



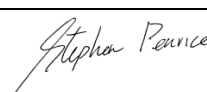
Energy & Sustainability Strategy Report

**Proposed Sheltered Housing
127a & 127b London Road
Waterlooville
Hampshire
PO7 7SH**

Churchill Retirement Limited

**Issue for Submission to Planning
January 2015**



NHBC reference number:	27698/EE5855
Client:	Churchill Retirement Limited
Contact person:	Chris Geddes
Address:	Churchill House, Millstream House, Parkside RINGWOOD, Hampshire, BH24 3SG
Telephone:	01425 462 116
Email:	Chris.Geddes@planningissues.co.uk
Development name:	127a & 127b London Road
Development Address:	Waterlooville, Hampshire, PO7 7SH
Site layout plan reference:	10072WV – RF02
Issued by:	NHBC Services Ltd. NHBC House Davy Avenue Knowlhill Milton Keynes MK5 8FP Tel : +44 (0) 844 633 1000 Fax: +44 (0) 844 633 0032
Author:	Alex Taylor
Position:	Senior Energy Consultant
Signature:	
Reviewed by:	Stephen Penrice
Position:	Energy Consultant
Signature:	

Document Issue Record:

Issue Number	Issue Date	Issue Description
1	21-01-2015	Issue for Comment
2	21-01-2015	Issue for Submission to Planning

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1 Executive Summary

1.1 A feasibility study has been undertaken on behalf of Churchill Retirement Living by NHBC Sustainability Services for the Energy and Sustainability Strategy for their proposed site at 127a & 127b London Road in Waterlooville the proposals are to create twenty seven retirement flats with associated communal areas, which will include a resident's entrance foyer at ground floor, circulation spaces, etc.

1.2 As part of the planning process the development needs to meet the requirements of Havant Borough Council's planning policies with regards to sustainable development the following policy is applicable:

Policy CS14 Efficient Use of Resources

1.3 NHBC Sustainability Services have undertaken an energy options appraisal to determine the appropriate energy strategy for this development and ensure the development's requirement for finite energy resources is minimised, whilst maximising the benefits of Low or Zero Carbon (LZC) Technologies.

1.4 In order to meet with the high standards of environmental performance for planning the developer has proposed that the development will be assessed against the Code for Sustainable Homes (CfSH) and achieve Level 3* the dwellings will also need to comply with the carbon dioxide emissions target and fabric energy efficiency standard as set by Part L1a 2013 of the approved Building Regulations.

1.5 It has also been assumed that in order to comply with planning requirements for energy efficiency in new developments and contribute towards the PUSH Target, the development would be required to reduce CO₂ emissions by 10% when compared to the Building Regulations target as set under Part L1a 2013.

1.6 With regards wider sustainability issues the developer's indicative specification shows the development could achieve a CfSH Level 3* Rating. The review provided has been based on the version of the assessor manual as published in November 2010, taken into consideration the Code Addendum (2014) England – May 2014.

1.7 Appendix A of this report summarises the developments performance against the various categories within the CfSH and confirms that Level 3* is attainable.

1.8 Carbon dioxide emissions as calculated by the Building Regulations SAP 2009 methodology will be reduced through energy-efficiency measures, as this is likely to be a cost-effective route to reduce initial carbon dioxide emissions and consequently the quantity or type of renewables required. To meet these energy efficiency requirements, the following measures are proposed in addition to minimum Building Regulation requirements:

- U-values as follows:
 - U-value of heat-loss floors 0.12 W/m²K

- U-value of heat-loss walls 0.23 W/m²K
- U-value of party walls to be 0.00 W/m²K
- U-value of roofs 0.12 W/m²K
- U-value of windows 1.5 W/m²K (transmissivity of glass = 0.63 e.g. double glazing with low-e coating, Argon fill, 12mm gap)
- Air permeability of no greater than 5.00 m³/hm² when tested at 50 Pa
- Thermal bridges minimised to ensure an effective y-value of no more than 0.08
- Direct electric heating with time and temperature control (panel heaters used to provide baseline data)
- Heat loss through the domestic hot water cylinder minimised to 1.31 KWh per day
- Energy-efficient light fittings to 100% of fixed internal light fittings
- Centralised Mechanical Ventilation.

1.9 A statement of energy and carbon dioxide emissions is shown in Table 1 and is based on the development built to the proposed specification including energy-efficiency measures. Table 2 shows the targets placed upon the development in order to meet with various parts of the planning requirements.

Table 1:

	<u>Total Energy Demand (kWh/yr)</u>	Associated Total CO ₂ (kg CO ₂ /yr)
Space Heating	<u>60,855</u>	31,584
Water Heating	<u>41,921</u>	21,757
Pumps & Fans	<u>851</u>	442
Lighting	<u>17,330</u>	8,994
Appliances & Cooking	<u>55,426</u>	28,766
TOTALS	<u>176,382</u>	91,542
	<u>Total</u> Energy Demand (kWh/yr)	Associated <u>Total</u> CO ₂ (kg CO ₂ /yr)

Table 2:

Regulated Target CO ₂ Emissions – Flats and Communal Areas (Part L 2013) – Excludes Appliances & Cooking	53,902 kg CO₂/ yr
Target CO ₂ Emissions (Regulated) – Flats and Communal Areas (Part L 2013) to achieve an assumed 10% Planning Target	48,511 kg CO₂/ yr
Carbon Dioxide Emissions reduction required to achieve Planning Target	14,265 kg CO₂/ yr

1.10 Where renewable energy systems can be modelled by the SAP 2012 methodology, this has been used. This is the method applicable to the building areas being assessed under Part L1a.

1.11 Communal Air Source or Ground Source Heat Pumps (HPs) are suggested as a solution and are the developer's preferred option; these would meet with the planning target in terms of reducing the sites carbon dioxide emissions by onsite renewable energy, and allow the site to reduce its total energy demand. Providing space heating only from HPs would reduce the development's total energy demand by just under 41,837 kWh per year

which is equivalent to a 35% reduction (compared to their current practices), in addition CO₂ emissions would be reduced by just under 13 Tonnes of CO₂ per year, when compared to the target set by Part L 2013 for both the flats and communal areas.

- 1.12 If the HPs were to provide both space and water heating savings would almost double.
- 1.13 Solar Photovoltaics and Solar Water Heating are unlikely to be able to meet the energy targets placed upon the development as single technologies; combined with other measures such as further fabric energy efficiency measures or a combination of LZC Technologies these may be provide an alternative solution.

2 Introduction

- 2.1 Churchill Retirement Living are proposing to develop the site currently occupied by two dwelling houses at 127a & 127b London Road in Waterlooville the proposals are to create twenty seven new retirement flats with associated communal areas which will include a resident's entrance foyer at ground floor, circulation spaces and manager's office.
- 2.2 As part of the planning process the development needs to meet the requirements of Havant Borough Council's planning policies with regards to sustainable development the following policy is applicable:

Policy CS14 Efficient Use of Resources

Planning permission will be granted for development that:

- 1. Provides adequate land or funding for waste management infrastructure.**
- 2. Locally contributes to the delivery of the PUSH target of 100MW of renewable energy by 2020 for the whole of the PUSH area. Major areas[#] of development must ensure that their on-site renewable energy production is maximised and resource efficiency is maximised.**
- 3. On completion, unless proven to be financially or technically unviable, meets the following standards:**
 - **Residential development – Level 3 of the Code for Sustainable Homes;**
 - **Multi occupation homes and non-residential development over 500sqm - BREEAM standard 'very good'.**
 - **Improvements to these standards throughout the plan period will be encouraged.**
 - **Particular attention should be paid to water efficiency measures.**
- 4. Allowable Solutions' may be used to achieve higher levels of carbon reduction where on-site proposals are not feasible or viable.**

[#] Major Development Areas are defined as 250 dwellings or more and 5,000 square metres of non-residential floorspace.

- 2.3 NHBC Sustainability Services have undertaken an energy options appraisal to determine the appropriate energy strategy for this development and ensure the development's requirement for finite energy resources is minimised, whilst maximising the benefits of Low or Zero Carbon (LZC) Technologies. Consideration has also been given to renewable and low carbon sources, taking into account energy-efficiency measures to reduce the baseline energy demand. This included an energy analysis of the development.
- 2.4 In order to meet with the high standards of environmental performance for planning the developer has proposed that the development will be assessed against the Code for Sustainable Homes (CfSH) and achieve Level 3* the dwellings will also need to comply with the carbon dioxide emissions target and fabric energy efficiency standard as set by Part L1a 2013 of the approved Building Regulations.

