have found the following:

		Be Lean	Be Clean	Be Green	
Regulated CO_2 Emissions	Baseline (Part L 2010 TER)	Proposed Gas Baseline (DER) no LZC or Energy Efficiency Measures	Proposed Building (DER) With MVHR	Proposed Building (DER) With MVHR & PV	Final %age Reduction over Part L 2010 Baseline
Total Regulated (tCO_2/yr)	47.64	47.34	42.09	34.87	**26.81%**
%age Reduction over Part L 2010	N/A	**0.63%**	**11.65%**	**26.81%**	N/A
% age Reduction from Energy Efficiency Services & LZC	N/A	N/A	**11.09%**	**20.14%***	N/A

*Note that the PV requirements are given for indicative purposes and should be reviewed once the final specifications have been agreed. SAP 2009 methodology accounting for actual orientation, pitch and local irradiance.

As shown in the table above, the implementation of enhanced building fabric specification and energy efficiency measures in conjunction with a Photovoltaic system will ensure the London Plan 2011 and the CS13 target are met for the development. All of the unshaded PV space has been utilised.



In summary, the presented strategy offers the following savings from enhanced building fabric specifications and Low and Zero Carbon Technologies:

- A 26.81% reduction in regulated CO_2 emissions over the Part L compliant baseline (TER) from fabric specifications, energy efficiency measures and the implementation of Low & Zero Carbon technologies (LZC).
- A 20.14% reduction in regulated CO_2 emissions from Low & Zero Carbon technologies (LZC)
- A 15.79% reduction in all site CO_2 emissions from the Part L compliance baseline (TER) from enhanced building fabric specifications, energy efficient services and Low & Zero Carbon technologies (LZC). This includes both regulated CO_2 emissions (measured for Part L) and the unregulated CO_2 emissions (attributed to cooking & appliances as calculated by SAP)
- An 11.25% reduction in all site CO_2 emissions from Low & Zero Carbon technologies (LZC) compared to the proposed total dwelling emission rates (regulated & unregulated).

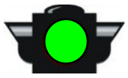
As this analysis is based on indicative SAP calculations and the outcomes should be confirmed at later stage by actual SAP calculations, once the detailed design has been finalised. As such, the findings should be taken as indicative and are presented for illustrative purposes to show how the scheme can satisfy the planning requirements.

Additionally, the implementation of the proposed PV system is subject to a detailed roof design analysis to ensure there is enough space to fit the system.

Appendix A: Details of Preferred Technologies

Solar Photovoltaic cells (PV)

Photovoltaic Cells (PV) generate electricity from sunlight using semiconductor cells linked together to form a module. Electricity can still be generated in cloudy and overcast conditions, although more can be generated in direct sunlight.



The conditions that provide optimal generation in the UK are with South facing panels with a 30° elevation and no overshadowing.

Photovoltaic panels are considered as one of the preferred LZC technologies for this development. The implementation of this technology requires very few alterations to the design and does not add a high load to the roofs.

