Wellesley
ALDERSHOT

ENERGY STRATEGY: SITE WIDE

DECEMBER 2012

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Contents

Appendices

0. Executive Summary

This report has been prepared to support the outline planning application for the Aldershot Urban Extension, hereafter referred to as Wellesley.

It defines the schemes current approach to delivery of an energy and carbon reduction strategy in accordance with national, regional and local planning obligations and aspirations of Rushmoor Borough Council (RBC).

The energy strategy described within this report has been prepared in accordance with the principles of the energy hierarchy and responds to zero carbon methodology, to deliver sustainable low carbon communities.

The report defines performance targets for dwellings at Wellesley and outlines a number of alternative energy scenarios with a commentary on future framework for ensuring these targets are achieved.

Energy efficiency measures are presented in order to drive down energy usage compared with current design practices. Once high levels of fabric energy efficiency are meet on-site low-carbon heat and power is reported, in line with zero carbon methodology.

Combined Heat and Power (CHP) and community heating is well suited to elements of a large scale residential development at Wellesley, where a sufficient magnitude of heat and density of dwellings exist, to aid technical and financial viability.

With Wellesley phased over a long period of time, multiple energy centres with their own community heating networks appear to be more suitable than a single site wide energy centre scheme, which is unlikely to achieve sufficient system efficiencies to be cost effective.

A number of renewable technologies are suitable for Wellesley and their individual merits shall be assessed further at detailed design stages, allowing for an optimum technologies mix in support of a low carbon, sustainable urban extension at Wellesley.

Potential solutions are presented in line with current performance targets with consideration given to post 2013 targets, which will see the introduction of revised Building Regulations in line with zero carbon policy and guidance.

The aspirations of Wellesley to deliver zero carbon buildings in accordance with forthcoming policy and guidance will require a holistic energy strategy that considers the optimum balance between environmental, financial and social aspects.

0.1 Disclaimer

Any potential options proposed within this report are considered to be helpful illustrations of typical approaches to compliance and should not be regarded as definitive. There will be numerous routes to compliance, utilising any number of variations of the solutions put forward by this report.

1. Introduction

This Energy Strategy accompanies a ‘Hybrid’ planning application submitted by Grainger plc (hereafter known as the ‘Applicant’) to Rushmoor Borough Council (RBC) for the development of land within Aldershot known as the Aldershot Urban Extension (AUE), hereafter referred to as ‘Wellesley’. The Applicant seeks outline planning permission for residential development of up to 3,850 dwellings with associated infrastructure including access, and Maida Zone - Phase 1 detail for 228 dwellings at Wellesley (the Hybrid Application). This Energy Strategy should be read in conjunction with the corresponding application forms and drawings, along with the suite of documents that support this Hybrid Application. For further details on the Hybrid Application please refer to the Planning Statement.

As part of the submission package some plans are for approval, whilst others are for information/illustrative purposes only. Plans that are not for approval are clearly labelled ‘illustrative’ or ‘for information’. All other plans should be determined by the LPA as application drawings. The illustrative masterplan is one way of interpreting the site against the opportunities and constraints identified and tested in the parameter plans. The parameter plans are for approval. Detailed proposals, following consent granted pursuant to the Hybrid Application, will be submitted to RBC in accordance with the Development Zones identified by the Applicant, as one or more Reserved Matter Application per Development Zone, which will include Listed Building Applications and Conservation Area Applications as appropriate.

This report has been produced by the Capita Symonds Sustainable Engineering Design Team. It aims to present a holistic energy strategy for Wellesley, taking into account general considerations for outline planning. This document is intended to lead the technology choice and design process setting out guiding principles that are to be developed further at each of the detailed design stages.

Typical building specifications are outlined for compliance with current policy and guidance is provided as to what can be expected over the coming years in line with the zero carbon trajectories for domestic buildings (2016) and non-domestic buildings (2019). As the definition of zero carbon non domestic buildings is less developed than that for homes, this report will focus on the residential components of Wellesley.

1.1 Energy Strategy

The site wide energy strategy has been developed by considering five key elements that when considered sequentially will support the development of a low carbon, sustainable urban extension at Wellesley.

- The first key element is the site consideration and development of solutions on a plot by plot and building by building basis in line with current national and local policies and regulations. With the development being phased over a number of years, local policies and regulations should be followed at the time that detailed design of each respective phase is undertaken. Careful consideration should be given to the Government's evolving definition of zero carbon and the associated implication of 'allowable solutions' that would class developments as having zero carbon emissions.

  Detailed technical energy assessments should be carried out on each phase on a plot by plot basis. As detailed information for each phase becomes available, the technical assessments should review the energy efficiency principles adopted on the future developments and align with the overall site wide energy strategy.

- The second element of the energy strategy for Wellesley is to review the energy-related improvements which are made to buildings that are retained to those measures which are technically, functionally and economically feasible, while adhering to Building Regulations for existing dwellings and other buildings.

  Recognising that in some instances, certain energy efficiency measures may not be possible as this would compromise the aesthetic and heritage value of the building. For those buildings, balanced considerations should be given for energy conservation, character preservation and the practical application of the proposed solutions.

- The third, fourth and fifth elements describe the underpinning Energy Hierarchy principles 'Be Lean' (use less energy), 'Be Clean' (supply energy efficiently), 'Be Green' (use renewable energy).

- Under the third element, due consideration is given to taking the maximum economic benefit from the orientation of buildings, and the incorporation of lean design techniques including fabric energy efficiency standards. Energy efficiency is a key consideration for Wellesley and in line with Rushmoor Borough Council's Core Strategy, this area will be maximised first, before renewable technologies are considered. Where possible, the energy strategy will look to deal with and minimise the causes of energy usage. Remaining energy requirements will look to be met through clean or green measures where technically and financially viable.

- The fourth element considers the use of combined heat and power (CHP) systems wherever technically and economically feasible, and to connect them to district heating networks where the density and type of buildings along with magnitude of heat is appropriate. The choice of fuel (including between natural gas and biomass) will be made on a case-by-case basis to reflect location-specific constraints and opportunities.

- After consideration of the above, the fifth element focuses on 'being green' through the use of on-site renewable energy.

- Overall, the energy strategy shall be informed by the emerging Government Policy and regulations over the project time period. Given the considerable uncertainty associated with the estimation of long term carbon emissions, any projections which go beyond 2016 cannot be relied upon. However the energy strategy shall ensure that the low carbon principles of the development shall remain in line with the Government's energy policies and regulations throughout the project life.

1.2 REPORT OVERVIEW

The analysis undertaken within this report can be summarised by the following sections.

SECTION 1: Introduction
Provides an outline of the report in line with current zero carbon methodology and presents the energy strategy to be adopted for outline planning and detailed applications.

SECTION 2: Policy & Guidance
Details current and proposed policy in line with the perusal of zero carbon targets.

SECTION 3: 'Be Lean'
Passive and active measures are discussed as ways of reducing energy demand through improved energy efficiency.

SECTION 4: 'Be Clean'
The use of combined heat and power along with district heating networks are reviewed, with consideration of the potential technical and financial viability of such schemes.

SECTION 5: 'Be Green'
A variety of low to zero carbon technologies are reviewed, outlining potential energy sources for further consideration.

SECTION 6: Energy & Carbon Assessment
A dwelling base-case specification is suggested for which potential improvements will be measured against.

SECTION 7: Carbon Compliance
Potential solutions are proposed for meeting a 0 and 25% improvement of dwelling emission rate over target emission rate in line with Part L 2010 and Code for Sustainable Homes.

SECTION 8: Allowable Solutions
The concept of allowable solutions is discussed, with reference to achieving zero carbon targets for regulated energy.

SECTION 9: Future Proofing
Key issues for consideration that may apply to Wellesley beyond 2016 are discussed.

SECTION 10: Existing Buildings
Energy efficiency requirements are considered for existing buildings on site, with examples of low cost, easily implemented measures outlined.

SECTION 11: Conclusion
Key issues for the development of Wellesley are highlighted.

2. Policy & Guidance

Recently published material from the Zero Carbon Hub and the Department for Communities and Local Government (DCLG)[1] begins to outline possible ways of achieving the Government's requirement of zero carbon homes from 2016; with a focus on absolute energy and CO_2 targets, fixed by dwelling type i.e. apartment, mid-terrace, end-terrace /semi-detached and detached.

The contained Energy Strategy will aim to follow this guidance, providing an understanding of the proposed regulations and how they will affect Wellesley over the coming years.

2.1 Current & Future Policy

Following the Budget 2011 announcement, that the definition of zero carbon for new homes would be limited to emissions potentially covered by Building Regulations (space heating, hot water and fixed lighting), unregulated energy is no longer included in the 2016 definition for zero carbon homes.

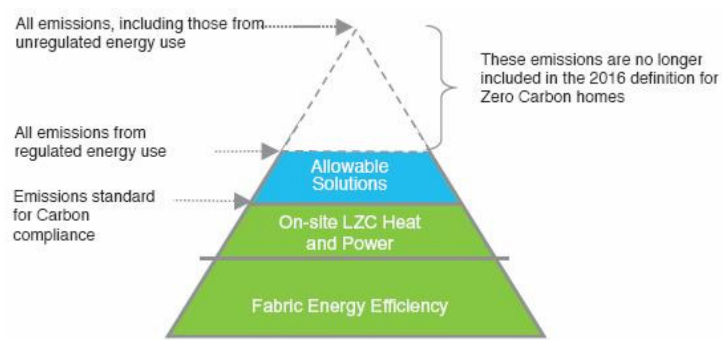

Figure 2.1: Zero Carbon Policy, post-Budget 2011

Absolute targets (for new homes to meet) have been introduced for 2013 and 2016, which according to the "2012 consultation on changes to the Building Regulations in England, Section two – Part L (Conservation of fuel and power), Proposed changes to technical guidance" issued in January 2012, are to be implemented within Part L 2013.

Key issues to note are the introduction of a Fabric Energy Efficiency Standard (FEES) which sets a maximum limit on the amount of energy that would normally be needed to maintain comfortable internal temperatures in a home. The fabric must be sufficiently good to ensure that heating and cooling energy does not exceed these figures.

Absolute CO_2 emissions targets for zero carbon homes have been developed by a task group led by the Zero Carbon Hub (February 2011) and the following recommendations have been agreed to be applied to 'built performance' within 2016 Building Regulations (and use 2016 CO_2 emissions factors):

- 10 $kgCO_{2(eq)}/m^2$/year for detached houses
- 11 $kgCO_{2(eq)}/m^2$/year for attached houses
- 14 $kgCO_{2(eq)}/m^2$/year for low rise apartment blocks (four storeys and below)

[1] Refer to Appendix E for key documentation

Two options have been proposed for 2013; a ‘FEES plus efficient services’ option or a ‘Half way point’ option. The first option is preferred by the government. Here the CO_2 target is set by the National Calculation Methodology (NCM) on the basis of a new 2013 compliant concurrent notional model. The second option sets an absolute CO_2 target which is half way from current Part L 2010 baseline to the proposed 2016 targets for zero carbon homes.