- 2.5 It has also been assumed that in order to comply with planning requirements for energy efficiency in new developments and contribute towards the PUSH Target, the development would be required to reduce CO₂ emissions by 10% when compared to the Building Regulations target as set under Part L1a 2013.
- 2.6 With regards wider sustainability issues the developer's indicative specification shows the development could achieve a CfSH Level 3* Rating. The review provided has been based on the version of the assessor manual as published in November 2010, taken into consideration the Code Addendum (2014) England – May 2014.
- 2.7 Appendix A of this report summarises the developments performance against the various categories within the CfSH and confirms that Level 3* is attainable.
- 2.8 As the design is at an early stage and technical data is not yet available to allow the detailed energy calculations to be undertaken for the development representative information has been sourced from developments assessed previously.
- 2.9 Where renewable energy systems can be modelled by the SAP 2012 methodology, this has been used.
- 2.10 In most cases the system costs are based on benchmark figures, or manufacturers' estimates – they are not intended as an accurate cost guide. The cost of any communal heating system has not been included in the calculations. Where grant funding is available, capital costs could be reduced.

3 Site Description

- 3.1 The current proposals show that once complete the development will comprise of twenty seven retirement flats, and will also include communal facilities: heated circulation areas, an owner's entrance lobby and guest suite. The development is up to three storeys with two areas of traditional trussed roof structure, separated by a flat roof area.
- 3.2 The predicted windspeed for this location (PO7 7SH) is 3.1 m/s (source: [EST Wind Speed Prediction Tool](#)). The Energy Saving Trust does not recommend installing a domestic small scale wind turbine in areas with wind speeds of less than 5 metres per second. Wind speeds of less than 5 metres per second are unlikely to provide a cost effective source of electricity (based on current technologies), therefore this technology has been considered no further in this report.
- 3.3 Self shading by the roof structure may limit the roof area available for use by solar technologies.

4 Background

- 4.1 Planning Policy in England is in the process of undergoing significant change following the passing of the Localism Act on 15 November 2011. In support of this the National Planning

Policy Framework (NPPF) was published on 27th March 2012, with the policies in the Framework applying from the day of publication.

- 4.2 The NPPF incorporates at its heart a 'presumption in favour of sustainable development' and states that this should be seen as a golden thread running through both plan-making and decision-taking. 'For the planning system delivering sustainable development means:

- **an economic role** – contributing to building a strong, responsive and competitive economy, by ensuring that sufficient land of the right type is available in the right places and at the right time to support growth and innovation; and by identifying and coordinating development requirements, including the provision of infrastructure;
- **a social role** – supporting strong, vibrant and healthy communities, by providing the supply of housing required to meet the needs of present and future generations; and by creating a high quality built environment, with accessible local services that reflect the community's needs and support its health, social and cultural well-being; and
- **an environmental role** – contributing to protecting and enhancing our natural, built and historic environment; and, as part of this, helping to improve biodiversity, use natural resources prudently, minimise waste and pollution, and mitigate and adapt to climate change including moving to a low carbon economy.

These three components should be pursued in an integrated way, looking for solutions which deliver multiple goals. There is no necessary contradiction between increased levels of development and protecting and enhancing the environment, as long as development is planned and undertaken responsibly. The planning system must play an active role in guiding development to sustainable solutions.'

- 4.3 The NPPF aims to strengthen local decision making and reinforce the importance of up-to-date local plans. It constitutes guidance for local planning authorities and decision-takers both in drawing up plans and as a material consideration in determining applications. The various planning policy statements and planning policy guidance documents which were in place before the publication of the NPPF have been revoked and replaced by the NPPF, with the different sections of the NPPF setting out guidance for achieving sustainable development.
- 4.4 The Code for Sustainable Homes (November 2010 (Code Addendum (2014) England)) provides an up-to-date national standard for sustainable building practice. It uses a sustainability rating system which assesses nine design categories including energy and water consumption and waste reduction, and gives a dwelling an overall rating on the scale from Code Level 0 through to Code Level 6. There is no mandatory requirement for new dwellings to be assessed against the Code. BREEAM provides a similar standard for multi-residential and non-residential developments.
- 4.5 At the same time, world resources of fossil fuels (i.e. coal, oil and gas and their derivatives) are being depleted and are becoming uneconomic to source. Energy prices in the UK have increased significantly in recent years, partly due to the reserves of natural gas in the North Sea being reduced and consequently a higher proportion of gas and other fossil fuels being imported. Fossil fuel prices have historically been affected by political factors and linked to

global events, and fluctuate due to the consequent market instabilities. This affects both gas and electricity prices, as a significant percentage of electricity in the UK is generated from gas. As the proportion of imported gas increases over time in the medium term, prices are likely to increase further. Governments therefore attach a high level of importance to security of energy supply.

- 4.6 Therefore, there are legislative requirements and political and economic incentives, in addition to environmental reasons, to reduce both carbon dioxide emissions and energy consumption.

5 Building Regulations

- 5.1 Building Regulations Approved Document Part L1A (2013) for new-build self-contained residential dwellings has four main requirements at the design stage:

- Dwelling Emission Rate must not be greater than the Target Emission Rate
- Dwelling Fabric Energy Efficiency (DFEE) must not be greater than the Target Fabric Energy Efficiency (TFEE) – this is a new measure in Part L which ensures a fabric first approach to compliance
- Minimum standards for thermal performance, e.g. relating to U-values, air permeability and thermal bridges
- Minimum standards for efficiency of services.

- 5.2 Approved Document Part L2A (2013) applies to new-build developments which are not self-contained residential dwellings. This includes conditioned common areas of residential buildings, and has similar types of requirements to Part L1A, although the levels set depend on the nature of the use of the building and its service strategy.

6 Statement of Energy Use and Carbon Dioxide Emissions

6.1 This statement of energy and carbon dioxide emissions is based on the development built to the proposed specification including energy-efficiency measures, measured using the Building Regulations SAP 2012 methodology for the dwellings, with an allowance for cooking and appliances determined using the guidance contained within Section 16 of the SAP Rating. The SBEM methodology (the non-residential equivalent to SAP) has been used to determine the energy and carbon dioxide emissions associated with space heating, water heating, ventilation and lighting of the heated communal parts. The following figures are based on the developer's proposed fabric specification, along with space and water heating provided by electricity.

	Total Energy Demand (kWh/yr)	Associated Total CO ₂ (kg CO ₂ /yr)
Space Heating	60,855	31,584
Water Heating	41,921	21,757
Pumps & Fans	851	442
Lighting	17,330	8,994
Appliances & Cooking	55,426	28,766
TOTALS	176,382	91,542

Regulated Target CO ₂ Emissions – Flats and Communal Areas (Part L 2013) – Excludes Appliances & Cooking	53,902 kg CO ₂ / yr
Target CO ₂ Emissions (Regulated) – Flats and Communal Areas (Part L 2013) to achieve an assumed 10% Planning Target	48,511 kg CO ₂ / yr
Carbon Dioxide Emissions reduction required to achieve Planning Target	14,265 kg CO ₂ / yr

Reference data used in this report

Emission factors:¹

1kWh electricity	-	0.519 kg CO ₂
1kWh grid-displaced electricity	-	0.519 kg CO ₂
1kWh gas	-	0.216 kg CO ₂
1kWh biomass (wood logs to pellets)	-	0.016 to 0.039 kg CO ₂

Purchase fuel prices:²

Electricity	-	12.44 p/kWh
Gas	-	5.27 p/kWh

¹ From SAP 2012 methodology and Approved Document Part L1A & L2A (2013).

² Domestic tariff. Taken from Scottish Power Domestic Dual-fuel Tariffs, based on no standard charge and variable rate dependent on fuel usage (kWh), March 2013. For mains gas, the higher rate (base usage) has been adopted as these highly insulated dwellings are unlikely to exceed the threshold consumption. For electricity, the lower rate (peak usage) has been adopted as this will form the basis of the savings.

