

elementenergy

**N & NE Hedge End SDA
Energy strategy options
appraisal**

FINAL REPORT

for
Partnership for Urban
South Hampshire

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1 Introduction

The requirement for a Strategic Development Area (SDA) to the north / north east of Hedge End was identified in policy SH2 of the South East Plan. The Hedge End SDA is to provide up to 6,000 dwellings, of varying types and sizes, together with substantial employment, community, retail and other supporting uses. The Hedge End SDA will be one of two proposed by the South East Plan, the other is to be located in Fareham Borough and will provide up to 10,000 dwellings.

The responsibility for identification of the SDA site and defining its overall form falls to the relevant local authority, through their Local Development Framework. In the case of the Hedge End SDA, the area of search spans across the Eastleigh Borough and Winchester City Council boundary, as shown in the Figure below.

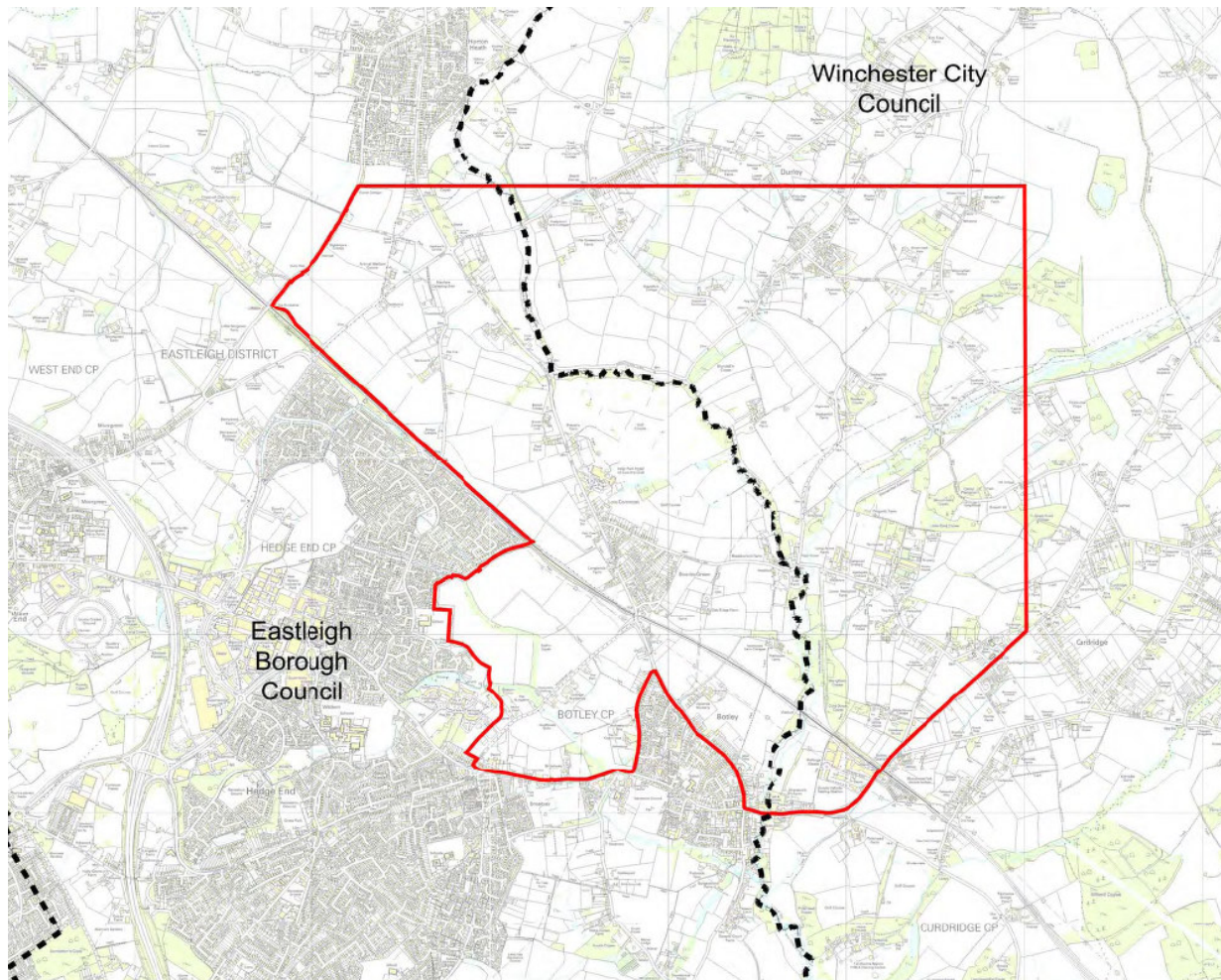


Figure 1, Map of the N/NE Hedge End area of search

Given the scale and regional significance of the Hedge End SDA, it is important that a strategy is developed to ensure the CO₂ impact of the development is minimized. It is particularly important on a large site such as this, which will potentially be built-out in parcels by a number of developers, to develop an energy strategy as part of the overall master plan, to ensure that potential benefits of a coordinated approach are fully exploited.

There are a number of policies concerning energy and CO₂ emissions performance that will be relevant to the Hedge End site and these are discussed in detail in Section 2 of this report. Based on the forecasted timeline for development of the site, it is likely that zero carbon homes policy will apply to much of the residential development. This will ensure that a high level of carbon reduction is delivered compared to current standards of construction. There may be an opportunity on a site of this scale, however, to exceed the standards required by Building Regulations and zero carbon policy.

A higher requirement for CO₂ reduction than is required by Building Regulations and zero carbon policy will need to be set through local planning policy. Currently, Winchester City Council is further ahead than Eastleigh Borough Council in terms of developing the sustainable design and construction and renewable energy policies that will form part of the Local Development Framework. Winchester has published a draft Core Strategy Preferred Options document for consultation, which includes some tough sustainable policies, including a requirement for residential development post-2016 to achieve Code for Sustainable Homes Level 6 and BREEAM 'Excellent' standard in non-residential buildings.

Element Energy has conducted a prior study into the viability impacts of Winchester City Council's draft Core Strategy policies. This study found that the costs of compliance with the CO₂ reduction policies would be very high, particularly for small sites. The study assessed the impact of revisions to the Core Strategy policy, including the potential of reducing the onsite CO₂ reduction requirement and providing an option for developers to offset by paying into a local carbon offset fund.

The scope of the prior study did not include assessment of sites of the scale of the N/NE Hedge End SDA. The scale of this site is expected to lead to economies of scale, particularly with regards to site-wide energy systems, that result in a lower cost of compliance with stringent CO₂ reduction policies.

This study extends the prior analysis to consider the SDA site. In addition to assessment of capital costs associated with complying with relevant policies, such as zero carbon homes policy and the Winchester City Council draft Core Strategy policy, this study considers the revenues associated with operation of site-wide energy strategies. The economic modelling enables an estimation of the investment in development of the energy system that might be secured from the private sector and the impact of this investment on the additional costs incurred by the developers.

2 Policy background

The next decade will be a period of rapid change of policy concerning the energy and CO₂ emissions performance of new buildings. The principle tools used to enforce improving standards will be the Building Regulations and the Zero Carbon, expected to be introduced in 2016 for domestic buildings and 2019 for the non-domestic sector. In addition to these national policies, local planning authorities have been given a remit to identify areas of particular opportunity for advanced standards of CO₂ reduction or renewable energy generation, i.e. going beyond the minimum standards required by regulations, and to set local planning policy to ensure they are exploited. The key policy developments of relevance to the SDA site are described in this section.

2.1 Building Regulations: Part L

2.1.1 Current standards and changes over time

In terms of energy use and CO₂ emissions the relevant aspect of the Building Regulations is Part L. This sets minimum standards for new homes in the form of a **dwelling emission rate** (DER), measured as kilograms of CO₂ per square metre of floor area per year (kgCO₂/m².yr). Periodic reviews and changes to the regulations are necessary and the current revision is Part L 2006.

The current Building Regulations, while ensuring a decent level of construction in terms of insulation standards and air-tightness, do not demand any particular innovation in terms of building services, beyond efficient thermal plant (e.g. condensing gas boilers).

The government has committed to introducing zero carbon homes policy from 2016. To deliver this vision Part L1A (covering new dwellings) is due to be changed in 2010, 2013 and 2016, with each revision stipulating more stringent standards in terms of carbon emissions. Similarly, revisions to Part L2A (which covers buildings other than dwellings) are also expected, with a current target date of zero carbon non-domestic buildings from 2019. The proposed changes to Part L1A are summarised in the following figure.

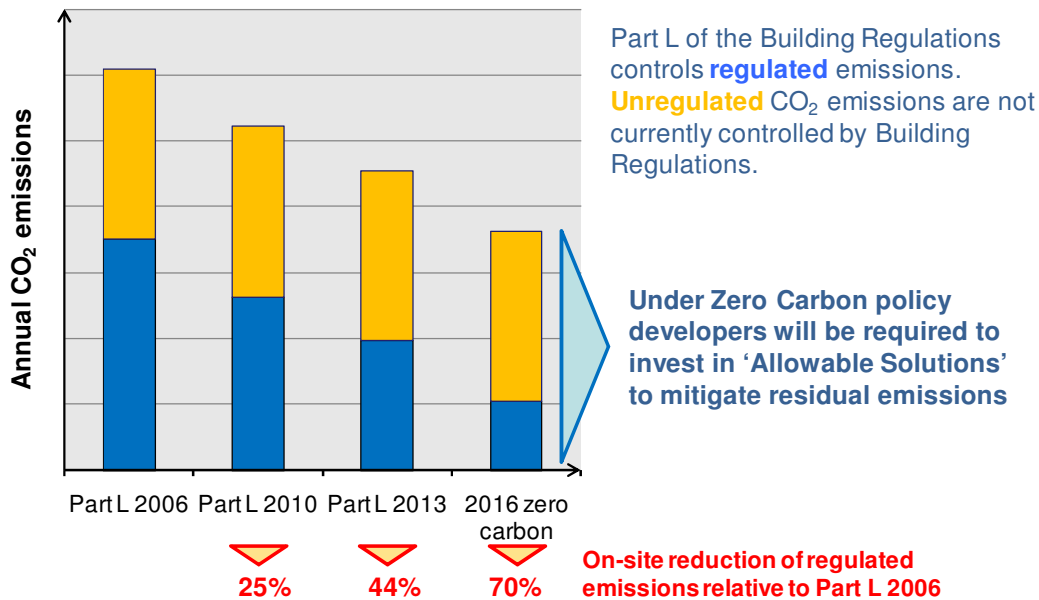


Figure 2: Graphic representation of proposed changes to the Building Regulations

Building Regulations split total CO₂ emissions from dwellings into two types: **regulated** and **unregulated** emissions. Regulated emissions are those arising from fuel use for space and water heating, any fixed cooling systems, fixed lighting and fans and pumps installed. Unregulated emissions include those arising from energy used for cooking and any electricity for appliances.

