Building Engineering - Sustainability

Prepared on behalf of the participating Local Authorities of Hertfordshire

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Hertfordshire Renewable and Low Carbon Energy Technical Study

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List of Acronyms

AD	Anaerobic Digestion
ASHP	Air Source Heat Pump
BER	Building Emission Rate
BR	Building Regulations
CERT	Carbon Emission Reduction Target
CHP	Combined Heat & Power
CIL	Community Infrastructure Levy
CO_2	Carbon Dioxide
COP	Coefficient of Performance
DER	Dwelling Emission Rate
DH	District Heating
ESCo	Energy Services Company
FiT	Feed in Tariff
GIS	Geographic Information System
GSHP	Ground Source Heat Pump
HECA	Home Energy Conservation Act
JESSICA	Joint European Support for Sustainable Investment in City Areas
kWh	Kilowatt hour
LA	Local Authority
LABV	Local Asset-Backed Vehicles
LDF	Local Development Framework
LPA	Local Planning Authority
LSP	Local Strategic Partnership
MWh	Megawatt hour
NI	National Indicator
PPS	Planning Policy Statement
PV	Photovoltaic
RLC	Renewable and Low Carbon
ROC	Renewables Obligation Certificate
SAP	Standard Assessment Procedure
SHLAA	Strategic Housing Land Availability Assessment
SHMA	Strategic Housing Market Assessment
TER	Target Emission Rate

Non Technical Summary

This Non-Technical Summary includes the recommended policy options and guidance on potential wording

Project Background and Objectives (Chapter 1)

AECOM has been commissioned by the participating local planning authorities[1] (LPAs) of Hertfordshire (the 'project group'), to undertake a Renewable and Low Carbon Energy Study. The study will support the reduction of CO_2 emissions from residential and non-domestic buildings in the County through the use of planning policy. This in turn will encourage the uptake of Renewable and Low Carbon (RLC) technologies. Please note, this study refers to "Renewable and Low Carbon" rather than "Low and Zero Carbon" in order to be consistent with the terminology in The PPS1 Supplement on Planning and Climate Change.

The study will form part of the evidence base for the emerging Core Strategies for each of the participating LPAs and reflects the requirements of Planning Policy Statement (PPS) 1 'Delivering Sustainable Development', and the PPS1 Supplement on Planning and Climate Change. It is also intended to inform future development of other local development documents.

The objectives of the study are to identify the:

- Distribution and extent of existing and potential RLC energy resources within Hertfordshire, and how they can be exploited, in relation to specific new developments and larger scale heat and power generation.
- Feasibility of setting an on-site CO_2 reduction target from decentralised RLC energy sources in new development.
- Potential for policies for inclusion in the Core Strategy set in the context of future requirements of the Code for Sustainable Homes, and to some extent BREEAM for non-domestic buildings.
- Delivery mechanisms to assist participating LPAs in implementing policies adopted.

The Need for a RLC study – Policy Context (Chapter 1)

The main objective of this study is to meet the policy requirements set by PPS1 and its Supplement, and to identify options for delivering Renewable and Low Carbon opportunities to Hertfordshire. The key requirements for local planning authorities are to have "*an evidence-based understanding of the local feasibility and potential for renewable and low-carbon technologies".*

Particular regard has been made to the policy requirements set out in the PPS1 Supplement in the preparation of this study. In addition, a government consultation on a replacement PPS 'Planning for a Low Carbon Future in a Changing Climate' was published on 9th March 2010, which aims to combine and update the existing PPS on climate change and PPS22 on renewable energy. While this is not yet policy it does provide an important indication of the government's future direction of travel. In summary, it supports the notion that the role of planning is to identify energy and climatic opportunities and risks spatially and to use this understanding to set out planning policies designed to support action and delivery, while also acting as a wider resource for use by the local authority and local strategic partnerships.

Policy ENG1 of the East of England Plan encourages new development to be located and designed to optimise its carbon performance and states that local authorities should encourage the supply of energy from decentralised renewable and low carbon energy sources. The Plan also sets targets for renewable and low carbon energy generation in the region (Policy ENG2) and encourages Development Plan Documents to set ambitious but viable proportions of the energy supply of new development to be secured from such sources.

The current 2006 Building Regulations Part L governs the energy efficiency of buildings measured by reductions in CO_2 emissions. Following consultation, the Government announced a policy in July 2007[2] that all new homes will be designed to be zero carbon from 2016. In Budget 2008, the Government announced an ambition that new public sector buildings should be zero carbon from 2018, one year in advance of the commercial new non-domestic buildings sector.

To enable industry to gear up to zero carbon the following interim changes to the Building Regulations for homes are likely to be introduced:

- 2010 = 25% improvement in regulated emissions (relative to 2006 levels). This corresponds with the mandatory energy and CO_2 standards for Level 3 of the Code for Sustainable Homes.
- 2013 = 44% improvement in regulated emissions (relative to 2006 levels), corresponding to Code Level 4 mandatory energy and CO_2 standards.

A further consultation in 2008[3], followed by a Government statement in July 2009 confirmed the definition of zero carbon that will be applied to new homes and set out how it will be taken forward. Achieving zero carbon will include three stages:

1. **Energy Efficiency** - taking account of the building fabric energy efficiency
2. **Carbon Compliance -** taking account of systems and controls, such as heating/cooling systems, RLC technologies and mechanical ventilation.
3. **Allowable Solutions -** covering the remaining carbon emitted from the dwelling for 30 years.

Government has not yet confirmed how the allowable solutions will operate; however, it is likely to result in significant investment in off-site renewable and low carbon measures in local areas. Planning will have a key role in identifying these opportunities. Allowable solutions could be a future source of finance for local authorities for renewable and low carbon energy schemes.

Hertfordshire in Context – Existing Energy Demand (Chapter 2)

The County has a land area of 1,634 square kilometres and comprises one city and a variety of market towns, industrial towns, new towns, commuter villages and rural villages. At the last census (2001), Hertfordshire had a total population of approximately 1,034,000, 87% of whom live in the 45 settlements of over 3,000 people. The County has a large number of 'Special Designations'. There were approximately 420,650 households with residents in Hertfordshire at the time of the last Census in 2001 (although current statistics suggest this figure is now around 457,000) and the majority are owner-occupied.

Although housing provision targets for each local authority have been set at the regional level through the East of England Plan (some of which have been removed following a successful legal challenge), more recent Strategic Housing Market Assessments (SHMA) were carried out in 2008, and updated in September 2009. Three SHMAs were produced. In addition, the project group provided, where available, copies of their Strategic Housing Land Availability Assessments (SHLAAs).

Data from both the SHMAs and SHLAAs, and where required the East of England Plan, has been used to inform the modelling undertaken for this study. GIS maps have been produced to show CO_2 emissions per unit area, and density of average heat and electricity demand from existing buildings (i.e. 'anchor loads') across Hertfordshire, based on the model.

Key considerations emerging in relation to existing energy demand are summarised as follows:

- Domestic per capita CO_2 emissions in the County are higher than both the regional and the national average and Hertfordshire is expected to deliver many tens of thousands more homes by 2021.
- Updates to Part L and the Zero Carbon Hierarchy will see decentralised energy through RLC technologies and district heating playing a significant role in delivering zero carbon homes from 2016.
- Local planning policy is expected to play a major role in facilitating the move towards zero carbon by gearing up the house building industry and supply chain to 2016.
- Areas of high energy demand and related CO_2 emissions from existing buildings are concentrated in the higher density areas of the major settlements. Buildings and developments in these areas offer the biggest potential as anchor loads for district heating opportunities.
- Future new development may offer opportunities to improve the energy performance of existing development through the delivery of district heating systems.

Opportunities for Energy Efficiency (Chapter 3)

We have considered the opportunities for reducing CO_2 emissions through increased energy efficiency in the existing stock and in new developments. Improvements to the Building Regulations over the last few decades have led to current standards relating to energy consumption and CO_2 emissions being significantly higher than for existing buildings. This means that new buildings will be responsible for less CO_2 emissions than the equivalent existing buildings. Therefore, to make significant reductions in energy use and CO_2 emissions, it is

[1] The participating LPAs are: Broxbourne Borough Council; Dacorum Borough Council; East Herts District Council; Hertsmere Borough Council; North Herts District Council; St Albans District Council; Three Rivers Borough Council; Watford Borough Council; Welwyn Hatfield Borough Council; Hertfordshire County Council.

[2] Building A Greener Future: Policy Statement

[3] Definition of zero carbon homes and non-domestic buildings (Department for Communities and Local Government, December 2008)

vital that local authorities address the existing stock efficiency levels alongside promoting high standards in new development. For this reason, this study also considers related opportunities to improve energy efficiency in existing buildings.

Key considerations in relation to opportunities for energy efficiency are summarised below. In many cases the implications go well beyond the remit of planning:

- Energy use and CO_2 emissions from the existing building sector are likely to be significantly higher than for post 2010 construction for many decades to come.
- There may be significant potential in some authorities to reduce energy demand through solid wall insulation, and efforts should be made to identify potential dwellings and assess the viability of installing insulation.
- Improved thermal performance of homes can lead to a rebound effect, where CO_2 savings are partially offset by improvements in comfort. Assessing potential energy and CO_2 savings should take account of this effect when monitoring.
- Appropriate specification of new buildings or renovations can reduce energy demand and improve thermal comfort, including overheating.

Opportunities for District Heating and CHP (Chapter 4)

We have considered the opportunities for reducing CO_2 emissions through the supply of low carbon heat. District heating (DH) is an alternative method of supplying heat to buildings, using a network of super insulated pipes to deliver heat to multiple buildings from a central heat source, such as a Combined Heat and Power (CHP) plant. A CHP plant is essentially a local, smaller version of a traditional power station but by being combined with heat extract, the overall efficiency is much higher (typically 80% – 85%). Whilst the electrical efficiency of smaller CHP systems is lower than large scale power generation, the overall efficiencies with heat use are much higher resulting in significant CO_2 reductions.

The current and draft replacement PPS places significant emphasis on DH and on the role of local authorities in its facilitation. In this chapter we discuss the opportunities in Hertfordshire for establishing DH networks and CHP.

It is theoretically possible to develop a DH network with CHP anywhere that there are multiple heat consumers; however the basic economics of schemes, the size of the CHP engine and the annual hours of operation (or base load) mean that viability is limited to higher density areas. CHP is therefore most effective when serving a mixture of uses, to guarantee a relatively constant heat load. High energy demand facilities such as hospitals, leisure centres, public buildings and schools can act as anchor loads to form the starting point for a district heating and CHP scheme. Key considerations for DH and CHP are as follows:

- DH and CHP increases the efficiency of heat and power generation compared with conventional generation. This results in significant CO_2 reductions, and can contribute to renewable energy targets if powered by biomass or biogas.
- Heat mapping suggests that there could be a significant potential for CHP and district heating in Hertfordshire. In all cases this needs further analysis on a case by case basis using the heat mapping of potentially viable areas in this study as a starting point.
- Further opportunities will be presented by proposed new development, but their extent will be affected by a range of factors, including future heating demands. CHP and DH are most viable when there is a mix of uses with a high and stable heat demand.
- Opportunities for DH will be greater where new developments can be physically linked to buildings in existing developments.
- It is likely that the roll out of DH in existing areas will require some form of public sector support.

Opportunities for Renewable and Low Carbon Technologies (Chapter 5)

We have considered the various RLC technologies currently available and their implications for feasibility and viability. From information provided by the project group and our own research we were able to outline the opportunities for decentralised renewable and low carbon energy installations in Hertfordshire, based on the existing installations and development coming forward. Key considerations are summarised as follows:

- Hertfordshire has resource potential for large scale wind turbines across 604 km^2. This potential should be exploited due to the significant CO_2 emission reductions that large scale wind offers.
- Smaller, 'community' scale turbines of around 15m to 45m tip height could be an opportunity in most areas of the County. Smaller turbines have a significantly reduced visual impact and would be particularly suited to farms, industrial sites and municipal buildings such as community centres or schools.

It should be noted that some land designated as a 'soft' constraint will not physically prevent the installation of wind turbines. These areas may have constraints which <u>will</u> need careful examination on a case by case basis to ensure that wind turbine development is appropriate to the area, but should not be considered a blanket constraint'

Government policy on development in the green belt is set out in PPG2. The opportunity areas identified in the study area treat Green Belt as if development of renewable or low carbon energy generation automatically conflicts with that designation and is therefore not acceptable. However, PPS22 is clear that whilst elements of many renewable energy projects will comprise inappropriate development, this does not preclude them from taking place should very special circumstances be demonstrated. Very special circumstances for example could include the wider environmental benefits associated with increased production of energy from renewable sources. The location of opportunity areas and therefore energy generation of the study area is potentially greater if GB designation is viewed within the context of PPS22.

Further information and guidance on green belts is provided within this report.

- The County can generate around 1,330,000 MWh from energy crops and 50,000 MWh from arboriculture arisings per year. This is equivalent to the carbon emitted from around 93,500 typical detached homes. Energy crops are relatively expensive compared to some other biomass fuels but do have the potential to provide very significant volumes of fuel.
- There is also significant potential from parks and highways waste, cattle and pig manure, and chicken litter.
- Assuming most of the County's waste resource is solid waste and utilised as energy from waste, the electricity output would be 49,000 to 114,000 MWh and the emission savings would be 28,000 to 65,000 tonnes.
- No resource for geothermal, marine wave or tidal, and very little resource for hydro, has been identified.
- Hertfordshire has potential to exploit a range of microgeneration technologies, including:
  - Solar thermal and PV.
  - Heat pumps (air and ground sourced) may be suited to areas not served by gas and where under floor heating is possible.
  - Biomass heaters are ideal in lower density areas for individual buildings and where DH is feasible in higher density areas.
  - There is limited data on energy generation from building mounted wind turbines in urban locations but early examples appear to have generated significantly less than was predicted by manufacturers and installations should carefully consider local topography.
  - Fuel cells can be used as CHP systems in buildings but are considered to be an emerging technology and currently the costs are high.

The Energy Opportunities Plan (Chapter 6)

The Energy Opportunities Plan presents the outcome of the resource mapping and has been used to support the development of RLC polices, in line with PPS1 Supplement and the draft replacement PPS. Using information supplied by the project group and our own research we used GIS to map the opportunities for generating and supplying energy from RLC sources on a County-wide basis, as well as scaled down to a local authority level (these maps have been supplied separately to each participating local authority). The Plan demonstrates the local potential in terms of resource availability and energy demand and identifies current and future opportunities.

The Energy Opportunities Plan plays a key role in developing and supporting planning policies, targets and delivery mechanisms within the LDF process, and can bring added benefit and support to the Core Strategy and other Development Plan Documents. The Plan should also be regarded as a corporate as well as planning resource and used to support other council and LSP strategies, as well as cross-County strategies for maximising the potential for decentralised energy.

However, it should be noted that although the Energy Opportunities Plan provides an overview of potential applicable RLC technologies and systems within an area, it doesn't replace the need for a site specific RLC feasibility study for proposed development sites, and this should be undertaken or requested by the LPA.

The Energy Opportunities Plan shows opportunities for biomass fuel production from various sources throughout Hertfordshire. Exploiting this resource would help ensure a constant and sufficient resource is available if biomass plants were to be promoted, without the need for considerable transportation.

Hertfordshire has good wind energy opportunities as shown in the wind speed map of the County in Section 5 (Figure 5.1). However, land availability after engineering and physical constraints have been considered will limit resource potential and other softer constraints need to also be considered on a case by case basis. Although not mapped, smaller scale wind development is less constrained and therefore offers good potential for reducing CO_2 from small sites and from buildings, and should be considered positively by LPAs across the County in appropriate areas.

The Plan presents clearly opportunities for exploiting DH. Viability of potential schemes will be improved by linking of new and existing development, sharing energy centres and making use of anchor loads. The proximity to neighbouring local authorities is important in that it provides opportunities for cooperative working, but it should also be noted that this can present risks. It would be appropriate to use the Energy Opportunities Plan to identify where these opportunities may lie and work with neighbouring authorities, developers and other stakeholders on cross-County strategies. By identifying now the investment opportunities for DH infrastructure that would be utilised by development coming forward in the future, the Plan can go some way to supporting the ramp-up to zero carbon homes in 2016 and the drive towards decentralised energy.

The Use of 'Character Areas' in Policy Testing (Chapter 6)

As demonstrated by the Energy Opportunities Plan, developments in some parts of the County will have RLC energy supply opportunities which are not afforded to developments elsewhere in the County. To reflect this County variation when testing the policy options, three character areas have been defined with the following assumptions:

- **Energy Constrained:** This assumes that no community or large scale renewable or low carbon energy resources are available in the vicinity of the development site. Options for complying with the policy options are limited to what can be achieved in individual buildings, namely microgeneration technologies such as solar thermal and solar PV, or gas CHP systems providing individual buildings, or payment to a Carbon Buyout or Allowable Solutions Fund (if implemented by Hertfordshire LPAs). This option assumes that biomass is not feasible due to delivery and/or air quality constraints.
- **District Heating:** This assumes that the site is in an area where district heating beyond the site boundary may be a viable option. This could be because there is sufficient local heat demand from existing buildings to justify establishing a district heating network, or there is a local source of available heat, such as the biomass proposal in Potter's Crouch in St Albans or energy from waste site in Westmill.
- **Wind:** This assumes that the site is in a location where wind speeds and constraints mapping indicates that on or near-site wind turbines could be an option.

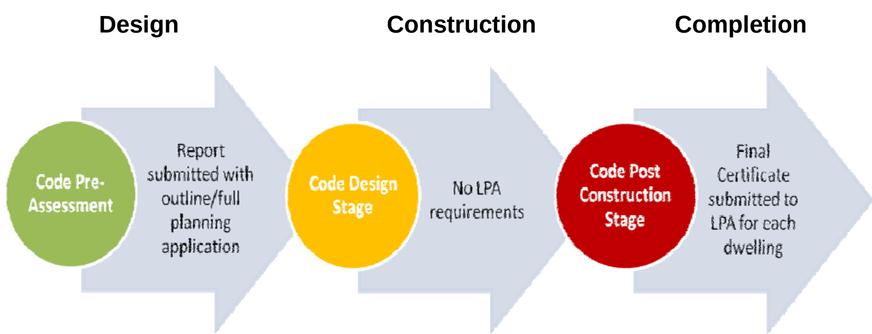
The Code for Sustainable Homes (Chapter 7)

We have assessed the technical feasibility and the construction cost implications of achieving different levels of the Code for Sustainable Homes (Code). The Code is the national standard used to assess the environmental performance of dwellings and can be used by LPAs to define planning policy standards. The PPS1 Supplement supports the use of Code and states: "*when proposing any local requirement for sustainable buildings planning authorities should specify the requirement in terms of achievement of nationally described sustainable buildings standards, for example in the case of housing proposals to be delivered at a specific level of the Code for Sustainable Homes"*.

The Code assessment method encourages a development to go beyond the regulatory minimum by adopting better sustainability practice. It addresses a range of sustainability issues such as energy, water, waste, materials and surface water runoff. Some issues are mandatory to achieve at each Code level (1 to 6, with Level 6 of the energy section equating to a zero carbon home – the Building regulations definition of zero carbon currently differs from that included in the Code); however points are awarded for achieving the voluntary/tradable credits.

The mandatory elements of the energy section, which is broadly aligned with Part L of the Building Regulations, tends to be the most challenging to achieve, but can provide significant carbon savings. The water section can also bring benefits through reducing a dwelling's water consumption. This issue is particularly pertinent to Hertfordshire. The County is one of the driest in the UK and water resources are predicted to decrease in the future due to climatic change and pressure through significant housing development. The East of England Regional Assembly supports a maximum water use rate of 105 l/p/d, which equates to Levels 3 and 4 of the Code and can be met relatively inexpensively through water efficient sanitaryware. The water elements of Levels 5 and 6 can also be particularly challenging and costly to implement.

The Code offers LPA officers a useful tool for validating compliance with sustainable construction policies through the use of 3^{rd} party verification and certification of Code dwellings. An example of how the Code could be applied to the planning application process is provided below:



A number of key considerations have emerged in relation to the Code. Setting requirements through policy for the use of Code in new development would:

- Meet the objectives of PPS Planning and Climate Change in terms of local requirements for sustainable buildings
- Improve the overall environmental performance of new development providing both environmental and social benefits on a local and national scale
- Go some way towards addressing the potential future impacts of climate change through the reduction of CO2 emissions and adaptation measures
- Support developers and the supply chain in gearing up to zero carbon
- Assist development control officers in assessing and validating compliance with policies and targets though the use of 3rd party certification

In addition:

- The Code Cost Review indicates that a significant proportion of the costs of delivering current Code levels arise in meeting the standards for energy and CO_2 emissions.
- The Code is under review and the energy section is likely to change significantly. The costs associated with the updated energy section are still to be determined. However there is unlikely to be any major changes to other sections of the Code.
- The Code level 3 mandatory 25% Dwelling Emission Rate (DER) improvement is due to become a legal requirement through Building Regulations from the end of 2010 and therefore should not be considered as an additional build cost.
- There is a jump in cost when moving from Code Level 4 to Code Level 5 due to the associated improvement to the DER, but also the need for water re-use and recycling systems to achieve the 80 l/p/d maximum water use rate.
- Although it could be reasonably justified for an LPA to require a Code rating of Level 3 or 4, and potentially a BREEAM rating of 'Very Good' for non-domestic development, a development's ability to deliver this rating may need to be assessed on a case by case basis, taking into account the physical site constraints which may affect achievement of some credits.
- Come 2016, planning will still have a role to play in requiring developments to consider and achieve sustainable buildings in a holistic way and not just through zero carbon.

Target Recommendations (Chapters 8 and 9)

The analysis and discussion in this section allows recommendations to be made on the type and extent of policy which can be applied to new development across Hertfordshire. An in-house AECOM spreadsheet model was used to carry out a technical feasibility analysis for various Policy Options for a range of Case Study development sites. It is important to recognise that the proposed changes to Building Regulations leading to zero carbon are very challenging in themselves and are based on extensive technical and financial viability analyses. Alongside this, the rapid changes in proposed regulations means that any locally implemented policies will only impact on the shorter term (the next 6 years for homes) and then be overtaken by national regulation. Therefore, the recommended policy options should provide greater CO2 reductions where possible but in a way which does not significantly impact on development viability.

When interpreting the model findings it is important to note that the cost uplifts above business as usual reflect constructions costs only and do not themselves constitute a viability assessment. To make a judgement on the viability or otherwise of particular targets these numbers should be included in a full viability assessment, perhaps undertaken alongside an assessment of affordable housing viability. The recommendations set out here will need to be considered again following such an assessment.

The two policy options based around percentage improvements on Building Regulations provide small CO_2 savings. Policy 1 (BR+10%) often shows the same capital cost uplift savings as Policy 2 (BR + 15%) but can often be met with the same or similar measures required for Building Regulations. Therefore, Policy 2 is considered preferable to Policy 1.

The Advanced Code +2 Policy (Policy option 4) has been shown to be significantly more expensive than the Advanced Code +1 Policy (Policy option 3) and it is considered that the technology and allowable solutions costs required to meet the 100% reduction in regulated emissions in 2011 could be too financially demanding for developers. Therefore Policy option 3 is considered further in preference over Policy option 4.

The Advanced Code +1 Policy (Policy option 3) shows a capital cost of between zero and £6,000 per dwelling before 2017 and zero and £140 per sqm for non-domestic buildings before 2020. This may be challenging but is considered achievable for most sites, and is currently required for all publicly funded social housing by the Homes and Communities Agency. The higher CO_2 reduction requirements of Policy option 3 (Advanced Code+1) could promote earlier adoption of district heating networks as a means to achieving compliance before 2017. This has the advantage of building capacity and helping developing a supply chain for the construction of zero carbon homes prior to 2017. Furthermore, the use of allowable solutions before 2017 can provide a potential route for reducing CO_2 emissions in the existing building sector.

Policy option 5, which promotes renewable energy in meeting Building Regulations targets, does not result in higher CO_2 savings, but can increase construction costs. The nature of this policy is also against the aims of PPS1 by stipulating the technologies should be renewable and not simply low or zero carbon, and it is therefore not justifiable. The requirement to deliver the target CO_2 reduction via specific technologies also makes demonstrating compliance more complicated since it involved calculating the proportion that has come from the renewable technologies.

In summary, a policy requiring CO_2 standards one step ahead of the Building Regulations based on the Code for Sustainable Homes mandatory CO_2 standards (Policy option 3) is considered to be the most suitable type of policy for large developments in district heating and wind opportunity areas. This provides relatively large CO_2 reductions beyond national standards in the period up to 2016 (and 2019 for non domestic), and helps to promote measures which support future improvements in CO_2 reduction, but with relatively small additional costs. For development in energy constrained areas, the less demanding Policy option 2 is considered suitable. These targets are reflected in the proposed policy wording.

Proposed Policy Wording (Chapter 9)

A suite of planning policies is recommended to assist in delivering the Energy Opportunities Plan. The policies have been developed based on the outcomes of the policy testing and in terms of feasibility and impact on development cost.

In identifying and appraising policy options we have started from the basis that meeting the challenges of climate change and increasing renewable and low carbon energy capacity cannot and should not be delivered through planning alone. Understanding the role of planning as part of a wider set of national, regional and local delivery mechanisms is crucial. That said, planning is unique in being the only activity that is able to build up a comprehensive spatial understanding of the opportunities and constraints for decentralised renewable and low carbon energy.

Using the Energy Opportunities Plan as the starting point, potential policy and delivery mechanisms have been assessed for their impact on both existing and new development (Chapter 6). The evidence demonstrates that the energy technologies available and the CO_2 reductions that may be achieved differ according to the type of development and its location in the district. Three different character areas have been identified to reflect this local variation.

This approach allows us to take advantage of the distinct merits of the planning system in promoting decentralised renewable and low carbon energy without unnecessarily stretching its remit where other regulatory or support regimes may be better placed to take a lead. Importantly, the focus on delivery mechanisms also allows us to address the difficult issue of developer viability by potentially shifting much of the additional cost burden away from developers and onto third parties.

Policy recommendations and predicted CO_2 savings are based on the assumption that the trajectory to zero carbon continues as proposed and that as-built development matches design. Changes to national policy, including future proposals for the Building Regulations, would alter the relative impact of the policies described here. In this event, the policy recommendations described here should be reviewed.

The following policy recommendations are made either for incorporation into Core Strategies or other local development documents or guidance.

The Energy Opportunities Plan

The district or borough specific Energy Opportunities Plan should be incorporated into Core Strategies and should be reviewed regularly to ensure they remain up-to-date.

Core Strategy Recommendation 1: The Energy Opportunities Plan

Planning applications for new development will need to demonstrate how they contribute to delivery of the opportunities identified in the current Energy Opportunities Plan. Different energy technologies and CO_2 reduction strategies will suit different parts of the district/borough and different types of development. To reflect this we have identified three character areas: as shown in the Energy Policy Map (*LPA to insert reference to the EOP*):

- Energy constrained – Areas where district heating or energy from wind is either not feasible or viable. Due to the constrained nature of the site, developers will be required to achieve CO_2 emissions reductions in line with Building Regulation Part L (non domestic buildings) and the Code for Sustainable Homes (Domestic Buildings). However, developments would still be expected to explore the feasibility of other opportunities for renewable or low carbon energy generation, from microgeneration or biomass for example. Larger development sites that come forward within energy constrained areas may be suitable to support renewable and low carbon technologies that would allow higher carbon reduction targets to be met. This will be assessed on a site-by-site basis.
- District heating – the Council's ambition is to develop networks across each district heating priority area. New development in these areas should, where possible, contribute to this objective by considering district heating as their first option for the heat supply to the site.
- Wind – wind priority areas have been identified to encourage consideration of wind turbines as stand-alone projects or turbines linked to new and existing development.

A district/borough-wide Supplementary Planning Document will be prepared for each character area to help developers understand what is expected of them for the different development types set out in these Character Areas.

Policy Justification

The Energy Opportunities Plan acts as the key spatial map for energy projects in Hertfordshire. It underpins the policies described here and sets out where money raised through mechanisms such as the Community Infrastructure Levy (CIL) could be spent. It should be used to inform the Sustainable Community Strategy and other corporate strategies, and investment decisions taken by the local authority and local strategic partnership (see Appendix D for further detail on delivery mechanisms).

The energy opportunities include commercial and community scale wind; district heating using waste heat from local sources or from community scale CHP, particularly if development is led by the Council; biomass boilers and other microgeneration technologies. However, the policy does not seek to rule out any other technology if it is in-line with council objectives to deliver reductions in CO_2 or increase the supply of decentralised renewable and low carbon energy.

The character area approach is designed to help applicants determine which technologies are likely to be most suited to a given area. It also seeks to encourage energy installations that will contribute to delivering all opportunities identified in the current Energy Opportunities Plan in the most effective way. The policy recognises, however, that the pace of change is rapid in this field and new technologies are likely to become viable and feasible within the lifetime of this plan and that the applicability of existing technologies to different development types is also likely to change. This could mean the technologies not currently considered suitable to particular areas may become so. It is not the intention to restrict this kind of innovation and LPAs should be prepared to discuss proposals that deviate from the Energy Opportunities Plan and character areas with applicants at the pre-application stage. The SPD will provide information to inform pre-application discussions, including which technologies work well together and which do not.

The policy recognises that different character areas and development types will have different opportunities for achieving CO_2 reductions. For example, developments in energy constrained areas will have fewer opportunities for delivering CO_2 reductions cost effectively than those in the other two character areas. However, it may be possible for some larger scale development proposed within Energy Constrained areas to achieve higher levels of carbon reduction. This is most likely to be (but not limited to) developments which are sufficiently large, or with a sufficiently high heat load, to support heat network schemes. In this instance it is likely that stand alone developments will be able to support decentralised heat networks to serve the site itself and not rely on a proximity to an identified district heating opportunity area outside the development boundary. Similarly, small developments are also likely to have fewer opportunities than major development (i.e. applications for development over 10 residential units, 1,000 sqm of commercial).

Core Strategy Policy Recommendation 2: Energy and CO_2 Reductions for New Developments in Energy Constrained Areas

All new residential developments in **Energy Constrained Areas** will be required to achieve the following levels of the Code for Sustainable Homes (Code) as a minimum. This requirement will not come into effect until successive updates to Part L of the Building Regulations become mandatory:

- 2010 –Code level 3 as a minimum will be required for all new homes once updates to Part L come into effect (currently scheduled for October 2010).
- 2013 - Code level 4 as a minimum will be required for all new homes once updates to Part L come into effect.
- 2016 - Code level 6 will be required for all new homes once updates to Part L and the national Zero Carbon Homes policy come into effect.

All new non domestic buildings in Energy Constrained Areas will be expected as a minimum to achieve CO_2 emissions reductions in-line with the Building Regulations Part L. This requirement will not come into effect until successive updates to Part L of the Building Regulations become mandatory:

- 2010 – 25% reduction in the Building Emission Rate compared to the Target Emission Rate defined by the Building Regulations (currently scheduled for October 2010).
- 2013 – 44% reduction in the Building Emission Rate compared to the Target Emission Rate defined by the Building Regulations (reductions above 70% can be delivered using allowable solutions).
- 2019 Zero Carbon – no additional requirement.

Where the proposed new development is located within an Energy Constrained Area, the local authority expects the Energy Opportunities Plan to be used to explore other opportunities for renewable and low carbon energy generation (other than wind or district heating) in order to help meet Building Regulation minimum levels and / or Code for Sustainable Homes. Other opportunities could include microgeneration or heat from biomass for example.

It is expected that over time the status of some land currently designated as energy constrained will change and no longer present such constraints. In this event the Council will expect all new residential developments of 10 dwellings and above and new non-domestic developments of 1000 sqm and above to meet the targets set out in *CSP Recommendation 3* or *CSP Recommendation 4*; whichever policy is proven by the applicant to be the most viable in order to achieve the required target.

Larger development sites that may come forward in energy constrained areas may be suitable to support renewable and low carbon technologies that would allow higher carbon reduction targets to be met. All new development within energy constrained areas with a sufficient heat load should consider installing a district heating network to serve the site. Unless the applicant can demonstrate that compliance with these requirements on a particular site is neither feasible nor viable, these developments will be required as a minimum to achieve the levels of Code for Sustainable Homes set out in Core Strategy Policy Recommendation 3.

(Note for LPAs: If a Carbon Buyout Fund is to be created then the following text is recommended)

If an applicant can demonstrate that compliance with the target or the specific requirements from both of these policies are not feasible on site, a payment into the Carbon Buyout or 'Allowable Solutions' Fund will be required.

Core Strategy Policy Recommendation 3: Energy and CO_2 Reductions for New Developments in District Heating Opportunity Areas

All new residential developments of 10 dwellings or more in **District Heating Opportunity Areas** as a minimum will be required to achieve the following levels of the Code for Sustainable Homes (Code). This requirement will not come into effect until successive updates to Part L of the Building Regulations become mandatory:

- 2010 –Code level 4 as a minimum will be required for all new homes once updates to Part L come into effect (currently scheduled for October 2010).
- 2013 - Code level 5 as a minimum will be required for all new homes once updates to Part L come into effect.
- 2016 - Code level 6 will be required for all new homes once updates to Part L and the national Zero Carbon Homes policy come into effect.