7 Methodology

- 7.1 Typical sample flats on a similar development (at Hall Lane in Chingford) have been assessed using SAP 2012. Detailed information was taken from the DER (Dwelling Emission Rate) worksheets to provide a breakdown for the residential areas of space heating, water heating, lighting, pumps and fans. The assessments have been based on the developer's proposed specification, without the inclusion of low or zero carbon equipment.
- 7.2 The non-flatted areas on the same development as noted above, have been assessed using IES's Virtual Environment and the latest SBEM methodology applicable to Part L2a 2013 (VE 2014 – BRUKL Compliance Check: v4.1.e.5). Information extracted from this SBEM assessment has then been used to establish the baseline CO₂ emissions associated with the provision of space and water heating, lighting and ventilation to the communal areas within this development.
- 7.3 The baseline has been established on electric space heating and water heating. Churchill Retirement Living have proposed this approach as it is a direct comparison to their specification traditionally used in a development of this type to comply with older versions of Part L which, for reasons of flexibility, control and thermal comfort, they consider to be the most appropriate taking into account their residents profile.
- 7.4 Sizing renewable energy technologies on a percentage CO₂ savings requirement is a relatively new planning requirement and there are some publications that set out methodologies for doing so:
- The 'Renewables Toolkit' (Integrating Renewable Energy Into New Developments: Toolkit For Planners, Developers And Consultants), GLA in association with London Renewables and London Energy Partnership, September 2004
 - Low or Zero Carbon (LZC) Technologies, ODPM, March 2006.
- Both of these are over eight years out of date, and are hence cited for reference.
- 7.5 Once the carbon dioxide emissions and energy demand for the site had been determined, and the relevant targets calculated and energy efficiency measures taken into account as applicable, the various renewable energy technologies set out in the section Ene 7 LZC Technologies of the Code for Sustainable Homes were analysed and appraised for their suitability due to their economic and technical feasibility, and the suggested option(s) selected.
- 7.6 Where technologies can be modelled by the SAP 2012 methodology, i.e. for photovoltaics, and individual solar thermal systems, individual and communal biomass boilers and heat pumps for heating, this has been used, as it is the method applicable to the CfSH assessment. For other technologies, manufacturer's data or the Renewables Toolkit have

been used as appropriate, details of the technologies would need to be provided to BRE at an early design stage for their approval and determination of energy provided

- 7.7 Each technology has been assessed for its economic viability. For this, an estimate has been made of the annual energy cost savings, taking account of estimated annual maintenance costs where known, and fuel costs where appropriate. Simple payback times have also been calculated - however, these assume current and constant fuel/electricity prices; higher fuel prices will reduce payback times and vice versa. Where generated electricity cannot be used on site, the surplus can be sold back to the grid. However, at present this is generally less economic. For simplicity, the calculations assume that all generated electricity is used to offset grid electricity.
- 7.8 'Feed in Tariffs' introduced from the 1st of April 2010, allow householders/ landlords to benefit financially from the installation of micro generation technologies in three ways:
- **Generation tariff** – a set rate paid by the energy supplier for each unit (or kWh) of electricity generated. This rate will change each year for new entrants to the scheme (except for the first 2 years), but households will continue on the same tariff for 20 years, or 25 years in the case of solar electricity (PV). From August 2012 for PV the tariff was set at 16 pence per kWh – depending on the size of installation (prior to the 12th December 2011 the tariff was up to 43.3 pence per kWh).
 - **Export tariff** - a further 3p/kWh will be received from the energy supplier for each unit exported back to the electricity grid, that is when it isn't used on site. The export rate is the same for all technologies.
 - **Energy bill savings** – direct savings on electricity bills, because generating electricity to power appliances means not so much electricity has to be bought from the supplier.
- 7.9 Communal lighting energy use is not included in the figures for self-contained residential dwellings as it is not a feature of the SAP software, but it is included in the total energy use by the SBEM methodology for the common areas.
- 7.10 The energy use for lighting external to the building is not considered in either of the calculations (i.e. entrance lighting and external space lighting) and will be minimised by specifying dedicated energy-efficient fittings, which have an efficacy of at least 45 lumens per circuit watt, and energy efficient lighting controls appropriate to these areas.

Examples of appropriate lighting controls for these areas are:

- Entrance areas - either daylight sensing or timer-control (set to come on in the absence of daylight / dusk-dawn only).
- Burglar security lighting to be a maximum of 150watts and provided with both PIR and daylight control.

- 7.11 It should be noted that actual building energy consumption and hence carbon dioxide emissions are likely to, in practice, differ from the predicted figures, due to the variability of occupant behaviour.
- 7.12 In most cases the system costs are based on benchmark figures, or manufacturers' estimates – they are not intended as an accurate cost guide. Note that the cost of the plant room, central gas boilers, heat distribution network and HIUs have not been included in the calculations of the payback time, where applicable, as these items would be required anyway with a standard communal heating system without any renewable energy component.
- 7.13 Each technology has been assessed for its ability to reduce energy demand and offset carbon dioxide emissions, when compared against the baseline data for the development. Estimates have been made using what is considered to be the best available data.
- 7.14 At the detailed design stage, it will be necessary to undertake further energy calculations for the development (i.e. SAP 2012 for the flats and SBEM assessments for the heated communal areas). The sizing of the proposed technologies will then need to be amended accordingly. It is recommended that at this later stage, more specific costing data should be obtained from suppliers for the finalised renewables strategy.
- 7.15 The key dwelling types and non-dwelling areas analysed were as follows, selected to be representative of the development:
- 1 Bedroom Ground Floor (8 no. on development)
 - 1 Bedroom Mid Floor Flat (6 no. on development)
 - 1 Bedroom Top Floor Flat (5 no. on development)
 - 2 Bedroom Ground Floor Flat (2 no. on development)
 - 2 Bedroom Mid Floor Flat (2 no. on development)
 - 2 Bedroom Top Floor Flat (4 no. on development)
 - (the above breakdown reflects the heat loss characteristics of the flats and not the actual floor location within the building)
 - Heated Communal Areas – 430m² (approximately)

8 Energy-efficiency

- 8.1 The most cost-effective method of improving energy-efficiency and reducing the long-term carbon dioxide emissions of a new development is typically through improvements to the design and layout of the buildings and to the thermal performance of the building fabric. Together these factors will affect the building for its entire life, much longer than the lifetime of any heating system or renewable energy technologies.
- 8.2 Passive design methods and features to reduce the development's energy demand may include the following (on brownfield sites it is difficult to embrace all of these issues):
- All living areas to face south where possible and to have larger glazed areas, to maximise the benefit of daylighting and solar gains (especially useful in the winter as it reduces the heating demands). Because this is a redevelopment of an infill site opportunities are limited in this respect, in addition the density of the site means some of the dwellings will be plotted to face north east/ north west
 - Sleeping areas, kitchens and bathrooms to face north where possible, and have smaller glazed areas to minimise heat losses
 - External shading of rooms as necessary to prevent summertime overheating, and prevent the need for cooling equipment.
- 8.3 Measures to improve the thermal performance of the building's fabric focus on specifying higher levels of insulation for the roof, external walls and floor, and the upgrading of windows and doors to higher performance units. Other important measures include the achievement of lower air permeability and the minimisation heat loss through thermal bridges (junctions in the building fabric, and openings through building structure).
- 8.4 The specification of low-energy appliances, although reducing energy consumption, does not lower the Dwelling Emission Rate (DER) in SAP 2012. This is because the DER does not take into account energy consumption from appliances. Similarly, energy savings achieved through fitting low-flow hot water taps and showers are not taken into account.
- 8.5 It is assumed that the carbon dioxide emissions will be reduced initially through energy-efficiency measures as this is likely to be a cost-effective route to reduce initial carbon dioxide emissions and consequently the quantity of renewables required.
- 8.6 This has been confirmed to be potentially achievable for the dwelling types assessed with the following specification:
- U-values as follows:
 - U-value of heat-loss floors $0.12 \text{ W/m}^2\text{K}$
 - U-value of heat-loss walls $0.23 \text{ W/m}^2\text{K}$
 - U-value of party walls to be $0.00 \text{ W/m}^2\text{K}$
 - U-value of roofs $0.12 \text{ W/m}^2\text{K}$

- U-value of windows 1.5 W/m²K (transmissivity of glass = 0.63 e.g. double glazing with low-e coating, Argon fill, 12mm gap)
- Air permeability of less than 5.00 m³/hm² when tested at 50 Pa
- Thermal bridges minimised by adopting accredited construction details or equivalent
- Electric heating with time and temperature control (panel heaters used to provide baseline data)
- Heat loss through the domestic hot water cylinder minimised to 1.31 KWh per day (It has been assumed that individual hot water cylinders are specified to each dwelling, except for the option where a communal air source heat pump provides domestic hot water)
- Energy-efficient light fittings to 100% of fixed internal light fittings under Part L1a 2013 and for the purposes of this report, this will reduce the baseline CO₂ emissions
- Centralised Mechanical Ventilation.