In general the energy strategy proposed will follow the well established ‘energy hierarchy’, which appears in many Government energy policy documents, summarised as ‘Be Lean, Be Clean, Be Green’.

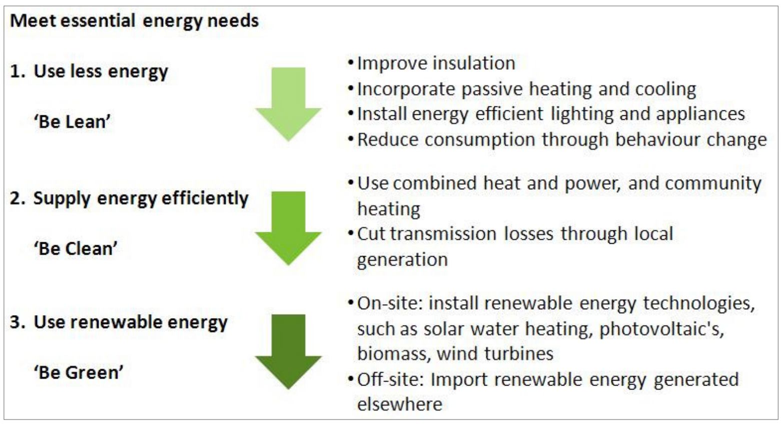

Figure 2.2: Energy Hierarchy

2.2 ZERO CARBON HOMES

The Zero Carbon Hub has outlined the following definition of a ‘zero carbon home’ and what the requirements are likely to be when introduced into Building Regulations in 2016. A ‘zero carbon home’ is one where CO_2 emissions from regulated energy use (space heating, hot water, lighting, ventilation) are reduced to zero by a combination of three factors:

1. **Ensuring an energy efficient approach to building fabric design**
   A minimum Fabric Energy Efficiency Standard (FEES) has been defined, to which a zero carbon home has to comply, based on main dwelling types:
   - 46 kWh/m^2/year for detached houses
   - 46 kWh/m^2/year for end terrace /semi-detached houses
   - 39 kWh/m^2/year for mid-terrace house
   - 39 kWh/m^2/year for apartments

2. **Reducing CO_2 emissions on-site through low and zero carbon technologies and connected heat networks**
   A limit to the on-site CO_2 emissions from a zero carbon dwelling had been defined (depending on dwelling type). The recommended levels to be applied to ‘built performance’ within the 2016 Building Regulation are (using 2016 CO_2 emission factors):
   - 10 $kgCO_{2(eq)}/m^2$/year for detached houses
   - 11 $kgCO_{2(eq)}/m^2$/year for attached houses
   - 14 $kgCO_{2(eq)}/m^2$/year for low rise apartments

3. **Mitigating the remaining carbon emissions through Allowable Solutions which secure carbon saving away from site**

The first two steps are together referred to as Carbon Compliance. The third step, Allowable Solutions, is a means by which emissions at or below the level set for Carbon Compliance can be mitigated elsewhere.

Figure 2.3 presents the updated zero carbon policy, now considering only the regulated energy use of a building.

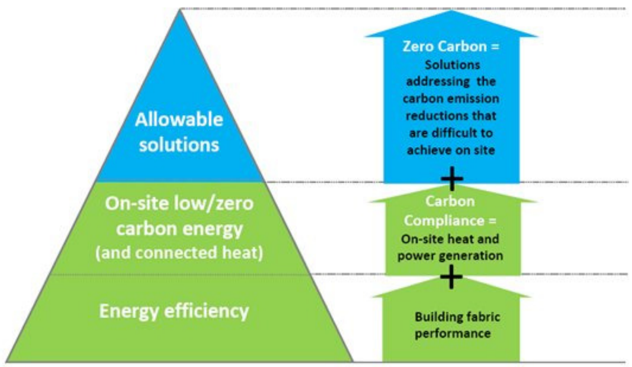

Figure 2.3: Zero Carbon Hierarchy

2.3 BUILDING REGULATIONS PART L 2010

The 2010 update of Approved Document L (ADL) required dwellings to be designed to emit 25% less CO_2 than previous (2006) regulations.

No new dwellings are exempt for the energy efficiency requirements of the Building Regulations. In the Secretary of State's view, compliance with the energy efficiency requirements could be demonstrated by meeting all five criteria set out in the following paragraphs.

- Criterion 1: in accordance with regulation 17C, the calculated rate of CO_2 emissions from the dwelling (the Dwelling Emissions Rate, DER) must not be greater than the Target Emissions Rate (TER). Criterion 1 is regulation and is therefore mandatory, whereas Criteria 2 to 5 are only guidance.
- Criterion 2: the performance of the building fabric and the fixed building services should achieve reasonable overall standards of energy efficiency.
- Criterion 3: the dwelling should have appropriate passive control measures to limit the effect of solar gains on indoor temperatures in summer, irrespective of whether or not the dwelling has mechanical cooling.
- Criterion 4: the performance of the dwelling, as built, should be consistent with the DER
- Criterion 5: the necessary provisions for energy efficient operation of the dwelling should be put in place.

2.4 BUILDING REGULATIONS PART L 2013 CONSULTATION

The Government has announced that from 2016 all new homes, and from 2019 all new non-domestic buildings, in England will be built to zero carbon standards. Options for changes to the Regulations in 2013 have been developed to act as an interim step on the trajectory towards achieving zero carbon standards from 2016/19.

The Government consultation on proposed changes to the Part L Building Regulations is due to come into force in October 2013. For new domestic buildings, the consultation proposes two scenarios, summarised below and compared with the current approach:

	2010	2013 'FEES plus Services' Option and Hybrid Approach	2013 'Halfway Point' Option and Full Absolute Approach
CO_2 Target	Relative improvement on 2002 notional building (same size and shape as actual building)	CO_2 target set by National Calculation Methodology (NCM) on the basis of a new 2013-compliant concurrent notional building (same size and shape as actual building) to set the Target Emission Rate (TER)	Absolute CO_2 emission performance target set at a 'halfway point' to the Zero Carbon Hub's proposed 2016 Carbon Compliance targets. Based on modelling using preliminary 2013 CO_2 emissions factors, the absolute values would be: - 13 $kgCO_2/m^2/yr$ for mid-terrace and detached houses - 14 $kgCO_2/m^2/yr$ for end terrace and semi-detached houses - 15$kgCO_2/m^2/yr$ for low rise apartment blocks
Energy Target	No energy target	Absolute fabric energy efficiency standard (FEES)	
Energy Target Level	n/a	'Full FEES' levels of: - 39 $kWh/m^2/yr$ for apartment blocks and mid-terrace houses - 46 $kWh/m^2/yr$ for end-terrace, semi-detached and detached houses **OR** 'Interim FEES' levels of: - 43 $kWh/m^2/yr$ for apartment blocks and mid-terrace houses - 52 $kWh/m^2/yr$ for end-terrace, semi-detached and detached houses	

Table 2.1: Part L 2013 Scenario Options

The Government's preferred option is for the hybrid approach. This strikes a reasonable balance by retaining some of the flexibility of the relative approach, whilst aiding the move towards zero carbon and more efficient building form by introducing an energy target that all buildings must meet.

2.5 CODE FOR SUSTAINABLE HOMES

The Code for Sustainable Homes (CSH) is a Government standard to specify and assess the environmental performance of new homes. There is currently much debate over the future of the CSH and it is due for revision to bring it up to date with the changing policy background and in particular to align it with the developing zero carbon homes policy.

At present, to achieve Code Level 4, developers would need to demonstrate a 25% (in Dwelling Emission Rate over the Target Emission Rate) improvement on 2010 standards and to meet Code Level 5 a 100% improvement would be needed (i.e. zero 'regulated' emissions from buildings). These stringent on-site CO_2 reduction standards typical of higher levels of the code (Levels 5 and 6) are now out of step with the Government's zero carbon homes policy and the Government intends to publish a revised Code alongside the final 2013 Part L changes.

It should also be noted that "the Code remains a voluntary scheme and there is no Government policy promoting any specific Code levels, let alone Code Level 6 (aside from Homes and Communities Agency funded schemes to be built at Code Level 3). A Code home incorporates many more sustainability features than just energy related equipment and is significantly more expensive to build"[2].

2.6 RUSHMOOR BOROUGH COUNCIL

Rushmoor Borough Council's Core Strategy adopted in October 2011, includes Core Policy CP3, which sets out the Council's policy on Renewable Energy and Sustainable Construction.

There is an emphasis on meeting Code for sustainable Homes standards with the caveat that updates to Building Regulations are considered as stated above these are scheduled for 2013. In effect Rushmoor Borough Council appears to be following guidance from Government policy as discussed above.

Policy CP3 - Renewable Energy and Sustainable Construction

Renewable and Low Carbon Energy

The assessment of proposals for the development of decentralised, renewable and low carbon energy sources, will give consideration to their contribution towards meeting national and local renewable energy targets and carbon dioxide savings.

Planning applications that include new buildings will demonstrate how they help to deliver the Energy Opportunities Plan including, where appropriate, district heating with Combined Heat and Power networks.

Sustainable Construction

All development proposals will demonstrate how they will incorporate sustainable construction standards and techniques.

Unless it can be demonstrated that it would not be technically feasible or financially viable, applications will demonstrate that they will be completed in accordance with:

- For new dwellings, full Code for Sustainable Homes standards or the equivalent of:
  - At least Code Level 3 from the adoption of the Plan; and
  - At least Code Level 4 once further updates to Part L of Building Regulations have come into effect (currently scheduled for 2013).
- For other major developments,[87] BREEAM 'Very Good' standard (or any future national equivalent).

Figure 2.4: Policy CP3, Rushmoor Borough Council Core Strategy Adopted October 2011

[2] 2012 Consultation on Changes to the Building Regulations in England, Section Two, Part L (Conservation of Fuel and Power); January 2012; Department for Communities and Local Government

2.7 SUMMARY

The following outlines the targets to be achieved for Wellesley based on proposed guidance. This will need to be reviewed as the project progresses, in line with current policy.

In line with project phasing and the proposed submission of the detailed planning application for Maida Zone - Phase 1 pre October 2013, targets shall be considered from 2010 until what has been proposed so far for 2016. These targets will begin to guide the design process for Phase 1 onwards of Wellesley.

