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Hastings Borough Renewable and Low Carbon Energy Study

for

Hastings Borough Council

21/08/09

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Glossary

CCHP	Combined cooling heat and power
CHP	Combined heat and power
CSH	Code for Sustainable Homes
CSB	Code for Sustainable Buildings
DH	District heating
GIS	Geographic Information Systems - geographical mapping software
kW	Kilo watt (capacity)
kWe	Kilo watt (electrical capacity)
kWt	Kilo watt (thermal capacity)
MW	Mega watt
ORC	Organic Rankine Cycle - a form of biomass CHP

TABLE OF CONTENTS

1. EXECUTIVE SUMMARY

A comprehensive analysis of the low carbon energy strategies appropriate for the new developments planned in the Hastings Borough up to 2026 has been completed. An optimised low carbon technology dispatching strategy has been produced, which facilitates compliance with local and national carbon reduction and associated local planning targets in a viable and cost effective manner.

The results of this analysis form a robust evidence base which should be used to guide low carbon strategic planning in the borough.

The analysis highlights that uptake of a balanced mix of low carbon technologies will be required in Hastings if local and national CO_2 reduction targets are to be achieved.

1.1. The local challenge

Given its importance as a regional hub, Hastings is likely to undergo significant regeneration and expansion in both the residential and non-domestic sectors over the next twenty years. The development of new build sites in Hastings will result in an associated increase in local energy demands and CO_2 emissions.

Should the planned new build Hastings developments continue to be built to current Part L 2006 standards, the CO_2 impact of the developments will increase rapidly:

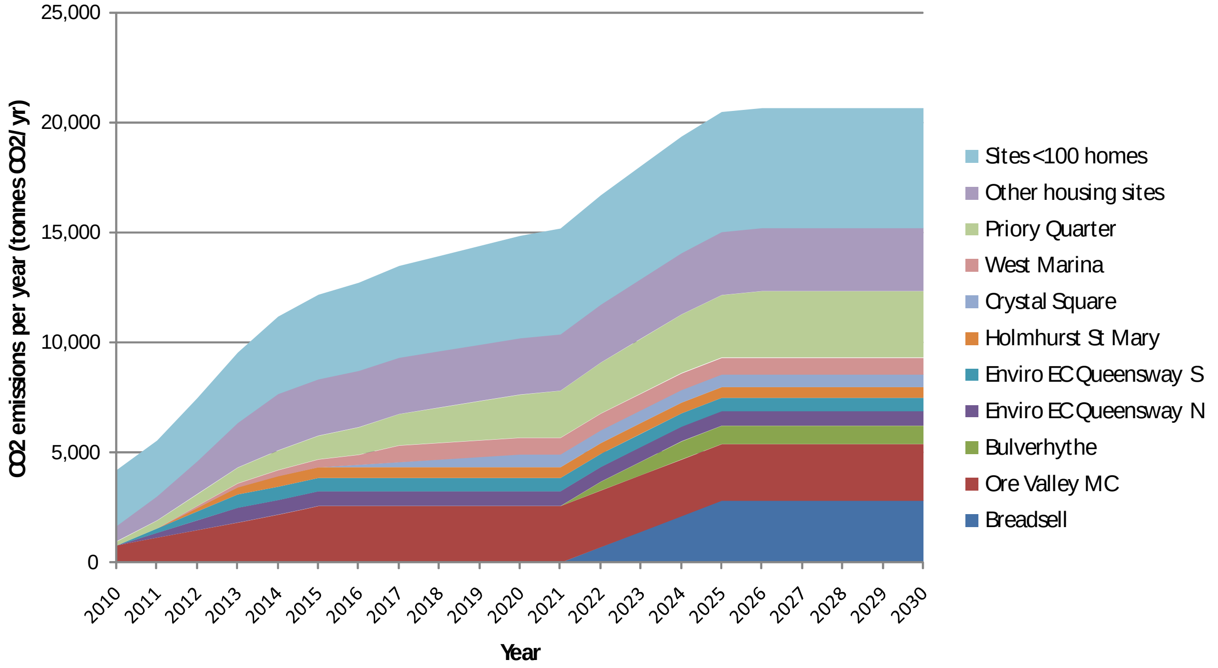

***Figure 1** - annual CO_2 emissions which will result from the Hastings new build developments if all buildings continue to be built to part L 2006 (domestic) or best practice benchmarks (non-domestic).*

Annual CO_2 emissions by 2030 could total more than 20,000 tonnes/yr.

Central Government carbon reduction policy (projected tightening of building regulations in line with the Code for Sustainable Homes and Code for Sustainable Buildings) will demand significant reductions in these projected emissions. These reduction standards will become increasingly onerous over the coming decade and will require significant capital investment in renewable and low carbon technologies in Hastings.

Economic analysis indicates that a minimum capital investment of ~£25M in renewable/low carbon technologies will be required in the Hastings borough.

1.2. Low carbon opportunities in Hastings

There are many technological strategies which can be deployed to reduce the carbon emissions emitted by new build developments. These strategies employ mixtures of the following low carbon measures:

1. **Thermal performance/fabric improvement measures:**
Examples include: basic heating controls (e.g. delayed start thermostats and zoned and timed heating controls), improvements in building insulation (e.g. cavity wall insulation, loft insulation etc) and heat recovery systems. These measures reduce the heating and hence fuel demands of buildings.

2. **Clean energy generation technologies:**
These technologies generate heat, electricity or a combination of the two from non-renewable resources (e.g. natural gas-fired CHP). The overall system efficiency of clean energy systems is higher than those of conventional heating and electrical systems, allowing significant CO_2 savings to be realized.

3. **Renewable energy generation technologies:**
These technologies directly generate heat (e.g. solar water heating), electricity (e.g. solar photovoltaics) or a combination of the two (e.g. biomass-fired combined heat and power systems) from renewable sources.

Despite the fact that there is a broad range of low carbon technologies available to building developers, previous extensive studies[1] and past experience indicate that new build developers will very likely deploy low carbon strategies based on assessments of:

1. **Technical feasibility:**
A low carbon strategy must be appropriate for deployment on a given site, and allow attainment of the required carbon reduction target.

2. **Capital expenditure**
Developers strongly favour the feasible low carbon strategy which represents the lowest capital expenditure.

Technologies which save a fixed quantity of carbon at the lowest capital cost are said to have a *high CO_2 capital cost effectiveness* (measured in capital £ per kg of CO_2 saved) – these technologies will be strongly favoured by developers on sites where they are technically viable.

The graphs presented below display the capital cost effectiveness of a comprehensive list of low carbon technologies (including thermal/fabric improvements and active generation technologies) in both the domestic and non-domestic sectors. Results are displayed for a typical semi-detached house (although variations with house size are negligible) and a typical non-domestic property:

[1] The growth potential for microgeneration in England, Wales and Scotland – Element Energy
https://www.ofgem.gov.uk/ofgem-publications/58092/element-energy-presentationpdf

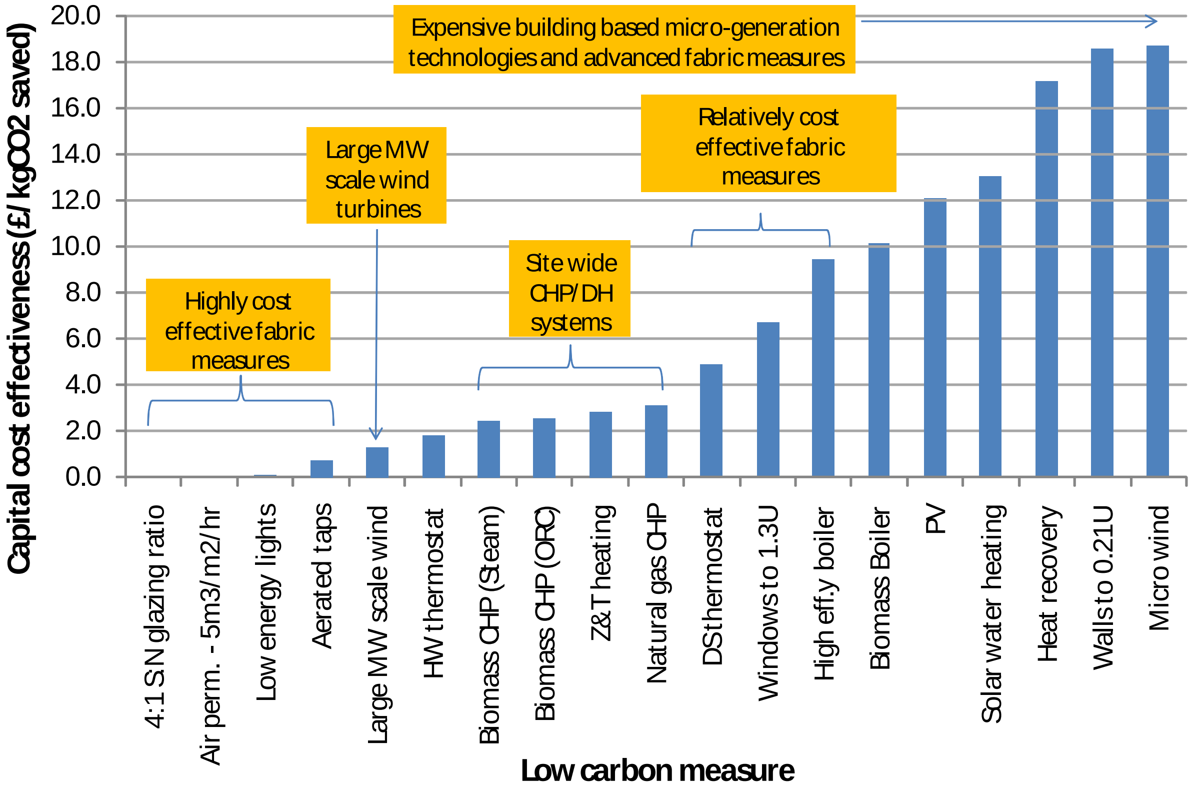

Figure 2 - *CO_2 capital cost effectiveness of low carbon technologies for a typical semi detached house.*

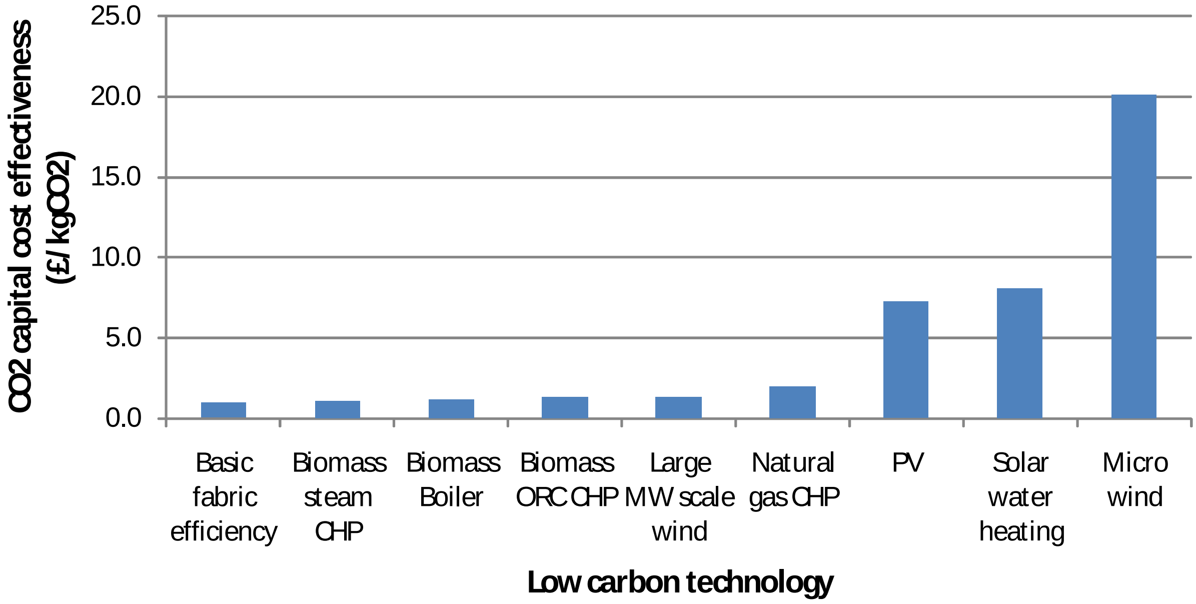

Figure 3 - *CO_2 capital cost effectiveness of low carbon technologies for a typical non-domestic property*

The graphs indicate that the most cost effective new build low carbon energy strategies in Hastings will incorporate:

- Installation of a basic level of building thermal/fabric performance improvements (with respect to baseline designs).

- Deployment of MW scale wind turbines or CHP/DH systems (or biomass boilers in non-domestic buildings) – subject to technical feasibility. N.B: initial site analysis indicates that there will be no economically viable opportunities for biomass CHP systems on the new build sites in Hastings.

Using the insights of the analysis outlined above, cost effective and technically viable low carbon energy strategies were formulated for a representative sample of the new build sites planned in the Hastings borough. These strategies took account of the local low carbon resource constraints e.g. a constrained biomass resource and a lack of suitable sites for the installation of large wind turbines (see section 1.2.1).

Interrogation of the nature of these strategies leads to the following higher level conclusions:

1. Carbon offsetting strategies (using MW scale wind turbines) are often the most cost effective means of achieving low carbon CSH/CSB targets.

   However, since these strategies have practical deployment limitations within the Hastings borough, they should be avoided at low CSH/CSB code levels:

   - They place a strain on the limited local MW wind resource

     Suitable MW scale wind sites in Hastings are severely restricted by local geography (see below – section 1.2.1)

   - They evoke complications with regard to current CSH private wire legislation

     The current phrasing of the CSH does not allow energy generation technologies located at remote locations to contribute to onsite CO_2 reduction.

2. The most appropriate and recommended low carbon energy strategies in Hastings are therefore those which **minimize the requirement for regional MW scale wind carbon offsetting whilst incurring the minimal capital cost.**

A preferred and optimal low carbon technology dispatching strategy can be defined for all new build development sites in the Hastings borough which observes this maxim. This strategy is fully described in the main report, and can be summarised in the following diagram:

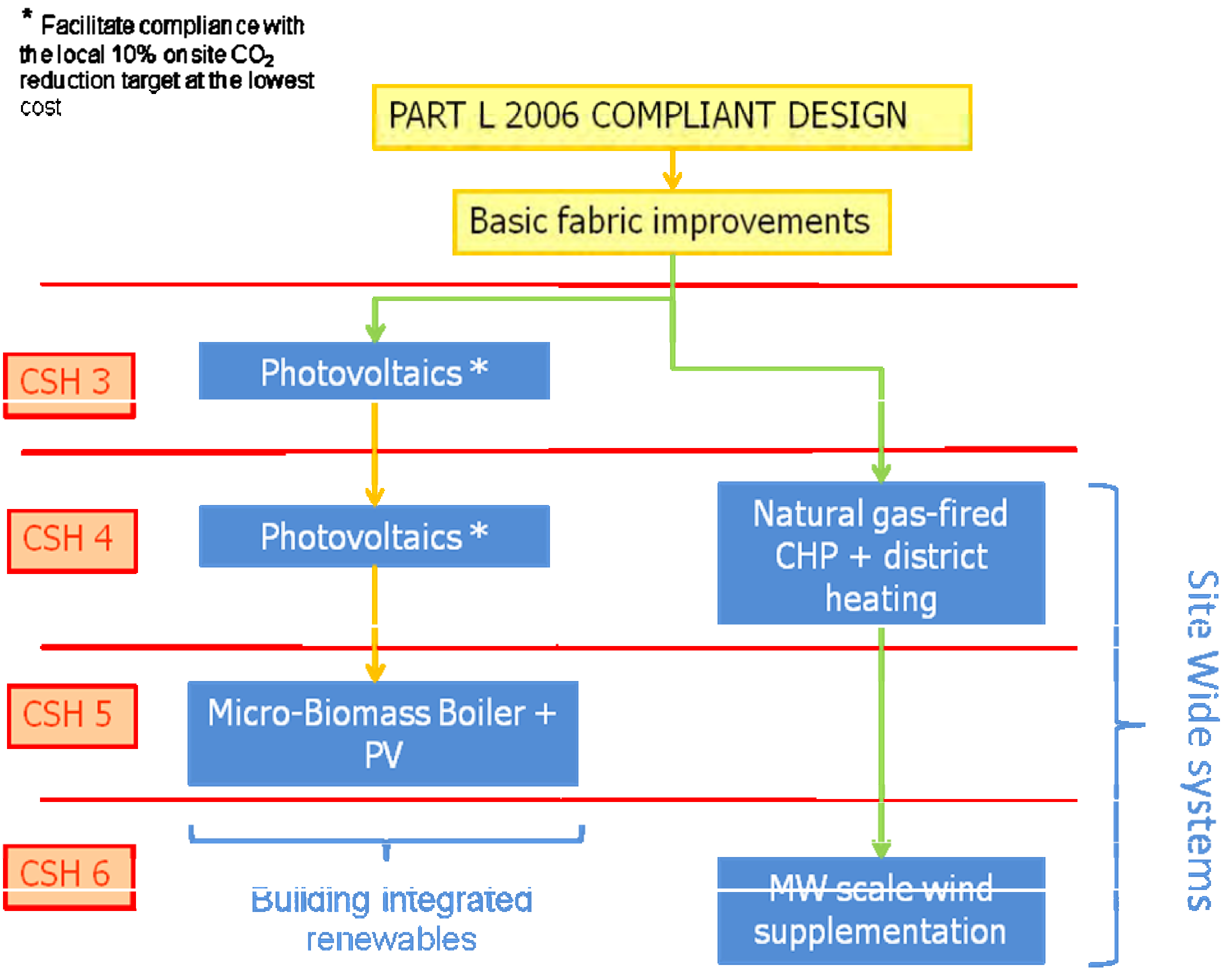

Figure 4 – *Schematic diagram outlining the most technically feasible and cost effective methods of achieving increasingly stringent levels of the CSH in Hastings. The green route indicates the preferred and optimal low carbon energy strategy (subject to technical feasibility on a specific site). The gold route shows an alternative and more expensive approach, incorporating building integrated renewable technologies – this strategy is not recommended.*

Similar results were derived in the non-domestic new build sector.

At the very lowest CSH/CSB code levels, building integrated renewables e.g. PV can be cost effective as they can be sized to exactly meet a specific CO_2 reduction target i.e. the local onsite 10% CO_2 reduction rule (see section 1.4 – preferred approach 46). Biomass boilers are often highly cost effective in non-domestic properties with higher heating demands.

For higher code levels (CSH/CSB level 4 and above) site wide energy systems could be more cost effective than building-by-building low carbon energy strategies. Natural gas-fired CHP systems and district heating networks can facilitate compliance with CSH 4 (on viable sites) and avoid the need for MW scale wind carbon offsetting. Installed CHP capacity reduces the capacity of MW scale wind turbines required in the region. This is important, as local geography severely restricts the number of viable MW scale wind sites.

At the highest CSH/CSB code levels some MW scale wind carbon offsetting is likely to be required to facilitate compliance.

In order to implement the cost effective low carbon energy strategies outlined above on the new build sites in Hastings, developers will need to exploit the key low carbon opportunities inherent to the borough:

1.2.1. Low carbon strategic opportunity: MW scale wind

The Hastings borough has one of the most abundant wind resources in the UK. Average wind speeds as high as 7.6m/s are observed in the borough. Large wind turbines installed in the region have the potential to be highly economic.

Large stand alone MW scale wind turbines can provide some of the most cost effective CO_2 savings of all renewable energy generation technologies.

Technological deployment projections indicate that in order for the Hastings borough to achieve the low carbon targets of the CSH and CSB, 4-6MWe of installed MW scale wind capacity will be required.

GIS resource mapping indicates that the number of suitable MW scale wind sites in the borough is severely restricted by local geography, including the site of the High Weald AONB, local SSSIs and benchmarks governing the suitable separation distance of wind turbines from existing buildings.

However, sites with large potential are situated in:

1. Pebsham countryside park
2. In East Ore

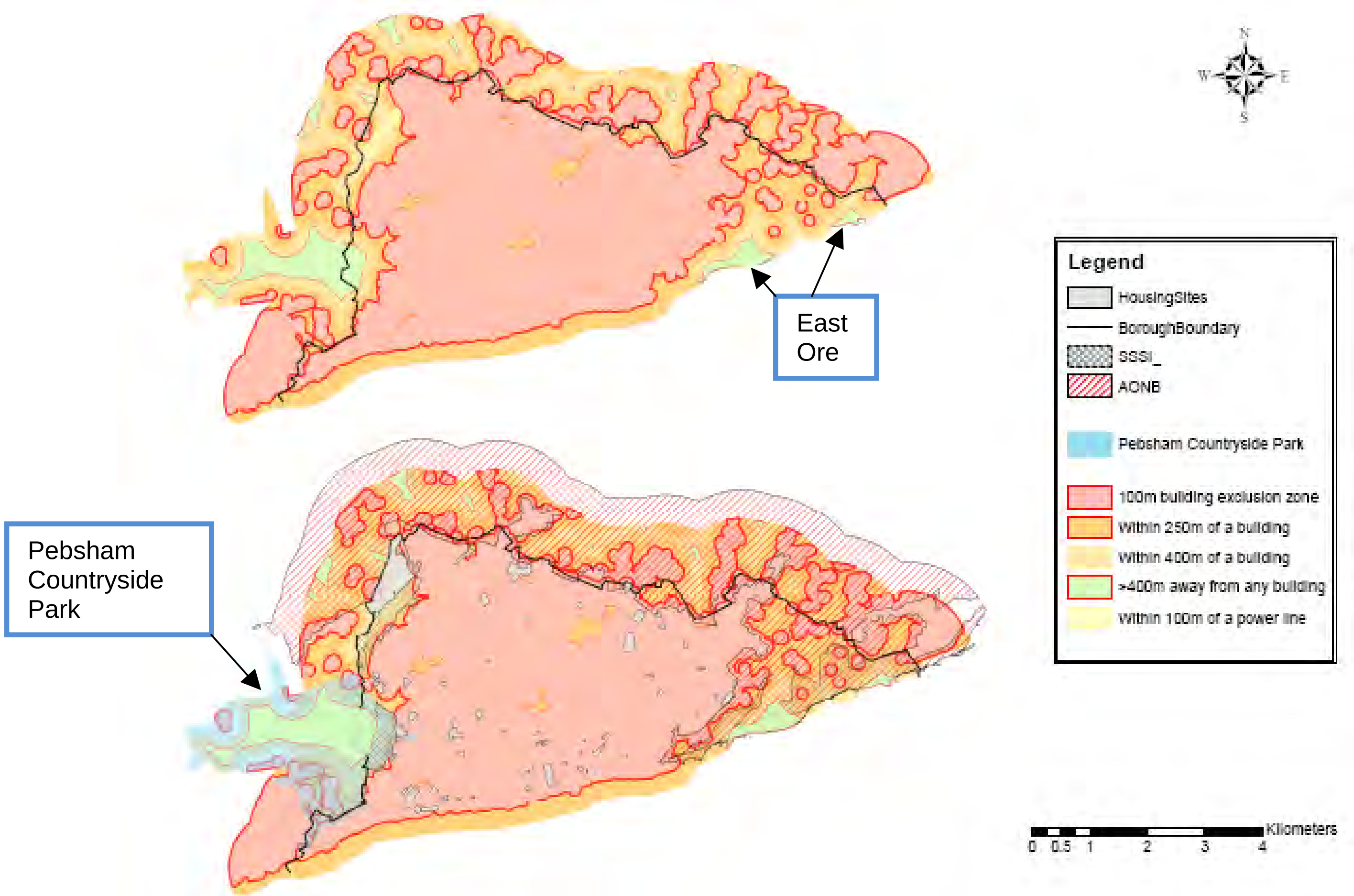

Figure 5 – *Suitable and economically viable MW scale wind sites in Hastings*

1.2.2. Low carbon strategic opportunity: combined heat and power and district heating

Combined heat and power (CHP) systems connected to district heating (DH) networks can provide CO_2 savings with cost effectiveness comparable to that of MW scale wind systems.

High (and highly concentrated) heating demands are essential for the operation of viable and economically favourable CHP engines and DH networks. Site energy analysis indicates that there are many opportunities for the installation of technically feasible and economically viable natural-gas fired CHP systems and district heating networks on the new build sites in Hastings. Technological deployment projections indicate that in order for the Hastings borough to achieve the low carbon targets of the CSH and CSB, ~1.5Mwe of installed natural gas-fired CHP capacity will be required.

No economically viable opportunities for biomass-fired CHP systems were identified.

Site-wide DH networks catalysed by new build developments can also be expanded into the neighbouring existing build stock to facilitate further, highly cost effective CO_2 savings.

GIS mapping of the heat demand density of Hastings indicates that there are two key high heat density opportunity areas - where new build developments are planned - which could be used to catalyse the introduction and expansion of district heating networks into the existing build stock within Hastings. These sites are major heat demand hotspots located:

- In the vicinity of Conquest hospital
- In central St Leonards/Castle (in the vicinity of the Summerfield Sports Centre)

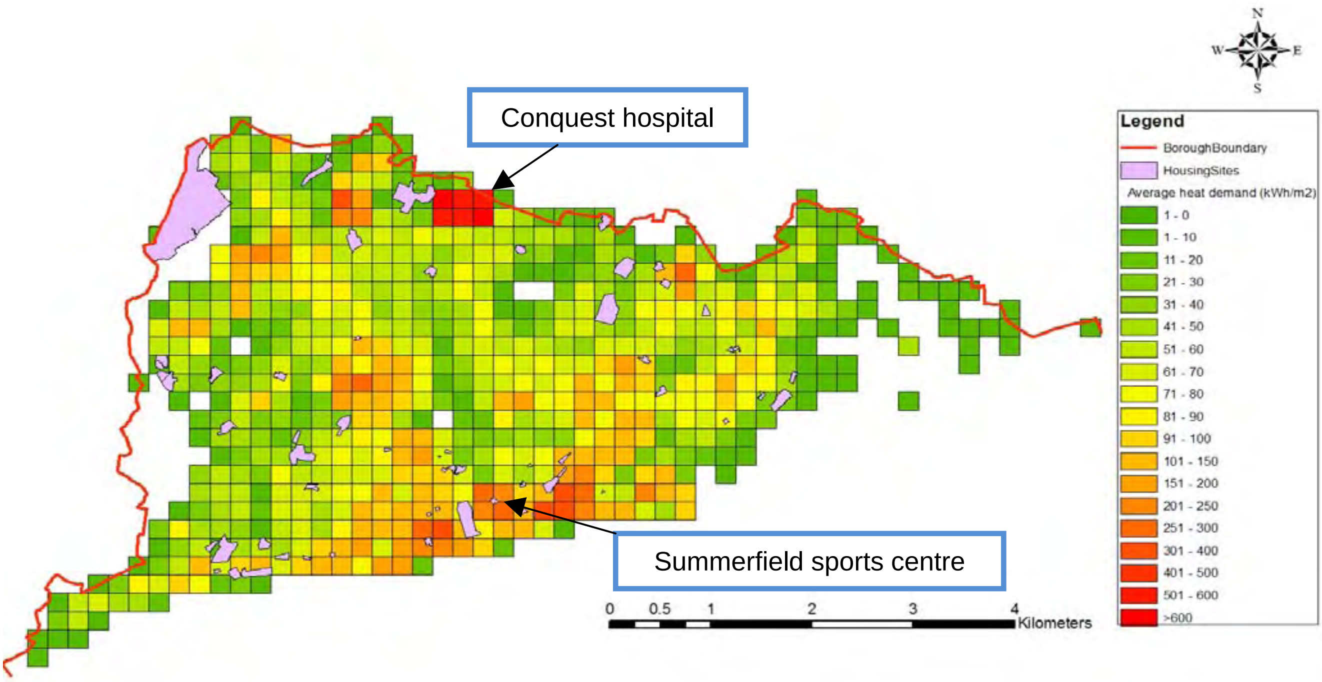

Figure 6 – *Strategic opportunities for CHP/DH systems in the Hastings borough*

1.3. Carbon reductions achievable

Delivery of the opportunities detailed above will help to ensure that the new build developments in Hastings can achieve the required CO_2 reduction standards. The following graph shows the projected CO_2 emissions resulting from the new build developments in Hastings if the targets of the CSH and CSB are met:

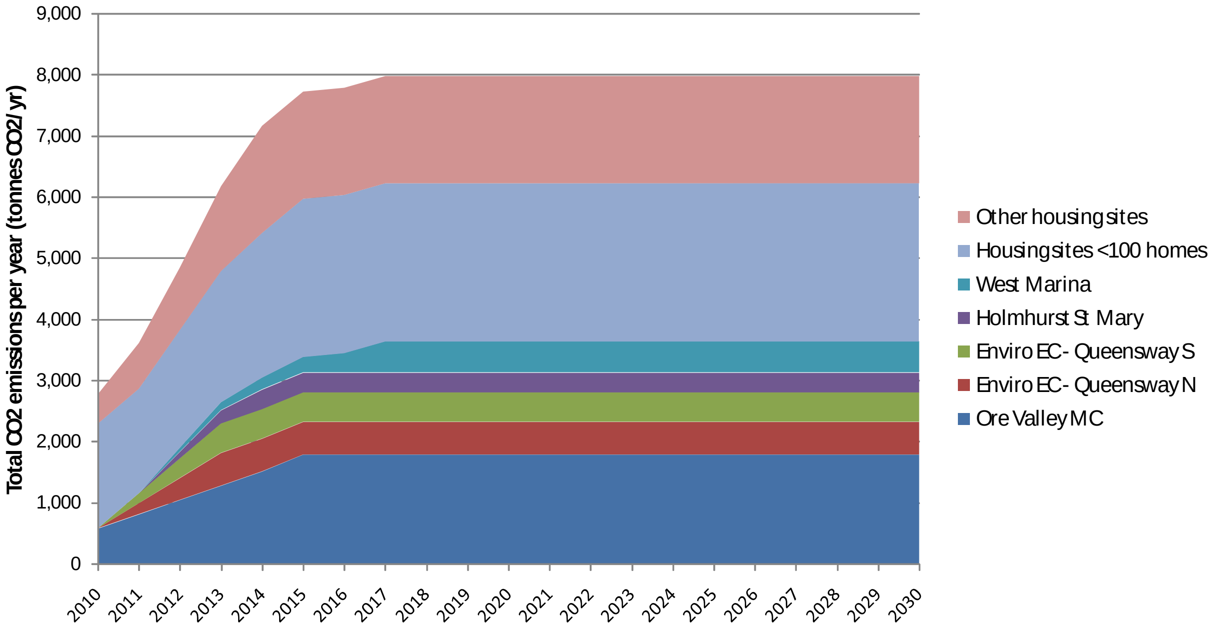

Figure 7 - *annual CO_2 emissions from the Hastings new build developments if the targets of the CSH and CSB are met. Note that emissions plateau after 2016 as new developments must be zero carbon.*

Projected annual CO_2 emissions from the new build sites could be reduced to ~8,000tonnes/yr if the CSH and CSB central Government CO_2 reduction standards are met – a 60% reduction with respect to the projected baseline emissions which would result if the new build developments continued to be built to current Part L standards.