Note that the following site assumptions are made:

- Average exposure and overshadowing
- Window reveals of 0.01m
- Heat emitters: radiators
- Secondary heating as per Part L1a requirements
- No open flues or chimneys

8.7 The above specification achieves an area weighted DFEE of 37.4, compared to a TFEE of 38.7 (both kWh/m² per year), representing a 3% improvement of the target set by Part L1a.

9 Combined Heat and Power (CHP)

- 9.1 Combined Heat and Power (CHP) involves a generator powered by any fuel which produces electricity and heat simultaneously, in the same way as a power station. However, it can be much more efficient than a power station because both the electricity and the heat can be used (power stations typically expel waste heat to the atmosphere), and can generate electricity for local use thereby reducing transmission losses. The electricity generated can be low carbon due to these reasons, and the carbon dioxide emissions can be further reduced if a low-carbon fuel is used: the most common fuel for CHP is natural gas, which is inherently lower carbon than the coal-dominated mix of fuels used for electricity generation for the national grid.
- 9.2 Biomass is emerging as a fuel for CHP which will further reduce carbon dioxide emissions. This is considered as renewable energy and is discussed in more detail in a later chapter.
- 9.3 CHP brings significantly larger carbon savings to mixed use developments which have a large and constant demand for either heating or cooling. This is because the ratio of production of heat and electricity is dominated by heat (by a ratio of between 2:1 for a large engine to as high as 10:1 for domestic-scale micro-CHP) so without a large heating or cooling demand, either very little electricity is generated or waste heat is produced. Also if plant is operating at a low or variable output it is much less efficient. This can make carbon savings marginal, and can even lead to higher carbon dioxide emissions than using grid electricity and heat provided by a gas condensing boiler, due to the overall lower efficiency of a CHP engine. CHP units are typically sized to meet the constant heating demand, which for residential developments is the hot water demand. It is considered bad practice to size to the electricity demand and 'dump' waste heat. Excess electricity can be exported to the national grid and this is standard practice. For most developments the CHP will not generate sufficient electricity to meet the full demand over a full yearly cycle. CHP can be viable for residential developments but a certain size and density is required before the benefit of the CHP overcomes the lower efficiency and heat and electricity transmission losses.
- 9.4 CHP plant sizes range from large-scale units (typically >2MWe) suitable for large mixed-use developments, through small-scale 'mini' units (e.g. 30kWe-2MWe, suitable for communal heating systems) down to micro-CHP (under 30kWe) intended for individual buildings (and also specialist uses such as for boats).
- 9.5 CHP can also meet building cooling demands, often by absorption cooling, where heat generates coolth through the expansion of a refrigerant gas. This is a very cost-effective and low-carbon method of cooling buildings compared with conventional systems, which typically run using grid electricity. Therefore, the presence of a summer-time cooling load can help to balance the winter heating demand and hence make CHP more viable. A CHP

system that additionally provides cooling is known as CCHP (Combined Cooling, Heat and Power).

- 9.6 Micro-CHP for individual dwellings can typically reduce carbon dioxide emissions by at least a few percent. However, this technology is not a fully proven technology yet, and is also best suited to older dwellings with a high space heating demand as this will enable more carbon dioxide emissions to be offset as more electricity is generated. Micro-CHP engines are not currently available on the market.
- 9.7 The relatively small size and low density of this development makes a communal system less viable due to infrastructure costs and management implications.
- 9.8 The figures given in the summary are based upon 'rules of thumb' and published benchmarks, and as such should be used only as a guide: the feasibility and economic viability of CHP depends critically on the combined heat and power profiles, and must be assessed in detail by a specialist before proceeding.
- 9.9 ESCos (Energy Services Companies) can provide a 'turnkey' solution with respect to a CHP plant and/or district heating systems. They typically take full responsibility for the entire heating system, supplying and installing, in addition to managing and maintaining all the equipment, although other arrangements may apply. The ESCo then supplies heat and power to the development, charging users a price for delivered heat and electricity, in order to cover their costs.
- 9.10 Due to the small size of the development it is unlikely an ESCo would be interested in being involved.
- 9.11 Gas CHP plant has an expected lifespan of around 15 years.
- 9.12 At this time, grant assistance is not available for gas CHP plant, although the technology can qualify for Enhanced Capital Allowances, subject to terms and conditions³.
- 9.13 For this development, a CHP system is considered to be not likely to be viable. CHP requires a good year-round heat demand to operate efficiently, and this development requires only hot water demand, on an insufficiently large-scale to justify CHP as efficient engines with this low level of output are not currently available. Furthermore the move from SAP 2005 to SAP 2009, and changes to Part G of the Building Regulations (Water Consumption), have reduced the assumed hot water demand within a dwelling. Comparing the SAP 2005 and SAP 2009 calculations undertaken on the flats reviewed on this site, the reduction in hot water energy requirements is about 30%, further reducing the potential for specification of CHP.

³ <http://www.eca.gov.uk/>

10 Analysis of Renewable Energy Options

10.1 The Code for Sustainable Homes, EcoHomes and BREEAM assessments refer to Low and Zero Carbon (LZC) technologies which are noted in the following table, as well as gas CHP and others. This report has been expanded to consider these other technologies but most have been considered unlikely to be feasible for this site. Gas CHP has also been included in the table as this is a low-carbon technology which can help reduce the benchmark carbon dioxide emissions when a renewable energy target applies:

Technology		Output			
	Low-carbon (LC) or zero-carbon (ZC).	Electricity	Domestic hot water	Space heating	Space cooling
Gas CHP	LC	√	√	√	√
Photovoltaic (PV) panels	ZC	√			
Solar thermal	ZC		√	(√)	
Biomass boiler	LC		√	√	
Heat pump (for heating)	LC		(√)	√	
Heat pump (for cooling)	LC				√
Biomass CHP	LC	√	√	√	√

10.2 Where outputs are indicated in parentheses, the technology generally only makes only a minor contribution to the total demand, and/ or requires a specific configuration which is not standard practice.

10.3 At this stage, heat pumps for cooling can be omitted from the list of appropriate technologies for this development, as there is no confirmed cooling demand to the flats or communal areas of the building.

10.4 The remaining technologies have been assessed in turn for their financial and technical feasibility, and each one is summarised in the following chapters.

11 Photo-Voltaics

- 11.1 The energy in sunlight is converted directly into electricity by photovoltaic (PV) cells, which are semiconductor devices. No moving parts are involved. Individual cells only generate low voltages and currents, so they are usually grouped in rectangular 'modules' that comprise a transparent cover, a metal mounting frame and a backplate, thus forming a weatherproof enclosure. Modules are often grouped into arrays. PV cells can also be moulded into solar slates or solar tiles for integration into roofs, or bonded onto glass or metal sheets for incorporation into architectural glazing and fascia systems.
- 11.2 For this development, the roofs are pitched at about 40°, with areas of traditional trussed roof structures, separated by a flat roof valley. The roof structure is disjointed in its orientation, with areas of pitched roof facing north/south & east/west; the optimum position for solar panels therefore would be on the southerly facing roofs.
- 11.3 The system proposed as likely to be the most suitable for the trussed roofs are solar tiles such as the Solar C21e which are visually very similar to a standard tile for a pitched roof; for the flat roof areas other systems may be more suitable, Solar PV modules could provide part of the solution.