Traditionally Part L has only dealt with buildings’ regulated emissions. However, zero carbon homes policy requires all regulated and unregulated emissions to be offset, either through on-site measures or through investment in Allowable Solutions, which will be used to achieve equivalent carbon savings elsewhere.

As indicated by Figure 2, future changes to Part L are measured relative to Part L 2006, with reductions in regulated emissions of 25%, 44% and 70% required by on-site means from 2010, 2013 and 2016 respectively.

2.2 Zero carbon policy

2.2.1 Zero carbon homes

Zero carbon policy will work alongside the Building Regulations to ensure that a developer must act to eliminate or offset all emissions associated with their development (including both regulated and unregulated emissions). It has been recognised that to eliminate all emissions through provision of on-site low carbon and renewable energy is prohibitively expensive and may not be technically achievable in certain types of development. In light of this, government proposes that the zero carbon standard will be based on a hierarchy of CO₂ reduction through energy efficiency, CO₂ reduction through provision of on-site low carbon energy supply and finally, offsetting the remaining CO₂ emissions from the development by investing in carbon reduction projects elsewhere. This hierarchy is shown in the diagram below.

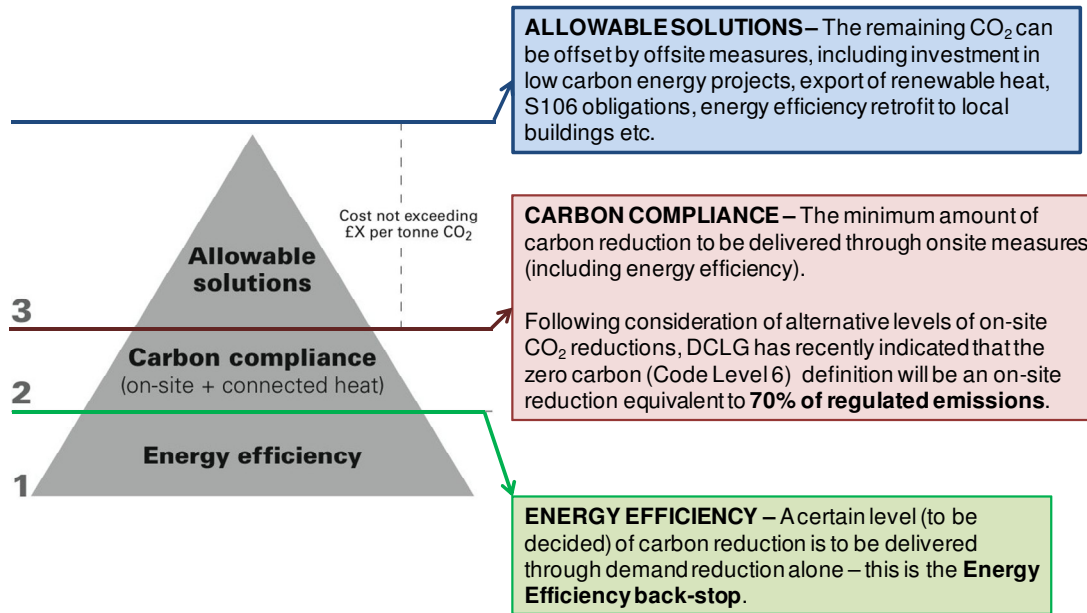


Figure 3: Schematic describing the hierarchical approach to CO₂ emissions reduction used in the definition of zero carbon homes and buildings

Energy efficiency back-stop levels, based on the work of the Zero Carbon Hub¹, are included in the Department of Communities and Local Government (DCLG) consultation on zero carbon homes.² The recommended levels are not yet part of formal policy and are therefore subject to change. However, they give an indication of the preferred metrics and likely level of improvement that will be required.

The hierarchical structure of the zero carbon policy is expected to be applied to domestic and non-domestic buildings alike. However, the level of carbon compliance may differ between building types (potentially even between various types of non-domestic building), to reflect the differing challenges of reducing CO₂ with different building forms and uses.

2.2.2 Zero carbon non-domestic buildings

The proposed definition of the zero carbon standard in non-domestic buildings is less developed than is the case for zero carbon homes. Government recognises the differing technological challenges in achieving deep carbon reductions between domestic and non-domestic buildings, the diversity of the non-domestic building stock and therefore its carbon intensity impact and the increased likelihood of a change of building use that could have a large impact on carbon emissions.

As a starting point, zero carbon consultation states that the zero carbon standard for non-domestic buildings should at least cover regulated emissions and that following a hierarchical approach, similar to that proposed for zero carbon homes, would be sensible. However, there is still uncertainty over whether the levels of the hierarchy, in particular the carbon compliance level which sets the CO₂

¹ See www.zerocarbonhub.org/news_details.aspx?article=5.

² DCLG consultation: *Sustainable New Homes: The Road to Zero Carbon: Consultation on the Code for Sustainable Homes and the Energy Efficiency standard for Zero Carbon Homes*. See www.communities.gov.uk/planningandbuilding/buildingregulations/legislation/codesustainable/

reduction to be delivered through energy efficiency and onsite measures, should be the same as those adopted in the case of homes.

The government is committed to revising Part L for non-domestic buildings in 2010 to require a 25% reduction in CO₂ compared to Part L 2006. It is proposed that a Forward Thinking paper on the possible changes to be made in the 2013 revision of Part L could be published alongside the 2010 amendments. The detail of the 2013 amendments would then be consulted on in due course.

The trajectory beyond 2013 will be informed by the availability and viability of technical solutions and the range of allowable solutions. Current research by the UK Green Building Council suggests that moving beyond a 44% reduction on Part L 2006 will require a step-change in the availability of technical solutions and the cost-effectiveness of those measures. At this stage, Government will consider whether interim steps should be introduced between 2013 and 2019.

2.2.3 Allowable solutions

The Government is yet to define what the range of allowable solutions for offsetting any residual CO₂ emissions will be, or the practical implementation measures. However, the following possible allowable solutions received broad support in the December 2008 consultation on zero carbon homes:³

- Further CO₂ reductions (beyond the mandatory minimum level) through onsite measures.
- Energy efficient appliances that meet a high standard installed as fittings in the home.
- Advanced building control systems to reduce energy use in the home.
- Export of low carbon or renewable heat to other developments.
- Investment in low and zero carbon community heating infrastructure.

This list is by no means finalised and other allowable solutions remain under consideration.

³ *Sustainable New Homes – The Road to Zero Carbon: Consultation on the Code for Sustainable Homes and the Energy Efficiency standard for Zero Carbon Homes*, p.32.
www.communities.gov.uk/publications/planningandbuilding/futureofcodeconsultation.

2.3 Codes and certificates

2.3.1 The Code for Sustainable Homes

The Code for Sustainable Homes (CSH) is a national standard for sustainable building. New homes are assessed against nine design categories from Energy / CO₂, to Water, Materials, Management and Ecology. Based on credits awarded under these categories an overall star-rating is awarded, from one to six stars, which are known as Code Levels (e.g. three stars is Code Level 3). Code Level 6 is the highest sustainability rating and achieving this standard represents a significant challenge.

Unless stipulated by local planning policies, building to any level of the Code remains voluntary for private development. However, gaining a Code rating became mandatory for new homes from May 1st 2008. If no target Code level is sought the dwelling is given a 'Nil Rated' status. While the Code is a voluntary standard, all public sector housing must currently achieve level 3 to obtain central government funding. This minimum standard is set to rise to level 4 from 2011.

The CSH has been designed to show the future for the building industry. For example, the mandatory requirements in terms of CO₂ reduction in the Code mirror the proposed changes to Part L in 2010 and 2013. Therefore developers building Code homes gain relevant experience that will allow them to comply with future changes to minimum mandatory standards imposed through changes to Building Regulations.

2.3.2 BREEAM

The BRE Environmental Assessment Methodology is an internationally recognised environmental assessment method for buildings which sets standards in terms of sustainable design. The BREEAM is used to assess buildings against set criteria (in similar categories used in the CSH) and provide a score which is translated into a rating of Pass, Good, Very Good, Excellent or Outstanding.

2.3.3 Energy Performance Certificates

Energy Performance Certificates (EPCs) grade the performance of a building in terms of energy efficiency and CO₂ emissions on a scale from A to G (A being the best performing), similar to the energy performance certification of white goods. Their purpose is to provide better information to prospective buyers or tenants on the energy efficiency of the building and to advise on how the energy performance could be improved. All buildings that are newly constructed, sold or let require an EPC (with a few exceptions, including places of worship, temporary buildings and non-dwellings under 50m²).

The energy performance of the building is rated against a common benchmark, allowing the EPC rating to be used as a comparative metric with other buildings in the stock. In the case of dwellings an energy efficiency rating and an environmental rating is given, rating the dwelling on likely running costs and CO₂ emissions respectively. For non-dwellings a single CO₂ based rating is given, taking into account the performance of the building fabric and services. In each case the EPC rating is accompanied by a recommendations report, advising on cost-effective actions that could be taken to improve the performance of the building. EPCs are valid for a period of ten years, unless part of a Home Information

Pack (HIP), in which case the EPC must be less than three years old when the home is first put on the market. Example EPC ratings for a typical dwelling are shown below.