All new non domestic buildings of 1000 sqm ore more in **District Heating Opportunity Areas** as a minimum will be expected to achieve the following CO_2 emissions reductions in advance of the Building Regulations Part L. This requirement will not come into effect until successive updates to Part L of the Building Regulations become mandatory:

- 2010 – 44% reduction in the Building Emission Rate compared to the Target Emission Rate defined by the Building Regulations.
- 2013 – 100% reduction in the Building Emission Rate compared to the Target Emission Rate defined by the Building Regulations (reductions above 70% should be delivered using allowable solutions).
- 2019 - Zero Carbon – no additional requirement.

New development in District Heating Opportunity Areas should, where possible, contribute to this objective by considering district heating as their first option for meeting the target. It is important to recognise that different development types will have different opportunities, therefore:

- All developments should seek to make use of available heat from district heating networks, including those supplied by heat from waste management sites or power stations.
- Larger developments should consider installing a district heating network to serve the site. The ambition should be to develop strategic area wide networks and so the design and layout of site-wide networks should consider the future potential for expansion into surrounding communities. Where appropriate, applicants may be required to provide land, buildings and/or equipment for an energy centre to serve existing or new development.
- New development should be designed to maximise the opportunities to accommodate a district heating solution, considering: density, mix of use, layout, phasing and specification of heating, cooling and hot water systems.

An SPD will be prepared and will set out the approaches that developers might adopt to deliver the target.

These requirements will apply to a development in or adjacent to a District Heating Opportunity Area or located close to potential sources of waste heat unless the applicant can demonstrate that compliance with these requirements on a particular site is either not feasible or not viable.

(Note for LPAs: If a Carbon Buyout Fund is to be created then the following text is recommended)

If an applicant can demonstrate that compliance with the target or the specific requirements is not feasible on site, a payment into the Carbon Buyout or 'Allowable Solutions' Fund will be required.

Small Developments

Small developments (under 10 residential units or 1,000 sqm of commercial) should consider connection to available district heating networks. Where a district heating network does not yet exist, applicants should consider installing heating and cooling equipment that is capable of connection at a later date.

Core Strategy Policy Recommendation 4: Energy and CO_2 Reductions for New Developments in Wind Opportunity Areas

All new residential developments of 10 dwellings or more in **Wind Opportunity Areas** as a minimum will be required to achieve the following levels of the Code for Sustainable Homes (Code). This requirement will not come into effect until successive updates to Part L of the Building Regulations become mandatory:

- 2010 –Code level 4 as a minimum will be required for all new homes once updates to Part L come into effect (currently scheduled for October 2010).
- 2013 - Code level 5 as a minimum will be required for all new homes once updates to Part L come into effect.
- 2016 - Code level 6 will be required for all new homes once updates to Part L and the national Zero Carbon Homes policy come into effect.

All new non domestic buildings of 1000 sqm or more in **Wind Opportunity Areas** as a minimum will be expected to achieve the following CO_2 emissions reductions in advance of the Building Regulations Part L. This requirement will not come into effect until successive updates to Part L of the Building Regulations become mandatory:

- 2010 – 44% reduction in the Building Emission Rate compared to the Target Emission Rate defined by the Building Regulations.

- 2013 – 100% reduction in the Building Emission Rate compared to the Target Emission Rate defined by the Building Regulations (reductions above 70% should be delivered using allowable solutions).
- 2019 - Zero Carbon – no additional requirement.

New development in wind opportunity areas should consider wind as their first option for meeting the requirements of Policy 4. Wind Opportunity Areas have been designated to encourage applications for all scales of wind turbines, particularly but not exclusively:

- From community groups, co-operatives and individuals
- Related to new domestic and non-domestic developments. Large and mixed-use developments in appropriate locations should consider installing a wind turbine or turbines to serve the site's energy needs.

These requirements will apply to a development in a Wind Opportunity Area unless the applicant can demonstrate that compliance with these requirements on a particular site is either not feasible or not viable.

(Note for LPAs: If a Carbon Buyout Fund is to be created then the following text is recommended)

If an applicant can demonstrate that compliance with the target or the specific requirements is not feasible on site, a payment into the Carbon Buyout or 'Allowable Solutions' Fund will be required.

Wind power will play an important role in reducing CO_2 emissions and increasing installed renewable and low carbon energy capacity. Criteria policies should be prepared to guide applicants and development management decisions.

Policy justification – targets

Changes to the Building Regulations in 2010, 2013, 2016 and 2019 are expected to bring in tighter standards for CO_2 emissions. After 2016 it will be necessary for all new residential buildings to be delivered as zero carbon homes, with the equivalent standard for non-residential buildings due to be introduced in 2019. The role of planning in requiring new development to incorporate such technologies should therefore be limited to a supporting one.

The intention is to encourage applicants to reduce CO_2 emissions from proposed development beyond the Building Regulations requirements, where feasible and viable, and to obtain financial contributions towards community scale renewable and low carbon energy infrastructure. Three target options are recommended for a combination of targets and/or payments into a Carbon Fund, represented by the policy options above.

The targets proposed seek to accelerate the move towards zero carbon ahead of Building Regulations. All new buildings over a set threshold - both residential and non-residential - would be expected to achieve CO_2 emissions reductions one step ahead of the Building Regulations Code Level equivalent with the exception of developments in Energy Constrained Areas. This should be met through a combination of passive energy efficiency measures, incorporation of active energy efficiency, on-site renewable and low carbon energy technologies and direct connection to heat or power (not necessarily on-site).

The proposed policy provides flexibility in proposing renewable and low carbon solutions. The policy recognises that different opportunity areas and development types will have different opportunities for achieving CO_2 reductions. For example, new residential development in energy constrained areas will have fewer opportunities for delivering CO_2 reductions cost effectively than those in the other two opportunity areas.

The proposed policy should be simple to operate for both development managers and developers. Development managers can assess compliance with the targets by asking for design stage and as-built Building Control Compliance documentation.

The evidence base produced in support of this policy demonstrates that the targets should be achievable with minimal impact on overall development costs compared to the Building Regulations base case. It is up to the applicant to demonstrate this to the contrary on a case-by-case basis. However, it is recognised that there may be circumstances when it is not possible or desirable. An example might be in an energy constrained conservation area, where microgeneration technologies may be considered unacceptably intrusive. For such cases there is the option of introducing a Carbon Buyout or 'Allowable Solutions' Fund, with contributions based on the residual carbon emissions after any energy efficiency or on-site generation measures. The Carbon Buyout Fund would act as a 'stop-gap' before 'Allowable Solutions' are brought in through the Building Regulations (note – the Allowable Solutions mechanism is still out to consultation). Further detail on Carbon Buyout Funds and Allowable Solutions is given is Chapter 9.

Policy justification – district heating

The PPS1 Supplement and the draft PPS actively encourage seeking opportunities to set higher standards on specific sites where it can be justified on viability and feasibility grounds. The purpose of this policy is to prioritise district heating in areas where opportunities are the greatest.

The long-term ambition should be to deliver a strategic district heating network across the district heating opportunity areas. Developments will need to show in a design and access statement or energy statement their assessment of the potential to deliver a reduction in the development's CO_2 emissions to the target level using a district heating network. It is recognised that the opportunities for installing such a network across existing communities are, for the most part, beyond the scope of planning. Therefore, the policy requires development to be able to connect once such a network is in place and to be designed to be compatible with future networks, in terms of layout, density and so on. The policy requires larger more strategic new developments to install their own network, which can later be connected up to a larger network or incorporate existing nearby buildings. This has the benefit of reducing CO_2 emissions in new development and contributing to the longer term objective.

Where appropriate, applicants may be required to provide land, buildings and/or equipment for an energy centre to serve proposed or multiple developments. Such a requirement will be important for ensuring availability of the necessary space in the right location for an energy centre designed to serve more than one development. It is expected that requirements will be discussed in pre-application discussions and will be included as part of a planning condition. In order to provide additional certainty to the installation of district heating networks it is recommended that a Local Development Order be considered for the district heating opportunity areas.

This policy supports the approach of building up large scale networks over time. This barriers and challenges associated with developing large scale networks can hinder their development. Therefore by using policy to support smaller scale schemes in different developments and areas, opportunities are provided for combining these into larger scale networks at a later date.

Criteria that have been used to define the district heating opportunity areas are set out opposite.

- New development:
  - o Large scale mixed use development – enables good anchor load and diversity of heat demand
  - o Proximity to high heat density areas of existing buildings – enables extension into existing development
  - o Proximity to existing heat sources
- Existing development:
  - o Heat demand density of at least 3,000kW/km^2 . These areas generally have higher density residential or commercial buildings. The presence of large public sector buildings can assist with acting as a catalyst for schemes.
  - o Proximity to sources of heat (e.g. industrial processes) – enables zero carbon energy source

The final wording of this policy and its justification will need to be based on decisions taken about the wider role of the local authority and its partners. Options and their implications for planning policy are discussed in more detail in Chapter 10.

Policy justification – wind

The planning policy approach represents the application of national policy to the Hertfordshire context. The PPS1 Supplement on Planning and Climate Change and PPS22 (Renewable Energy) are both supportive of wind power and this policy has been worded accordingly. The primary driver for such a strongly worded supportive policy for wind are the twin challenges of achieving the national legally binding 34% reduction in CO_2 emissions over 1990 levels by 2020 and the equally binding requirement for the UK to generate 15% of its total energy from renewable sources, also by 2020. The Government's Renewable Energy Strategy expects a significant proportion of this to be delivered from onshore wind. It is evident therefore that every available opportunity for wind power needs to be taken advantage of.

The Energy Opportunities Plan is likely to be more directed at opportunities for community scale wind turbines since commercial developers looking to install large scale wind turbines are likely to develop their own constraints maps. Therefore policies should be prepared to guide applicants and development management decisions for community scale turbines.

The wind opportunity areas seek to promote community scale turbines. As such, the designation is based on the following criteria:

- Good local wind resource, consider hilltops, avoid forested areas.
- Close to electricity infrastructure (e.g. 10-30kV power lines, substations) to connect to grid.
- Close to roads, railways for easier transport of components to site.
- Close to the community involved (but not close enough to cause noise issues).
- Consideration of environmentally and archaeologically sensitive areas.
- Consideration of areas of high landscape quality (e.g. AONBs).
- Consideration of local airports and defence structures (e.g. radars and flight paths).
- Consideration of local residential areas.

Clearly some of these criteria are the same as those used by commercial wind developers. An important distinction is the proximity to the community involved. Here we have assumed that communities investing in their own wind turbine would be keen to be able to see it, but equally these locations are less likely to be of interest to commercial developers.

Developers within wind opportunity areas will need to show in a design and access statement that they have fully considered the potential to deliver the required targets using a wind turbine or turbines on site. Where no opportunities exist on-site applicants should demonstrate that they have considered off-site opportunities.

The final wording of this policy and its justification will need to be based on decisions taken about the wider role of the local authority and its partners. Options and their implications for planning policy are discussed in more detail in Chapter 10.

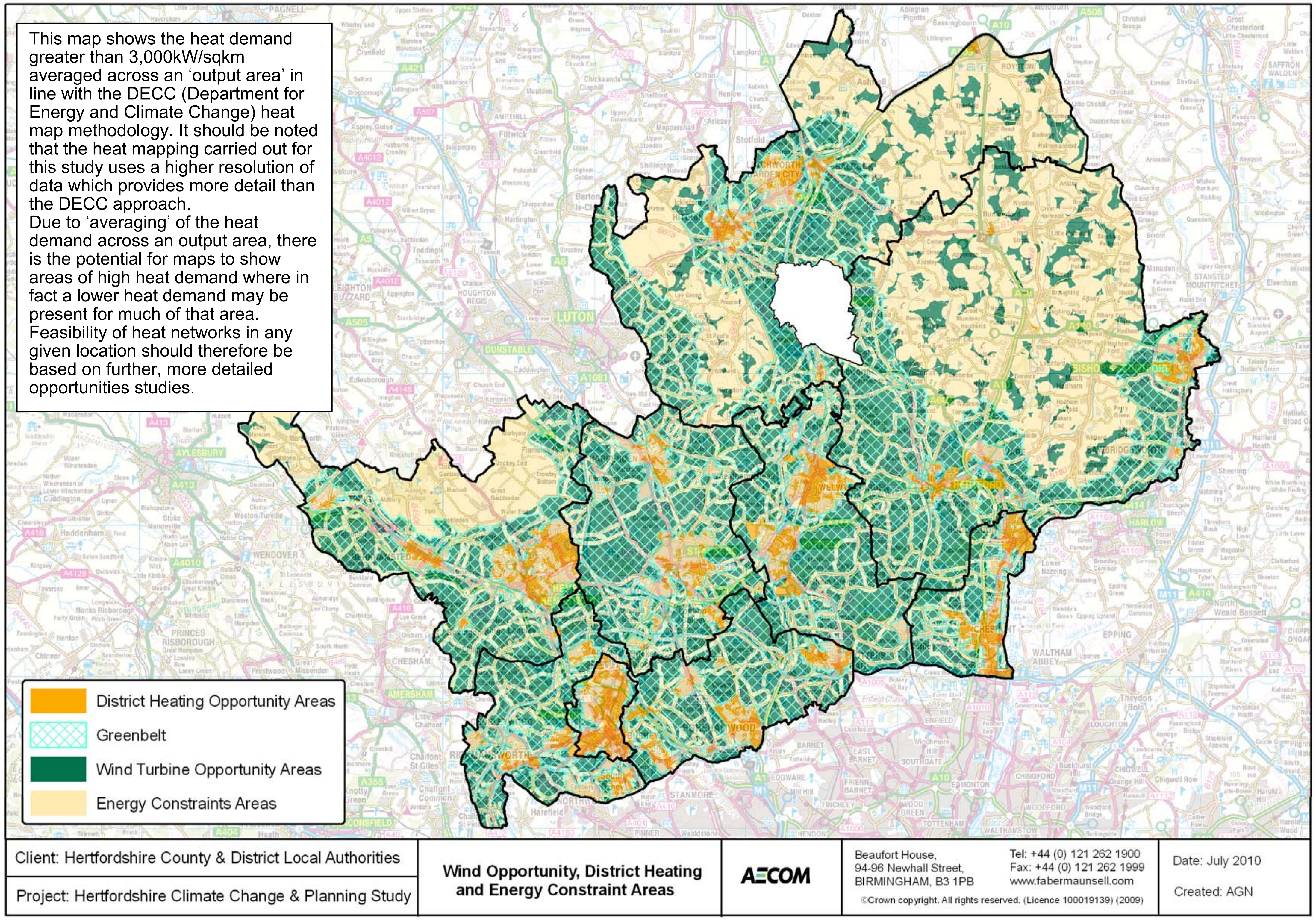


Figure TS1 – Map showing large scale wind opportunity, district heating opportunity and "energy constrained" areas

Delivery of Renewable and Low Carbon Energy in Hertfordshire (Chapter 10)

There are a wide range of delivery mechanisms that can be employed to support planning for energy. Not all will be suitable for Hertfordshire and mix will be needed to encompass all of the energy opportunities. This report provides the context for making those decisions. Further work, discussions and advice will be needed to make them happen. As a first step we recommend that the following next steps be discussed across the County:

Provide the necessary leadership and skills

- The County and its districts must take strategic leadership role together with Local Strategic Partnerships to ensure the necessary political and stakeholder buy-in. This will involve using this study inform preparation of relevant strategies, including climate change and energy strategies.
- Skills must be developed across the councils and its partners and awareness raised amongst communities and stakeholders.

Priority actions and projects

- The County and its districts need to set out a clear framework which gives relative certainty. Action should be prioritised at strategic locations.
- Initiatives to support the proposed residential energy efficiency retrofit policy should be designed to reduce the financial burden on households.
- The County and its districts should work with eligible partners to develop a micro-generation retrofit strategy.
- A set of priority district heating schemes should be drawn up by the County, its districts and partners and further feasibility work carried out. This should be based on factors such as financing options, planning, liaison with stakeholders including the RDA, phasing and type of development.
- Should the County and its districts agree to lead installation of district heating networks then it is recommended that they explore the option of establishing a Local Development Order in order to add certainty to the development process and potentially speed up delivery.
- Beyond the large scale wind opportunity areas identified in the energy opportunities plan opportunities should be explored for isolated turbines in commercial areas The County, its districts and partners should identify delivery opportunities, considering available financial mechanisms, publically owned land and community involvement and ownership.
- Opportunities for biomass, biofuels and biogas should be explored with partners in the wider region.
- The County, its districts and partners should undertake further work to explore the role for the local authority to link housing development to energy supply delivery.

Delivery vehicles and funding

- The County, its districts and partners need to establish an appropriate form of delivery vehicle or vehicles to pursue the key energy efficiency and supply opportunities. Further work will be needed to understand what is suitable for individual districts and project but will need to consider ESCo, partnerships and joint ventures.
- Funding mechanisms should be identified and applied first to priority schemes, co-ordinated through the appropriate delivery vehicle. These could include:
  - Delivery of whole house and street-by-street energy efficiency improvements and retrofit of micro-generation technologies.
  - Setting up a Carbon Buyout Fund, possibly using the CIL or allowable solutions. This should be used to pay for projects identified in the Energy Opportunities Plan, including large or small wind turbines off-site in the wind opportunity areas. Further work will need to be undertaken to establish the extent of the opportunities.
  - Developing a plan to deliver allowable solutions to ensure funding from new development is directed towards the best solutions in a coordinated way.

Communities are likely to play a crucial role in the delivery of energy infrastructure. However, to be successful further work will be needed to explore how communities function within Hertfordshire.

1 Introduction

1.1 Project Scope

AECOM (formerly Faber Maunsell) has been commissioned by the participating local planning authorities[4] (LPAs) of Hertfordshire (referred to as the 'project group'), to undertake a Renewable and Low Carbon Energy (otherwise known as Renewable and Low Carbon "RLC") Study. Please note, this study refers to "Renewable and Low Carbon" rather than "Low and Zero Carbon" in order to be consistent with the terminology in The PPS1 Supplement on Planning and Climate Change.

The study will support the reduction of carbon dioxide (CO_2) emissions from residential and non-domestic buildings in the County through the use of planning policy. This in turn will encourage the uptake of RLC technologies resulting in an increased supply of energy from renewable and low carbon sources.

The study is part of the evidence base for the emerging Core Strategies for each of the participating LPAs and reflects the requirements of Planning Policy Statement (PPS) 1 'Delivering Sustainable Development', and the PPS1 Supplement on Planning and Climate Change. It is also intended to inform future development of other local development documents.

The objectives of the study, as defined in the brief, are to identify:

- The distribution and extent (with mapping) of existing and potential renewable and low carbon energy resources (e.g. wind, biomass, hydro, solar, CHP) within Hertfordshire and how they can be exploited, in relation to specific new developments and larger scale heat and power generation
- Feasibility of setting an on-site CO2 reduction percentage target contribution from decentralised renewable and low carbon energy sources in new development
- Potential for policies for inclusion in the Core Strategy set in the context of future requirements of the Code for Sustainable Homes, and to some extent BREEAM measures for non-domestic buildings.
- Delivery mechanisms to assist participating LPAs in implementing policies adopted, including an assessment of the feasibility of establishing an Energy Service Company.

1.2 Structure of the Report

The report is structured as follows:

1. **Introduction:** Introduction to the purpose and scope of the study.

2. **Hertfordshire in Context:** Summary of the national, regional and local policy context. This chapter also includes a brief description of the existing building stock in the County and the nature of future development across the County.

4. **Opportunities for Energy Efficiency Improvements**: Discussion of the potential to reduce baseline energy demand by designing the form, fabric and services of new buildings to higher energy efficiency standards and refurbishing existing buildings.

5. **Opportunities for District Heating:** Assessment of the potential to supply low carbon heat through district heating with CHP, using maps of heat demand and other local characteristics.

6. **Opportunities for Renewable and Low Carbon Technologies:** Assessment of the potential for supplying energy from renewable and low carbon sources.

7. **Code for Sustainable Homes:** Overview of the implications for future development of setting targets using the Code for Sustainable Homes and BREEAM standards.

8. **Policy Testing:** Describes the policy options and case study development types that have been modelled and tested on their viability.

9. **Policy Recommendations:** Sets out the viability outcomes from the policy testing and puts forward the recommendations for policies that could be applied across the LPAs.

10. **Delivering Renewable and Low Carbon Energy in Hertfordshire:** Discussion of the different mechanisms which may assist in delivering the proposed policy and targets for the district.

Appendix A: Details of workshops held to present interim results of study and harness views of stakeholders on appropriate policy for Hertfordshire.

Appendix B: Description of modelling carried out to estimate current and future energy demand and CO_2 emissions in Hertfordshire, and subsequently test policy and target options.

Appendix C: Detailed description of renewable and low carbon technologies assessed in the study.

Appendix D: Description of funding available for renewable and low carbon technologies.

1.3 The Need for a Renewable and Low Carbon Energy Study

The main objective of this study is to meet the policy requires set by PPS1 'Delivering Sustainable Development' and its Supplement on Planning and Climate Change, and to deliver Renewable and Low Carbon opportunities to Hertfordshire. The key requirements for local planning authorities are summarised below:

- PPS1 and its Supplement on Planning and Climate Change

PPS 1 'Delivering Sustainable Development' (2005) emphasises the need to promote more sustainable development, and the PPS1 Supplement on Planning and Climate Change expects local authorities to encourage the uptake of decentralised, renewable and low carbon energy generation through the Local Development Framework (LDF).

The PPS1 Supplement states that planning authorities should have "*an evidence-based understanding of the local feasibility and potential for renewable and low-carbon technologies".* It goes on to explain that, by drawing on the evidence base and with consistency in housing and economic objectives, planning authorities should:

> *"(i) set out a target percentage of the energy to be used in new development to come from decentralised and renewable or low-carbon energy sources where it is viable. The target should avoid prescription on technologies and be flexible in how carbon savings from local energy supplies are to be secured;*
>
> *(ii) where there are particular and demonstrable opportunities for greater use of decentralised and renewable or low-carbon energy than the target percentage, bring forward development area or site-specific targets to secure this potential; and, in bringing forward targets,*
>
> *(iii) set out the type and size of development to which the target will be applied; and*
>
> *(iv) ensure there is a clear rationale for the target and it is properly tested."*

The PPS1 Supplement states that in preparing Local Development Framework (LDF) Core Strategies, planning authorities should:

> *"Consider identifying suitable areas for renewable and low-carbon energy sources, and supporting infrastructure. Care should be taken to avoid stifling innovation including by rejecting proposals solely because they are outside areas identified for energy generation and…*
>
> *Expect a proportion of the energy supply of new development to be secured from decentralised and renewable or low-carbon energy sources."*

- Draft PPS: Planning for a Low Carbon Future in a Changing Climate

A draft replacement for PPS22 and the PPS1 Supplement on Planning and Climate Change entitled Planning for a Low Carbon Future in a Changing Climate was published for consultation on 9th March 2010. The draft PPS represents an evolution rather than revolution in the way planners deal with climate change, reflecting the significant legislative and policy changes over the past couple of years and providing a far clearer policy framework for planners. Importantly, it lends support to the spatial and facilitative approach that a growing number of authorities have been adopting, including the approach set out here for the Hertfordshire authorities. It is important to note that while we have considered the draft PPS to some extent as part of this study, the current published PPSs continue to be the national policy position.

In summary, the draft supports the notion that the role of planning is to identify energy and climatic opportunities and risks spatially and to use this understanding to set out planning policies designed to support action and delivery, while also acting as a wider resource for use by the local authority and local strategic partnerships.

We have carried out an initial review of the consultation draft. Some of the key messages are noted below:

- Much of the real value of the draft PPS lies in its clear support for identifying energy opportunities through the evidence base. Rather than

[4] The participating LPAs are: Broxbourne Borough Council; Dacorum Borough Council; East Herts District Council; Hertsmere Borough Council; North Herts District Council; St Albans District Council; Three Rivers Borough Council; Watford Borough Council; Welwyn Hatfield Borough Council; Hertfordshire County Council.

necessarily being highly technical, an evidence base should focus on spatially identifying energy opportunities and using this to inform policy-making.

- The role of targets in new development is significantly reduced, relying instead on the building regulations. Specifically:
    - Emphasis for stand-alone energy schemes is on setting criteria based policies at local level, with targets set at regional level using DECC.
    - It spells out how targets should be expressed in LDDs '*if*' they are used, rather than the implication in the current PPS1 Supplement that they '*should*' be used.
    - Increasingly demanding building regulations means that area-wide decentralised energy targets will not be necessary after 2013, though they are supported prior to this.
    - Sites specific targets can still be used, including Code/BREEAM targets (where justified these can be applied to whole areas).
    - The emphasis is very much on using policy to support developers in meeting regulatory requirements, e.g. creation of or connection to district heating.
- Viability is still a key issue. Further clarification will hopefully be included in the forthcoming practice guide since it is proving a challenging issue for many planners. A shift away from on-site energy targets should, however, help to reduce the need for detailed viability studies.
- The green belt policy makes it clear that many renewable energy projects will be inappropriate and that developers will need to demonstrate "very special circumstances" if they are to proceed. These circumstances however include wider environmental benefits associated with renewable energy and suggest that green belt is viewed as a very useful opportunity.

2 Hertfordshire in Context

2.1 Policy Context

The challenge of climate change and the need to reduce greenhouse gases and stabilise CO_2 levels in the atmosphere has intensified. There is now a comprehensive range of legislation and policy at various scales which supports the development and implementation of decentralised renewable and low carbon energy policy and targets

At the international level, the Kyoto Protocol is currently being updated. The 'Bali Roadmap', an output from the Climate Change Conference in Bali (December 2007) set out a two year process to finalise a new legally binding international treaty at the United Nations Climate Change Conference in Copenhagen in December 2009 (COP15). COP15 did not produce this legally binding treaty. Politicians from the 192 participating countries recognised - through the Copenhagen Accord - the scientific view that the temperature increase should be held below a 2°C rise, and promised financial aid to developing countries to help them adapt to climate change. Further political effort is required to establish a new programme to reach an international, and legally binding, agreement on climate change.

The opportunity offered by Copenhagen (COP15) for politicians to set international targets to encourage quick and decisive action in this area was missed. On the global stage the politics lags behind the scientific imperative for early intervention to address this issue. However, the lack of an international agreement will not prevent concerted domestic action from countries showing leadership in tackling climate change.

The UK is already committed to meeting European CO_2 and energy targets, agreed between the European Commission and the Member States. The European Union has agreed to reduce CO_2 emissions by 20% on 1990 levels by 2020, with an intention to increase this target to 30% if international agreement is reached which commits other developed countries and the more advanced developing nations to comparable reductions. In addition the UK **Climate Change Act (2008)** sets a legally binding target for reducing UK CO_2 emissions by at least 80% by 2050. It also established the **Committee on Climate Change** which is responsible for setting binding carbon budgets for 5 year periods. In the 2009 Budget, the first three carbon budgets were announced, with the aim of achieving a 34% reduction in emissions by 2020. The Act is supported by the **UK Low Carbon Transition Plan (2009)**, which sets out the Government's approach to meeting their carbon reduction commitments. The plan includes commitments to reducing greenhouse gas emissions from the existing housing stock by 29% on 2008 levels by 2020 and by 13% for places of work.

The EU has also agreed to increase the proportion of its energy supplied from renewable sources to 20% by 2020, including electricity, heating energy and transport energy. As its contribution, the UK has committed to supply 15% of all the energy it uses from renewable sources by 2020. To achieve this, it is anticipated that renewable sources will need to contribute approximately 30% of our electricity supply, 12% of heating energy and 10% of transport energy, as set out in the UK's **Renewable Energy Strategy (2009)**. The draft **Heat and Energy Saving Strategy (2009)** aims to ensure that emissions from all existing buildings are approaching zero by 2050.

The recently published **Household Energy Management Strategy (HEMS)** entitled **'Warm Homes, Green Homes' (March 2010)** sets out the strategic role that local authorities have to play and provides a new focus on district heating in suitable communities by removing barriers to the development of heat networks, encouragement of combined heat and power and better use of surplus heat through carbon pricing mechanisms.

The role of local authorities is further endorsed by a recent Audit Commission report into the role of local councils in reducing domestic CO_2 emissions[5], which emphasises that *"councils can use their influence, legal powers and resources to:*

- Lead – encouraging local communities and public and private sector organisations to take action on domestic energy by developing a clear strategic vision, facilitating partnership working, providing information, advice and support and championing energy issues;
- Oblige – using powers within the planning system to promote the development of more sustainable homes and increase the supply of low-carbon and renewable energy; enforcing Building Regulations; and using the HHSRS[6] to improve private sector homes; and
- Subsidise – funding measures in council homes and using financial incentives – such as council tax rebates, and direct funding, for example – home improvement grants or loans to promote take-up of measures to improve energy efficiency and supply low-carbon and renewable energy.*"*

Planning has an important part to play in making this a reality, particularly in providing the evidence and resource assessments, policies and targets that underpin wider local authority CO_2 reduction strategies.

In terms of District Heating (DH), HEMS states:

"District heating using CHP has the potential to deliver significant carbon savings and lower bills, but requires significant local coordination and specific support, for example through the planning system, to promote market confidence and growth"

Through HEMS, Government will support the roll-out of DH through a framework of policy and financial support, including:

- Clarifying the role of local authorities in driving deployment of DH and consulting on specific provision through a revised PPS on climate change;
- Strengthening expectations on suitable local authorities to develop local partnerships that drive deployment of low carbon and renewable options such as heat networks in their areas. The development of new Local Carbon Frameworks will support this change;
- Integrating policies for Zero Carbon Homes to support investment in larger offsite solutions such as DH, which typically offer better value carbon savings (decisions on how to meet these aims will be taken by summer).

The **Planning and Compulsory Purchase Act (2004)** placed sustainable development at the heart of the planning system. The **Planning Act (2008)** established a single development consent regime and a new planning process for nationally significant infrastructure projects. The Act also introduced the enabling legislation for the Community Infrastructure Levy (CIL) which will empower local authorities to levy a charge on development to support infrastructure development.

The key national planning policy in relation to energy and climate change is set out in **PPS1 Supplement on Planning and Climate Change**; their implications are described in Chapter 1. **PPS22: Renewable Energy (2004)** established some key principles which regional planning bodies and local authorities should adhere to in planning for renewable energy, in particular the requirement to encourage rather than restrict renewable energy development. The Government is reviewing the PPS1 Supplement and PPS22 and has just published a **new combined PPS** on **Planning for a Low Carbon Future in a Changing Climate**. Having reviewed the consultation the broad policy goals of the PPS Supplement have not changed significantly.

The current Regional Spatial Strategy for the region is the **East of England Plan** which covers the period 2001 to 2021. The Plan identifies resource efficiency, sustainable energy generation and sustainable design as the key measures for delivering sustainable development and minimising CO_2 emissions. Policy ENG1 encourages new development to be located and designed to optimise its carbon performance and states that local authorities should encourage the supply of energy from decentralised, renewable and low carbon energy sources.

POLICY ENG1: Carbon Dioxide Emissions and Energy Performance

Working with regional partners, EERA should consider the performance of the spatial strategy on mitigating and adapting to climate change through its monitoring framework and develop clear yardsticks against which future trends can be measured, which should inform the review of the RSS and the preparation of Local Development Documents.

To meet regional and national targets for reducing climate change emissions, new development should be located and designed to optimise its carbon performance. Local authorities should:

- encourage the supply of energy from decentralised, renewable and low carbon energy sources and through Development Plan Documents set ambitious but viable proportions of the energy supply of new development to be secured from such sources and the development thresholds to which such targets would apply. In the interim, before targets are set in Development Plan Documents, new development of more than 10 dwellings or 1000m² of non-residential floorspace should secure at least 10% of their energy from decentralised and renewable or low-carbon sources, unless this is not feasible or viable; and
- promote innovation through incentivisation, master planning and development briefs which, particularly in key centres for development and change, seek to maximise opportunities for developments to achieve, and where possible exceed national targets for the consumption of energy. To help realise higher levels of ambition local authorities should encourage energy service companies (ESCOs) and similar energy saving initiatives.

The Plan also sets targets for renewable and low carbon energy generation in the region (Policy ENG2) and encourages Development Plan Documents to set ambitious but viable proportions of the energy supply of new development to be secured from such sources, as well as the development thresholds to which such targets would apply.

POLICY ENG2: Renewable Energy Targets

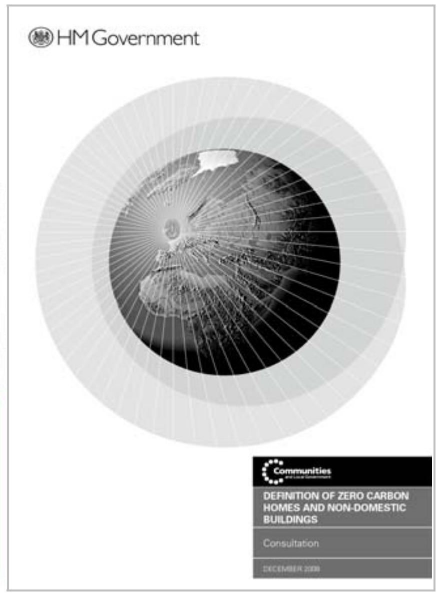
The development of new facilities for renewable power generation should be supported, with the aim that by 2010 10% of the region's energy and by 2020 17% of the region's energy should to come from renewable sources. These targets exclude energy from offshore wind, and are subject to meeting European and international obligations to protect wildlife, including migratory birds, and to revision and development through the review of this RSS.

[5] Audit Commission (October 2009) 'Lofty Ambitions: The Role of Councils in Reducing Domestic CO_2 Emissions: Local Government'
[6] Housing Health and Safety Rating System.