Photovoltaics: technology summary – based on available roof area	
General:	
PV selection	Solar C21e
Technology type	Monocrystalline
Panel efficiency	14.9 % (for whole panel) 20.0% (cell efficiency)
Roof pitch	40°
Estimated efficiency loss due to pitch & orientation	1.80% - when facing south 20% - when facing east/west
Average level of overshadowing	Overshadowing is low for the majority of the roof
System performance to meet Planning Target	
Estimated annual energy production (Done using SAP 2009 Table H2)	16,752 kWh per year
Estimated annual CO₂ offset	8,694 kg CO₂ (Target Reduction = 14,265)
System peak power	21.31 kW(peak)
Estimated lifetime CO ₂ savings ⁴	173,886 kg CO ₂
System physical characteristics:	
Required number of panels	263 – Facing South @ 40° 146 – Facing East/ West @ 40°
Required roof area⁵	135m² - Facing South 75m² - Facing East or west
Other land use requirements	None
Other issues:	
Impact on services	Minimal. May need 'three-phase' connection.
Impact on roof structure	8 kg per panel, however each panel will replace the

⁴ Assumes an operational lifetime of 20 years

⁵ This is a theoretical figure – actual systems are made of a whole number of panels of pre-defined size, dependent upon the manufacturer

	same area and associated weight of traditional tiling/ slating.
Noise impact	Usually the only system noise is from the inverter cooling fans, which, if audible at all, should be no louder than computer cooling fans.
Visual impact	Modules are usually visible, although often not unattractive, and can be integrated within a building's cladding or roof structure. PV installations can advertise the green credentials of their owners.
Local planning requirements	Needs to be considered, particularly in conservation areas, although roof integrated solar tiles could avoid any such issues. Planning permission will usually be needed in conservation areas and national parks, and on listed/heritage buildings where the PV surfaces – typically a glossy deep blue – might clash aesthetically.
Life cycle assessment (cost and carbon dioxide)	Relatively high embodied energy/ carbon dioxide emissions, but will repay within a few years. Long lifetime with low maintenance requirements and costs.
Potential for export of energy	The system will typically be grid-connected and export at times of excess generation of electricity.
Technical feasibility	Poor – as a single technology it is unlikely that there will be sufficient roof space available to effectively incorporate Solar PV in order to meet the planning requirements.
Economic appraisal:	
Equipment budget⁶ (based on 2.5k per kWp)	£53,279
Displaced electricity cost per annum	£4,764
Estimated payback time	11 Years
Available grant funding	Not known to be available – incentive now through Feed in Tariffs
Economic feasibility	Reasonable

⁶ Includes inverters and other system components, and installation

12 Solar Thermal

12.1 Solar collectors (panels) absorb solar radiation and convert it to heat which is transferred to a hot water cylinder by circulating fluid through a series of pipes to pre-heat the water in the cylinder. This pre-heated water is then further heated to useable temperature by an auxiliary system (boiler or electric immersion heater). Solar hot water systems do not usually contribute to the central heating system. There are two standard types of collector: flat plate and evacuated tube.

12.2 See Section 11.2 for commentary relating to roof pitch and orientation.

12.3 A communal system would be proposed for this development as the simplest way to integrate the required pipework into the building.

Solar thermal: technology summary	
General:	
Panel selection	Velux CLI SO8 4000
Technology	Flat Plate
Roof pitch	40°
Estimated efficiency loss due to pitch & orientation	1.80%
Average level of overshadowing	Overshadowing is low for the majority of the roof
System performance:	
Estimated annual energy production (reduction in energy demand achieved by Solar Water Heating)	22,998 kWh – figure based on SAP data for typical flats
Estimated annual CO₂ offset	11,936 kg CO₂ per year 5.68% reduction over Building Regulations Target
Estimated lifetime CO ₂ savings ⁷	238,717 kg CO ₂
System physical characteristics:	
Required number of panels	28 (one per dwelling + one for the communal areas)
Required roof area⁸ (assumes 2.5m² per panel)	70 sq m
Other land use requirements	None
Other issues	
Impact on services	Dual-coil hot water cylinder required per dwelling, or communal thermal store typically required per block of flats
Impact on roof structure	Additional 50 kg per panel (typical), if roof integrated this will be offset by reduction in standard tiling/ slate loads.
Noise impact	Usually the only system noise is from the small circulation pump which, if audible at all, should be no louder than a modern central heating pump.
Visual impact	Planning permission will usually be needed in conservation areas and national parks, and on listed/heritage buildings. Collectors are usually visible, although often not unattractive, and can be integrated within a building's cladding or roof structure, or incorporated

⁷ Assumes an operational lifetime of 20 years

⁸ This is a theoretical figure – actual systems are made of a whole number of panels of pre-defined size, dependent upon the manufacturer

	within skylight modules.
Local planning requirements	Needs to be considered, particularly in conservation areas, although roof integrated solar thermal tiles could avoid any such issues.
Life cycle assessment (cost and carbon dioxide)	Low embodied energy/ carbon dioxide emissions which is repaid within a few years (faster than photovoltaics for example). Long lifetime with relatively low maintenance cost requirements.
Potential for export of energy	There is generally insufficient heat generated by a solar thermal system to make export of heat viable.
Technical feasibility	Poor – as a single technology it is unlikely to meet with planning requirements.
Economic appraisal:	
Equipment budget⁹	£140,000
Displaced fuel cost per annum (electric)	£2,861
Estimated payback time	49 years 8 to 20 years generally quoted: depends on fuel displaced, conversion efficiency, and fossil fuel/energy price escalation. Solar thermal systems generally have payback times in excess of 10 years but actual figures depend on the system type and orientation. Reduced hot water demand assumed in SAP 2012, means that this technology gives a lower output and lower reduction of carbon dioxide emissions compared to a similar assessment done using SAP 2005. If the occupier has not paid for the installation (e.g. housing association properties), the payback is not their concern. Savings start immediately, and so this technology can help to relieve fuel poverty.
Available grant funding	Not known to be available – renewable heat incentives are available, but only to individual homeowners.
Economic feasibility	Reasonable

⁹ Estimated system cost including installation. Communal systems require more complex and longer pipe runs than those found in one/ two storey housing.

13 Biomass

13.1 Biomass Boilers (Communal)

- 'Biomass' in the domestic sector nearly always refers to wood fuel, as wood chip is rarely suitable at this scale. Biomass is only a renewable resource if the trees are replaced once felled for fuel:
- Logwood – derived from coppiced, pollarded, or felled trees with minimum processing, but which does need prolonged seasoning to reach the desired moisture content.
- Wood pellets – which are formed from dry seasoned wood waste (e.g. from furniture factories) and which suit fully automated fuel handling and combustion control.

13.2 Points to remember:

- Not all biomass equipment is approved for operation in smokeless zones.
- Some models have very hot ($>200^{\circ}\text{C}$) exposed surfaces.
- Never oversize as low output levels can result in incomplete combustion, tar formation in flues, etc. and shorten system life.
- A dry, covered fuel store is required with adequate space – wood is bulky, and often bulk discounts depend on logs or pellets being delivered in sizeable quantities, e.g. tonne loads.
- When not in use for extended periods (e.g. over the summer), appliances need to be thoroughly emptied of ash, stripped internally, and cleaned out to avoid corrosion problems.
- Flues should be inspected pre- and post-heating season, and swept as necessary.
- If devices are not fitted with automatic ignition, then once lit they will stay lit whether there is a demand for heat or not. Slumbering, i.e. burning with a low flame continues to consume fuel and produce some heat, usually in the range 10%–15% of rated output.
- If heat dumping (usually to a single radiator) during boiler slumber periods is undesirable, then a thermal store can be incorporated into the LPHW circuit: this can accumulate heat for later use and also help to meet peak heat demands, thus also addressing another problem – the inclination to oversize the boiler (see third bullet point above).

13.3 Because of capital costs, human input (the requirement to fill the biomass boiler), and fuel price disparities, biomass systems have rarely, in the past, been installed in the UK where gas is available. Space for fuel storage, and to accommodate the heating equipment (which is usually larger than the equivalent gas- or oil-fired device), is required. Biomass appliances are not available for wall-mounting. Neither Individual biomass boilers nor a Communal biomass system (with centralised boilers and heat network) have been considered likely to be feasible for this development. The predominant issue is capital and

operational cost, and ongoing management issues of operation and fuel delivery. For a communal system, the cost of the heat network is also a key consideration.

14 Biomass CHP

- 14.1 The term 'renewable combined heat and power' usually refers to the use of biofuels rather than the gas or oil used in more traditional CHP system installations. Such biofuels include biogas (perhaps from landfill), wood and farm waste. At present the only renewable CHP plant operating in the domestic sector in the UK is operating at a community scale. Renewable CHP is an emerging energy technology that is only available at the community scale. Higher levels of insulation and the general trend in the domestic sector of reduced heat demands and increasing electrical demands may make community scale heating schemes less attractive on a purely economic level. However, their CO₂ saving potential and the benefits with regard to addressing fuel poverty may make this technology politically, ethically and environmentally an attractive option for many new and existing housing developments.
- 14.2 For the same reasons as stated for gas CHP (Section 9 of this report), biomass CHP is unlikely to be an effective technology for this development. In fact, biomass CHP is only currently available at a much larger industrial or community scale compared to gas CHP. Therefore it has not been considered any further in this report.
- 14.3 CHP powered by sewerage gas or other biogases is a similar technology with very similar impacts. It has not been considered likely to be feasible for this development due to a lack of suitable fuel source in the vicinity, and the early stage of development of the technology.