Advantages

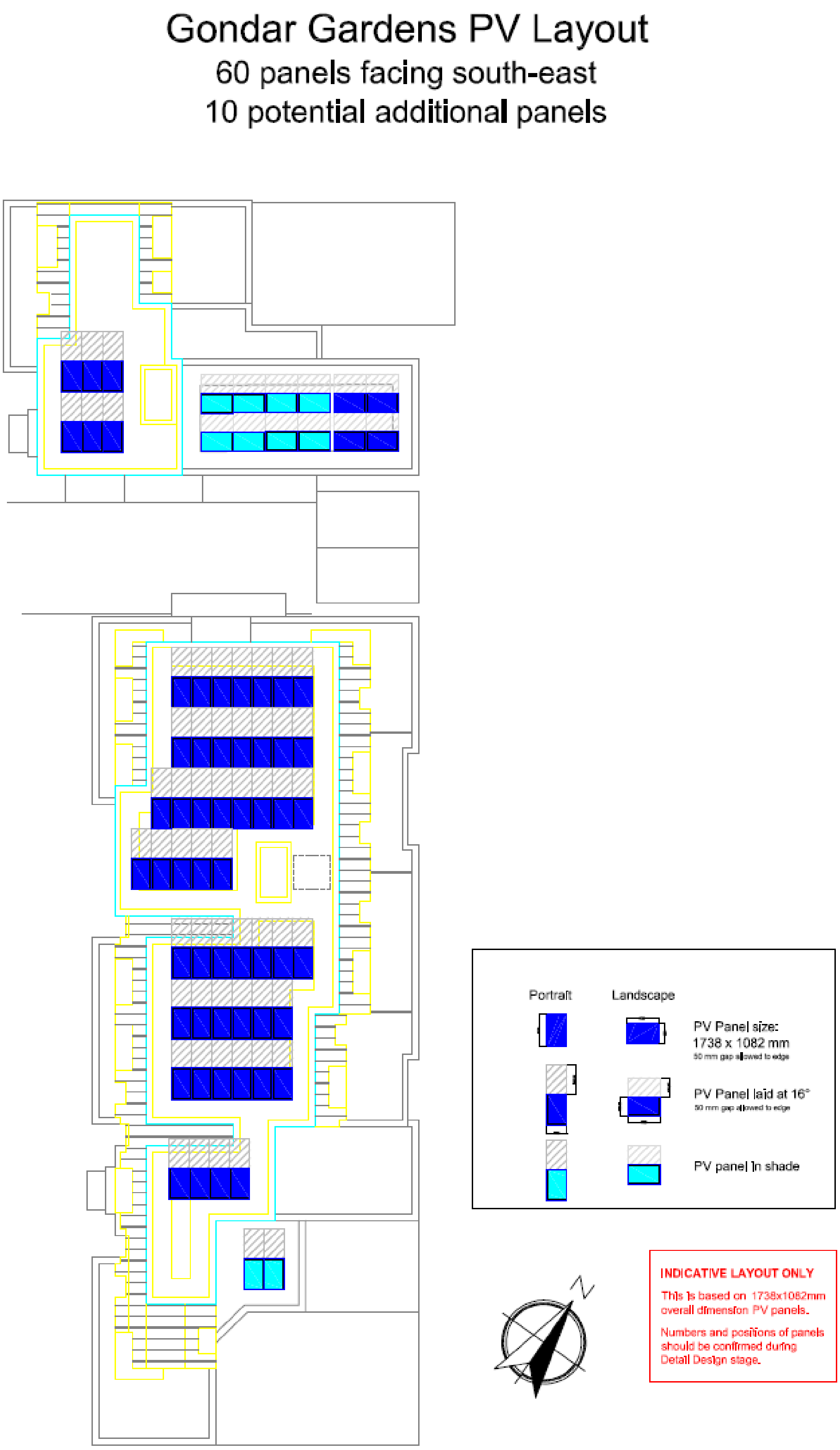
- Costs continue to fall as technology improves
- Many panels are guaranteed for 20-25 year lifetimes but are expected to last longer
- Maintenance is low as panels are usually cleaned by rainwater
- The technology has been in existence for a long time and is well understood
- Low Planning Risk
- Easier and quicker to install compared to other LZCs
- The technology is eligible for the Feed-in Tariff (FiT)

Disadvantages

- Any shading can seriously impact the efficiency of the system. Careful consideration should be given to the current and future levels of shading (e.g. service pipes/flues)
- Integration with Green Roofs can be an issue

A1: Solar Analysis

The indicative drawing below identifies the number of PV Panels that could be accommodated on the top roof of the building.



Appendix B: Further Technologies to Consider

Photovoltaic thermal panels (PVt)

Hybrid solar systems that combine both photovoltaic cells with solar thermal collectors are extremely effective technologies. A pitfall of dedicated PV units is that they lose efficiency when they get too hot.

The integration of a solar thermal element to the unit allows the PV cells to stay cooler thereby improving efficiency whilst also producing useful hot water.

This allows both electrical generation and reduction in heating demand for hot water for a development. This technology has recently been accepted in the SAP methodology.

Advantages

- Electricity and hot water generated at the same time
- Higher efficiency than standard PV panels as cooling lowers resistance
- Eligible for both the Feed-in Tariff and the Renewable Heat Incentive

Disadvantages

- Currently systems are slightly more expensive than standard PV systems
- Adds extra load to roofs as it is heavier than PV
- The implementation of this system requires additional hot water storage capacity to be installed, which can be an issue for apartment blocks

Considerations

- Any shading of panels can seriously impact the heat generated. Careful consideration should be given to the current and future levels of shading (e.g. account for services flue, adjacent buildings etc.)
- PV-t systems may require installation of additional hot water cylinders within the dwellings

Air Source Heat Pumps (ASHP)

ASHPs are usually situated just outside a building and use the surrounding air as the heat source. An electric fan draws the air over an evaporator, cooling the heat stream and providing heat to the pump. The units are capable of delivering all of the space and water heating for buildings. Some units are also capable of providing cooling..

The advantages of these units are that they are easily installed and have low maintenance requirements. Some ASHP have received bad press but this can be due to poor installation or more so due to uninformed use of the owners. When correctly implemented and used appropriately, units with high Coefficient of Performance result is lower bills and high carbon savings for buildings.

Advantages

- Easily installed on the outside of building.
- Low maintenance requirements.
- Single unit can provide heating and cooling requirements.
- When used appropriately, decreased energy bills and carbon footprint can be witnessed, particularly when replacing electric heating systems.

Disadvantages

- Poorly commissioned systems can give lower CoP meaning savings on energy bills may not be realised. Users in reality often complain of much higher bills.
- Electricity is needed to operate the ASHP.

Considerations

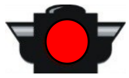
- The pump can generate increased noise levels, particularly during defrost cycles. An acoustic assessment may be necessary, particularly in urban areas.