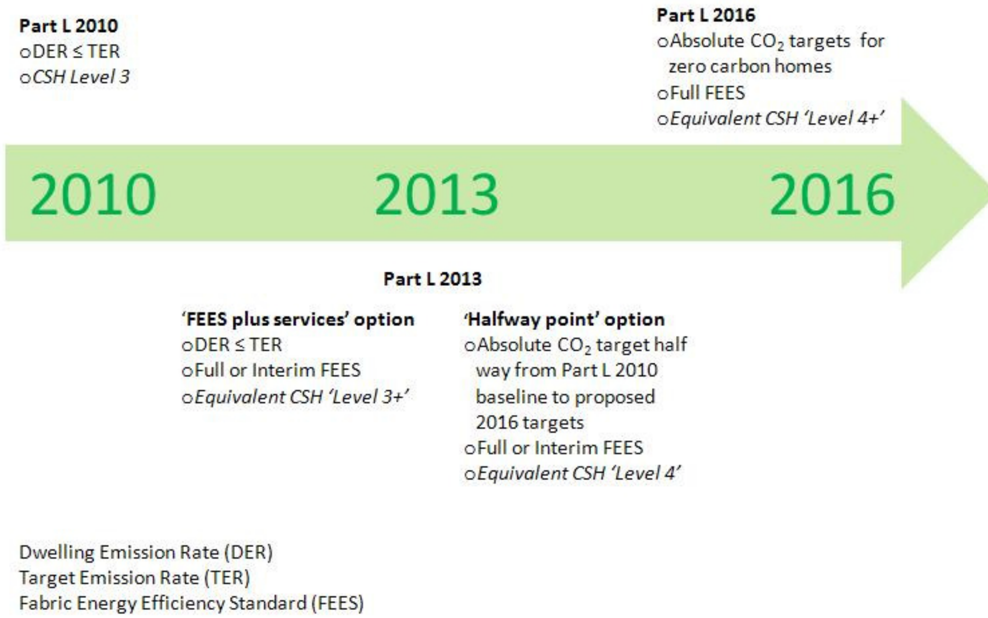

Figure 2.5: Timeline to Zero Carbon (2016)

3. Energy Efficiency ('Be Lean')

3.1 Fabric Energy Efficiency

Fabric energy efficiency is the first element of the zero carbon homes policy hierarchy (illustrated by Figure 2.3) and will ensure new homes meet high standards of fabric energy efficiency. It is intended to limit the energy demands of space heating and cooling for a dwelling and be achieved through passive measures only. It is therefore not affected by the heating system type or ventilation strategy and can be met through the appropriate selection of the following:

- Building fabric U-Values
- Thermal bridging
- Air permeability
- Thermal mass
- Features which affect lighting and solar gain

Wellesley will ensure all new dwellings achieve good levels of thermal insulation, reduced thermal bridging and low air permeability.

The Zero Carbon Hub has outlined target fabric levels to meet the Fabric Energy Efficiency Standard (FEES) for both 'Interim FEES' and 'Full FEES' for a variety of building types (refer to Appendix B). Although the requirement to specifically meet some form of the FEES will only come into force with Part L 2013 it would be recommended that an enhanced building fabric (over current standards) is considered for earlier stages of Wellesley (i.e. Maida Zone - Phase 1), as it represents good design in line with the 'Be Lean' thinking of the energy hierarchy.

For each dwelling type, two example specifications which meet the 'Interim FEES' and 'Full FEES' target are provided. The first is a balanced approach, which sets out to improve performance across all fabric elements. The second sets the wall, floor and roof U-values at the limiting values proposed in the 2012 Part L consultation. In this case the specification of other elements are altered in order to achieve the target FEES[3].

The recommendations have been provided by the Zero Carbon Hub as guidance and it should be noted many other options would be available in meeting the fabric energy efficiency targets.

3.2 Energy Efficiency Measures

Reducing the energy required of a building is the first step of the energy hierarchy and ensures a buildings form and services are designed as efficiently as possible. Wellesley is to take the maximum economic benefit from the orientation of buildings and the incorporation of lean design techniques, including in particular active consideration of best practice fabric energy efficiency standards and the maximum use of passive heating and cooling techniques.

The focus of ensuring buildings use less energy, in effect 'being lean', sits with the design process and principally with the specification of building materials and mass (as outlined in Section 3.1). Energy demand reduction can be achieved by focusing on principles of good environmental design. Through the optimisation of building orientation, shape, glazing ratios and internal layouts, passive measure will be enhanced.

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[3] Informing the Part L 2013 Consultation, Fabric Energy Efficiency for Part L 2013, Worked Examples and Fabric Specification, February 2012; Zero Carbon Hub

In general the aim is to maximise daylight while reducing thermal stresses on the building, helping to alleviate lighting and cooling requirements, allowing for lower energy consumption and reduced CO_2 emissions.

Active design measures focusing on building services, for example: efficient heating /cooling equipment, mechanical ventilation, hot water, fixed lighting and active controls shall also be included in the holistic strategy of minimising energy use.

Wellesley will incorporate the following robust energy performance specifications and holistic low energy design concepts:

- Building envelope: Building thermal elements and glazing with enhanced U-values and air permeability rates will be proposed. A good building envelope will remain throughout the life of the building and is the primary climatic modifier.

- Thermal mass: The buildings will use the thermal mass of their structure to store heat in the winter (from occupants and equipment) and provide cooling in the summer (via a night time cooling strategy).

- Limiting solar gain: Solar shading to reduce the risk of overheating during summer will be delivered via strategically located overhangs and shading devices.

- Natural ventilation: Where possible residential accommodation will be dual aspect to facilitate cross flow ventilation to maintain comfortable internal temperatures.

- Daylighting: Electrical demand for artificial lighting will be minimised by maximising natural daylight into buildings. This will be achieved by optimising glazing ratios and a light palette of colours to the interior to improve daylight penetration.

- Internal lighting: Low energy lighting will be provided throughout the development. Lighting controls and sensors will be proposed to common areas and corridor spaces within apartments.

- Ventilation: Where necessary a high level of indoor air quality will be provided by whole-house mechanical ventilation systems with high efficiency heat recovery.

- Electrical appliances: All developer-provided major electrical appliances (i.e. refrigerators, freezers, washing machines, tumble dryers, dishwashers) will be highly energy efficient ('A Rated' or higher).

- Operation: A responsible lifestyle will be promoted through the use of smart metering in all residential units. Such meters indicate in real time the amount and cost of energy being consumed, thereby prompting residents to conserve energy.

PASSIVE CONSIDERATIONS
Space heating and cooling related to:
- Building fabric U-values
- Thermal bridging
- Air permeability
- Thermal mass
- Solar shading
- Gains from metabolic, lighting, solar & household appliances

ACTIVE CONSIDERATIONS
Building services:
- Efficiency of heating /cooling equipment (boilers, air conditioners etc)
- Mechanical ventilation
- Hot water
- Active controls
- Fixed lighting

Figure 3.1: Energy Efficiency Considerations ('Be Lean')

4. On-Site Low-Carbon Heat & Power: CHP Analysis ('Be Clean')

Following on from Wellesley being designed to use less energy though a combination of fabric improvements and efficient services, on-site low to zero carbon energy generation will now be considered. In the first instance Combined Heat and Power (CHP) and its potential link to District /Community Heating systems is reviewed. This is in line with the second consideration of the energy hierarchy to supply energy efficiently (i.e. 'Be Clean').

This section outlines key considerations for the use of a CHP and community heating network rather than the technical and economical feasibility of such technologies. This will need to be undertaken at detailed design stages where the individual merits of such a system can be assessed, in line with the density and type of buildings in the specific Development Zones.

It is evident from the phasing of Wellesley (over a number of years), that a single neighbourhood heating system would not be the most practical and cost effective solution to serve the site. Multiple energy centres with their own community heating networks, strategically located to maximise dwelling density and the magnitude of heat available, appear to be better suited to the Development Zones of Wellesley. This solution should help increase efficiencies of such a scheme, improving its financial viability.

Any existing energy centres on or around the site have been discounted for use at Wellesley for this stage due to the phasing issues. Typically Wellesley will require tailored energy centres to deal with specific Development Zones, as deemed necessary at detailed design stages.

4.1 Combined Heat and Power Considerations

CHP refers to the local simultaneous generation of electricity and heat by recovering and using the waste heat from power generation.

Carbon emissions of a CHP system are therefore much lower than for conventional electricity generating plants which 'dump' heat that cannot be put to good use. The overall efficiency of CHP can be more than 80% which compares favourably with 40% achieved at an average power station.

CHP plant allows a more efficient use of natural resources, resulting in a reduction of the site's actual energy costs. However the narrowing gap between gas and electricity prices will affect the financial viability of CHP and will need to be considered at individual phases of Wellesley.

Biomass can also be used as a fuel source for CHP plant and is a lower carbon alternative. Biomass CHP systems are even less carbon intensive than natural gas powered plant, as they use a lower carbon, more sustainable fuel source. The choice of fuel (between natural gas and biomass) will be made on a case by case basis to reflect location specific constraints and opportunities.

CHP is available in a wide range of outputs capable of serving a single building or an entire site. Micro-CHP systems have outputs suited to the energy demands of an individual household, although they are typically less cost effective than larger scale installations.

CHP is especially suitable for buildings or sites which have a high and constant demand for heat. In order to generate economic and environmental savings, CHP plant should generally operate for a minimum of 4,000-5,000 hours a year[4].

Residential accommodation is generally suitable for small scale packaged CHP systems and will be considered for the individual Development Zones of Wellesley based on their energy demands.

4.2 District Heating Considerations

A district heating (DH) system delivers heat to multiple buildings from a central energy centre. The heat distribution network can provide the facility to make use of heat from low carbon sources such as CHP (reviewed in Section 4.1). Its use will enable specific zones of Wellesley to benefit from low to zero carbon energy sources that may not be easily installed in individual buildings (for example biomass). It also allows for fuel flexibility as the energy centre may use a variety of heat sources.

For both economic and environmental reasons, district heating is best suited to areas with a high concentration of heat demand. New buildings for Wellesley will offer greater ease of installation from the outset but also substantially reduced heat demand (due to improved fabric performance and thus heat loss).

A distribution network of flow and return pipes transfers heat (via hot water) from the source to connected buildings. Heat exchangers are installed within each building and the energy can be recorded using heat meters.

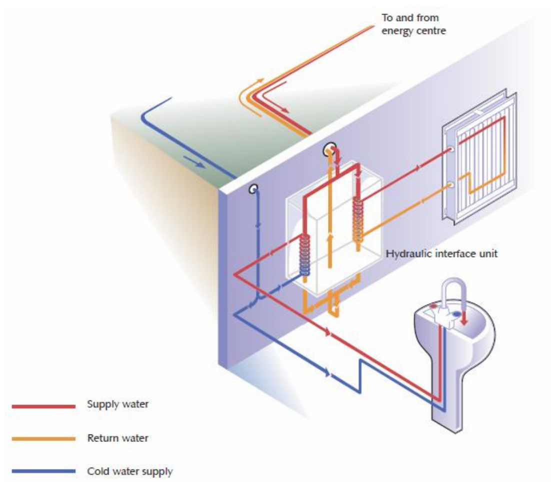

Figure 4.1: Pipe network to individual building[5]

Where DH schemes are proposed for the new developments there will be a benefit to connect all existing buildings nearby if possible and this should be considered at the detailed design stages. Viability of schemes will also be improved if there is a nearby 'heating anchor' (a large energy user with a continuous heat demand i.e. hospitals or leisure centres with heated pools) adjacent to the individual Development Zones.