The participating Hertfordshire LPAs are at various stages of developing their council's **Core Strategy**. A number of policies relating to energy and CO_2 emissions are emerging. A summary of each LPAs Core Strategy status and relevant emerging polices was carried out as part of the Stage One Hertfordshire Planning Performance and Climate Change scoping study, which has been used to inform the work carried out as part of this study.

2.2 Building Regulations and Zero Carbon

The current 2006 Building Regulations Part L require that CO_2 emissions calculated for a new development should be equal to or less than a Target Emission Rate. This is in the region of 20% lower than emissions from a building which complies with the 2002 Building Regulations, depending on the specific building type.



Following consultation, the Government announced in July 2007[7] that all new homes will be designed to be zero carbon from 2016. The following interim changes to the Building Regulations for homes are likely to be introduced:

- 2010 - 25% improvement in regulated emissions (relative to 2006 levels). This corresponds with the mandatory energy and CO_2 standards for Level 3 of the Code for Sustainable Homes.
- 2013 - 44% improvement in regulated emissions (relative to 2006 levels), corresponding to Code Level 4 mandatory energy and CO_2 standards.

The changes in 2010 (expected to come into effect in October) and 2013 will only apply to emissions that are inside the dwelling and are regulated (heating, ventilation, cooling and lighting). From 2016, the requirements will apply to all emissions associated with energy use in the dwelling, including cooking and other appliances (referred to as unregulated).

[7] Building A Greener Future: Policy Statement

In Budget 2008, the Government announced an ambition that new public sector buildings should be zero carbon from 2018, one year in advance of the commercial new non-domestic buildings sector. It defined the scope of this ambition as covering the central (but not local) government estate, hospitals, the defence estate, prisons, courts and schools (although the latter are subject to a separate 2016 zero carbon ambition under the Building Schools for the Future programme).

A further consultation in 2008[8], followed by a Government statement in July 2009 confirmed the definition of zero carbon that will be applied to new homes and set out how it will be taken forward (Figure 2.1). Achieving zero carbon includes three stages:

1. **Energy Efficiency**, the minimum level of which has not yet been agreed, but is likely to be measured in kWh/m^2/year and differentiate between dwelling types. This stage will take account of building fabric energy efficiency such as U-values, air tightness, thermal bridging and thermal mass.
2. **Carbon Compliance**, set at 70% of regulated emissions (the DER) and will take account of systems and controls, such as heating/cooling systems, RLC technologies and mechanical ventilation.
3. **Allowable Solutions**, which will cover the remaining carbon emitted from the dwelling for 30 years. The final list has yet to be confirmed but may include:
   - o Further carbon reductions on site, through energy efficiency or on-site generation
   - o Energy efficient appliances
   - o Advanced forms of building control systems which reduce the level of energy use in the home
   - o Exports of low carbon or renewable heat from the development to other developments
   - o Investments in Renewable and Low Carbon community heat infrastructure

Other allowable solutions remain under consideration. A final Government announcement is expected towards the end of 2010.

The adoption of allowable solutions into Building Regulations means that there could be a significant investment in low carbon measures in local areas through developers either opting to save CO_2 offsite, or pay into an allowable solutions offset fund. It is currently not known how an offset fund would be administrated or who (potentially a local authority) would be allowed to allocate funding. However this could be a future source of finance for local authorities which can be used to contribute to low carbon energy schemes.

[8] Definition of zero carbon homes and non-domestic buildings (Department for Communities and Local Government, December 2008)

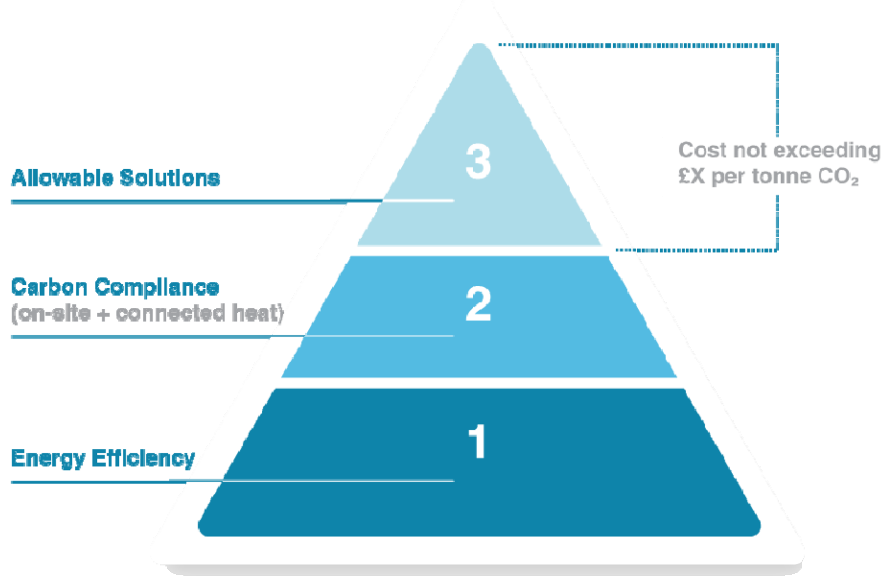


Figure 2.1: The Zero Carbon Hierarchy: stages of a zero carbon home

2.3 Measuring Sustainability

2.3.1 BREEAM

The Building Research Establishment Environmental Assessment Method (BREEAM) assesses the environmental performance of new and existing non-residential buildings. A BREEAM rating is awarded based on achievement of credits in categories such as energy, water, materials, waste, pollution, health and well-being, management, land use and ecology, and transport.

As of August 2008, the ratings that can be achieved are Pass, Good, Very Good, Excellent and Outstanding, with mandatory requirements for each rating. There is no legal requirement for non-domestic development to have a BREEAM rating, but they are commonly required by local planning authorities or as a condition of Government funding. For example, the Building Schools for the Future programme requires new school buildings to achieve at least a BREEAM Very Good rating.[9]

2.3.2 Code for Sustainable Homes

The Code for Sustainable Homes (the Code) is the national standard assessment system for new housing in England and came into effect in April 2007. The Code assesses a development against a set of criteria in nine categories: energy and CO_2 emissions, water, materials, surface water run-off, waste, pollution, health and well-being, management, and ecology.

The Code awards a rating to a dwelling, ranging from level 1 to level 6 (the highest level of performance). The rating depends on whether the dwellings meet a set of mandatory standards for each level, as well as their overall score. (Table 2.1)

Code Levels	Mandatory Requirements		Total Points Score out of 100
	Energy Improvement over TER[10]	Water Litres/person/day	
Level 1 ★	10%	120	36
Level 2 ★★	18%	120	48
Level 3 ★★★	25%	105	57
Level 4 ★★★★	44%	105	68
Level 5 ★★★★★	100%	80	84
Level 6 ★★★★★★	Zero Carbon	80	90

Table 2.1: Minimum requirements for the six levels under the Code

Since May 2008 it has been compulsory for new homes to have a Code rating as part of the Home Information Pack, although homes that have not undergone a Code assessment will automatically be issued with a 'nil-rated' certificate.

Residential developments supported by funding from the Homes and Communities Agency (i.e. affordable housing), or any other government-funded support mechanism, are currently required to achieve Code level 3. Although development seeking funding from the next round in 2011 will now have to achieve Code level 4.

2.4 The County of Hertfordshire

Hertfordshire, one of the Home Counties, is part of the East of England region and is the most southernly county in the region. It is bordered by Greater London, Buckinghamshire, Bedfordshire (the unitary authorities of Luton and Central Bedfordshire), Cambridgeshire and Essex. Hertfordshire is made up of 10 districts/boroughs, 9 of which are participants in this study. (Figure 2.2)

The County has a land area of 1,634 square kilometres, and comprises one city (St Albans) and a variety of market towns, industrial towns, new towns, commuter villages and rural villages. At the last census (2001), Hertfordshire had a population of approximately 1,034,000, 87% of whom live in the 45 settlements of over 3,000 people. The four southernmost districts/boroughs of Broxbourne, Hertsmere, Watford and Three Rivers, and Stevenage towards the north, are the most urban, with East Hertfordshire and North Hertfordshire having large rural, fairly sparsely populated areas.

The County has the following 'Special Designations':

- Green Belt
- Chiltern Area of Outstanding Natural Beauty
- Colne Valley & Lea Valley Regional Parks
- Garden Cities (Letchworth, Welwyn Garden City)
- New Towns (Stevenage, Hatfield, Hemel Hempstead, Welwyn Garden City)
- Conservation Areas
- Area of confirmed Community Forest (Watling Chase)
- Aldenham Country Park
- National Trust Land - at Ashridge and Shaw's Corner (Ayot St Lawrence)
- English Heritage – i.e. Berkhamsted Castle
- SSSIs - there are 43 Sites of Special Scientific Interest in the County
- Scheduled Ancient Monuments - statutory protected archaeological sites
- Sites of European Designation

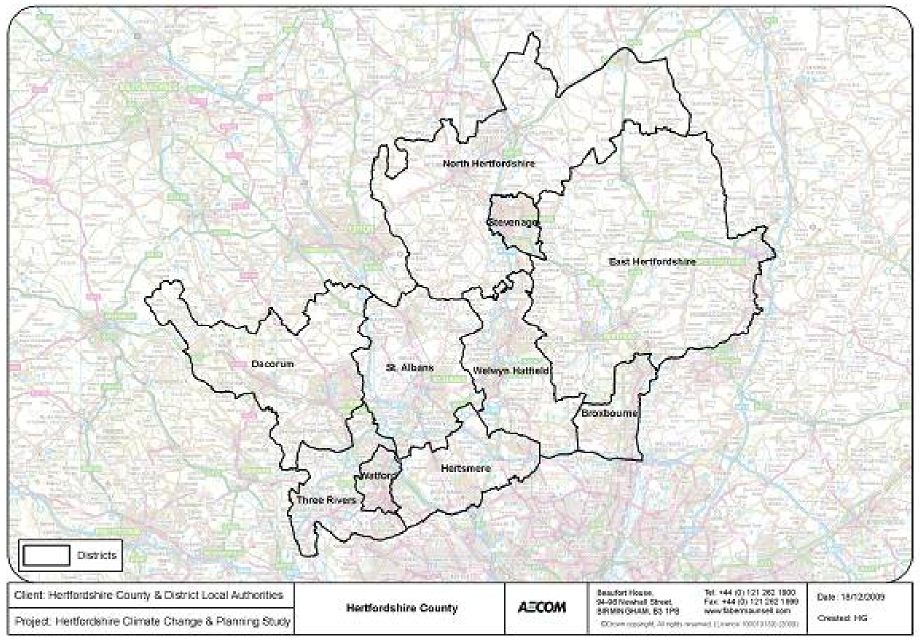


Figure 2.2: Map of Hertfordshire Districts and Boroughs

2.5 Existing Building Stock

2.5.1 Housing

There were approximately 420,650 households in Hertfordshire at the time of the last Census in 2001 (although current statistics suggest this figure is now around 457,000) and the majority are owner-occupied (Table 2.2). The total number of household spaces including vacant properties and holiday accommodation/second residence equates to just over 430,300. The majority of dwellings in Hertfordshire are terraced or semi-detached (Figure 2.3).

Housing Tenure	Number of households*	Proportion
Owned	305,171	73%
Social rented	79,162	19%
Private rented/other	36,317	8%
Total	**420,650**	**100%**

Table 2.2: Housing Stock in Hertfordshire by Tenure (Source: Office of National Statistics, based on the 2001 census) *with residents.

[9] An introduction to Building Schools for the Future (produced for department of Children, Schools and Families by 4ps and Partnerships for Schools, 2008)
[10] TER refers to the target emission rate which dwellings are required to achieve under Part L of the Building Regulations.

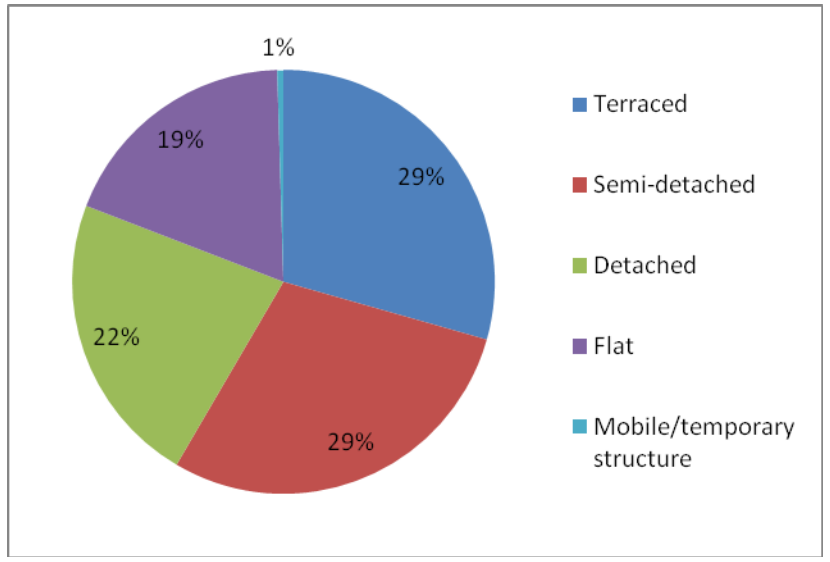


Figure 2.3: Housing stock by type (Source: Office of National Statistics, 2001 Census)

It should be noted that this information has been provided for context only and that the population figures and tenure breakdown does not inform the modelling or policy testing in this study.

2.5.2 Non-residential

Employment locations are concentrated primarily in urban locations such as Welwyn Garden City, Watford, Hemel Hempstead, St Albans, Bishop Stortford, Borehamwood and Cheshunt (and Stevenage).

2.6 Future Development

2.6.1 Housing

The East of England Plan (Policy H1) sets Hertfordshire a target of 83,200 new homes between 2001 and 2021. Of this, 17,480 dwellings have already been built between 2001 to 2006. This target, when broken down per district/borough (Table 2.3), sees the highest distribution of new housing within East Herts.

District / Borough **Figures excluded pending legal challenge and repair*	**Minimum to build (April 2001 to March 2021)**	***Of which already built (April 2001 to March 2006)***
Broxbourne	5,600	*1,950*
Dacorum*	-	-
East Hertfordshire	12,000	*2,140*
Hertsmere	5,000	*1,080*
North Hertfordshire	6,200	*1,900*
St Albans	7,200	*1,830*
Stevenage	n/a	*n/a*
Three Rivers	4,000	*1,010*
Watford	5,200	*1,410*
Welwyn Hatfield*	-	-

Table 2.3: Hertfordshire Housing Provision by District/Borough (Source: East of England Plan 2001 - 2021)

The published East of England Plan contained a housing requirement for Hertfordshire of 83,200 dwellings. *However, following a successful legal challenge there are currently no housing figures for Dacorum and Welwyn Hatfield districts. Figures for these two local authorities have therefore been excluded from the table.

Although housing provision targets have been set at the regional level for Hertfordshire, more recent Strategic Housing Market Assessments (SHMA) were carried out in 2008, and updated in September 2009. Three SHMAs were produced:

- (Draft) London Commuter Belt West: Dacorum, Three Rivers, St Albans, Hertsmere, Watford and Welwyn Hatfield;
- London Commuter Belt East: East Herts, Broxbourne (and Uttlesford in Essex);
- Stevenage and North Herts (it should be noted that there is a provision for a further 9,600 dwellings which will be provided as urban extensions to Stevenage within North Hertfordshire. This is likely to affect the scale of development that will take place in North Herts).

In addition to the SHMAs, the project group provided, where available, copies of their Strategic Housing Land Availability Assessments (SHLAAS). Based on these, Figure 2.4 maps out the housing development sites potentially coming forward.

Data from both the SHMAs and the SHLAAs, and where required the East of England Plan, has been used to inform the modelling undertaken for this study.

2.6.2 Employment Sites

The East of England Plan identifies Hemel Hempstead and Stevenage as regionally strategic employment locations, along with other locations in the County where this would support strong continued growth of mature and emerging clusters and sectors. This would include supporting the regeneration of the Lee Valley.

Policy E5 identifies Watford, Hemel Hempstead, St Albans and Welwyn Garden City (and Stevenage) as towns or regional centres of strategic importance for retail and other town centres purposes.

The London Arc Job Growth and Employment Study were used to inform the case studies against which policy options were tested (Chapter 8).

The East Herts Employment Land Review (October 2008) forecasts a significant growth in B1 (Office) employment.

Figure 2.5 shows the potential employment sites coming forward in Hertfordshire.

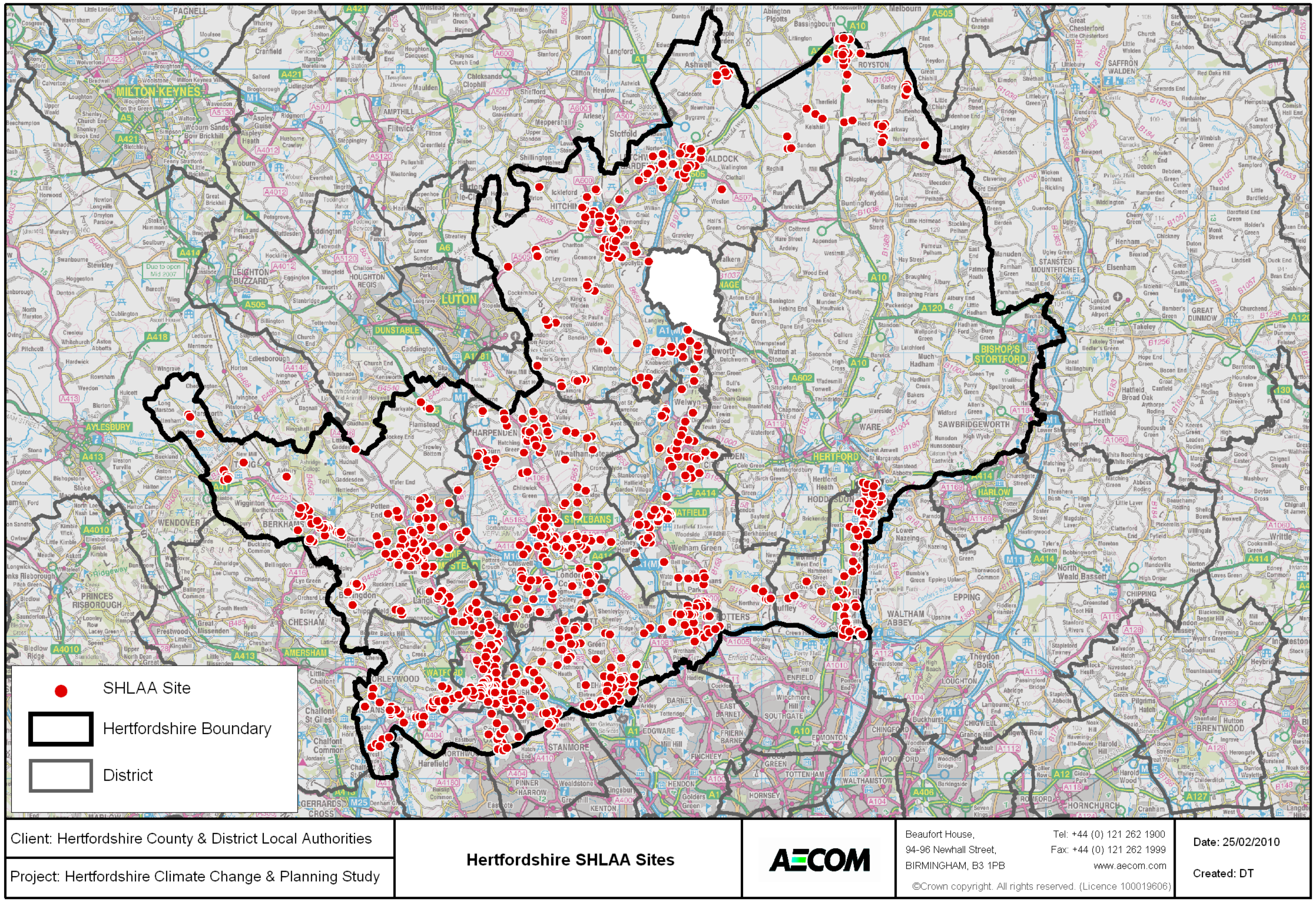


Figure 2.4: Map of potential housing development sites from SHLAA studies, rejected sites removed (data on potential housing development was unavailable for East Herts)

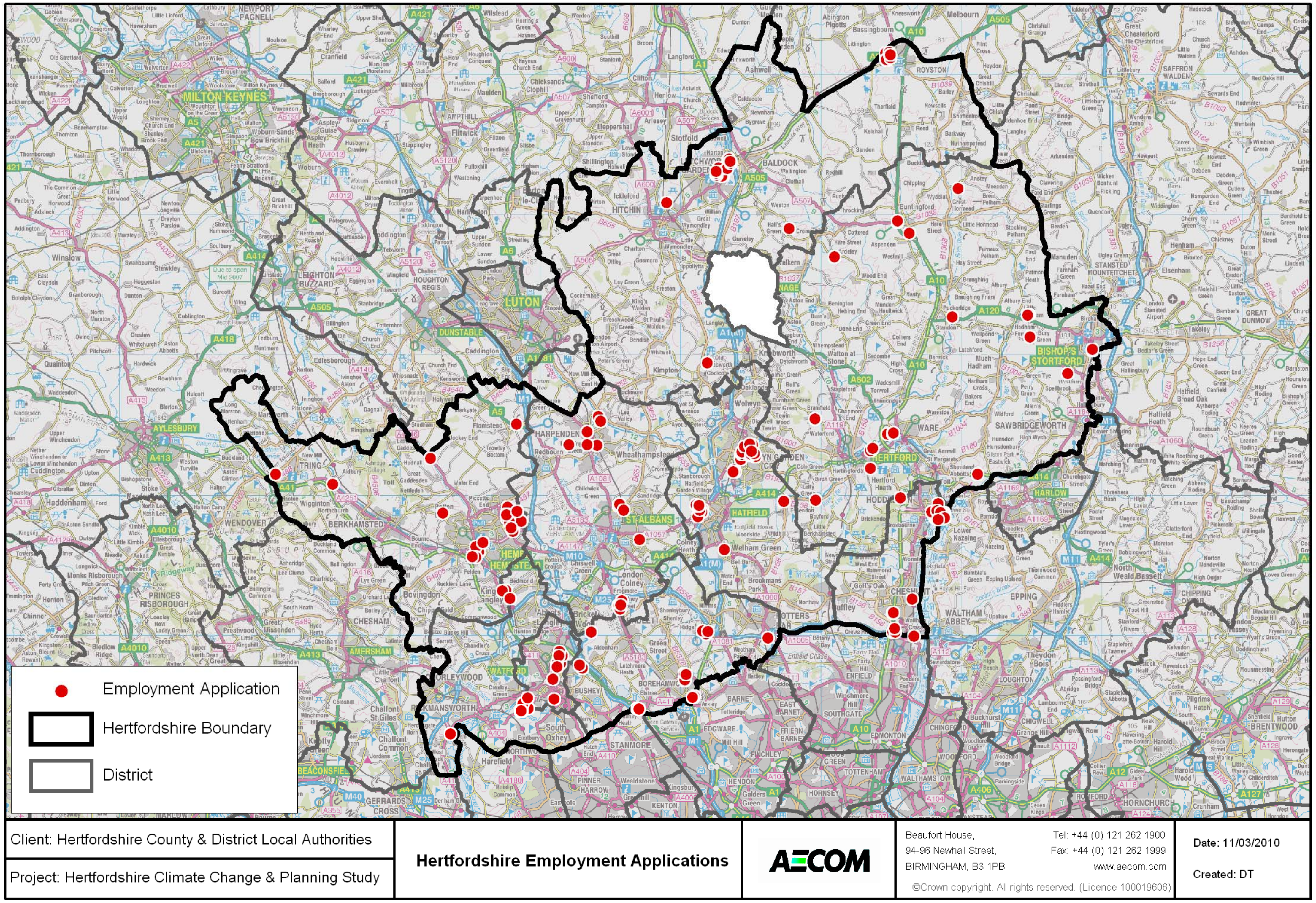


Figure 2.5: Map of employment application sites in Hertfordshire over 1000sqm (Information provided by the County Council)

2.7 Baseline Energy Consumption and CO_2 Emissions

The National Indicator (NI) 186 statistics provides a breakdown of CO_2 emission sources for each local authority area across three sectors – Industry/Commercial, Domestic and Road Transport. The summary data for the ten local authorities in Hertfordshire is presented opposite in Table 2.4. (Stevenage figures have been provided for comparison)

This data shows that the sector responsible for the largest volume of CO_2 emissions is domestic (40% across the County), followed by Industry/Commercial (38%) and Transport (22%). This is shown graphically in Figure 2.6.

This highlights that the existing residential building stock is responsible for a significant volume of total emissions, and since future overall housing growth is proposed this sector should provide a focus for reducing emissions from both future development and the existing building stock.

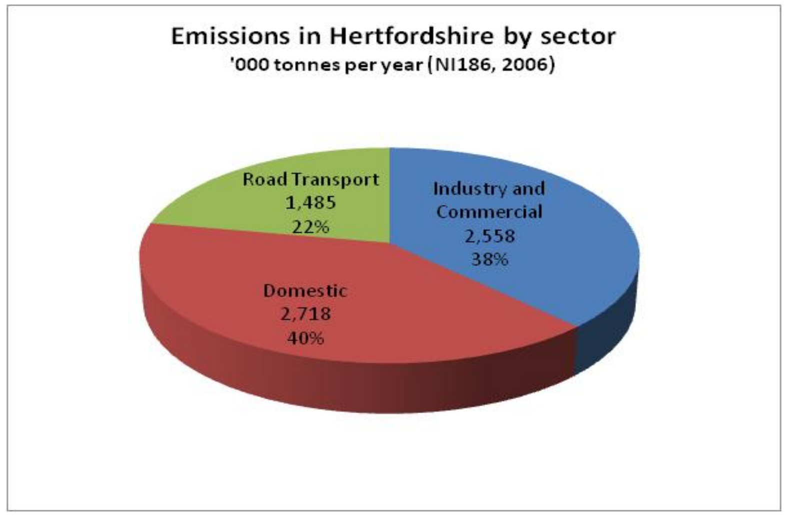


Figure 2.6: Emissions in '000 tonnes in Hertfordshire by sector - NI 186, 2006

Local Authority	Industry and Commercial	Domestic	Road Transport	Total	Population '000 (mid-year estimate 2006)	Per capita 2.7.6 emissions (t) 2.7.7
Broxbourne	165	215	108	487	89	5.5
Dacorum	255	358	215	828	138	6.0
East Hertfordshire	339	351	281	971	133	7.3
Hertsmere	256	257	127	640	96	6.7
North Hertfordshire	301	312	197	810	122	6.7
St. Albans	247	358	174	779	131	5.9
Stevenage	270	176	75	521	79	6.6
Three Rivers	163	233	94	490	86	5.7
Watford	221	200	82	503	80	6.3
Welwyn Hatfield	341	258	132	732	106	6.9
County Total	**2558**	**2718**	**1485**	**6761**	**1,060**	**6.4**

Table 2.4: 2006 mid-year summary of emissions per sector for each of Hertfordshire's Local Authorities ('000 tonnes) (Source: National Indicator Set, Audit Commission, release date - 2009)

The proportion of emissions (and total emissions) varies significantly across the County, as shown in Table 2.4, reflecting to some degree the characteristics of the local authority. For example, some districts/boroughs have larger economic centres and therefore have more industrial and commercial buildings than others. In some of the larger and more rural authorities, such as East Herts, you would expect to see higher transport emissions from people have to travel further to reach amenities and places of employment.

Table 2.5 compares the emissions from the domestic sector across each local authority area between 2005 and 2006. Data from the National Indicator Set shows that on a per capita basis, the average domestic emissions across the East of England are 2.48 tonnes per year, compared with 2.53 tonnes per year for the UK. Table 2.5 below shows that in 2006 the County average exceeded both regional and national levels *(figures for Stevenage are included for comparison)*.

	Domestic emissions (tonnes per capita)	
	2005	**2006**
Broxbourne	2.39	2.42
Dacorum	2.56	2.59
East Hertfordshire	2.58	2.64
Hertsmere	2.64	2.68
North Hertfordshire	2.52	2.56
St. Albans	2.70	2.73
Stevenage	2.20	2.23
Three Rivers	2.64	2.71
Watford	2.45	2.50
Welwyn Hatfield	2.38	2.43
Average	**2.51**	**2.55**

Table 2.5: Domestic per capita emissions from Hertfordshire Local Authorities

2.8 Mapping Energy Demand and CO_2 Emission

The County's CO_2 emissions presented in this chapter are reflective of the baseline energy consumption, or 'demand', from Hertfordshire's existing built environment. To better enable a clear picture of where these demands are highest, and subsequently help identify 'anchor load' locations for potential district heating schemes, information received from the project group on building energy consumption has been modelled. A number of outputs have been produced – heat and electricity demand maps show the average consumption density per square km (calculated as kWh of energy consumption divided by (8760 hours per year x sqkm). The electricity and heat demand maps give a spatial indication of how electricity and heat are being consumed in Hertfordshire. A CO2 map shows how CO2 emissions are distributed spatially in Hertfordshire.

The outputs from the model have been plotted onto maps using GIS. Figures 2.7 and 2.8 show density of average heat and electricity demand from existing buildings across Hertfordshire, based on the model, with Figure 2.9 showing in more detail areas where heat demand is over 3,000 kWh/km^2/year. The last map in this chapter (Figure 2.10) shows modelled CO_2 emissions per unit area related to energy use in existing buildings.

2.9 Key Considerations Emerging from this Chapter

- National CO_2 emissions reduction and renewable energy generation targets are very demanding.
- Domestic per capita CO_2 emissions in the County are higher than both the regional and the national average.
- Hertfordshire will have to deliver its share of renewable and low carbon energy generation in line with current and emerging regional targets, informed by local resource assessments.
- Hertfordshire is expected to deliver many tens of thousands more homes by 2021.
- Updates to Part L and the Zero Carbon Hierarchy will see renewable and low carbon technologies playing a significant role in the development of new homes from 2013 through Building Regulations.
- Local planning policy will need to play a major role in gearing the house building industry and supply chain up to meeting the zero carbon homes policy.
- There is an increasing emphasis through emerging government energy policy on the role of district heating to meet future energy demand, and the requirement for strategic level planning to facilitate its delivery. Local authorities are expected to play a key role.
- CO_2 emissions from existing buildings are also an important consideration. A significant proportion of existing housing is in private ownership and therefore the responsibility for improving the energy efficiency of the dwelling lies with the householder. Local authorities play a role too by encouraging improvements through promotion and incentive.
- Areas of high energy demand and related CO_2 emissions from existing buildings are concentrated in the higher density areas of the major settlements. Buildings and developments in these areas offer the biggest potential as anchor loads for district heating opportunities.
- New housing development tends to be focused in or around existing urban settlements with very few in outlying/rural areas. Therefore, future new development may offer opportunities to improve the energy performance of existing development through the delivery of district heating systems.
- This study is based on data and information that was correct at the time of writing. However it should be noted that the RSS is under review and future revisions may have implications for the key considerations emerging from this chapter.