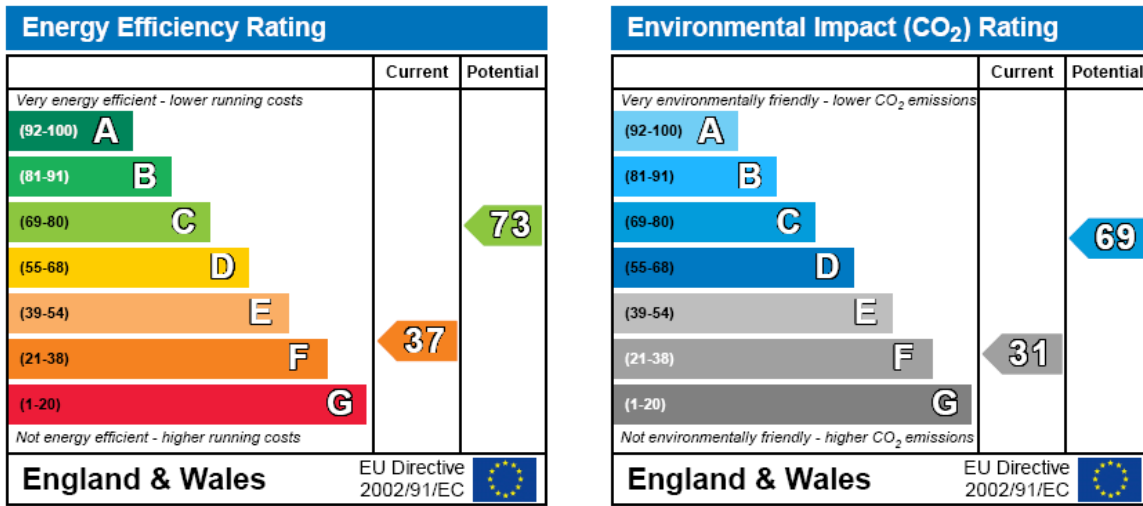


Figure 4: Energy Performance Certificate ratings for a typical home

2.4 Low and zero carbon technology support mechanisms

2.4.1 Overview

In addition to regulation to drive through CO₂ reductions in new buildings, the Government has introduced and is planning to introduce further policies to support installation of new renewable energy generating capacity. These policies include changes to planning policy to facilitate development of renewables and also a range of financial incentives which improve the business case for investing in renewable technologies and could help to mitigate the additional cost to developers associated with meeting regulations.

2.4.2 Renewable Obligations Certificates

ROCs are tradable certificates which are issued to generators of renewable electricity for every MWh of electricity generated. The certificates must be purchased by electricity supply companies to prove they have invested sufficiently in renewable generation. The value of the certificates, which can be sold alongside sale of the actual power, fluctuates due to demand, but is typically in the region of £40/MWh. To date the RO system has mainly supported growth of large scale wind turbines, as it has proved to be an insufficient incentive for more expensive or riskier technologies. To help overcome this issue the Government has proposed a ROC banding system, with four bands:

- Established: 0.25 ROCs/MWh.
- Reference: 1 ROC/MWh.
- Post-demonstration: 1.5 ROCs/MWh.
- Emerging technologies: 2 ROCs/MWh.

The following table summarises which technologies are currently allocated to each band.

Band	ROCs / MWh	Technologies
Established	0.25	Landfill gas.
Reference	1	Hydro-electric, onshore wind, geopressure, energy from waste with CHP, energy crop co-firing, biomass co-firing with CHP.
Post-demonstration	1.5	Offshore wind, energy crop co-firing with CHP, dedicated biomass.
Emerging technologies	2	Wave, tidal, solar PV, geothermal, gasification / pyrolysis, anaerobic digestion, dedicated energy crops, dedicated biomass with CHP, dedicated energy crops with CHP.

Figure 5, ROC banding proposals⁴

⁴ From <http://chp.decc.gov.uk/cms/roc-banding/>. Sewage gas and biomass co-firing are eligible for 0.5ROCs / MWh.

In April 2010 the feed-in tariff will be introduced in the UK to offer greater support to small scale renewable electricity generators. The FiT will apply to sub-5MWe generators, and payments are due to begin from April 2010. ROCs are set to remain in place as the primary support mechanism for larger scale generators.

2.4.3 Feed-in tariff

The FiT differs from ROCs support in that it provides guaranteed, fixed tariff payments for every unit kilowatt hour (kWh) of renewable electricity generated. The FiT represents a higher level of financial support than ROCs as it has been designed to offer a return on investment of 5-8%.

Feed-in tariff payments vary by technology and by installed capacity. However, the FiT applicable at the date a system is commissioned is guaranteed over the defined tariff payment lifetime. Furthermore, both export and tariff payments are linked to inflation (the RPI) for new and existing installations.

In February 2010 the UK Government confirmed the levels of support that the FiT will offer, and confirmed that payments will be made from April 2010. The FiT applies to Great Britain and forms a key part of the Government's strategy to meet renewable energy generation and CO₂ reduction targets. This support mechanism is expected to be in place for at least the next decade. However, a review of the tariffs is due in 2013, at which point the support levels could be reduced. Having said this, the overall aim of the FiT is to encourage the uptake of renewable energy technologies by making them an attractive financial proposition, and the review should therefore only adjust for changes in technology costs and other relevant developments.

2.4.4 Renewable Heat Incentive

The introduction of a renewable heat incentive (RHI) to support the development of low carbon and renewable heating technologies lags behind the FiT by around a year. Work is on-going within Government to define the scope of the RHI, to set the support levels and design the payment structure. Proposed levels of support have been published by DECC in the RHI consultation, which began at the start of February 2010 and runs until April 26th 2010.⁵ RHI payments are expected to come in from around April 2011.

⁵ Proposed tariff levels are set out in the consultation document (p.46-47), which is available for download from the DECC website:
www.decc.gov.uk/en/content/cms/consultations/rhi/rhi.aspx.

2.5 Local Planning Policy

2.5.1 The South East Plan

NRM11 – Development design for energy efficiency and renewable energy

This policy requires local authorities to develop policies to require proportions of energy demand from new developments to be met by decentralised or renewable sources. Until these local documents are developed, this proportion is set at 10% of the energy needs of the development.

NRM12 – Combined heat and power

Local development documents should encourage the integration of CHP in all developments, and district heating networks in large developments in mixed use. The use of biomass should be investigated and promoted where possible.

NRM 13-16 – Renewable energy targets and local planning policies

These policies set regional renewable energy targets, and describe that policies that local authorities should put in place to deliver renewable energy in their jurisdiction.

2.5.2 Local Development Document policies

The area of search for the SDA falls within Eastleigh and Winchester districts and feasibility of the scale, extent and location of the SDA is currently being examined by PUSH. Both Councils are due to publish core strategy documents in autumn 2010. This will establish any local policies relating to the SDA, energy standards and strategy. In addition, subject to the outcome of the feasibility testing, a joint Supplementary Planning Document for the SDA will be prepared, to develop a masterplan with more site-specific criteria and policies.

Winchester City Council published a draft version of its core strategy in 2009⁶. There are two key policies relevant to this study:

CP13 – Sustainable Low and Zero Carbon Built Environment

This policy sets out the standards that will be required for new residential and non-residential buildings in the Winchester area. Specifically it requires that:

- All new residential buildings comply with the requirements of Level 3 of the Code for Sustainable Homes (except for energy and water, where Level 5 will be required). From 2016, all new homes must meet all the requirements of CSH Level 6.
- Non-residential development that requires an Energy Performance Certificate to meet 'BREEAM Excellent' standard from adoption of this Plan and 'BREEAM Outstanding' standards from 2012, or the equivalent standards from the 'Code for Sustainable Buildings' when it is launched.

⁶ The Core Strategy Preferred Options document is published at <http://www.winchester.gov.uk/preferredoption>

CP14 – Renewable and Decentralised Energy

This policy sets out a 'hierarchy' of CO₂ reduction techniques that should be employed in new developments. These are:

- Connection to district heating / CHP networks
- Generation of 20% of energy demand on-site
- Use off-site generation to meet emissions reductions targets
- Contribute to the District's carbon reduction fund

In the current absence of core strategy policies for the SDA, we have tested energy options against the known requirements of proposed government legislation and Winchester's draft core strategy energy policies. However, readers should refer to the separate report produced for Winchester City Council regarding viability of Policies CP13 and CP14 (footnote reference) and note that these policies may be amended as a result, prior to adoption.

3 Site energy demand forecasts

3.1 Land-use assumptions

The forecasts of energy demand growth for the N & NE Hedge End site have been based on the indicative schedule of accommodation proposed in the document *TfSH M27 Corridor Study – Draft Land Use Assumptions Rev C (Jan 2010)*. The land-use assumptions used are tabulated below:

3.1.1 Dwelling mix

Dwelling Mix	Dwellings	Dwelling floorspace (m ²)
4b house	1,200	110
3b house	2,100	88
2b house	1,200	75
2b flat	900	66
1b flat	600	50
Total	6,000	

Figure 6, Indicative number and mix of dwellings. Dwelling floorspace assumptions are based on typical figures.

The average density of the residential development is assumed to be 40 dph, consistent with the South East Plan, and subject to future masterplanning and feasibility testing. This average is likely to comprise a wide range of characters and densities, from higher density local centres to low density housing.

3.1.2 Non-residential land-uses

Employment uses	GFA (m ²)
B1	45,880
B2	8,140
B8	19,980
Sub-total	74,000
Other employment and non-residential uses	GFA (m ²)
Leisure	2,000
restaurant	1,000
hotel/conference	n/a
Food retail	4,000
non-food retail	4,000
Local council offices	2,500
Health	1,000

Education	Tbc
Defence	n/a
Workshops	n/a
Sub-total	14,500
TOTAL non-residential	88,500

Figure 7, Indicative schedule of non-residential land-use.

The assumed phasing of the build-out of the N & NE Hedge End site has been adapted from the *N/NE Hedge End SDA initial feasibility study (2006)*. The timings of the key stages in the build out are given below:

Date	Key stage
2014	1st phase commences
2016	1st phase completions
2016	Construction of later phases commences
2018	First occupation of later phases
2026	6000 residential completions

Figure 8, Indicative phasing of the development

3.2 Energy demand forecasts

Based on the indicative mix of land-uses and phasing of the development, forecasts for the growth of thermal and electrical demand on the site have been developed. Based on the phasing of the site build, it has been assumed that the vast majority of the development is likely to fall under Zero Carbon Homes policy (though some early phase approvals could fall within Part L 2013⁷). For this reason, it is assumed that the buildings are constructed to a high level of fabric energy efficiency performance. The assumptions regarding the fabric performance of the domestic buildings used within the energy load modeling are tabulated below.