15 Heat Pumps

Ground-source Heat Pumps for Heating

- 15.1 Ground source heat pumps (GSHPs) use the same principle as a refrigerator, circulating liquid refrigerant to absorb the energy (heat) from a space. The refrigerant on one side of the circuit (the evaporator) evaporates from a liquid to a vapour and absorbs heat energy in doing so. This is later compressed on the other side of the circuit (the condenser) causing its pressure and temperature to rise and the vapour reverts to a liquid. The hot refrigerant passes through a heat exchanger – in a domestic refrigerator this is attached to the rear – transferring heat to the surrounding environment and cooling the refrigerant. The cycle is continuous.
- 15.2 Open-loop GSHP systems using ground water were the most widely used type because the ground water could be extracted and returned using inexpensive wells that required little ground area. But available water is limited, and can foul the evaporator and cause corrosion of the pipework. In addition, there are increasingly stringent environmental regulations on the use of ground water.
- 15.3 Closed loop or ground coupled systems are now the more favoured solution and use a sealed ground heat exchanger (a sealed loop of pipe) buried either horizontally (using a slinky-type coil to maximise the heat extraction from the trench) or vertically (by boring) in the ground. Refrigerant can be circulated directly through this ground heat exchanger (direct expansion systems) but refrigerant leakage and contamination risks make an indirect system using a water/antifreeze solution and heat exchangers the preferred option.
- 15.4 Heat Pumps tested under SAP Appendix Q tend to deliver higher efficiencies than the efficiencies assumed in SAP 2012. The following website contains a searchable database which can be used to source a tested system, this is only however applicable to ASHPs serving individual dwellings:

- <http://www.sap-appendixq.org.uk/page.jsp?id=1>

Air-source Heat Pump for Heating

- 15.5 Air source heat pumps (ASHPs) use the same principles as the GSHP described previously. The basis of the heat pump, therefore, is to take low-grade energy from the surrounding air by means of a fan pulling the outside air over a heat exchanger (evaporator); this energy is then upgraded and the higher temperature refrigerant vapour is released by means of another heat exchanger (condenser).
- 15.6 In ASHPs this heat exchange can be to the air inside the dwelling, and distributed to the different rooms by ducts and supply grilles. Alternatively, the heat exchange can be to water; it is this hot water that is the basis for the dwelling's heating circuit. This heating circuit can be an under-floor heating system or fan-coil units installed in the different rooms, or a combination of the two.

- 15.7 ASHPs are not particularly suited to cold winters, where coils may need to be defrosted or an alternative source of heating used in particularly severe conditions.
- 15.8 They are best suited to new build applications as they are most efficient when supplying low temperature distribution systems such as under-floor heating. Heat pumps have a typical operating temperature limit of 55°C and are not suitable to provide all the heating load (monovalent system). However, it is worth considering a bivalent system where the heat pump is used to provide the base heating load, with an auxiliary system covering the additional heating demand. However, all these factors act to reduce the carbon dioxide emission savings of the technology compared to a standard gas boiler.
- 15.9 Cost-effectiveness is difficult to evaluate because of the need for auxiliary heating and 'down-time' due to unsuitable source air conditions. However, it is likely to be similar to that of a GSHP. ASHPs form the largest market share of all the heat pump options, but most of these installations rarely perform the heating duty and are mainly used in their reversible mode to provide cooling.
- 15.10 Heat Pumps tested under SAP Appendix Q tend to deliver higher efficiencies than the efficiencies assumed in SAP 2012, the following website contains a searchable database which can be used to source a tested system, this is only however applicable to ASHPs serving individual dwellings:
- <http://www.sap-appendixq.org.uk/page.jsp?id=1>
- 15.11 For this development a communal system would be preferable, as it would allow for all the external plant to be concentrated into one plant room which could be coherent visually with the overall design, rather than a separate external unit for each dwelling. For the purposes of the technical and economic analysis SAP 2012 has been used to assess the performance of two different scenarios (with a comparative estimate made for the communal areas):
- Option 1 – Communal GSHPs/ ASHPs – providing space and water heating to flats, and space heating to communal areas
 - Option 2 – Communal GSHPs/ ASHPs – providing space heating only
- 15.12 An efficiency of 400% has been used in the SAP Calculations, this has been taken from similar developments, which have been provided with design data on the proposed system, the final figure used in the SAP calculation would need to allow for the performance of the specific model of heat pump installed and any other additional heat sources required to supplement heat demand at peak times.

Air/ Ground-source Heat pump (heating): technology summary	
General:	
Model:	Dimplex
System performance:	
Contribution to building's energy requirements	Would require confirmation from installer, and would affect the overall seasonal efficiency of system.
Estimated annual reduction in Total Energy Demand	Option 1 – 67,226 kWh per year (55.6%) Option 2 – 41,837 kWh per year (34.6%)
Estimated annual CO₂ offset (Against Part L Target)	Option 1 – 26,016 kg of CO₂ per year (48%) Option 2 – 12,839 kg of CO₂ per year (24%)
Estimated lifetime CO ₂ savings ¹⁰ (Whole Development)	Option 1 – 520,314 kg CO ₂ Option 2 – 256,773 kg CO ₂
Suggested heat pump size (output)	Would require confirmation from installer
System physical characteristics:	
Estimated plant room size	This would need confirmed by the system designer.
Other land use requirements	For communal heat pumps, an 'external' plant room would be required – this could be an enclosed space with louvres to allow ambient air to pass through.
Other issues:	
Impact on services	Underfloor heating system recommended for optimum efficiency. 3-phase electricity supply needed. An immersion coil is needed in the hot water cylinder for peak load and back-up. Otherwise the heat pump replaces space and water heating sources.
Noise impact	Heat pumps can emit constant noise due to the operation of the fan and compressor. Although this is generally low level noise, locating heat pump units in close proximity to neighbouring properties should be avoided.
Visual impact	An 'external' plant room would be required for communal system, however this could be designed to blend into the overall design and is likely to be preferable to individual units which would require separate external fan coils – similar to condensers normally associated with air conditioning units.
Local planning requirements	The plant room location and size would need to be fully agreed with the planning authority.
Life cycle assessment (cost and carbon dioxide)	Low embodied energy/ carbon dioxide emissions, repaid within a few years. The internal components have long life expectancy and high reliability, and therefore there are low maintenance costs.
Potential for export of energy	Heat can be exported in principle but the high efficiencies of small systems means that this would rarely be undertaken.
Other	None
Technical feasibility	Heat Pumps could be used to contribute towards the targets set by Policy CS14
Economic appraisal:	

¹⁰ Assumes an operational lifetime of 20 years

Equipment budget ¹¹	£5,000 per dwelling (provided by the developer for ASHP providing space heating only; the cost for providing both space and water heating would need to be confirmed by the supplier, but is assumed to be at least 20% more).
Annual fuel saving per annum ¹² (Compared to base case)	Option 1 - £8,363 Option 2 - £5,205
Estimated payback time	27 Years (ASHP providing space heating only) ASHP providing space and water heating would be expected to have a much shorter payback based on the annual fuel savings calculated.
Available grant funding	Not known to be available – renewable heat incentives are available, but only to individual homeowners.
Economic feasibility	Reasonable

¹¹ Estimated system cost including installation, but excluding cost of underfloor heating system. Also excludes the cost of the heat main and HIUs needed for a communal system.

16 Other Renewable Technologies

16.1 There are a number of other technologies that are suitable on a limited number of sites with special conditions in place, but were not feasible for this development.

16.2 Micro-scale hydro power technologies:

- This includes water wheels and more sophisticated technologies utilising the energy of moving water. On sites with a suitable water feature such as a fast-flowing river, this could be a LZC technology worth considering. However, it was not considered likely to be feasible on this site due to the lack of such a feature.

16.3 Tidal power and wave power:

- Tidal barrages and other technologies can harness the energy of the sea and tidal watercourses. However, this site is inland with no such watercourses and therefore this technology is not appropriate.

16.4 Biomass single-room heaters/ stoves:

- These can be a feasible technology to retrofit in an existing home when the central heating system is being retained, and can be a striking and attractive feature. However, they will provide lower carbon dioxide savings than a biomass boiler due to their limited usage, and have similar management and fuel storage issues, so there are unlikely to be many circumstances where biomass room heaters or stoves would be preferred to biomass boilers for new-build development. They are not considered likely to be feasible on this site for this reason.