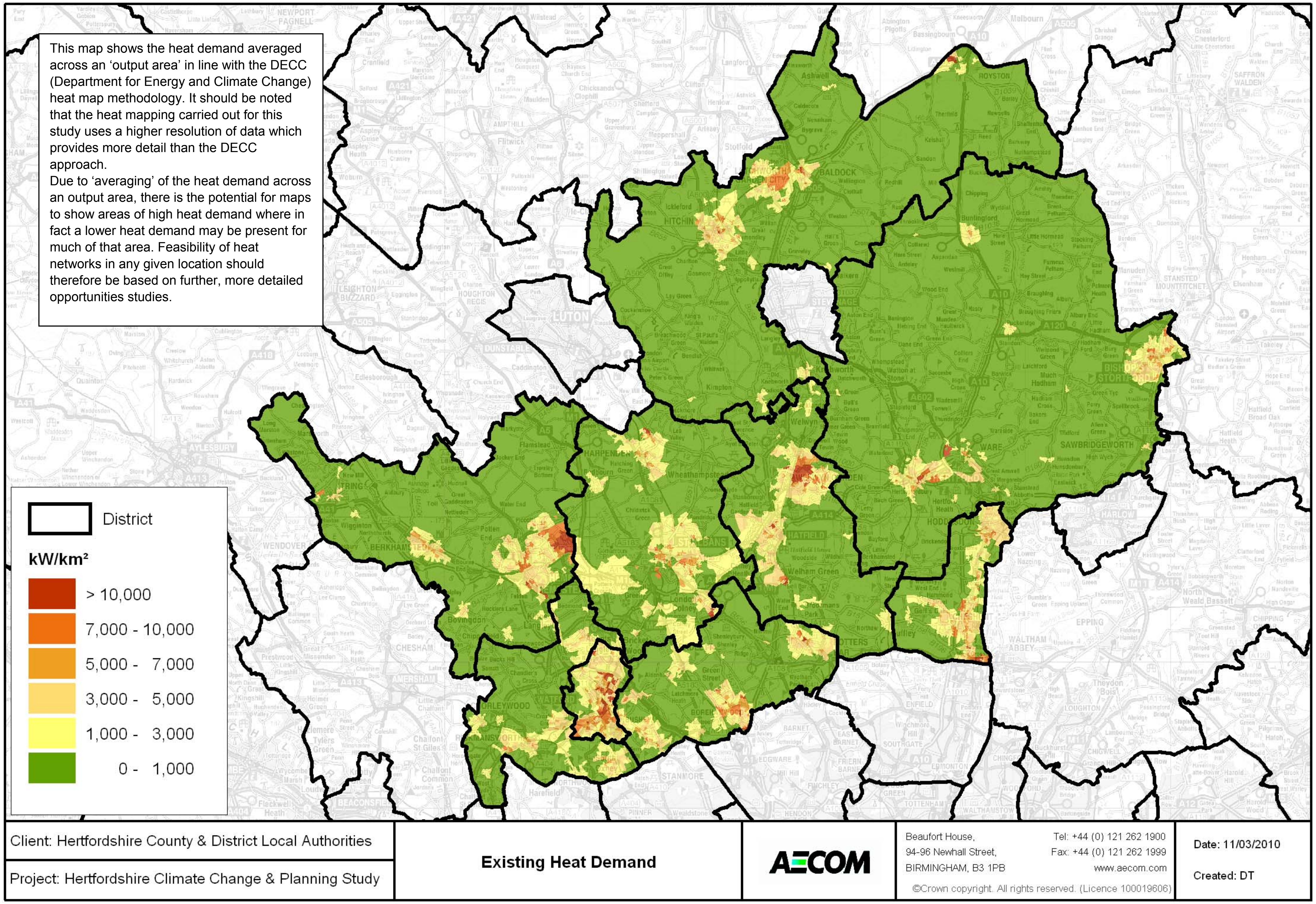


Figure 2.7: Average heat demand density map for existing buildings in Hertfordshire, 2009, in kW/km^2 (Source: Hertfordshire energy model, AECOM)

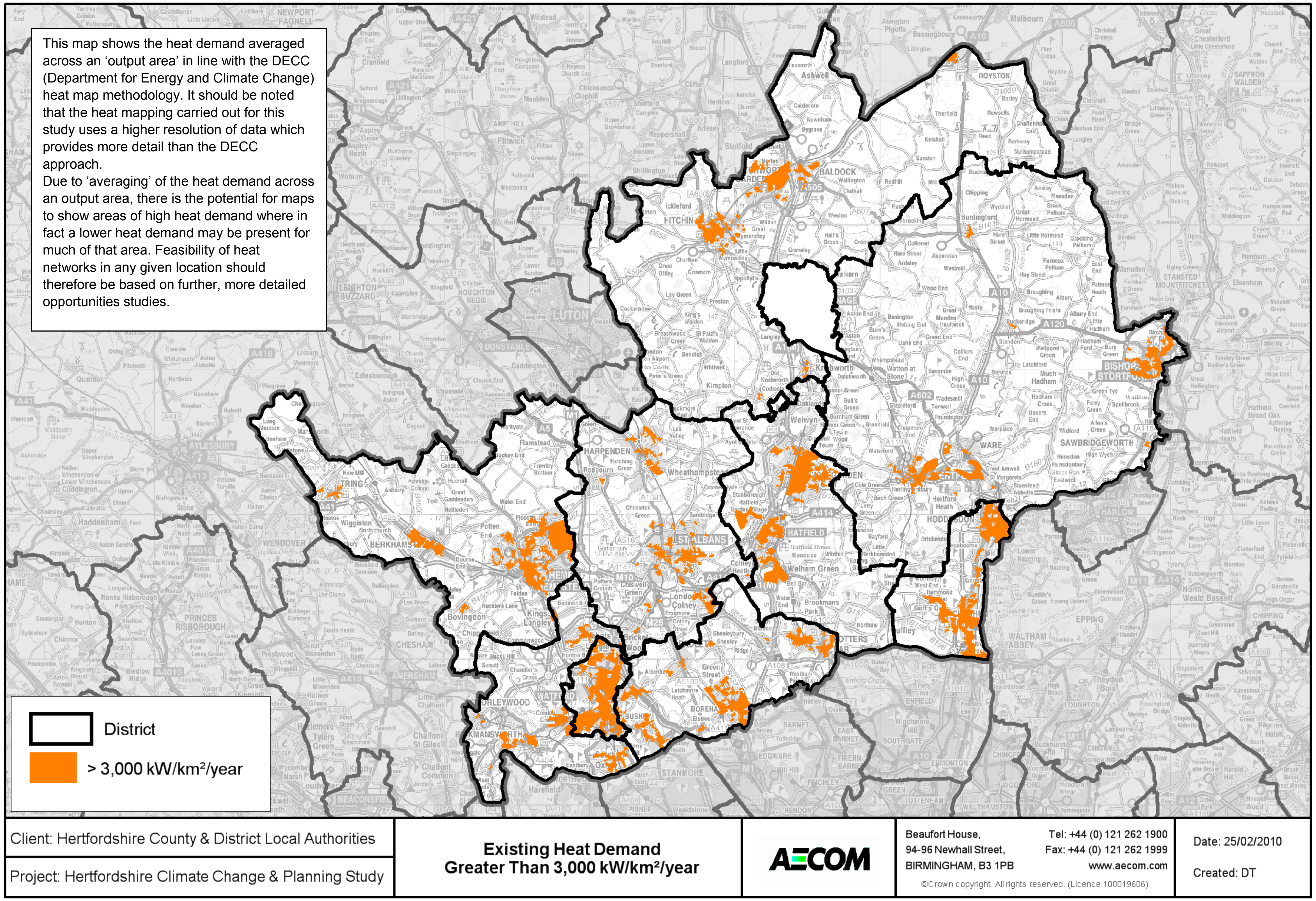


Figure 2.8: Heat demand density map for demand over 3,000 kW/km^2/year, 2009 (Source: Hertfordshire energy model, AECOM)

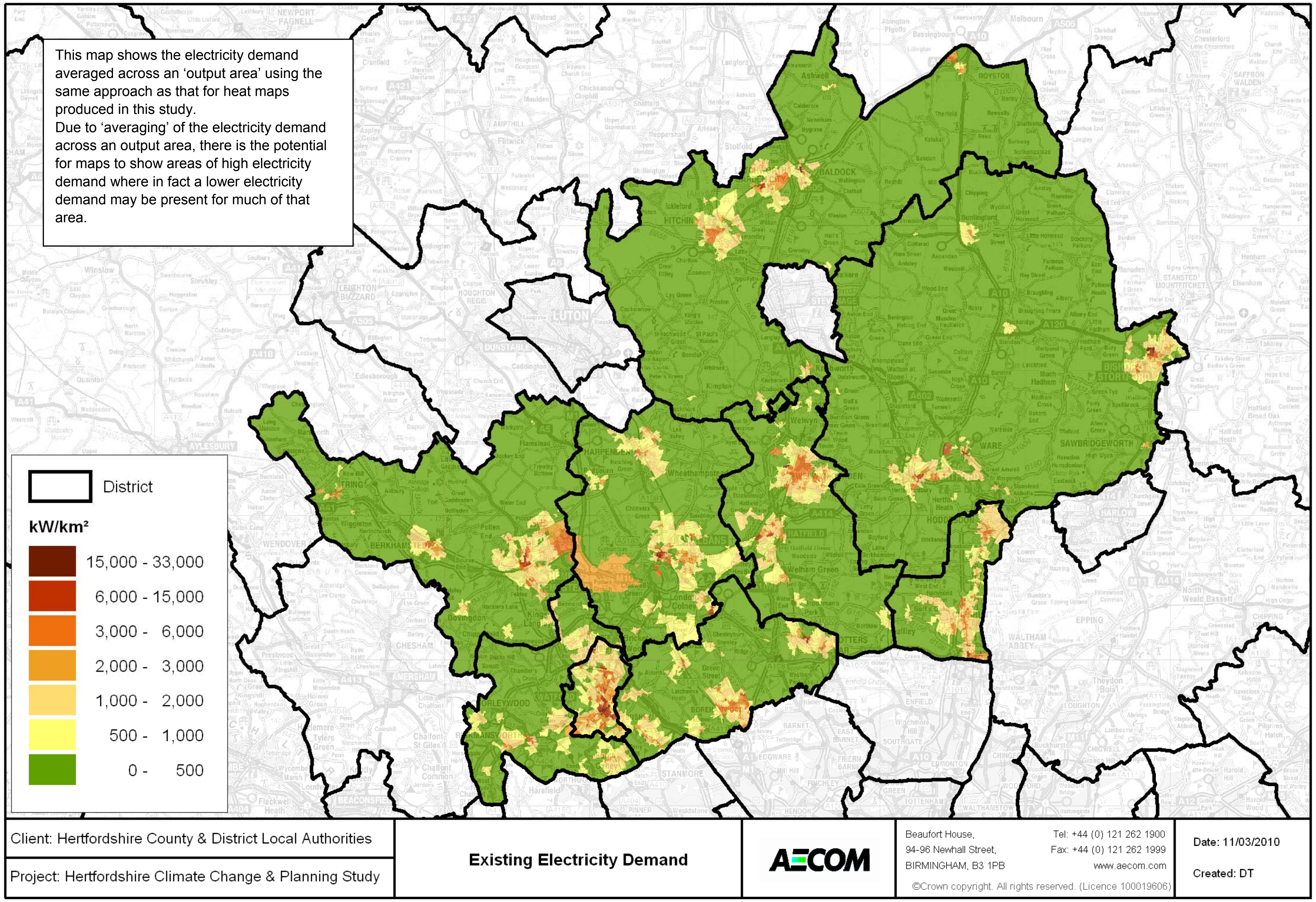


Figure 2.9: Average electricity demand density map for existing buildings in Hertfordshire, 2009, in kW/km^2 (Source: Hertfordshire energy model, AECOM)

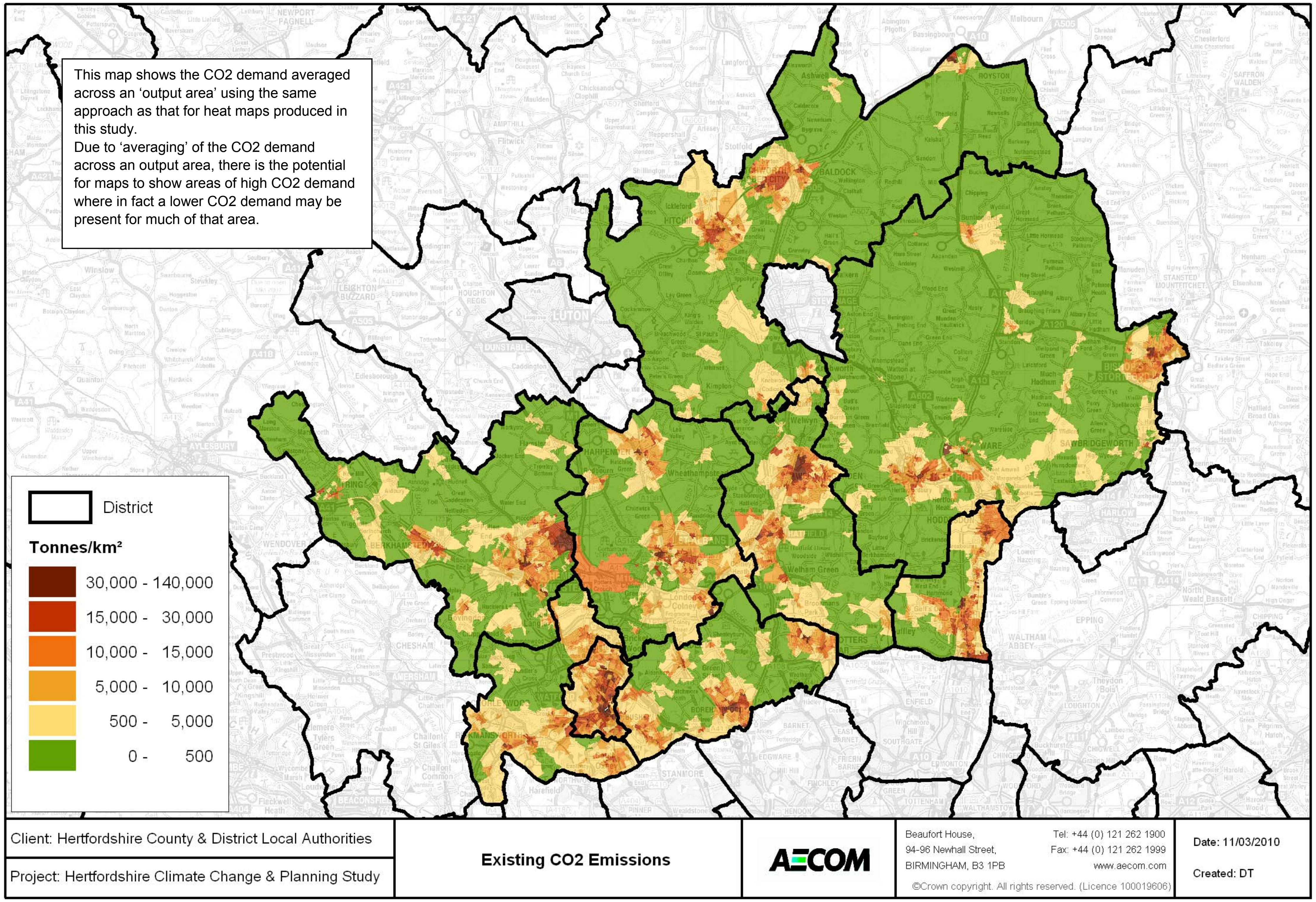


Figure 2.10: Annual CO_2 emissions map for existing buildings in Hertfordshire, 2009, in tonnes/km^2 (Source: Hertfordshire energy model, AECOM)

3 Opportunities for Energy Efficiency

Improvements to the Building Regulations have led to current standards relating to energy consumption and CO_2 emissions being significantly higher than for older buildings. In addition to this, despite growth levels proposed in Hertfordshire, the majority of buildings in the County by 2050 will still be buildings constructed prior to this study. Therefore, to make significant reductions in energy use and CO_2 emissions, it is vital that local authorities address the existing stock efficiency levels alongside promoting high standards in new development. For this reason, this study also considers related opportunities to improve energy efficiency in existing buildings.

3.1 Energy Efficiency

The energy performance of buildings depends on a number of factors including:

- **Building types:** In general, dense development is more energy efficient. Buildings which are less spaced out and share walls (for example terraced houses and flats) have a lower heat loss area and lower heat demand than for more separated building types such as detached homes. It is also often the case that on dense developments, dwelling sizes are lower which again result in lower energy demand. It is important to note that the energy demand intensity on dense developments is usually higher than for less dense developments – this is due to there being a greater floor area / number of dwellings in the same spatial area as a less dense site.

  On new developments, increasing the density on masterplans can also facilitate more options for delivering decentralised renewable and low carbon heat and power by improving the economic viability of schemes. If density is increased to create greater open space, there may also be more options for larger scale renewable generation such as site-scale wind turbines, but this needs to be balanced against potential problems with reducing the space for building mounted technologies such as photovoltaics or solar thermal systems. This latter issue is particularly relevant on high density urban developments where the building heights mean that very little roof area is available for the installation of solar technologies in relation to floor areas.

- **Age:** Thermal performance of buildings has improved with time, particularly following the introduction of Part L of the Building Regulations and progressive increases in its minimum requirements. Insulation, glazing performance and air-tightness have all improved significantly with these and so generally the opportunities or 'key wins' for improving energy efficiency are greater on the older building stock. The uptake of some energy efficiency measures is relatively independent of age (for example loft insulation is as likely to be installed into a 1900 home as a 1970 home with retrofit). However, other measures are heavily dependent on age, with particular examples being glazing (with sash windows on older properties being expensive and difficult to replace with double glazed equivalents) and solid walls (typically found on pre 1920 dwellings) requiring internal or external insulation.

- **Tenure:** Tenure and the utility billing arrangements affect the energy use of a property. The most recent English House Condition Survey revealed that social sector homes on average have been the most energy efficient and have also shown the highest rate of improvement since 1996[11]. This is due to government funded schemes such as the Decent Homes Programme, large scale retrofit opportunities, and the generally newer nature of the social housing stock.

  In some rented or leased properties, payment of a fixed service charge rather than utility bills linked to metered consumption reduces the incentive for tenants to minimise their own energy use, whereas landlords may be less inclined to make improvements to the building where tenants pay energy bills directly. Government has proposed the introduction of a "green landlord scheme" to incentivise landlords to invest in whole house energy efficiency. In the interim period, LAs could implement a similar, local scheme which will encourage landlords with poorly performing properties to invest in energy efficiency.

Under The Home Energy Conservation Act 1995 (HECA), local authorities with housing responsibilities are required to implement practical and cost-effective measures to improve the energy efficiency of all accommodation in their area and report on progress. The target is to achieve a 30% reduction in energy consumption across the entire housing stock (including private housing) from 1995 levels by 2011. Annual reports publish the progress of each authority against this target. Table 3.1 opposite illustrates the rates for each of the project group authorities in Hertfordshire (figures for Stevenage are included for comparison).

The latest HECA results from 2007 show that on average, Hertfordshire is behind the national average in terms of improvement from 1995, at 1.7% below the average 21.6% reduction and 2.1% behind the targeted 22% reduction. This does not necessarily mean that the efficiency levels in Hertfordshire are lower than the national average, because the data is based on the 1995 starting point, at which point Hertfordshire may have had more efficient stock than the national average. However, it does give some indication of the improvements during the HECA period and the uptake of measures.

Within Hertfordshire, there is a significant range in improvement between the authorities. By 2007, Watford had significantly exceeded the target at 27.1% improvement whilst Broxbourne achieved around half the target at 12.8% (although Stevenage is not included as part of this study, it has the lowest reduction in energy use at 9.8%).

This data indicates that the uptake of efficiency measures across the County and the efficiency of authority led schemes are extremely variable, with some authorities performing significantly better than others. Alongside this, the County is performing worse than average suggesting that there is potentially greater scope for making efficiency savings than in other areas of the country.

It is important to note that there is a degree of uncertainty over the accuracy of HECA data due to a lack of standardised reporting / calculation methodology, and so if different authorities monitor and report using different methods, the results may misrepresent relative performance. This should always be considered when analysing these results.

Authority	Progress in 2007
Broxbourne	**12.8%**
Dacorum	23.0%
East Hertfordshire	22.8%
Hertsmere	21.1%
North Hertfordshire	**19.5%**
St Albans	22.8%
Stevenage	9.8%
Three Rivers	20.7%
Watford	27.1%
Welwyn Hatfield	**19.3%**
NATIONAL AVERAGE	21.6%
NATIONAL TARGET FOR 2007	22.0%
HERTFORDSHIRE AVERAGE	19.9%
Data in bold indicates no reporting for 2007 and previous years figures used.	
Data in red indicates figures below the County average.	

Table 3.1: 2007 HECA progress for each authority (taken from the 2007 HECA Progress Report).

3.2 Improving Energy Efficiency of Homes

A range of measures which can be used in existing and new homes in order to improve energy efficiency are presented below. It should be noted that improving energy efficiency does not always result in a corresponding reduction in energy consumption. A "rebound effect"[12] has been identified where potential energy and CO_2 savings from energy efficiency improvements are counteracted by changes in occupier behaviour. For example, if a heating system is replaced with a more efficient version, or insulation levels are improved, this doesn't necessarily mean that occupants will turn down room thermostats. Indeed, there can be a tendency for occupiers to make use of these benefits by increasing heating temperatures. A similar effect can be observed when energy costs are reduced. This effect may be particularly prevalent in fuel poverty homes where current levels of heating may be below those required for comfort, and any efficiency improvements lead to adequate levels of comfort being achieved rather than efficiency savings.

[11] English House Condition Survey 2007 (Department for Communities and Local Government, September 2009)

[12] Zero Carbon Britain – An Alternative Energy Strategy (Centre for Alternative Technology and the University of East London, 2007)

3.2.1 Insulation

The rate of heat loss through the building fabric will depend upon the thermal properties of the building material and the area through which heat loss can take place; this is measured by a parameter known as a U-value. A lower U-value value means a lower rate of heat loss.

In existing buildings, the main method of improving the U-values of the fabric is through improved insulation in the loft and cavity walls where possible; this is straightforward to apply and relatively cheap. In general, there has nationally been a relatively good uptake of the standard insulation measures following incentive schemes, efficiency commitment schemes on utility providers and education combined with high energy costs. In general, these simple measures have a short payback, and it is expected that they will almost reach saturation in the next decade.

A sector which is difficult to improve significantly is older buildings (typically pre 1930) which consist of solid walls with no cavity to insulate, leading to very high thermal losses through the walls. Insulation can be added to these structures either internally or externally. Internal insulation requires cladding of walls with insulation and a new interior plasterboard surface. This has the effect of reducing floorspace, and can have a significant impact on internal fixtures and fittings, particularly in homes with period features. External insulation consists of a cladding and rendering process which has obvious impacts on external appearance. However, in some areas, the visual impact may be acceptable (for example, in concrete walled dwellings with existing render) but on older historic properties, the effect may not be desirable. Although the cost of installing external insulation on solid walled properties is generally more expensive than fitting internal insulation (costing many £1000s per dwelling), it is generally far less disruptive and allows the works to be undertaken with occupants in-situ. The added costs decanting and potential relocation of occupants must also be considered.

Data from the Home Energy Efficiency Database (HEED) operated by the EST provides the number of homes in Hertfordshire which may be suitable for cavity wall insulation, or which may require solid wall insulation. This data is summarised in Table 3.2 below.

In general the number of homes with the potential for cavity wall insulation is relatively low, with typically 10 – 20% of an authority's dwellings having the potential to be retrofitted. In most authorities, the majority of homes with cavity walls have had them insulated; either at the time of build, or as retrofit. However, as a cost effective measure it is important for all the Local Authorities to maximise the savings available from cavity wall insulation and target the remaining private and public sector homes with potential.

The number of homes with solid walls differs significantly between Hertfordshire's authorities, with Watford having the highest proportion at 45%, and Welwyn Hatfield the lowest at 12%. This is almost certainly due to the age of these towns with Watford having a large proportion of older dwellings built pre 1930. It is important for each LA to identify the housing stock with solid walls and assess the potential for solid wall insulation. In the early years, it is likely that the greatest potential is in the social housing sector where large scale retrofit combined with similar dwelling designs can help reduce the installation costs of solid wall insulation combined with helping to alleviate fuel poverty. It is likely that a great many homes, particularly in the private sector and in historic areas, will not be able to install solid wall insulation in the near future.

	% solid	% cavity	No. dwellings with solid walls	No. dwellings with unfilled cavity walls
Broxbourne	20%	7%	7,015	2,680
Dacorum	33%	15%	18,586	8,676
E. Herts	23%	20%	12,399	10,641
Hertsmere	31%	14%	11,865	5,581
N. Herts	36%	5%	17,813	2,672
St Albans	21%	10%	11,141	5,343
Three Rivers	43%	13%	14,580	4,546
Watford	45%	13%	15,054	4,189
Welwyn Hatfield	12%	5%	4,855	1,957

Table 3.2: Summary of the potential for cavity wall insulation and solid wall insulation in Hertfordshire (Source: Homes Energy Efficiency Database [HEED], 2010)

The discussion has so far covered existing buildings. Energy efficiency levels in the new building sector is covered in Part L of the Building Regulations and recent revision combined with the trajectories set by government mean that standards should be high. As part of the current Building Regulations consultations, a back-stops position is being developed which means that all buildings must meet strict criteria for efficiency, irrespective of other CO_2 reducing measures. It should be recognised that there are diminishing returns in installing ever greater levels of insulation and there is a point where the cost and practical benefits if increasing insulation thickness will outweigh the small energy and CO_2 benefits.

3.2.2 Air Tightness and Thermal Bridging

Alongside thermal losses through fabric (the conduction of heat), buildings lose heat through air transfer – this could be desired air transfer for ventilation or undesirable air leaks.

Existing buildings can be very leaky (a poor air tightness) due to gaps around openings and penetrations, and general leaks in the fabric and between structural elements. A common place is between floors and walls. Basic draft proofing measures can have a large effect at improving the air tightness, for example ensuring that windows and doors seal when closed, sealing openings around window and door frames, service pipes, and minimising infiltration around floor perimeters. It is unlikely that in existing dwellings, these basic measures will affect in-door air quality although suitable ventilation should be provided for wet areas such as kitchens and bathrooms.

In new construction, air tightness is covered by Part L of the Building Regulations with a minimum value of 10 m^3/m^2hr @ 50 Pa required, verified by pressure testing. These air tightness rates will improve with further revisions of the building regulations to improve standards further. With traditional masonry construction, it is important that attention is paid to construction detail to ensure that all penetrations and joints between elements are adequately sealed. Rates less than 3 m^3/m^2hr @ 50 Pa have been recorded. However, with modern methods of construction including pre-fabricated timber and steel frame structures and panelised systems, there is potential for more reliably improving air tightness making use of precision factory fabrication and reduced joints between components.

It is often recommended that homes with very low air permeability levels install mechanical ventilation in order to ensure adequate ventilation for healthy living conditions and the prevention of condensation. Heat recovery systems which extract heat from exhaust air and pre-heat incoming air can mean that overall thermal losses from ventilation are minimised. However, it is important that the systems are well specified and have high efficiency fans and heat exchangers, to prevent the increase electricity consumption outweighing the thermal savings in terms of CO_2.

Thermal bridges occur where there is a break in the insulation resulting in a route which has a good thermal conductivity. Typical areas are around openings, and joints between floors, walls, and roofs. In existing buildings, there is relatively little which can be done to reduce thermal bridging in structural elements. However simple design details in new buildings can greatly reduce the losses, and standardised Accredited and Enhanced Construction Details allow designers to reduce the losses at bridges.

3.2.3 Lighting

The penetration of natural daylight should be maximised where possible in new buildings to reduce the use of artificial lighting within buildings. This requires correct orientation of the building, optimisation of internal layout, and maximising window dimensions and heights. However it is important to also prevent overheating in summer and thermal losses in winter, and so south facing orientations should be accompanied by suitable shading mechanisms, and glazing should be high efficiency.

All buildings could make use of dedicated low energy lighting in conjunction with appropriate controls to reduce energy consumption. For example, smart controls can be specified which enable all lights to be switched off from a single switch, thus avoiding lights being left on during the night or periods of non-occupancy. External lighting can be controlled using daylight sensors or timers to avoid lights being switched on during daylight hours. Similarly, PIR sensors should be used for security lighting.

3.2.4 Heating and Hot Water

In addition to improving insulation and air-tightness, heating fuel demand can also be reduced by replacing an old boiler with a high efficiency condensing boiler. These recover heat from the flue of the boiler, which would otherwise be wasted, and can convert over 86% of the energy in the fuel into heat, compared to as low as 65% for an old, inefficient boiler.[13] Under current Building Regulations, it is now only possible to install high efficiency condensing boilers, and it is expected that over the next decade, most remaining inefficient boilers will have been replaced.

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[13] Source: Energy Saving Trust (www.energysavingtrust.org.uk/Home-improvements-and-products/Heating-and-hot-water)

CO_2 emissions can also be reduced by switching heating fuel for a less carbon-intensive alternative. Where a connection to the gas grid is available, natural gas produces lower CO_2 emissions per unit of heat supplied than grid-supplied electricity, oil or coal.

In older dwellings, hot water is a relatively small component of heat demand, whereas in modern thermally efficient dwellings, the hot water fraction is significantly higher. In all cases, improving boiler efficiency will reduce energy consumption for hot water, and where a cylinder based system is present, further reductions can be made through insulating of internal pipework and by using a foam-insulated cylinder. An additional measure is to reduce the demand for hot water, and efficient fittings such as aerated taps and shower heads can make significant improvements.

3.2.5 Passive Design and Reducing Overheating

There is a real risk of overheating in many of our buildings as higher temperatures are becoming more commonplace due to the effects of climate change. Overheating is often caused by excessive solar gains, particularly during summer. Mechanical cooling is also sometimes used to help avoid overheating which can increase CO_2 emissions through electricity consumption. Passive approaches include building orientation, shading (e.g. external louvres, shutters, or overshading from balconies), natural ventilation design, and the specification of green roofs and walls. Effective design can reduce overheating and provide beneficial solar gains during the winter months.

Thermal mass can also help control temperatures by acting as a buffer to the temperature variations through the day, by absorbing heat as temperatures rise and release heat as temperatures fall. For traditional masonry or stone construction, external walls will have large areas of external thermal mass. For timber or steel construction, thermal mass can be incorporated into the floors and internal walls. The addition of phase change materials to walls and floors in both existing and new buildings can add thermal mass[14].

3.2.6 PassivHaus

PassivHaus is a German standard for ultra-energy-efficient homes where demand for space heating is dramatically reduced, often to the point where a separate heating system (such as a gas boiler) is no longer necessary. A system will still be needed to supply hot water. The standard is met by using passive design, specifying very low U-Values, air tightness, thermal bridging, and the use of mechanical ventilation with heat recovery. There is currently considerable interest in this building technique in the UK, as evidenced by its mention in the recent zero carbon consultation[8]. It remains to be seen whether it will take off as a viable option for new development.

[14] Phase change materials can increase the thermal mass of a building by storing latent heat through the phase change of a material rather than relying on large amounts of material. For example, the change of wax from a solid to a liquid stores latent heat which would require many more times the mass of an alternative material, such as concrete, with no phase change.

Figure 3.1. Example of a Passivhaus development in Austria

3.3 Energy Efficiency in Non-domestic Buildings

Many of the options for reducing CO_2 emissions from housing are also applicable to non-domestic buildings. However, non-domestic buildings tend to be more complex due to the variety of building types, the range of activities that they accommodate and the use of more sophisticated building services. Analysis of monitored data suggests that the energy performance of a non-domestic building is generally determined by its fabric, the mechanical services and the occupants. These operate as a system and each controls a range of performance. A poorly performing building may require much input from services, which if badly managed can lead to high energy consumption. The reverse may also be true. The variation in the fabric, mechanical services or occupant behaviour can result in a 20 fold variation in energy performance.

Principles that could be adopted when improving energy efficiency in non-domestic buildings are described below.

Excessive areas of glazing should be avoided.

CIBSE TM23[15] sets out best practice air permeability rates for different building types which should be adopted for all buildings.

The most appropriate and efficient form of heating for a non domestic building will vary depending on the use. For buildings which are used intermittently (such as churches) or which have large air volumes (such as industrial units) radiant heating may be an effective form of heating. For buildings which are used more regularly and those with smaller air volumes, central hot water systems will be more effective.

[15] TM23 Testing buildings for air leakage (CIBSE, 2000)

The use of air conditioning has become widespread and is likely to become more so as summertime temperatures increase due to climate change. Air conditioned offices can consume about twice as much energy as naturally ventilated buildings[16]. However, studies have shown that in spite of the extra capital and running costs, occupant satisfaction is no greater (and often lower) than in naturally ventilated buildings. There is, therefore, a case for implementing strategies in non-domestic buildings that reduce the need for air conditioning. These can include:

- Controlling solar gains through glazing - making maximum use of daylight while avoiding excessive solar gain
- Selecting equipment with reduced power requirements (e.g. flat screen monitors)
- Separating high heat demand processes (including industrial processes, mainframe computers, large photocopiers etc) from office accommodation
- Making use of thermal mass (and enhancing thermal mass with phase change materials) in combination with night ventilation to reduce peak temperatures. The building effectively acts as a heat store / buffer, preventing overheating in summer.
- Providing effective natural ventilation
- Shading devices for the windows
- Using task lighting to reduce background luminance levels
- Reducing energy demand for lighting by installing energy efficient lighting with a high light output ratio and selecting lamps with a high luminous efficacy
- The use of pale colours on walls and ceilings to reduce the need for artificial lighting
- Providing effective controls which prevent lights being left on unnecessarily.

Effective window design is essential in naturally ventilated buildings. Windows should allow ease of control by occupants regardless of desk arrangements. The benefits of daylighting and good window design are not only related to energy savings. There is growing evidence that the view from windows and the perception of the presence of daylight, even without direct views, is valued by occupants. This can lead to increased well-being and productivity, and also increased tolerance of non-neutral environmental conditions. In office environments the window design must ensure that glare is avoided to prevent blinds from being left closed minimising the benefits of effective day lighting.

[16] Energy consumption guide 19: Energy use in office (CIBSE)

Figure 3.2: Strategies to improve energy efficiency in non-domestic buildings. Shading devices fitted to Lycée Chevrollier, a high school in France (above), and solar shading and natural lighting, Jubilie Campus (below)

3.4 Key Considerations Emerging from this Chapter

This chapter has considered the opportunities for reducing CO_2 emissions through increased energy efficiency in the existing stock and in new developments. Key considerations emerging from this chapter are:

- Energy use and CO_2 emissions from the existing building sector are likely to be significantly higher than for post 2010 construction for many decades to come.
- HECA statistics suggest that Hertfordshire in general is improving the efficiency of the domestic stock at lower rates than other parts of the country.
- There may be significant potential in some authorities to reduce energy demand through solid wall insulation, and efforts should be made to identify potential dwellings and assess the viability of installing insulation.
- Improved thermal performance of homes can lead to a rebound effect, where CO_2 savings are partially offset by improvements in comfort. Assessing potential energy and CO_2 savings should take account of this effect when monitoring.
- Appropriate specification of new buildings or renovations can reduce energy demand and improve thermal comfort, including overheating.