DH schemes involve major capital investment and the heat distribution network is one of the most expensive elements. Therefore, in order to minimise pipe length per unit of heat

[4] Renewable Energy Sources for Buildings; 2006; CIBSE
[5] The Performance of District Heating in New Developments, Application Guidance, IP 3/11; April 2011; BRE

delivered, DH is best installed in areas with a high concentration of heat demand. The higher density Development Zones for Wellesley will favour such networks and help ensure cost effectiveness.

To assess the feasibility of using DH to supply the heat for the residential developments both the dwelling density and magnitude of heat requirements must be considered (i.e. heat demand density). The new dwellings with their lower heat demands will mean that higher densities may be required for DH to be a viable solution.

Linear heat density can be used to give an indication of the heat density of a certain area, taking into account spatial distribution of the buildings and network design.

Figure 4.2 issued by the BRE[6] outlines typical trench lengths for sites with varying dwelling densities s follows:

- A detached housing development with about 15 dwellings/ha
- Mixed residential development with detached, semi-detached and terraced houses equivalent to about 30 dwellings/ha
- A development with blocks of flats with about 60 dwellings/ha

Three energy efficiency scenarios have also been included to show the effect of improving the efficiency of buildings.

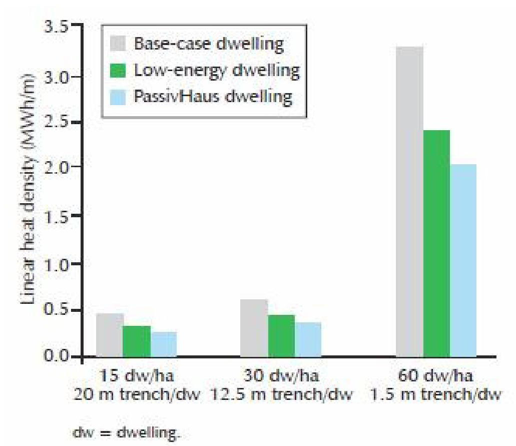

Figure 4.2: Relationship between dwelling density, length of network pipe trench per dwelling and linear heat density[6]

As illustrated developments with a higher dwelling density (and thus greater liner heat density) require less length of network pipe trench per dwelling.

The feasibility of each Development Zone has to be assessed separately and heat distribution losses for potential DH networks will need to be evaluated. The heat distribution loss of DH network refers to the energy that is lost between the energy plant and heat delivery to individual buildings. Consideration of the heat distribution loss is of major importance when investigating the feasibility of DH to supply a certain area and in particular to supply areas with energy efficient buildings. In such applications the heat distribution loss can constitute a significant percentage of the heat supplied to the network. This increases the amount of primary energy consumed and therefore the running costs. It also raises the associated carbon emissions.

[6] The Performance of District Heating in New Developments, Application Guidance, IP 3/11; April 2011; BRE

Figure 4.3 illustrates typical percentages of heat distribution losses to heat delivered for the same three sites with varying dwelling density. Again the greater the dwelling density and /or liner heat density, the less sensitive the percentage of heat distribution losses to heat delivered.

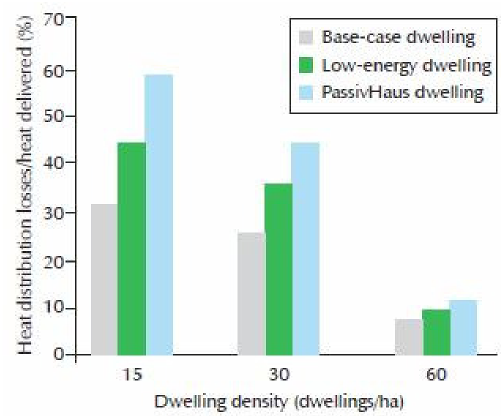

Figure 4.3: Heat distribution losses by dwelling density[7]

As well as increasing the total heat delivered by a DH network a reduction of heat distribution losses is an important aspect of improving DH network performance especially when using DH to supply heat to areas of low density heating. The following can be considered and in order to reduce heat distribution losses:

- Using higher performance pipes
- Reducing the heat network operating temperatures
- Using smaller diameter pipes.

[7] The Performance of District Heating in New Developments, Application Guidance, IP 3/11; April 2011; BRE

5. On-Site Low-Carbon Heat & Power: Renewable Analysis ('Be Green')

After consideration of the previous energy efficient design principles, namely; to use less energy ('be lean') and to supply energy efficiently ('be clean'), the use of renewable energy ('be green') will be assessed in terms of the overall energy strategy for Wellesley. This study will look to reduce carbon dioxide emissions and atmospheric pollutions by encouraging local energy generation from renewable sources to supply a significant proportion of the sites energy demand.

In line with changing policy and guidance, Low to Zero Carbon (LZC) technologies will be necessary to help Wellesley meet the planned carbon reduction targets. A combination of LZC technologies at variety of installed capacities may be required for different buildings and zones of the development, depending on the submission dates of individual detailed planning applications.

5.1 LZC Technologies Feasibility Review

A preliminary assessment was undertaken to determine the most appropriate LZC technologies for Wellesley, based on their suitability for the site and development. The LZC technologies reviewed have been recognised by the Department for Business Enterprise and Regulatory Reform (BERR) Low Carbon Building Programme (LCBP).

Comprehensive technical and financial assessments will be required at detailed planning stages for any technology deemed viable for Wellesley and chosen for further consideration.

LZC Technology	Suitable for Site	Reason	Preferred Option	Reason
Solar				
Photovoltaics (PVs)	☑	Reasonable solar resource available throughout the UK. Annual total global horizontal irradiation in Aldershot appears to be around 900-1000 kWh/m^2.	☑	Sufficient solar exposure to the roofs of Wellesley. Appears to be sufficient un-shaded roof area and ability to position panels optimally, to face between south east and south west at an elevation of 30 to 40 degrees. Availability of grants (Feed-in-Tariff) will help the financial justification of PVs.

LZC Technology	Suitable for Site	Reason	Preferred Option	Reason
Solar Thermal (Hot Water)	☑	Solar collectors are able to receive both direct (sunlight) and diffuse (daylight) solar energy. Therefore this system is well suited to the UK, which experiences a high percentage of cloudy days. It is the sum of both direct and diffuse solar energy that permits solar thermal systems to achieve a reasonable performance, in relation to converting total global radiation into useful heat energy.	☑	The orientation and nature of the roofs for Wellesley appear to be favourable to the installation of solar technologies. Residential buildings have a substantial year round demand for hot water which will improve the viability of an installation. However, it is worthwhile to note that solar thermal installations are not to be recommended in conjunction with any CHP systems (if deemed viable), as these two technologies would 'compete' to meet the available heat demand, particularly during summer periods. Availability of grants (Renewable Heat Incentive) will help the financial justification for solar thermal.
Water				
Small Scale Hydro Power	☒	Unfeasible as there is very little flow in the canal that runs along the top of the site.	☒	n/a
Tidal Power	☒	Unfeasible as the site is located inland.	☒	n/a
Wave Power	☒	Unfeasible as the site is located inland.	☒	n/a

LZC Technology	Suitable for Site	Reason	Preferred Option	Reason
Wind				
Wind turbines	☑	The average wind speed on site according to the UK Wind Speed Database (Department of Energy & Climate Change) is in the region of 5m/s which is adequate for generating worthwhile quantities of electricity.	☒	There are a number of obstructions on the Wellesley site which could interfere with the wind flow and cause turbulence, having a detrimental effect on performance of any potential wind turbines. Potential location at the edge of the site is adjacent to an area of historic interest and as such wind turbines may not be granted planning permission. Although previous reports (AECOM) recommended a large wind turbine, its installation is expected to have a negative impact on the potential financial benefits of developing the site.
Biomass				
Biomass Single Room Heaters /Stoves	☑	Initial investigations appear to show potential for local supply and delivery of biomass fuel.	☒	Not Applicable due to potential Air Quality issues of small biomass installations, which are likely to be too small to warrant the expensive pollution abatement equipment necessary to maintain air quality.
Biomass Boilers Individual Buildings	☑	Initial investigations appear to show potential for local supply and delivery of biomass fuel.	☒	Not applicable due to potential transportation issues with the simultaneous delivery of biomass to multiple points within the site.
Biomass Community Heating Schemes	☑	Large scale nature of the scheme would appear to warrant a community heating network that could use biomass as the fuel.	☑	Large scale residential developments are generally viable for district heating networks. Viability for individual Development Zones will need to be undertaken at detailed design stages.

LZC Technology	Suitable for Site	Reason	Preferred Option	Reason
Community Heating				
Including utilising waste heat from processes such as large scale power generation where the majority of heat comes from waste heat	☑	Large scale residential developments with sufficient magnitude of heat and appropriate dwelling densities are suitable for the use of district heating networks using combined heat and power as its energy source.	☑	Viability for individual Development Zones will need to be undertaken at detailed design stages.
Combined Heat and Power				
Natural Gas	☑	CHP is a well developed technology and an efficient way of generating both heat and power on site. Buildings on site appear to have a year round demand for hot water and a reliable base load for electricity which are necessary for preliminary viability.	☑	CHP along with a community heating system appears to be well suited to the scale of the site. Density and phasing of developments must be considered to ensure the viability of such a scheme.
Biomass	☑	CHP systems are a highly efficient way to use both fossil and renewable fuels and can be run using gas or biomass. Initial investigations appear to show potential for local supply and delivery of biomass fuel.	☑	A biomass CHP along with a community heating system appears to be well suited to the scale of the site and in helping to achieve proposed carbon targets. Density and phasing of developments must be considered to ensure the viability of such a scheme. The Renewable Heat Incentive (RHI) could significantly help improve the financial viability of such a system.

LZC Technology	Suitable for Site	Reason	Preferred Option	Reason
Biofuels /Bioliquids	☑	Like biomass, biofuels are a form of 'bioenergy' but in liquid form. It is typically used as vehicle fuel and can be used to power engines including generation plant.	☒	By 2020, the demand for biofuels for cars will be substantially higher due to the targets agreed under the EU biofuel Directive. As such biofuels will not be considered for use at Wellesley.
Sewerage Gas and other Biogases	☒	Biogas generation is more suited to sites with good access to manure or food wastes.	☒	n/a
Heat Pumps				
Ground Source Heat Pumps	☑	Ground source heat pumps may be used to generate heat for space heating and domestic hot water. There appears to be sufficient ground space on the Wellesley site for the installation of a ground source system. Buildings within Wellesley are to be served by low temperature heating circuits suited to ground source heat pumps.	☑	Sufficient ground space around the development is required for the installation of a horizontal closed loop system and vertical systems will require the ground to be free from obstructions. Further investigation will be required before this technology can be deemed viable. To achieve a high Coefficient of Performance (COP) from the GSHPs, that would provide worthwhile benefits against conventional natural gas heating methods, ideally lower temperature heating applications such as underfloor heating systems should be used.