1.4. Hastings low carbon policy recommendations

As noted previously, attainment of the CO_2 reduction standards mandated by the projected tightening of building regulations - in line with the CSH and CSB - will incur significant capital costs. The lack of sound commercial models for CO_2 reduction means that well informed, clear, local government policy must be the key driver to obtaining compliance with central government carbon reduction standards.

The following statements should be included in local low carbon strategic policy (in each case the recommended policy statement is presented, followed by a robust evidence base. The policy statements are presented as amendments to the current “preferred approach” statements where appropriate).

Preferred Approach 44 – Sustainability and design – Recommended policy statement

Incorporate a strategic policy that:

Promotes development that will minimise energy consumption and CO_2 production, through appropriate building layout and orientation, building form and design and accounting for the micro-climate.

Require that all dwellings demonstrate a CO_2 reduction of at least 10% (relative to a baseline estimate) through fabric and thermal performance improvement measures. The baseline will be the Part L regulations in force at present (December 2008), and will be calculated using a methodology approved for Part L calculations.

Promotes development that incorporates renewable and low carbon energy production facilities into new developments to minimise carbon dioxide production.

Manages and reduces the threat of flooding through the consideration of planning applications using the Strategic Flood Risk Assessment and the incorporation of appropriate Sustainable Drainage Systems in new development.

Minimizes consumption of natural and non-renewable resources.

Protects against light, air, land, noise and water pollution.

Promotes development that incorporates recycling facilities, and uses waste as a resource.

Meets high water efficiency standards.

Promotes safe, ‘Secure By Design’ and community safety features.

Evidence base

This policy statement outlines the higher level aims of the preferred approach statements. They aim to: reduce the CO_2 emissions and energy demands of new build developments; minimize the consumption of natural resources in the Hastings borough and promote recycling. The statement falls in line with the aims of cross-cutting policy 4 of the South East plan, and fits well within a regional policy context.

Paragraph two specifically considers CO_2 emission reduction targets derived from increased building thermal/fabric performance.

- Analysis shows that the most appropriate carbon reduction strategies, for all CSH/CSB code levels, include the use of some basic fabric and thermal performance improvements.

- Analysis further indicates that a CO_2 reduction target of ~10% with respect to baseline estimates is highly feasible technically and a cost effective method of reducing CO_2 emissions. This level of thermal/fabric improvement is highly recommended.

- Demanding this level of fabric/thermal performance improvement has the following advantages:

  1. **Cost effectiveness**

     Application of basic thermal/fabric improvement measures to buildings is a very cost effective method of saving carbon

  2. **Conservation of the local MW scale wind resource**

     Analysis indicates that a significant capacity of MW scale wind will be required in Hastings to offset the CO_2 impact of new build developments, particularly at high CSH/CSB code levels. Application of basic fabric measures to buildings can reduce the need for MW scale carbon offsetting (not required at CSH 3) and preserve the highly constrained local resource.

  3. **Future-proofing of domestic building designs**

     Incorporating basic thermal/fabric improvement measures at this early stage future proofs domestic building designs for higher CSH code levels. These code levels will require mandatory improvement in building thermal performance.

     By changing building designs now, developers can avoid constantly updating domestic building designs as low carbon legislation becomes increasingly more stringent. This can save developers money in the long term and reduce the long term cost of compliance with low carbon legislation in Hastings.

  4. **Decreased consumption of natural resources**

     Improved building thermal performance decreases the consumption of e.g. natural gas and lowers fuel bills. This is a particularly important advantage in a deprived borough such as Hastings.

Preferred approach 45: Renewable energy – standalone schemes – Recommended policy statement

Proposals for renewable energy developments, including any ancillary infrastructure or building will be favourably considered if:

1) Their scale, form, design, materials and cumulative impacts can be satisfactorily assimilated into the landscape or built environment and would not harm the appearance of these areas; and

2) They would not impact adversely on the local community, economy, biodiversity or historical interests.

The Council will investigate the area's potential for accommodating renewable and low carbon energy sources and supporting infrastructure. Suitable sites will be identified through the forthcoming Sites Allocation Development Plan Document.

Evidence base

- No changes to this existing statement are recommended.
- Analysis indicates that a significant capacity of MW scale wind capacity will be required in Hastings to offset the CO_2 impact of new build developments. The local council should therefore favourably consider plans to develop standalone renewable schemes in the borough.

Preferred approach 46: Renewable Energy – onsite provision – Recommended policy statement

Developers should consider a comprehensive range of renewable and low carbon energy technologies on their sites, some of which may be more appropriate in different locations.

All developments will be expected to reduce their CO_2 emissions (relative to a baseline estimate) by 10% through onsite renewable energy generation, unless it can be demonstrated that the development will be unviable in terms of development type, location, design or economics. The baseline estimate should be produced using an approved methodology e.g. SAP.

A site which can reduce its CO_2 by a factor greater than 10%, through the use of low carbon energy systems, such as CHP, will be allowed to use this technology to meet the requirement.

Evidence base

The original local planning target - to produce 10% of new development energy demands through onsite renewable energy production - has been amended to a 10% CO_2 reduction (from baseline) through onsite renewable/clean energy production. The reasons for these changes are detailed in section 3.3.

The onsite 10% CO_2 rule will be vital if the low carbon targets of the Hastings borough are to be realised. Implementation of the rule has the following advantages:

1. **Reduces the demand for MW scale wind carbon offsetting**

   MW scale wind carbon offsetting is the most cost effective method of achieving large CO_2 reductions. However, the MW scale wind resource in the Hastings borough is highly constrained. Local planning targets which reduce the CO_2 emissions of new build sites through onsite renewable/clean energy generation help to reduce the installed capacity of MW scale wind required in the borough.

2. **Promotes the uptake of CHP/DH and micro-generation.**

   Analysis indicates that a balanced mix of low carbon energy generation technologies will be required if Hastings is to achieve mandatory national CO_2 reduction targets. The Hastings borough cannot rely upon low carbon energy strategies dominated by a single technology e.g. MW scale wind, as the local resource is heavily constrained.

   The 10% onsite CO_2 rule forces developers to consider micro-generation and CHP systems at an early stage. This will help developers to adjust to the planned timetable for the CSH/CSB, which will require a sudden and very large increase in renewable/clean energy generation technology capacities at higher code levels.

   Local planning targets that support the development of carbon reducing technologies are required now to ensure that the market develops sufficiently to be able to deliver the capacities required for the high code levels.

Allowing clean energy generation technologies e.g. natural gas-fired CHP to contribute to the 10% onsite CO_2 rule has the following advantages:

1. **Cost effectiveness**

   Non-renewable low carbon energy generation technologies can be a more feasible and more cost effective means of reducing carbon than renewables (see Figure 12).

2. **Deployment of DH networks at an early stage promotes flexibility in borough wide low carbon energy strategies**

   The most cost effective low carbon energy strategies for attaining high CSH/CSB levels incorporate MW scale wind turbines and/or biomass-fired steam CHP engines and DH networks (see Figure 12 Chapter 4).

Promoting the installation of natural gas-fired CHP engines and DH networks now means that gas engines can be replaced with biomass engines in the future as heat networks expand, effective heat demands placed upon the networks increase and higher CSH/CSB CO_2 reduction targets become mandatory in Hastings.

Early installation of CHP systems and DH networks in Hastings creates a high level of flexibility in future low/zero carbon energy strategy.

3. Deployment of DH networks offers retrofit opportunities:

Significant CO_2 savings can be made by extending CHP/DH networks - catalysed by new developments – into existing properties with higher heating loads. This extension could also make the development of a CHP/DH system on a new build development more economically/technically viable in the first instance. There are a number of excellent heating network retrofit opportunities in Hastings (see section 7.2).

The 10% onsite CO_2 rule is an extremely powerful local planning target, with many far reaching implications. Adoption of the recommended policy statement will help Hastings Borough Council to develop an effective and flexible low carbon energy strategy.

Hastings Borough Council currently has no low carbon policies relating to:

1. Combined heat and power and district heating systems

2. The attainment of low carbon targets on sites where current low carbon technologies are not feasible or represent an unacceptable capital cost

The following additional policy statements are highly recommended by Element Energy in light of the analysis undertaken in this report.

As before, the recommended policy statement is presented along with a comprehensive evidence base.

Preferred approach 47: Supporting CHP/CCHP and heat networks – Recommended policy statement

Incorporate a strategic policy which:

Ensures that local, existing heat and cooling networks are identified and safeguarded.

Maximizes the opportunities for providing new networks that are supplied by decentralized energy (including renewable generation).

Ensures that developers evaluate combined cooling, heat, and power (CCHP) and combined heat and power (CHP) systems on all new developments, and where a new CCHP/CHP system is installed as part of a new development, examine opportunities to extend the scheme beyond the site boundary to adjacent areas.

Ensures that developers study the following heat and cooling network strategies before submitting a planning application:

- connection to existing CCHP/CHP distribution networks
- site-wide CCHP/CHP powered by renewable energy
- natural gas-fired CCHP/CHP
- communal heating and cooling fuelled by renewable sources of energy
- natural gas-fired communal heating and cooling.

Ensures that it is feasible for new developments to connect to existing heating and cooling networks.

Requires all developments to demonstrate that their heating, cooling and power systems have been selected to minimise carbon dioxide emissions.

Sites where it can be demonstrated that non-renewable CCHP/CHP and heating and cooling networks could produce CO_2 savings equal to or greater than those possible using onsite renewable energy generation technologies will be exempt from onsite renewable energy generation targets.

Evidence base

Analysis indicates that a balanced mix of low carbon energy generation technologies will be required to allow the Hastings borough to achieve mandatory CO_2 reduction targets. CHP/DH systems can provide highly cost effective CO_2 savings and are likely to be an important component of the low carbon energy strategy in the borough. Promotion of CHP/DH systems falls in line with the policy amendment NRM12 of the South East plan and hence fits well within a wider regional policy framework.

Designers should therefore be required to assess the technical and economic feasibility of CHP/CCHP and DH systems on their sites when writing a planning application, even if such systems are not required to achieve the CO_2 reduction targets required of a site.

Where there is an obvious opportunity to extend heat and cooling networks beyond the boundary of a site (and hence promote further highly cost effective CO_2 savings), developers should make this point clear. There may be a possibility of combining heat networks and increasing the cost effective CO_2 savings which can be attained (and reducing capital installation costs).

Dwellings should be built so that they can easily be retrofitted and connected to heat networks which may expand throughout Hastings. This may allow significant, cost-effective retrofit CO_2 savings to be made in the future.

Non-renewable clean energy systems e.g. natural gas-fired CHP can provide significant CO_2 savings, however under current planning policy in Hastings, such non-renewable systems must be supplemented with expensive building mounted renewables and are hence an unfavourable economic proposition. Exemption from the 10% onsite CO_2 rule would make them far more appealing economically.

N.B: the CHP technology order outlined in the recommended policy statement decreases in the cost effectiveness of CO_2 saved from the first option to the last.

Preferred approach 48: Low carbon buy-out fund – Recommended policy statement

Hastings Borough Council will explore the option of a CO_2 buy-out fund.

The fund will be designed to allow sites to achieve the required low carbon through energy trade agreements throughout the borough, facilitating the most cost effective CO_2 savings in the Hastings borough.

Access to the buyout option will only be granted for those sites where it has been demonstrated that achieving the required CO_2 reduction standards onsite is technically or economically unfeasible.

The tariff level of any CO_2 buy-out will be determined following further evidence base work, but will be set at a level which encourages developers to explore all relevant onsite clean/renewable energy generation technologies in the first instance.

Capital contributions to the CO_2 buy-out fund will be used to fund major low carbon developments in the Hastings borough.

Evidence base

Some sites may not be able to achieve the required carbon targets using on site technologies. Low carbon technologies may be unviable on a specific site, or represent an unfeasible capital cost.

The most cost effective carbon savings often require the use of standalone technologies e.g. MW scale wind turbines, which are remote from the development. In order to ensure that these standalone renewable technologies do develop, and at an appropriate scale, a centralised, buyout fund would be required.

The “buy-out price” or tariff of any fund should be set at a level which supports the proliferation of the preferred renewable/clean energy technologies e.g. it should not be set lower than the cost of a typical CHP system and DH network if you want these technologies to be seriously considered by developers, as they will simply buy-out of their low carbon onsite obligations.

However, the buy-out price cannot be set so high as to make development economically unfeasible.

Energy strategy analysis in Hastings suggests that the most cost effective energy strategies for achieving high CO_2 reductions will incorporate:

- Site-wide CHP systems with district heating (biomass CHP being the most cost effective)
- Offsite MW scale wind supplementation

Proceeds from the buy-out fund could be used to install MW scale wind capacity in some of the suitable and very windy sites in the Hastings borough.

2. INTRODUCTION

2.1. Climate change and the need for national environmental policy

An overwhelming body of scientific evidence indicates that the Earth's climate is changing rapidly, and to a large extent as a result of increases in greenhouse gas emissions produced by human activities.

It therefore falls upon national governments to implement policy to achieve a reduction in greenhouse gas emissions (especially carbon dioxide). The lack of sound commercial models for CO_2 reduction means that policy is the key driver in mitigating climate change. The Kyoto Treaty, operating at the international scale, has spearheaded a set of frameworks in which trading blocs (such as the EU) and national governments have begun to act.

The UK has committed to a 60% reduction in CO_2 emissions by 2060 (from 1990 levels), with real progress by 2010 and 2020. Integral to this goal are the government's targets to produce 10% of UK electricity from renewables by 2010 and 20% by 2020 and to produce 15% of all UK energy from renewables by 2020.

It is in the wider context of international obligations that Government - and ultimately UK boroughs and cities - must frame their low carbon energy policies.

2.2. Implications of national planning guidance at the local level

In order to facilitate the attainment of the international low carbon obligations outlined above, the UK government has produced documents which guide the formulation of local framework documents relating to renewable/clean energy production and the mitigation of global climate change.

The introduction of national planning guidance such as the Supplement to PPS1 (on Climate Change)[2] and PPS22 (on renewables)[3] has greatly increased the role and responsibility regions and local authorities now have in reducing CO_2 emissions and in meeting renewable energy requirements. A strong evidence base (on energy and CO_2) is now required to support regional planning policies and for the production of sound Local Development Frameworks.

The production of a strong evidence base requires expertise in a number of diverse issues such as:

- Regional renewable capacity assessments, often using Geographic Information Systems to organise and report on data.
- Experience in low carbon building design combined with an appreciation of current and future building design legislation.
- Knowledge of the potential (and limitations) of renewable, distributed and microgeneration technologies alongside their future cost and performance.
- Experience with interpreting this information to help produce strong and effective local planning policy.

Hastings Borough Council is amongst a hand-full of local authorities which are actively seeking to understand and address the implications that central government low carbon energy policy will have at the local level.

The following report will produce the evidence base required to guide and support local low carbon energy policy in the foreseeable future. Adoption of the policy recommendations ultimately produced will assist Hastings in playing an integral role in reducing national CO_2 emissions and contributing to national renewable energy production targets.

[2] Planning Policy Statement 1: Delivering Sustainable Development
https://webarchive.nationalarchives.gov.uk/20081212130531/http://www.communities.gov.uk/
planningandbuilding/planning/planningpolicyguidance/planningpolicystatements/planningpolicystatements/pps1/

[3] Planning Policy Statement 22: Renewable Energy
https://webarchive.nationalarchives.gov.uk/20120920011611/http://www.communities.gov.uk/archived/
publications/planningandbuilding/pps22

3. HASTINGS NEW BUILD DEVELOPMENTS

3.1. Overview of new build developments

Hastings has a population of 86,000 and is an urban centre set in the largely rural area of East Sussex. This means the town has an important role as a centre of economic activity and transport services and as a "regional hub" (as recognized in the regional spatial strategy).

Given its regional importance, the town is committed to regeneration and facilitating expansion in the domestic and commercial sectors. Local targets envisage ~5,000 new build homes in the region by 2026 - with large associated increases in office and retail floor space.

3.2. National environmental planning policy

Should the planned new build Hastings developments continue to be built to Part L 2006 standards (domestic sector) and today's best practice non-residential benchmarks, the CO_2 impact of the developments will be significant:

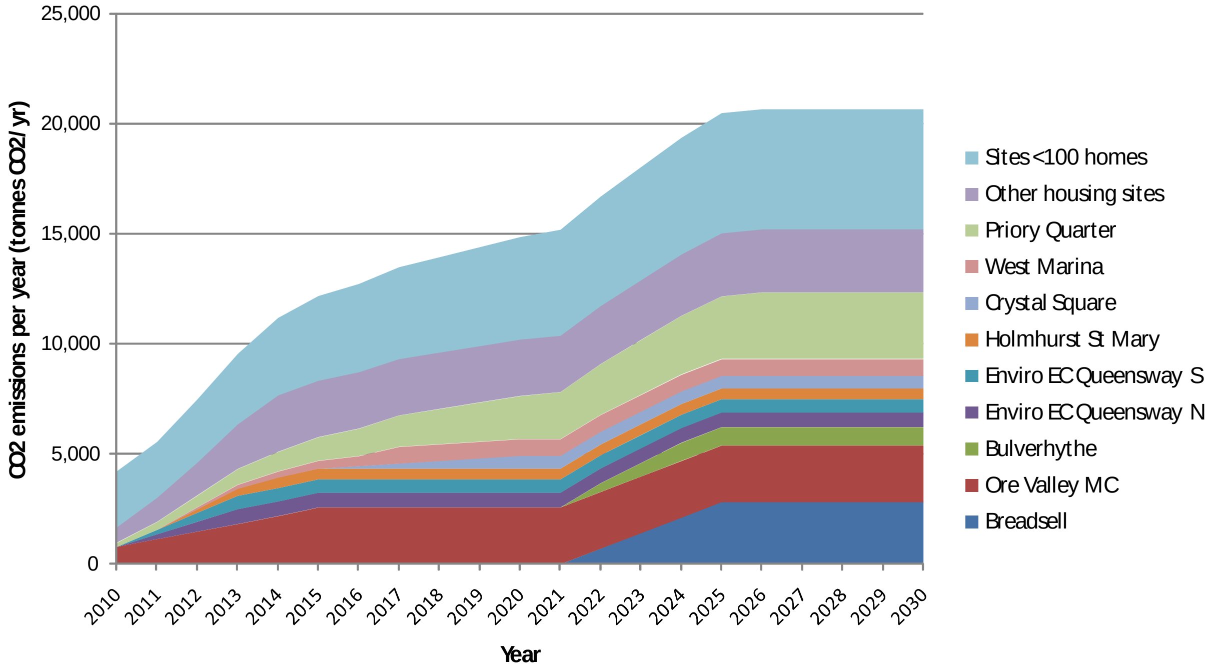

***Figure 8 -** annual CO_2 emissions which will result from the Hastings new build developments if all buildings continue to be built to part L 2006 (domestic) or best practice benchmarks (non-domestic).*

The new build developments will emit ~20,000 tonnes of CO_2 per year by 2030.

The cumulative CO_2 emissions over time will also be substantial:

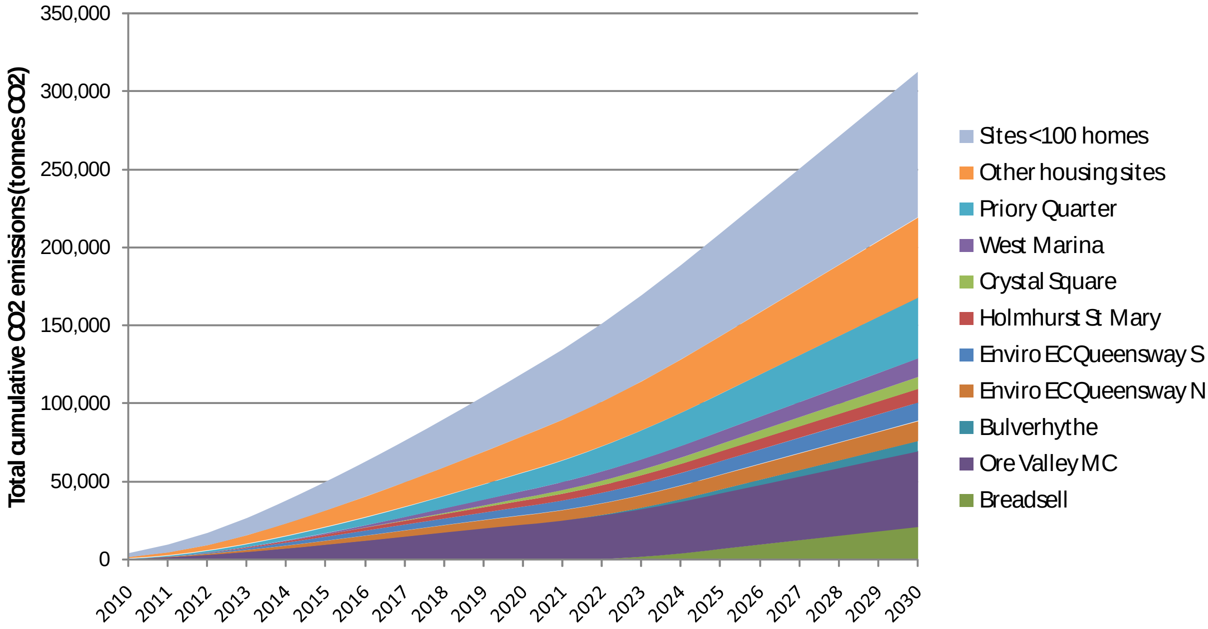

Figure 9 - *cumulative CO_2 emissions resulting from the new build developments in Hastings if low carbon legislation does not become more stringent in the future.*

However, significant CO_2 emissions mitigation is possible if central government CO_2 reduction targets can be met.

The dominant policies governing the sustainable development of the Hastings new build developments are the Code for Sustainable Homes (CSH - domestic sector) and the Code for Sustainable Buildings (CSB - non-domestic sector).

The CSH sets mandatory CO_2 reduction targets (expressed as a percentage relative to baseline emission rates) which will become increasingly stringent, in a step-wise progression over the next decade.

The CSH envisages zero carbon homes from 2016 onwards. The CSB targets and timelines are currently under consultation, but are likely to mirror those of the CSH.

The CO_2 reduction targets of the CSH are outlined below:

Code Level	% Improvement on Part L (2006)
1	10
2	18
3	25
4	44
5	100
6	A net zero carbon home

% reduction of emissions relating to heating, lighting & ventilation

Net zero CO2 including emissions relating to electricity consumption by appliances

Table 1 - *table of percentage emissions reductions required to achieve consecutive CSH levels*

The current central government timeline states that the CSH code levels will be introduced as follows:

- CSH level 3 – 2010
- CSH level 4 – 2012
- CSH level 6 – 2016

The CO_2 reduction targets and timeline of the CSB are estimated from the Green Building Council report on the potential for CO_2 reductions in non-domestic buildings[4]. The timeline for introduction assumed in this report will follow that of the CSH and will require mandatory CO_2 reductions of 20% (2010), 40% (2012) and 100% (2016) with respect to baseline CO2 emissions.

In non-domestic properties, substantial CO_2 savings can be achieved through improvements in building thermal/fabric performance. This report will assume that the following fabric derived CO_2 savings (with respect to baseline) are required under the CSB: 10% (2010), 20% (2012) and 40% (2016). Therefore, a non-domestic property built in 2012 - which must attain a 40% CO2 reduction - will meet half this target through fabric efficiency (20%) and the other half through active clean/renewable energy generation.

Code level	Introduced	% improvement on best practice benchmarks	% improvements through energy efficiency
3	2010	20	10
4	2012	40	20
6	2016	100	40

Table 2 - *table of percentage emissions reductions required to achieve consecutive CSB levels*

Attainment of the CSH/CSB standards for the new build developments in Hastings could result in significant annual CO_2 savings:

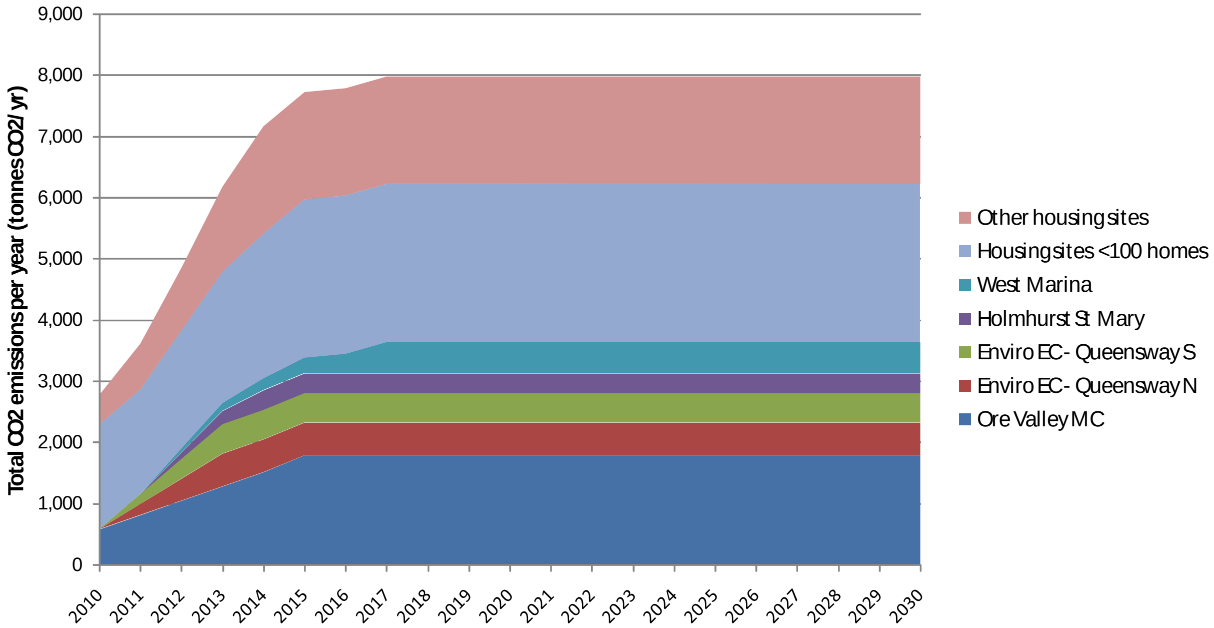

Figure 10 - *annual CO_2 emissions from the Hastings new build developments if the targets of the CSH and CSB are met. Note that emissions plateau after 2016 as new developments must be zero carbon.*

An approximate 60% reduction in annual CO_2 emissions by 2030 is possible if the targets of the CSH and CSB are met on the Hastings new build development sites.

[4] Report on carbon reductions in new non-domestic buildings – UK green building council http://www.communities.gov.uk/documents/planningandbuilding/pdf/carbonreductionsreport.pdf

Substantial cumulative CO_2 savings could also be realised:

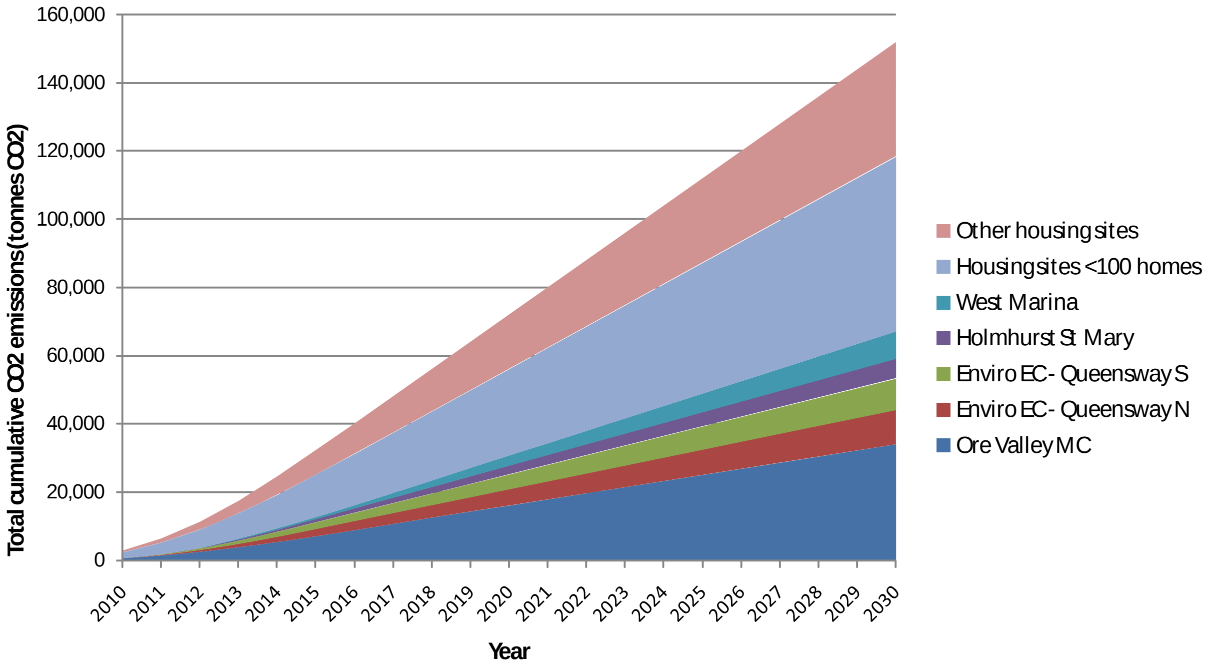

Figure 11 - *cumulative CO_2 emissions resulting from the Hastings new build developments if the targets of the CSH and CSB are met.*

An approximate 50% reduction in the amount of CO_2 emitted by the new build Hastings developments between now and 2030 could be achieved, if the CSH and CSB targets can be attained.

It should be noted from an early stage that the later CO_2 reduction targets required under the CSH and (potentially under the) CSB are extremely onerous. CSH/CSB level 6 would require that the entire heating and electrical demands (including appliance use and cooking in domestic properties) are either met or offset by renewable/clean energy generation. Meeting the low carbon levels will be expensive and in virtually all cases are not predicted to result in a return upon capital investment.

- The Code for sustainable Homes and Code for Sustainable Buildings will require increasingly stringent CO_2 reductions (with respect to standard 2006 designs) of domestic and non-domestic properties.
- The CO_2 reduction targets and timeline of the developing CSB are likely to mirror those of the more mature CSH.
- From 2016 all developments should be zero carbon.
- Significant CO_2 savings can be recognized by 2030 if the targets on the CSH and CSB are met on the Hastings new build development sites – 60% reduction in annual CO_2 emissions by 2030 and a 50% reduction in cumulative CO_2 emissions between 2010 and 2030.

3.3. Local environmental planning policy affecting the Hastings new build developments

In addition to the CSH and CSB, the Hastings borough has a local "Merton rule"[5] planning target regarding onsite renewable energy generation. The target currently states that:

"…..*all new commercial development above a threshold of 1000m^2, or residential development of 10 or more dwellings, will be expected to provide at least 10% of their energy requirements from onsite renewable energy generation, unless it can be demonstrated that the development will be unviable in terms of development type, location, design or economics."*[6]

This policy statement seeks to:

1. Reduce CO_2 emissions from new build developments – in line with the CSH and CSB.

2. Promote the uptake of micro-generation technologies within the borough. This can help developers and installers to gain experience of working with renewable energy technologies at an early stage, before the CSH/CSB targets become more stringent and greater installed capacities of renewable technologies are required.