⁷ The relevant Building Regulations for a particular development, or phase of development, are set at the point that Building Control Approval is granted. If the Building Regulations change between granting of Building Control approval and start of construction, it is assumed that the existing approval will be valid for a period of 1 year, after which the developer will have to comply with the higher regulatory standard.

Fabric performance parameter	Value
U-values (W/m ² K)	
Door	1.1
Window	1.1
Roof window	1.1
Basement floor	0
Ground floor	0.15
External wall	0.15
Roof	0.13
Party wall	0.1
Air permeability (m ³ /m ² /hr)	4

Figure 9, Fabric energy efficiency assumptions for domestic buildings

The forecasts of thermal and electrical energy demand as the site is built out and becomes occupied over the period to 2026 is given in the plots below.

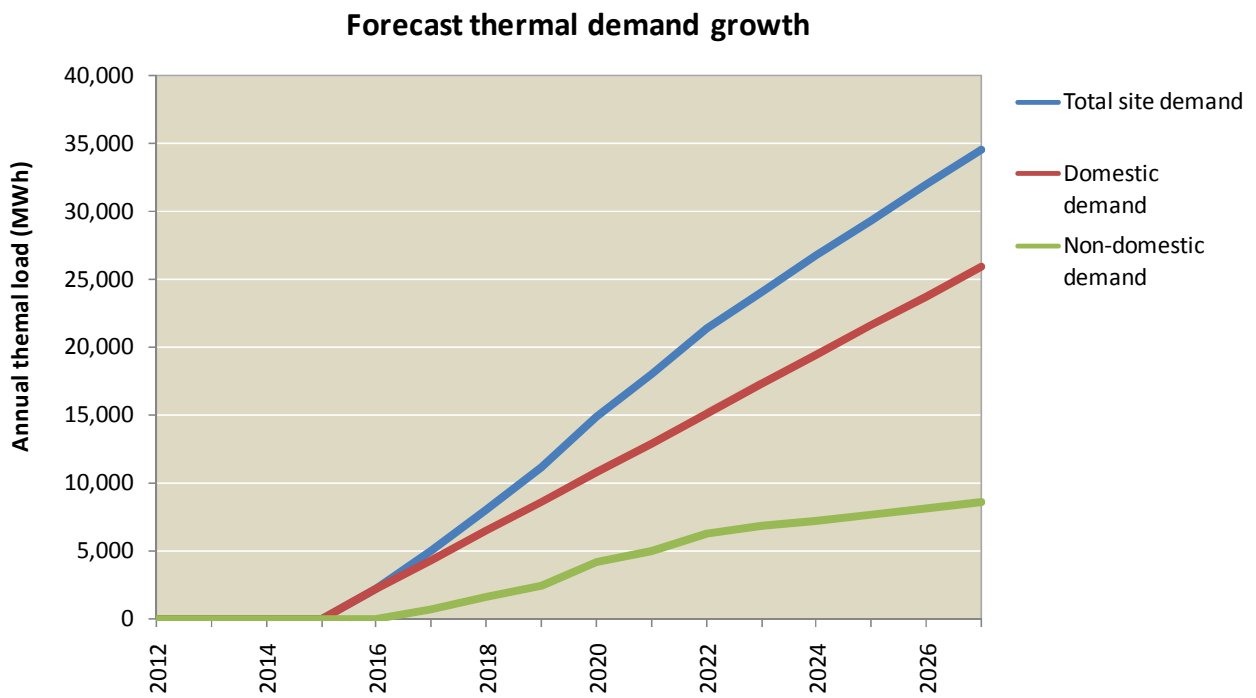


Figure 10, Forecast growth of thermal demand as the Hedge End site is built out and becomes occupied

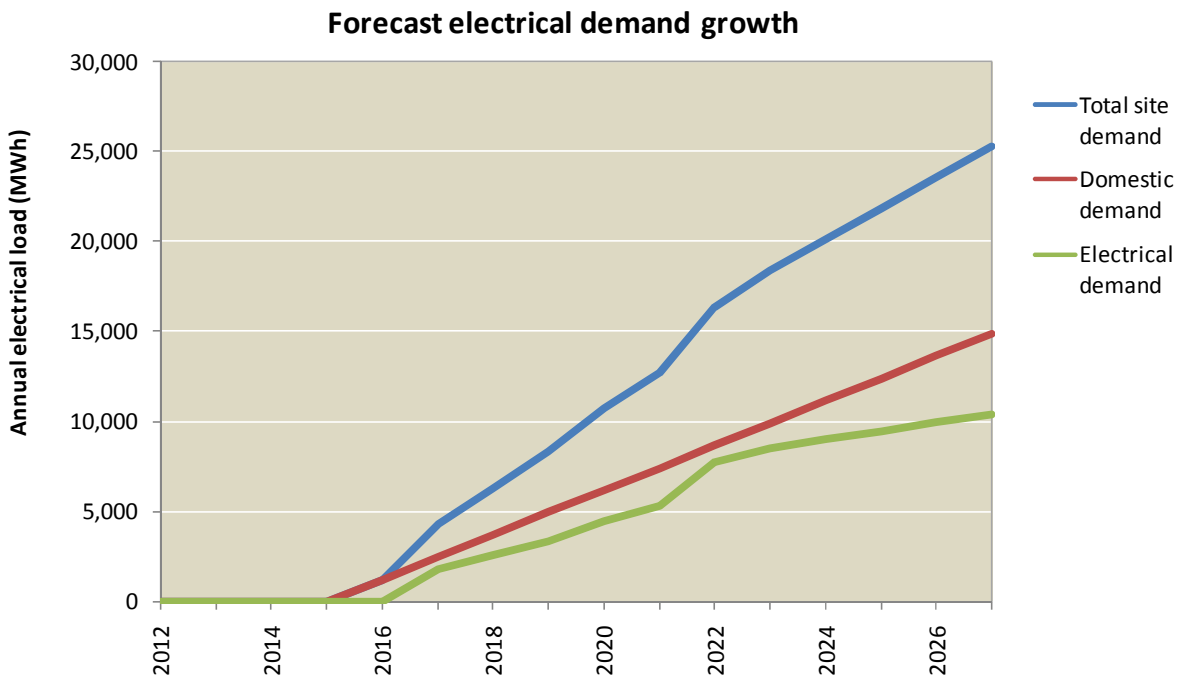


Figure 11, Forecast growth of electrical demand as the Hedge End site is built-out and becomes occupied

The total annual energy demands for the domestic and non-domestic parts of the development, once completed and occupied (assumed date is 2026), are summarised in the table below.

Site load forecast (2026)	Thermal demand (MWh/yr)	Electrical demand (MWh/yr)
Domestic	26,000	15,000
Non-domestic	8,600	10,400
Total	34,600	25,400

Figure 12, Summary of the anticipated final thermal and electrical loads, disaggregated between domestic and non-domestic uses, once the Hedge End site is completed.

4 Energy strategy options

Given that the development has a large housing component, an initial assessment of potential energy strategies for the site has been focused on achieving the required energy performance standards for residential development, whilst also taking into account the energy loading requirements for supporting employment, education and community uses.

Tightening of Part L of the Building Regulations will require reductions in the regulated emissions of domestic buildings from those permissible under current Part L, as set-out in Section 2.1.1. Zero Carbon Homes standard, due to be introduced in 2016, will require a 70% reduction of regulated emissions from the current Part L standard. The remaining regulated and unregulated emissions will be dealt with through investment in Allowable Solutions.

The mandatory CO₂ standards of the Code for Sustainable Homes at Code Levels 3 and 4 mirror the standards proposed under Part L 2010 and 2013, respectively. However, under the current Code policy, Code Level 5 and 6 go further in terms of reduction of regulated emissions than is proposed through changes in Building Regulations and introduction of Zero Carbon Homes policy. Code Level 5 stipulates that 100% of regulated emissions should be eliminated by effectively onsite measures, i.e. energy efficiency and generation of low carbon energy, whereas Code Level 6 requires that all emissions, regulated and unregulated, are eliminated by measures applied on the site.

The most relevant standards for the N & NE Hedge End site are those of the Zero Carbon Homes policy, which the majority of the site is expected to fall within, and the Code Level 5 standard, which is currently required under Policy CP13 of the Winchester Core Strategy Preferred Options document and is likely to be incorporated into the Building Regulations at around the time development is expected to start.

A range of energy strategy options, appropriate to the range of improvements in CO₂ standards required by changes to Part L and the various Code levels, have been considered. Each of these energy strategies have been assessed in terms of the associated extra-over (E/O) cost of construction, i.e. the additional capital cost compared to construction of a Part L 2006 compliant dwelling (fabric efficiency to current Part L standards and heating provided via a condensing gas boiler). These E/O costs – including the cost of fabric performance improvement, all low carbon technologies and heat distribution infrastructure – are shown in Figure 13 below. The E/O costs are given for the average dwelling on the development, i.e. the total E/O cost for the whole development has been averaged across the 6,000 dwellings.