4 Opportunities for District Heating & CHP

The energy demand of buildings has traditionally been met by electricity supplied by the national grid, heating supplied with individual boilers and cooling supplied through chillers. The PPS1 Supplement supports the development of networks to supply electricity, heating and in some cases cooling at a community scale from local sources (referred to as decentralised energy).

Additionally, the draft PPS on Planning for a Low Carbon Future in a Changing Climate (currently out to consultation) places further emphasis on district heating (DH) and the role of local authorities. The main points relating to DH in the consultation PPS are summarised below:

- Public buildings are most suited for DH and are key for reducing risk for developers.
- Local planning authorities (LPAs) will be expected to assess opportunities for decentralised energy, focusing on opportunities "at a scale which could supply more than an individual building".
- Greater emphasis will be placed on LPAs, particularly in urban areas, having up to date heat mapping as part of their evidence gathering so that maximum efficiency can be achieved through siting of plant.
- Benefits of connecting DH in new developments to existing buildings are identified. This allows for developers to gain economies of scale by building bigger plants than required for their own projects and is "a more cost-effective way of meeting zero carbon targets".
- There is a table showing that "in most cases it is cheaper (to meet renewable targets using DH)".
- The draft confirms the PPS1 Supplement position that new developments can be mandated to connect to a district heating scheme.

This chapter discusses the opportunities in Hertfordshire for establishing DH networks.

4.1 District Heating

District heating is an alternative method of supplying heat to buildings, using a network of super insulated pipes to deliver heat to multiple buildings from a central heat source. Heat is generated in an energy centre and then pumped through underground pipes to the building. Building systems are usually connected to the network via a heat exchanger (also known as a heat interface unit (HIU)), which replaces individual boilers for space heating and hot water. Whilst there is some amount of thermal loss from the heat distribution infrastructure, the aggregation of small heat loads from individual buildings into a single large load allows the use of large scale heat technologies, including the capture of waste heat from industrial processes or power generation, or other large scale heat generation technologies which are not viable at a smaller scale. Of particular interest is combined heat and power (CHP).

4.2 Combined Heat and Power (CHP)

The traditional method of generating electricity at power stations is relatively inefficient, with at least 50% of the energy in the fuel being wasted in the form of heat. Whilst this could be used for a district heating scheme, power generation is often not close enough to heat demand centres, and there are significant challenges in establishing large scale (town and city-wide) heat networks for connection to power stations in the UK.

A CHP plant is essentially a local, smaller version of a power station but by being combined with heat extract, the overall efficiency is much higher (typically 80% – 85%). Whilst the electrical efficiency of smaller CHP systems is lower than large scale power generation, the overall efficiencies with heat use are much higher resulting in significant CO_2 reductions. An additional benefit can be the reduced need for major grid reinforcement through the integration of smaller local power generation. A standard, gas-fired CHP based on a spark ignition engine typically achieves a 35% reduction in fuel use compared with conventional power stations and gas boilers. There are many other CHP technologies available based on gas or steam turbines, or gasification. The use of bio-fuels in these systems can provide almost 100% reductions in CO_2 from electricity and heat generation.

4.3 Local Potential for District Heating and CHP

For existing development, DH is suited to areas of high heat density where a large amount of heat can be distributed over a relatively small amount of network infrastructure. This typically limits schemes to high density areas. Hertfordshire has a number of urban centres with relatively high density and which have potential for the development of heat networks. To help identify potential locations where networks may be viable, this study has produced a heat map of the County which visually shows the level of heat demand. We are not aware of any DH schemes currently installed in the County.

4.3.1 Heat Mapping of Hertfordshire

Heat demand in Hertfordshire has been mapped to identify locations with high heat demand which may be suitable for DH and CHP (Figure 2.7 on page 19). Further details of the heat mapping process are provided in Appendix B.

The viability of heat networks and CHP in new developments differs from that of existing areas, as the level of heat demand in new buildings is much lower due to the Building Regulations improving thermal efficiency. The high standards required for CO_2 emissions mean that alternative lower cost options may not be available, and the economic basis for selecting CHP and DH is significantly different.

4.3.2 Locations with Potential for CHP

It is theoretically possible to develop a DH network with CHP anywhere that there are multiple heat consumers; however the basic economics of schemes limit viable schemes to higher density areas as discussed. The main driver of the cost of a new heat network is the length of underground pipework required. It is therefore preferable to limit the distance between heat customers, by prioritising areas of higher density development.

The economics of district heating networks and CHP are also determined by technical factors including the size of the CHP engine and annual hours of operation (or base load). Ideally, a system would run for at least 4,500 hours per year for a reasonable return on investment which is around 17.5 hours per day, five days per week, or 12.5 hours every day of the year. CHP is therefore most effective when serving a mixture of uses, to guarantee a relatively constant heat load. High energy demand facilities such as hospitals, leisure centres, public buildings and schools can act as anchor loads to form the starting point for a district heating and CHP scheme. These also use most heat during the day, at a time when domestic demand is lower.

Another contributory factor to the economic viability of CHP is the difference between the cost of electricity and gas, referred to as the "spark gap". The greater the cost of electricity compared to gas, the more likely a CHP installation is to be viable due to increased revenues from the sale or use of electricity.

The potential for district heating powered by CHP can be assessed at a high level by setting a threshold heat density above which schemes become viable. Previous research into the economics of district heating and CHP has suggested that a threshold of 3,000 kW/ km^2 can give financial returns of 6%, which is below typical commercial rates of return but greater than the discount rate applied to public sector financial appraisal.[17] (Refer to Figure 2.8 on page 24 for areas which achieve this threshold)

For a threshold of 5,000 kW/ km^2, the existing heat demand that could be served by district heating is estimated at 37% of existing building heat demand and for a threshold of 7,000kW/ km^2, this is estimated to be 22% of existing building heat demand

Assuming a district heating viability threshold of 3,000 kW/ km^2 (see Figure 2.8), it can be surmised that urban areas such as Watford, Hemel Hempstead, Welwyn Garden City, Hatfield, Cheshunt, Hitchin, Letchworth, Hoddesdon, Hertford and Bishop Stortford all have large areas with district heating potential.

It should be noted that the discussion around viability presented here is very high level, and all potential CHP and district heating schemes should be assessed on a case by case basis, taking into account local conditions and heat users, and financial models. For this reason, the viability level of 3,000 kW/ km^2 should be used as a first level pass and the actual level may fall below or above this, with potentially large implications on the overall viable heat loads. Figure 2.8 on page 24 illustrates the relation of overall heat load in Hertfordshire to the viability level.

At lower heat densities, the overall level of heat demand is extremely sensitive to the viability level. For example, for a threshold level of greater than 3,000 kW/km^2 per year of heat demand, district heating is estimated to be viable for 78% (100%-22%) of existing building heat demand, but this reduces to about 37% of heat demand if the viability level is 5000 kW / km^2. At the higher viability levels (essentially the heavily urbanised areas) the sensitivity is much less (the graph is less steep) and determining the exact viability level is less critical.

In new development, targets for CO_2 reductions mean that the economic viability level changes because "business as usual" is no longer an option. Therefore the viability of district heating and CHP schemes depends on what the alternative options are to achieve the required CO_2 reductions.

[17] The potential and costs of district heating networks (Faber Maunsell & Poyry, April 2009)

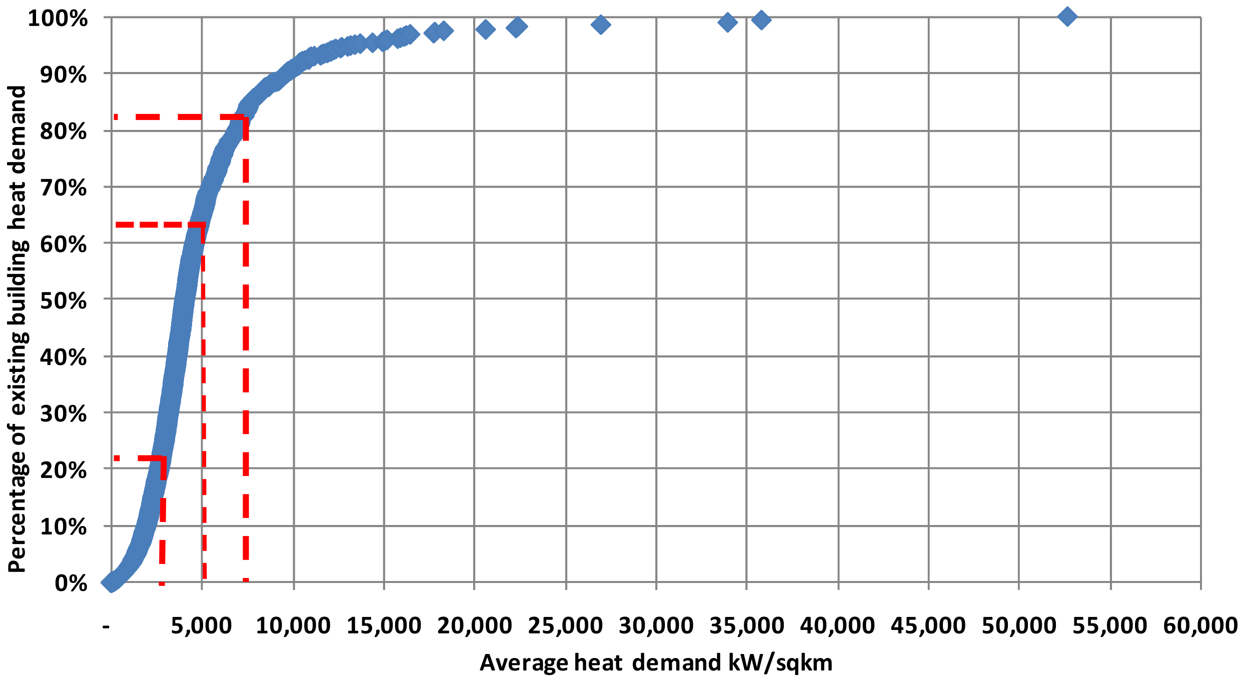

Figure 4.1 Sensitivity chart showing relation of overall heat load in Hertfordshire to the viability level

For new development, the improving insulation standards mean the requirement for space heating is relatively low and demand is only present during the winter months. Therefore hot water is the most consistent year round load and schemes are often sized on hot water demand to prevent heat dumping in summer months. For higher CO_2 reduction targets, such as those in Code 4 upwards, and building regulations from 2013 (for homes), District Heating may be one of the more economic methods of achieving targets, especially in mixed use and higher density developments. Whilst planning policy can not specify technologies or systems where supporting infrastructure (such as a local source of waste heat or neighboring DH scheme) is not available, the planning process should encourage the development of DH schemes in new development where viable.

One method of maximising the benefits of CHP and DH in new developments is to link smaller developments together, maximizing the load and potential efficiencies; another is to link the new development to existing areas. This includes development within both built-up areas, such as town centres, and urban extensions. Local planning authorities and other public stakeholders have a key responsibility to ensure that this can happen by the following:

- Ensuring that planning encourages the linking of development and use of heat networks where viable.
- The provision of public sector anchor loads to act as catalysts for heat networks to which new development can connect. This can include the creation of long term heat contracts to provide some degree of financial security to the network operator.
- The provision of financial support in the form of grant or low cost finance to assist with infrastructure costs.

In general it is unlikely that heat networks will develop in existing areas on a purely commercial basis without some form of support from the public sector.

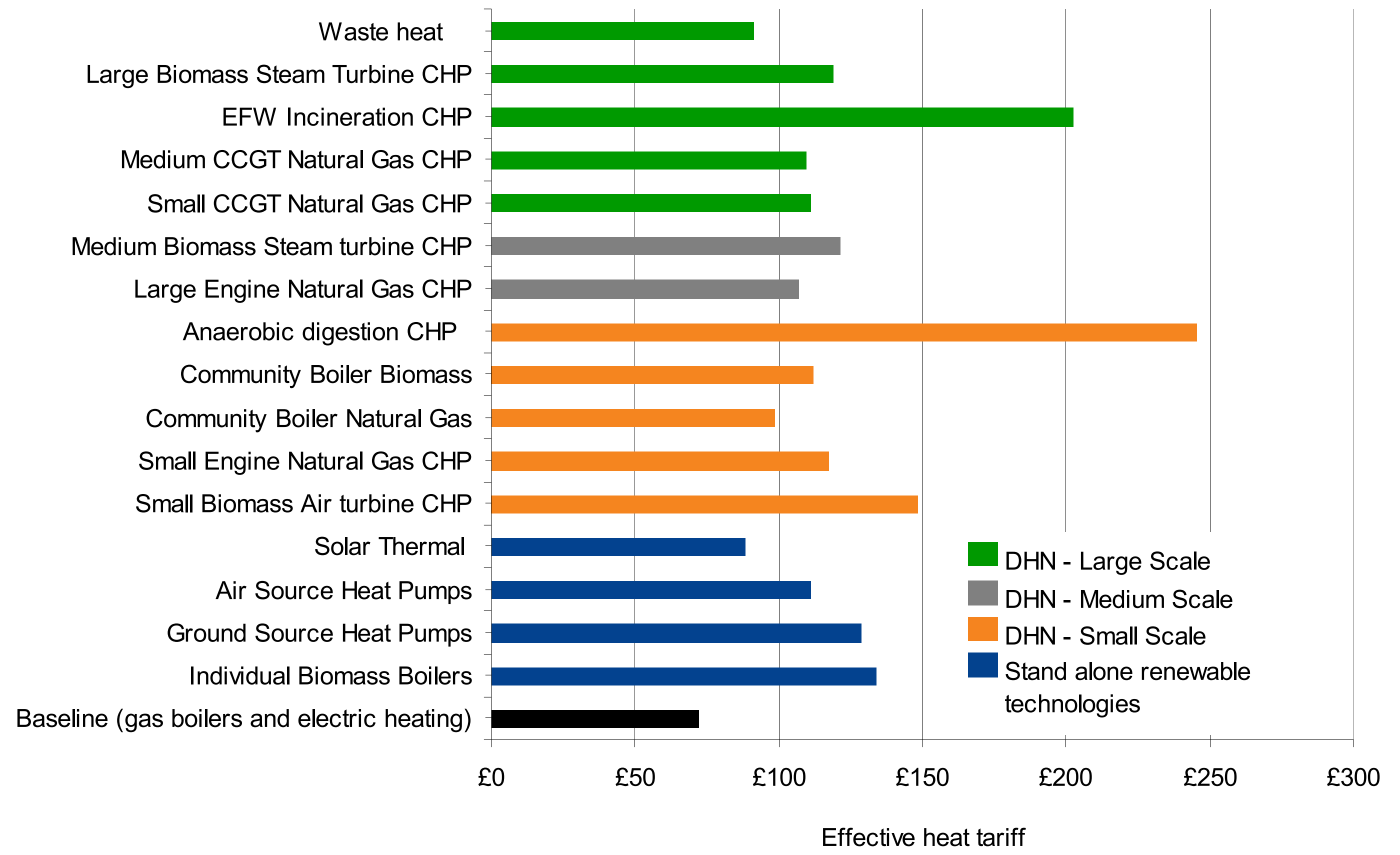

Figure 4.2 Cost of heat provision by technology in £/MWh, based on current market conditions.* Waste heat is heat obtained at very low wholesale cost from power plants or industrial processes. Community Boiler refers to district heating, DHN in legend refers to District Heating Network. Solar thermal heating provides domestic hot water only. (Source: The potential and costs of district heating networks, Faber Maunsell AECOM and Poyry)[17]

4.4 Financial Implications of District Heating with CHP

Figure 4.2 compares the capital cost of a range of renewable and low carbon heat technologies with gas and electric heating. Full infrastructure costs of converting existing homes to district heating can vary from about £5,000 per dwelling for flats, to around £10,000 per dwelling for detached or semi-detached properties; details can be seen in Table 4.1. These costs assume no prior district heat network infrastructure in the area and that existing dwellings are fitted with individual heating systems. Table 4.2 provides the cost of providing district heating with CHP to non-domestic buildings.

The main benefit of moving to district heating networks is the carbon savings that they can deliver. Figure 4.3 shows the potential cost per tonne of CO_2 saved for a range of heat generating technologies. The figures are based on carbon factors that reflect today's grid mix. District heating with CHP is cheaper in terms of cost per tonne of CO_2 saved than heat pumps; air source heat pumps can actually result in a net increase in CO_2 emissions.

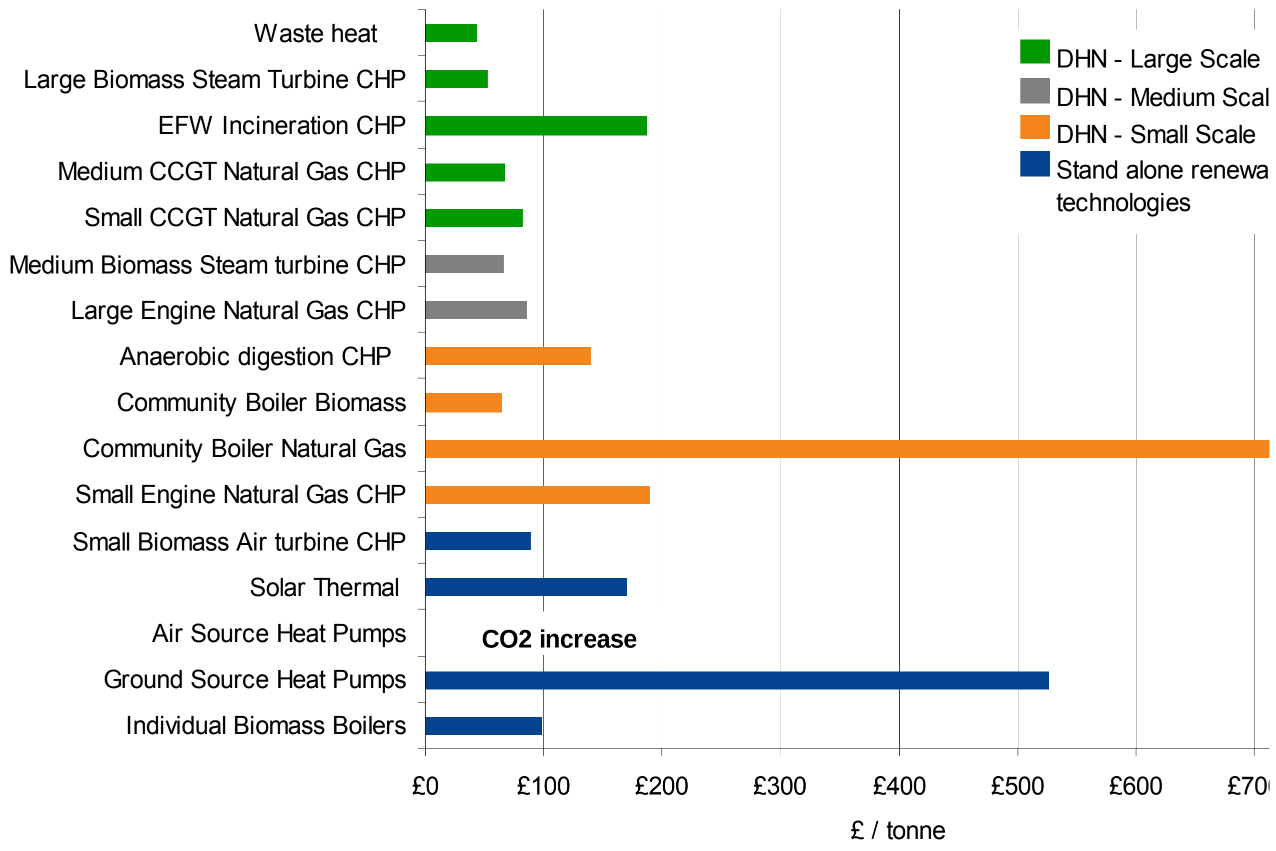

Figure 4.3: Cost compared to CO_2 saved by heat provision technology, in £/tonneCO_2 saved. Waste heat is heat obtained at very low wholesale cost from power plants or industrial processes. Community Boiler refers to District Heating, DHN in legend refers to District Heating Network. Solar thermal heating applies to water-heating only. (Source: The potential and costs of district heating networks, Faber Maunsell AECOM and Poyry) [17]

Type of Area	Total District Heating Network mechanical and civil costs of distribution pipework Cost	Heat Interface Unit (HIU) and Heat Meter Cost
City Centre	£8.40 per m^2	£20.00
Other urban area	£16.50 per m^2	£20.00

Table 4.2: District heating network costs for non-domestic buildings. The Hydraulic Interface Unit (HIU) is the exchanger device that replaces the boiler and transfers heat from the district heating network into the home. (Source: The potential and costs of district heating networks, Faber Maunsell AECOM and Poyry)

Dwelling Type	District Heating mechanical and civil costs of distribution pipework Cost	District Heating Branch mechanical and civil costs of distribution pipework Cost	Heat Interface Unit (HIU) and Heat Meter Cost	Total Cost
Small terrace	£2,135 Based on outline network design and costing	£1,912 Based on outline network design and costing plus additional costs for HIU and metering.	£2,300 (includes £1,600 HIU, £200 for heat meter, and £500 for installation)	£6,347
Medium / Large terrace	£2,135 Based on outline network design and costing	£2,255 Based on outline network design and costing plus additional costs for HIU and metering.	£2,300 (includes £1,600 HIU, £200 for heat meter, and £500 for installation)	£6,690
Semi-detached	£2,719 Based on outline network design and costing	£2,598 Based on outline network design and costing plus additional costs for HIU and metering.	£2,300 (includes £1,600 HIU, £200 for heat meter, and £500 for installation)	£7,617
Semi detached	£2,719 Based on outline network design and costing	£3,198 Based on outline network design and costing plus additional costs for HIU and metering.	£2,300 (includes £1,600 HIU, £200 for heat meter, and £500 for installation)	£8,217
Converted flat	£712 Assumes that infrastructure costs for a 3-story converted terrace are split between 3 flats.	£752 Assumes that branch costs for a terrace are split between 3 flats with an HIU and heat meter for each flat.	£2,300 (includes £1,600 HIU, £200 for heat meter, and £500 for installation)	£3,764
Low rise flat	£1,500 Estimate	£1,500 Internal pipework	£2,300 (includes £1,600 HIU, £200 for heat meter, and £500 for installation)	£5,300
High rise flat	**£1,000** **Estimate**	**£1,500** **Internal pipework**	**£2,300** **(includes £1,600 HIU, £200 for heat meter, and £500 for installation)**	£4,800

Table 4.1: District heating costs for homes. The Heat Interface Unit is the exchanger device that replaces the boiler and transfers heat from the district heating network into the home. (Source: The potential and costs of district heating networks, Faber Maunsell AECOM and Poyry) [17]

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4.5 Key Considerations Emerging from this Chapter

The sections above have considered the opportunities for reducing CO_2 emissions through the supply of low carbon heat. Key considerations emerging from this chapter are:

- District heating and CHP increases the efficiency of heat and power generation compared with conventional generation resulting in significant CO_2 reductions, and can contribute to renewable energy targets if powered by biomass or biogas
- Heat mapping suggests that there could be a significant potential for CHP and district heating in Hertfordshire based on a heat density viability analysis. In all cases this needs further analysis on a case by case basis using the heat mapping of potentially viable areas in this study as a starting point.
- Further opportunities will be presented by proposed new development, but their extent will be affected by a range of factors, including future heating demands. CHP and district heating are most viable when there is a mix of uses with a high and stable heat demand
- Opportunities for district heating will be greater where new developments can be physically linked to buildings in existing developments
- District heating with CHP is many cases offers lower cost CO_2 savings than smaller scale alternatives such as heat pumps; air source heat pumps can actually result in a net increase in CO_2 emissions
- Full infrastructure costs of converting existing homes to district heating can vary from about £5,000 per dwelling for flats, to around £10,000 per dwelling for detached or semi-detached properties. It is likely that the roll out of district heating in existing areas will require some form of public sector support.

5 Opportunities for Renewable and Low Carbon Technologies

This chapter outlines the opportunities for decentralised renewable and low carbon energy installations in Hertfordshire, at a range of scales.

The methodology used in this section closely follows (where possible) the methodology set in Renewable and Low-carbon Energy Capacity Methodology commissioned by the Department for Energy and Climate Change (DECC) and the Department for Communities and Local Government (CLG). Where there is an absence of guidance, assumptions were made. These are all listed in Appendix B.

A large part of Hertfordshire is land designated as greenbelt. Government policy on development in the greenbelt is set out in PPG2. The opportunity areas identified in this study highlight the greenbelt areas and show the impact that this may have on development of renewable and low carbon energy schemes. However, PPS22 is clear that whilst elements of many renewable energy projects will comprise inappropriate development, this does not preclude them from taking place should "very special" circumstances be demonstrated. Very special circumstances for example could include the wider environmental benefits associated with increased production of energy from renewable sources. The location of opportunity areas and therefore energy generation of the study area is potentially greater if greenbelt designation is viewed within the context of PPS22. The constraints maps are presented in a way which shows the opportunity areas without greenbelt constraints and with the greenbelt shown as an overlay to allow the reduction in available opportunity areas to be highlighted.

5.1 Large Scale Wind Resource

Wind turbines convert the energy contained in the wind into electricity. Large scale, free standing turbines have the potential to generate significant amounts of renewable energy.

5.1.1 Existing Large Scale Wind Energy

Large scale wind turbines are those with the capacity of around 1MW or above and are typically used in the UK in commercial wind farms, with sizes now commonly being 2.5MW. There are currently no large-scale wind developments in Hertfordshire. Two applications for large scale wind farms have been made in the County but neither has been permitted.

Another application of 3 wind turbines each rated at 2 MW has also been rejected. The turbines were planned to be located at Weston Hills in North Hertfordshire.

5.1.2 Local Potential for Large Scale Wind Energy

The wind resource in Hertfordshire is potentially suitable for large scale wind energy with average wind speeds of 5.5 m/s at 45m height throughout the County, according to the UK Wind Speed Database (Figure 5.1).At lower heights, and especially in urban areas, it is likely that the UK Wind Speed Database is not representative due to localised turbulence effects. However in the more rural areas and at the heights of large scale turbines, modelled in this study (typically 80m hub height); this data is likely to be accurate, with higher speeds above the 45m baseline. We therefore believe that a minimum average windspeed of 6m/s can be used across the County – this can be suitable for economic operation of large scale wind turbines.

Physical constraint geographical information systems (GIS) mapping has been carried out to identify areas where large scale wind energy may be feasible, based on a wind turbine with an 80m rotor diameter and 120m tip height. There are no official guidelines for the constraints on locating wind turbines and a detailed case-by-case study is required in all cases. For this reason, this study uses two separate constraints analyses. The first set of constraints is based on engineering constraints (areas where it is physically impossible to develop turbines and therefore represent the absolute constraints) and comprises:

- Roads
- Railways
- Inland Waters – rivers, canals, lakes, reservoirs
- Built up areas – houses, buildings
- Airports
- Buffer around roads and rail lines of 132 m (110% of turbine height)

The second analysis encompasses additional constraints[18] where wind turbine development may possibly conflict with land uses and includes all of the following (including the engineering constraints above). This could results in a significant reduction in available land area for large scale turbines:

- AONB
- SSSI
- Wildlife Sites
- Conservation Areas
- Ancient Woodlands
- Woodlands
- Greenbelt
- Local Nature Reserve
- Area of Archaeological Significance
- Scheduled monuments
- RSPB Reserves
- Ramsar Sites
- Waterside Green Chains
- 500 m buffer zone from urban – built up areas.
- 5 km from airports (Luton, Stansted, any major airfields)

[18] *The North Hertfordshire Core Strategy Preferred Options (2007) proposed that the green belt should be extended to cover the area bounded by the Metropolitan Green Belt to the south, the Luton Green Belt to the west and the A505 Offley Bypass to the north. This has not been included in the wind maps.*

It should be noted that some land designated as a 'soft' constraint will not physically prevent the installation of wind turbines. These areas may have constraints which <u>will</u> need careful examination on a case by case basis to ensure that wind turbine development is appropriate to the area, but should not be considered a blanket constraint'

Government policy on development in the green belt is set out in PPG2. The opportunity areas identified in the study area treat Green Belt as if development of renewable or low carbon energy generation automatically conflicts with that designation and is therefore not acceptable. However, PPS22 is clear that whilst elements of many renewable energy projects will comprise inappropriate development, this does not preclude them from taking place should very special circumstances be demonstrated. Very special circumstances for example could include the wider environmental benefits associated with increased production of energy from renewable sources. The location of opportunity areas and therefore energy generation of the study area is potentially greater if GB designation is viewed within the context of PPS22.

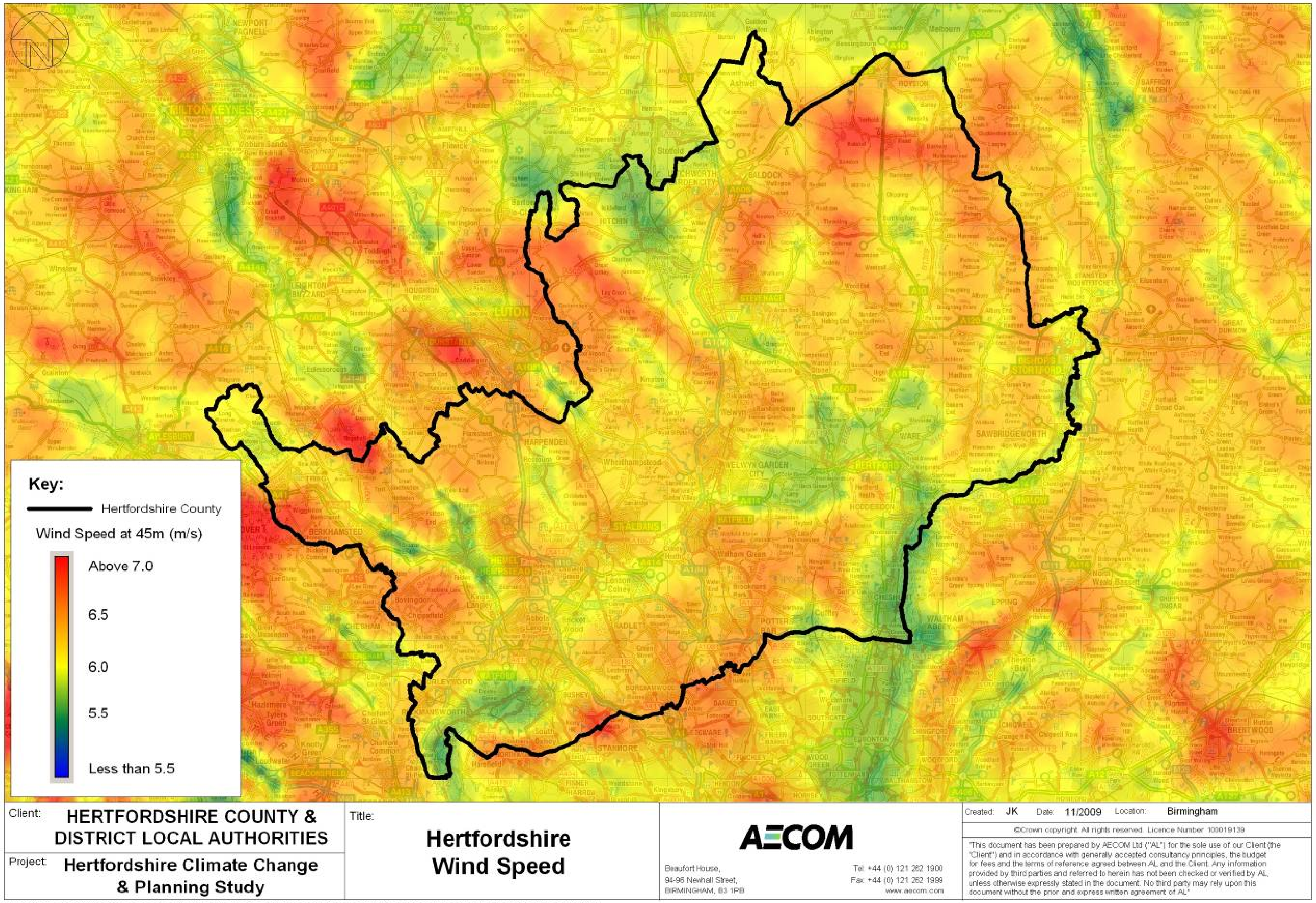
Further information and guidance on green belts is provided within this report.

Figure 5.2 and Figure 5.3 on the following pages represent the GIS maps of engineering and further constraints.

Users of the latter map (Figure 5.3 Further constraints) should take into consideration the previous comment regarding soft constraints, particularly greenbelt, when determining suitable sites for wind energy applications.

The total area of land in Hertfordshire that is potentially suitable for large scale wind turbines is approximately 1,084 km^2 according to the engineering constraints analysis and 82.75 km^2 according to the further constraints analysis. This excludes land currently designated as greenbelt. Greenbelt constitutes an additional 521 km^2 area[19] available for large wind turbine installations. Therefore if greenbelt is included in the total area available for wind development this amounts to a total land area of 604 km^2. In general, around 9MW of large scale wind capacity can be installed per square kilometre of available land – this is roughly three to four large turbines. Thus 5,436 MW of installed wind capacity could be achieved if all of the 604 km^2 land area was made available. On greenbelt land alone this equates to 4,689 MW of capacity (or roughly 2,300 large scale wind turbines). This could provide the total electricity consumption for approximately1.5 million homes and offset the total CO_2 emissions related to that consumption.

[19] This area takes into account the constraints in greenbelt. For example roads, railways and rivers are subtracted from this area as these project constraints to large wind turbines.