The policy has some worthwhile goals, but requires revision. The reduction metric of the CSH and CSB legislation is a percentage of CO_2 emissions with respect to baseline.

To avoid confusion between energy and CO_2 targets the local planning target should be amended to require a 10% CO_2 reduction with respect to baseline CO_2 emissions.

The policy should also be amended to allow clean energy technologies (non-renewable) – which can promote substantial CO_2 savings - to contribute towards meeting the 10% CO_2 reduction target. Non-renewable low carbon energy generation technologies (such as gas fired CHP) can be a more feasible and more cost effective means of reducing carbon than renewables (see next section); these must be included alongside renewables.

All analysis which follows will assume these 2 policy amendments are implemented. The policy will henceforth be referred to as "the 10% onsite CO_2 rule".

- The local planning requirement to produce 10% of the energy demand of a new development using renewable energy generation should be amended.
    - The 10% energy production target should be amended to a 10% CO_2 reduction target with respect to baseline emissions
    - Clean energy generation technologies such as CHP, alongside renewables can facilitate significant CO_2 savings and should be allowed to contribute to the target.

Further implications for local low carbon planning policy will be discussed in detail in section 8.2.

[5] No longer available online.
[6] Hastings Borough Council – Preferred Approach Statements

4. STRATEGIES FOR ACHIEVING LOW CO_2 TARGETS

The CO_2 reduction targets of the CSH and CSB are onerous and will require significant capital expenditure on renewable/clean energy generation technologies. The following section will explore the low carbon strategies and technologies which will allow the new build Hastings developments to attain the required national and local low carbon targets in the most appropriate and logical manner.

There are many technological strategies which can be deployed to reduce the carbon emissions emitted by both new and existing developments. These strategies employ mixtures of the following low carbon measures:

4. **Thermal performance/fabric improvement measures:**
Examples include: basic heating controls (e.g. delayed start thermostats and zoned and timed heating controls), improvements in building insulation (e.g. cavity wall insulation, loft insulation etc) and heat recovery systems. These measures reduce the heating and hence fuel demands of buildings.

5. **Clean energy generation technologies:**
These technologies generate heat, electricity or a combination of the two from non-renewable resources (e.g. natural gas-fired CHP). The overall system efficiency of clean energy systems is higher than those of conventional heating and electrical systems, allowing significant CO_2 savings to be realized.

6. **Renewable energy generation technologies:**
These technologies directly generate heat (e.g. solar water heating), electricity (e.g. solar photovoltaics) or a combination of the two (e.g. biomass-fired combined heat and power systems) from renewable sources.

These technologies embody the essence of the greater London authority guidance on reducing carbon emissions[7]:

- "Be lean…" – reduce building energy demands with respect to baseline.
- "Be clean…" – produce, deliver and utilize energy in an efficient manner.
- "Be green…" – produce energy from renewable sources.

4.1. Onsite and offsite low carbon systems

Onsite low carbon technologies – as defined in the Code for Sustainable Homes - include building fabric improvement measures, micro-generation technologies integrated into buildings e.g. roof-mounted PV, CHP engines and site-wide DH networks, and any other technology sited on (or in the immediate vicinity of) a new development. These technologies must provide heating or electricity to the development directly e.g. through a dedicated private-wire network or bespoke heating network. The CO_2 saved by these technologies can be credited to the development directly and can contribute to compliance with CSH/CSB low carbon targets.

Offsite low carbon technologies such as mega-watt scale wind turbines operating in locations remote from a new development cannot (according to the current draft of the CSH) contribute to the CO_2 reduction targets of a new development unless the turbine and site are connected by a dedicated electrical connection i.e. private wire arrangement. This legislation is currently in a state of flux and is likely to be revised.

The use of offsite systems e.g. MW scale wind turbines can be relatively commercially attractive. Turbines can be sited in optimal offsite locations with high wind speeds, instead of being sited in potentially less suitable locations adjacent to new developments. MW scale turbines in very windy locations may represent a commercially viable low carbon energy generation opportunity.

[7] The London Plan – cross cutting policies
https://www.london.gov.uk/sites/default/files/the_london_plan_malp_final_for_web_0606_0.pdf

4.2. Technology choice – how will low carbon targets be achieved in Hastings?

Despite the fact that there is a broad range of low carbon technologies available to building developers, previous extensive studies[8] and past experience indicate that developers will very likely deploy low carbon strategies based on assessments of:

3. **Technical feasibility:**
   A low carbon strategy must be appropriate for deployment on a given site, and allow attainment of the required carbon reduction target.

4. **Capital expenditure**
   Developers strongly favour the feasible low carbon strategy which represents the lowest capital expenditure.

Technologies which save a fixed quantity of carbon at the lowest capital cost are said to have a *high CO_2 capital cost effectiveness* (measured in capital £ per kg of CO_2 saved) – these technologies will be strongly favoured by developers.

The graphs presented below display the capital cost effectiveness of a comprehensive list of low carbon technologies (including thermal/fabric improvements and active generation technologies) in both the domestic and non-domestic sectors. Results are displayed for a typical semi-detached house (although variations with house size are negligible) and a typical non-domestic property:

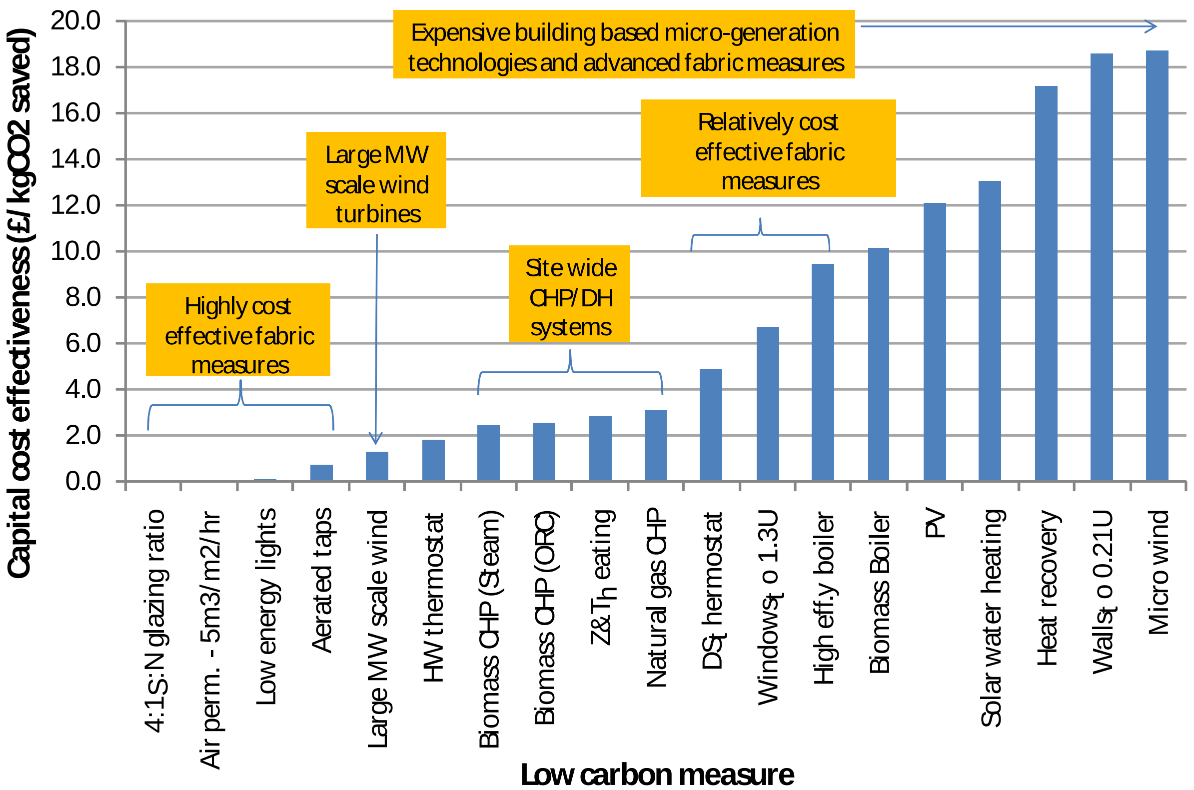

Figure 12 - *CO_2 capital cost effectiveness of low carbon technologies for a typical semi detached house.*

The residential thermal/fabric improvement measures studied on the graph are:

1. 4:1 S:N glazing

   4/5 of all windows are designed to be south facing. Heating bills are reduced as solar heating gains are higher.

[8] The growth potential for microgeneration in England, Wales and Scotland – Element Energy
https://www.ofgem.gov.uk/ofgem-publications/58092/element-energy-presentationpdf

2. Low flow taps

   Hot water consumption can be significantly reduced by fitting aerated tap fixtures.

3. Low energy lights

   Installing low energy lighting instead of standard incandescent bulbs can significantly reduce lighting electrical demands.

4. Air permeability reduced to $5m^3/m^2/hr$

   Decreasing the air permeability of homes slows the leakage of heat to the atmosphere and reduces heating demands.

5. Basic heating controls

   a. Thermostat in hot water cylinder

      Controls the temperature of domestic hot water and avoids overheating. Heating demands are reduced.

   b. Zoned and timed heating controls

      Allow occupants to heat specific areas of the homes at specific times. These controls allow occupants to live comfortably without heating unoccupied areas of the home unnecessarily.

   c. Delayed start thermostat

      Delayed start thermostats delay the start-up of the home heating system until the latest possible moment, thus avoiding unnecessary heating.

6. High efficiency boiler upgrades

   Standard gas boilers can be upgraded to high efficiency condensing boilers, reducing heating fuel demands.

7. Upgraded windows

   Thermal leakages through windows can be reduced by installing double or triple glazing.

8. Upgraded walls

   Thermal leakages through walls can be reduced by increasing wall thickness or using materials which conduct heat less well.

9. Heat recovery

   The air in homes must be constantly recycled to ensure adequate ventilation and prevent the growth of mould. Heat recovery systems use the warmth of expelled air to heat incoming cooler air. Heat is recycled, reducing heating demands.

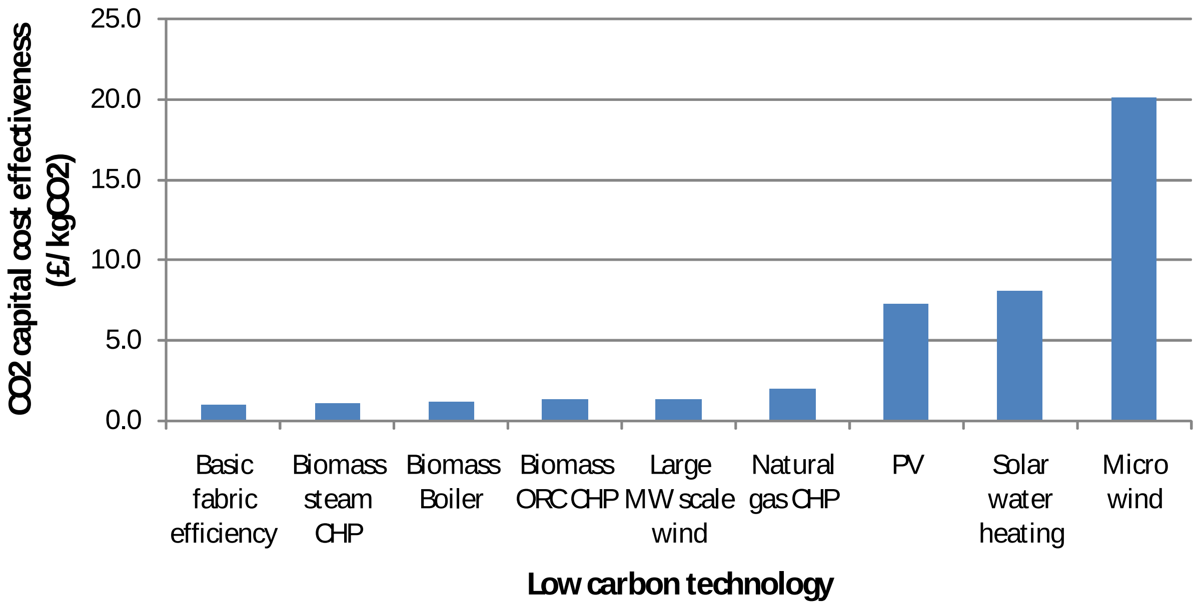

Figure 13 - *CO_2 capital cost effectiveness of low carbon technologies for a typical non-domestic property*

Fabric costs were derived from a recent Cyril Sweett report[9]. All technology performance and cost data can be viewed in appendix 9.1.

The graphs illustrate several key points:

1. Basic building design and performance improvements e.g. solar orientation (4:1 ratio of S:N glazing) and reduced air permeability provide the most cost effective CO_2 savings in both domestic and non-domestic properties. Advanced fabric measures e.g. reducing wall U-values are not cost effective.

2. Large MW scale wind turbines and site-wide CHP systems with district heating networks (biomass or gas-fired) are the most capital cost effective energy generation technologies (biomass boilers are competitive in the non-domestic sector only).

3. Building mounted renewable energy generation technologies are extremely expensive and are not economically favourable relative to MW scale wind and CHP/DH based low carbon systems for high CSH/CSB levels.

Preliminary cost analysis and the 10% onsite CO_2 rule

Despite the fact that building mounted renewable energy generation technologies represent an expensive method of saving carbon, analysis indicates that PV systems represent the cheapest method of achieving compliance with the 10% onsite CO_2 rule in the domestic sector. This owes to the fact that PV arrays can be precisely sized to provide a 10% CO_2 reduction with respect to baseline emissions (~0.5kWe of PV is required per dwelling). More CO_2 capital cost effective systems such as domestic micro-biomass boilers and natural gas-fired CHP systems are sized to meet large fractions of the heating demands of domestic properties, and as a result save far more carbon than the 10% target, but at increased capital cost.

Analysis further indicates that biomass boilers are the cheapest way to comply with the 10% onsite CO_2 rule in non-domestic buildings, despite the fact that they save more carbon than necessary.

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9 Cost Analysis of The Code for Sustainable Homes http://www.communities.gov.uk/publications/planningandbuilding/codecostanalysis

Figure 12, Figure 13 and preliminary cost analysis therefore indicates that the most cost effective new build low carbon energy strategies in Hastings will incorporate:

- A basic level of building thermal/fabric performance improvement from baseline – the exact fabric standards appropriate will be explained in the next chapter.
- Deployment of MW scale wind turbines or CHP/DH systems (or biomass boilers in non-domestic properties) – subject to technical feasibility.
- Installation of the minimum capacity of PV to allow compliance with the 10% onsite CO_2 rule in domestic properties.

(Note that this outline strategy is relatively robust and the same solutions apply even if:

1. Developers favour low ongoing technology running costs over low upfront capital costs
2. Technology capital costs vary markedly over the time frame of this study (present – 2026). Variation in cost over the time period has been included in this assessment.

For further data see appendices 9.4 and 9.5).

These insights help to focus the technological strategies that will be modelled and explored for the new build development sites around Hastings in the next chapter.

- CO_2 reductions can result from:
    - Increased building fabric performance – “be lean”
    - Clean energy production and delivery e.g. natural gas-fired CHP – “be clean”
    - Deploying renewable energy generation technologies – “be green”
- Developers favour the technically feasible low carbon strategy which represents the lowest capital cost.
- Analysis indicates that the most capital cost effective low carbon energy strategies will require:
    - Highly cost effective building thermal/fabric performance improvements
    - MW scale wind turbines or site-wide CHP/DH systems fuelled by biomass or natural gas (and biomass boilers in non-domestic properties)
    - PV to allow compliance with the 10% onsite CO_2 rule in domestic properties
- Building integrated renewable micro-generation technologies and advanced fabric measures e.g. heat recovery, incur comparatively higher capital costs.
- Variations in capital costs with time and developer preference (prioritisation of running costs over upfront capital costs) will not significantly affect the relative cost effectiveness of low carbon energy technologies between now and 2026.

5. OPTIMAL LOW CARBON ENERGY STRATEGIES FOR SPECIFIC NEW DEVELOPMENT SITES IN HASTINGS

The following chapter will examine the most suitable and cost effective low carbon energy strategies for a comprehensive range of new build development sites in Hastings.

Five new build development sites will be studied. The sites are fully representative of the new developments planned in the Hastings borough:

1. The Ore Valley Millennium Community (2010)
   - CSH 3
   - Mixed residential and non-domestic land uses

2. West Marina (2012)
   - CSH 4
   - Mixed residential and non-domestic land uses

3. Breadsell Lane (2022)
   - CSH 6
   - Mixed residential and non-domestic land uses

4. Priory Quarter (Post 2016)
   - CSB 6
   - Large non-domestic development site

5. Springfield Valley
   - A range of CSH level targets will be examined
   - Very small scale domestic development site

Studying the sites noted above will allow optimal low carbon strategies to be formulated for sites which vary fully with respect to:

1. The CSH/CSB low carbon target required of a site

2. The exact land uses present on a site

The insights derived from the analysis of these sites can be used as a broader template to determine optimal low carbon energy strategies for all the new build developments in the Hastings borough. Optimal low carbon strategies will be cost effective and also address and assuage other, wider practical considerations and concerns.

5.1. Low carbon energy strategies studied

The interim results from chapter 4 allow analysis to focus on some of the most cost effective and feasible low carbon energy strategies. These strategies will incorporate:

a. A level of improved building thermal/fabric performance – the appropriate level will be determined in this chapter.

b. Large MW scale wind turbines and/or site-wide CHP/DH systems (or biomass boilers in residential properties)

c. Installation of the minimum capacity of PV to allow compliance with the 10% onsite CO_2 rule in domestic properties at minimal capital cost.

In order to determine the optimal low carbon energy strategy for a specific new build development site, test scenarios must:

a. Assess the capital costs of varying levels of building thermal/fabric performance improvement

b. Assess the capital cost of low energy strategies dominated by MW scale wind and CHP/DH systems.

Five low carbon energy strategies have been selected. They represent the most cost effective and/or practical methods of achieving low carbon targets on a new build development site:

1. **Wind dominated – no building thermal/fabric performance improvements**

    a. No initial application of building thermal/fabric improvement measures to new buildings

    b. Application of building integrated renewables to facilitate compliance with the 10% onsite CO_2 rule at minimal capital cost

    - PV arrays in new build domestic properties
    - Biomass boilers in non-domestic properties

    c. Any remaining CO_2 emissions offset using MW scale wind turbines

2. **Wind dominated – basic building thermal/fabric performance improvements**

    As above, but a basic level of building thermal/fabric performance improvement measures are initially applied.

    The level of fabric performance improvement corresponds to applying the highly cost effective and relatively cost effective fabric packages noted in Figure 12 in chapter 4.

    Application of these fabric measures results in a ~10-15% reduction in CO_2 emissions with respect to baseline (part L compliant design) in domestic properties.

3. **Wind dominated – advanced building thermal/fabric performance improvements**

    As above, but an advanced levels of building thermal/fabric performance improvement measures are initially applied e.g. heat recovery systems.

These three initial low carbon energy strategies allow the optimal level of building thermal/fabric performance improvement for the new build domestic developments in Hastings to be assessed. The fabric performance levels required of non-domestic buildings are enshrined in the CSB legislation.

4. **CHP/DH dominated**

    a. Initial application of basic fabric improvements to buildings

    - Significantly reducing the heating loads of buildings using advanced fabric measures could make CHP unfeasible therefore only basic levels are applied.

    b. Deployment of site-wide CHP/DH systems serving all properties

    - The opportunity for biomass CHP systems will be explored initially. However, these systems have a minimum required electrical demand capacity (see appendix 9.1).

- If sufficient electrical demand capacity for biomass CHP is not available, then less cost effective gas-fired CHP systems will be deployed.

- A very low minimum electrical demand capacity is required for gas CHP systems to be viable. All sites of >100 homes or exhibiting an equivalent electrical load will be appropriate for gas-fired CHP systems with DH.

5. Building integrated renewables

a. Initial application of basic fabric improvements to buildings

b. Installation of biomass boilers and large capacities of PV

- These technologies allow attainment of CSH/CSB low carbon targets using building integrated technologies only.

Initial testing

Initial testing indicated that there are no viable opportunities for good quality biomass-fired CHP/DH systems on the new build development sites in Hastings. This testing is explained more thoroughly in appendix 9.3. Any installed biomass-fired CHP systems would need to be substantially oversized. This would result in the dumping of excess produced heat to the atmosphere.

Therefore, the energy strategies which are initially assessed below will only consider natural gas-fired CHP/DH systems. Oversized, heat dumping biomass-fired CHP/DH systems will be covered in later variation analyses (see chapter 6.6).

The low carbon energy strategies detailed in this section and their implications will now be assessed on the five representative new build development sites.

5.2. The Ore Valley Millennium Community

The Ore Valley Millennium Community is a mixed land use development incorporating domestic and non-domestic land uses.

The site will incorporate:

- 800 new homes – with a rough 50:50 split between flats and houses
- 330m^2 of new offices
- 330m^2 of new retail floor space
- A 1,500m^2 new health centre

Domestic properties will be required to achieve CSH level 3 (a 25% reduction in regulated CO_2 emissions from baseline). Non-domestic properties will be required to achieve the corresponding CO_2 reduction target of the CSB – a 20% CO_2 reduction with respect to baseline emissions (10% of which must be achieved through improved energy efficiency). These CO_2 reductions are the least onerous demanded under the CSH and CSB.

All properties must also comply with the local 10% onsite CO_2 rule.

Results:

The installed capacities of low carbon technologies required under the 5 low carbon energy strategies outlined in section 5 are presented in the graph below:

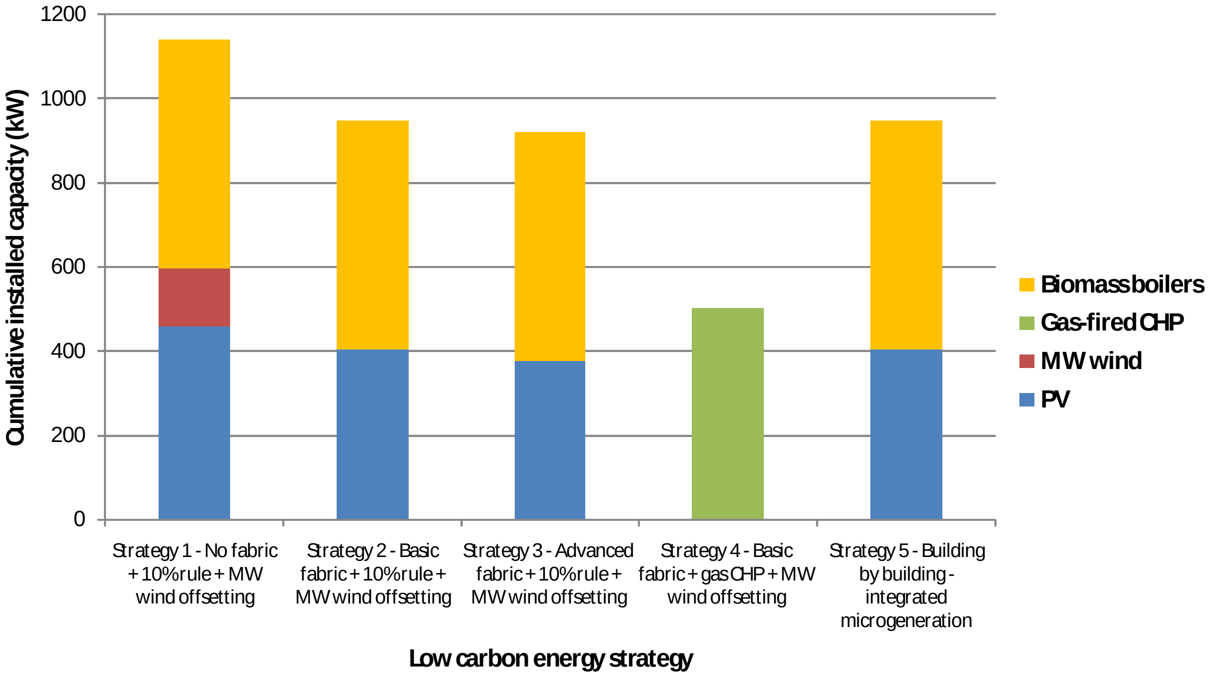


Figure 14 - *installed capacities of low carbon technologies required for a comprehensive range of low carbon energy strategies at the Ore Valley Millennium Community. N.B: capacities are measured in kWe except for biomass boiler capacities which are measured in kWt.*

Deployment of the technology capacities required in Figure 14 will incur significant capital cost. The capital costs per technology and in total are presented in the graph below:

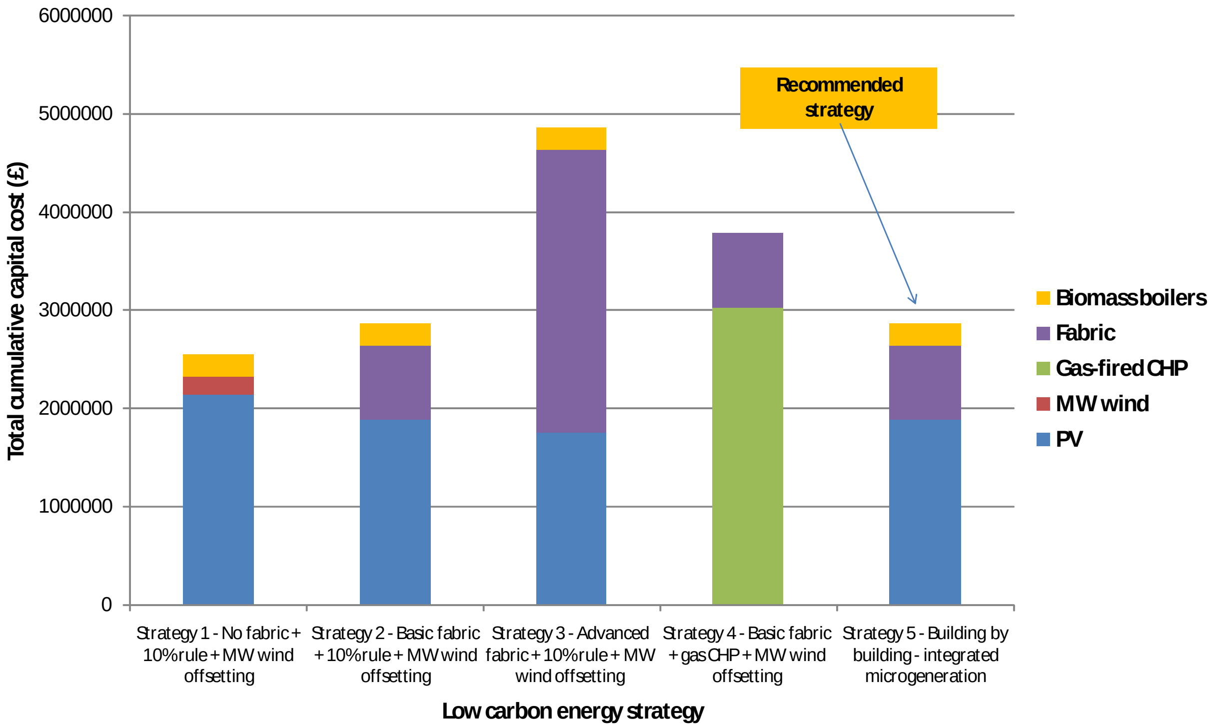


Figure 15 - *cumulative capital cost required to achieve mandatory CO_2 targets at the Ore Valley Millennium community.*

The graphs above indicate that:

1. Installing basic levels of fabric efficiency (to decrease baseline CO_2 emissions by 10%) does not increase capital costs significantly.

   However, advanced fabric measures e.g. heat recovery systems, are extremely expensive and exhibit lower cost effectiveness with respect to active renewable/low carbon micro-generation technologies such as PV and biomass boilers.

   Installation of basic levels of fabric improvements measures is therefore recommended.

2. Building by building low carbon energy strategies are cheaper than site-wide natural gas-fired CHP/DH systems at CSH/CSB level 3. Only carbon offsetting strategies (incorporating MW scale wind turbines) are more cost effective.

However, carbon offsetting strategies suffer limitations in the Hastings borough and should be avoided at low CSH/CSB code levels:

- The MW scale wind resource in Hastings is extremely constrained (see GIS wind resource mapping – section 7.1). Use of building by building low carbon energy strategies conserves this resource whereas the use of MW scale wind carbon offsetting strategies does not.

  The resource will be required to achieve higher CSH/CSB levels on later development sites – especially CSH 6 (see chapter 5.4).

- Current CSH/CSB legislation requires MW scale turbines to be linked directly (via private wire networks) to new build developments. Building-by-building low carbon energy strategies avoid legislative complications on early CSH level 3 new build development sites. The legislation is currently under revision and should be clearer for later development sites post CSH 4 (2012).

Recommended low carbon energy strategy at the Ore Valley Millennium Community

Building-by-building strategies are recommended at CSH/CSB level 3. These low carbon energy strategies incorporate:

1. Basic levels of building thermal/fabric improvement measures (to reduce domestic baseline CO_2 emissions by ~10%)

2. Renewable micro-generation technologies to facilitate compliance with the 10% onsite CO_2 rule (PV – domestic, biomass boilers – non-domestic)

Building by building low carbon energy strategies exhibit many advantages at CSH/CSB level 3.

Advantages

1. **Cost effectiveness**

   The strategy represents a cost effective method of achieving compliance with low carbon legislation at CSH level 3 (and associated CSB level). Only carbon offsetting strategies incorporating MW scale wind turbines are more cost effective.

2. **Avoidance of MW scale wind carbon offsetting – noted above**

3. **Future-proofing of domestic building designs**

   Incorporating basic thermal/fabric improvement measures at this early stage future proofs building designs for higher CSH/CSB code levels, which will require mandatory improvement in building thermal performance.

   By changing building designs now, developers can avoid constantly updating designs as low carbon legislation becomes increasingly more stringent. This can save developers money in the long term.

4. **Decreased consumption of natural resources**

   Improved building thermal performance decreases the consumption of e.g. natural gas and lowers fuel bills. This is a particularly important advantage in a deprived borough such as Hastings.

Building-by-building low carbon energy strategies are therefore recommended for achieving the lowest CSH/CSB code levels (CSH 3 and equivalent CSB level) on new build development sites in Hastings.

Caveats

A number of important caveats should be placed upon the recommendation made above.

1. **Building integrated renewable energy technologies may not be appropriate for all new development sites:**

Specific renewable/low carbon energy generation technologies may not be appropriate on specific new build development sites e.g. solar PV and solar water heating systems may not be appropriate if a development suffers substantial over-shading.

2. **Building by building low carbon energy strategies may not represent the lowest cost of compliance with low carbon legislation on phased development sites:**

If several development phases are planned at the same site, some of which will be required to achieve CO_2 reduction targets above CSH level 3 (and associated CSB level), building-by-building low carbon energy strategies may become less attractive (see analysis of West Marina below).

Implementing building-by-building approaches in the short-term could reduce site electrical/heating loads and make CHP/DH systems (which are cost effective at higher CSH/CSB levels – see following chapter) unfeasible for later development stages.

This could increase the long term cost of compliance with low carbon legislation.