Assessment of the extra-over capital costs of a range of energy strategy options for the Hedge End site

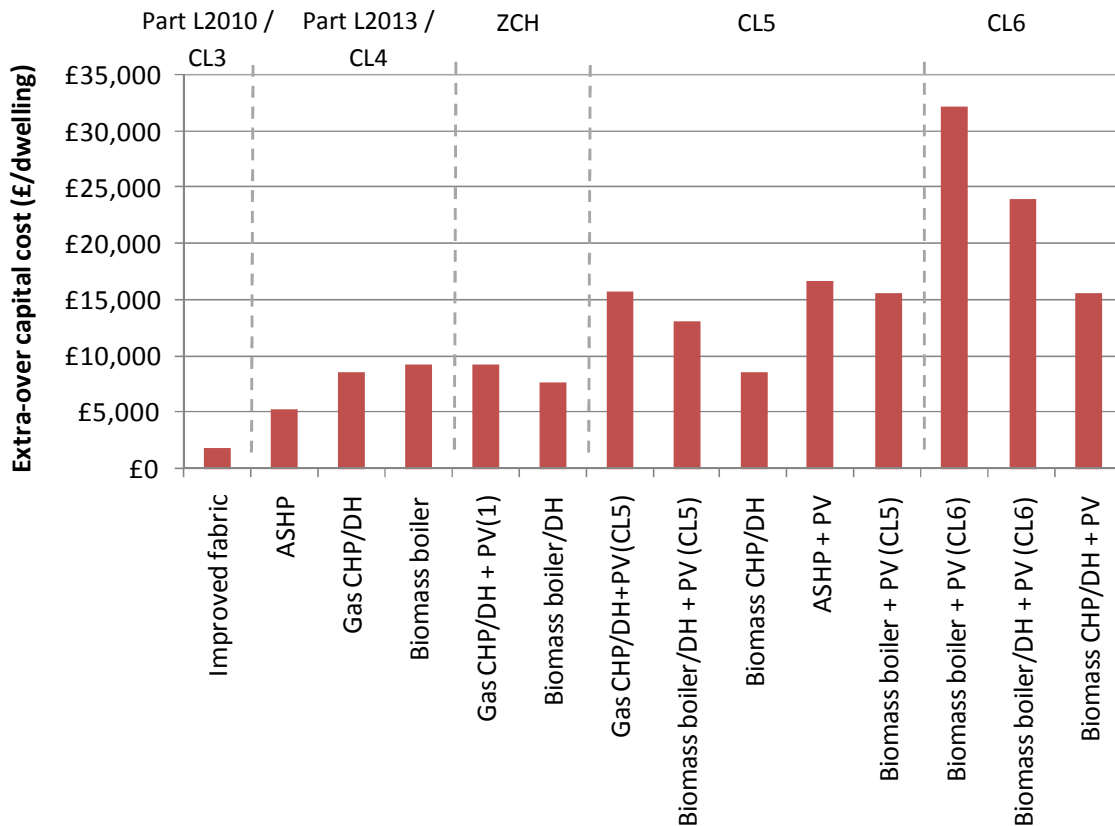


Figure 13, Extra-over costs per dwelling, for the average dwelling on the Hedge End site, for a range of energy strategy options, devised to meet the reductions of regulated emissions required by the various Code for Sustainable Homes standards and anticipated changes to Building Regulations (* ZCH = Zero Carbon Homes policy – a 70% reduction of regulated emissions)

Due to the indicative phasing of the SDA, the energy strategies of most relevance are those that deliver a 70% to 100% reduction of regulated emissions. The lowest cost strategies at this level of improvement are those that involve a district heating (DH) system, rather than technologies installed at an individual dwelling scale.

The E/O costs of strategies at the 70% level of reduction of regulated CO₂ emissions (Zero Carbon Homes standard) are approximately £8,000 to £9,000 per dwelling. The cost of the gas CHP strategy is slightly more costly than that based on biomass boilers due to the requirement for installation of photovoltaics to achieve the 70% reduction.

In order to achieve a 100% reduction of regulated emissions (Code Level 5 standard), an increased amount of low carbon electricity generation is required. Under the assumption that large-scale wind

turbines are not appropriate to the site, this increases the requirement for photovoltaics and so increases the E/O cost considerably. The biomass CHP based strategy has the lowest E/O cost at this level of CO₂ reduction, as it requires the least additional PV capacity.

Based on the initial assessment of strategy options for the domestic development, and the likely mix of uses, a district heating based energy strategy is expected to be most cost-effective in achieving the high levels of CO₂ reduction required at the N & NE Hedge End SDA. In the following section, site-wide district heating based strategies are considered in more detail.

5 Economic analysis of site-wide systems

In the following analysis of site-wide energy strategy options, the total energy loads for residential and non-residential development in the SDA have been assessed. The forecast growth of site-wide energy loads used in the analysis is discussed in Section 3.

5.1 Plant options and sizing

The assessment has considered three options for the type of thermal plant used to provide heat to the district heating system:

- Gas CHP
- Biomass CHP
- Biomass heat only boilers (HOBs).

Modelling of the site's daily and seasonal thermal load profiles has been undertaken to inform sizing of each of these technology options. In the case of the CHP systems, the plant should be sized in order to ensure that it will accumulate a minimum of 5,000 full load equivalent operating hours per year. This is a widely used rule-of-thumb for the utilisation required for CHP plants to give a viable return on capital investment. Based on the load profiles for the N & NE Hedge End site, a CHP plant with a thermal capacity of 4 MW is expected to be appropriate, based on the thermal loads expected once the whole site is occupied (this assumes the CHP is operated to follow the heat load, i.e. the CHP thermal output will match the heat load, unless the heat load exceeds the peak thermal capacity of the system).

Gas CHP systems based on reciprocating engine technology are available across a wide-range of power output. At the large-scale (i.e. MWs of power output), they have high electrical efficiency (35 to 40%) and heat:power ratios of around 1.5, i.e. for every unit of power generated, 1.5 units of useful heat can be extracted. Therefore, an engine with a 4 MW thermal output would be expected to deliver around 2.5 MW of electrical output when operating at peak load.

The most proven biomass CHP technology is based around steam-cycle technology. However, these systems are only commercially viable at scales of around 2 – 3 MW electrical output which, due to the lower electrical efficiency of the steam-cycle, corresponds to a thermal output of around 10 MW. This type of technology would therefore be over-sized for the Hedge End site, requiring too much heat to be rejected. A biomass CHP technology that is available in the size range of interest to the SDA is based on the Organic Rankin Cycle (ORC) technology. The ORC unit has an even lower electrical efficiency, only around 15%, hence a system sized at the appropriate thermal capacity of 4 MW would deliver around 925 kW of electrical output at full load (a heat:power ratio of 4.3:1). Although biomass ORC CHP technology is not familiar in the UK - currently there is only one operating plant - it is widely used on the continent, with hundreds of plants in Northern Europe.

Biomass boilers are less capital intensive than CHP units and so it is not as critical that very high levels of utilisation are achieved. In the case of the biomass HOB option, the plant has been sized so that it

achieves fewer full-load run hours than the CHP, but meets a larger proportion of the overall site thermal load. A total capacity of biomass HOB of 6.5MWth has been selected.

5.2 Capital costs

For each of the thermal plant options an estimate of the cost of the energy centre, including the plant and ancillary components, has been developed. These capital cost estimates are based on recent budget cost figures obtained from suppliers of each technology. The capital cost estimates are tabulated below:

Parameter	Biomass ORC CHP	Gas CHP	Biomass boilers
Thermal capacity (kW)	4000	4000	6500
Electrical capacity (kW)	925	2500	-
Primary plant capital cost	£4,250,000	£2,266,667	£3,250,000
Back-up boiler plant	£240,000	£240,000	£240,000
Energy centre and ancillaries	£650,000	£350,000	£525,000
Total capital cost of primary plant	£5,140,000	£2,856,667	£4,015,000
Approximate energy centre area*	2,450 m ²	1,650 m ²	2,150 m ²

* indicative energy centre footprint, including primary thermal plant, boiler room, biomass store (as appropriate).

Figure 14, Estimated capital costs for energy centres based on three thermal plant options

The capital costs shown above include only the thermal plant and energy centre, they do not include the costs of the heat distribution network required to convey heat around the site. There is currently insufficient information on the N & NE Hedge End master plan to enable a reliable estimation of the cost of district heating network to be made. Rule-of-thumb figures for the costs of networks on sites of various density can be applied, such as those contained within the Poyry and Faber Maunsell study, *'The Potential and Costs of District Heating Networks'*. On the basis of these existing published studies, a provision of £6,000 has been allowed per dwelling for connection to the district heating system (includes heat transmission and distribution infrastructure. The cost of the heat exchanger and heat meter are assumed to be approximately offset by the avoided cost of a gas boiler).

5.2.1 Revenue assumptions

A number of revenue parameter assumptions have been made in the economic analysis of the plant options. The key assumptions are tabulated below:

Revenue parameter	Value
Domestic gas price	3.7 p/kWh (increases following DECC central scenario)
Commercial gas price	3.3 p/kWh (increases following DECC central scenario)
Woodchip price	3.5 p/kWh
Electricity export tariff	5 p/kWh
Renewable heat incentive (RHI)	
Biomass HOB	1.6 p/kWh
Biomass CHP	2.5 p/kWh
Feed-in tariff (PV electricity)	26.8 p/kWh
ROC band (biomass CHP)	1.5 ROCs/MWh
ROC price	4.5 p/kWh

Figure 15, Assumed values for the key revenue parameters used in the economic analysis

The heat sale price for domestic and commercial customers on the district heating network has been indexed to the domestic and commercial gas price, respectively, with an uplift for guarantee of supply.

5.3 Economic analysis

5.3.1 Base case – build to meet Building Regulations

In the first instance, the economics have been assessed assuming that the site is built-out to meet the relevant building regulations. Based on the phasing assumptions discussed in Section 3, this corresponds to a first phase of domestic units (around 500 dwellings) being constructed to Part L 2013 and the remainder being constructed to Zero Carbon Homes policy. In addition to the capital costs for the thermal plant and energy centre, the costs of any photovoltaics required to meet the regulations have been included in the economic assessment.