LZC Technology	Suitable for Site	Reason	Preferred Option	Reason
Water Source Heat Pumps	☑	An open loop system could abstract water from the canal (that runs along the top of the site) and extract the heat via a heat pump, releasing the cooled water back into the canal. Alternatively, water source heat pumps could be utilised for cooling around the development (where required).	☒	An accessible source of ground water must be available for extraction. A full site survey will be required to investigate the viability of this technology. A water extraction license is required and the involvement of Environment Agency would be recommended at an early detailed design stage. The canal is outside of the ownership of Grainger and its designation as a SSSI, which means that any proposals to use the canal would require considerable work to justify and although it may be technically feasible will most likely be regulatory unfeasible.
Geothermal Heating Systems	☒	High level investigations suggest the site is not above any significant thermal reservoir for extraction of heat at high temperatures.	☒	n/a
Air Source Heat Pump	☑	ASHPs operate on a similar principle to a GSHP but use external ambient air as a heat source or heat sink and can provide both heating and cooling requirements.	☑	A high Coefficient of Performance (COP) is required to gain worthwhile benefits over gas methods of heating. High COPs are better achieved when low temperature systems are used i.e. underfloor heating.

LZC Technology	Suitable for Site	Reason	Preferred Option	Reason
Other				
Fuel cells using hydrogen generated from any of the above 'renewable' sources	☒	Hydrogen fuel cell technology is still at an early stage of development and has not necessarily been 'tried and tested' as with the other technologies reviewed.	☒	Although a 'hydrogen economy' is a long term goal, the production of hydrogen is currently commercially restrictive. Fuel cells CHP may be an appropriate technology in the future providing capital and maintenance costs become comparable to engine based CHP.

Table 5.1: High Level LZC Technology Review

5.2 SUMMARY

Based on the high level review contained within Table 5.1, the following LZC technologies have been identified as potentially viable for integration with buildings and zones of Wellesley:

- Solar Thermal
- Photovoltaics
- Combined Heat and Power (CHP)
- Biomass for CHP
- Ground Source Heat Pumps (GSHP)
- Air Source Heat Pumps (ASHP)

These technologies will be considered as part of individual solutions to meet the carbon requirements of the development over the forthcoming years.

Heat generation (for space and water heating) is currently the most significant use of regulated energy in the home. Solar Thermal, Ground and Air Source Heat Pumps have all been identified to provide Low and Zero Carbon (LZC) heat.

However, as carbon reduction targets are reduced in line with forthcoming policy and guidance, it will become increasingly difficult to achieve the required level of carbon emissions simply through LZC heat generation. LZC electricity generation may also be needed, for which a smaller range of options have been identified.

Photovoltaic (PV) panels have been outlined as viable for the site and is a mainstream technology, currently usable for a wide variety of individual dwelling types and locations. Combined Heat and Power (CHP) is another option identified but will only be appropriate in some situations as outlined by Section 4.

Individual technologies can therefore be combined to match the energy demand of the site better, targeting both gas and electricity consumption. In these cases the compatibility of individual renewable systems must be considered, ensuring the technologies are not 'competing' against each other, which may reduce their overall efficiency. The matrix below illustrates which LZC technologies outlined for Wellesley complement each other in providing a holistic renewable 'green' strategy.

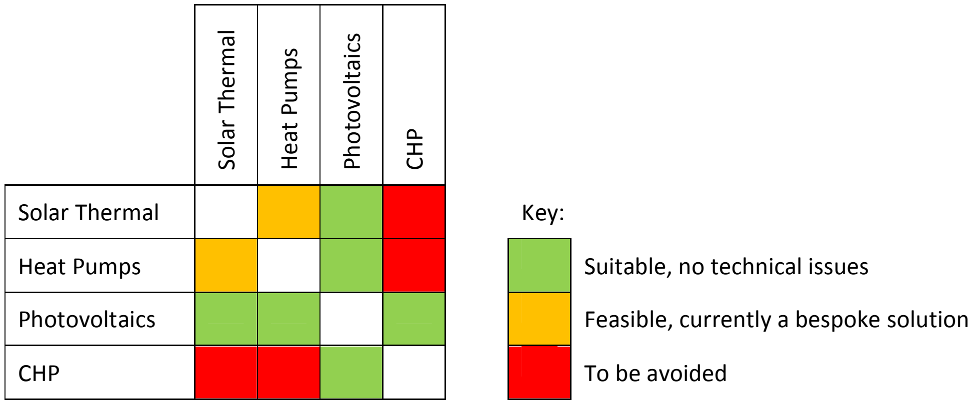

Figure 5.1: LZC Technologies Matrix

6. Energy & Carbon Assessment

The energy and carbon assessment outlined in this section is intended to be used as a starting point for discussions and begins to outline a combination of measures needed to comply with current policy and guidance. It is intended to provide a broad understanding of the specification that may need to be incorporated, as a starting point for detailed design.

There will be numerous routes to compliance, especially regarding the phasing of Wellesley and detailed design stages will no doubt see the development of bespoke cost effective strategies to meet the requirements at that given time. The options proposed within this high level analysis are considered to be helpful illustrations of typical approaches and should not be regarded as definitive.

Modelling has been carried out via the approved JPA Designer SAP 9.90 software and is used to demonstrate compliance of a typical building with Part L 2010 i.e. to achieve a zero percentage improvement in Dwelling Emissions Rate over Target Emission Rate (TER). In line with the council's aspiration to provide an exemplar development, a percentage of dwellings are intended to meet Code for Sustainable Homes (CSH) Level 4, even though not required by policy at the initial phases of the design (i.e. 2010 to 2013). As such this analysis will also review options in achieving a 25% improvement in DER over TER.

Due to planned changes in SAP assessment methodology, carbon emissions factors and other parameters to reflect future changes to Building Regulations in 2013, 2016 and beyond the detailed analysis contained within this report will only consider the above mentioned scenarios in line with 2010 requirements. Any analysis that could be undertaken for future scenarios would need to be revisited once the changes have been made and particular recommendations of carbon compliance may need to be adjusted.

Likely changes for the next revision of Building Regulations will be discussed, outlining what may need to be considered when preparing to meet these higher standards, expected to apply from 2013.

6.1 Base Specification

The base specification reflects current guidance outlined within Approved Document L1A (ADL1A) and can be achieved with readily available materials and common construction methods.

The base specification assumes that homes will have natural ventilation (provided by a combination of trickle vents, opening windows and intermittent extractor fans).

Of growing significance is the heat loss due to thermal bridging (the heat loss at junctions of external surfaces and around the edges of openings and complicated constructions such as bay windows and dormers).[8] This analysis assumes thermal bridging (y-value) of 0.08W/m^{2}K, which is based on the selection of Accredited Construction Details (ACDs).

All scenarios have been modelled with a mains gas combination condensing boiler (SEDBUK efficiency of 90%) with weather compensator, boiler interlock, programmer, radiators with thermostatic radiator valves (TRVs) and boiler energy manager. It is also assumed that all hot water systems will be separately timed and thermostatically controlled.

[8] Part L 2010 – Where to Start: An Introduction for House Builders and Designers; 2011; NHBC Foundation

The windows modelled are thermally efficient, typically double glazed with low-e coating. The overall light transmittance of the units (g-value) is set at a typical value of 0.63.

Lighting throughout the buildings is assumed to utilise 100% low energy fixed light fittings.

The base specification does not by itself achieve Part L1A compliance so a variety of possible routes to compliance are suggested in Section 7.

Element	Specification
External wall U-value	0.30 W/m^2K
Party wall U-value	0.00 W/m^2K
Ground floor U-value	0.25 W/m^2K
Roof U-value	0.20 W/m^2K
Windows U-value	2.00 W/m^2K
Doors U-value	2.00 W/m^2K
Thermal bridging (y-value)	0.08 W/m^2K
Thermal mass parameter	Program calculated
Air permeability	10 $m^3/h.m^2$ @50Pa

Table 6.1: Base Specification

6.2 DWELLING TYPES

The base specification and subsequent analyses contained within this report are based on a typical mid-terrace house. The terraced house has two storeys with an internal area of 76m^2, comprising three bedrooms, one bathroom and one WC. The glazed area is approximately 12% of the total internal floor area. An East /West orientation has been assumed for this preliminary study.

Figure 6.1: Mid-terrace house

As outlined in current and forthcoming guidance, a number of different dwelling types have been identified. These will specifically need to be considered individually with the introduction of Part L 2013 which begins to set out tailored energy and CO_2 targets per each building type.

As standards are raised there is a benefit to recognising the differing abilities of building types to cut energy demands and carbon emissions. For example apartments and mid-terrace houses have the natural advantage of lower external floor/wall/roof area per dwelling (and thus lower heat loss) than semi-detached and detached houses.

Also the cost effectiveness of using renewable energy technologies in different building types vary considerably; for example, the roof space available for photovoltaic panels is proportionately higher per dwelling in a detached house than in a tall thin apartment block[9].

[9] 2012 Consultation on Changes to the Building Regulations in England, Section Two, Part L (Conservation of Fuel and Power); January 2012; Department for Communities and Local Government

7. Carbon Compliance Target

The following options will consider compliance of regulatory CO_2 targets typically for Part L 2010 (i.e. from now till the introduction of Part L 2013). Two sets of scenarios are modelled with options to meet a 0 and 25% improvement in Dwelling Emission Rate (DER) over Target Emission Rate (TER), in line with requirements of Code for Sustainable Homes (CSH) Level 3 and 4, respectively.

Discussion is provided for post 2013 and how the intended CO_2 reductions can be related to current definitions. This will help provide some idea of what potential measures may be required, at these later stages of Wellesley.

7.1 Building Regulations 2010

In line with the minimum percentage requirements of DER over TER, for compliance with Part L 2010, two options have been presented. At this stage of compliance, solutions have been specified without the inclusion of Low to Zero Carbon (LZC) technologies. Although the South East Plan (SEP), Policy NRM11 has a 10% renewable energy requirement, the Council's Core Strategy Policy supersedes this, outlining energy efficiency as a key consideration[10].

Options A and B will therefore look at meeting a 0% improvement of DER over TER without the inclusion of renewable technologies. If for instance a photovoltaic systems was to be adopted it may be possible reduce the fabric performance specified.

Option A assumes fabric improvements as noted in Table 7.1.

Option A: enhanced fabric	
Element	**Specification**
External wall U-value	0.19 W/m^2K
Party wall U-value	0.00 W/m^2K
Ground floor U-value	0.11 W/m^2K
Roof U-value	0.14 W/m^2K
Windows U-value	1.60 W/m^2K
Doors U-value	1.00 W/m^2K
Air permeability	5 $m^3/h.m^2$ @50Pa

Table 7.1: Option A – 0% DER over TER

Option B assumes a high efficiency whole house MVHR system with a specific fan power (SFP) of 0.85 W/l/s and 90% heat recovery.