The technical and economic feasibility of CHP/DH systems should therefore be assessed for all new development sites in Hastings (see chapter 8.2 – policy recommendations) at the initial planning stage.

Conclusions

- Carbon offsetting strategies are highly cost effective at low CSH/CSB levels, but should be avoided as they:
  1. Tax the constrained borough MW wind resource – required at higher code levels
  2. Conflict with current CSH private wire legislation.
- Relatively cost effective building by building low carbon energy strategies are therefore recommended at low CSH/CSB code levels for the mixed use new development sites in Hastings.
- These strategies incorporate:
  1. Basic levels of fabric efficiency improvement measures
  2. Building integrated renewable energy generation technologies – to facilitate compliance with the 10% onsite CO_2 rule
- A basic improvement in fabric performance which results in a 10% CO_2 reduction from baseline emissions is highly feasible, cost effective and recommended in domestic properties (fabric efficiency targets in non-domestic properties are covered within the developing CSB legislation).
- This level of fabric performance improvement has a number of advantages:
  1. Relatively cost effective
  2. Avoids the use of MW scale carbon offsetting at low CSH/CSB code levels
  3. Future proofs domestic building designs against changes in CSH legislation – saving developers money
  4. Decreases the consumption of natural resources e.g. natural gas and decreases fuel bills for end users.

5.3. West Marina

West Marina is a mixed use development located in West St Leonards.

The site incorporates:

- ~250 new build flats
- A 70 bed landmark hotel
- A local café
- A local community centre
- Several beach huts and kiosks – assumed to have no energy demands

Domestic properties will be required to achieve CSH level 4 (a 44% reduction in regulated CO_2 emissions from baseline).

Non-domestic properties will be required to achieve the corresponding CO2 reduction target of the CSB – a 40% CO_2 reduction with respect to baseline emissions (20% of which is achieved through energy efficiency measures).

All properties must also comply with the local 10% onsite CO_2 rule.

<u>**Results**</u>

The installed capacities of low carbon technologies required under the five low carbon energy strategies outlined in section five are presented in the graph below:

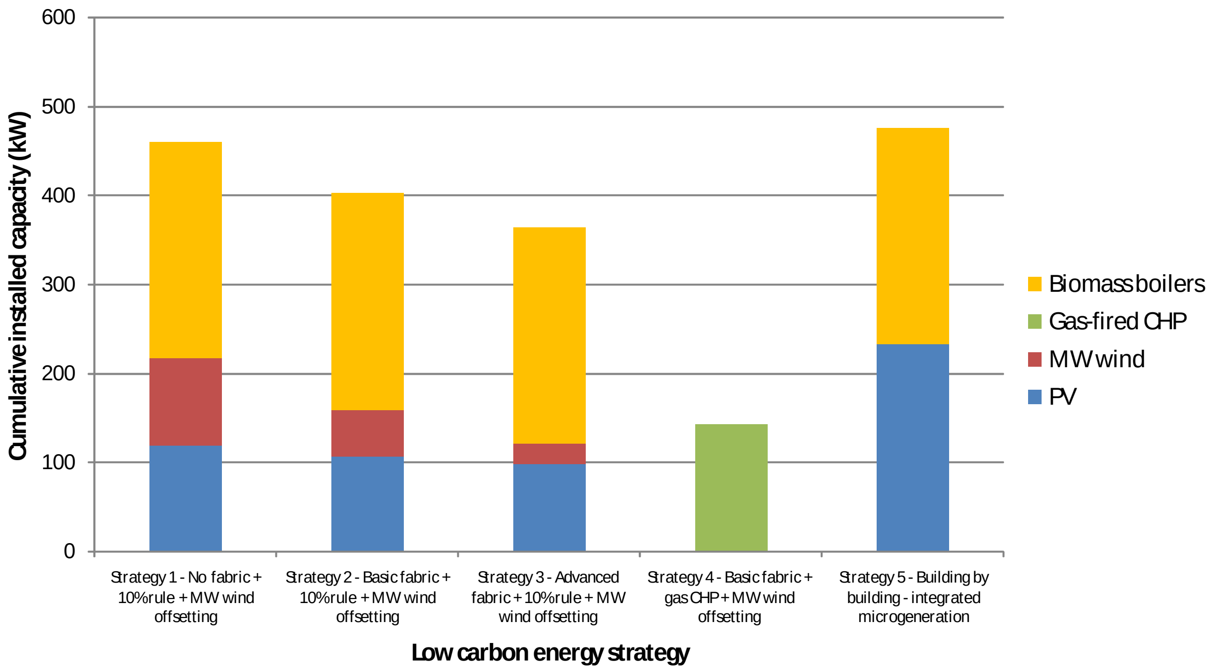


Figure 16 - *installed capacities of low carbon technologies required for a comprehensive range of low carbon energy strategies at West Marina. N.B: capacities are measured in kWe except for biomass boiler capacities which are measured in kWt.*

Deployment of the technology capacities required in Figure 16 will incur significant capital cost. The capital costs per technology and in total are presented in the graph below:

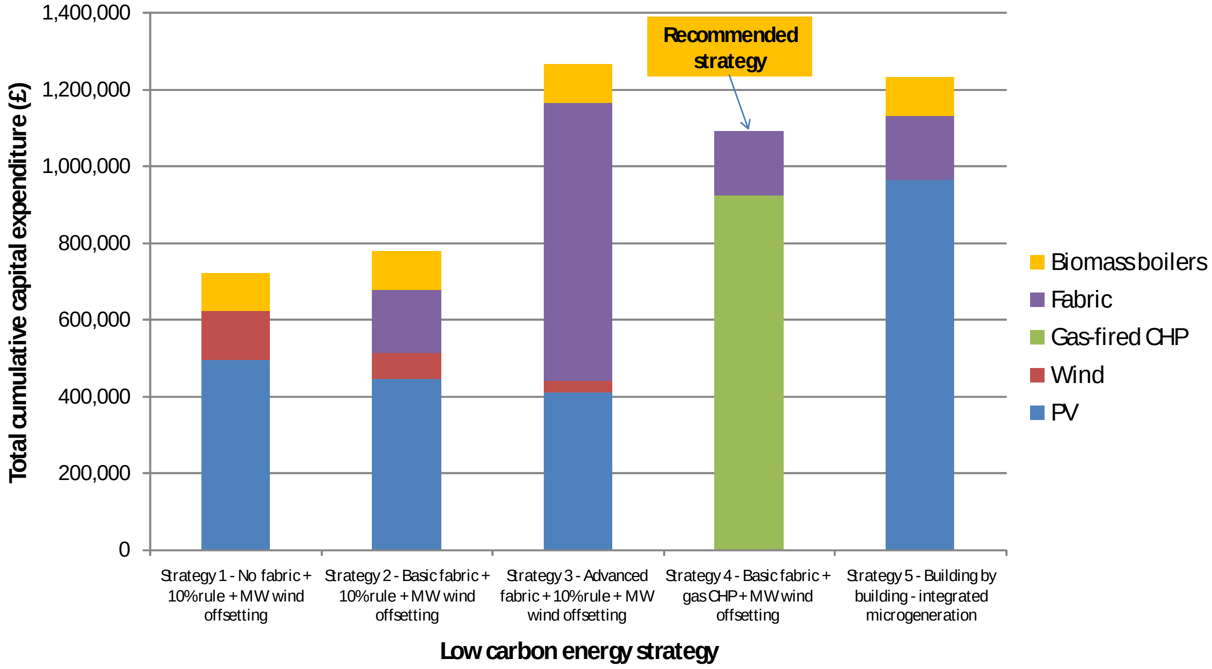


Figure 17 - *cumulative capital cost required to achieve mandatory CO_2 targets at West Marina.*

The graphs above indicate that:

1. Installing basic levels of fabric efficiency (to decrease baseline CO_2 emissions by 10%) does not increase capital costs significantly.

   However, advanced fabric measures e.g. heat recovery systems, are extremely expensive and exhibit lower cost effectiveness with respect to active renewable/low carbon micro-generation technologies such as PV and biomass boilers.

   Installation of basic levels of fabric improvements measures is therefore recommended.

2. Site-wide CHP/DH low carbon energy strategies become cheaper than building-by-building strategies at CSH level 4 (and associated CSB level). Only offsetting strategies (incorporating MW scale wind) are more cost effective. However, these offsetting strategies are subject to the limitations outlined in section 5.2. and should be avoided where possible.

Recommended low carbon energy strategy at West Marina

Site-wide natural gas-fired CHP/DH low carbon energy strategies are therefore recommended at CSH/CSB level 4. These strategies incorporate:

1. Basic levels of building thermal/fabric improvement measures (to reduce domestic baseline CO_2 emissions by ~10%)

2. Centralised natural gas-fired CHP engines connected to site-wide DH networks

Site-wide CHP strategies exhibit many advantages at CSH/CSB level 4.

Advantages

1. **Cost effectiveness**

   The strategy represents a cost effective method of achieving compliance with low carbon legislation at CSH/CSB level 4. Only carbon offsetting strategies incorporating MW scale wind turbines are more cost effective.

CHP/DH dominated strategies also have the following advantages at CSH/CSB level 4:

2. **MW scale wind carbon offsetting strategies are avoided**

   - Use of basic fabric measures and gas-fired CHP systems conserves the constrained Hastings MW scale wind resource. A significant installed capacity of MW scale wind will be required to offset carbon emissions and achieve CSH/CSB level 6 on later new build development sites (see next chapter).

   - Legislative complications regarding MW scale turbines and private wire systems are avoided.

3. **CHP/DH systems tackle heating derived CO_2 emissions directly**

   - CHP engines produce heat directly. This heat is distributed to domestic properties and non-domestic buildings through a site-wide DH network and used directly to meet building heating demands.

   - Offsetting low carbon energy strategies do not directly meet building heating demands.

4. **Deployment of DH networks at an early stage promotes flexibility in borough wide low carbon energy strategies**

   - The most cost effective low carbon energy strategies for attaining high CSH/CSB levels incorporate MW scale wind turbines and/or biomass-fired steam CHP engines and DH networks (see Figure 12 Chapter 4).

   - Installing natural gas-fired CHP engines and DH networks now means that gas engines can be replaced with biomass engines in the future as heat networks expand, effective heat demands placed upon the networks increase and higher CSH/CSB CO_2 reduction targets become mandatory in Hastings.

   - Wind dominated low carbon energy strategies do not offer this flexibility.

5. **Deployment of DH networks offers retrofit opportunities:**

   - Significant CO_2 savings can be made by extending DH networks - catalysed by new developments – into existing properties with higher heating loads. There are a number of excellent heating network retrofit opportunities in Hastings (see section 7.2).

Site-wide natural gas-fired CHP systems with DH are therefore recommended for achieving CSH/CSB level 4 on new build mixed land use development sites in Hastings.

Caveats

Site-wide CHP/DH systems may not be viable technically or economically on specific sites e.g. small residential sites. Alternative low carbon strategies must be considered – see section 5.6.

Conclusions

- MW scale wind carbon offsetting strategies are the most cost effective low carbon strategies at CSH/CSH level 4, but should be avoided as they:
    1. Tax the constrained borough MW wind resource – required at higher code levels
    2. Conflict with current CSH private wire legislation.
- Site-wide natural gas-fired CHP systems with DH networks become more cost effective than building by building low carbon energy strategies at CSH/CSB levels 4 and above and are recommended.
- These strategies incorporate:
    1. Basic levels of fabric efficiency improvement measures (10% CO_2 reduction from baseline – see previous chapter)
    2. Site-wide natural gas-fired CHP engines and DH networks.
- Deployment of natural gas-fired CHP and DH networks has a number of advantages:
    1. Relatively cost effective
    2. Avoids the use of MW scale wind carbon offsetting at low CSH/CSB code levels
    3. Tackles CO_2 emissions derived from building heating demands directly
    4. Promotes flexibility in the borough wide low carbon energy strategy – gas-fired engines can be replaced with biomass-fired engines quickly and easily to achieve higher CO_2 savings at more stringent CSH/CSB code levels
    5. Promotes opportunities for extending heating networks into the existing stock – see chapter 7.2

5.4. Breadsell Lane

Breadsell Lane is a mixed use development located in Ashdown.

The site incorporates:

- ~750 new build homes – with an approximate 2:1 split of houses to flats
- 10,000m^2 of new office floor space

Domestic properties will be required to achieve CSH level 6 (net zero carbon).

Non-domestic properties will be required to achieve the corresponding CO_2 reduction target of the CSB – a 100% CO_2 reduction with respect to baseline emissions (40% of which is achieved through energy efficiency measures).

All properties must also comply with the local 10% onsite CO_2 rule.

Results

The installed capacities of low carbon technologies required under the five low carbon energy strategies outlined in section 5 are presented in the graph below:

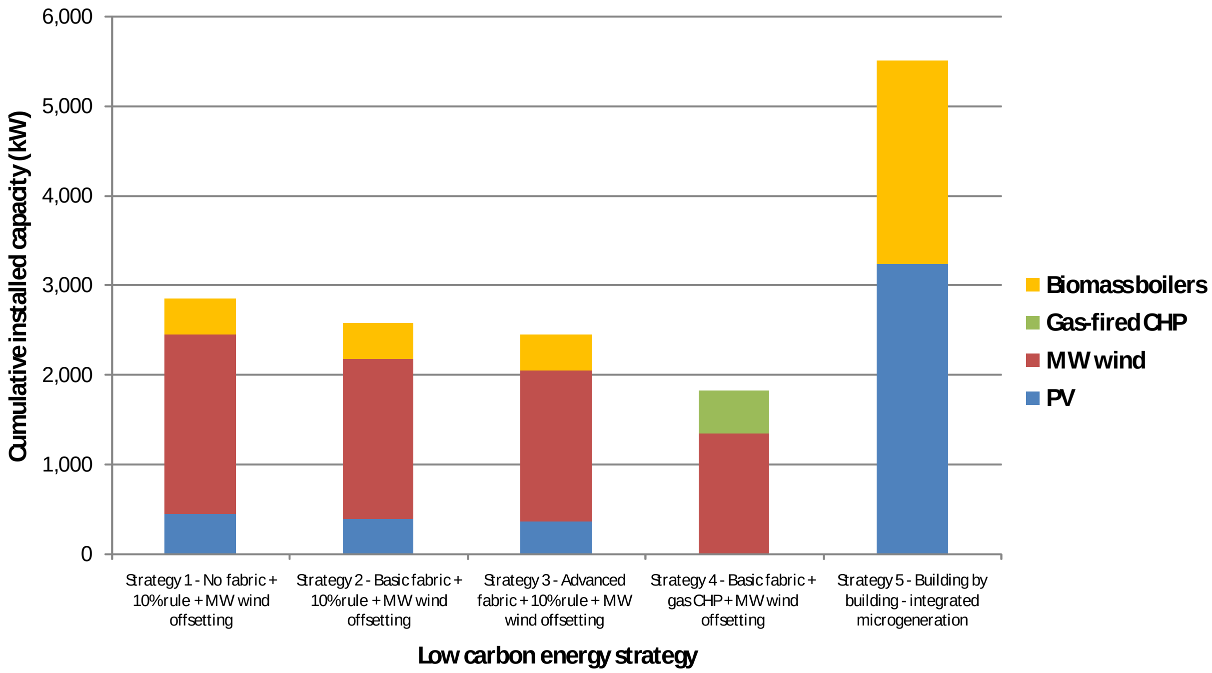


Figure 18 - *installed capacities of low carbon technologies required for a comprehensive range of low carbon energy strategies at Breadsell Lane. N.B: capacities are measured in kWe except for biomass boiler capacities which are measured in kWt.*

Deployment of the technology capacities outlined in figure 11 will incur significant capital cost. The capital costs per technology and in total are presented in the graph below:

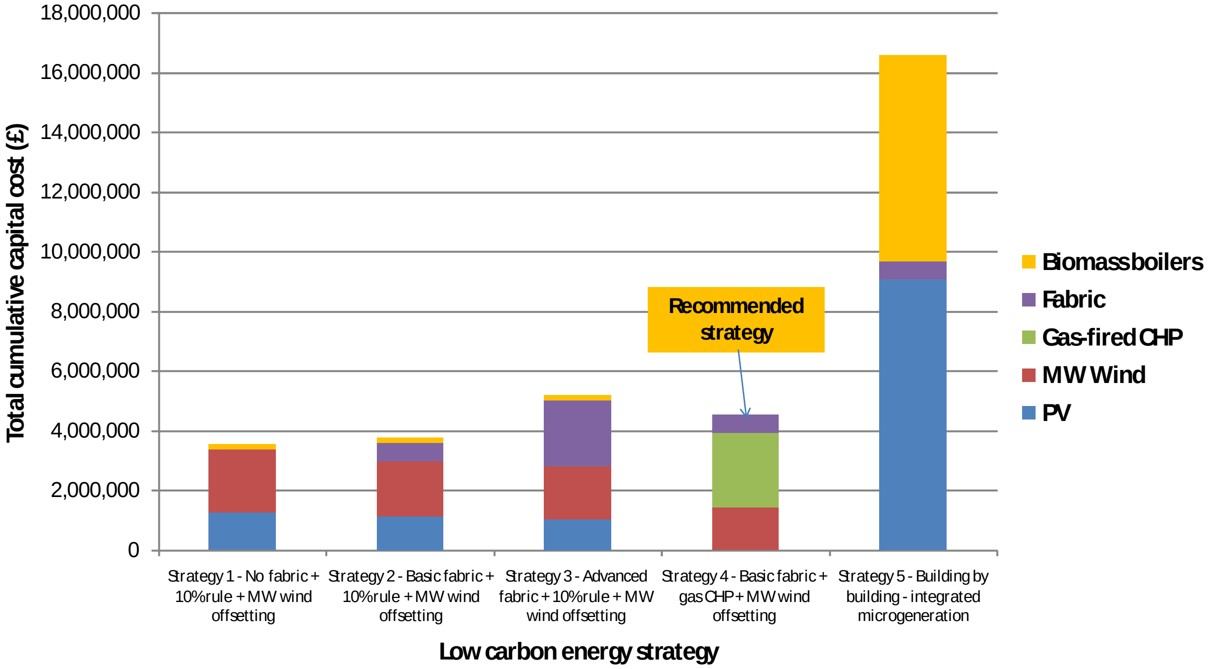


Figure 19 - *cumulative capital cost required to achieve mandatory CO_2 targets at Breadsell Lane.*

The graphs above indicate that:

1. Installing basic levels of fabric efficiency (to decrease baseline CO_2 emissions by 10%) does not increase capital costs significantly.

   However, advanced fabric measures e.g. heat recovery systems, are extremely expensive and exhibit lower cost effectiveness with respect to active renewable/low carbon micro-generation technologies such as PV and biomass boilers.

   Installation of basic levels of fabric improvements measures is therefore highly recommended.

2. Site-wide natural gas-fired CHP/DH low carbon energy strategies are far cheaper than building-by-building strategies at CSH/CSB level 6.

   Only offsetting strategies (incorporating MW scale wind) are more cost effective. However, these offsetting strategies are subject to the limitations outlined in section 5.2. and should be used only as a last resort.

   N.B: Application of basic fabric improvement measures and gas-fired CHP systems in isolation cannot facilitate compliance with CSH/CSB level 6. Some MW scale wind offsetting will be mandatory at the highest CSH/CSB code levels.

Recommended low carbon energy strategy at Breadsell Lane

Site-wide natural gas-fired CHP/DH low carbon energy strategies - supplemented with MW scale wind offsetting - are therefore recommended at CSH/CSB 6.

These strategies incorporate:

1. Basic levels of building thermal/fabric improvement measures (to reduce domestic baseline CO_2 emissions by ~10%)

2. Centralised natural gas-fired CHP engines connected to site-wide DH networks

3. MW scale wind offsetting of any remaining CO_2 emissions.

Advantages

Site-wide CHP strategies exhibit many advantages at CSH level 6 (and the associated CSB level). These advantages are identical to those laid out in full in section 5.3.

Site-wide CHP systems with DH and some supplementing MW scale wind offsetting are therefore recommended for achieving CSH/CSB level 6 on new build mixed land use development sites in Hastings.

Conclusions

- MW scale wind carbon offsetting strategies are the most cost effective low carbon strategies at CSH 6 (and the associated CSB level), but should be avoided as far as possible as they:

    1. Tax the constrained borough MW wind resource

    2. Conflict with current CSH private wire legislation.

- Site-wide natural gas-fired CHP systems with DH networks will be far more cost effective than building by building low carbon energy strategies at CSH levels 6 (and associated CSB level) and are recommended for the mixed use new developments in Hastings required to achieve CSH/CSB level 6.

- These systems cannot however facilitate compliance with CSH/CSB level 6 in isolation – some level of MW scale wind carbon offsetting will be required.

- The recommended low carbon strategies for mixed use new build developments in Hastings at the highest CSH/CSB code levels will therefore incorporate:

    1. Basic levels of fabric efficiency improvement measures (10% CO_2 reduction from baseline – see previous chapter)

    2. Site-wide natural gas-fired CHP engines producing heat and electricity.

    3. MW scale wind carbon offsetting of remaining emissions

- Deployment of natural gas-fired CHP and DH networks has a number of advantages:

    1. Highly cost effective

    2. Avoids the use of MW scale carbon offsetting at low CSH/CSB code levels

    3. Tackles CO_2 emissions derived from building heating demands directly

    4. Promotes flexibility in the borough wide low carbon energy strategy – gas-fired engines can be replaced with biomass-fired engines quickly and easily to achieve higher CO_2 savings

    5. Promotes opportunities for extending heating networks into the existing stock – see chapter 7.2

5.5. Priory Quarter

Priory quarter is a large non-residential development located in Castle, central Hastings.

The site plans incorporate:

- ~32,000m^2 of new office floor space
- ~18,000m^2 of university floors space

The developmental will be built in a series of phases over the next 10-15 years. Much of the non-domestic floor space will therefore be required to achieve the highest standards of the CSB – a 100% CO_2 reduction with respect to baseline emissions (40% of which is achieved through energy efficiency measures).

The development must also comply with the local 10% onsite CO_2 rule.

Results

The installed capacities of low carbon technologies required under the relevant low carbon energy strategies outlined in section 5.1 are presented in the graph below:

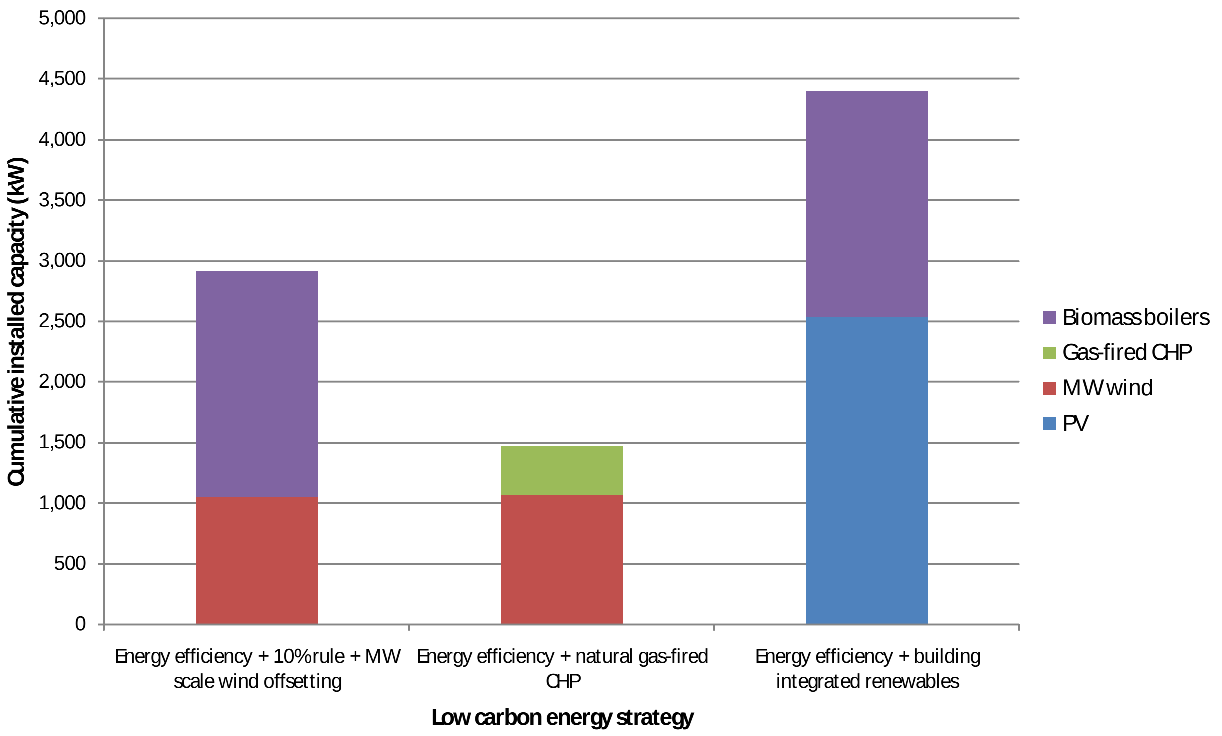


Figure 20 - *installed capacities of low carbon technologies required for a comprehensive range of low carbon energy strategies at Priory Quarter. N.B: capacities are measured in kWe except for biomass boiler capacities which are measured in kWt.*

Deployment of the technology capacities required in Figure 20 will incur significant capital cost. The capital costs per technology and in total are presented in the graph below:

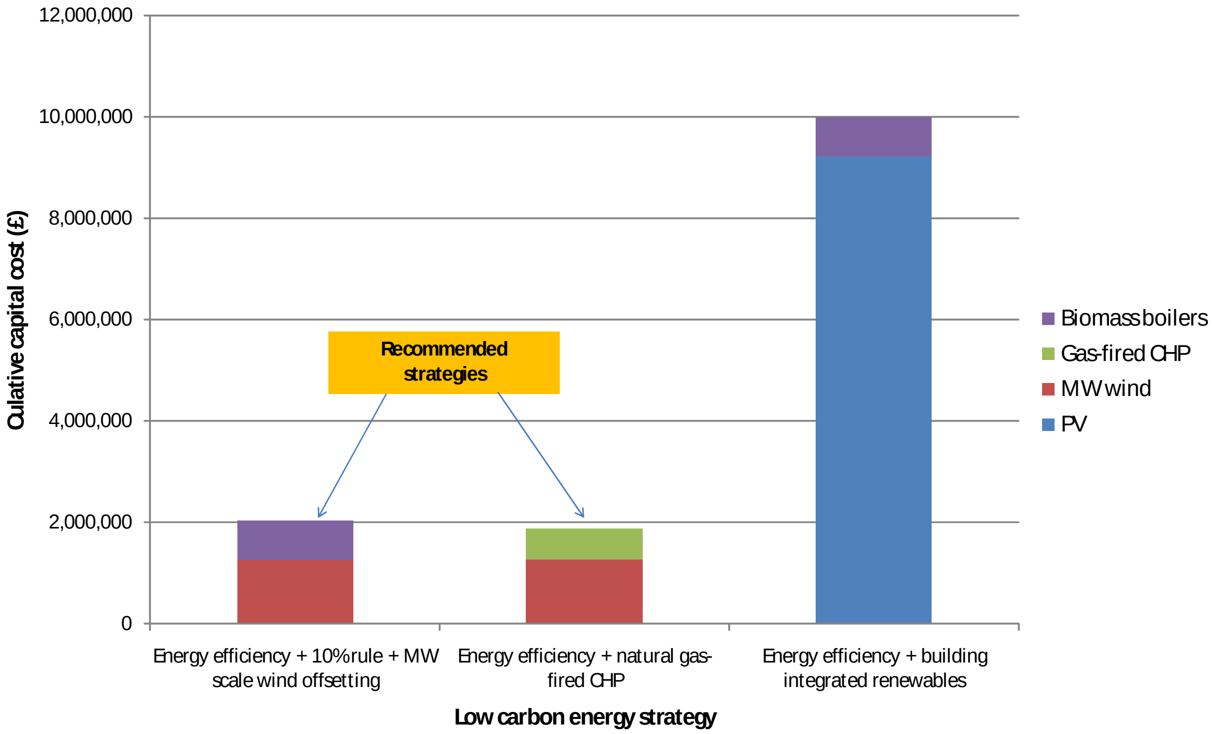


Figure 21 - *cumulative capital cost required to achieve mandatory CO_2 targets at Priory Quarter. N.B: The capital costs associated with improved fabric efficiency are not shown – no suitable information available.*

The graphs above indicate that:

1. Site-wide natural gas-fired CHP/DH and biomass boiler low carbon energy strategies supplemented with MW scale wind CO_2 offsetting are far cheaper than building-by-building strategies at CSB level 6. The two strategies incur approximately the same capital cost.

2. Application of energy efficiency improvement measures and natural gas-fired CHP systems or biomass boilers cannot facilitate compliance with CSB level 6 in isolation. Some MW scale wind offsetting will be mandatory.

Recommended low carbon energy strategy at Priory Quarter

Site-wide natural gas-fired CHP/DH or biomass boiler low carbon energy strategies supplemented with MW scale wind offsetting are recommended at the highest CSB levels in non-domestic properties. These strategies incorporate:

1. Basic levels of energy efficiency improvement measures
2. Centralised natural gas-fired CHP engines or biomass boilers connected to site-wide DH networks
3. MW scale wind offsetting of any remaining CO_2 emissions.

These low carbon energy strategies exhibit many advantages at the highest CSB levels.

Advantages

1. **Cost effectiveness**

   The strategies represent the most cost effective methods of achieving compliance with low carbon legislation in the non-domestic sector.

2. **Deploying biomass boilers/natural gas-fired CHP systems reduces the amount of MW scale wind carbon offsetting required**

   - Installing gas-fired CHP systems or biomass boilers reduces site heating demands and conserves the constrained MW scale wind resource.
   - Legislative complications regarding MW scale turbines and private wire systems are avoided – as noted previously.

3. **CHP/DH systems and biomass boilers tackle heating derived CO_2 emissions directly**

   - CHP engines and biomass boilers produce heat directly. This heat is distributed site buildings through a site-wide DH network and used directly to meet building heating demands.
   - Offsetting low carbon energy strategies do not directly meet building heating demands.

4. **Deployment of DH networks offers retrofit opportunities**

   - Significant CO_2 savings can be made by extending DH networks - catalysed by new developments – into existing properties with higher heating loads. There are a number of excellent heating network retrofit opportunities in Hastings (see section 7.2).
   - Site-wide natural gas-fired CHP systems or biomass boilers with DH and some degree of MW scale wind offsetting are therefore recommended for achieving the highest CSB code levels on new build development sites in Hastings.

Conclusions

- Site-wide natural gas-fired CHP systems or biomass boilers linked to DH networks represent the lowest cost of compliance with low CSB levels and the 10% onsite CO_2 rule and are highly recommended.
- At the highest CSB levels MW scale wind carbon offsetting will be required.
- The recommended low carbon strategies for non-domestic new build developments in Hastings at the highest CSB code levels will therefore incorporate:
    1. Basic levels of fabric efficiency improvement measures (in line with CSB legislation)
    2. Site-wide natural gas-fired CHP engines or biomass boilers connected to DH networks
    3. MW scale wind carbon offsetting
- Deployment of these low carbon energy strategies has a number of positive advantages:
    1. Highly cost effective
    2. Avoids the use of MW scale carbon offsetting at low CSH/CSB code levels
    3. Tackles CO_2 emissions derived from building heating demands directly
    4. Promotes opportunities for extending expanding heating networks into the existing stock, facilitating further CO_2 savings – see chapter 7.2

5.6. Small residential sites – Springfield Valley

Many new build residential developments in Hastings will be small scale and result from either infilling on brown-field sites, or subdivision of the existing housing stock.