Appendix C: CHP appraisal

B1: CHP feasibility

Combined Heat & Power (CHP)

CHP generates heat for space heating or hot water requirements whilst simultaneously generating electricity for on-site use or exporting to the grid. The systems are usually 'heat led' with much more heat generated than electricity. CHP works best with buildings that require a high demand of heat for a sustained period of time such as hospitals, swimming pools or hotels.



Based on the SAP calculations it has been concluded that the heating base loads of the development do not allow for an efficient operation of a CHP plant. Specifically, the hot water loads are minimal and will not ensure that a CHP unit would operate for the optimal number of hours during the year to be financially feasible over its lifetime.

Advantages

- Electricity generated from existing heating needs.
- Fewer transport/distribution losses than electricity from the grid.

Disadvantages

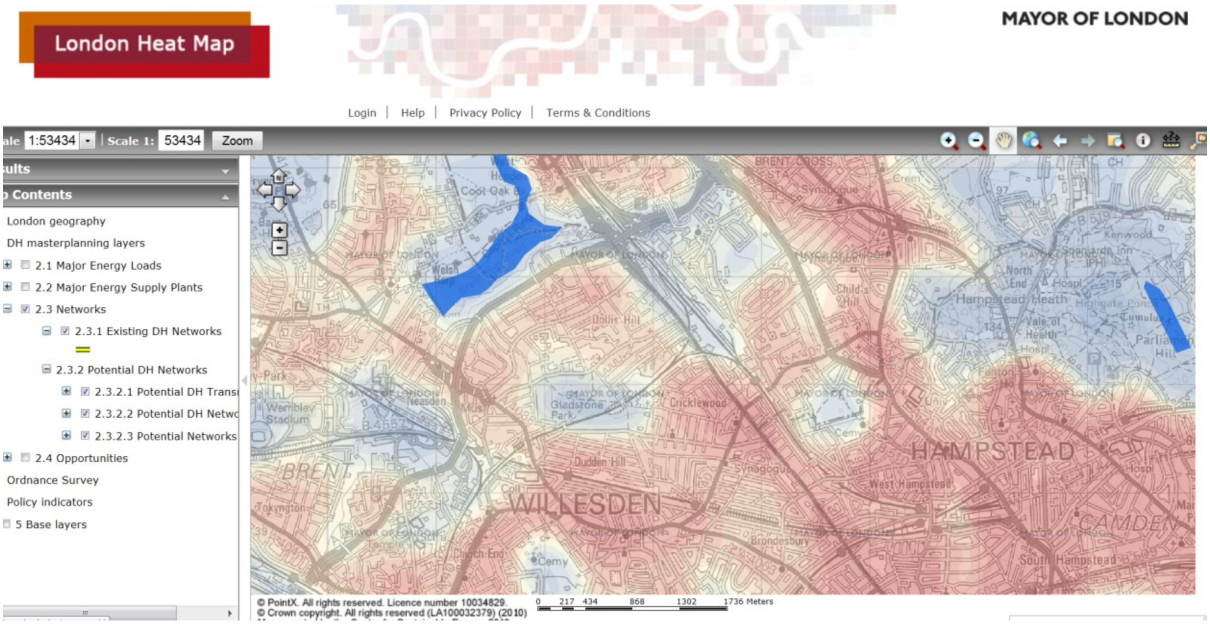
- Most suited to buildings with a prolonged high heating demand
- Most installations use Gas therefore not a renewable technology
- Works best when run for long hours to improve efficiency, therefore needs a constant heat demand; in this instance the CHP would not have large heat loads year round
- Management risk associated with contracts and metering of heat and electricity
- Expensive to install and manage when compared to other solutions. Legal implications associated to Occupants' rights and protection with community heating schemes
- Typical cost circa £5k to £7k per dwelling (install) once plant back up boilers, pipework, hydraulic interface units, meters etc.
- Regular expensive maintenance required and full overhaul after 10 to 15 years depending on yearly hours run
- Payback for CHP relies on all electricity to be used on site, and legally occupants have a right to change supplier with a month's notice
- Air pollution should be considered in urban areas

B2: Connection to existing Heat Network

As part of the CHP feasibility, the London Heat Map tool was consulted and there are, at present, no existing CHP networks that can feasibly be connected to, as shown in the screen shot below. There are a number of reasons why CHP has been discounted for the development.

Firstly, CHP uses gas and is therefore not as preferred as the presented solution. A specific distribution network would need to be incorporated in to the building, which would increase costs. CHP units also require regular maintenance, which is expensive, as well as a full overhaul after ~10-15 years (depending on running hours). Additionally, they can also raise air pollution issues.

Figure 1: London Heat Map



In addition the map below comes from the Camden Planning Guidance 3 document and shows the areas located within 1 km radius of an existing or emerging heat network.

The Gondar Gardens development is located at more than 2 km from the nearest heat network, therefore the connection to this infrastructure has not been considered as feasible for economical and technical reasons (please see image overleaf from CPG3).

Figure 2: Developments within 1km radius of an existing or emerging network