The economics of the three plant options have been assessed on a Net Present Value (NPV) basis, assuming a discount rate of 10% (typical commercial discounting) over a period of 20 years. The present values of costs and revenues and overall NPV for each plant option is shown in the chart below:

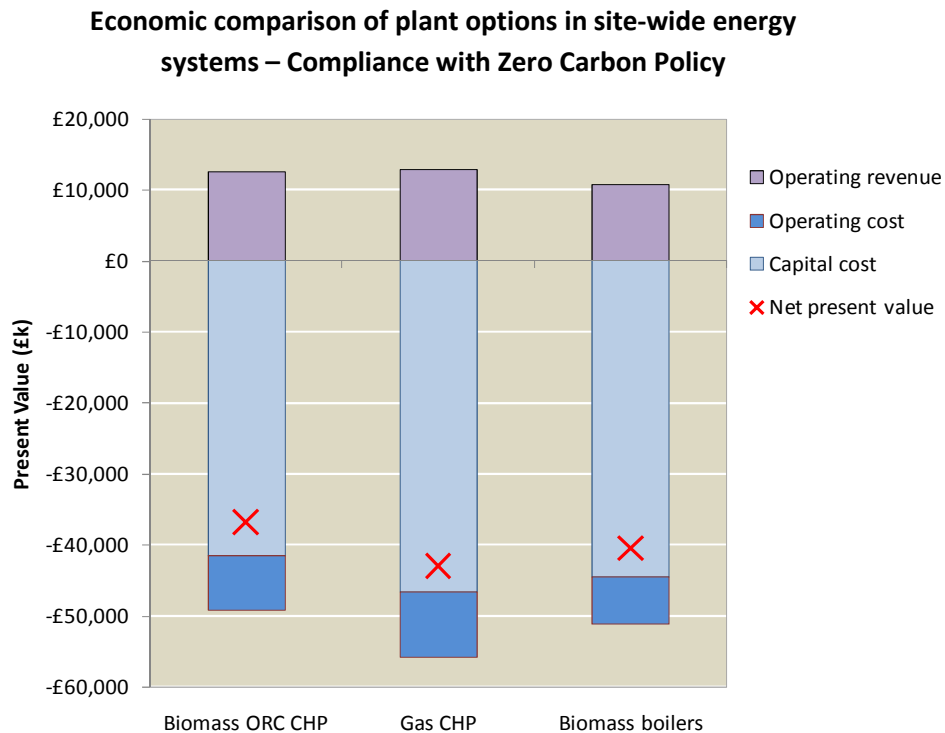


Figure 16, Present value of capital costs, operating costs and revenues for each of the plant options (over a 20 year period), assuming plant is sized to deliver the carbon reduction required by Building Regulations. The resulting net present values are indicated by red crosses.

The net present value is heavily negative in each case. This is a result of the large capital investment in the district heating infrastructure, which is not paid off over the 20-year timescale by sale of heat, electricity and incentives for generating renewable energy. This cost will have to be met by the developer as connection charges.

The biomass ORC CHP system is predicted to provide the best economic return, with an overall net present cost of £36m.

The economics of the gas CHP and biomass HOB options are less attractive, providing net present costs of approximately £43M and £40M respectively. In the case of the gas CHP system, a substantial capacity of PV, around 2.5 MW, is required to meet the Zero Carbon Homes standard across the site.

5.3.2 Compliance with Winchester Draft Core Strategy Policy

A further comparison of the economics of each plant option has been performed assuming compliance with Policy CP13 in the Winchester Core Strategy Preferred Options paper, i.e. Code Level 5 for energy prior to 2016 and Code Level 6 thereafter. In this case the net-present values are significantly more negative, due to the large investment required in PV to meet the more stringent policy target.

Economic comparison of plant options in site-wide energy systems in combination with photovoltaics– Compliance with Winchester Core Strategy policy CP13

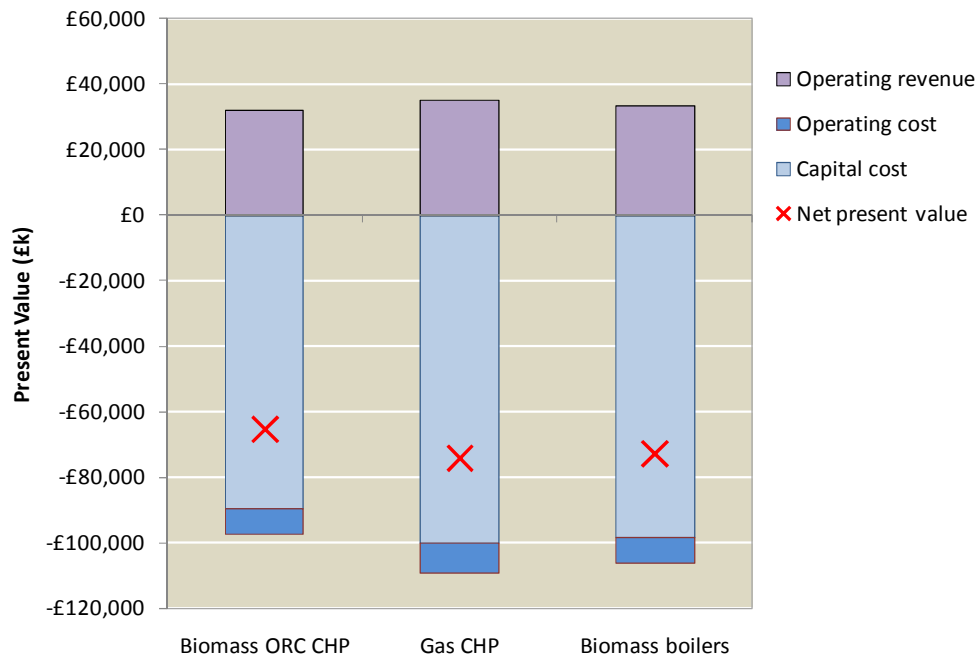


Figure 17, Present value of capital costs, operating costs and revenues for each of the plant options (over a 20 year period), assuming plant is sized to deliver the carbon reduction required for the whole development to comply with Winchester Core Strategy policy CP13. The resulting net present values are indicated by red crosses.

The requirement for photovoltaics to meet the policy target ranges from a total of 8.7 MW in the case of the biomass CHP system (a 3.4 kWp system on every domestic property) to 25.6MW in the gas CHP case (a4.3 kWp system on every dwelling). It may be impractical to install this capacity of PV (even in the case of the biomass CHP) may be impractical, given the roof area constraints.

A further assessment has been performed assuming that biomass boilers are installed alongside the main thermal plant, in order to meet the peak heat loads. The economic comparison in this case is given below.

Economic comparison of plant options in combination with biomass back-up boilers & photovoltaics – Compliance with Winchester Core Strategy policy CP13

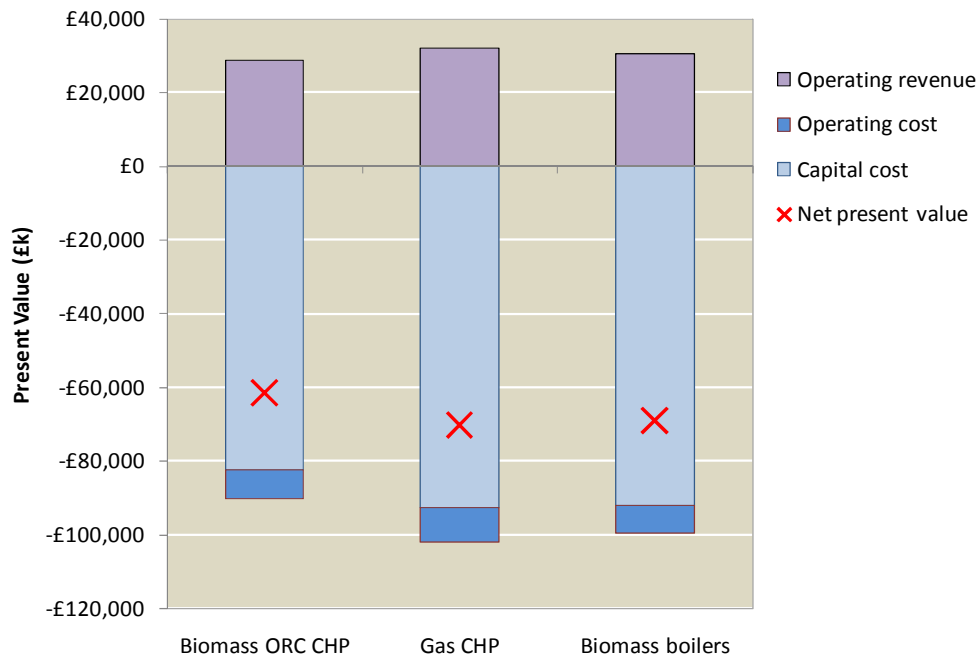


Figure 18, Present value of capital costs, operating costs and revenues for each of the plant options (over a 20 year period), assuming plant is sized to deliver the carbon reduction required for the whole development to comply with Winchester Core Strategy policy CP13. The resulting net present values are indicated by red crosses.

The economics are still heavily negative when considered at a discount rate of 10%, however, the use of additional biomass generation to achieve the required energy standard has reduced the overall costs. Even with biomass boilers meeting the whole of the peak heating load, however, some PV is still required in order to achieve the necessary CO₂ reduction. In this case the amount of PV required ranges from 16 MW, under the biomass CHP option, to 20.5 MW with a gas CHP thermal plant.

5.3.2.1 Variation on Winchester Core Strategy policy

The Winchester Draft Core Strategy policy CP13, requiring Code Level 6 energy standard to be met post-2016, will be very difficult to achieve, on both cost grounds and due to the quantity of onsite renewable electricity generation required. In recognition of this, a variation of policy CP13 has been assessed, where it is assumed that a Code Level 5 energy standard must be achieved. This policy is still more stringent than the expected regulations (i.e. requires a higher level of onsite CO₂ reduction), but will not require such large capacity of renewable electricity generation to be installed on-site.