16.5 Fuel cells:

- Fuel cells are a developing technology, with more immediate potential in industrial processes and transport. However, in the near future they could be a source of heat and power for homes and other types of building, if they become available on an appropriate scale. If they are powered by hydrogen generated by a renewable energy source then they are a potentially feasible way of reducing carbon dioxide emissions. However, they have not been considered likely to be suitable for this development due to lack of proven technology at this time. However, they could be worth investigating as the technology develops.

16.6 Energy from waste:

- Small-scale energy from waste (e.g. domestic refuse) is not currently commercially available, as only at large scale are sufficient temperatures possible to overcome pollution issues and the variability of the fuel source. However, on very large developments of at least several hundred homes, or where an existing heat network can be tapped into, then this could be a feasible technology for reducing carbon

dioxide emissions. It has not been considered likely to be suitable for this development because the development is not of a sufficient scale and there is no existing heat network in the vicinity.

16.7 Community heating, e.g. utilising waste heat or biomass fuel:

- On very large developments of at least several hundred homes with a suitable source of waste heat in the vicinity (e.g. a power station), or a suitable source of fuel such as biomass, or where an existing heat network can be tapped into or a new one set up, then this could be a feasible technology for reducing carbon dioxide emissions. It has not been considered likely to be suitable for this development because the development is not of a sufficient scale and there is no existing heat network or heat source in the vicinity.

16.8 Geothermal heating systems

- Where the site has a suitable source of geothermal heat, then this is a possible option for reducing carbon dioxide emissions. It has not been considered likely to be suitable for this development because of a lack of any known source in the vicinity.

16.9 Note on export of heat and electricity:

- The feasibility of exporting heat and electricity from the system has been considered. In the case of electricity, contact would be made with the local electricity provided to discuss a grid connection for export of excess generated electricity, and this would be set up if possible. Exporting heat would be more problematic as there is no infrastructure in place for this, and there is no significant demand for heat in the vicinity as neighbouring properties are residential so would be expected to have a relatively low heat demand, and have little incentive to join to a heat network.

17 Summary of Energy Options

17.1 The site is a small site with limited viable options for incorporating renewable energy. The technologies considered focus on those suitable for application on a small/ individual building scale.

Technical Feasibility of Technologies to Meet Required Target

Technology	Technically Feasible	Reason	Comments
Solar Water Heating	Unlikely as sole solution	Technology developed and readily available for building integration. Suitable roof area, slope & orientation could be accommodated on this development to make this technology viable.	Solar water heating in itself is unlikely to be able to provide a large enough carbon reduction to achieve the Planning Requirements.
Photo-voltaics	Unlikely as sole solution	Technology developed and readily available for building integration. Suitable roof area, slope & orientation is available.	It is unlikely sufficient roof area can be accommodated to achieve the Planning Requirements for reducing in CO ₂ emissions.
Ground Source Heat Pump	Likely	Sufficient space is likely to be available on site. The technology has the ability to offset at least 24% of the developments CO ₂ emissions when compared to the Building Regulations target.	Ground conditions need to be assessed for suitability for horizontal heat collection loop. Careful consideration of the design of the communal heating system will be required in order to minimise uncontrolled heat loss to communal areas. Current development proposals would need to be updated to include for a plant room.
Air Source Heat Pump	Likely	The technology has the ability to offset at least 24% of the developments CO ₂ emissions when compared to the Building Regulations target.	Careful consideration of the design of the communal heating system will be required in order to minimise uncontrolled heat loss to communal areas. Current development proposals show for a Plant Room on the Second Floor, with the external units to be possibly located on the adjacent flat roof.
Building-integrated Wind Turbines	Unlikely	Wind speed likely to be too low and exacerbated by 'wind spoiling' features, e.g. trees and adjacent buildings.	Technology unlikely to be able to generate sufficient energy to meet planning target.

Biomass Boilers	Unlikely	Management issues regarding boiler operation and fuel supply.	Space required for boiler, flue and fuel storage and delivery. If located in a smoke control area, suitable model needs to be specified. Additional heat sources such as gas heating would be required to back up biomass boilers.
Micro Hydro	Unlikely	No watercourse on site – requires site with watercourse with high head or high flow.	
Fuel Cells	Unlikely	Reliable technology not available – still in early stage of development for domestic application.	
Biomass CHP	Unlikely	Development too small –this technology is only viable on much larger scale.	
Gas CHP	Unlikely	Development too small –this technology is only viable on larger scale.	

18 Conclusions

- 18.1 Low and Zero Carbon Technologies (LZC) referred to by the Code for Sustainable Homes, have been reviewed for both their economic benefits and their ability to meet level three of the Code for Sustainable Homes (CfSH) in relation to the energy and CO₂ emissions category. The LZC Technologies have been reviewed following on from the application of energy efficiency measures to reduce the baseline energy consumption.
- 18.2 Consideration has also been given to the inclusion of Gas CHP in order to supply energy to the development more efficiently, however for this development it is unlikely to be suitable.
- 18.3 Communal Air Source or Ground Source Heat Pumps (HPs) are suggested as a solution and are the developer's preferred option; these would meet with the planning target in terms of reducing the sites carbon dioxide emissions by onsite renewable energy, and allow the site to reduce its total energy demand. Providing space heating only from HPs would reduce the development's total energy demand by just under 41,837 kWh per year which is equivalent to a 35% reduction (compared to their current practices), in addition CO₂ emissions would be reduced by just under 13 Tonnes of CO₂ per year, when compared to the target set by Part L 2013 for both the flats and communal areas.
- 18.4 If the HPs were to provide both space and water heating savings would almost double.
- 18.5 The following tables summarise for the dwellings assessed the Dwelling Emission Rates and Target Emission Rates based on the use of HPs providing firstly Space Heating Only, and then Space & Water Heating. The tables also confirm the percentage improvement over the Target Emission Rate set by Part L1a 2013, this improvement is used to assess the number of credits achievable in Issue Ene 1 – Dwelling Emission Rate of the Code for Sustainable Homes (CfSH).

<u>Space Heating Only</u>	Part L1a 2013 TER (kgs of CO ₂ /m ² per year)	DER ((kgs of CO ₂ /m ² per year)	Improvement over Part L1a
1 Bed Ground Floor	28.01	23.13	17%
1 Bed Mid Floor	24.53	21.71	11%
1 Bed Top Floor	27.62	22.99	17%
2 Bed Ground Floor	24.92	20	20%
2 Bed Mid Floor	21.54	18.64	13%
2 Bed Top Floor	24.53	19.83	19%

<u>Space & Water Heating</u>	Part L1a 2013 TER (kgs of CO ₂ /m ² per year)	DER ((kgs of CO ₂ /m ² per year)	Improvement over Part L1a
1 Bed Ground Floor	28.01	12.3	56%
1 Bed Mid Floor	24.53	10.96	55%
1 Bed Top Floor	27.62	12.22	56%
2 Bed Ground Floor	24.92	11.24	55%
2 Bed Mid Floor	21.54	9.92	54%
2 Bed Top Floor	24.53	11.12	55%

For the November 2010 (Code Addendum (2014) England) version of the code assessor's manual it is acceptable to assess the area weighted average improvement over Part L1a,

the dwelling mix for the proposed development shows the improvement for flats would be 16% when only space heating is by HPs, and then 55% when the HPs are sized to also provide hot water services to the flats.

- 18.6 Part of the overall CfSH Assessment is a review of renewable energy systems and their carbon dioxide emissions offset, in this section of the code there are two credits available, the following table shows the percentage reduction in CO₂ emissions achieved by Air Source Heat Pumps, and calculated using the methodology laid out in issue Ene 7 of the CfSH Version Nov 2010:

	<u>Space Heating Only</u>	<u>Space & Water Heating</u>
1 Bed Ground Floor	-7%	16%
1 Bed Mid Floor	-9%	15%
1 Bed Top Floor	-7%	17%
2 Bed Ground Floor	-7%	14%
2 Bed Mid Floor	-8%	14%
2 Bed Top Floor	-6%	14%

The above figures have been based on an efficiency of 400% for the HPs, it is therefore likely all dwellings will achieve a reduction in CO₂ emissions in excess of 15% if both space & water heating are provided by Heat Pumps. The above calculations would need to be updated to reflect new guidance in the Code Addendum (2014) England.