One example of such a site is Springfield Valley (housing site D13). Only 10 new flats are planned for the site.

The low carbon options available to such a small site are extremely limited. The sites are likely to be too small and disjointed to make any sort of site wide DH system commercially viable.

The most feasible low carbon energy strategies are likely to be:

1. **Dwelling by dwelling low carbon energy strategies**
   - Fabric measures and building integrated renewables are used to attain the required CSH and local planning low carbon targets.
   - Previous analysis indicates that a level of fabric which decreases house CO_2 emissions by 10% from baseline is highly feasible and cost effective.
2. **Carbon offsetting strategies**
   - Fabric efficiency measures are used as above.
   - PV is applied to facilitate compliance with the 10% onsite CO_2 rule (~0.5kWe per dwelling).
   - MW scale wind turbines are used to offset the remaining carbon emissions of the dwellings.

We will now explore the relative cost of using these strategies to achieve CSH levels 3, 4 and 6 and compliance with the local 10% onsite CO_2 rule for a site such as Springfield Valley.

<u>CSH 3</u>

Application of basic fabric improvement measures and enough PV to facilitate compliance with the 10% onsite CO_2 rule facilitates automatic compliance with the CSH 3 carbon reduction target (25% reduction in regulated emissions). No wind offsetting is required.

The capital costs incurred by this strategy are presented in the graph below:

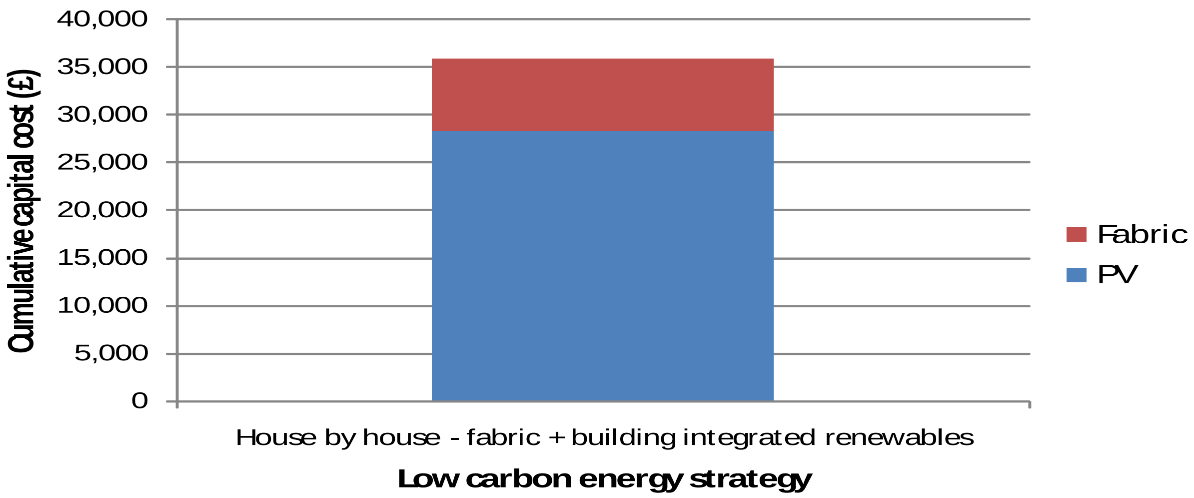


Figure 22 - *cumulative capital cost required to achieve site-wide compliance with CSH 3 at a small residential site like Springfield Valley.*

The necessity to comply with the 10% onsite CO_2 rule constrains and shapes the appropriate low carbon energy strategy at CSH 3.

Compliance with the 10% onsite CO_2 rule is likely to cost ~£3,000-£4,000 per dwelling.

CSH 4

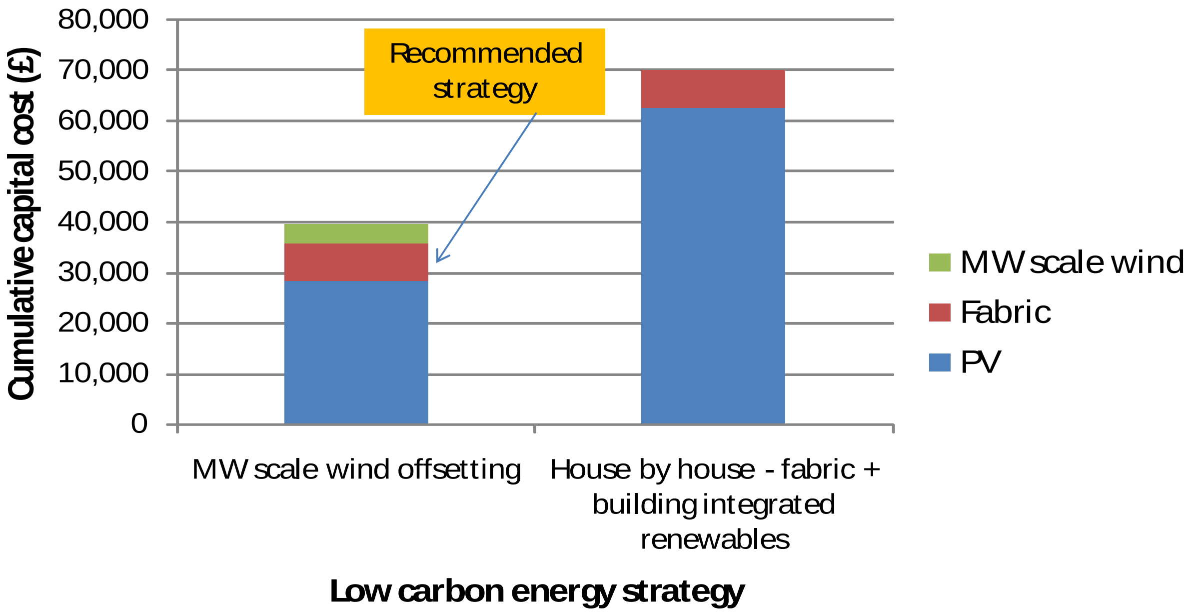


Figure 23 - *cumulative capital costs required to achieve CSH 4 at a small residential site like Springfield Valley.*

By CSH level 4 dwelling by dwelling low carbon energy strategies become extremely expensive (~£7,000 per dwelling) as large installed capacities of expensive PV are required (~1kWe per dwelling).

MW scale wind offsetting strategies become far more cost effective (~£4,000 per dwelling) and are likely to be strongly preferred by developers, if technically feasible.

CSH 6

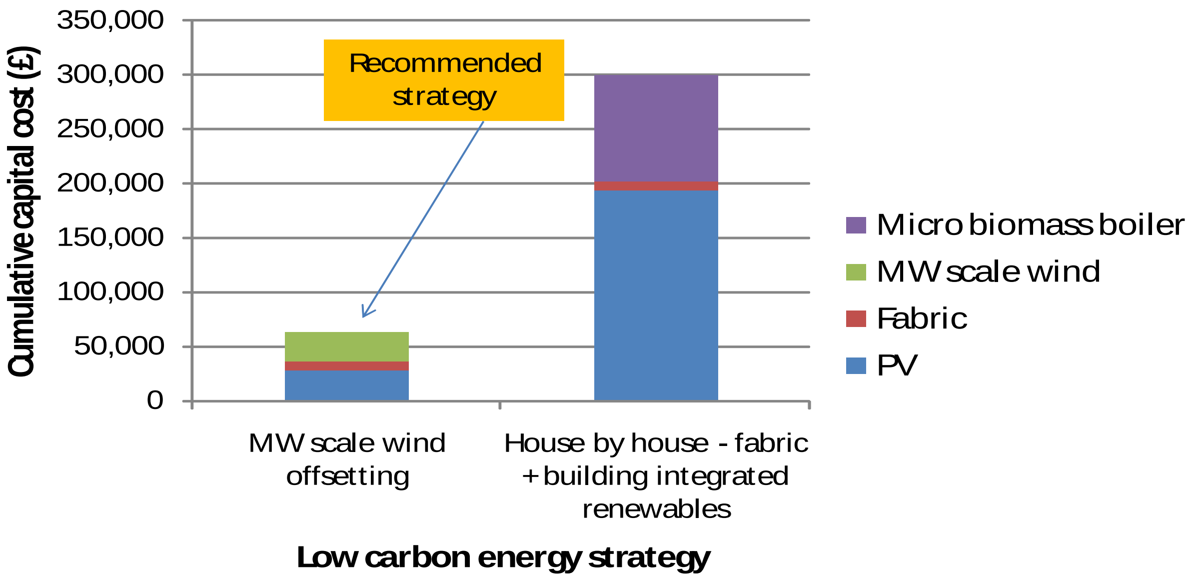


Figure 24 - *cumulative capital costs required to achieve CSH 6 at a small residential site like Springfield Valley.*

By CSH level 6 dwelling by dwelling low carbon energy strategies are prohibitively expensive (~£30,000 per dwelling) as domestic micro-biomass boilers and large installed capacities of expensive PV are required to achieve the required carbon reduction target.

MW scale wind offsetting strategies represent 1/5 of the cost of dwelling by dwelling low carbon energy strategies (~£6,000 per dwelling) and are likely to be strongly preferred by developers.

It is strongly recommended that developers of small residential sites required to meet CSH levels 4 and above be allowed to make use of MW scale wind carbon offsetting (having complied with the 10% onsite CO_2 rule).

Developers could be allowed to buy-out of their low carbon obligations on a specific site by making financial contributions to a low carbon buy-out fund administered by Hastings Borough Council. The capital in this fund would then be used to promote large CO_2 savings elsewhere in the Hastings borough – see chapter 8.2).

Conclusions

- For CSH levels above 3, MW scale wind carbon offsetting strategies will be cheaper than building by building low carbon energy strategies for small residential developments
- By CSH 6 dwelling by dwelling low carbon energy strategies are prohibitively expensive and could hinder or even halt development on small new build domestic sites.
- Small domestic developments required to achieve CSH levels 4 or above should :
    1. Install basic fabric performance improvements (targeting a 10% reduction in CO_2 emissions from baseline)
    2. Install enough PV to allow compliance with the 10% onsite CO_2 rule
    3. Offset further CO_2 emissions using remote MW scale wind offsetting
- Developers could be allowed access to a local low carbon buy-out fund. Capital contributions to the fund would be used to facilitate more cost effective CO_2 savings elsewhere in the Hastings borough.

5.7. Conclusions – Hastings preferred low carbon technology dispatching strategy

Appropriate and viable low carbon energy strategies have now been formulated for a representative sample of the new build sites planned in the Hastings borough. Interrogation of the nature of these strategies leads to the following higher level conclusions:

3. Carbon offsetting strategies (using MW scale wind turbines) are often the most cost effective means of achieving low carbon CSH/CSB targets.

   However, since these strategies have practical deployment limitations within the Hastings borough, they should be avoided at low CSH/CSB code levels:

   - They place a strain on the limited local MW wind resource
   - They evoke complications with regard to current CSH private wire legislation

4. The most appropriate and recommended low carbon energy strategies in Hastings are therefore those which **minimize the requirement for regional MW scale wind carbon offsetting whilst incurring the minimal capital cost.**

A preferred low carbon technology dispatching strategy can be defined for all new build development sites in the Hastings borough which observes this maxim:

CSH/CSB level 3

At this level offsetting strategies can be avoided at minimal capital cost by:

- Applying basic levels of thermal/fabric performance improvements to buildings

  Analysis indicates that a level of fabric improvement which promotes ~10% reduction in baseline CO_2 emissions is cost effective and highly feasible in domestic properties. This level of fabric improvement is highly recommended.

  The levels of fabric improvement required of non-domestic properties are contained within the assumed targets of the CSB.

- Applying building integrated renewables to allow compliance with the local onsite 10% CO_2 rule:

  Analysis indicates that the lowest cost compliance methods are:

  1. Application of ~0.5kWe of PV per domestic property
  2. Installation of biomass boilers in non-domestic properties

This combination of basic fabric measures and renewables allows compliance with the 10% onsite CO_2 rule and CSH/CSB level 3 carbon reduction targets at minimal cost, without resorting to MW scale wind carbon offsetting.

Application of basic levels of fabric improvements also has further advantages:

1. Domestic building designs are future-proofed against changes in CSH legislation
2. Decreased consumption of natural resources and fuel bills for end users

CSH/CSB level 4

At this level offsetting strategies can be avoided at minimal capital cost by:

- Applying basic levels of thermal/fabric performance improvements to buildings
- Deploying natural gas-fired CHP engines connected to DH networks on appropriate and technically feasible sites[10]

This combination of basic fabric measures and clean energy generation allows compliance with the 10% onsite CO_2 rule and CSH/CSB 4 carbon reduction targets at minimal cost, without resorting to MW scale wind carbon offsetting.

Deployment of natural gas-fired CHP systems also has many advantages over turning to MW scale wind carbon offsetting strategies:

1. CHP/DH systems tackle heating derived CO_2 emissions directly
2. Deployment of DH networks at an early stage promotes flexibility in borough wide low carbon energy strategies – upgrade to biomass CHP is simple and could facilitate greater cost effective CO_2 savings
3. DH networks can be extended to existing properties to promote further cost effective CO_2 savings.

CSH/CSB level 6

At the most onerous CSH/CSB level, carbon offsetting strategies cannot be avoided – some MW scale wind capacity will be required.

The capacity of MW scale wind required can however be minimized by initially following the low carbon technology strategies outlined at CSH/CSB level 4. Remaining carbon emissions can then be offset using MW scale wind turbines.

N.B There is no central government target date for CSH level 5. Preferred low carbon energy strategies at CSH/CSB level 5 would be similar to those presented above for CSH/CSB level 6, but would require less MW scale wind carbon offsetting.

[10] Site-wide natural gas-fired CHP/DH systems are not appropriate for very small domestic developments (<100 homes). Where these sites are required to meet CSH levels 4 and above, developers should follow the low carbon energy strategies outlined for CSH level 3 and then be allowed to offset their remaining CO2 emissions using MW scale wind.

6. HASTINGS BOROUGH PREFERRED LOW CARBON ENERGY STRATEGY

Application of the preferred low carbon technology dispatching strategy outlined at the end of the previous chapter could allow the Hastings borough to achieve its national CO_2 reduction obligations. However, meeting these low carbon targets will require deployment of large capacities of low carbon energy generation technologies and will incur significant capital costs. For clarification, significant costs will be incurred to meet national energy related legislation, and extra costs may be incurred to meet the local planning target.

6.1. Preferred low carbon dispatching strategy – installed low carbon technology capacities

The graph below shows the installed capacities of low carbon technologies which will be required in Hastings, if the preferred dispatching strategy is followed.

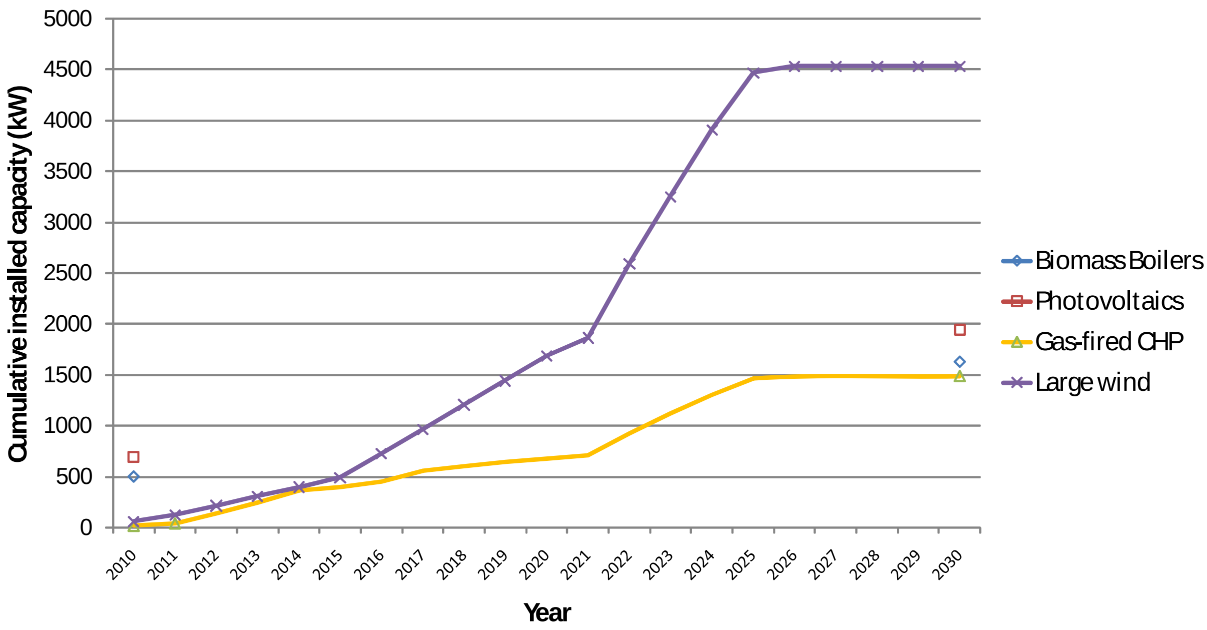


Figure 25 - *installed capacities of low carbon technologies required in Hastings under the preferred technological dispatching strategy. All capacities are presented in kWe (except biomass boilers – presented in kWt). Basic fabric improvements are not presented on the graph.*

The graph indicates:

1. ~1.5MWt of installed biomass boiler capacity will be required in Hastings by 2030. This capacity is mostly installed in non-domestic properties required to meet low CSB levels pre-2016.

2. ~1.5MWe of installed gas-fired CHP engines will be required. There are no viable opportunities for biomass-fired CHP systems on the new build development sites in Hastings.

3. A significant capacity of PV is envisaged. This capacity arises as a consequence of the 10% onsite CO_2 rule. Installing ~0.5kWe of PV is the cheapest method of attaining compliance with the 10% target in large numbers of domestic properties.

4. A substantial capacity of regional MW scale wind capacity will be essential (~4-5MWe). This capacity will be required to offset the CO_2 emissions of properties which are required to attain the highest CSH and CSB standards (net zero carbon developments).

   Despite modelling a low carbon technology dispatching strategy which was designed to minimize the requirement for regional MW scale wind carbon offsetting, a significant capacity of installed MW scale wind will nevertheless be required in the Hastings borough.

6.2. Preferred low carbon dispatching strategy – low carbon technology capital costs

Application of the technology capacities outlined above is predicted to incur the following additional capital costs (over Part L 2006):

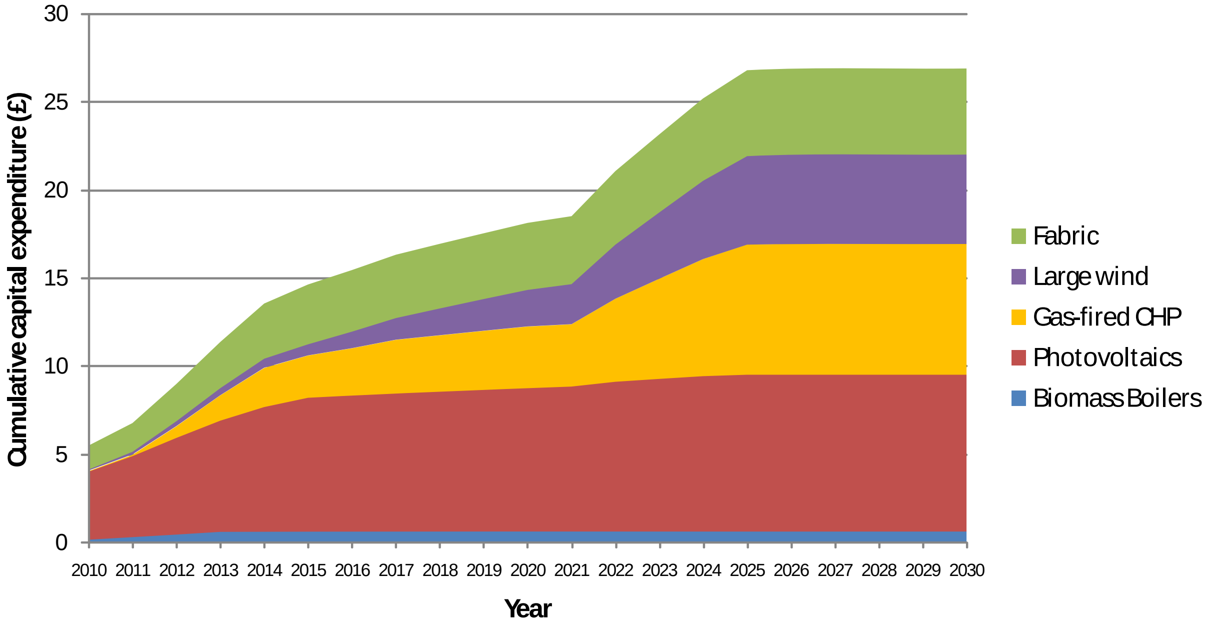


Figure 26 - *cumulative capital cost of technologies installed under a preferred low carbon technology dispatching strategy*

The capital cost of technologies deployed on new build development sites under the preferred low carbon technology dispatching strategy is significant ~£27M

A large fraction of this capital cost results from the 10% onsite CO_2 rule. The application of PV in large numbers of domestic properties incurs a cost of ~£8M – 30% of the total technological expenditure.

It should be noted that compliance with the 10% onsite CO_2 rule will be intrinsically expensive in domestic dwellings (~£4,000 per dwelling).

Despite the fact that MW scale turbines represented the largest installed kW capacity, the capital cost of the installed turbines is only £5M (<20% of the total technology capital expenditure). This underlines the cost effective nature of MW scale turbines in appropriate locations.

6.3. Preferred low carbon dispatching strategy - biomass fuel demand

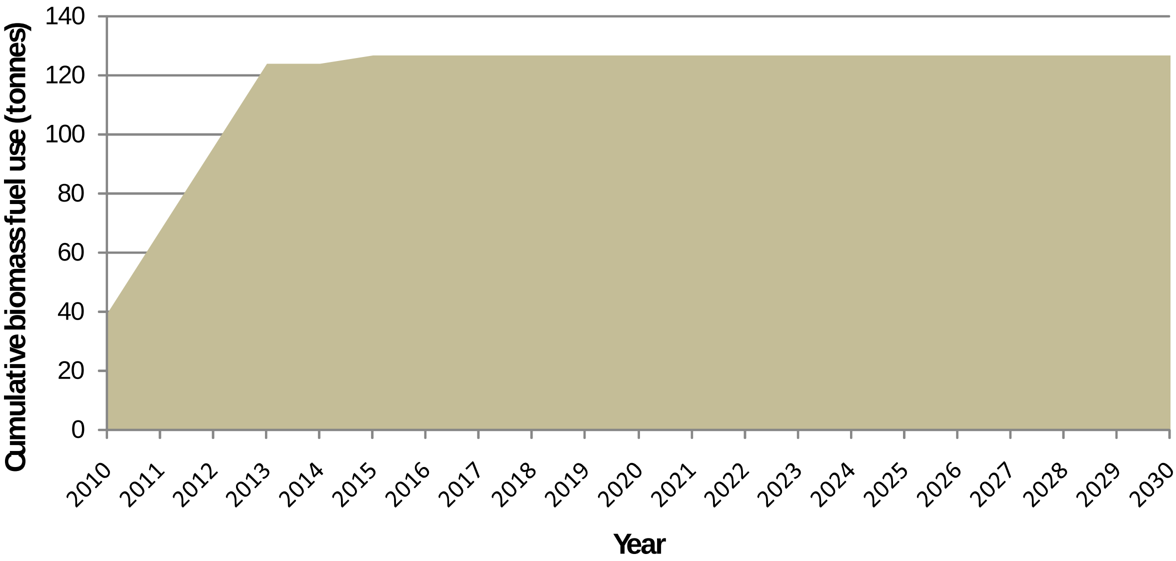


Figure 27 – projected *annual Hastings borough biomass fuel demand - under the preferred technology dispatching strategy.*

The annual biomass heating fuel demand of the Hastings borough under the preferred dispatching strategy is projected to be a little over 120tonnes/yr by 2030. This demand is very low and reflects the fact that there is a lack of opportunities for viable biomass fired CHP on the new build development sites planned in Hastings (at current levels of technology).

All biomass fuel demand is derived from biomass boilers operating in non-domestic properties.

This level of demand can easily be met using local biomass sources (see GIS resource mapping – chapter 7.3).

6.4. Preferred low carbon dispatching strategy - conclusions

- The preferred low carbon energy dispatching strategy will require significant capacities of:

  1. PV

  Installation of PV facilitates compliance with the 10% onsite CO_2 rule at minimal capital cost in a large number of domestic properties.

  The capital cost of PV will represent a large fraction (~30%) of the total capital expenditure on low carbon technologies.

  2. Natural gas-fired CHP

  There are no viable opportunities for “good-quality” biomass-fired CHP on the new build development sites in Hastings. Natural-gas fired CHP systems allow cost effective CO_2 savings to be made without recourse to MW scale wind carbon offsetting strategies and straining the constrained borough MW wind resource.

  3. MW scale wind

  Despite modelling a low carbon technology dispatching strategy which attempted to minimize the requirement for MW scale wind carbon offsetting, a significant capacity of installed MW scale wind capacity will nevertheless be required within the Hastings borough (~4-5MWe) to facilitate compliance with the highest CSH/CSB code levels.

- The lack of viable opportunities for biomass-fired CHP systems in Hastings means that the projected demand for biomass fuel is likely to be low ~120tonnes/yr

6.5. Variation analysis 1 – no CHP/DH

The projected technology mix, capital costs and biomass fuel demands could be changed dramatically if certain borough wide variables are altered. This variation examines the effect of developers failing to install any CHP engines or DH networks in the borough.

No CHP/DH - Technology deployment mix

The graph below shows the installed capacities of low carbon technologies which will be required in Hastings, if developers fail to install any CHP/DH systems:

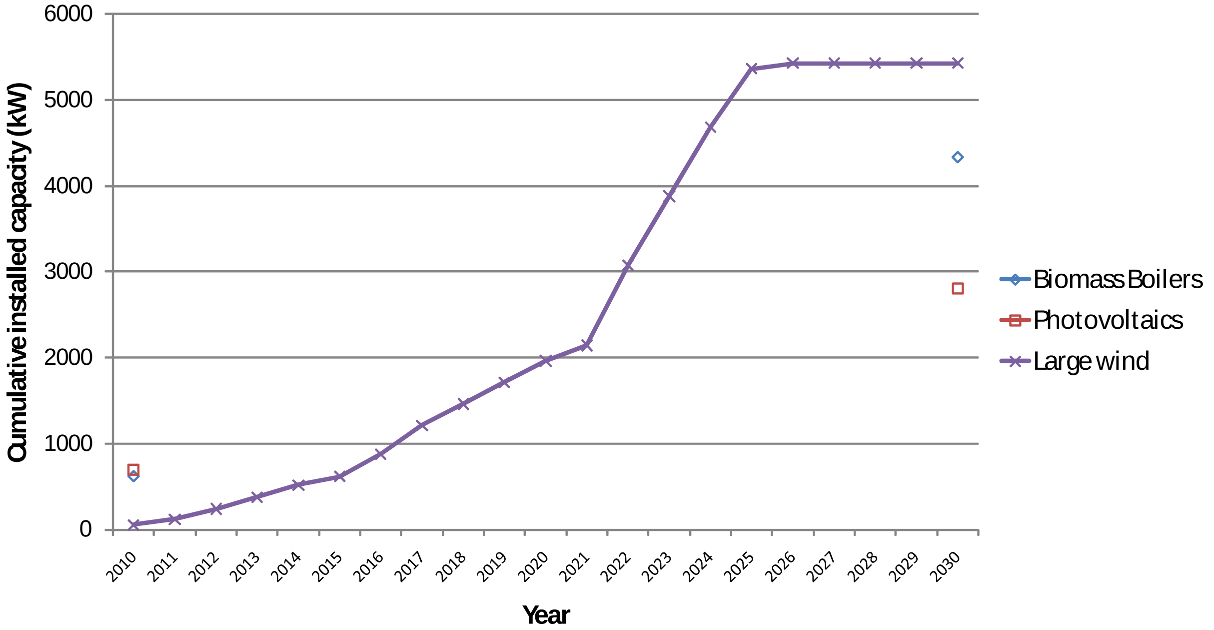


Figure 28 - *installed capacities of low carbon technologies required in Hastings if no CHP/DH systems are installed/viable. All capacities are presented in kWe (except biomass boilers – presented in kWt). Basic fabric improvements are not presented on the graph.*

The technology mix changes considerably if no CHP/DH systems are installed on the new build sites in Hastings:

1. The required capacity of regional MW scale wind required increases by 1MWe to a total of 5.5MWe.

2. Projected PV capacities increase by ~40%. In the preferred dispatching strategy, the installation of natural gas-fired CHP systems allowed domestic properties on a site to comply automatically with the 10% onsite CO_2 rule. In this variation ~0.5kWe of PV is required to facilitate this compliance at minimal capital expenditure in large numbers of domestic properties.

3. The projected capacity of biomass boilers approximately trebles. Biomass boilers represent the cheapest cost of compliance with the 10% onsite CO_2 rule in non-domestic properties. With no site-wide CHP/DH systems installed, biomass boilers are deployed.

No CHP/DH - Technology capital costs

Installation of the technology capacities outlined above will incur significant capital costs:

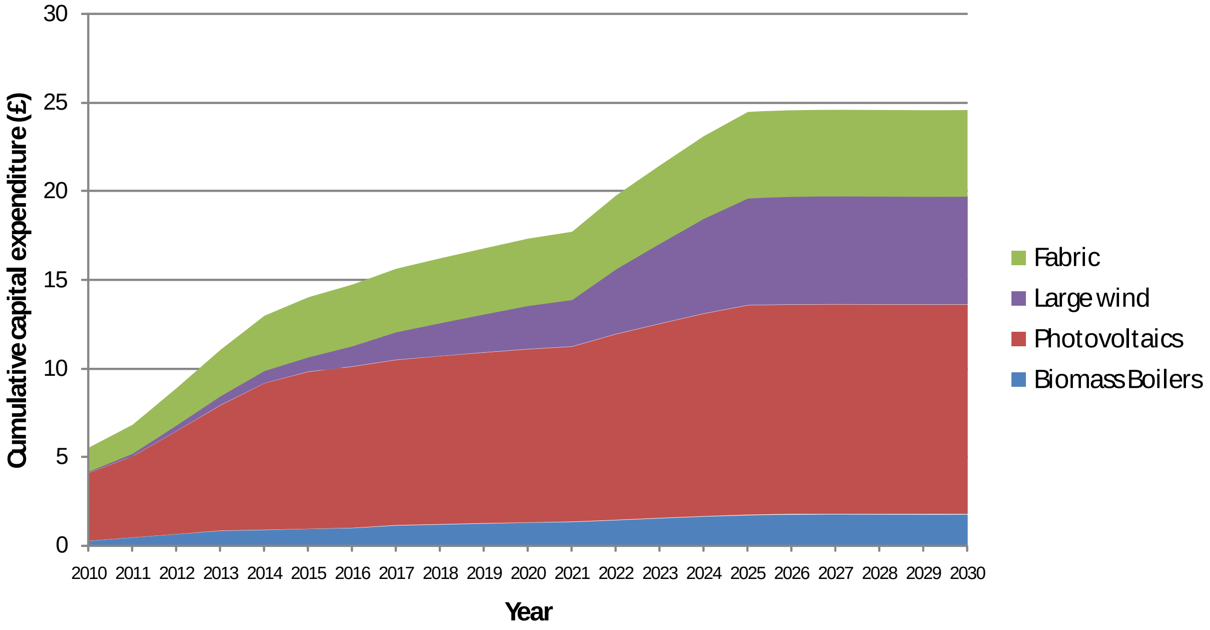


Figure 29 - *cumulative capital cost of technologies installed in Hastings if developers fail to deploy any CHP/DH systems*

The capital cost of technologies deployed is marginally lower relative to the preferred low carbon technology dispatching strategy ~ £25M compared to an initial £27M. This reflects the high cost effectiveness of MW scale wind turbines which are installed to offset most of the CO_2 emissions previously tackled by the CHP/DH systems.