F:\TP\Map_Data\Project_areas\Hertfordshire Project\GIS data\Wind data\Wind Speed\Hertfordshire Windspeed.WOR

Figure 5.1: Hertfordshire Wind Speed Map The majority of areas at a 45 m height exhibit windspeeds of 5.5 m/s or more. At the height of large scale turbines (typically around 80m hub height) these speeds will be higher.

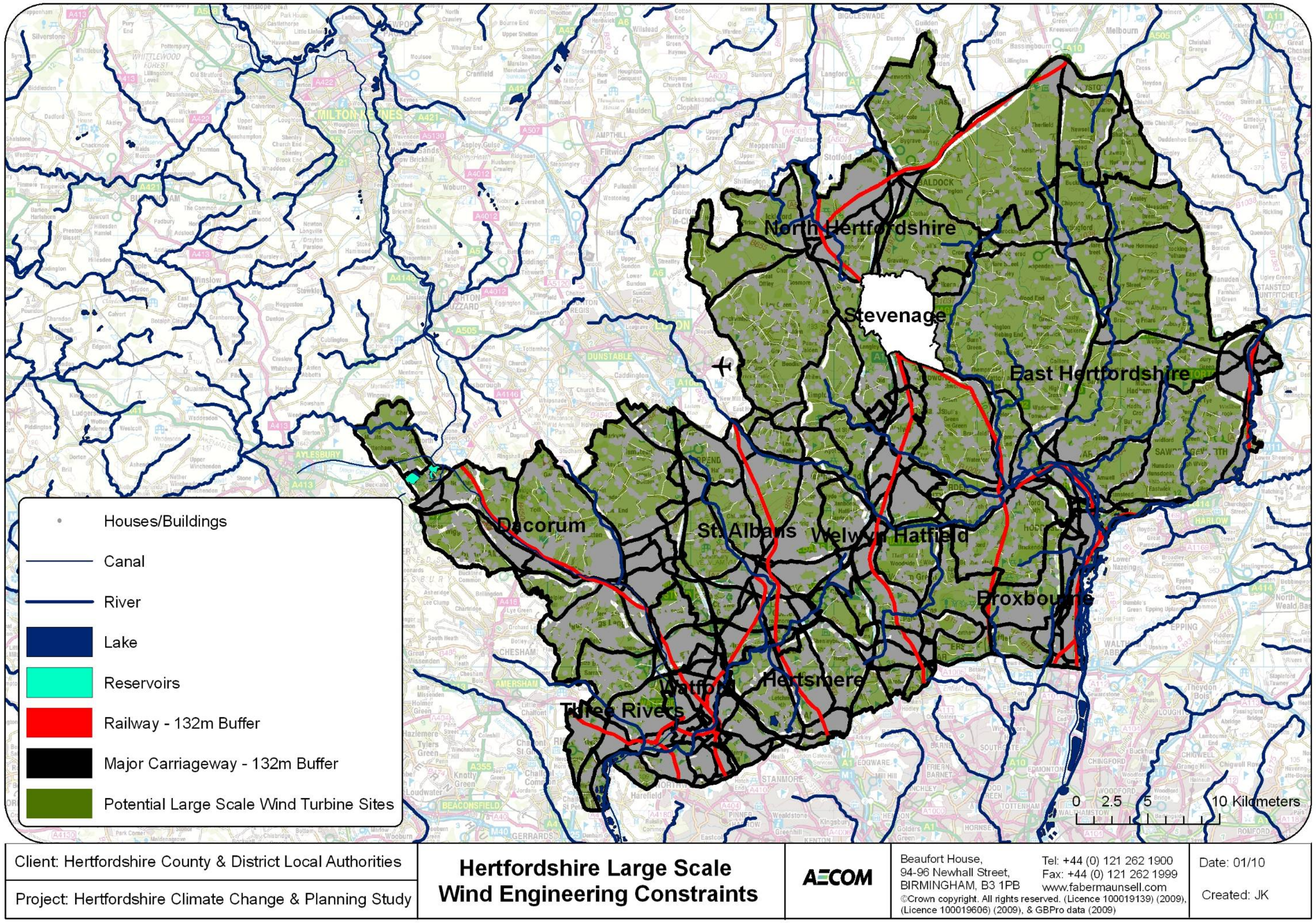


Figure 5.2: Hertfordshire Large Scale Wind Constraints Analysis - Engineering Constraints. There is 1,084 km^2 of land identified as suitable for large scale wind assuming no further constraints.

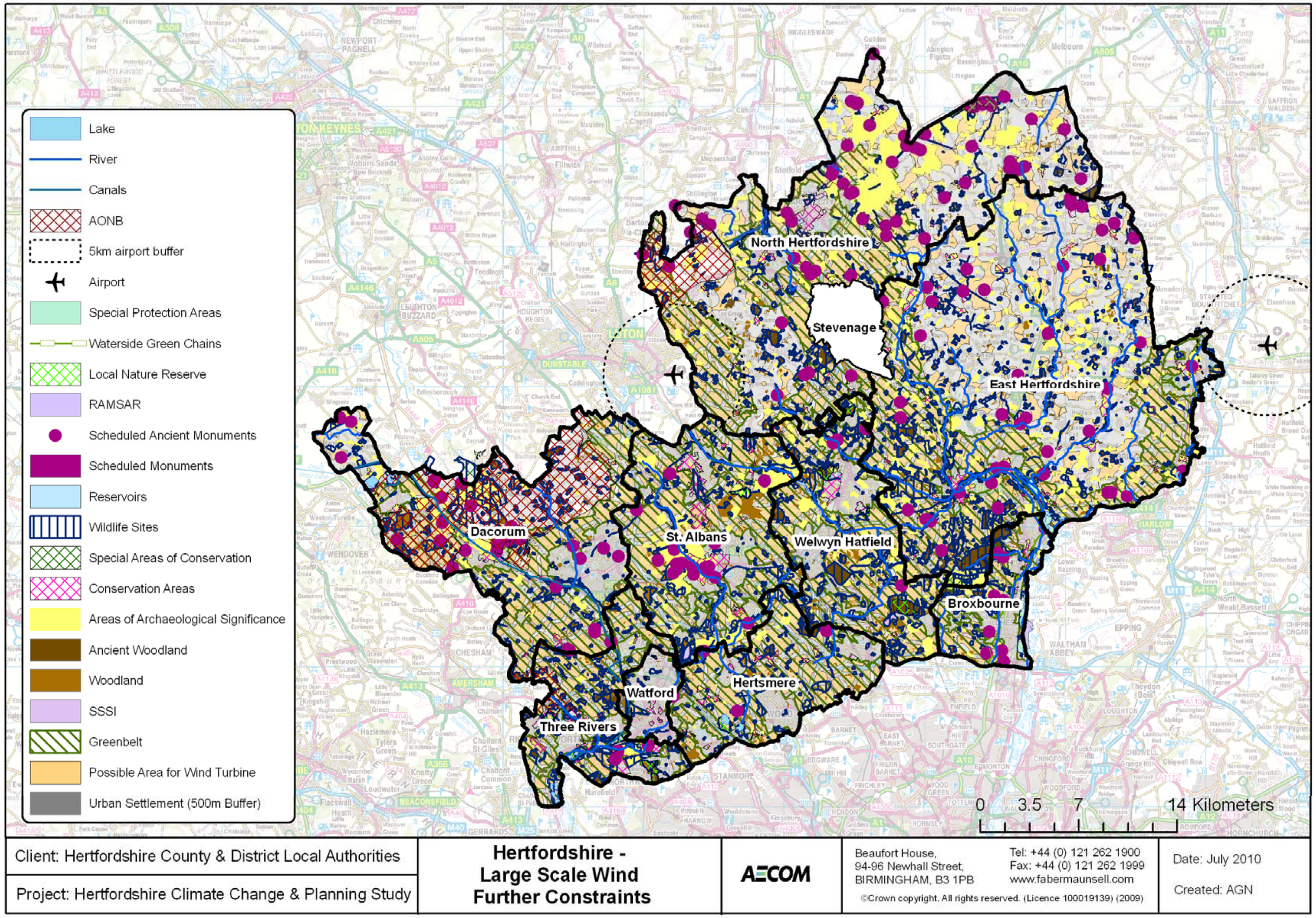


Figure 5.3: Hertfordshire Large Scale Wind Constraints Analysis - Further Constraints. The introduction of the further constraints results in a land area of 82.75 km^2 being identified as suitable for large scale wind.

5.2 Large Wind Capacity in Hertfordshire according to further constraints analysis

It should be noted that this analysis is indicative and that considerably more land could be available for wind development if constraints labelled as 'soft' are not viewed as absolute constraints by the LPA. Please refer to the comment made in section 5.1.1 regarding the need for a positive approach.

The 1,084 km^2 land availability assessed with the engineering constraints only represents a very optimistic view, and almost certainly, the land area which is actually suitable for large wind will be further constrained. If the further constraints are applied, the land area reduces to 83 km^2. This represents a relatively pessimistic view and in reality, large scale wind turbine development will be viable within many of the areas defined as "further constraints". For example, the 500m buffer zone around urban areas could be significantly reduced if visual impact and noise mitigation can be improved, or if the wind turbines are community owned resulting in a higher level of acceptance with local residents. One important constraint in determining the capacity is the greenbelt area. greenbelt in Hertfordshire constitutes 521 m^2 of land and therefore the available area for wind development would be 604 km^2 if greenbelt were included.

It should be noted that a Whole Region Wind Assessment [20]has been carried out for the East of England. A conclusion from this report is that the south of the region (including Hertfordshire) is less windy when compared to Cambridgeshire, Norfolk and Suffolk and therefore less viable for large scale wind. Although this statement is correct (Norfolk, Suffolk and Cambridgeshire will certainly offer more potential for large scale wind due to a better wind resource) this does not mean there is no wind potential at all in Hertfordshire. Indeed, due to this lesser large scale potential, there is an argument for Hertfordshire LPAs to be looking favourably upon smaller viable proposals (such as community scale wind) in the County due to the significant CO_2 savings that can be realised by wind energy at this smaller scale, and the opportunity it presents for helping to tackle climate change.

If 10% of all of the land identified under "further constraints (with greenbelt area included) is made available for large scale wind, then 540 MW capacity could be achieved – this is roughly 270 large scale turbines. Assuming a capacity factor of 23%, this would have an annual generation of more than 1 million MWh a year, which is equivalent to the electricity requirements of roughly 192,250 typical detached homes, or 618 ktonnes of CO_2 per year. These results are summarised in Table 5.1. Detailed feasibility studies should always be carried out to confirm the suitability of these areas and precise locations for turbines on a case by case basis. This analysis should always challenge the further constraints identified in line with PPS 22 to assess whether developing wind turbines in these areas will have an adverse impact, potentially opening up further areas to the development of large wind. **Large Scale Wind Turbines**	**Further Constraints**
Number of turbines	270
Rated power of turbines	2 MW
Hub Height	80 metres
Rotor Diameter	80 metres
Installed capacity	540 MW
Annual generation	1,088,610 MWh
Potential for CO_2 savings	618,330 tonnes
Number of homes equivalent (energy)	192,250

Table 5.1: Large scale wind energy resource in Hertfordshire according to further constraints analysis

5.2.1 Financial Implications of Large Scale Wind

Wind turbines, when located appropriately in areas of high wind speeds, are one of the most cost effective renewable energy technologies currently available in the UK. Generally the capital cost per unit output reduces as the size of the turbine increases. Large scale wind power is projected to cost around £800,000 per megawatt installed[21]. A typical cost breakdown is provided in Figure 5.4 below.

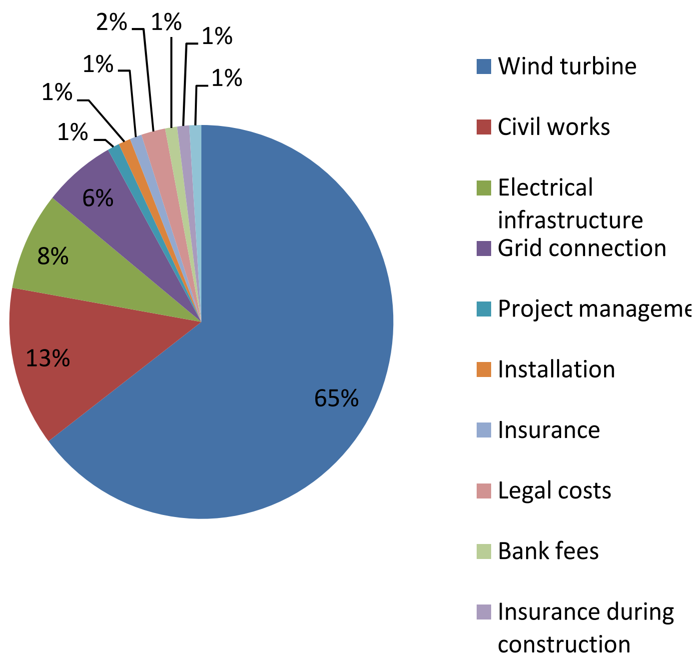


Figure 5.4: Capital cost breakdown for a large scale wind turbine. (Source: The economics of onshore wind energy; wind energy fact sheet 3, DTI) [22]

5.3 Medium and Small Scale Wind Energy Resource

Suitability of wind speeds in the district mean that smaller scale turbines of the order of 15m in tip height could be a significant opportunity, including in some areas that are not suitable for large scale wind. Smaller wind turbines have a significantly reduced visual impact and would be particularly suitable for farms and industrial sites, but also for municipal buildings such as community centres or schools. There are many examples of these turbines installed in schools, industrial estates and farms throughout the country some within very close proximity to the buildings and the residential areas.

5.3.1 Existing Installations

There are a number of small scale turbines installed in Hertfordshire. The largest is installed at the Renewable Energy Systems (RES) office near Kings Langley. This is a Vestas 225 kW turbine with a hub height of 36m and a rotor diameter of 29m. The turbine has been in operation since 2004 and produced so far just under 1000 MWh electricity. There are also a number of smaller turbines installed in Hertfordshire. These are;

- 2 x 6 kW turbines at Leventhorpe School in Sawbridgeworth. It is the first school in Hertfordshire to have planning permission granted for two 6kW wind turbines. (Figure 5.5)
- 20 kW Turbine at Howe Dell School in Hatfield
- 2 x 20 kW Gazelle Turbines with 20 m hub height and 26 m tip height in Welwyn Garden City at Tesco Headquarters
- 6KW turbine at the Council offices in Cupid Green Depot, Redbourn Road in Hemel Hempstead,
- 15KW wind turbine at Astley Cooper School in Grovehill, Hemel Hempstead

Figure 5.5: 2 x 6 kW Turbines at Leventhorpe school

[20] [20] Hertfordshire Renewable Energy Study, Renewable Energy Options for Hertfordshire, July 2005 Entec UK Limited

[21] BWEA Small Wind Turbine FAQ (BWEA website, accessed September 2009)

[22] The economics of onshore wind energy; wind energy fact sheet 3 (DTI, June 2001)

Based on the information provided to inform this study, there are a limited number of planned / proposed turbines in the County:

- 1kW turbine, with a rotor diameter of 1.75m, at Abbot Hill School, Bunkers Lane Hemel Hempstead
- 6kW Turbine, with a rotor diameter of 5.5 m, at Hemel Hempstead School, Heath Lane, Hemel Hempstead.

Figure 5.6 on page 37 shows the locations of the existing, planned and rejected wind turbines. The siting constraints on smaller scale turbines are dependent on a case by case basis – due to their smaller size the restrictions which may apply to large turbines covering visual appearance and noise do not apply to smaller scale systems, and in general, they can be located in most areas providing sufficient wind resource is available, including residential and urban areas, close to roads, and in areas of environmental sensitivity.

Due to their low height, the performance of small turbines is heavily dependent on localised wind conditions which in turn is influenced by the local topography and built environment. It is therefore important that the whole of Hertfordshire should be considered as suitable for small scale wind, but with suitable wind analysis carried out on a site basis.

For the purpose of estimating the potential resource, it has been assumed that 100 small scale turbines could be accommodated, on farms, in parks, near municipal buildings, community centres, schools or industrial estates, although there could be the potential to install significantly more. Installation of 100, 15 kW turbines would add 1.5MW to the district's renewable energy capacity and assuming a capacity factor of 10% would generate approximately 1,314 MWh annually. The contribution from 100 small scale turbines is around 26% of the energy generated by one large scale turbine, demonstrating the efficiencies of scale that can be achieved with large scale wind.

We have obtained costs from a manufacturer of small scale wind turbines. These costs are based on an installed cost of £50,000 for one 15 kW turbine and include civil works for an average site. Therefore the total cost would be around £5 Million. These results are summarised in Table 5.2.

Small Scale Wind Turbines	
Number of turbines	100
Hub Height	15 metres
Rotor Diameter	9 metres
Installed capacity	1.5 MW
Annual generation	1,314 MWh
Potential for CO_2 savings	746 tonnesCO_2
Number of homes equivalent (energy)	231

Table 5.2: Small Scale Wind Turbine potential of Hertfordshire

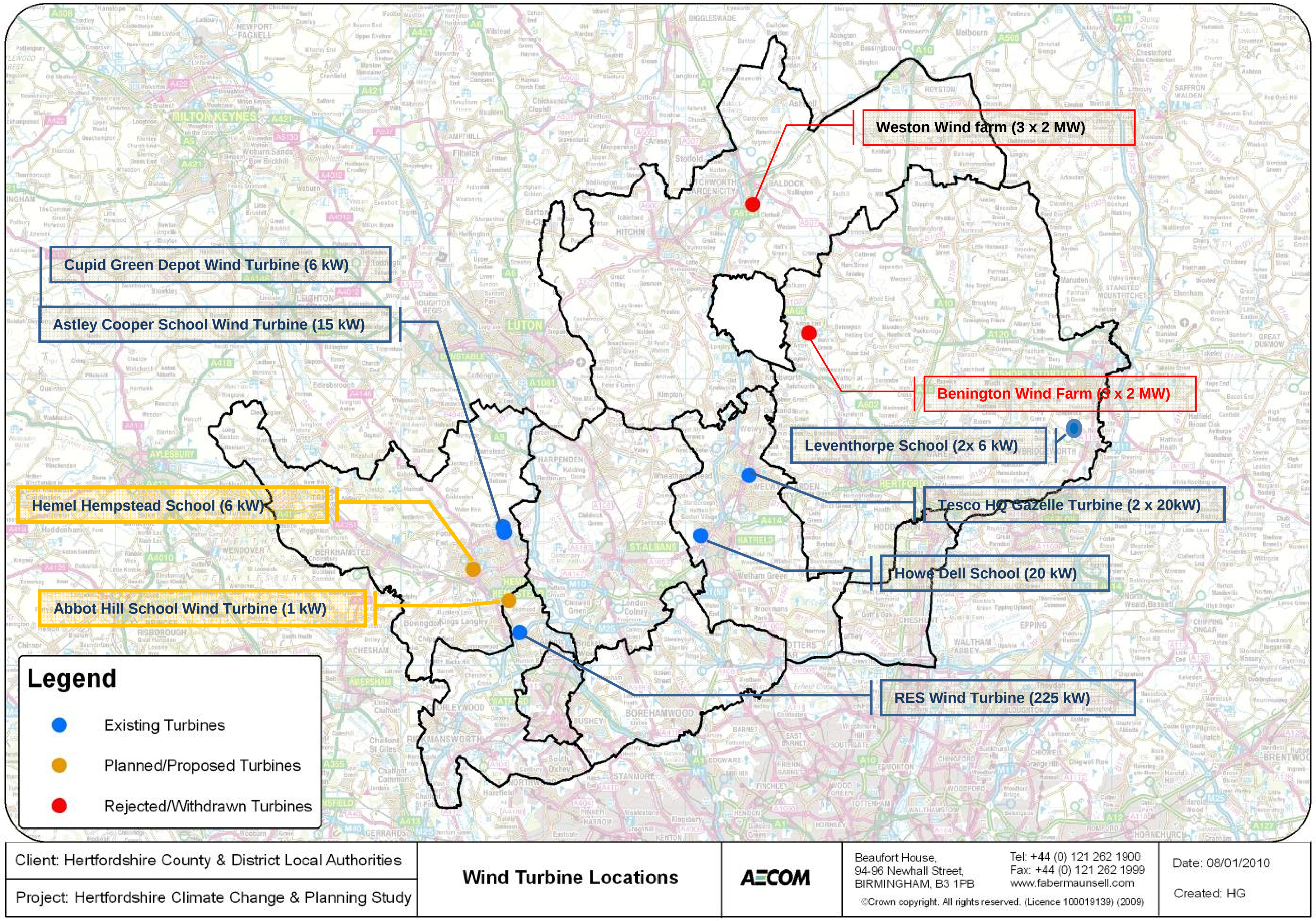


Figure 5.6: Wind turbine locations in Hertfordshire

5.4 Biomass Energy

Biomass is a collective term for all plant and animal material. It is normally considered to be a renewable fuel, as the CO_2 emitted during combustion has been (relatively) recently absorbed from the atmosphere by photosynthesis. Most CO_2 associated with the use of biomass fuels is due to the processing and transportation stages, which typically rely on grid electricity and fossil fuels. Liquid biomass fuels are not considered in this study. They are more applicable to transport sector in the form of bio-diesel and bio-ethanol and outside of the scope of this study.

5.4.1 Existing Biomass Energy Generation Sites

There are no medium to large scale existing biomass plants in Hertfordshire. A planning application has been made by Navitas Environmental for biomass plant to produce electricity. The proposed scheme will utilise 60,000 tonnes of waste wood with a production capacity of 6 MWe. The location of the proposed scheme is Appspond Lane, Potter's Crouch, St Albans.

A green waste digester in Much Hadham was permitted in June 2005 to produce bio-gas.

5.4.2 Biomass Resource

The assessment is based on the regionally available feedstock. GIS mapping exercise has been carried out to estimate the biomass resource in Hertfordshire. Natural England's agricultural land classifications have been used to assess the potential for energy crops and datasets from the Forestry Commission and Natural England have been used for wood biomass arisings. Four sources of biomass have been explored:

- Potential contribution of dedicated energy crops
- Arisings from arboriculture management
- Arisings from management of parks, highways, open spaces, green waste and waste wood. Currently these arisings are not collected in a coordinated manner.
- Contribution through wet biomass
- Industrial and municipal timber waste
- Agricultural Waste

The following areas of biomass resource have been estimated. The units are in square km. Each type of biomass brings its own set of constraints and these should be explored in detail before finalising locations.

Areas of biomass (km^2)	
Ancient Woodlands:	57
Woodland:	53
Parks:	59
Urban Areas:	234
Grade 2:	307
Grade 3:	953
Grade 4:	23
Grade 5:	0.41

Table 5.3: Biomass Resource of Hertfordshire

HCC has a large estate; The County Council controls over 10,380 acres of rural land and it is one of the largest landowners in Hertfordshire.

5.4.3 Energy Crops

The potential for energy crops has been assessed according to the availability of suitable arable land, taking into account competing land uses and typical yields. Agricultural land use classification maps[23] have been used to delineate appropriate soil types (Figure 5.7 on page 40).

The following criteria have been used to assess capacity:

- Grades 1 and 2 land have been omitted as being reserved for food production. These areas are prime quality land.
- The total energy crop potential includes use of 75% of grade 3 land and 20% of grade 4 land. These are of poorer quality and less suited to food production.
- Short rotation coppice (SRC) willow as the main energy crop. It has been assumed that 8 oven dried tonnes of willow SRC could be derived per hectare of grade 3 and 4 land.[24]

The area available for Grade 3 land was estimated to be 953 km^2 and for Grade 4 land 23 km^2. The assessment suggests that the County can generate around 1,330,000 MWh per year from energy crops enough to heat 88,000 homes and equivalent to 225,000 tonnes of CO_2 savings.

If the biomass resource was used for electricity then 95 MW electrical plant can be installed based on the available energy crops resource. With the electrical efficiency of 35% and 80% availability this would mean 233,000 MWh electrical supply (sufficient to provide electricity to 40,000 homes) and 126,500 tonnes of CO_2 savings.

5.4.4 Arboriculture

Locations of woodland have been mapped (Figure 5.7) and their areas were calculated. The assessment included areas of Woodlands and Forestry Commission Management areas in Hertfordshire. A realistic figure for biomass yield has been derived from these areas, using assumptions from the DECC methodology.

The total area of woodlands was found to be 57 km^2 and Forestry commission woodlands were found to be 53 km^2. In addition a new forest in North of St Albans that is being planted with the total area of 3.4 km^2 was also added to the calculation.

If all potential arisings were collected, around 22,500 oven dried tonnes would be available annually for energy generation equating to 50,111 MWh sufficient to heat approximately 3,300 homes and displacing 8,500 tonnes CO_2.

5.4.5 Parks and Highways Waste

The maintenance of parks, gardens, road and rail corridors and other green spaces gives rise to plant cuttings that can be used as fuel. Hertfordshire Council is responsible for the management of over 5,900 hectares of amenity land including parks and gardens.

To estimate the potential resource from pruning and cuttings we have used GIS mapping, and parks and gardens information from the local authorities. It was assumed that cuttings from 20% of the total area could be gathered for biomass fuel. This would provide 2,360 oven dried tonnes for annual energy generation equating to 6,600 MWh, reducing CO_2 emissions by 1,100 tonnes.

5.4.6 Wet Biomass Resource

Other sources of biomass include animal waste, such as poultry litter and manures. Potential energy generation from animal waste is based on number of animals in the County and standard energy conversion figures for anaerobic digestion [25, 26]. We have used Defra Agricultural and Horticultural Survey - England (June 2008) datasets to estimate the number of animals and the wet biomass resource in the County. According to the databases there are roughly around 407,000 poultry, 15,500 cattle and 8,000 pigs in the County.

Cattle and Pig manure is typically converted to energy through anaerobic digestion (AD) that produces bio-gas. It has been assumed that small scale AD plants can be installed within farms throughout Hertfordshire. This is because a centralised large scale plant taking manure from a number of sources would not be economically viable due to high haulage costs. In addition the energy yield from animal wastes is relatively low (due to the feedstock already being largely digested) and these schemes should be seen as a waste treatment process as

[23] Dataset downloaded from MAGIC website. www.magic.gov.uk
[24] DECC Regional Renewable Energy Targets Methodology

[25] Opportunities for anaerobic digester CHP systems to treat municipal and farm wastes (The Agricultural Research Institute of Northern Ireland, Science Service, DARD, 2005)
[26] Biomass Task Force Report to Government (DEFRA, October 2005)

much as an energy generation process. The relatively poor economics mean that smaller simple local schemes at farm scale are probably preferable.

Assuming all of the resource (pig and cattle manure) can be utilised to AD plants, this would be expected to generate around 21,270 MWh per year of heat (saving 3,600 tonnes of CO_2, equivalent to that emitted by 1,000 homes). On a typical farm AD plant processes 5,000cu.m of pig slurry and 10,000 tonnes of maize silage and the electrical output would be in the region of 500 kW electrical. Of this amount approximately 5% of the output would come from the manure due to the low calorific value.

Poultry litter is generally converted to electricity by way of direct combustion. There are in total more than 407,000 poultry in the County (380,000 of these are chicken - broilers and 26,000 chicken – layers). The litter would provide enough energy for a plant of around 1MW electrical capacity and around 2,700MWh of electrical generation with 1,500 tonnes of CO_2 savings (equivalent of a1,000 dwellings).

5.4.7 Agricultural Waste

According to June 2008 Agricultural and Horticultural Survey of England, Hertfordshire has 38,559 hectares of wheat and 8,647 hectares of oil seed rape fields. This resource provides a significant opportunity for energy production from agricultural biomass waste. Half of this resource is used as bedding for cattle farming. The remaining could be used for electricity production (as heat generation is not seen as a viable use of straw). The output would be 32,340 MWh electrical and the CO_2 emission savings would be approximately 18,350 tonnes.

5.4.8 Industrial and Municipal Timber Waste

Industrial waste consists of packaging waste and construction wood waste. It has been estimated that the construction and packaging waste in Hertfordshire is 46,000 tonnes and timber waste by households is about 7,150 tonnes. Assuming 50% of this is available then 108,000 MWh heating with 18,000 tonnes of CO_2 savings could be provided. If the resource is used for power generation only (not CHP) then a circa 4 MW electrical plant (based on 6,000 tonnes waste wood per MW capacity) could be installed to produce approximately 27,000 MWh electricity (assuming 20% electrical efficiency) per year (enough for around 4,700 detached homes per year).[1]

5.4.9 Transporting Biomass

It is generally accepted that sourcing biomass locally is the best environmental option as the emissions associated with biomass fuels are those of processing and transport.

However a recent technical paper which investigates biomass fuel emissions estimates that energy use due to 200 km return journey is less than 2% of the energy in biomass fuel27. Therefore energy use in transport shouldn't be a concern. However it would still be most appropriate to source locally and effects on air quality (NOx emissions), traffic and noise would need to be considered carefully together with the implications on air quality and the other effects to the neighbourhood. This is especially important for air quality management areas.

27 Freight Transport and Deployment of Bioenergy in the UK, Dr. David Bonilla Transport Studies Unit University of Oxford, December 2009

5.4.10 Financial Implications of Biomass

Forest residues, whilst abundant, are produced at a cost which varies significantly depending upon market conditions, type of plantation, size, and location. Typical production costs for a range of products is £30 - £45 per tonne, this includes £5 per tonne for transport costs for local supply. Establishment of energy crops is estimated to cost approximately £2,000/hectare (Table 5.4).

Activity	Cost Per Hectare
Ground preparation (herbicides, labour, ploughing and power harrowing)	£133
Planting (15,000 cuttings, hire of planter and team)	£1,068
Pre-emergence spraying (herbicide and labour)	£107
Year 1 management costs (cut back, herbicides, labour)	£112
Harvesting	£170
Local use (production, bale shredder, tractor and trailer)	£378
Total	£1,968

Table 5.4: Indicative costs of establishing willow SRC energy crops, exclusive of payments from grants or growing on set aside land. Costs for miscanthus SRC are expected to be broadly comparable (Source: Energy Crops, CALU and Economics of Short Rotation Coppice, Willow for Wales[28], [29])

A recent analysis of the potential income from both willow SRC and miscanthus suggested that for medium yield land (i.e. Grade 3) the average annual income would be £187 to £360 per hectare[29]. Energy crops are relatively expensive compared to some other biomass fuels but do have the potential to provide very significant volumes of fuel (Figure 5.8).

[28] Economics of short rotation coppice (Willow for Wales, July 2007)
[29] Energy Crops, Economics of miscanthus and SRC production (CALU, November 2006)

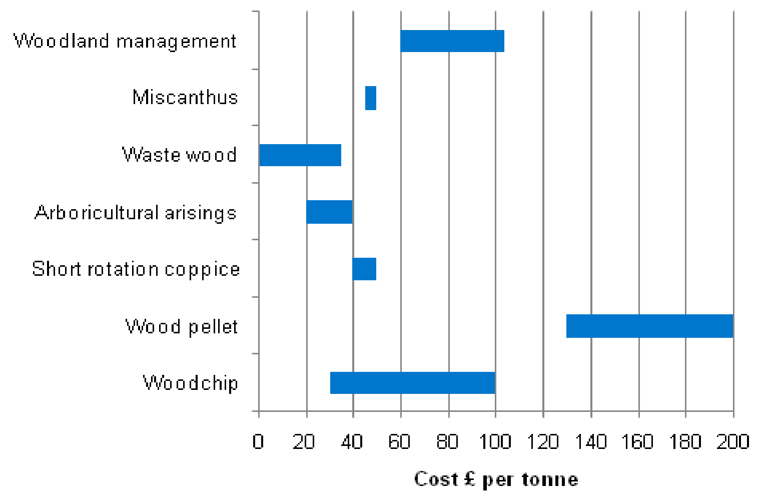


Figure 5.8: Guideline costs for different biomass fuels. (Source: Biomass heating: A practical guide for potential users)

The biomass fuel supply chain is currently in its infancy and the market conditions are extremely variable. This makes the long-term forecasting of biomass system costs extremely difficult. For example, biomass fuel, particularly waste wood, has in the past been either free of charge or attracted a gate fee (where the supplier pays the user a fee which is lower than the alternative disposal cost). However as the market for biomass increases with additional biomass electricity, heat, and CHP capacity being installed, the demand will increase and the fuel will command a higher premium. It is important for LPAs to consider the longer term potential market conditions around biomass for new developments. There is also a potential role for local authorities and Counties to assist with establishing a robust biomass supply chain to provide some degree of long term stability.

5.4.11 Summary of Biomass Resource

The total biomass resource in the County, based on this assessment, is summarised in Table 5.5 on page 41.

However this analysis is based on the data available from official – national sources and the data provided by local authorities constitutes a relatively small proportion of this resource. In general, local authority derived data is likely to be more up-to-date and accurate and so these figures should only be taken as approximate.