Option B: whole house mechanical ventilation with heat recovery	
Element	**Specification**
External wall U-value	0.20 W/m^2K
Party wall U-value	0.00 W/m^2K
Ground floor U-value	0.15 W/m^2K
Roof U-value	0.14 W/m^2K
Windows U-value	1.60 W/m^2K
Doors U-value	1.00 W/m^2K
Air permeability	5 $m^3/h.m^2$ @50Pa

Table 7.2: Option B – 0% DER over TER

[10] Refer to Appendix A for local authority correspondence

The following three options look to improve upon current requirements and achieve a 25% improvement of DER over TER, in line with requirements for CSH Level 4. To achieve this target the use of LZC technologies will be required. The LZC review outlined in Section 5 presented; photovoltaic, solar thermal, heat pumps and CHP technologies as viable for use with Wellesley.

Due to the high level nature of this study and intention to provide general recommendations, a solution using Combined Heat and Power (CHP) has not been included. CHP will only be appropriate in some situations and its feasibility will be dependent on specific detailed design information.

A combination of measures, acting together, could also provide the desired result. It should also be noted that this analysis cannot reproduce all the opportunities and challenges which arise for each individual building or Development Zones for Wellesley.

This analysis will aim to develop standard building specifications that can be used to express overall feasibility of solutions at different stages of the development.

Option C assumes a roof mounted 1 kWp photovoltaic system, equating to around $8m^2$ in area. An optimum roof pitch (30-45 degrees) and orientation (South West to South East) has been assumed.

Option C: photovoltaic panels	
Element	**Specification**
External wall U-value	0.19 W/m^2K
Party wall U-value	0.00 W/m^2K
Ground floor U-value	0.14 W/m^2K
Roof U-value	0.14 W/m^2K
Windows U-value	1.60 W/m^2K
Doors U-value	1.00 W/m^2K
Air permeability	5 $m^3/h.m^2$ @50Pa

Table 7.3: Option C – 25% DER over TER

Option D assumes 8.0 m^2 flat plate solar thermal panels with a dedicated solar storage of 110 litres. SAP 2009 default values for system efficiency have been used. A high efficiency whole house MVHR system with a specific fan power (SFP) of 0.85 W/l/s and 90% heat recovery is also utilised.

Option D: solar thermal panels	
Element	**Specification**
External wall U-value	0.19 W/m^2K
Party wall U-value	0.00 W/m^2K
Ground floor U-value	0.11 W/m^2K
Roof U-value	0.14 W/m^2K
Windows U-value	1.20 W/m^2K
Doors U-value	0.80 W/m^2K
Air permeability	3 $m^3/h.m^2$ @50Pa

Table 7.4: Option D – 25% DER over TER

Option E assumes an air source heat pump (ASHP) with a 300% space heating efficiency (seasonal COP of around 3) and 140% water heating efficiency with a 150 litre vessel volume. System efficiency based on product database utilising ‘Daikin Altherma Split ASHHP product EKHBH008B /ERHQ006BV3’.

Option E: air source heat pump	
Element	**Specification**
External wall U-value	0.25 W/m^{2}K
Party wall U-value	0.00 W/m^{2}K
Ground floor U-value	0.20 W/m^{2}K
Roof U-value	0.15 W/m^{2}K
Windows U-value	1.80 W/m^{2}K
Doors U-value	1.20 W/m^{2}K
Air permeability	10 m^3/h.m^2 @50Pa

Table 7.5: Option E – 25% DER over TER

7.2 FUTURE CHANGES TO THE BUILDING REGULATION IN 2013 AND 2016

In line with planned changes to Building Regulations as outlined in Section 2 it is clear that there will be a need for further improvements to fabric performance, with an emphasis on building an airtight and well insulated building and that all homes will need some form of renewable energy installed /connected.

Considering the two scenarios put forward for Part L 2013, the 'FEES plus efficient services' option model estimates an 8% aggregate (average across different dwelling types, taking into account build rates) CO_2 reduction from 2010 at an average cost per dwelling of £795. The 'Halfway point' option model estimates a 26% aggregate CO_2 reduction from 2010 levels at an average cost per dwelling of £2,866[11]. Appendix C outlines the approximate reductions in CO_2 emissions and increases in capita costs over and above Part L 2010 standards for both options.

The carbon targets recommended for 2016 Building Regulations apply to built performance and can therefore not be directly compared with current standards. However, in addition to any potential carbon savings achieved by moving from designed to built performance, the percentage improvements on the 2006 standard would be in the region of approximately[12]:

- 60% for detached houses
- 56% for attached houses
- 44% for low rise apartment blocks

(Part L 2010 required a 25% improvement to the CO_2 emissions compared with a notional Part L 2006 dwelling).

Ultimately through a combination of clean, lean and green design principles, as reviewed in the previous Sections, the forthcoming Carbon Compliance Targets can be achieved. This is the second element of the Zero Carbon Hierarchy (Figure 2.3) and is two thirds of the way to zero carbon (from regulated energy).

[11] 2012 Consultation on Changes to the Building Regulations in England, Section Two, Part L (Conservation of Fuel and Power); January 2012; Department for Communities and Local Government

[12] Carbon Compliance, Setting an Appropriate Limit for Zero Carbon New Homes, Findings and Recommendations; February 2011; Zero Carbon Hub

8. Allowable Solutions

Energy efficiency improvements and the use of on-site low-carbon heat and power will be employed by Wellesley to reduce its carbon emissions. However, it may not be technically possible to reduce regulated CO_2 emissions of the dwellings to zero via on-site measures alone.

The concept of Allowable Solutions has been introduced to stop this being necessary. They are a means by which carbon emissions at or below the level set for Carbon Compliance can be mitigated elsewhere.

A payment (depending on the outstanding amount of CO_2) will be required to secure equivalent emissions reductions via near-site or off-site carbon saving (Allowable Solution) projects. However, it should be noted that where it is viable to reduce emissions further than the Carbon Compliance levels on-site, the use of Allowable Solutions to achieve zero carbon may not be required.

The use of Allowable Solutions and as such any payments will not be required for Wellesley until zero carbon standards are required and introduced in policy. As outlined in Section 2.2 this is currently planned for 2016.

The Government has not yet made any decisions about the scope or price of Allowable Solutions or how they are to be delivered[13], although it is understood that the likely range is £50-£100/tCO_2. The Zero Carbon Hub have outlined a number of scenarios illustrating the impact of Allowable Solutions prices at £50, £75 and £100/tCO_2 and how this impacts the overall cost of meeting zero carbon requirements (refer to Appendix D). In summary the cost of Allowable Solutions makes a considerable difference to the total cost of zero carbon and therefore is a very important factor in site viability.

Figure 8.1 illustrates the contribution of; fabric improvements, efficient services and on-site low to zero carbon energy generation, and Allowable Solutions in meeting the targets for different dwelling types.

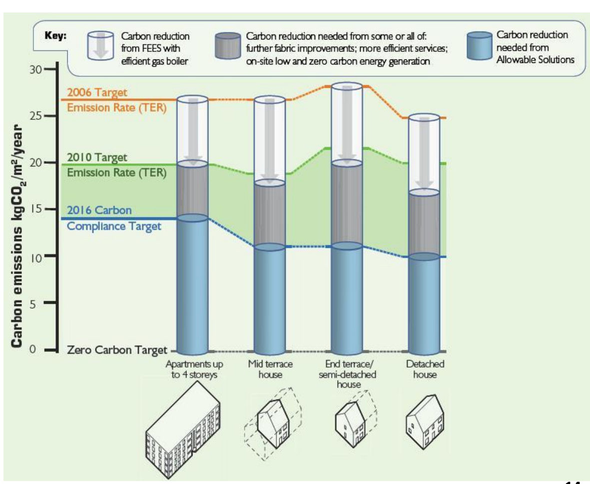

Figure 8.1: Carbon emission factors projected for 2016[14]

[13] Carbon Compliance, Setting an Appropriate Limit for Zero Carbon New Homes, Findings and Recommendations, February 2011; Zero Carbon Hub

[14] Fabric Energy Efficiency for Zero Carbon Homes, A Flexible Performance Standard for 2016; Zero Carbon Hub

9. Future Proofing

Looking beyond 2016, key issues of consideration have been highlighted below and will impact upon the design at latter stages of the development. Different solutions and considerations to those covered by this report may potentially be required, ensuring carbon targets are still met in a cost effective way, while adhering with current requirements.

9.1 Changing Carbon Emission Factors

During the 15 years from 2016 the national grid will start to decarbonise, while at the same time the carbon performance of gas will also change as a result of changes in where it is sourced. As a result, carbon emission factors for both grid electricity and gas will substantially change.

Proposed reductions in emissions of national grid electricity have been predicted by the Committee on Climate Change and are illustrated below.

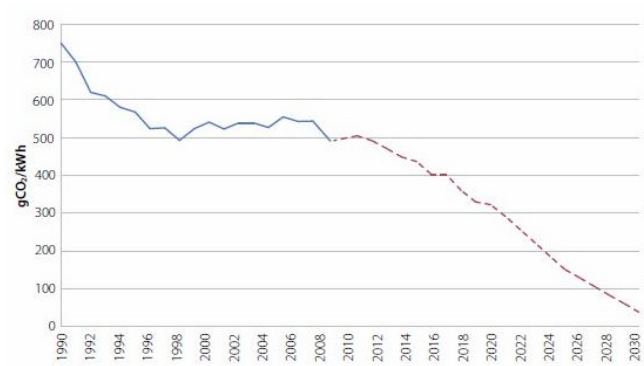

Figure 9.1: Emissions intensity of electricity[15]

Such a development will have an impact on the potential carbon reduction benefits of different technologies. Technologies that use grid electricity as their energy source, for example heat pumps, will benefit from lower carbon factors of grid electricity, improving their carbon reduction potential significantly. However renewable technologies that look to minimise the use of grid electricity, for example PVs, will see their potential for reducing carbon significantly reduced, due to the ‘cleaner’ nature of grid electricity.

The practical effect will be that to achieve the same levels of Carbon Compliance with a gas boiler will require increasing the amounts of PV, but with a heat pump will require reducing amounts of PV. The effect is likely to be compounded by progressive improvements in the efficiency of heat pumps.

9.2 Escalation of Energy Prices

Changes in prices of natural gas and electricity will affect the commercial viability of solutions and must be considered at detailed design phases. Any increases in the cost of grid supplied electricity will, for example, dramatically improve the financial benefits of PV installations, which will help developments reduce their need for ‘expensive’ grid supplied electricity. Coupled with a reduction in cost of PV systems the economical benefits may be quite significant compared with grid supplied electricity usage.

[15] Source: Committee on Climate Change

The use of district heating (DH) networks and specifically its potential for diversification of fuel supply by means of more than one fuel source is an attractive feature for future considerations. Improving the security of supply as well as providing a buffer against price volatility in the market for traditional fuels.

9.3 Climate Change

The impact of climate change is particularly relevant to Wellesley given the extended construction programme and life expectancy of the buildings. Potential building design solutions will have to adapt, to deal with a climate that may be significantly different from that in which it first evolved.

In general according to the UK Climate Projections (UKCP09), warmer conditions are expected in the coming years. Warmer winters will generally have a positive effect on buildings, with dwellings requiring less space heating allowing for reduced heat costs.