- 18.7 In addition to meeting the CO₂ reduction targets to achieve credits in Ene 7 there are also some additional caveats which need to be met to fully achieve these credits:

- Ene7 credits can only be awarded where the specified LZC technology(s) are certified under the Microgeneration Certification Scheme (MCS). However the MCS does not currently cover systems over 50kWe. According to Dimplex it is unlikely a MCS type scheme covering larger systems will be in place in the near future.
- Code specifies for Ene 7 credits for Heat pumps:

It must also meet the EU Directive which specifies amongst other requirements “Only heat pumps with an output that significantly exceeds the primary energy needed to drive it should be taken into account”

- 18.8 The CfSH also awards credits for improving the fabric energy efficiency (FEES) performance of dwellings in Issue Ene 2 – Fabric Energy Efficiency, the following table summarises the performance of the dwellings assessed:

	<u>Fabric Energy Efficiency kWh/m²/year</u>
1 Bed Ground Floor	41.12
1 Bed Mid Floor	30.66
1 Bed Top Floor	39.97
2 Bed Ground Floor	40.19
2 Bed Mid Floor	30.41
2 Bed Top Floor	39.12

Individually assessed this shows the number of credits awarded would be between 6 and 9 credits, however in this issue of the CfSH it is possible to apply an area weighted average approach - for this development the area weighted average FEES are just over 37.4

kWh/m²/year, which would allow for between seven and eight credits to be awarded in this section of the CfSH assessment (maximum credits in this section are nine credits).

- 18.9 Solar Photovoltaics and Solar Water Heating are unlikely to be able to meet the energy targets placed upon the development as single technologies; combined with other measures such as further fabric energy efficiency measures or a combination of LZC Technologies these may be provide an alternative solution.
- 18.10 Appendix A of this report contains a review of the CfSH assessment for the development and provides confirmation that Level 3* could be achieved based on the developer's indicative specification as adopted on similar developments.

19 References and Further Guidance

Resource	Link to Guidance
Code for Sustainable Homes	http://www.energysavingtrust.org.uk/business/Building-Professionals/New-housing/The-Code-for-Sustainable-Homes
EST Accredited Construction Details	http://www.planningportal.gov.uk/england/professionals/en/1115314255826.html
EST Enhanced Construction Details	http://www.energysavingtrust.org.uk/business/Building-Professionals/Helpful-Tools/Enhanced-Construction-Details
Low Carbon Buildings Programme, Phase 2	http://www.lowcarbonbuildingsphase2.org.uk/
NHBC Foundation - 'A Review of Micro-generation and Renewable Energy Technologies' (2008)	www.nhbc.co.uk
NHBC Guide to Renewable Energy	www.nhbc.co.uk
Solar Trade Association	http://www.greenenergy.org.uk/sta/index.html
The Microgeneration Certification Scheme	http://www.microgenerationcertification.org/

20 Appendix A



Churchill Retirement Living

Pre-assessment Code for Sustainable Homes: 2014 Addendum Technical Guidance

London Road, Waterloooville, PO7 7EB

Prepared for: -
Churchill Retirement Living
19th January 2015

By: Inderjit Khun Khun
NHBC Sustainability Consultant

Specification Base

Churchill's standard specification has been used for the pre-assessment and is summarised below:-

Materials	Roof: Timber trussed rafters and joists with insulation, concrete tile slate effect (TBC) External walls: - Brickwork outer leaf, insulation, dense solid blockwork inner leaf, cement mortar, plaster, paint GG 806170027 - Cement rendered dense solid blockwork cavity wall, insulation, cement mortar, plasterboard on battens, paint GG806180036 A+ rated - PV weatherboarding on timber battens, insulation, medium dense solid blockwork wall, cement mortar, plasterboard, paint GG806220045 A+ Party Wall: Twin leaf 100mm solid dense aggregate blocks (1850-2300kg/m³) with 75mm min. cavity, type A wall ties, 8mm sand:cement render, gypsum based board (8 kg/m²) on dabs and paint to each side GG818190017 Partitions: Galvanised steel stud, plasterboard, paint GG809760002 Ground Floor: Screed on insulation laid on grouted beam and dense solid block flooring GG820140032 Separating Floor: Robust detail E-FC-9: Proprietary floor covering B bonded to 65mm min sand:cement screed (80kg/m²) on precast reinforced hollow planks (150mm min., 300kg/m² min.) with ceiling treatment (CT0/1 metal ceiling system) GG929550007 Windows PVC-U window with steel reinforcement, double glazed (TBC) GG813100009 All insulation materials to have a GWP of less than 5.
Space and Water Heating	Space Heating: Dimplex, LA60TU, Community air source heat pump, minimum 290% efficiency Radiators throughout: communal areas standard/LST radiators, self contained dwellings to have hot air convection boost facility. Hot water: direct from ASHP
Ventilation	Greenwood Unity CV100, Rigid ductwork, through wall and in duct No Air Conditioning/comfort cooling
Sanitary Specification	WCs: Roca 4.5/3 dual flush Flow rates to showers to be 5 litres per min (at 0.3MPa; 37°C delivered temp) Flow rates to whb taps to be 3 litres per min (at 0.3MPa) Flow rates to kitchen taps to be 5 litres per min Baths not to be provided Washing machine and dishwasher not provided (typical consumption assumed for CSH) No water softener to be installed.
Mandatory Items	It is assumed that all Mandatory requirements for CSH will be met
Surface Water Drainage	Assessor has consulted EA map which confirms that the site appears to be within a low flood risk area. A full FRA will need to be undertaken to confirm.
Local Authority Services	Recycling and waste information has been obtained from Havant Borough Council – there is a comprehensive recycling scheme available. Assessor suggests that they are contacted to ensure the proposed development's integration with the scheme.
Ecology	Google maps confirm the site prior to development is brownfield, containing existing buildings associated hard landscaping and soft landscaped areas. A suitable CSH ecological report will be required from a suitably qualified ecologist which confirms the ecological value of the site and recommendations for enhancement. There is likely to be a positive improvement in change of ecological value for the site from pre to post development (inclusive of ecological enhancement in planting scheme)

Score Sheet CSH Nov 2010		Max Credits For Issue	Likely Score
Ene1	Dwelling Emission Rate (DER)	10	6.00
Ene2	Fabric Energy Efficiency (FEE)	9	7.00
Ene3	Energy Display Devices	2	0.00
Ene4	Drying Space	1	1.00
Ene5	Energy Labelled White Goods	2	1.00
Ene6	External Lighting	2	2.00
Ene7	Low/Zero Carbon (LZC) Technologies	2	2.00
Ene8	Cycle Storage	2	0.00
Ene9	Home Office	1	1.00
approx. Ene credit value		1.17%	23.48%
Wat1	Indoor Water Use	5	5.00
Wat2	External Water User	1	0.00
approx. Wat credit value		1.50%	7.50%
Mat1	Environmental Impact of Materials	15	10.00
Mat2	Sourcing Materials - Basic Building Elements	6	3.00
Mat3	Sourcing Materials - Finishing Elements	3	2.00
approx. Mat credit value		0.30%	4.50%
Sur1	Management of Surface Water Runoff	2	0.00
Sur2	Flood Risk	2	2.00
approx. Sur credit value		0.55%	1.10%
Was1	Storage of Non-recyclable / Recyclable Waste	4	4.00
Was2	Construction Site Waste Management	3	2.00
Was3	Composting	1	0.00
approx. Was credit value		0.80%	4.80%
Pol1	Global Warming Potential of Insulants	1	1.00
Pol2	NOx Emissions	3	0.00
approx. Pol credit value		0.70%	0.70%
Hea1	Daylighting	3	1.00
Hea2	Sound Insulation	4	1.00
Hea3	Private Space	1	1.00
Hea4	Lifetime Homes	4	0.00
approx. Hea credit value		1.17%	3.50%
Man1	Home User Guide	3	3.00
Man2	Considerate Constructors Scheme	2	0.00
Man3	Construction Site Impacts	2	2.00
Man4	Security	2	0.00
approx. Man credit value		1.11%	5.55%
Eco1	Ecological Value of Site	1	1.00
Eco2	Ecological Enhancement	1	1.00
Eco3	Protection of Ecological Features	1	1.00
Eco4	Change in Ecological Value of Site	4	2.00
Eco5	Building Footprint	2	0.00
approx. Eco credit value		1.33%	6.66%
Total Likely Score			57.79%

The worst case self-contained dwelling is anticipated to achieve a score of 57.79% which is sufficient to gain a Code Level 3 rating (57% score required).