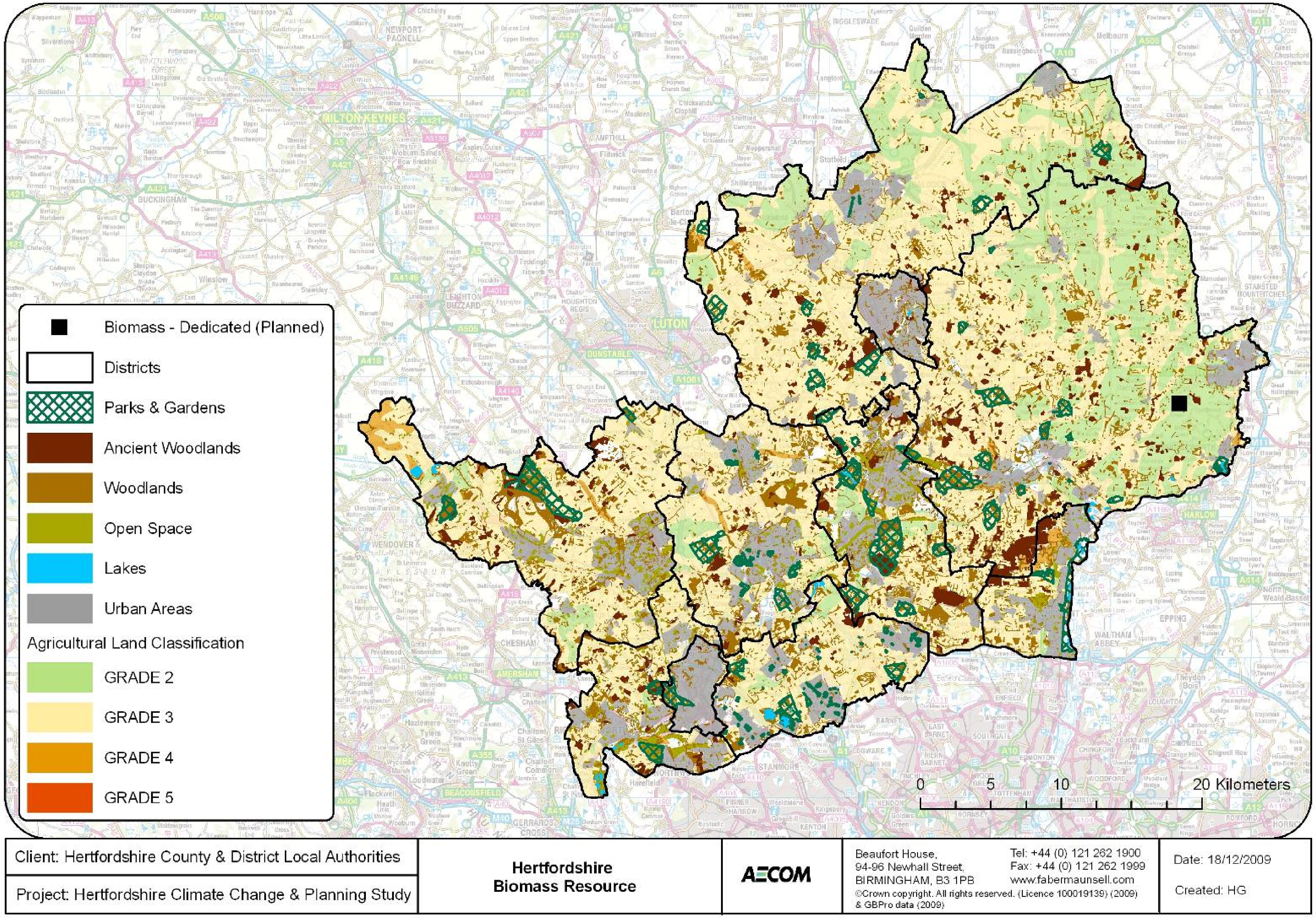


Figure 5.7: Biomass resource in Hertfordshire

Source	Recoverable Biomass	Area/Number in Hertfordshire	Useful Proportion	Useful amount	Moisture Content	Calorific Value	Annual generation	CO_2 savings	Number of homes equivalent (energy)	Number of homes equivalent (CO2)
	odt/hectare	hectares or number of animals	%	odt/tonnes	%	GJ/odt	MWh	tonnes	detached	detached
Agricultural Land Grade 3 (SRC)	8	95,300	75%	571,800	30%	13.00	1,321,599	223,350	88,106.6	62,916
Agricultural Land Grade 4 (SRC)	8	2,300	20%	3,680	30%	13.00	8,506	1,437	567.0	405
Ancient Woodland	2	5,700	100%	11,400	45%	12.50	25,335	4,281	1,689	1,206
Forestry Commission Woodland	2	5,316	100%	10,632	45%	12.50	23,629	3,993	1,575	1,125
Woodland creation - Hertfordshire Forest	2	344	75%	516	45%	12.50	1,147	193	76	55
Country Parks, Historic Parks and Gardens	2	5,900	20%	2,360	n/a	15.76	6,613	1,117		315
Household and Commercial wood waste	-	-	-	26,651	n/a	18.30	108,391	18,318	9,033	6,450
Waste from agriculture	4	23,947	100%	88,604	20%	-	32,340	18,369	2,156	5,174
Poultry (Broilers)	-	381,375	-	11,144	40%	22.00	2,485	1,411		398
Poultry (Layers)	-	25,906	-	1,113	70%	25.00	248	141		40
Cattle	0	15,506	-	188,786	88%		20,137	3,403	1,342	959
Pigs	0	8,024	-	10,657	91%		1,133	191	76	54

Table 5.5: Overview of potential biomass resource in Hertfordshire

5.5 Geothermal Energy

Geothermal energy is derived from the very high temperatures at the Earth's core and requires extraction of heat from deep wells (geothermal energy should not be confused with the extraction of low grade heat using ground source heat pumps at the earth's surface). The exploitation of geothermal resources in the UK continues to be minimal since there are only a few places where hot dry rocks are sufficiently close to the surface to make exploitation cost effective. Most of the hot dry rocks resource is concentrated in Cornwall; studies have concluded that *"generation of electrical power from hot dry rock was unlikely to be technically or commercially viable…in the UK, in the short or medium term."*[30] This technology has therefore not been considered further.

5.6 Marine Energy

There is no coastline in the County and so marine wave and tidal technologies have not been considered further.

5.7 Hydro Energy

Hydropower generates electricity from passing water (from rivers or stored in reservoirs) through turbines. The energy extracted from the water depends on the flow rate and on the vertical drop through which the water falls at the site (the head). Existing and potential hydro energy capacity in Hertfordshire was reviewed in 2005[31] . According to this study Hertfordshire does not have a significant hydro electric potential and all of potential is located at small, low-head, relatively modest flow sites. The 'Salford Study[32]' identified 12 sites within Hertfordshire for consideration. However all 12 were concluded to be uneconomical. The total maximum potential capacity of the above sites amounts to some 330kW installed capacity. In addition to these sites a map review of the County identified a number of other former mill sites, weirs and canal locks all of which will have some, all be it very small potential. It is estimated that there may be a further 100 sites or so with a capacity of between 10 and 20kW. Hence if every site with any potential was to be developed the total resource is unlikely to be significantly more than 2MW.

Although the potential is small refurbishment of the existing but currently unused weirs present a very good opportunity to explore this available resource – a good example is the small hydro electric scheme at Lemsford Mill in Welwyn Hatfield. The only proposed hydro installation is in East Hertfordshire. The Council is proposing to install a small hydro facility at the weir on the river Lea next to Castle Hall in Hertford.

Since producing the Energy Opportunities Plan, the Environment Agency has published a study of hydro power in England and Wales – *Mapping Hydropower Opportunities and Sensitivities in England and Wales – Technical Report, February 2010*[33].

[30] Sustainable Energy — without the hot air (Mackay, D.J.C, November 2008)

[31] Hertfordshire Renewable Energy Study, Renewable Energy Options for Hertfordshire, July 2005 Entec UK Limited

[32] Small Scale Hydroelectric Generation Potential in the UK, Salford University, 1989

[33] Mapping Hydopower Opportunities and Sensitivities in England and Wales, The Environment Agency, February 2010 http://www.environment-agency.gov.uk/shell/hydropowerswf.html

5.8 Waste Heat and Electricity

Heat and electricity from waste has the benefits of both reducing the waste going into landfill and producing energy from low carbon source. Existing waste to energy sites were investigated and shown in the table on the following page[34].

5.8.1 Waste Potential in Hertfordshire

Hertfordshire needs to manage all the waste produced in the County and some of London's waste. This consists of 3m tonnes of waste in total (2m of this is generated by Hertfordshire[35]) and includes municipal waste (0.5m tonnes), construction and demolition waste (1.5 m tonnes), commercial and industrial waste (1m tonnes). Measures are already in place and about 60% of the County's municipal, commercial and industrial waste is currently recovered, recycled or composted. Currently the County Council's existing contracts comprise six landfill sites of which only two are in Hertfordshire. (The other ones are in Essex; Cambridgeshire; Bedfordshire and Buckinghamshire). A small amount of the waste is disposed of in the Westmill landfill site in the County and the rest is sent to other landfill sites outside of the county. Existing waste management facilities in the County (Figure 5.8) do not have enough capacity to recover the maximum amount of waste so a number of new facilities are needed to ensure a sustainable approach to waste management. In addition there is a significant shortage of landfill sites in the County and limited potential for new sites. The main landfill site in the County (Westmill) has limited capacity and is expected to be full by 2015[36].

Latest figures suggest that approximately 44% of the municipal waste in Hertfordshire has been recycled and composted last year, (which is close to the target of recycling a minimum of 50% by 2012). The remaining municipal waste is approximately 210,000 tonnes that cannot be reused or recycled due to the absence of alternative disposal methods in Hertfordshire. A municipal solid waste treatment facility has been proposed to recover most of this waste efficiently and turn into energy; however at the time of writing this proposal is still in discussion. Hertfordshire has recently been awarded funding by Defra for this scheme. It hasn't been designed yet however technologies considered for the facility are likely to be direct combustion for electricity production. The final decision of the site has not been made yet. The site is expected to be in operation by 2015.

Based on the available municipal waste resource an analysis has been carried out to estimate the output of this scheme. It has been estimated that a 27 MW electrical steam turbine / system can be installed supplying up to 47,300 MWh electricity with the CO_2 savings of 27,000 tonnes[37]. If a CHP system is considered then the electrical output would be circa 66,000 MWh and heat output would be circa 85,000 MWh and the CO_2 savings from heat and electricity supply would be around 37,500 tonnes. The plant would be enough to supply 11,600 homes with power and 5,600 homes with heat.

If a CHP system is installed the electricity produced by the scheme can be connected to the national grid, supply demand match is unlikely to be an issue (hence distribution or storage costs are not necessary). However the viability of using waste heat depends in part on the proximity and suitability of buildings in the area for district heating. Hertfordshire should consider the plant location with a view to maximising the use of waste heat for distribution in areas of high heat density as illustrated in the heat maps. Alternatively new housing developments could be considered where excess heat supply exist to make use of this otherwise wasted resource. Therefore proximity of the aforementioned system could be examined as a potential new housing development site.

In addition to meet the targets of different types of waste, Hertfordshire's requirements include new recycling, recovery and treatment sites to handle between 230,000 and 600,000 tonnes a year of commercial and industrial wastes.

Based on a number of sources, the remaining waste resource in the County is estimated to be between 280,000 – 650,000 tonnes. Assuming most of this resource is solid waste (less and less organic waste is envisaged to be sent to landfills) and utilised as energy from waste, the electricity output would be 49,000 to 114,000 MWh and the emission savings would be 28,000 to 65,000 tonnes.

Energy from waste has a number of discharges including ash and emissions to the atmosphere. Therefore it should be tightly regulated as flue gases may contain significant amounts of particulate matter, heavy metals, dioxins, sulphur dioxide, and hydrochloric acid. However a study found that energy from waste plants emitted fewer particles, hydrocarbons and less SO2, HCl, CO and NOx than coal-fired power plants, but more than natural gas fired power plants[38]

[34] Ref: Ofgem database

[35] http://enquire.hertscc.gov.uk/qol/2008/waste08.pdf, accessed Jan 2010

[36] Hertfordshire Minerals and Waste Development Framework Consultation on Waste Development Plan Documents Summary http://www.hertsdirect.org/docs/pdf/s/wasteconsum09.pdf, accessed on December 2009

37 Assumptions are from Renewable and Low-carbon Energy Capacity Methodology, Draft Final November 2009 10 kilo tonnes of SMW required for 1 MW capacity per annum.25% plant efficiency and 80% availability

[38] Waste-to-Energy Compared to Fossil Fuels for Equal Amounts of Energy". Delaware Solid Waste Authority. Archived from the original on 26 January 2008.

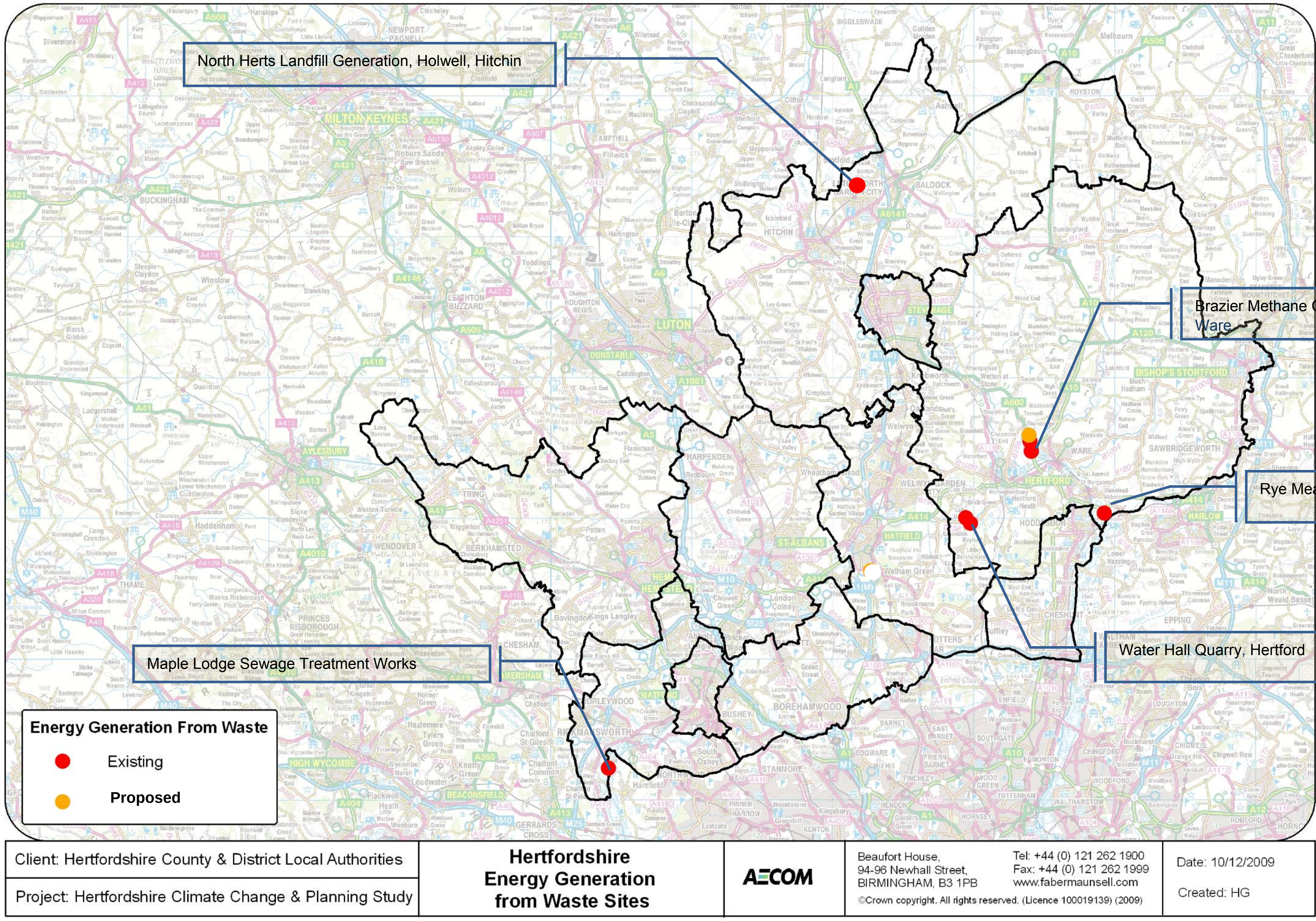


Figure 5.8: Existing and proposed energy generation from waste sites in Hertfordshire

5.9 Microgeneration Technologies

The term “microgeneration” is used to describe the array of small scale technologies, typically less than 50 kW electricity generation and 100 kW heat generation, that can be integrated as part of the development of individual sites, or retrofitted to existing buildings. These technologies tend to be less location specific and therefore have little influence on the spatial arrangement of sites.

Combinations of technologies can be applied but it is important to note that some combinations can lead to competition between systems and therefore sub-optimal performance, which will affect both output and maintenance. Generally, conflict occurs where multiple technologies are competing to provide heat, as opposed to electricity which can be exported if excess is generated.

The impact of competition can be avoided through appropriate sizing and design of the systems. For example, two heat supplying technologies could work effectively together if one is sized to meet the annual hot water demand while the other is sized and operated to meet only the winter space heating demands. Figure 5.9 shows potential combinations of high conflict (red), no conflict (green) and conflicts that can be avoided through appropriate design (yellow).

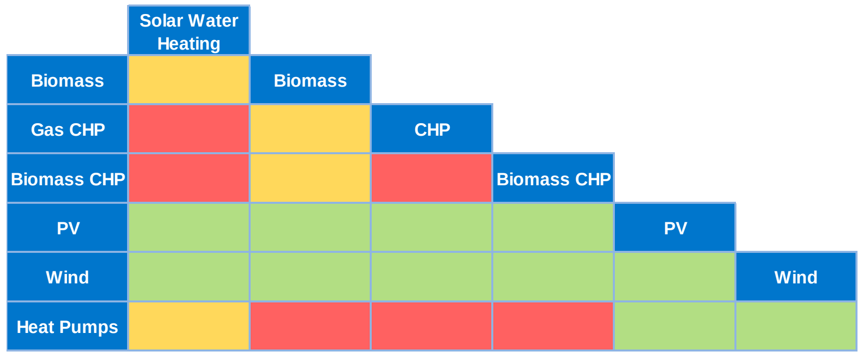


Figure 5.9 Potential conflicts between microgeneration technologies

Feed-in-tariff’s (FIT) in the UK came into force in April 2010[39] for installations not exceeding 5 MW[40]. The following low-carbon technologies are eligible:

- Anaerobic Digestion
- Hydro
- Micro CHP (pilot trails)
- PV
- Wind

For further information on FITs please refer to Appendix D.

5.10 Solar Energy

The two main solar microgeneration technologies currently in use are solar photovoltaics (PV) and solar water heating. The solar resource, in terms of annual irradiation per year, is similar across much of the UK, with Hertfordshire in southern part of the country at the higher end of the solar spectrum (Figure 5.10). Table 5.5 shows the potential for CO_2 savings from solar energy technologies.

Figure 5.11 shows how the output of solar systems varies by orientation and tilt of the installation. Panels should be mounted in a south-east to south-west facing location. The optimum angle for mounting panels is between 30º and 40º, although this is often dictated by the angle of the roof. Careful consideration should be given to placing the systems so that they are not over shaded by adjacent buildings, structures, trees or roof furniture such as chimneys.

Solar PV panels use semi-conducting cells to convert sunlight into electricity. The output is determined by the brightness of natural light available (although panels will still produce electricity even in cloudy conditions) and by the area and efficiency of the panels. PV is expensive in comparison to other renewable energy options, but is one of the few options available for renewable electricity production and is often one of the only on-site solutions to mitigate CO_2 reductions associated with electricity use. In addition initiation of feed in tariff is estimated to make this technology significantly more attractive solution financially. A feed-in tariff is a mechanism for encouraging investment in renewable generation. It is essentially a premium rate paid for clean generation, e.g. from solar panels or small wind turbines, and guaranteed for a long time period. Currently the tariff for PV is between 29 – 41 pence per kWh electricity production depending on the size of the system. Initial analyses suggest that this would have a significant impact on the finances of PV reducing the payback period to 12-15 years down from 60 years. Therefore it is anticipated that the deployment of this technology may be accelerated in the near future.

Solar water heating panels are used primarily to provide hot water. Output is constrained by the amount of sunlight available, panel efficiency and panel area. Devices are most cost effective when sized to meet 50-70% of average hot water requirements, which avoids wasting heat in the summer. It should be noted that solar water heating supplements and does not replace existing heating systems.

There are two standard types of solar water heating collectors: flat plate and evacuated tube collectors. Historically, flat plate collectors have dominated due to their lower cost per unit of energy saved. However, recent advances in evacuated tube collector design have achieved near parity in terms of cost per $kgCO_2$ saved. Generally, evacuated tubes are more expensive to manufacture and therefore purchase, but achieve higher efficiencies and are more flexible in terms of the locations they can be used (Table 5.5).

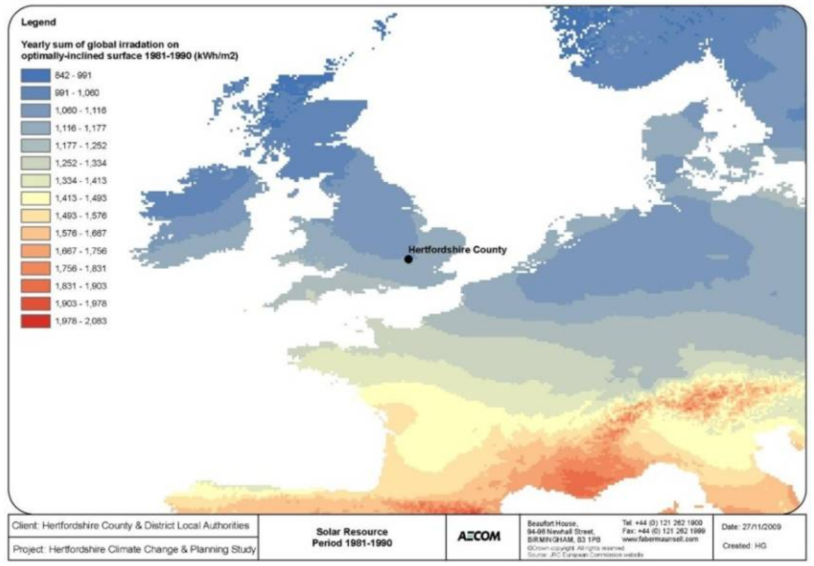


Figure 5.10: Solar Resource in Hertfordshire (Source: Photovoltaic Geographical Information System (PVGIS), JRC European Commission)[41]

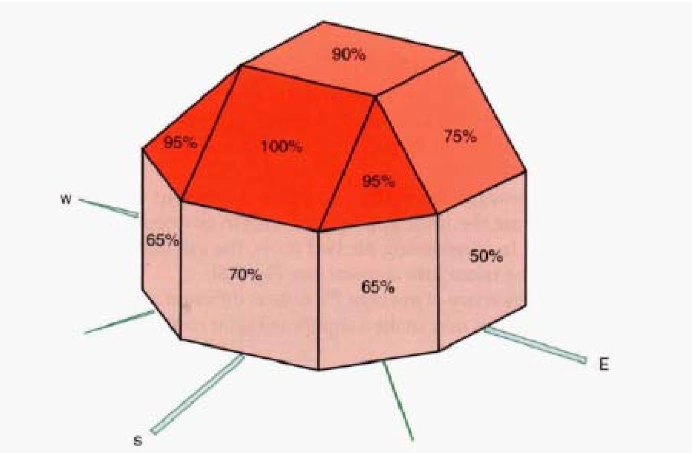


Figure 5.11: Optimum orientation for solar panels in the UK (Source: Sustainability at the Cutting Edge) [42]

[39] Green feed-in tariff needs to maximise solar power (Guardian website http://www.guardian.co.uk/environment/2009/may/14/feed-in-tariff-solar-power, accessed August 2009)
[40] Energy Act 2008 Section 41.4.b

[41] Photovoltaic Geographical Information System (PVGIS) (JRC Commission website, accessed October 2009)
[42] Sustainability at the Cutting Edge (Smith , F, 2007)

Technology	Solar Hot Water	Solar Photovoltaics (PV)
Approximate size required	~4 m^2 per dwelling	~8 m^2 per dwelling
Total cost of system	£2,500 for new build homes (2 kW system) £5,000 for existing homes (2.8 kW system) £1,000/kW for new build non-domestic £1,600/kW for existing non-domestic	£5,500 for new build homes (1 kWp system) £6,000 for existing homes (1 kWp system) £4,500/kW for new build non-domestic £5,000/kW for existing non-domestic
Annual Generation Potential	396 kWh/m^2 for flat plates 520 kWh/m^2 for evacuated tubes	850 kWh/m^2 for high performing systems
Potential for CO_2 savings	13% of total emissions for existing homes 23% of total emissions for new build homes	26% of total emissions for existing homes 38% of total emissions for new build homes

Table 5.5: Potential CO_2 savings for solar energy technologies. Buildings are assumed to have good practice energy efficiency (Hertfordshire Energy Model, AECOM)

5.11 Heat Pumps

Heat pumps are low carbon rather than renewable devices since they require electricity to run which is partially derived from fossil fuels. They can provide significant CO_2 savings in comparison to standard electrical heating systems, since they require around a third less electricity. However, due to the carbon intensity of the grid, CO_2 emissions from heat pumps are similar to those of an efficient gas heating system. As electricity is currently around four times more expensive than gas, running costs are also comparable with, and often higher than an equivalent gas system.

Heat pumps are primarily space-heating devices and the best efficiencies are achieved by running systems at low temperatures. For this reason, they are ideally suited for use in conjunction with under floor or air-based heating systems.

This creates a significant challenge for heat pumps installed in future homes, where hot water demands are likely to be comparable to the (reduced) space heating requirements. Due to the higher temperature requirements of hot water, the coefficient of performance (CoP – effectively the efficiency) of heat pumps reduces and so where the hot water is a significant fraction of the overall heating demand, the overall efficiency can be relatively poor. In such cases, heat pumps might be well be complemented by other microgeneration systems that are sized in relation to domestic hot water requirements, for instance, solar hot water systems.

The performance of ground source heat pumps is linked to the average ground temperature, while air source heat pump performance is influenced by the average air temperature. Table 5.6 shows the potential carbon savings from installing a heat pump to a new or existing building. The high cost of ground works for ground source heat pumps means that air source heat pumps are around half the installed cost, albeit with a lower efficiency. For air source heat pumps, retrofit costs are slightly higher than new build to allow for increases in plumbing and electrical work. For ground source heat pumps, the cost for retrofit is higher to allow for modifications to existing plumbing and removal of existing heating system, plus ground works costs when digging up an established garden.

There is a wide variation in costs for ground source heat pumps at the 20-100kW scale, principally due to differences in the cost of the ground works. The cost of the heat pumps themselves is also dependent on size as commercial systems are usually made up of multiple smaller units rather than a single heat pump. Due to these variations, heat pumps in the 20-100kW range are shown with an indicative cost of £1,000 per kW installed.

Technology	Air Source Heat Pump	Ground Source Heat Pump
Approximate size required	5 kW	5kW trench system for new build 11kW trench system for existing
Total cost of system	£5,000 for new build £7,000 for existing £500/kW for non domestic	£8,000 for new build £12,000 for existing £1,000/kW for non domestic
Potential for CO_2 savings	5% of total emissions for existing homes 0.25% of total emissions for new build homes	12% of total emissions for existing homes 8% of total emissions for new build homes

Table 5.6: CO_2 saving potential of heat pumps (based on 2007 costs) a borehole ground source heat pump system is more costly due to a high drilling cost of £30 per metre. A typical 70m borehole provides 3-5kW of heat output, giving a drilling cost of £4200 for an 8kW system (Source: The Growth Potential for Microgeneration in England, Wales and Scotland (Element Energy for BERR) [43]

5.12 Biomass Heating

Biomass heating is generally more suited to areas which are less urban, where land is available for fuel storage, and there is adequate access for fuel delivery vehicles. The most common application is as one or more boilers in a sequenced (multi-boiler) installation where there is a communal i.e. a block of flats or district heating system.

There is significant potential for small scale biomass heating in the district. Most of the local authorities have the potential of Grade 3 Agricultural resource, and woodlands (both ancient and forestry commission woodlands) are spread out across the County. There would be particular benefit in encouraging biomass in areas where district heating is feasible or where off –gas grid houses occur in rural areas. The rural areas are also likely to have better access to local biomass fuel. There are some Air Quality Management Areas designated in Hertfordshire, therefore care needs to be taken if biomass heat to be introduced in near the Air Quality Management Areas (although these do not necessarily preclude the use of biomass boilers).

Table 5.7 shows the CO_2 savings potential of biomass boilers. Existing building costs are considerably higher than new build costs due to the extra building and plumbing work. Costs are generally installation based and not size variable; this is because the actual boiler makes up a small proportion of the overall cost (Figure 5.12).

Technology	Small Scale Biomass Boiler
Approximate size required	8.8 kW for homes
Capital cost of system	£9,000 for new build homes £11,000 for existing homes
Potential for CO_2 savings	34% of total emissions for existing homes 33% of total emissions for new build homes

Table 5.7 CO_2 savings from biomass technologies

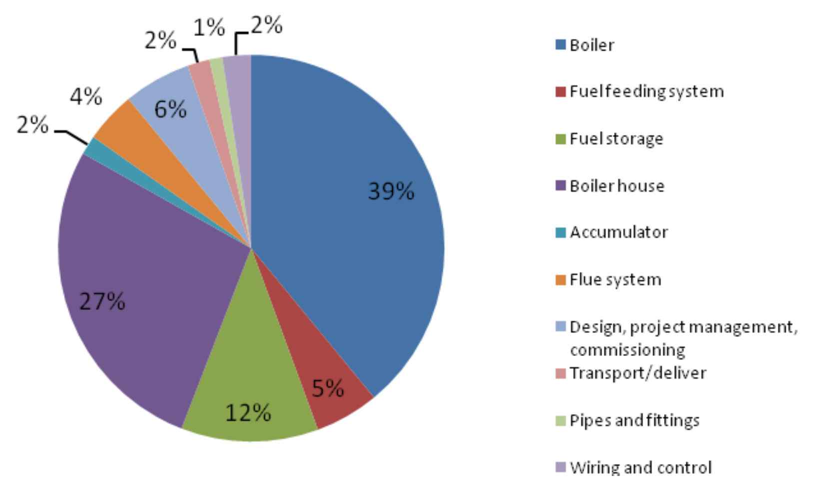


Figure 5.12: Capital cost/kW breakdown for example biomass heating project, based on a recently designed project of 500 kW capacity. The total system cost was £187,000. (Source: Biomass heating: A practical guide for potential users) [44]

[43] The Growth Potential for Microgeneration in England, Wales and Scotland (Element Energy for BERR, June 2008)

[44] Biomass heating A practical guide for potential users (Carbon Trust, January 2009)

5.13 Building Mounted Wind turbines

Over the last few years, a number of companies have started to market wind turbines designed specifically for building mounted applications. However, early feedback suggests that building mounted turbines located in urban areas suffer from lower and much more disrupted wind speeds (due to turbulence around buildings) than larger turbines mounted in open sites and this has a significant impact on their energy generation potential.[45] There is limited data on energy generation from building mounted wind turbines in urban locations but early examples appear to have generated significantly less than was predicted by manufacturers (in many cases only around 10% of the predicted output or even less). Even with reductions in turbine costs which may happen in the future, this level of operation is not economic or desirable and micro-wind turbines should only be located in areas where there is likely to be a suitable wind resource. Due to low costs associated with small capacities, a detailed resource / viability study will not be economic for each application, and so rules of thumb will need to be employed based on best practice.

AECOM are following the progress of monitoring studies and intend to include small scale wind turbines in their renewable feasibility assessments when performance data is available to make accurate estimates of likely performance. An assessment of their potential for CO_2 reduction has been excluded from this study.

5.14 Fuel Cells

Fuel cells CHP is an emerging technology and currently at a pre-commercial stage. Fuel cells are similar to batteries in that they produce electricity from a chemical reaction. However, whereas a battery delivers power from a finite amount of stored energy, fuel cells can operate indefinitely provided that a fuel source is continuously supplied; for current fuel cell CHP systems, this is currently natural gas, although the end aim is to operate fuel cells from renewably generated hydrogen.

There is debate as to whether electricity generation from fuel cells via hydrogen is better than generating electricity directly from renewable sources such as PV and wind. This is due to the inefficiencies in producing hydrogen, and then converting back into electricity, versus direct electricity generation. However a key advantage is the opportunity to store renewable electricity in the form of hydrogen, which can then be used to provide electricity on demands.

The capital cost of fuel cells is currently much higher than most other competing micro-generation technologies. Commercial large scale CHP fuel cells currently available cost approximately £3,000/kW. Fuel cell prices are expected to drop to £500-£1500/kW in the next decade with further advancements and increased manufacturing volumes.