An even larger fraction of this capital cost results from the 10% onsite CO_2 rule. The application of PV in large numbers of domestic properties incurs a cost of ~£12M – 50% of the total technological expenditure.

No CHP/DH - Biomass fuel demand

The graph below shows the projected biomass fuel demand under this variation:

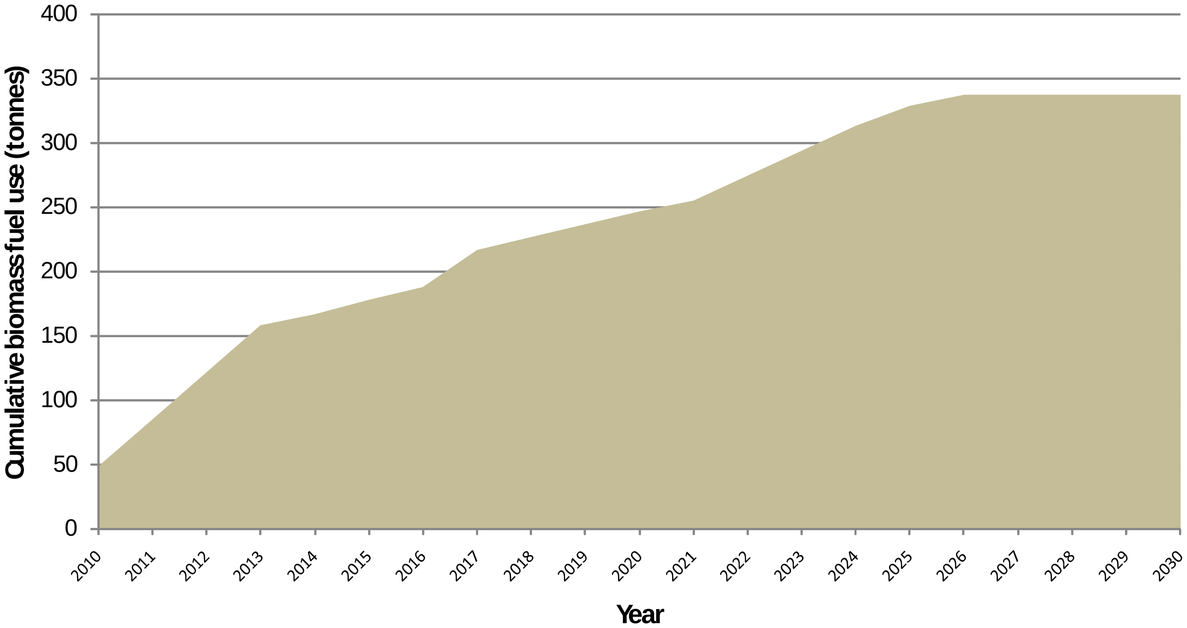


Figure 30 - *annual Hastings borough biomass fuel demand - under the preferred technology dispatching strategy.*

Biomass fuel demand increases in proportion with non-domestic biomass boiler deployment.- trebling to ~350tonnes/yr by 2030.

No CHP/DH - Conclusions

- If developers fail to deploy any CHP/DH systems on the new build developments in Hastings then the low carbon technological deployment mix will be dramatically altered:

  1. PV

  Under the preferred low carbon technology dispatching strategy, natural gas-fired CHP/DH systems facilitated compliance with the 10% onsite CO_2 rule. Without these strategies PV arrays must be deployed to facilitate compliance.

  The required installed PV capacity increases by ~40%

  The cost of PV installation comprises 50% of the total capital expenditure on low carbon technologies.

  2. Biomass boilers

  Increased capacities of biomass boilers are required to facilitate compliance with the 10% onsite CO_2 rule at minimal capital expenditure in non-domestic properties.

  The projected borough wide annual biomass fuel demand increases to ~350tonnes/yr. This demand will strain locally sourced biomass resources – see GIS resource mapping, section 7.3.

  3. MW scale wind

  An increased capacity of regional MW scale wind turbines is required (~5-6MWe) to offset the CO_2 emissions previously tackled by the CHP/DH systems.

  The overall capital cost of compliance with low carbon legislation in Hastings is similar to that required under the preferred low carbon technology dispatching strategy. However, the increased reliance on MW scale wind offsetting will tax the constrained borough MW scale wind resource – see GIS resource mapping, section 7.1.

6.6. Variation analysis 2 – No MW scale wind offsetting

In this variation no MW scale wind capacity can be installed in the region.

No MW scale wind offsetting – technology mix

The graph below shows the installed capacities of low carbon technologies which will be required in Hastings if no MW scale wind turbines can be installed:

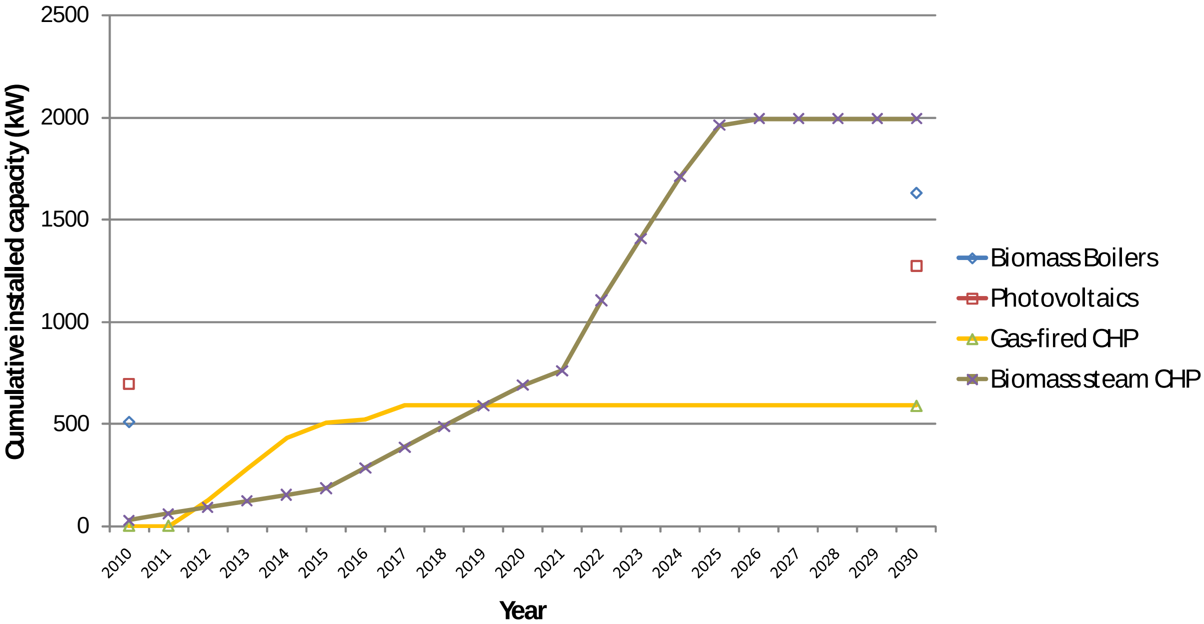


Figure 31 - *installed capacities of low carbon technologies required in Hastings if no MW scale wind capacity is available. All capacities are presented in kWe (except biomass boilers – presented in kWt). Basic fabric improvements are not presented on the graph.*

With no MW scale wind carbon offsetting, the only cost effective means of achieving the highest CSH/CSB code levels is deployment of biomass steam CHP engines (~2MWe) and DH networks.

As noted earlier, there are no viable opportunities – on planned new build sites – for good quality biomass CHP in Hastings. As such, installed biomass steam CHP engines would need to be electrically led, significantly oversized and run in heat dumping mode. Engines could be required to produce as much as 3-4 times as much heat as a site can feasibly use. This heat would be dumped to the atmosphere.

There is a small observed decrease in natural gas-fired CHP capacities, as biomass steam CHP engines replace gas engines on sites required to achieve high CSH/CSB code levels.

No MW scale wind offsetting – technology capital costs

Installation of the capacities of low carbon technologies outlined above will incur the following capital costs:

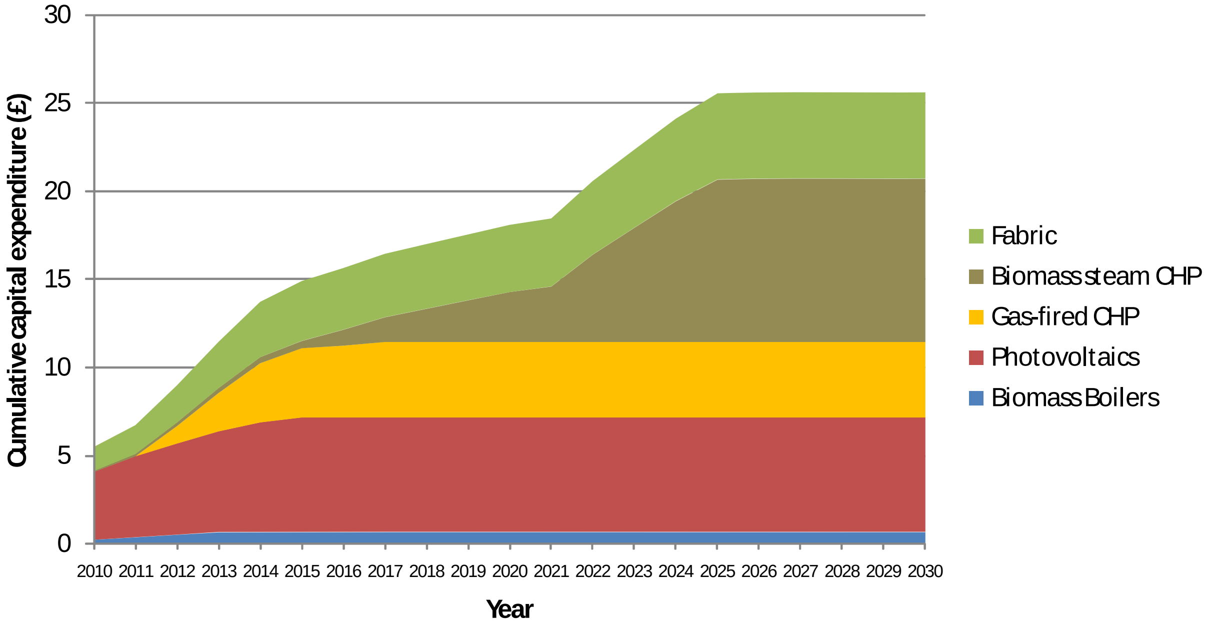


Figure 32 - *cumulative capital cost of technologies installed in Hastings if no MW scale wind capacity is available*

The capital cost of technologies deployed is marginally lower relative to the preferred low carbon technology dispatching strategy ~ £25-26M. This reflects the high cost effectiveness of biomass steam CHP/DH systems.

A large fraction of this capital cost (~30%) results from the application of PV in large numbers of domestic properties. PV facilitates compliance with the 10% onsite CO_2 rule at minimal capital cost in domestic properties.

No MW scale wind offsetting – biomass fuel demand

The projected biomass fuel demand in the Hastings borough under this variation is presented in the graph below:

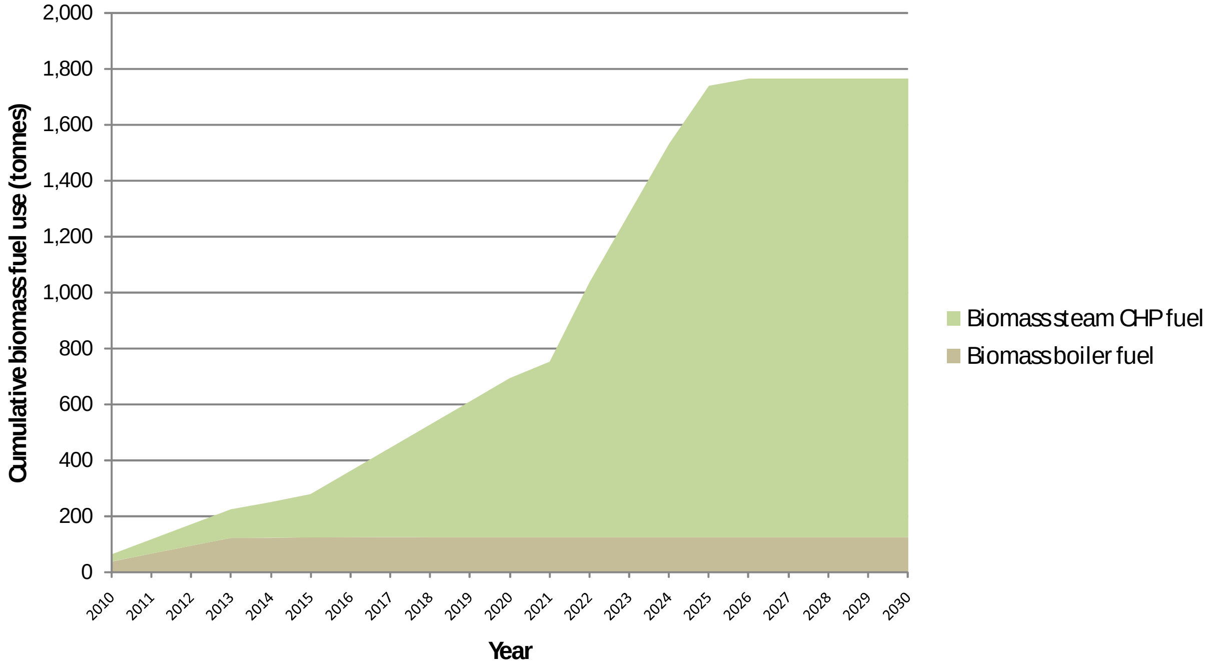


Figure 33 - *annual Hastings borough biomass fuel demand - under if no MW scale wind capacity is available to the borough.*

A huge increase in biomass fuel demand is observed relative to the preferred low carbon technology dispatching strategy. This increase reflects the wide-scale deployment of oversized biomass steam CHP engines.

Projections show that the borough will demand ~1.8ktonnes of biomass fuel annually by 2030. This demand cannot by borough sourced biomass reserves. The borough will need to secure biomass from the wider East Sussex area – see GIS resource mapping section 7.3.

No MW scale wind offsetting - Conclusions

- If no MW scale wind capacity can be secured in Hastings then the only cost effective method of achieving the most stringent CO_2 reductions of the CSH/CSB is deployment of biomass steam CHP/DH systems.

- However, there are no opportunities for “good quality” biomass CHP on the new build development sites in Hastings:

  Biomass-fired engines must be electrically led and run in heat dumping mode. Engines must be significantly oversized, producing 3-4 times the heat that can be feasibly used on a site. Excess heat is dumped to the atmosphere.

- The deployment of a large capacity of biomass CHP systems results in a large projected annual biomass fuel demand of ~1.8ktonnes/yr.

- The overall capital cost of compliance with low carbon legislation in Hastings is similar to that required under the preferred low carbon technology dispatching strategy. However, the increased reliance on biomass fuel will tax the constrained borough biomass resource – see GIS resource mapping, section 7.3.

- Evolving CSH legislation may also prohibit the deployment of heat dumping biomass-fired CHP engines.

6.7. Conclusions

- The variation analyses performed in sections 6.4 and 6.5 indicate the limitations of relying too heavily on any single low carbon technology in the Hastings borough.
  - Failure to deploy CHP/DH systems in the borough could result in an over reliance on MW scale wind carbon offsetting - overwhelming the local constrained MW scale wind resource.
  - Failure to deploy a sufficient capacity of MW scale wind turbines could result in the deployment of large numbers of oversized biomass CHP engines, overwhelming the local biomass resource.
- A balanced mix of low carbon technologies will therefore be required to facilitate compliance with the required low carbon legislation within Hastings. This balanced mix is provided by the preferred low carbon technology dispatching strategy detailed at the end of chapter 5.
- Local low carbon planning policy should therefore support the uptake and deployment of a varied range of low carbon technologies. This will be the focus of chapter 8.2 – Hastings low carbon policy recommendations.

7. GIS RESOURCE MAPPING

7.1. Wind

Wind speeds across the borough of Hastings, and Pebsham National Park were mapped using the NOABL wind speed database[11]. The map below illustrates the distribution of wind speeds at 25m above sea level across the Hastings borough.

The majority of Hastings and the surrounding area has average estimated wind speeds of greater than 5.5 m/s at 25m above sea level. This wind speed cut off is chosen in line with other studies[12] and assessments of the economics of purchasing, installing and operating a turbine. Below this wind speed, revenue from electricity generation may be insufficient to make a turbine economic.

Average wind speeds as high as 7.6m/s are observed along Hastings Ridge and in the Ore region to the East of the Borough. The potential for installing large wind turbines in these areas is very high.
In contrast wind speeds within the Pebsham Country Park are some of the lowest within the region, on average 5.6-5.7m/s at 25m above sea level.

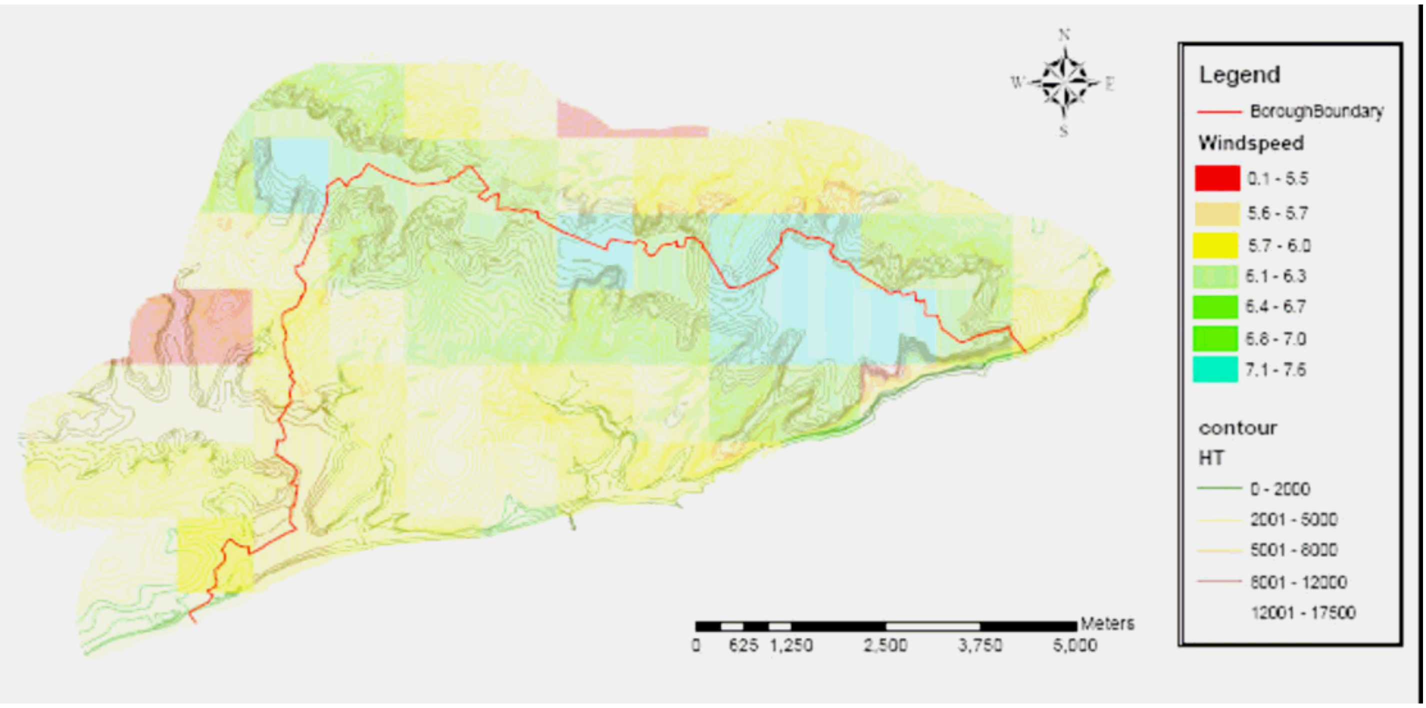


Figure 34 – *Map of average estimated wind speeds at 25m above sea level across the Hastings region.*

Caveat: Whilst the NOABL database takes into account the effects of air flow over topography on wind speed it does not allow for local thermally driven winds (e.g. sea breezes). In the case of Hastings therefore, wind speeds close to the coastline may be underestimated.
The wind speeds quoted are estimates and once a site is selected, an anemometer should be installed to measure the wind speed over a significant period of time.

[11] NOABL database provided by the Department for Business Enterprise and Regulatory Reform. http://www.wind-power-program.com/UK_wind_speed_database.htm

[12] London Energy Partnership: Wind and Biomass study

The potential for wind turbines in the Hastings borough - restrictions

The potential for medium-large scale wind turbines (500kW-2MW) within the region becomes highly restricted when adequate separation distances from buildings, railways, overhead power lines are taken into account.

The following exclusion zones were assumed:

	Distance	Type
All buildings	100m	Exclusion zone – Red
Power lines	100m	Exclusion zone – Yellow
Railways	100m	Exclusion zone – Yellow
Residential buildings	400m	

Table 3 – *Wind turbine exclusion zones as used in this study*

Exclusion distances of 100m from overhead power lines, buildings and railways are required for safety – to allow for the topple height of a large turbine. This exclusion zone is marked in red on the maps below.

Factors such as visual impact, noise, flicker and blade glint increase the recommended separation distance to 400m from residential buildings.

These exclusion zones have a major impact on the availability of suitable large sites in the Hastings region.

The availability of suitable large wind sites is further restricted by the presence of the High Weald Area of Natural Beauty (AONB) and several borough Sites of Special Scientific Interest (SSSI). Under PPS7 (see appendix 9.6), deployment of wind turbines is heavily scrutinised in AONBs, which are offered the highest status of protection in relation to landscape and scenic beauty. Wind turbines have, however, been constructed in several AONBs and National Parks (which are afforded the same status) e.g. Goonhilly Downs in Cornwall, and Wharrels Hill in Cumbria.

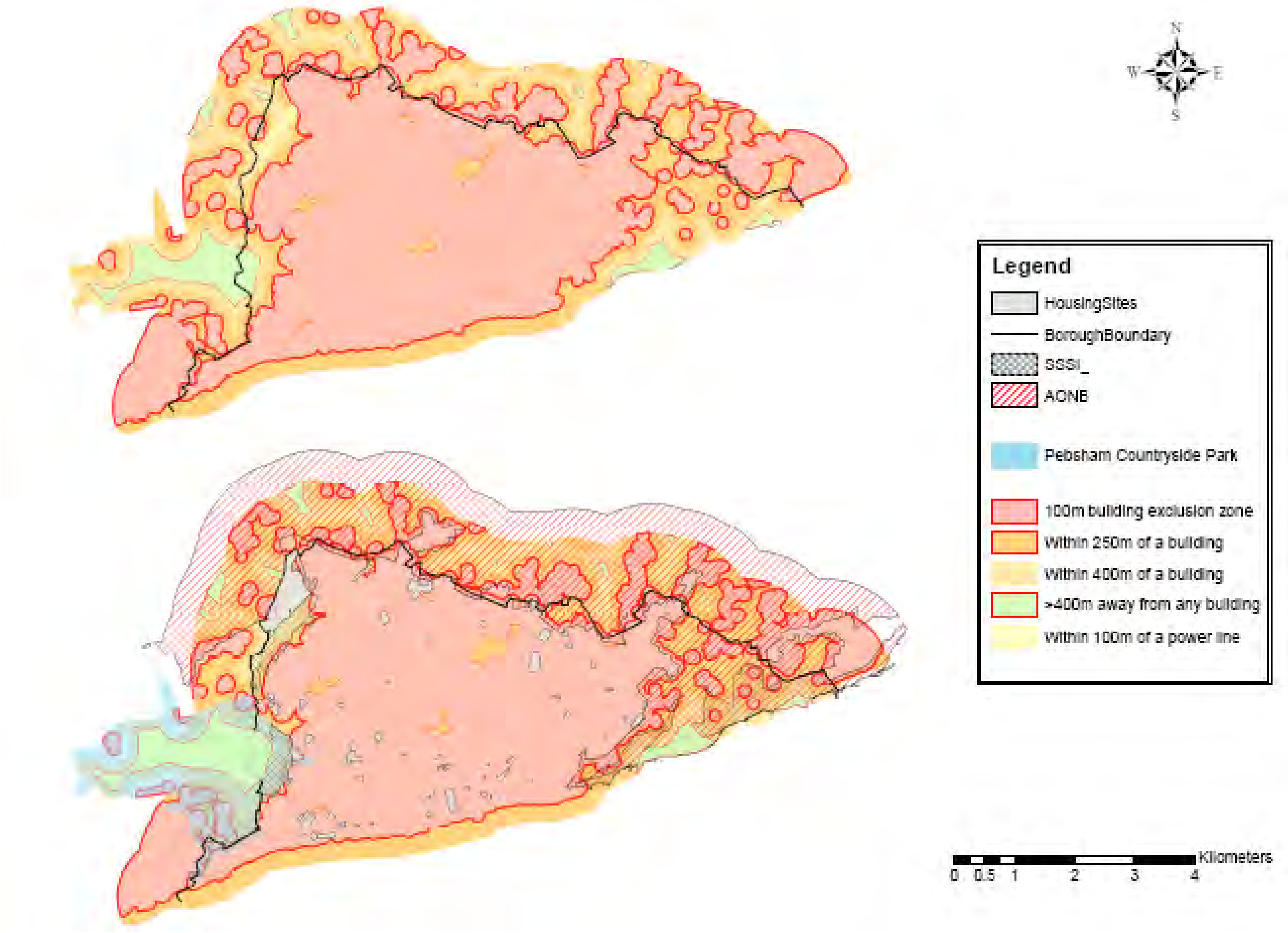


Figure 35 – *Maps of restriction zones applied to the existing building stock and infrastructure in Hastings. Sites in green are greater than 400m away from any building*[13] *and 100m away from railway sites and overhead lines. Map 2 also includes potential restrictions of AONBs and SSSIs*

In the following maps suitable large wind sites - situated outside all the exclusion zones outlined above - are shown in red.

New-build developments situated on the outskirts of Hastings - such as Breadsell Lane -could install a nearby large wind turbine, should installation be allowed in the High Weald AONB.

[13] Data available did not always distinguish between residential and non-residential properties, and therefore for security, a buffer zone of 400m was calculated from all buildings.

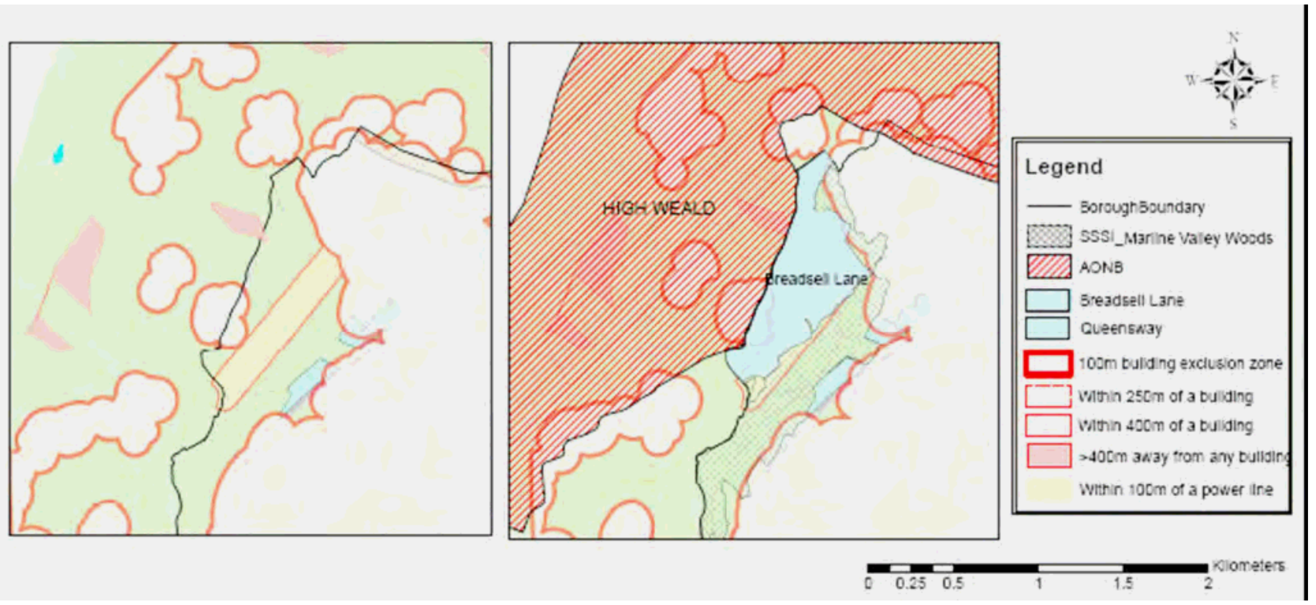


Figure 36 – *Region surrounding the proposed development of Breadsell Lane. Sites in red are the recommended distance away from buildings, railways and power lines.*

The only significant open space in the local area which avoids all exclusions zones and is located outside of either an AONB or SSSI is the Pebsham Countryside Park. This park has some of the lowest estimated wind speeds in the Hastings region, but the average estimated windspeed is still greater than 5.5 m/s.