Economic comparison of plant options in combination with photovoltaics – Code Level 5 energy requirement

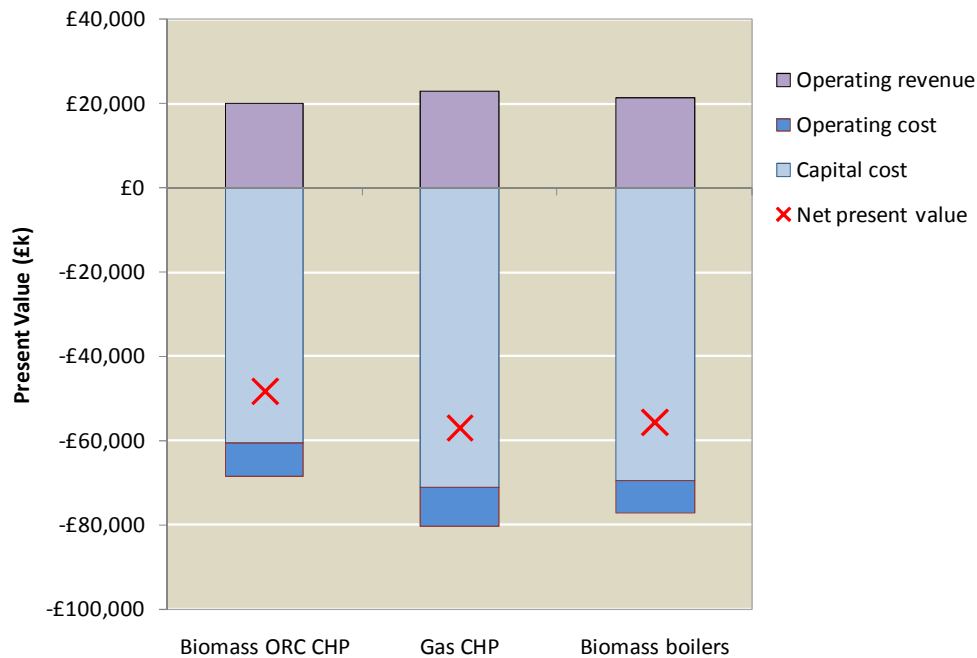


Figure 19, Present values of the capital cost, operating costs and revenues over a 20 year operating period (10% discount rate). The net present value of investment in the energy system is shown by the red crosses. Energy systems assessed are capable of delivering Code Level 5 energy standard in all dwellings.

The economics remain heavily negative, largely due to the capital cost of the district heating infrastructure. The net present values have improved, however, by around £17million for each system, compared to the case of compliance with the existing draft policy CP13. This is equivalent to a significant drop in the additional cost per dwelling of connecting to the district heating system (around £5,000 per dwelling).

In this case, the amount of PV required to reach the required level of onsite CO₂ reduction varies from 8.7 MW (1.45 kWp/dwelling) in the biomass CHP case, to 13 MW (3.4 kWp/dwelling) in the gas-CHP based system. The PV requirement in the biomass CHP case is more reasonable, in terms of availability of roof area, although in the case of the gas CHP system, the capacity of PV required per dwelling is still large.

5.4 Conclusions of the economic assessment

A site-wide energy system of the types discussed in the preceding section generates ongoing revenue, from heat sales to customers in the district heating network, electricity export and from the various incentives paid for generation of renewable heat and electricity. The developer of the N & NE Hedge End site would therefore be expected to be able to finance the cost of the energy system on the basis of the revenues forecast.

The discount rate of 10% used in the preceding section is typical of the rate of return required by a commercial investor in the energy system. The net-present value therefore represents the shortfall that would need to be met by the developer. This is likely to be paid as a connection charge that the developer pays to the operator of the district heating system for every dwelling (or commercial unit) that is connected to the network. The capital costs included in the assessment shown in the preceding section do not include the costs of the fabric improvements, which must also be met by the developer.

The economic analysis has shown that a biomass CHP energy system with district heating is likely to be the most cost-effective means of achieving high levels of CO₂ improvement on the SDA site, i.e. in compliance with zero carbon homes policy and Winchester Council's draft Core Strategy policies. The total on-cost per dwelling for the developer, i.e. cost of fabric improvement and cost of connecting to the district energy system (including the cost of additional PV that may be required to meet the standards) is shown in the figure below. The cost of the energy plant – thermal plant and photovoltaics – has been apportioned between the domestic and non-domestic development (on the basis of the heat loads of their contribution to the overall overall thermal demand).

Extra-over cost per dwelling if biomass CHP & DH energy strategy for varying policy scenarios

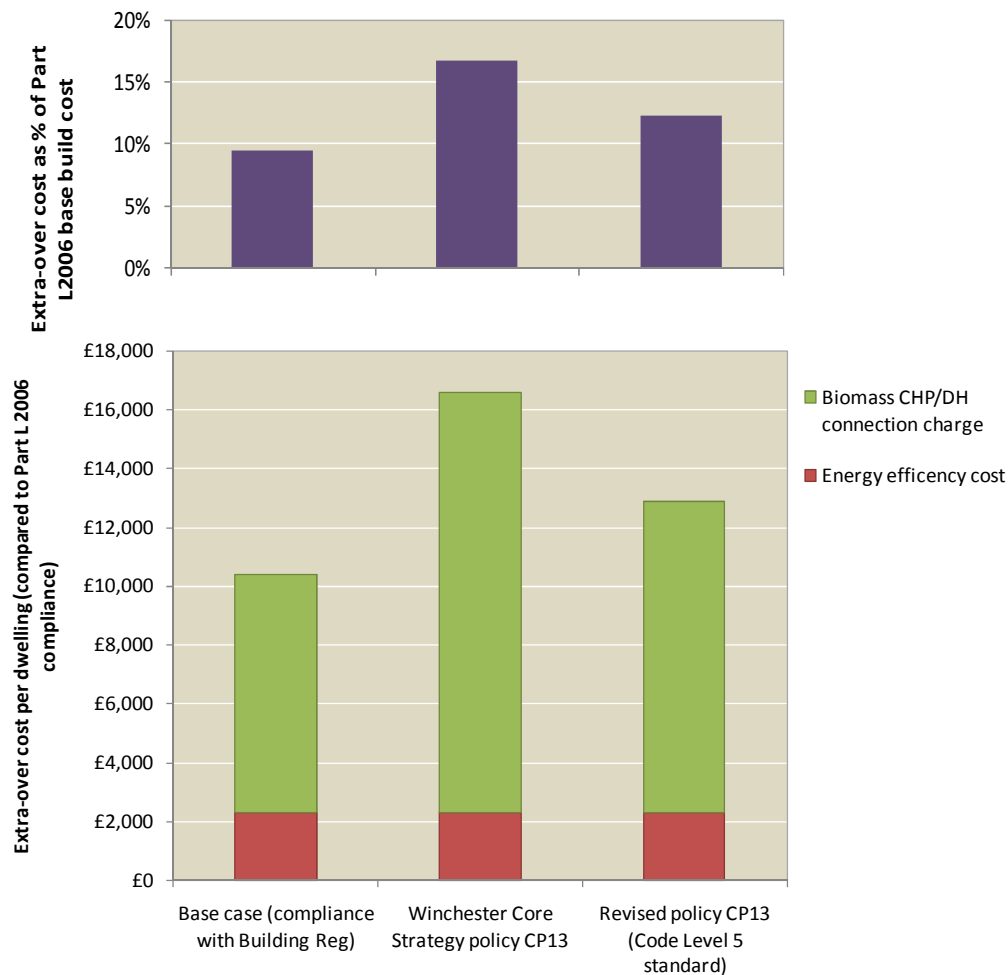


Figure 20, Summary of extra-over cost per dwelling for energy strategies based on a biomass ORC CHP system and district heating system. In the Base Case the plant is sized to deliver the CO2 reduction required for Building Regulations compliance. The extra-over costs of meeting the draft Core Strategy policy CP13 and a potential variant on this policy (requiring Code Level 5) are shown.

The additional cost per dwelling of meeting the Winchester Core Strategy Preferred Options document policy CP13, is around 16,500/dwelling. This is the additional cost compared to construction of the dwellings to current Part L2006 standards. The Base Case cost is the extra-over cost of meeting the advancing Building Regulations and Zero Carbon Homes policy on the Hedge End site. It can be seen that the additional cost of achieving the existing draft policy CP13 over meeting the minimum regulatory requirements is significant, at around £6,000/dwelling. If policy CP13 were to be revised such that Code Level 5 energy standard is required across the whole domestic development (i.e. no step-up to Code

Level 6 in 2016), then the increase in extra-over cost per dwelling is more limited, at just over £2,000 per dwelling

Given the levels of increased cost associated it with achieving Winchester Core Strategy draft policy, it will be necessary to agree an energy strategy and targets in conjunction with developer interests during the master planning and core strategy process.

6 Carbon reduction

Assuming construction to meet the Code Level 5 energy standard, all the regulated CO₂ emissions from the domestic development must be eliminated. This leaves only the unregulated emissions, i.e. those related to cooking and electricity use of appliances. The energy strategies considered in the preceding section meet this requirement through a combination of energy efficiency and low carbon energy generation measures. The impact of each of these measures on reduction of CO₂ emissions from the domestic development are shown in the figure below, for the case of the biomass CHP system with photovoltaics.

Reduction of domestic CO₂ delivered by each component in biomass CHP based energy strategy

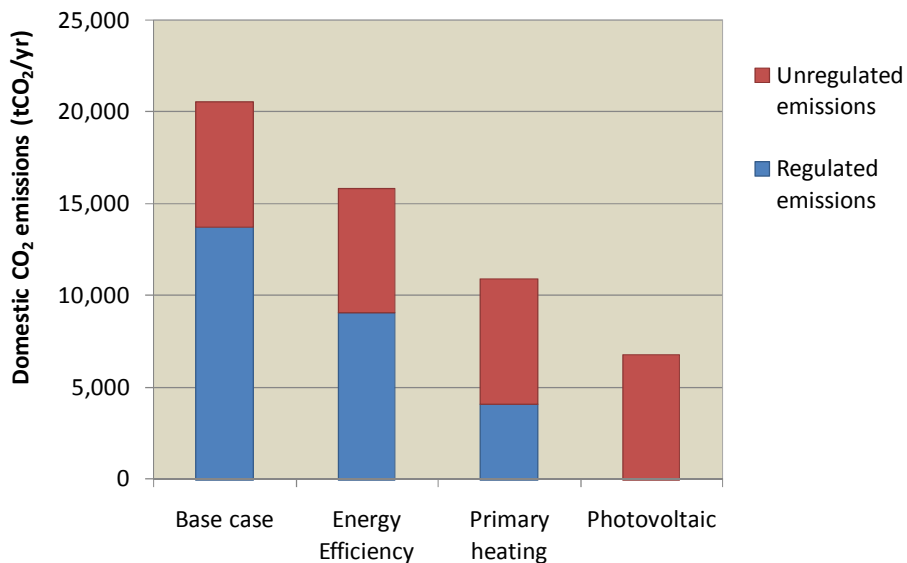


Figure 21, Domestic CO₂ reduction delivered by each component of the biomass CHP & PV energy strategy, compared to the site emissions in the case that all dwellings are constructed to current Part L (2006) standards.