Warmer summers will however represent a significant challenge in maintaining the thermal comfort of buildings and must be considered at the later stages of the design evolution. Typically high levels of airtightness and insulation work well in protecting buildings from overheating provided there is adequate solar shading.

Conventional cross ventilation through open windows and night purge ventilation strategies may also be used as part of the cooling concept when appropriate, such as during the cooler evening of a hot day. This will help to purge daytime heat and in combination these strategies could be capable of significantly buffering the daytime temperature swing.

Dealing with the cause of overheating in the first instance through; solar shading, improved glazing performance (g-values) or reducing glazing where appropriate can reduce solar gain significantly before it even enters the building. Where necessary, the demand for controlled mechanical ventilation with the ability to pre cool supply air will be reduced, saving on energy consumption, running costs and CO_2.

All appliances and lighting consume energy contribute to heating a building. These internal gains must be minimised to mitigate the risks of overheating. Energy efficient appliances and low energy lighting should be employed in all scenarios.

In essence all design will aim to maximise daylight while reducing thermal stresses on the building, helping to alleviate lighting and cooling requirements, allowing for lower energy consumption and reduced CO_2 emissions.

9.4 Requirements for Further Building Emissions Reductions

Considering the UK's energy and climate targets, further energy and emission reduction measures can be expected in the future. District Heating (DH) networks may provide the required flexibility to Wellesley allowing 'easier' integration of renewable technologies for meeting of future carbon emission targets.

The use of DH could enable significant proportions of Wellesley to be switched to new and emerging technologies fuelled with low and zero carbon energy sources. For example, a gas fired CHP engine could be replaced with or accompanied by a new higher efficiency model, a biomass-fired plant or even a hydrogen fuel cell at some stage in the future, with no disruption to residents.

Connections with other new developments, as and when they are due to be phased in could also help the business case for DH, providing a greater magnitude of energy requirements.

10. Existing Buildings

Considering the energy strategy for existing buildings on site, any proposal should comply with guidance provided by Building Regulations for existing dwellings and other buildings (Approved Documents L1B and L2B). Depending on the 'types of work' proposed energy efficient requirements may be required.

Historic and traditional buildings may have an exemption from the energy efficiency requirements where compliance would unacceptably alter the character or appearance of the building. This refers to; listed buildings (in accordance with section 1 of the Planning (Listed Buildings and Conservation Areas) Act 1990), buildings in conservation areas (in accordance with section 69 of the ACT) and scheduled ancient monuments (maintained under section 1 of the Ancient Monuments and Archaeological Areas Act 1979). Other special considerations may apply and this shall be assessed where necessary at detailed design stages.

When undertaking work on or in connection with a historic or traditional building, the aim should be to improve energy efficiency as far as reasonably practicable without prejudicing the character of the host building or increasing the long-term deterioration of the building fabric or fittings. The guidance given by English Heritage should be taken into account in determining appropriate energy performance standards for building work in historic buildings[16].

In terms of the overall energy strategy, Wellesley will aim to limit energy related improvements to buildings which are retained to those measures which are technically, functionally and economically feasible. Design proposals will include low cost energy saving measures, which can be easily adopted without damaging existing buildings fabric and may include (although not limited to):

- Draught-stripping and roof insulation.
- Additional fabric improvements limited to those that are critical (in accordance with Building Regulations).
- Boiler replacement with improved high efficiency gas-fired boilers.
- Any mechanical ventilation to have high efficiency heat recovery units.
- Reduce heating /increase cooling set points, if possible (install thermostats for greater control over heating and cooling).
- Promote the use of natural ventilation, reducing the need for mechanical ventilation.
- Introduce night time ventilation strategies to minimise use of any mechanical cooling.
- Making maximum use of daylight and providing appropriate lighting control sensors to help minimise reliance on artificial lighting.
- Install low energy lighting.
- Install building management systems (BMS) and smart meters.
- Install voltage optimisation and power factor correction systems.

Existing community buildings will be assessed for integration with any proposed District Heating (DH) networks. Not only does this allow existing buildings to benefit from a more efficient supply of energy but it could also help the overall viability of such DH schemes; where additional and varied loads will help ensure the continuous operation of a DH network and the CHP plant generating the energy.

Consideration of non obtrusive low carbon solutions will be reviewed for those buildings of historical value. Solar technologies are as such not expected to be used, instead biomass and ground source heat pumps will be considered, where and if required.

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[16] Approved Document L1B Conservation of Fuel and Power in Existing Dwellings; 2010 Edition; HM Government
Approved Document L2B Conservation of Fuel and Power in Existing Buildings other than Dwellings; 2010 Edition; HM Government

11. Conclusion

In the first instance as current policy and guidance stands it appears possible to achieve requirements of Part L 2010 through fabric improvements and the utilisation of good practice energy efficient measures and services.

If further improvements in Dwelling Emission Rate over Target Emission Rate are required in line with the aspiration by the council for an exemplar development, before they are required by policy, this could be achieved with the inclusion of renewable technologies.

The conclusions of the renewable analysis, aimed at determining which technologies are viable for integration with Wellesley are: photovoltaic's (PVs), solar thermal, combined heat and power (CHP) with natural gas or biomass as a fuel source and air /ground source heat pumps.

CHP will not be appropriate for all situations and its feasibility will be assessed in terms of district heating networks, at detailed design stages. Consideration must be given to the magnitude and demand of required, dwelling density, type of buildings and phasing.

To meet forthcoming carbon reduction targets the use of photovoltaic panels appears to provide a likely solution. Financial viability must be assessed at each detailed design stage ensuring it is the most economical solution. Improving efficiencies and reducing cost of PVs along with the availability of Feed in Tariff (FITs) will help, as will predicted increases in the price of grid electricity. However the decarbonisation of the national grid must be considered at later stages of Wellesley to assess the viability of PVs in providing significant carbon reductions.

The more stringent energy and carbon targets of 2016 and beyond do appear to lend themselves to a combination of renewable technologies working in harmony with a highly energy efficient building fabric, that would have already greatly reduced the actual demand for energy. The use of district heating networks may also allow sections of the development to continuously improve their carbon performance, if required, by being able to switch to low and zero carbon energy sources, as and when new and emerging technologies become available, all without major disruption to occupants.

Further analysis will be required at each detailed design phase to ensure the guiding principles of this document will achieve the required energy and carbon targets at the specific time.

The energy strategy for Wellesley Aldershot is to therefore follow the well established energy hierarchy of 'Be Lean, Be Clean, Be Green'. Wellesley Aldershot will look to promote passive and active energy efficiency measures to substantially drive down energy usage, compared with current design practices. Only then will Low to Zero Carbon Technologies be considered. Priority will be given to CHP and community heating (where viable), as this appears to provide a long term strategy to help support Wellesley, Aldershot achieve future energy and carbon targets.

Appendix A Local Authority Correspondence

From: Matthew Melville [mailto:matthew.melville@rushmoor.gov.uk]
Sent: 01 February 2012 16:02
To: Fran Pickering
Cc: Marcia McGinty; Jonathan Steele; John Thorne; Tracey Coleman
Subject: RE: Renewable Energy and Sustainability

Dear Fran

Thank you for your enquiry.

With regards to the South East Plan requirements, Policy NRM11 requires 10% renewable energy '...in advance of local targets being set in Development Plan Documents'. In accordance with the energy hierarchy (which prioritises minimising energy use), the Council's Core Strategy policy specifically does not include a target for renewable energy. There is therefore no requirement to produce this energy assessment.

Instead, the Council's Policy (CP3) focuses on the achievement of holistic sustainability levels (through the Code for Sustainable Homes and BRE) and the delivery of community-scale renewable/low carbon infrastructure (specifically District Heating).

With regards to the sustainability levels, a reasonable approach would be to require those parts of the site that receive full planning permission or reserved matters prior to April 2013 (or whenever Part L is tightened) to meet (at least) full Code Level 3. For Reserved Matters determined after April 2013, the dwellings covered by that consent would be required to reach (at least) full Code Level 4. By *full* Code Level, I mean certification against all parts of the Code, and demonstrated by a post-construction certificate.

For the outline planning application, the Council would also require a thorough assessment of the viability of the development for District Heating (as required by Policy CP3 and the Energy Opportunities Plan). It is considered that District Heating would provide a future proof way of providing green energy to the site (and potentially also the surrounding area). Whilst it is recognised that District Heating is unlikely to be viable across the whole site, it is most likely to be viable on parts of the development with the highest density and the non-residential uses (and this should inform your masterplanning). Viability may also be improved by connecting to heat users outside the site. To satisfy this part of the policy, we would therefore expect a full scoping of these opportunities.

I hope this is of help

Regards

Matthew

Matthew Melville
Senior Planning Officer (Policy)
Rushmoor Borough Council

01252 398739 (x8739)

Appendix B Fabric Specifications

The tables contained within this Appendix are from the following document issued by the Zero Carbon Hub, “Informing the Part L 2013 Consultation, Fabric Energy Efficiency for Part L 2013, Worked Examples and Fabric Specification, February 2012”.

House type 1: Detached house

The detached house has four bedrooms and an internal floor area of 118 m^2.

	Interim FEE (52 kWh/m²/yr)		Full FEES (46 kWh/m²/yr)	
	Example 1	Example 2	Example 1	Example 2
External wall U-value (W/m²K)	0.18	0.22	0.15	0.20
Ground floor U-value (W/m²K)	0.15	0.20	0.13	0.18
Roof U-value (W/m²K)	0.11	0.18	0.13	0.16
Windows U-value (W/m²K)	1.4 (double glazed)	1.0 (triple glazed)	1.2 (double glazed)	0.8 (triple glazed)
Doors U-value (W/m²K)	1.2	1.6	1.0	1.0
Air permeability (m³/hr/m² @ 50Pa)	5.1	5.4	5.2	5.1
Calculated thermal bridging (W/m²K)	0.058 (Int.)	0.04 (ECD)	0.04 (ECD)	0.025
DFEE (kWh/m²/yr)	51.99	52.00	45.97	45.95

House type 2: Semi-detached / end-terrace house

The semi-detached / end-terrace house has three bedrooms and an internal floor area of 76 m^2.

	Interim FEE (52 kWh/m²/yr)		Full FEES (46 kWh/m²/yr)	
	Example 1	Example 2	Example 1	Example 2
External wall U-value (W/m²K)	0.18	0.22	0.18	0.20
Party Wall U-value (W/m²K)	0.00	0.00	0.00	0.00
Ground floor U-value (W/m²K)	0.15	0.20	0.13	0.18
Roof U-value (W/m²K)	0.13	0.18	0.13	0.16
Windows U-value (W/m²K)	1.4 (double glazed)	1.4 (double glazed)	1.4 (double glazed)	1.2 (double glazed)
Doors U-value (W/m²K)	1.6	1.4	1.0	1.0
Air permeability (m³/hr/m² @ 50Pa)	5.1	5.0	5.0	4.8
Calculated thermal bridging (W/m²K)	0.088 (ACD)	0.051 (ECD)	0.051 (ECD)	0.04
DFEE (kWh/m²/yr)	51.94	51.96	45.95	45.93

House type 3: Mid-terrace house

The mid-terrace house has three bedrooms and an internal floor area of 76 m².