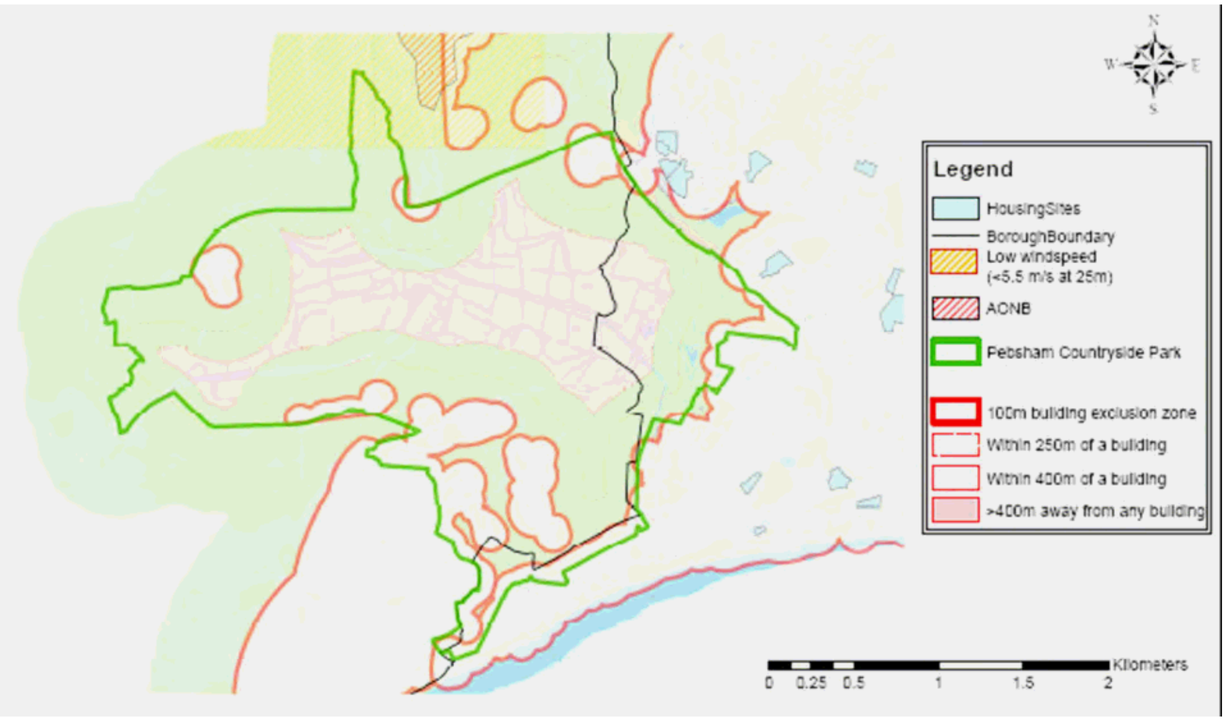


Figure 37 – *Potential for wind installation within and around Pebsham Countryside Park. Sites within the red region are a recommended distance away from buildings, railways and power lines.*

Hastings wind resource - conclusions

- The Hastings borough and immediate surrounding areas have consistently high estimated average wind speeds with respect to national averages.
- This high wind speeds are ideal for the optimal operation of large wind turbines.
- Suitable installation sites for large turbines (>1MWe), however, are severely limited in Hastings. Recommended separation distances for large turbines are:
    - Within 100m of existing power lines, railways and non-domestic buildings
    - Within 400m of existing domestic properties
- The installation of large wind turbines is also likely to be heavily restricted in the High Weald AONB.

7.2. Combined heat and power systems and district heating

The heat demands of the existing Hastings building stock were calculated based upon estimated floor areas and benchmark values of energy usage in domestic and non-domestic buildings.[14]. These estimates were compared with lower resolution data from BERR on actual local annual energy consumption[15].

The grids presented below highlight hotspots in heating demand in the existing building stock in the Hastings borough.

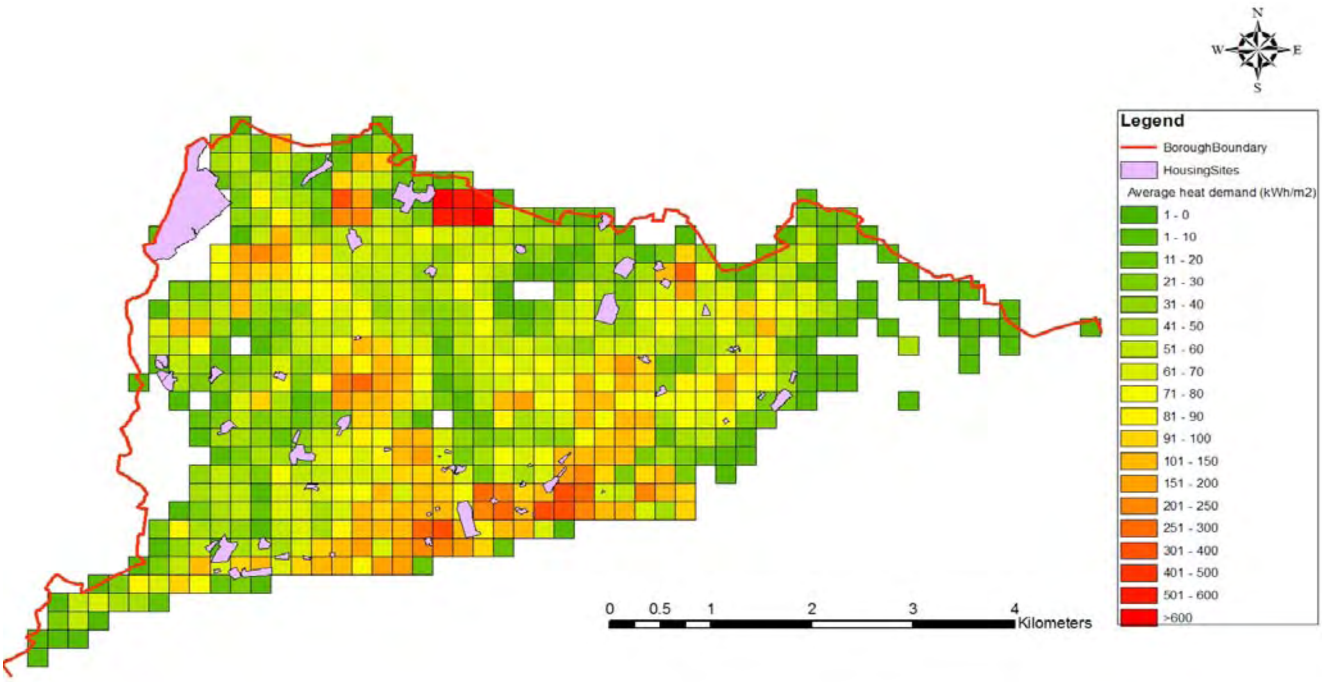


Figure 38 - *Heat density map (kWh/m2) of existing stock in Hastings Borough (200m grid)*

Major hotspots include (but are not limited to):

1. Conquest Hospital
2. Summerfield Sports Centre
3. The seafront areas of central St Leonards/Castle

High heating demands are essential for the operation of viable and economically favourable CHP engines and DH networks.

Developers of the new build sites at Holmhurst St Mary (adjacent to Conquest Hospital) and in the vicinity of the Summerfield Sports Centre should explore the feasibility and economics of including these large consumers of heat in a CHP system serving both the new build and existing properties.

[14] ECON 19
[15] It was noted that maps produced from this data at lower resolution, often missed identifying some high-end heat consumers due to smearing of demand over a much greater area

CHP systems and DH networks represent a very cost effective means of saving carbon on suitable new build developments, and CHP expanded systems which connect to existing high heat demands could benefit from:

1. Economies of scale
2. Diversity of energy demand

Incorporating existing high-end heat users in such a scheme has further significant advantages:

1. Significant CO_2 savings can be made in the connected existing build stock
2. Further surrounding properties can be easily connected to an expanding heating network – this expansion could facilitate future cost effective CO_2 savings

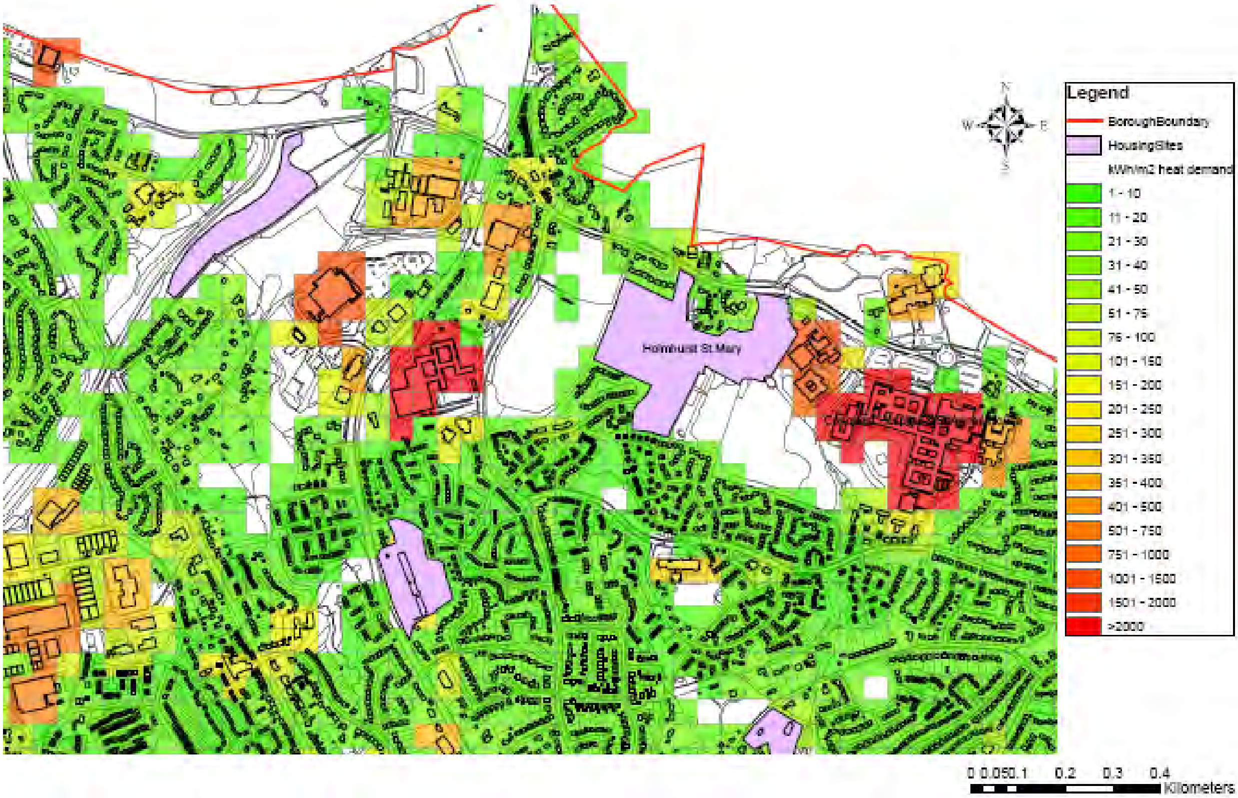


Figure 39 – *Heat density map of Conquest, in North Hastings, including Conquest Hospital and the proposed development of Holmhurst St Mary*

Figure 40 – *Heat density map of Central St Leonards/ Castle Seafront area, including Summerfield Sports Centre (with pool) at site D17*

- Heat density mapping of Hastings Borough identifies several locations of high existing heat demand. Important examples include:
    - Conquest Hospital
    - Summerfield Sports Centre
    - Seafront areas of Central St Leonards/Castle.
- New-build sites situated in close proximity to these existing hotspots could benefit by extending a CHP system to include these users. Potential advantages include:
    - Economies of scale
    - Diversity of energy demand
    - Significant CO_2 savings in the connected existing stock
    - Catalyzes the expansion of heating networks in Hastings – future cost effective CO_2 savings possible

7.3. Biomass

East Sussex has roughly twice the national average woodland resource. 30,000 hectares of East Sussex is woodland. This equates to approximately 17% of the land area of the county. Hastings borough itself has a woodland resource of c. 30 hectares, consisting primarily of non-coniferous trees.

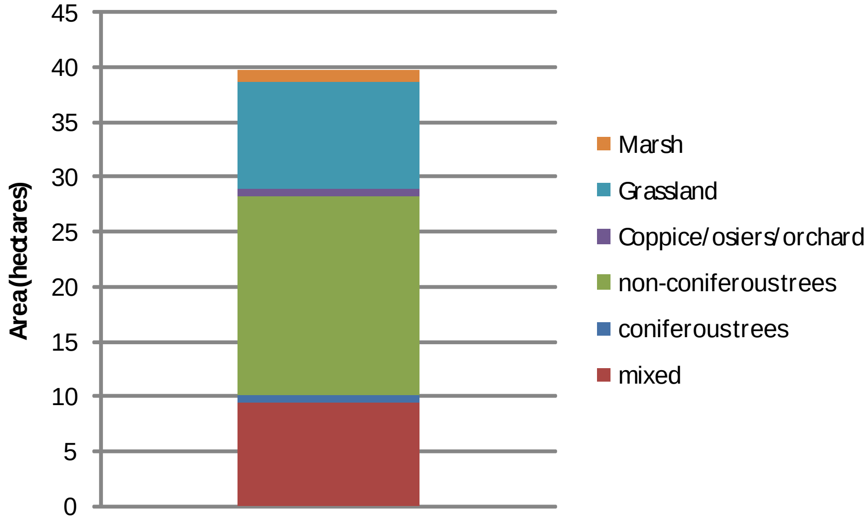


Figure 41 - *Hastings green space sub-divided by type*

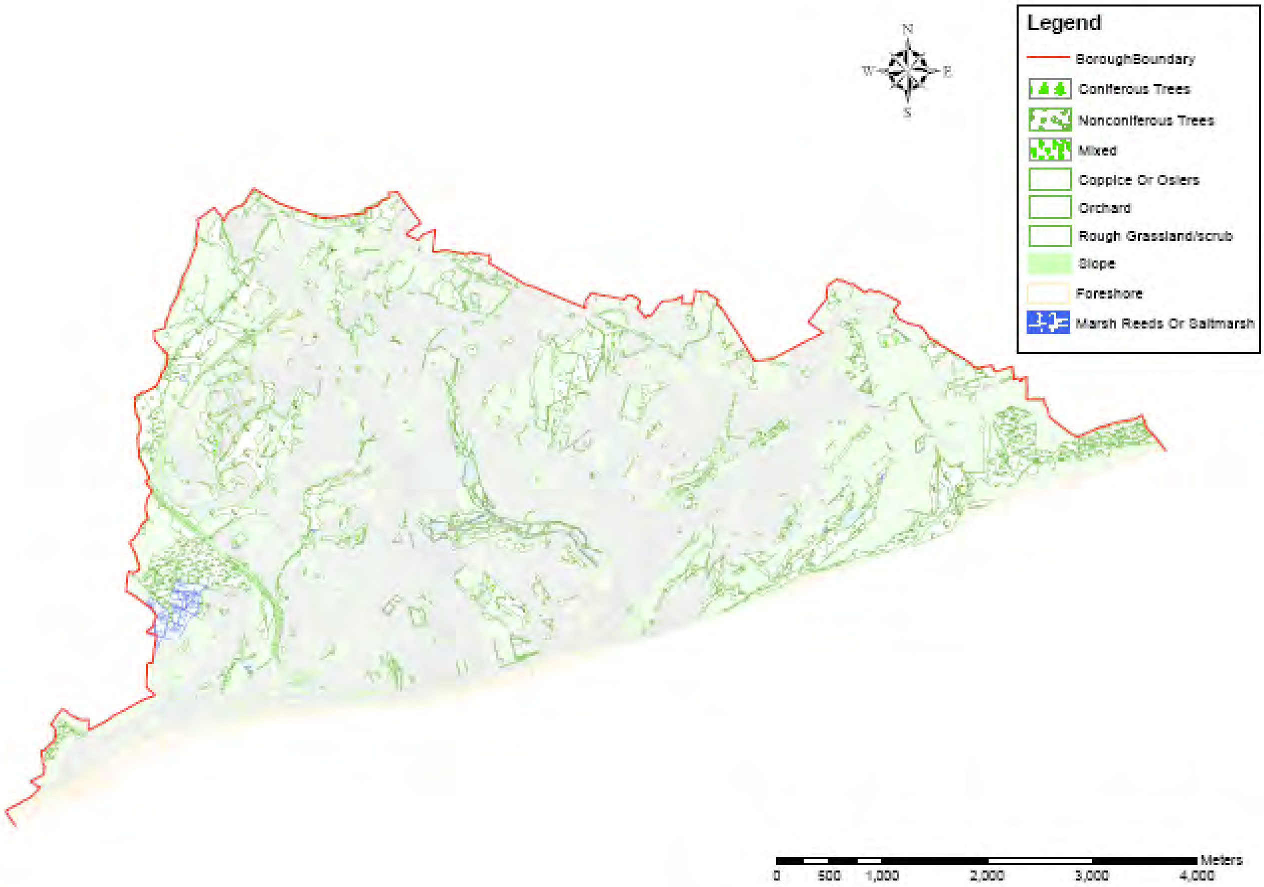


Figure 42 – *Map of biomass resource within the Hastings Borough Boundary*

The Forestry Commission gives the annual increment per hectare of forestry of different types, per annum as listed in the table below. This equates to the maximum amount of material that could be removed without depleting woodlands in the region.

Forestry Type	Yield (m^3/hectare per annum)
Conifer	10
Broad leaf (non-coniferous)	4
Mixed	6
Coppice	10

Table 4 – *Forestry Commission estimates of the maximum yield obtainable in forestry of different type*

This data was used to calculate an upper bound on the woodland resource available within the Hastings borough. A resource estimate was also carried out for a wider area, extending to a maximum of 20km from the Hastings Boundary (covering 60,000 hectares). Capping this distance at 20km ensures that CO_2 produced during the transport of biomass fuel does not significantly offset the CO_2 reduction benefits of utilising the resource.

The following table outlines the biomass resource available in the Hastings borough and the wider search area:

	Wider region (ha)	Maximum yield (m3)	Hastings (ha)	Maximum yield (m3)
Conifer	780	7800	0.8	8
Non-coniferous	3000	12000	18	72
Mixed	7100	42600	9.3	56
Coppice	1400	14000	0.6	6
TOTAL	**12300**	**77000**	**29**	**142**

Table 5 – *Estimated maximum resource available in Hastings borough and the wider region. 1 m^3 is approximately equivalent to 1 wet tonne[16] of biomass.*

A considerable proportion within the Borough for example is inaccessible, in steep railway cuttings or near Hastings cliffs. Access can be assumed to coppiced forestry, however, this represents a minor fraction of woodland. In the wider region, coppicing is more abundant, but so are competitors for this resource.

- The maximum biomass resource from the annual forestry increment within Hastings Borough boundary is c.140 tonnes.
- A significant proportion of this is likely to be inaccessible due to steep cliffs, railway cuttings and lack of access.
- The surrounding region (of radius c. 20km from the Borough boundary) has significant resource available including up to a maximum of c.14,000 t of coppice. Competition is expected for this resource.

[16] Source: Forestry Commission

8. FINAL CONCLUSIONS AND POLICY RECOMMENDATIONS

8.1. Final Conclusions

Low carbon legislation

Attainment of UK CO_2 reduction and renewable energy production targets will require definitive action to be taken at the local scale. Boroughs and cities must understand the implications of central government low carbon policy. They must formulate clear and informed low carbon policy now, to facilitate attainment of mandatory local CO_2 reduction targets in the coming decade.

The new build developments planned in Hastings will have a significant CO_2 impact. Baseline calculations suggest that if no low carbon legislation is enacted, CO_2 emissions from the new build developments will exceed 20,000 tonnes/yr in 2030. Cumulative CO_2 emissions between 2010 and 2030 are likely to total approximately 300,000tonnes.

Compliance with central government low carbon legislation (Code for Sustainable homes and Code for Sustainable Buildings) and the local 10% onsite CO_2 reduction rule will facilitate significant CO_2 savings. Annual CO2 emissions from the new build developments planned in Hastings could be reduced to 8,000 tonnes/yr – a 60% reduction - by 2030. Cumulative CO_2 emissions from 2010 to 2030 could be reduced to 150,000 tonnes – a 50% reduction.

Attaining CO2 reduction targets in Hastings

Analysis indicates that the most capital cost effective low carbon energy strategies in Hastings will deploy:

1. Basic thermal/fabric performance improvement measures e.g. simple heating controls

2. MW scale wind turbines or natural gas-fired CHP engines connected to district heating networks (there are no viable opportunities for biomass CHP systems on the new build development sites in Hastings)

These strategies will be favoured by building developers who prioritise minimisation of capital outlay.

Although MW scale wind strategies are highly cost effective in the Hastings borough, the borough MW scale wind resource is heavily constrained by local SSSIs and AONBs and guidelines ruling the minimum separation distance of large wind turbines from existing buildings.

The recommended low carbon energy strategies at each CSH/CSB code level are therefore those which avoid MW scale wind offsetting whilst incurring the minimum additional capital cost.

- At the lowest code levels application of basic fabric measures and a small capacity of a renewable energy generation technology (e.g. PV or SWH or a biomass boiler in non-domestic properties) facilitate compliance with the required CO_2 reduction targets at minimal capital cost.

- At intermediate code levels site-wide natural gas-fired CHP systems can displace MW scale wind capacity in a cost effective manner.

- At the highest code levels some MW scale wind carbon offsetting will be required.

These strategies represent the preferred low carbon technology dispatching strategy in Hastings and could allow the new build developments in Hastings to achieve mandatory CO_2 reduction targets in a cost effective manner.

Implications of the preferred low carbon technology dispatching strategy

Deployment of this preferred dispatching strategy will incur significant capital cost - £27M. A large proportion of this cost will be due to the micro-generation technologies required to facilitate compliance with the 10% onsite CO_2 rule at low CSH/CSB code levels (up to 30%).

Significant deployment of natural gas-fired CHP/DH and MW scale wind capacity is envisaged. A minimum capacity of approximately 4-5 MWe of MW scale wind will be required within the region to offset the CO_2 emissions of new build developments at the highest CSH/CSB code levels.

Vulnerability of low carbon energy strategies in Hastings

Variation analysis indicates that serious deviations from this preferred low carbon technology dispatching strategy will be hard to accommodate in Hastings.

1. If no CHP/DH systems are installed in the borough then new build development sites will increasingly rely on MW scale wind offsetting. The required capacity of MW scale wind increases significantly (~20%) to 5-6MWe. This capacity may be difficult to accommodate within the borough.

2. If no suitable MW scale wind sites can be identified then new build developments required to be net zero carbon will need to rely on oversized, heat dumping biomass CHP systems and DH networks. These systems waste the local biomass resource and may over tax it.

These variations indicate that reliance on a single low carbon technology may not be possible in Hastings. Uptake of a balanced mix of low carbon energy generation technologies will be required in the borough if local and central government carbon reduction targets are to be met.

Facilitating and promoting the proliferation of a comprehensive range of low carbon technologies should therefore be the central focus of local low carbon policy.

8.2. Hastings low carbon policy recommendations

Hastings Borough Council currently has a set of Preferred Approach Statements which seek to promote environmentally conscious new build development. However, taking into account the conclusions detailed in the previous section, we suggest that a number of alterations should be made to the phrasing of these preferred approach statements.

The following three policy statements are based on the original preferred approach statements. However, they have been amended by Element Energy in light of the analysis undertaken in this report.

In each case the following is presented:

1. Recommended low carbon policy statement

2. A rigorous evidence base explaining the policy approach and highlighting the changes made to the current policy wording

Preferred Approach 44 – Sustainability and design – Recommended policy statement

Incorporate a strategic policy that:

Promotes development that will minimise energy consumption and CO_2 production, through appropriate building layout and orientation, building form and design and accounting for the micro-climate.

Require that all dwellings demonstrate a CO_2 reduction of at least 10% (relative to a baseline estimate) through fabric and thermal performance improvement measures. The baseline will be the Part L regulations in force at present (December 2008), and will be calculated using a methodology approved for Part L calculations.

Promotes development that incorporates renewable and low carbon energy production facilities into new developments to minimise carbon dioxide production.

Manages and reduces the threat of flooding through the consideration of planning applications using the Strategic Flood Risk Assessment and the incorporation of appropriate Sustainable Drainage Systems in new development.

Minimizes consumption of natural and non-renewable resources.

Protects against light, air, land, noise and water pollution.

Promotes development that incorporates recycling facilities, and uses waste as a resource.

Meets high water efficiency standards.

Promotes safe, 'Secure By Design' and community safety features.

Evidence base

This policy statement outlines the higher level aims of the preferred approach statements. They aim to: reduce the CO_2 emissions and energy demands of new build developments; minimize the consumption of natural resources in the Hastings borough and promote recycling. The statement falls in line with the aims of cross-cutting policy 4 of the South East plan, and fits well within a regional policy context.

Paragraph two specifically considers CO_2 emission reduction targets derived from increased building thermal/fabric performance.

- Analysis shows that the most appropriate carbon reduction strategies, for all CSH/CSB code levels, include the use of some basic fabric and thermal performance improvements.

- Analysis further indicates that a CO_2 reduction target of ~10% with respect to baseline estimates is highly feasible technically and a cost effective method of reducing CO_2 emissions. This level of thermal/fabric improvement is highly recommended.

- Demanding this level of fabric/thermal performance improvement has the following advantages:

  1. **Cost effectiveness**

     Application of basic thermal/fabric improvement measures to buildings is a very cost effective method of saving carbon

  2. **Conservation of the local MW scale wind resource**

     Analysis indicates that a significant capacity of MW scale wind will be required in Hastings to offset the CO_2 impact of new build developments, particularly at high CSH/CSB code levels. Application of basic fabric measures to buildings can reduce the need for MW scale carbon offsetting (not required at CSH 3) and preserve the highly constrained local resource.

3. Future-proofing of domestic building designs

Incorporating basic thermal/fabric improvement measures at this early stage future proofs domestic building designs for higher CSH code levels. These code levels will require mandatory improvement in building thermal performance.

By changing building designs now, developers can avoid constantly updating domestic building designs as low carbon legislation becomes increasingly more stringent. This can save developers money in the long term and reduce the long term cost of compliance with low carbon legislation in Hastings.

4. Decreased consumption of natural resources

Improved building thermal performance decreases the consumption of e.g. natural gas and lowers fuel bills. This is a particularly important advantage in a deprived borough such as Hastings.

Preferred approach 45: Renewable energy – standalone schemes – Recommended policy statement

Proposals for renewable energy developments, including any ancillary infrastructure or building will be favourably considered if:

1) Their scale, form, design, materials and cumulative impacts can be satisfactorily assimilated into the landscape or built environment and would not harm the appearance of these areas; and

2) They would not impact adversely on the local community, economy, biodiversity or historical interests.

The Council will investigate the area's potential for accommodating renewable and low carbon energy sources and supporting infrastructure. Suitable sites will be identified through the forthcoming Sites Allocation Development Plan Document.

Evidence base

- No changes to this existing statement are recommended.
- Analysis indicates that a significant capacity of MW scale wind capacity will be required in Hastings to offset the CO_2 impact of new build developments. The local council should therefore favourably consider plans to develop standalone renewable schemes in the borough.

Preferred approach 46: Renewable Energy – onsite provision – Recommended policy statement

Developers should consider a comprehensive range of renewable and low carbon energy technologies on their sites, some of which may be more appropriate in different locations.

All developments will be expected to reduce their CO_2 emissions (relative to a baseline estimate) by 10% through onsite renewable energy generation, unless it can be demonstrated that the development will be unviable in terms of development type, location, design or economics. The baseline estimate should be produced using an approved methodology e.g. SAP.

A site which can reduce its CO2 by a factor greater than 10%, through the use of low carbon energy systems, such as CHP, will be allowed to use this technology to meet the requirement.

Evidence base

The original local planning target - to produce 10% of new development energy demands through onsite renewable energy production - has been amended to a 10% CO_2 reduction (from baseline) through onsite renewable/clean energy production. The reasons for these changes are detailed in section 3.3.

The onsite 10% CO_2 rule will be vital if the low carbon targets of the Hastings borough are to be realised. Implementation of the rule has the following advantages:

1. **Reduces the demand for MW scale wind carbon offsetting**

   MW scale wind carbon offsetting is the most cost effective method of achieving large CO_2 reductions. However, the MW scale wind resource in the Hastings borough is highly constrained. Local planning targets which reduce the CO_2 emissions of new build sites through onsite renewable/clean energy generation help to reduce the installed capacity of MW scale wind required in the borough.

2. **Promotes the uptake of CHP/DH and micro-generation.**

   Analysis indicates that a balanced mix of low carbon energy generation technologies will be required if Hastings is to achieve mandatory national CO_2 reduction targets. The Hastings borough cannot rely upon low carbon energy strategies dominated by a single technology e.g. MW scale wind, as the local resource is heavily constrained.

   The 10% onsite CO_2 rule forces developers to consider micro-generation and CHP systems at an early stage. This will help developers to adjust to the planned timetable for the CSH/CSB, which will require a sudden and very large increase in renewable/clean energy generation technology capacities at higher code levels.

   Local planning targets that support the development of carbon reducing technologies are required now to ensure that the market develops sufficiently to be able to deliver the capacities required for the high code levels.

Allowing clean energy generation technologies e.g. natural gas-fired CHP to contribute to the 10% onsite CO_2 rule has the following advantages:

1. **Cost effectiveness**

   Non-renewable low carbon energy generation technologies can be a more feasible and more cost effective means of reducing carbon than renewables (see Figure 12).

2. **Deployment of DH networks at an early stage promotes flexibility in borough wide low carbon energy strategies**

   The most cost effective low carbon energy strategies for attaining high CSH/CSB levels incorporate MW scale wind turbines and/or biomass-fired steam CHP engines and DH networks (see Figure 12 Chapter 4).

Promoting the installation of natural gas-fired CHP engines and DH networks now means that gas engines can be replaced with biomass engines in the future as heat networks expand, effective heat demands placed upon the networks increase and higher CSH/CSB CO_2 reduction targets become mandatory in Hastings.

Early installation of CHP systems and DH networks in Hastings creates a high level of flexibility in future low/zero carbon energy strategy.

3. Deployment of DH networks offers retrofit opportunities:

Significant CO_2 savings can be made by extending CHP/DH networks - catalysed by new developments – into existing properties with higher heating loads. This extension could also make the development of a CHP/DH system on a new build development more economically/technically viable in the first instance. There are a number of excellent heating network retrofit opportunities in Hastings (see section 7.2).

The 10% onsite CO_2 rule is an extremely powerful local planning target, with many far reaching implications. Adoption of the recommended policy statement will help Hastings Borough Council to develop an effective and flexible low carbon energy strategy.

Hastings Borough Council currently has no low carbon policies relating to:

1. Combined heat and power and district heating systems

2. The attainment of low carbon targets on sites where current low carbon technologies are not feasible or represent an unacceptable capital cost

The following additional policy statements are highly recommended in light of the analysis undertaken in this report.

As before, the recommended policy statement is presented along with a comprehensive evidence base.

Preferred approach 47: Supporting CHP/CCHP and heat networks – Recommended policy statement

Incorporate a strategic policy which:

Ensures that local, existing heat and cooling networks are identified and safeguarded.

Maximizes the opportunities for providing new networks that are supplied by decentralized energy (including renewable generation).

Ensures that developers evaluate combined cooling, heat, and power (CCHP) and combined heat and power (CHP) systems on all new developments, and where a new CCHP/CHP system is installed as part of a new development, examine opportunities to extend the scheme beyond the site boundary to adjacent areas.

Ensures that developers study the following heat and cooling network strategies before submitting a planning application:

- connection to existing CCHP/CHP distribution networks
- site-wide CCHP/CHP powered by renewable energy
- natural gas-fired CCHP/CHP
- communal heating and cooling fuelled by renewable sources of energy
- natural gas-fired communal heating and cooling.