The impact of the energy strategy on non-domestic emissions is shown in the figure below. The CO₂ saving of the biomass CHP system has been apportioned between the domestic and non-domestic parts of the development on the basis of the contribution of each part of the development to the overall heat load. Note that the capacity of photovoltaics included in the economic assessment was only that required to meet the CO₂ reduction target in the domestic development. Further low carbon energy generation would be required to meet higher levels of CO₂ reduction in the non-domestic development.

Reduction of non-domestic CO₂ delivered by biomass CHP based energy strategy

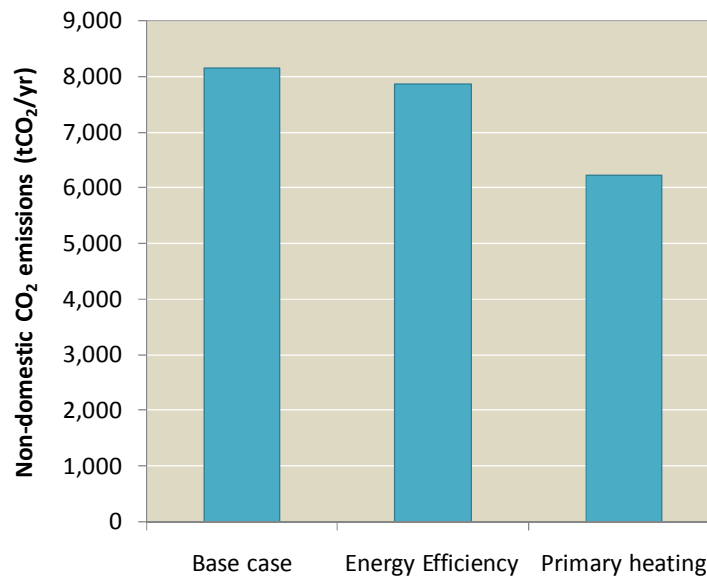


Figure 22, Reduction of non-domestic CO₂ emissions delivered by the biomass CHP energy strategy

The biomass CHP and district heating system energy strategy delivers a reduction of total non-domestic CO₂ emissions (i.e. regulated and un-regulated) of 25%. The level of CO₂ reduction through onsite measures required under forthcoming changes to the Building Regulations for non-domestic buildings and zero carbon policy is not yet known, however, it is likely that some additional low carbon generation will be required to achieve the required standards in parts of the non-residential development (particularly those that fall under the zero carbon buildings policy, post-2019).

The overall effect of the biomass CHP energy strategy on the site’s CO₂ emissions, compared to construction of the site to current standards, is shown below.

Reduction of site-wide emissions delivered by biomass CHP & DH energy strategy compared to compliance with regulations

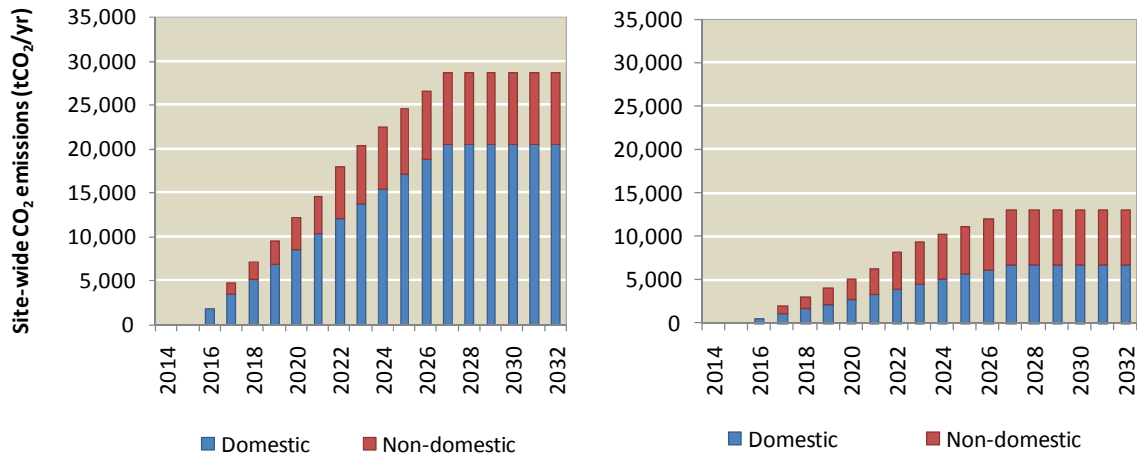


Figure 23, Overall impact of the biomass CHP energy strategy on the site-wide CO₂ emissions, compared to the emissions that would be generated were the site built to current standards.

7 Conclusions

The N/NE Hedge End SDA, which spans the boundary of Eastleigh Borough Council and Winchester City Council, will provide a major mixed-use development of some 6,000 dwellings and significant employment, retail, community and leisure space. This study assesses the costs associated with a variety of energy strategy options for the Hedge End SDA, focusing on those that are capable of delivering the high levels of CO₂ reduction that will be demanded by Building Regulations, Zero Carbon policy and the local development frameworks of the two councils.

On the basis of the current phasing forecast for the Hedge End SDA, the majority of the site will be built post-2016 and so will fall under the zero carbon homes policy. In terms of local development document policies, both councils are currently developing their Core Strategies. Winchester City Council has published a Preferred Options document for consultation, which contains two key policies with respect to sustainable buildings and CO₂ reduction, as follows – CP13 requires residential developments to achieve the energy standard of Code Level 5 prior to 2016 and be fully compliant with Code Level 6 thereafter. Non –residential developments should achieve BREEAM Excellent. CP14 states a technology hierarchy that developers should follow, favouring development of district heating systems with CHP.

Analysis of a range of energy strategies, suited to delivering varying degrees of CO₂ reduction, has shown that strategies based on centralized thermal plant and community heating systems provide the most cost-effective means of delivering CO₂ reductions in line with zero carbon homes standard (70% of regulated emissions) and higher levels of the Code for Sustainable Homes (i.e. Levels 5 & 6).

Installation of district heating infrastructure requires a significant capital investment. There is currently insufficient information on the layout of the site to make an informed budget estimate of the capital cost of the district heating system. In the economic modeling of district heating based energy strategies, an extra-over cost of £6,000 per dwelling has been allowed for the capital cost of the district heating system, which is intended to include installation of a heat interface unit and metering in the homes (this extra-over cost is compared to the cost of providing a gas boiler and connection to a gas network). More detailed work would be required once the site master plan is developed further, in order to provide a better estimate of the cost of an onsite heat network.

A number of options for the primary thermal plant that provides heat to the district heating system have been assessed. These options include:

- Gas CHP
- Biomass boilers
- Biomass CHP

Generally it has been assumed that back-up and peak loads would be met by gas boilers, with photovoltaics installed to meet any remaining CO₂ reduction requirement. A sensitivity to providing biomass boilers as the back-up plant has also been assessed.

The economics of each plant option, in combination with a site-wide district heating network, has been assessed. The net present value (NPV) of investing in the system has been assessed over a 20-year period, on the basis that a discount rate of 10% is applied (note that the assessment includes the investment in energy centre and district heating infrastructure and applies a common discount rate to each).

Three scenarios, in terms of the CO₂ reduction required, have been assessed for each plant option, as follows:

- Meeting the CO₂ reduction required by Building Regulations / Zero carbon policy
- Meeting the CO₂ reduction required by Winchester Core Strategy Preferred Options policy CP13 – Code Level 5 energy standard prior to 2016 and Code Level 6 thereafter.
- Achieving a potential variation on policy CP13, whereby the Code Level 5 energy requirement is applied across the development.

The NPV derived for each scenario and plant option are shown in the table below:

Net Present Value (£M)	Biomass CHP	Gas CHP	Biomass boiler
Building Regulation / Zero Carbon Policy	-36.8	-43.0	-40.5
Winchester Core Strategy Preferred Options policy CP13	-65.5	-74.2	-72.8
Code Level 5 energy standard	--48.4	-57.1	-55.7

Figure 24, Summary of net present values of investment in site-wide heating networks for three plant options in a variety of policy scenarios.

The NPV is highly negative in each case. This is largely due to the large capital investment required in the heating network, which is not recouped through the sale of energy and incentives received for renewable energy generation. The NPV represents the short-fall that would need to be made up assuming a 10% return on investment is required by the organisations financing development of the energy system. This might be levied as a connection charge on developers, for example.

The NPV becomes more negative for all plant options as the level of CO₂ reduction that must be delivered increases (i.e. depending on the policy scenario). To get to very high-levels of CO₂ reduction, for example those demanded by Code Levels 5 and 6, increasing capacity of photovoltaics is required.

Even accounting for the substantial revenue generated by the feed-in tariff, investment in PV does not provide a rate of return of 10% (hence installing additional PV results in a worsening NPV).

Based on the comparison of the three plant options, the biomass CHP system delivers the best economics (it also provides the largest CO₂ saving of the three options, such that less PV area would be required to meet the higher CO₂ targets).

Assuming that developers make a contribution toward the energy system development cost that is equivalent to the negative NPVs (i.e. in order to provide a 10% rate of return to investors in the system), then the extra-over cost per dwelling ranges from £10k, to meet zero carbon policy, to £16k, to meet the Winchester Core Strategy Preferred Option policy CP13 (based on the average dwelling on the site – this is equivalent to a 9.5% to 16.5% increase compared to today's construction costs).

The biomass CHP & district heating strategy presents the most economically favourable option to meet and exceed zero carbon policy on the Hedge End SDA. To comply with the Winchester Core Strategy Preferred Options policy CP13, which effectively requires net zero carbon standard across the residential development, is predicted to increase construction costs by > 16% for the average dwelling (compared to compliance with today's regulations). A more modest CO₂ reduction target, such as that required by Level 5 of the Code for Sustainable Homes, would result in a cost increase of around 12%. This compares to an estimated 10% increase to comply with zero carbon policy.