For examples of averaging across a terrace, please refer to page 8.

	Interim FEE (43 kWh/m²/yr)		Full FEES (39 kWh/m²/yr)	
	Example 1	Example 2	Example 1	Example 2
External wall U-value (W/m²K)	0.18	0.22	0.18	0.20
Party Wall U-value (W/m²K)	0.00	0.00	0.00	0.00
Ground floor U-value (W/m²K)	0.15	0.20	0.15	0.18
Roof U-value (W/m²K)	0.13	0.18	0.13	0.16
Windows U-value (W/m²K)	1.4 (double glazed)	1.2 (double glazed)	1.4 (double glazed)	1.2 (double glazed)
Doors U-value (W/m²K)	1.6	1.2	1.2	1.0
Air permeability (m³/hr/m² @ 50Pa)	5.1	4.8	5.2	4.9
Calculated thermal bridging (W/m²K)	0.077 (Int.)	0.063 (ECD)	0.04	0.04
DFEE (kWh/m²/yr)	42.91	42.97	38.96	38.99

House type 4: Apartment block

The apartment block comprises of 8 flats per floor, and extends over four storeys (total 32 flats). Each floor has four single aspect one-bedroom flats with an internal area of 43 m² and four 2-bedroom corner flats with a floor area of 67 m².

	Interim FEE (43 kWh/m²/yr)		Full FEES (39 kWh/m²/yr)	
	Example 1	Example 2	Example 1	Example 2
External wall U-value (W/m²K)	0.20	0.22	0.18	0.20
Party Wall U-value (W/m²K)	0.00	0.00	0.00	0.00
Sheltered wall U-value (W/m²K)	0.19	0.20	0.17	0.19
Ground floor U-value (W/m²K)	0.18	0.20	0.15	0.18
Roof U-value (W/m²K)	0.17	0.18	0.13	0.16
Windows U-value (W/m²K)	1.6 (double glazed)	1.4 (double glazed)	1.4 (double glazed)	1.2 (double glazed)
Doors U-value (W/m²K)	1.6	1.6	1.4	1.6
Air permeability (m³/hr/m² @ 50Pa)	5.3	5.3	5.2	5.4
Calculated thermal bridging (W/m²K), average for block	0.084 (ACD)	0.084 (ACD)	0.072 (Int.)	0.072 (Int.)
DFEE (kWh/m²/yr)	42.98	42.90	38.89	39.00

Appendix C Part L 2013 CO_2 Reduction & Cost Increase

The figures contained within this Appendix are from the following document issued by the Department for Communities and Local Government in January 2012: "2012 consultation on changes to the Building Regulations in England, Section two, Part L (Conservation of fuel and power)".

Table 2[22]

	Mid terrace house	End of terrace house	Detached House	4-storey apart-ment block	4-storey apart-ment block	Aggregate % reduction from 2010
'FEES plus efficient services'	**4%**	**7%**	**15%**	**0%**	**12%**	**8%**
'Half-way point' rounded	26%	28%	29%	19%	28%	26%
Fuel assumed	*Gas*	*Gas*	*Gas*	*Gas*	*Electricity*[23]	*Mix*

22 These figures are illustrative for consultation purposes, and use preliminary CO_2 emission factors.
23 If the fuel factor was retained at 2010 levels these figures would as for the gas heated 4 storey block

Table 3[24]

	Mid terrace house	End of terrace house	Detached House	4-storey apart-ment block	Average cost per dwelling
FEES plus efficient services	**£294**	**£755**	**£2,622**	**£248**	**£795**
Half-way point	£2,517	£3,131	£4,910	£1,959	£2,866
Fuel assumed	*Gas*	*Gas*	*Gas*	*Gas*	

24 The cost figures are for fabric and services improvements only, and do not include the costs of introducing a new quality assurance process. All the figures assume building to the full FEES targets, and are based on 2014 prices.

Appendix D Cost of Zero Carbon Homes

The following has been issued by the Zero Carbon Hub estimating the cost of zero carbon homes based on alternative Allowable Solutions prices.

Addendum: Updated cost of Zero Carbon Homes following 2011 Budget announcements by the Government:

Regulated energy only: " ... the Government will hold housebuilders accountable only for those carbon dioxide emissions that are covered by the Building Regulations, and will provide cost-effective means by which they can do this." *(HM Treasury & BIS, The Plan for Growth, March 2011)*

Allowable Solutions price: "... cost effective options for off-site carbon reductions, relative to the Government's pricing of carbon..." *(HM Treasury & BIS, The Plan for Growth, March 2011)* . No official announcement has been made by Government on the price of Allowable Soultions although we understand that the likely range is £50 - £100/tCO_2. We have therefore provided three tables below showing the impact of Allowable Solutions prices at £50, £75 and £100/tCO_2.

Allowable Solutions price @ £50/tonneCO_2 over 30 years

Dwelling Type	Carbon Compliance Level $kgCO_{2(eq)}/m^2/yr$	@ 2010 prices: Fabric ('06 to '10)	Fabric (over 2010)	Carbon Compliance (excl fabric)	Allowable Solutions	TOTAL over 2010	TOTAL over 2006	Base build cost	@ 2016 prices: Fabric ('06 to '10)	Fabric (over 2010)	Carbon Compliance (excl fabric)	Allowable Solutions	TOTAL over 2010	TOTAL over 2006
Low-rise Apartment Block, ave per unit	14	£1,071	£51	£2,600	£1,146	£3,797	£4,868	£60,000	£760	£36	£1,332	£1,146	£2,514	£3,275
Mid Terrace House	11	£1,194	£0	£5,752	£1,259	£7,011	£8,205	£67,820	£848	£0	£3,004	£1,259	£4,263	£5,111
End Terrace House	11	£1,804	£80	£6,632	£1,259	£7,971	£9,775	£71,820	£1,281	£57	£3,444	£1,259	£4,760	£6,041
Detached House	10	£3,153	£1,913	£7,809	£1,769	£11,491	£14,644	£107,380	£2,239	£1,358	£4,033	£1,769	£7,160	£9,398

Allowable Solutions price @ £75/tonneCO_2 over 30 years

Dwelling Type	Carbon Compliance Level $kgCO_{2(eq)}/m^2/yr$	@ 2010 prices: Fabric ('06 to '10)	Fabric (over 2010)	Carbon Compliance (excl fabric)	Allowable Solutions	TOTAL over 2010	TOTAL over 2006	Base build cost	@ 2016 prices: Fabric ('06 to '10)	Fabric (over 2010)	Carbon Compliance (excl fabric)	Allowable Solutions	TOTAL over 2010	TOTAL over 2006
Low-rise Apartment Block, ave per unit	14	£1,071	£51	£2,600	£1,719	£4,370	£5,441	£60,000	£760	£36	£1,332	£1,719	£3,087	£3,848
Mid Terrace House	11	£1,194	£0	£5,752	£1,889	£7,641	£8,835	£67,820	£848	£0	£3,004	£1,889	£4,893	£5,741
End Terrace House	11	£1,804	£80	£6,632	£1,889	£8,601	£10,405	£71,820	£1,281	£57	£3,444	£1,889	£5,390	£6,671
Detached House	10	£3,153	£1,913	£7,809	£2,653	£12,375	£15,528	£107,380	£2,239	£1,358	£4,033	£2,653	£8,044	£10,283

Allowable Solutions price @ £100/tonneCO_2 over 30 years

Dwelling Type	Carbon Compliance Level $kgCO_{2(eq)}/m^2/yr$	@ 2010 prices: Fabric ('06 to '10)	Fabric (over 2010)	Carbon Compliance (excl fabric)	Allowable Solutions	TOTAL over 2010	TOTAL over 2006	Base build cost	@ 2016 prices: Fabric ('06 to '10)	Fabric (over 2010)	Carbon Compliance (excl fabric)	Allowable Solutions	TOTAL over 2010	TOTAL over 2006
Low-rise Apartment Block, ave per unit	14	£1,071	£51	£2,600	£2,293	£4,944	£6,015	£60,000	£760	£36	£1,332	£2,293	£3,661	£4,421
Mid Terrace House	11	£1,194	£0	£5,752	£2,519	£8,271	£9,465	£67,820	£848	£0	£3,004	£2,519	£5,523	£6,370
End Terrace House	11	£1,804	£80	£6,632	£2,519	£9,231	£11,035	£71,820	£1,281	£57	£3,444	£2,519	£6,020	£7,300
Detached House	10	£3,153	£1,913	£7,809	£3,538	£13,260	£16,413	£107,380	£2,239	£1,358	£4,033	£3,538	£8,929	£11,167

Appendix E Key Documentation

The Building Regulations 2000, Conservation of fuel and power, Approved Document L1A, Conservation of Fuel and Power in New Dwellings; 2010 Edition; HM Government

The Building Regulations 2000, Conservation of fuel and power, Approved Document L1B, Conservation of Fuel and Power in Existing Dwellings; 2010 Edition; HM Government

The Building Regulations 2000, Conservation of fuel and power, Approved Document L2A, Conservation of Fuel and Power in New Buildings other than Dwellings; 2010 Edition; HM Government

The Building Regulations 2000, Conservation of fuel and power, Approved Document L2B, Conservation of Fuel and Power in Existing Buildings other than Dwellings; 2010 Edition; HM Government

2012 Consultation on Changes to the Building Regulations in England, Section Two – Part L (Conservation of Fuel and Power), Proposed Changes to Technical Guidance; January 2012; Department for Communities and Local Government

2012 Consultation on Changes to the Building Regulation in England, Section Two, Part L (Conservation of Fuel and Power); January 2012; Department for Communities and Local Government

Code for Sustainable Homes, Technical Guide; November 2010; Department for Communities and Local Government

Rushmoor Plan, Planning for Rushmoor's Future, Core Strategy; October 2011; Rushmoor Borough Council

Carbon Compliance, Setting an Appropriate Limit for Zero Carbon New Homes, Findings and Recommendations; February 2011; Zero Carbon Hub

Informing the Part L 2013 Consultation, Fabric Energy Efficiency for Part L 2013, Worked Examples and Fabric Specification, February 2012; Zero Carbon Hub

Fabric Energy Efficiency for Zero Carbon Homes, A Flexible Performance Standard for 2016; Zero Carbon Hub

Renewable Energy Sources for Buildings; 2006; CIBSE

The Performance of District Heating in New Developments, Application Guidance, IP 3/11; April 2011; BRE

Part L 2010 – Where to Start: An Introduction for House Builders and Designers; 2011; NHBC Foundation

Appendix F Locations of Energy Centres

Below is an illustrative plan highlighting where potential Locations of Energy Centres could be developed.

The size and location should be assessed as further detailed information sufficient for technical assessments become available for each phase.

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