Ensures that it is feasible for new developments to connect to existing heating and cooling networks.

Requires all developments to demonstrate that their heating, cooling and power systems have been selected to minimise carbon dioxide emissions.

Sites where it can be demonstrated that non-renewable CCHP/CHP and heating and cooling networks could produce CO_2 savings equal to or greater than those possible using onsite renewable energy generation technologies will be exempt from onsite renewable energy generation targets.

Evidence base

Analysis indicates that a balanced mix of low carbon energy generation technologies will be required to allow the Hastings borough to achieve mandatory CO_2 reduction targets. CHP/DH systems can provide highly cost effective CO_2 savings and are likely to be an important component of the low carbon energy strategy in the borough. Promotion of CHP/DH systems falls in line with the policy amendment NRM12 of the South East plan and hence fits well within a wider regional policy framework.

Designers should therefore be required to assess the technical and economic feasibility of CHP/CCHP and DH systems on their sites when writing a planning application, even if such systems are not required to achieve the CO_2 reduction targets required of a site.

Where there is an obvious opportunity to extend heat and cooling networks beyond the boundary of a site (and hence promote further highly cost effective CO_2 savings), developers should make this point clear. There may be a possibility of combining heat networks and increasing the cost effective CO_2 savings which can be attained (and reducing capital installation costs).

Dwellings should be built so that they can easily be retrofitted and connected to heat networks which may expand throughout Hastings. This may allow significant, cost-effective retrofit CO_2 savings to be made in the future.

Non-renewable clean energy systems e.g. natural gas-fired CHP can provide significant CO_2 savings, however under current planning policy in Hastings, such non-renewable systems must be supplemented with expensive building mounted renewables and are hence an unfavourable economic proposition. Exemption from the 10% onsite CO_2 rule would make them far more appealing economically.

N.B: the CHP technology order outlined in the recommended policy statement decreases in the cost effectiveness of CO_2 saved from the first option to the last.

Preferred approach 48: Low carbon buy-out fund – Recommended policy statement

Hastings Borough Council will explore the option of a CO_2 buy-out fund.

The fund will be designed to allow sites to achieve the required low carbon through energy trade agreements throughout the borough, facilitating the most cost effective CO_2 savings in the Hastings borough.

Access to the buyout option will only be granted for those sites where it has been demonstrated that achieving the required CO_2 reduction standards onsite is technically or economically unfeasible.

The tariff level of any CO_2 buy-out will be determined following further evidence base work, but will be set at a level which encourages developers to explore all relevant onsite clean/renewable energy generation technologies in the first instance.

Capital contributions to the CO_2 buy-out fund will be used to fund major low carbon developments in the Hastings borough.

Evidence base

Some sites may not be able to achieve the required carbon targets using on site technologies. Low carbon technologies may be unviable on a specific site, or represent an unfeasible capital cost.

The most cost effective carbon savings often require the use of standalone technologies e.g. MW scale wind turbines, which are remote from the development. In order to ensure that these standalone renewable technologies do develop, and at an appropriate scale, a centralised, buyout fund would be required.

The ”buy-out price” or tariff of any fund should be set at a level which supports the proliferation of the preferred renewable/clean energy technologies e.g. it should not be set lower than the cost of a typical CHP system and DH network if you want these technologies to be seriously considered by developers, as they will simply buy-out of their low carbon onsite obligations.

However, the buy-out price cannot be set so high as to make development economically unfeasible.

Energy strategy analysis in Hastings suggests that the most cost effective energy strategies for achieving high CO_2 reductions will incorporate:

- Site-wide CHP systems with district heating (biomass CHP being the most cost effective)
- Offsite MW scale wind supplementation

Proceeds from the buy-out fund could be used to install MW scale wind capacity in some of the suitable and very windy sites in the Hastings borough.

9. APPENDICES

9.1. Technology performance

Wind turbines

Wind turbines perform best in optimal locations with high wind velocities and low turbulence. This typically requires remote locations with minimal obstruction near by which may disrupt the air flow and create turbulence. In non optimal wind regime locations, the output will be heavily reduced.

Micro wind

Micro wind turbines are typically less than circa 1.5 kW and can be building mounted. This report assumes a maximum installation capacity of 1 turbine per dwelling.

Parameter	Value
Hub height above building	3 m
Load factor	3%

Large wind

Large wind turbines are designed for commercial operation. Indicative sizes are 100s kW – MW scale.

Parameter	Value	Comments
Load factor	22%	Commercial optimised land based wind farms may achieve 25 – 30%

Solar water heating

Parameter	Value	Comments
% of hot water demand met by system	50%	
Load factor	643 kWh / kWp.yr	Assumes efficiency of approximately 85% and capacity of 0.7 kW / m^2

Solar photovoltaics

Parameter	Value	Comments
Load factor	850 kWh / kWp.yr	850 kWh / kWp is typical for UK PV installations.

Biomass boilers

Micro biomass heating technologies are assumed to be fuelled by wood pellets.

Parameter	Individual
Indicative size	< 10 kW
Heating fraction met	100%
Efficiency	90%

CHP technologies

CHP technologies are typically sized to meet about 70 - 80% of the heating load. To meet the full load would require significant over sizing to meet peak loads, and so back-up boilers are activated when the CHP engine is at full load.

Community site-wide natural gas-fired CHP

Parameter	Value
Indicative technology type	Gas engine
Indicative size	10s – 100s kW
HP ratio	1.5:1 – 2:1
Overall efficiency (delivered heat and electricity)	5000 hours / yr (minimum for viability of community CHP)
Overall efficiency	85%

Community site-wide biomass-fired CHP

Parameter	Medium scale (organic Rankine cycle)	Large Scale (Biomass steam CHP)
Technology type	Organic fluid cycle	Steam turbine
Indicative size	100s kWe	MW
Heat to power ratio	4.3:1	3:1
Efficiency	80%	80%
Load factor	5000 hours / yr (typical minimum for viability of community CHP)	5000 hours / yr (typical minimum for viability of community CHP)

9.2. Technology cost

Micro wind

Year	Marginal cost		Fixed cost		Maintenance Cost
	£ / kWe		£ / installation		
	New build	Retrofit	New build	Retrofit	£ / yr
2007	£2,000	£2,000	£3,000	£3,500	£110
2008	£1,818	£1,818	£2,726	£3,180	£110
2009	£1,666	£1,666	£2,499	£2,916	£110
2010	£1,542	£1,542	£2,313	£2,699	£110
2011	£1,441	£1,441	£2,162	£2,522	£110
2012	£1,361	£1,361	£2,041	£2,381	£110
2013	£1,297	£1,297	£1,945	£2,269	£110
2014	£1,247	£1,247	£1,871	£2,183	£110
2015	£1,209	£1,209	£1,814	£2,116	£110
2020	£1,137	£1,137	£1,705	£1,989	£110
2025	£1,104	£1,104	£1,656	£1,932	£110
2030	£1,100	£1,100	£1,600	£1,850	£110
2040	£1,050	£1,050	£1,550	£1,800	£110
2050	£1,000	£1,000	£1,500	£1,750	£110

Notes:

- The capital cost of installed turbines is relatively insensitive to capacity, and strongly based on electrical and mechanical installation and size-independent hardware. A cost of £5,000 for a 1 kW turbine is assumed for this study[17].
- The fixed costs reduce over time to allow for improvements to mounting and installation, and the development of wind turbine specific power electronics.
- Maintenance costs are based on a bi-annual check and service taking 0.5 days. The actual maintenance may vary depending on the turbine quality and location, and these are an estimate.

[17] Capital costs are based on the following manufacturers: Ampair, Eclectic Energy, Marlec, Renewable Devices and Zephyr. Costs as low as £1,500 / kW have been advertised from Windsave but this is unlikely to be representative of future costs.

Large wind

Year	Marginal cost	Fixed cost	Maintenance Cost
	£ / kWe	£ / dwelling	£ / dwelling.yr
2007	£1,500		£23
2008	£1,472		£23
2009	£1,444		£23
2010	£1,417		£23
2011	£1,389		£23
2012	£1,361		£23
2013	£1,333		£23
2014	£1,306		£23
2015	£1,278		£23
2016	£1,250		£23
2017	£1,222		£23
2018	£1,194		£23
2019	£1,167		£23
2020	£1,139		£23
2021	£1,111		£23
2022	£1,083		£23
2023	£1,056		£23
2024	£1,028		£23
2025	£1,000		£23

Notes
- Capital costs are assumed to scale directly with capacity.
- The 2007 cost of £1,500 represents an upper end due to current supply constraint issues[18].
- Maintenance costs assume 1.5% of capex per annum [19]. For modelling purposes, 1kW per dwelling is allocated to evaluate maintenance costs (Maintenance will typically require 2 man days per year [20].)

[18] The value of £1,500 was supplied by the RAB microgeneration group.
[19] Danish Wind Energy Association. http://www.windpower.org/en/tour/econ/oandm.htm
[20] Man day information provided by UK wind farm developers RES (Renewable Energy Systems) and Ecotricity.

Domestic solar thermal

Year	Marginal cost		Fixed cost		Maintenance Cost
	£ / kW		£ / installation		
	New build	Retrofit	New build	Retrofit	£ / yr
2007	£859	£1,000	£1,500	£2,000	£44
2008	£818	£952	£1,420	£2,000	£44
2009	£780	£908	£1,340	£2,000	£44
2010	£747	£870	£1,260	£2,000	£44
2011	£716	£834	£1,200	£2,000	£44
2012	£688	£801	£1,140	£2,000	£44
2013	£663	£772	£1,060	£2,000	£44
2014	£640	£745	£1,030	£2,000	£44
2015	£619	£721	£1,000	£2,000	£44
2020	£543	£632	£890	£2,000	£44
2025	£502	£584	£800	£2,000	£44
2030	£450	£550	£770	£2,000	£44
2040	£400	£500	£750	£2,000	£44
2050	£350	£450	£750	£2,000	£44

Notes:

- Capital costs for solar thermal systems vary depending on the type of system and the specific installation requirements.
- The lowest suggested new build costs range from around £1,500 per system (circa 2 kW) not including hot water tank installation. However discussions with buyers suggests costs are closer to £2,500 [21].
- Fixed costs are based on additional £250-£850 for twin coil high performance vented hot water cylinder and circa £600 - £800 electrical and plumbing costs. For new build, the DHW cylinder price has a premium of £250 over the £600 cost of a standard unvented high performance cylinder.
- For existing buildings, installed costs are typically £4,500-£5,000 for a 4m^2 (2.8kWth) system, rising to £7500 for an 8m^2 system. This includes a vented twin coil hot water cylinder.[22]
- Projected costs allow for reductions in system cost through an increase in global production and installation, and changes to the technology making use of lower cost materials and quicker installations.
- Maintenance costs are based on professional check every five years taking 0.5 days.

[21] The solar trade association suggests a new build system cost of £1,500 to £5000 depending on volume whereas EST experience suggests between £2,000 and £2,500. A 2.8 m^2 DIY system from Solartwin Ltd currently retails for £2126.80 not including DHW cylinder or installation (http://www.solartwin.com/diy.htm)

[22] If a cylinder is already in place, the cost may be reduced by £600.

Solar thermal – non domestic

Year	Cost per kW heat		Maintenance Cost	
	£ / kWth		£ / yr	
	New build	Retrofit	New build	Retrofit
2007	£1,000	£1,600	£220	£220
2008	£952	£1,523	£220	£220
2009	£908	£1,453	£220	£220
2010	£870	£1,392	£220	£220
2011	£834	£1,334	£220	£220
2012	£801	£1,282	£220	£220
2013	£772	£1,235	£220	£220
2014	£745	£1,192	£220	£220
2015	£721	£1,154	£220	£220
2020	£632	£1,011	£220	£220
2025	£600	£1000	£220	£220
2030	£600	£1000	£220	£220
2040	£600	£1000	£220	£220
2050	£600	£1000	£220	£220

- Capital costs are based on an estimate of £800-£1200 per kW_{th} installed for new build from a UK manufacturer.
- Retrofit costs are higher due to the costs of gaining roof access and plumbing into an existing system.
- Maintenance costs are based on a half day annual service by a qualified heating engineer.

Domestic PV

Year	Marginal cost		Fixed cost		Maintenance Cost
	£ / kWe		£ / installation		
	New build	Retrofit	New build	Retrofit	£ / yr
2007	£3,983	£4,500	£1,500	£2,000	£110
2008	£3,659	£4,134	£1,500	£2,000	£110
2009	£3,373	£3,811	£1,500	£2,000	£110
2010	£3,121	£3,526	£1,500	£2,000	£110
2011	£2,899	£3,275	£1,500	£2,000	£110
2012	£2,703	£3,054	£1,500	£2,000	£110
2013	£2,529	£2,857	£1,500	£2,000	£110
2014	£2,376	£2,684	£1,500	£2,000	£110
2015	£2,240	£2,531	£1,500	£2,000	£110
2020	£1,759	£1,987	£1,500	£2,000	£110
2025	£1,491	£1,685	£1,500	£2,000	£110
2030	£1,300	£1,500	£1,500	£2,000	£110
2040	£1,100	£1,300	£1,500	£2,000	£110
2050	£1,000	£1,200	£1,500	£2,000	£110

Notes:
- Capital costs are based on a new-build system price circa £5,500 for a 1 kW system in 2007[23].
- The capital costs for retrofit installations are higher, at £6500 for a 1kWp system and £11000 for a 2kWp system.
- Cost projections allow for a significant reduction in cell cost through technical evolution and material supply improvements [24]. In the recent months, increased availability of silicon has enabled large reductions to be realised[25].
- The fixed costs include mechanical and electrical installation aspects which are not size dependent and will not be subject to the cost reductions of the PV panels.
- Maintenance costs are based on professional electrical check and clean every five years taking 0.5 days. An additional £1000 every 15 years is also included in this cost to allow for inverter replacement[26].

[23] System costs circa £5500 / kW have been provided by UK installers. This represents a conservative view and lower costs can be achieved.
[24] Photon consulting predict the cost of PV to reduce by 30% by 2010. The True Cost of Solar Power: 10 cents / kWh by 2010. Photon Consulting. 2007.
[25] Photon International. March 2007.
[26] Replacement inverters may be required every 15 years – UK industry source.

Non-domestic PV

Year	Total cost per kW		Maintenance Cost	
	£ / kWe		£ / yr	
	New build	Retrofit	New build	Retrofit
2007	£4,500	£5,000	£220	£220
2008	£4,134	£4,593	£220	£220
2009	£3,811	£4,234	£220	£220
2010	£3,526	£3,918	£220	£220
2011	£3,275	£3,639	£220	£220
2012	£3,054	£3,393	£220	£220
2013	£2,857	£3,174	£220	£220
2014	£2,684	£2,982	£220	£220
2015	£2,531	£2,812	£220	£220
2020	£1,987	£2,208	£220	£220
2025	£1,685	£1,872	£220	£220
2030	£1,350	£1,500	£220	£220
2040	£1,150	£1,300	£220	£220
2050	£1,000	£1,150	£220	£220

- New build costs are based on estimates from UK manufacturers. Retrofit costs are slightly higher due to costs of scaffolding and wiring.
- Maintenance costs are based on an annual visit by a qualified electrician taking half a day.

Domestic micro biomass boilers

Year	Cost per device		Maintenance Cost
	£ / installation		£ / yr
	New build	Retrofit	
2007	£9,000	£11,000	£220
2008	£8,837	£10,801	£220
2009	£8,677	£10,605	£220
2010	£8,518	£10,411	£220
2011	£8,361	£10,219	£220
2012	£8,206	£10,029	£220
2013	£8,052	£9,842	£220
2014	£7,901	£9,657	£220
2015	£7,751	£9,474	£220
2020	£7,031	£8,594	£220
2025	£6,358	£7,771	£220
2030	£6,229	£7,613	£220
2040	£5,611	£6,858	£220
2050	£5,040	£6,160	£220

Notes

- Micro biomass boilers for low thermal demand homes are currently available with 8kWth maximum capacity modulating down to 2 kW. The costs are therefore entirely installation based and not size variable. This may change as new products come to market They include allowance for installation and fuel storage / feed equipment. The costs do not include the space allowance or building of additional fuel storage[27]. A cost reduction is used to represent the immaturity of the very small scale UK biomass boiler sector.
- Existing build costs are considerably higher than new build costs due to the extra building and plumbing work, but installed costs are relatively size invariant, due to the fact that the boiler makes up a small proportion of the overall cost.
- 0.5 days maintenance assumed for the individual system.

[27] Okofen pellet boilers. http://www.organicenergy.co.uk

Non-domestic biomass boilers

Year	Cost per kW heat		Maintenance Cost
	£ / kW		£ / installation
	New build	Retrofit	
2007	£410	£410	£880
2008	£410	£410	£880
2009	£410	£410	£880
2010	£410	£410	£880
2011	£410	£410	£880
2012	£410	£410	£880
2013	£410	£410	£880
2014	£410	£410	£880
2015	£410	£410	£880
2020	£410	£410	£880
2025	£410	£410	£880
2030	£410	£410	£880
2040	£410	£410	£880
2050	£410	£410	£880

Notes:

- Capital costs are industry standards[28], and are consistent with an installed cost of approximately £40,000 for a 100kWth system.
- Maintenance costs for medium scale assume 2 visits (1 day each) per year for a 100 kW system.
- The 5,000 hours per year load represents a system meeting space and hot water demand throughout the year, making use of thermal storage for peak loads.

Combined heat and power systems with district heating

Upper bound cost estimates were calculated using previous CHP/district heating studies conducted at the Cranbrook new community in east Exeter[29]. Since capital costs are dominated by the costs of DH network pipes, costs are not likely to fall significantly during the period of this study.

Capital on cost of gas-fired CHP/DH - £3,700

Capital on cost of biomass-fired ORC CHP/DH - £4,250

Capital on cost of biomass-fired steam CHP/DH - £4,700

Notes:

Costs will vary with the specific density of a site.

[28] Biomass Sector Review for the Carbon Trust
[29] No longer available online.

9.3. Opportunities for biomass CHP in Hastings

In order to be technically viable on a site, biomass CHP engines require a site to have a minimum electrical demand/capacity. The table below shows the minimum electrical capacities required by two different biomass CHP engines:

Parameter	**Medium scale (organic Rankine cycle)**	**Large Scale (Biomass steam CHP)**
Technology type	Organic fluid cycle	Steam turbine
Indicative size	100s kWe	MW
Minimum electrical capacity	200kWe	2.5MWe

Table 6 – *Minimum electrical capacity required for viable operation of biomass CHP engines at current levels of technology.*

Modelling of the new build developments planned for Hastings (using new build electrical demand benchmarks) indicates that there are no sites which present a suitable electrical demand for a biomass-fired CHP system.

9.4. Variations in technology cost effectiveness – running costs

Although developers are overwhelmingly concerned with the capital cost effectiveness of low carbon technologies, some do consider the on-going running costs of equipment. The net annual "running" cost effectiveness of a comprehensive range of low carbon technologies is presented below for a typical semi-detached house:

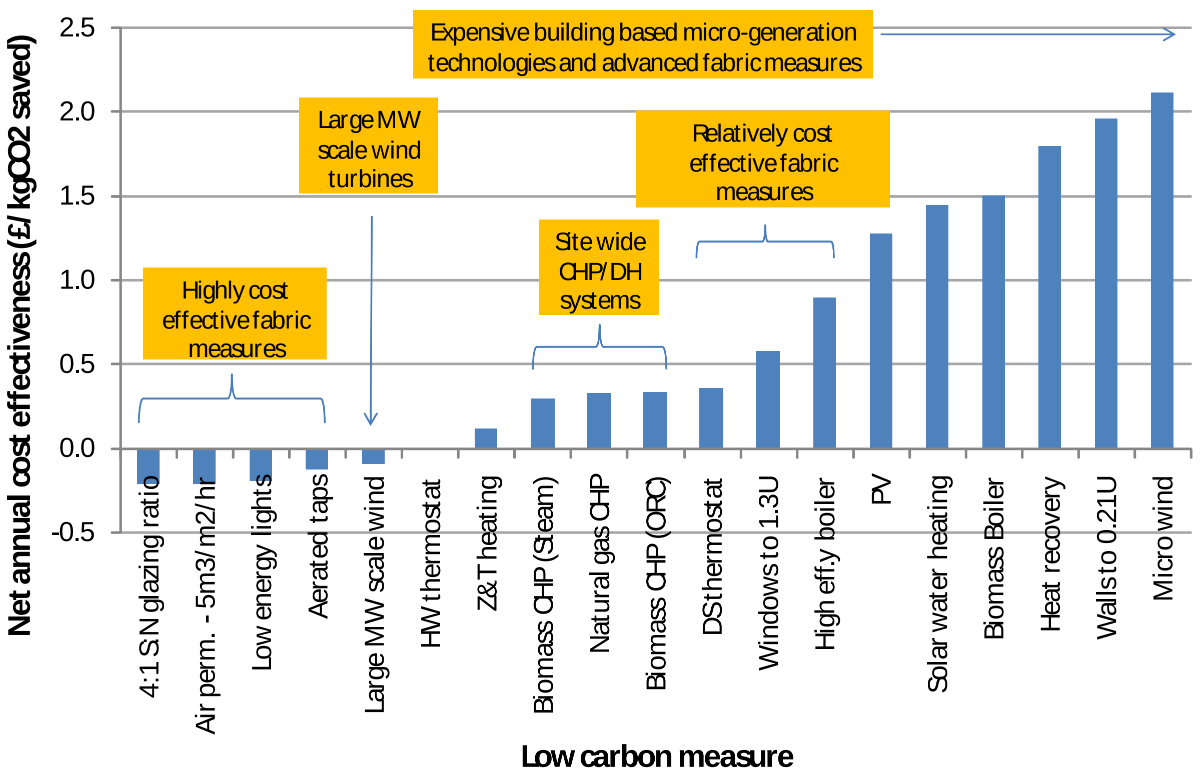


Figure 43 - *Running cost effectiveness (using the net annual cost) of a comprehensive range of low carbon energy technologies for a typical semi-detached house. Negative values indicate that a measure saves both carbon and money.*

The ranking of technologies barely changes between this graph and Figure 12. Basic fabric improvements and MW scale wind or CHP/DH systems are still highly cost effective relative to building based micro-generation technologies and advanced thermal/fabric performance improvement measures.

A similar pattern is observed in the non-domestic sector.

Whether developers prioritise capital or running costs, the most cost effective low carbon energy strategies will be very similar.

9.5. Variations in technology capital cost effectiveness – time

The Hastings new build developments under study will continue to be built out to 2026. During this time technology capital costs will vary due to market forces. These variations could result in a change in the relative CO_2 capital cost effectiveness of the technologies under study.

To study this possibility, the projected capital cost effectiveness was studied for 2025, using future technology capital cost projections from the Element Energy report on the *Growth Potential of Micro-generation in England, Wales and Scotland.* The graph displays the projected capital cost effectiveness of a comprehensive range of low carbon technologies in 2025:

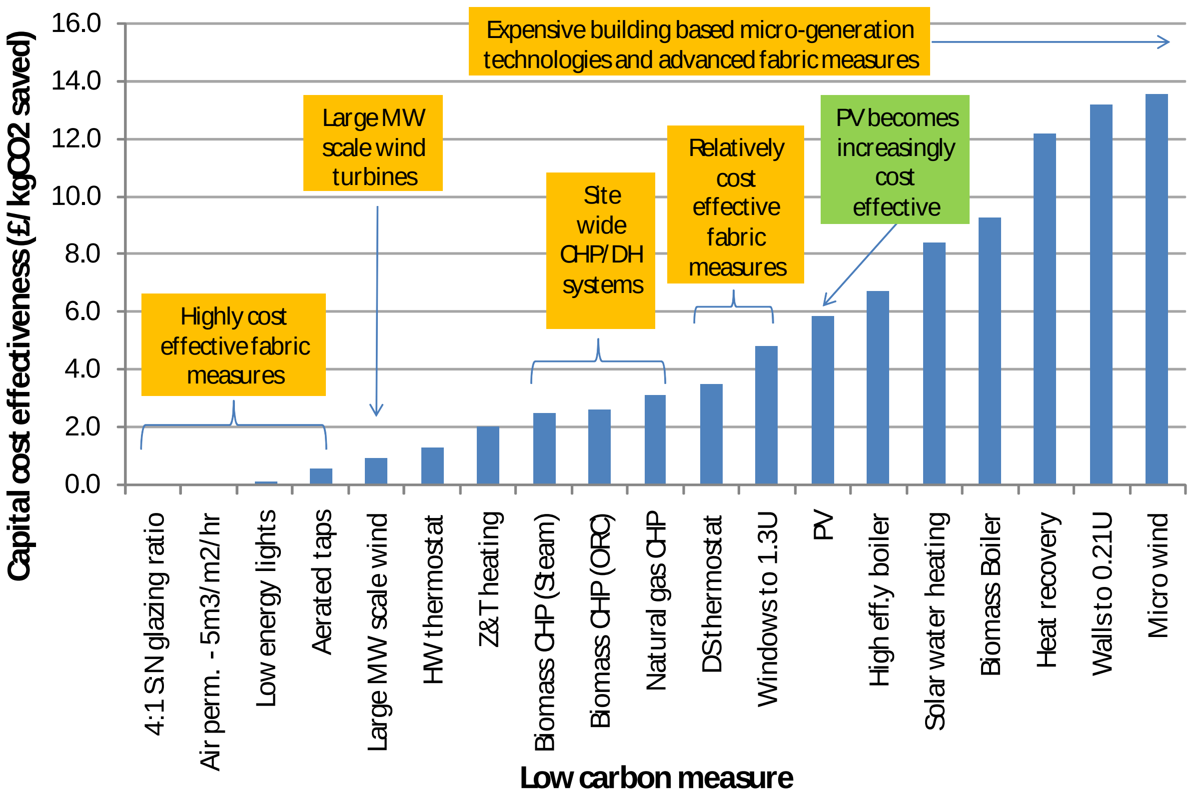


Figure 44 - *CO_2 capital cost effectiveness of a comprehensive range of low carbon technologies in 2025*

Comparison with Figure 12 indicates that the relative ranking of technology capital cost effectiveness does not change significantly between now and 2025. Basic fabric measures, MW scale wind turbines and CHP/DH systems remain the most capital cost effective low carbon technologies out to 2025. PV systems become more attractive financially as time progresses, but will still represent an expensive low carbon option.

A similar pattern was observed in the non-domestic sector.

9.6. Wind

PPS 7

“Nationally designated areas comprising National Parks, the Broads, the New Forest Heritage Area and Areas of Outstanding Natural Beauty (AONB), have been confirmed by the Government as having the highest status of protection in relation to landscape and scenic beauty. The conservation of the natural beauty of the landscape and countryside should therefore be given great weight in planning policies and development control decisions in these areas.
Major developments should not take place in these designated areas, except in exceptional circumstances. This policy includes major development proposals that raise issues of national significance. Because of the serious impact that major developments may have on these areas of natural beauty, and taking account of the recreational opportunities that they provide, applications for all such developments should be subject to the most rigorous examination. Major development proposals should be demonstrated to be in the public interest before being allowed to proceed. Consideration of such applications should therefore include an assessment of:

(i) the need for the development, including in terms of any national considerations, and the impact of permitting it, or refusing it, upon the local economy;

(ii) the cost of, and scope for, developing elsewhere outside the designated area, or meeting the need for it in some other way; and

(iii) any detrimental effect on the environment, the landscape and recreational opportunities, and the extent to which that could be moderated.”

Wind turbines inside National Parks, and AONBs

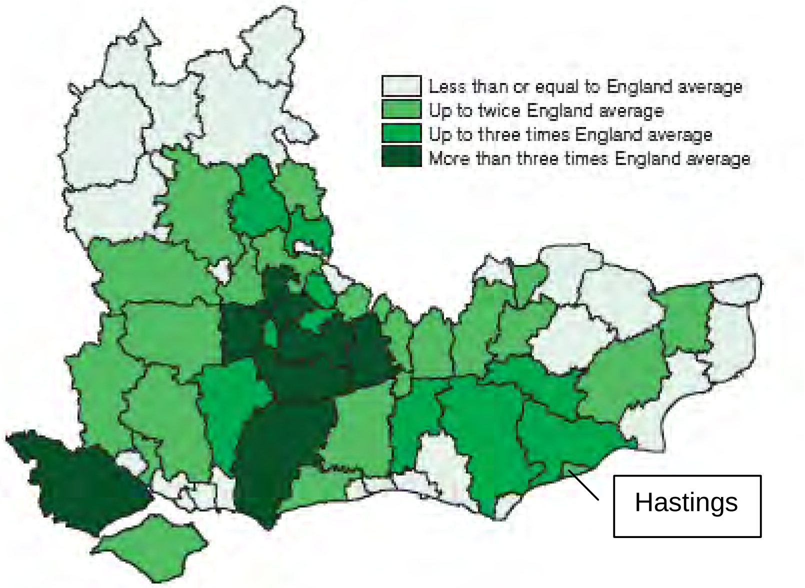
850kW wind turbine at Glyndbourne, in the South Downs
Controversial, permission from Secretary of State

Wharrels Hill, Cumbria in Lake District National Park (8 turbines 76 m high)

Goonhilly Downs, AONB and SSSI, 5.6MW wind farm (14 turbines), referred to Government Office South West which confirmed no action was warranted by the Secretary of State

9.7. Biomass

Southeast England forestry resource



Source: Forestry framework, the Forestry Commission

Hastings green space breakdown

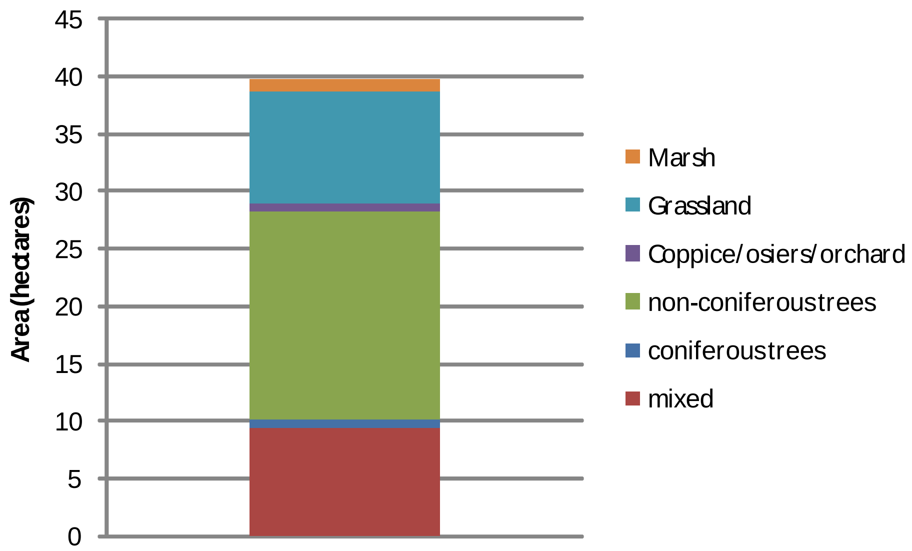


Figure 45 - *Hastings green space sub-divided by type*