[45] Micro-wind turbines in urban environments: an assessment (BRE, 2007)

5.15 Key Considerations Emerging from this Chapter

Key considerations emerging from the assessment of renewable and low carbon energy resources are:

- Hertfordshire has resource potential for large scale wind turbines across 83 km^2. If less than 10% of this were used, it could provide 74MW of installed capacity, comprising around 37 large turbines. This would generate 150,000 MWh annually, saving nearly 85,000 tonnes CO_2. This is equivalent to that emitted by over 26,000 typical detached homes, well over the total number of dwellings in the County including new development. If areas classed as constrained are available to additional capacity based on site analysis, then this potential could be greatly increased.
- Smaller scale turbines of around 15m to 45m tip height could be an opportunity in most areas of the County. Smaller turbines have a significantly reduced visual impact and would be particularly suited to farms, industrial sites and municipal buildings such as community centres or schools. Installation of 100, 15 kW turbines would add 1.5MW to the County's capacity and assuming a capacity factor of 10% would generate around 1,314 MWh annually.
- The County can generate around 1,330,000 MWh per year from energy crops on grade 3 and 4 land. This is equivalent to 225,000 tonnes CO_2, or carbon emitted from around 88,000 typical detached homes
- Potential annual arboriculture arisings are around 22,500 oven dried tonnes, equating to 50,000 MWh and displacing 8,500 tonnesCO_2 annually (equivalent to that emitted by 5,500 typical detached homes).
- Parks and highways waste from 20% of the total area would provide 2,360 oven dried tonnes annually, equating to 6,600 MWh and reducing CO_2 emissions by 1,100 tonnes.
- Cattle and Pig manure could be converted to energy through anaerobic digestion (AD) that produces bio-gas. This would be expected to generate around 21,270 MWh per year of heat (saving 3,600 tonnes of CO_2, equivalent to that emitted by 1,000 homes).
- Poultry litter could provide around 1MW electrical capacity and around 2,700MWh of electrical generation with 1,500 tonnes of CO_2 savings (equivalent of a 1,000 dwellings).
- Packaging waste and construction wood waste has been estimated to provide 135,000 MWh heating with 23,000 tonnes of CO_2 savings.
- Municipal solid waste has been estimated to feed into a 27 MW electrical steam turbine / system supplying up to 47,300 MWh electricity with the CO_2 savings of 27,000 tonnes. If a CHP system is considered then the electrical output would be 66,000 and heat output would be 85,000 MWh and the CO_2 savings from heat and electricity supply would be around 37,500 tonnes. The plant would be enough to supply 11,600 homes with power and 5,600 homes with heat.
- Energy crops are relatively expensive compared to some other biomass fuels but do have the potential to provide very significant volumes of fuel.
- No resource for geothermal, marine wave and tidal and very little resource for large-scale hydro have been identified.
- Hertfordshire has potential to exploit a range of microgeneration technologies, including:
    - solar thermal and PV
    - Heat pumps (air and ground sourced) may be suited to areas not served by gas and where under floor heating is possible
    - Biomass heaters are ideal in lower density areas for individual buildings and where district heating is feasible in higher density areas.
    - There is limited data on energy generation from building mounted wind turbines in urban locations but early examples appear to have generated significantly less than was predicted by manufacturers and installations should carefully consider local topography.
    - Fuel cells can be used as CHP systems in buildings but are considered to be an emerging technology and currently the costs are high.

6 The Energy Opportunities Plan

6.1 The Energy Opportunities Plan

Planning Policy Statement Planning and Climate Change states: *"There will be situations where it could be appropriate for planning authorities to anticipate levels of building sustainability in advance of those set out nationally. When proposing any local requirements for sustainable buildings planning authorities must be able to demonstrate clearly the local circumstances that warrant and allow this. These could include, for example, where there are clear opportunities for significant use of decentralised and renewable or low carbon energy"*

The draft PPS on Planning for a Low Carbon Future in a Changing Climate places further emphasis on the mapping of opportunities for decentralised energy, as well as the role of local authorities. Proposed Policy LCF 1:' Evidence base for plan-making' states: *"Local planning authorities should assess their area for opportunities for decentralised energy. The assessment should focus on opportunities at a scale which could supply more than an individual building and include up-to-date mapping of heat demand and possible sources of supply. Local planning authorities should in particular look for opportunities to secure:*

i. *decentralised energy to meet the needs of new development;*
ii. *greater integration of waste management with the provision of decentralised energy;*
iii. *co-location of potential heat suppliers and users; and,*
iv. *district heating networks based on renewable energy from waste, surplus heat and biomass, or which could be economically converted to such sources in the future."*

This chapter presents the mapping work carried out as part of this study in order to support the development of RLC polices, in line with the above statements.

Using information supplied by the project group and our own research we have used GIS to map out the opportunities for generating energy from RLC sources on a County-wide basis, as well as scaled down to a local authority level (these maps have been supplied separately to each participating LA). We refer to this map as an 'Energy Opportunities Plan'. The Plan has been prepared to demonstrate the local potential in terms of the resource availability and energy demand. The Plan identifies the opportunities that are currently available and those that will be available in the near future, i.e. potential for district heating networks.

Figure 6.2 and Figures 6.3 and 6.4 [which break the County map into two regional sections for further clarity] on the following pages, show the spatial distribution of the following opportunities:

- Existing and planned energy from waste plants (Landfill)
- Existing and planned wind turbines
- Rejected wind turbines
- Areas for potential large wind turbine locations (unconstrained)
- Location of planned biomass scheme
- Areas of parks and gardens, and areas of woodland
- Areas where energy crops could be grown as biomass for energy generation (Grade 3 and 4 agricultural land)
- Location of Rye House Power Station
- Areas of Potential District Heating

6.1.1 Opportunities for renewable energy

According to the Energy Opportunities Plan, Grade 3 and Grade 4 land areas are suitable for energy crops (although we are not assuming that all Grade 3 land be planted). The map shows an opportunity for biomass fuel production throughout Hertfordshire. In addition, presence of woodlands and parks provide an additional resource for biomass fuel from woody residue, i.e. cuttings and trimmings. This would mean that a constant and sufficient resource is available within the County, without the need for considerable transportation, if biomass plants were to be installed.

Wind energy as a resource shows a reasonable level of opportunity for large scale wind in the northern and eastern part of the County considering Hertfordshire's performance against other counties in the East of England region. However land availability after engineering and physical constraints have been considered may limit resource potential to small wind farms or one-off turbines.

Although not mapped, smaller scale wind development, such as community scale, offers a good opportunity for reducing CO_2 emissions from small sites and from buildings since these sites tend to be less constrained than those suitable for large scale wind.

6.1.2 Opportunities for district heating

The Plan presents clearly the opportunities for exploiting district heating potential at locations showing existing high heat demand, i.e. from existing buildings. It therefore encourages the linking of new development with existing development, shared energy centres and making use of anchor loads to maximise opportunities for DH as new development comes forward. The proximity to neighbouring LAs is important in that it provides opportunities for cooperative working, but it should also be noted that this can present risks. However it would certainly be appropriate to use the Energy Opportunities Plan to identify where these opportunities may lie (particularly where a planned new development in one district is in close proximity to an existing building, such as a large hospital, in a neighbouring district which could provide a potential anchor load) and work with neighbouring LAs, developers and other stakeholders on cross-County strategies for district heating.

By identifying now the investment opportunities for DH infrastructure that would be utilised by development coming forward in the future, the Plan can go some way to supporting the ramp-up to zero carbon homes in 2016 and the drive towards decentralised energy.

6.1.3 Opportunities for policy-making and joint strategies

The Plan provides an invaluable tool when developing planning policies, targets and delivery mechanisms within the LDF process, and can bring added benefit and support to the Core Strategy and other Development Plan Documents. The Energy Opportunities Plan should be used to support and add weight to policies that stipulate requirements for decentralised energy; whether these are through the setting of targets that exceed Building Regulations, the requirement for Code for Sustainable Homes, or a requirement for connecting to, or investing in, infrastructure to facilitate district heating.

It should be noted that although the Energy Opportunities Plan provides an overview of potential, applicable RLC technologies and systems within an area, it doesn't replace the need for a site specific RLC feasibility study for proposed development sites, and this should be requested by the LPA. However the Plan can be used alongside RLC policies to identify those RLC technologies that are potentially viable and warrant detailed investigation through a feasibility study.

The Plan should also be regarded as a corporate as well as planning resource and used to support other council and LSP strategies, as well as cross-district or cross-County strategies for maximising the potential for decentralised energy. Indeed, the draft PPS urges joint local authority strategies: *"In preparing the evidence base for plan-making consideration should be given to joint working across local planning authority boundaries to develop assessments for sub-regions, including city-regions.*"

6.2 Character Areas

As demonstrated by the Energy Opportunities Plan, developments in some parts of the County will have access to options for RLC energy supply which are not afforded to developments elsewhere in the County. To reflect this County variation when testing the policy options, three character areas have been defined (refer to Figure 6.1) with the following assumptions:

- **Energy Constrained:** This assumes that no community or large scale renewable or low carbon energy resources are available in the vicinity of the development site. Options for complying with the policy options are limited to what can be achieved in individual buildings, namely microgeneration technologies such as solar thermal and solar PV, or gas CHP systems providing individual buildings, or payment to a Carbon Buyout or Allowable Solutions Fund (if implemented by Hertfordshire LPAs). This option assumes that biomass is not feasible due to delivery and/or air quality constraints.
- **District Heating:** This assumes that the site is in an area where district heating beyond the site boundary may be a viable option. This could be because there is sufficient local heat demand from existing buildings to justify establishing a district heating network, or there is a local source of available heat, such as the proposed power station such as biomass proposal in Potter's Crouch in St Albans or energy from waste site in Westmill.

- **Wind:** This assumes that the site is in a location where wind speeds and constraints mapping indicates that on or near-site wind turbines could be an option.

6.3 Key Considerations Emerging from this Section

The key issues and considerations identified by the EOP in this Section have been summarised below:

- The potential for biomass production from energy crops and existing woodland residue is significant in Hertfordshire
- Community-scale wind offers opportunities across the County for reducing CO_2 emissions; however local buy-in would be required and could potentially provide a barrier to wind development.
- There is also an opportunity for dual RLC energy generation by siting community-scale wind turbines on agricultural land growing energy crops.
- Each district/borough provides some potential for district heating from existing buildings, and this potential could be optimised and expanded as new development comes forward.
- Cross-district strategies for district heating offers further CO_2 savings and should be explored where possible; however with regard to the potential risks of management.
- Access to RLC options will vary from site to site, with some sites experiencing particular constraints. This has been considered when testing policy options as part of Section 9 through the use of 'character areas'.

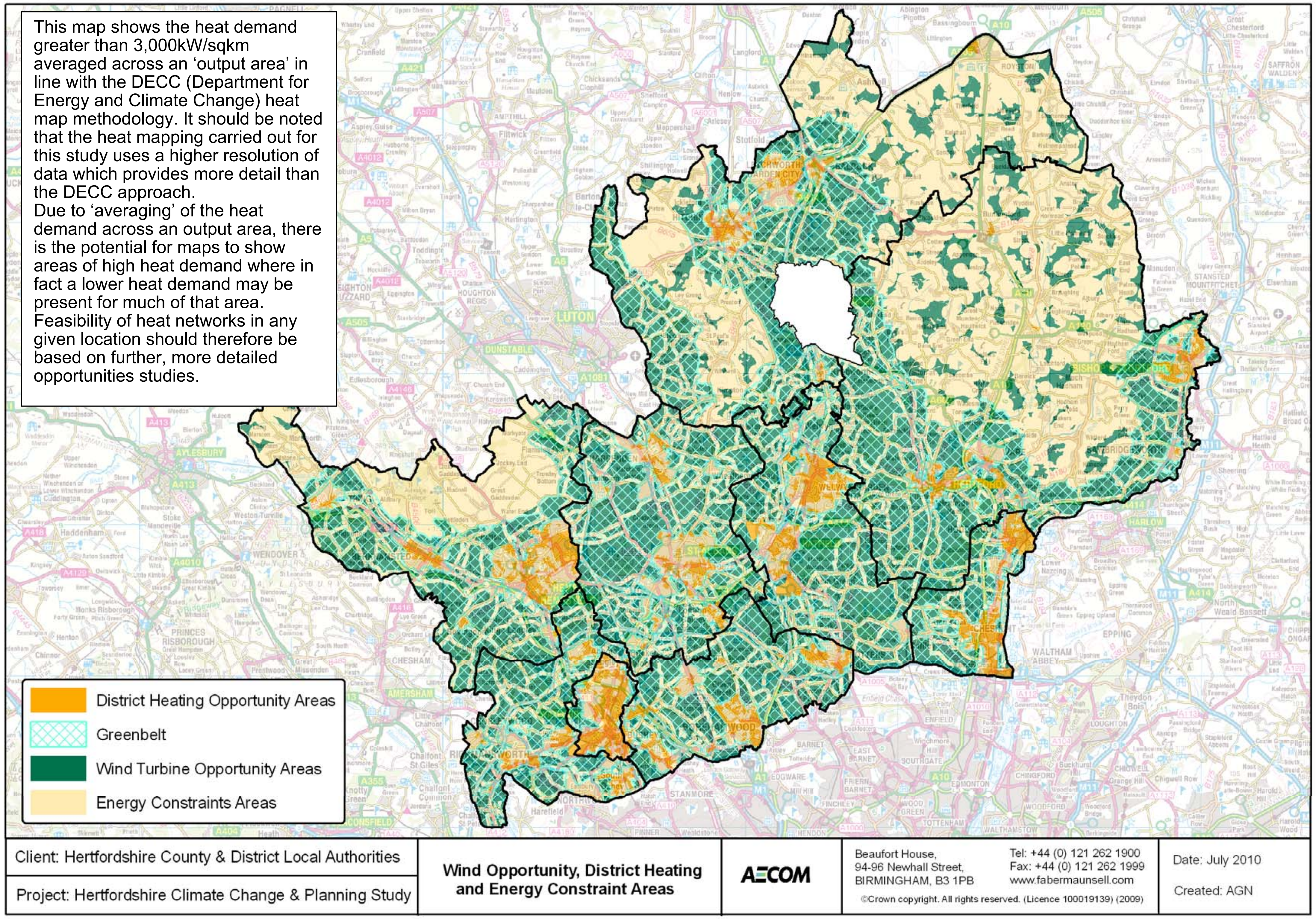


Figure 6.1 – Map showing large scale wind opportunity, district heating opportunity and "energy constrained" areas

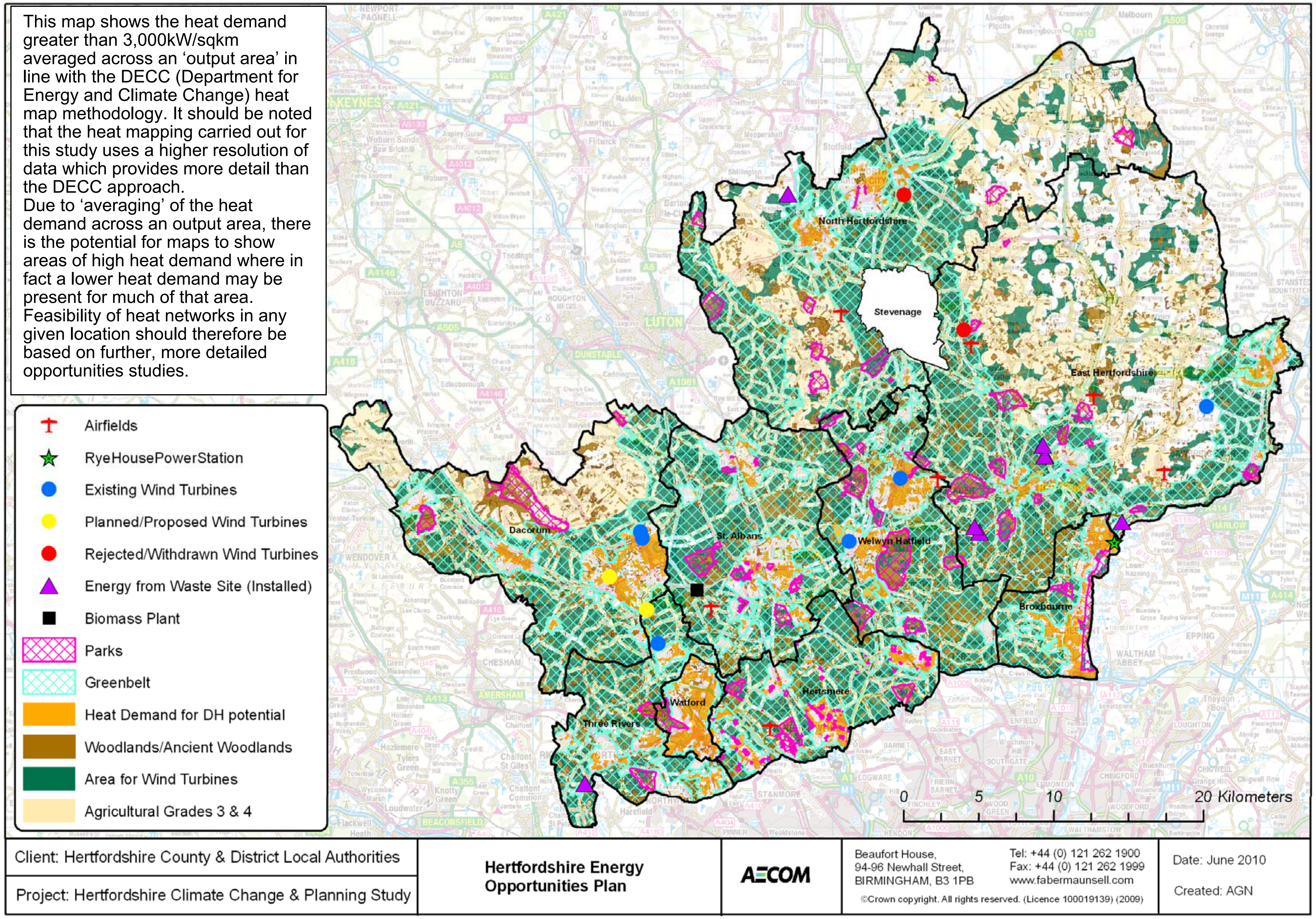


Figure 6.2: Hertfordshire Energy Opportunities Plan (Plans have also been produced at a local authority level to enable more clarity of the opportunities identified. These have been supplied to each of the project group partners separately to this report).

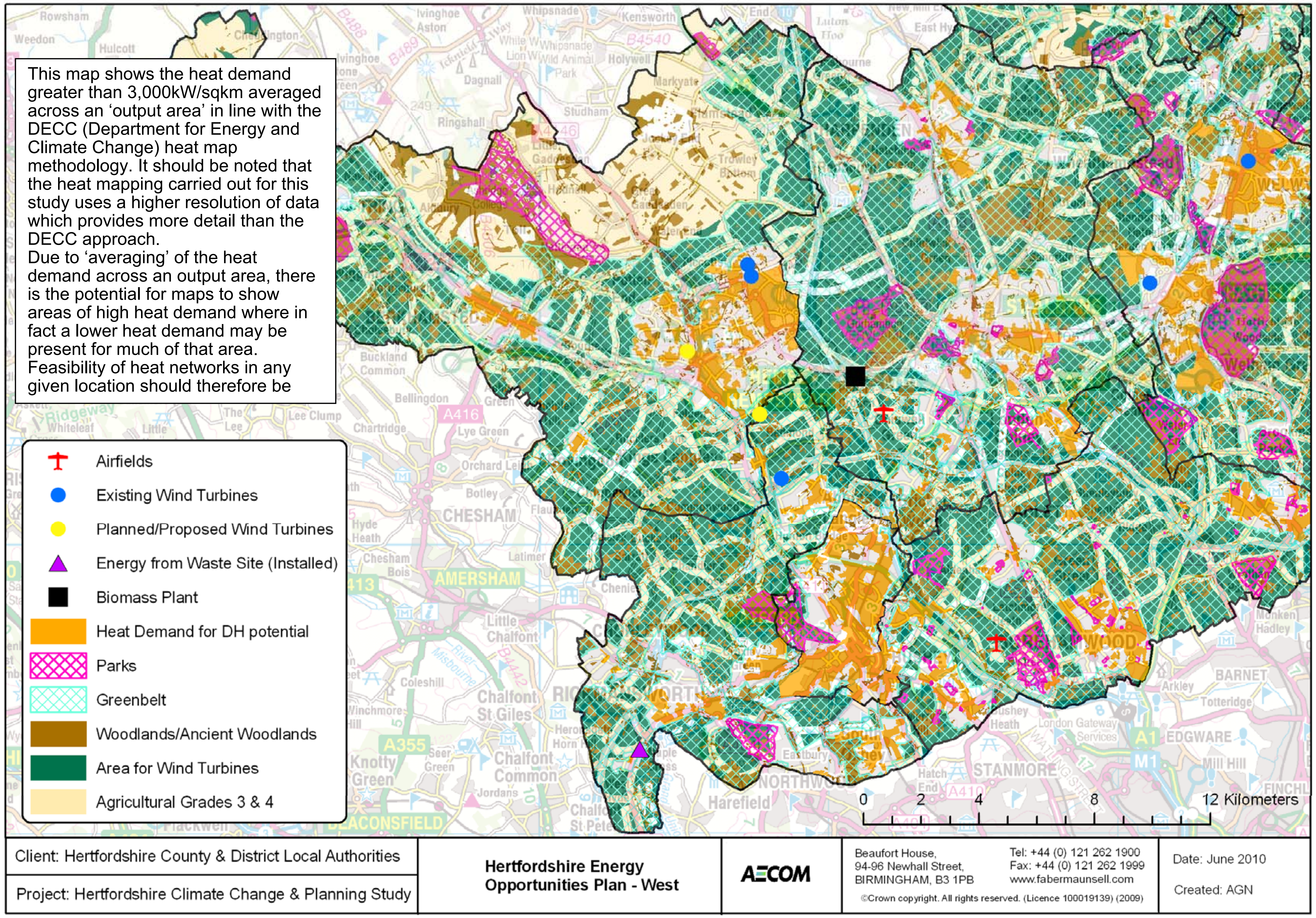


Figure 6.3: Hertfordshire Energy Opportunities Plan: West section

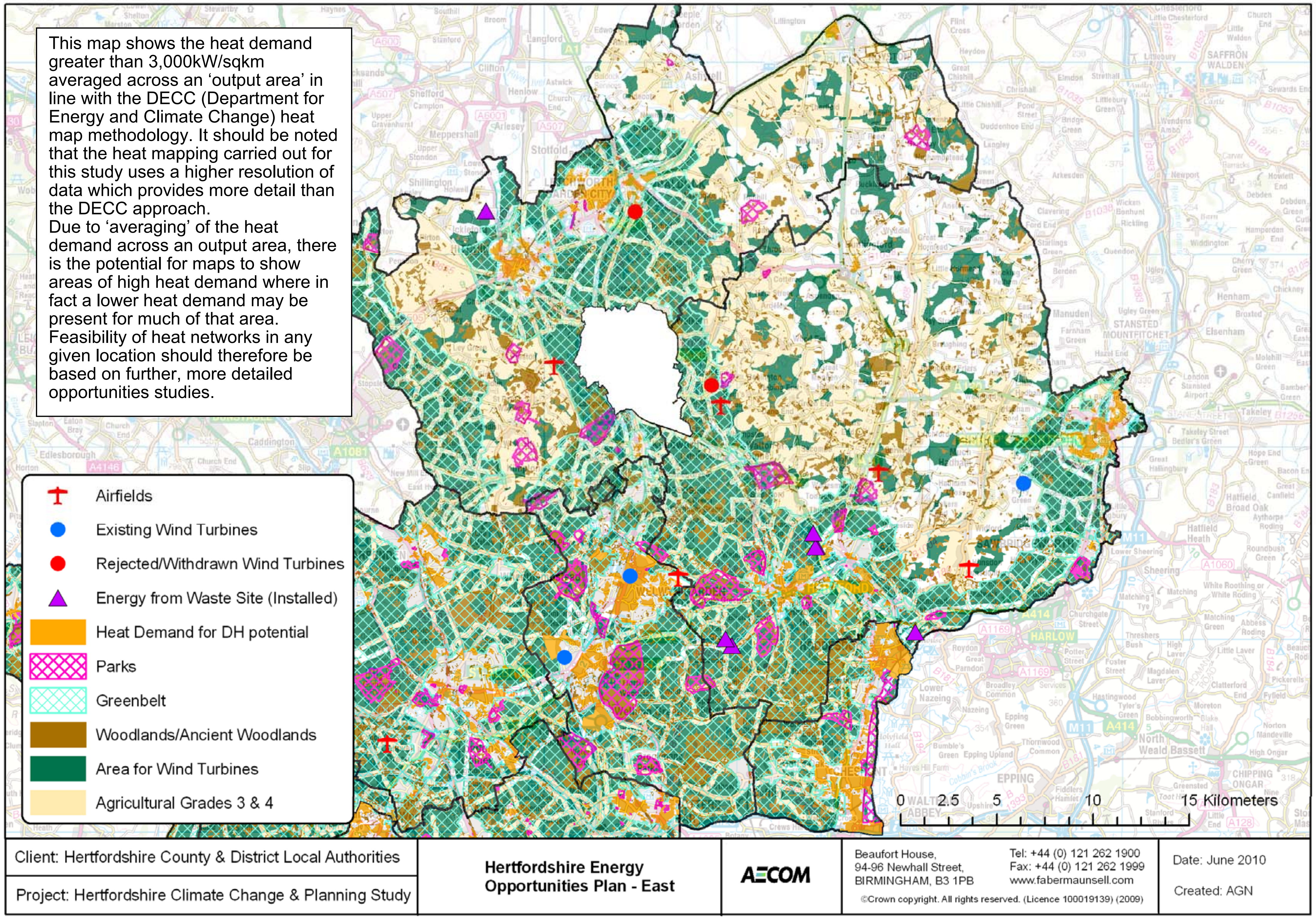


Figure 6.4 Hertfordshire Energy Opportunities Plan: Eastern section

7 The Code for Sustainable Homes

7.1 Policy for Delivering Sustainable Buildings

The PPS1 Supplement on Planning and Climate Change states:

"*when proposing any local requirement for sustainable buildings planning authorities should specify the requirement in terms of achievement of nationally described sustainable buildings standards, for example in the case of housing proposals to be delivered at a specific level of the Code for Sustainable Homes*".

In addition, the draft PPS proposes a policy (LCF9) which further supports the use of the Code for Sustainable Homes.

This requirement for policies on sustainable buildings is reflected in one of the objectives for this study, which is to advise on potential policies for inclusion in the Core Strategy, set in the context of future requirements of the Code for Sustainable Homes (Code).

The Code is owned and managed by the Department of Communities and Local Government (CLG). It should be noted that although widely used, BREEAM is not a government adopted national standard for measuring sustainability of buildings. Since it is owned and managed by BRE Global, a private organisation. We have therefore placed the main focus of this chapter on the achievability and viability of the Code.

Since the PPS1 Supplement was published in 2007, there has been further consultation on plans for a staged introduction of a zero carbon requirement for new homes and non-residential buildings in 2016 and 2019 respectively, through Part L of the Building Regulations. The energy and CO_2 emissions requirements of the higher levels of the Code have been superseded by future proposals for the Building Regulations. Future policy options for Hertfordshire's LPAs, including targets for emissions reductions and contribution required from renewable or low carbon energy generation, have therefore been established with reference to the latest proposals for the Building Regulations.

Nevertheless, it could still be beneficial to use the Code, and potentially BREEAM, as the basis for planning policies and targets for new development:

1. Requiring developments to achieve a minimum Code level or BREEAM rating would improve the overall environmental performance of new development in the district/borough.
2. In terms of the requirements of the PPS1 Supplement, it would go some way towards addressing the potential future impacts of climate change, as it would set standards in terms of water consumption, flood risk management and ecology, amongst other issues.
3. The Department of Communities and Local Government has indicated that Code is playing a significant role in gearing up the house building industry and supply chain to the zero carbon homes policy due to come into effect in 2016.
4. Code and BREEAM provide an established framework for assessing and certifying the performance of a development. A Code or BREEAM certificate can be used to demonstrate compliance with policy, reducing the burden on development control officers to assess technical planning submissions and provide assurance that planning requirements are being met by new developments in practice. Many LPAS across England have already adopted Code as a standard for enforcing sustainable design in new residential development through policy.

7.2 The Use of the Code in Planning Submissions

Where a developer is required to achieve a Code level rating (e.g. in order to access public funding or to comply with planning policy), a licensed assessor organisation will usually be contracted to provide design advice, as well as act as the formal assessor during the Code 'Design Stage' and 'Post Construction Stage'.

Code assessments are normally carried out in two formal stages:

- Design Stage (DS) – leading to an Interim Certificate. Under the Code, this stage is voluntary but highly recommended. The aim of the DS is to assess detailed design specifications for each dwelling to determine the interim rating. The DS should be carried out before construction begins i.e. RIBA stages A-G[46], however in reality some DS assessments will be carried out at any point up until the construction is complete (RIBA Stage K).
- Post Construction Stage (PCS) – leading to the Final Certificate. Under the Code, this stage is mandatory. The aim of the PCS is to assess each individual dwelling 'As Built' to determine the final score for the dwelling and its final Code level rating. The PCS assessment must be carried out after construction of the individual dwelling is complete, but before its occupation.

The assessment process for the DS and PCS is very similar. Evidence is collated and used as the basis for the assessor to determine how many credits are to be awarded for each issue. A summary report is submitted to the Code service provider (BRE or Stroma) for quality assurance and certification.

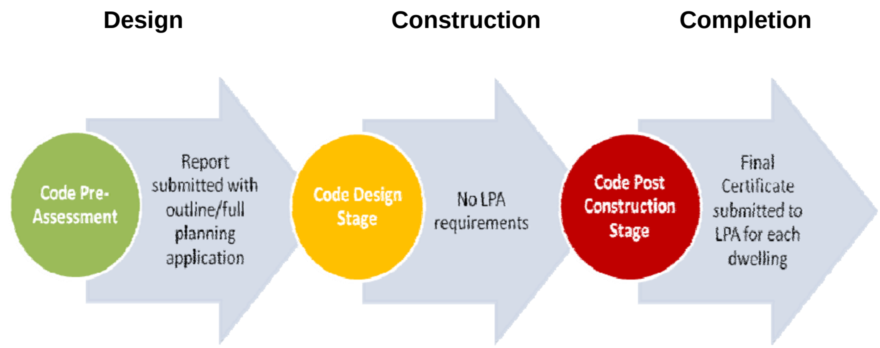
To enable the Code to be considered in the design of a dwelling as early on as possible, most assessor organisations now offer a third, initial stage known as a preliminary, or 'pre', assessment. The assessor organisation will work closely with the design team to identify the credit issues that will be appropriate to the dwelling/s and ensure sufficient credits are targeted to achieve the desired level rating. The pre-assessment offers the developer benefit in terms of cost planning and provides reassurance that the required Code level can be achieved. For the design team, the pre-assessment enables early action and design inclusion, which will reduce the likelihood of design iterations at a later stage which can be both time consuming and costly.

The pre-assessment is usually carried out at RIBA Stage C or D and can be submitted with the planning application to demonstrate to the local planning authority how the proposed development intends to achieve the required level rating. Indeed, many LPA Code policies state that a pre-assessment is required at the planning submission stage as evidence that the required Code level has been targeted. It would generally be unreasonable for a LPA to request a DS Interim Certificate with the planning submission since it is usually too early on in the development process for a DS assessment to have been carried out (the DS process, plus certification, can take up to a minimum of 8 weeks to carry out which would seriously impact upon the development programme).

[46] Royal Institute of Architects Outline Plan of Works

A planning condition is usually attached that Final Certificates for each dwelling being assessed must be presented once construction is complete and prior to occupation. If the certificate shows that the required Code level hasn't been achieved for a dwelling/s, this could be viewed as a breach of the planning condition and would be dealt with at the discretion of the LPA.

An example of how the Code could be applied to the planning application process is provided below:



7.3 Achievability of the Code

Where LPAs choose to adopt the Code as a policy standard for achieving sustainable buildings local characteristics and circumstances may need to be considered as to their impact on a development's ability to achieve credits. Indeed, PPS1 recommends that developments are assessed on a site-by-site basis when standards on sustainable design and construction are to be applied, to ensure viability. The Code sections that may give rise to potential issues of viability are discussed below:

7.3.1 Water use

Targets are set for average water consumption per building occupant. As a mandatory standard, Code levels 3 and 4 require a water use rate of no higher than 105 litres per person per day. This can be achieved by specifying water efficient sanitaryware and appliances (where applicable), without the need for a water reuse system, such as rainwater or greywater recycling. The higher levels of the Code (5 and 6) require water consumption of no more than 80 litres per person per day to be demonstrated. This rate is more challenging to achieve and would require some form of rainwater harvesting or greywater reuse on site. Costs of these are dependent on the scale of system, with individual house costs quoted at £2,650 but reducing to £800 for communal systems in flats. Communal systems can act as sustainable drainage systems (SUDS), for example, by holding and therefore slowing down the speed at which storm water enters the drainage system.

It should be noted that Part G of the Building Regulations has been amended to include a provision for water efficient installations to limit internal water consumption to 125 l/p/d. This rate applies to all domestic developments across England and Wales. However, as Figure 7.1 demonstrates, regions experience varying levels of annual average rainfall putting some regions at a higher risk of water shortages than others. Figure 7.1 shows that in 2009 the East of England experienced low average rainfall compared to many other regions. This is consistent with previous yearly rainfall records for the East of England.

Through the East of England Regional Assembly's (EERA) monitoring framework water consumption will be monitored against a target for domestic consumption of 105 litres/ person/ day (i.e. Levels 3 and 4 of the Code). This would equate to savings in water use of at least 25% in new development, compared with 2006 levels. This issue is supported through the East of England Plan (Policy WAT1).

Since it is possible to achieve this rate without incurring the expense of a water reuse system, LPA's would likely have sufficient justification in requiring through policy that development achieves a maximum water use rate of 105 l/p/d, or Code level 3 / 4.

Whilst the possible highest standards in water efficiency should be encouraged through policy (i.e. encouraging developers to achieve 80 l/p/d, equating to Code levels 5 and 6) an evidence base to demonstrate that water shortages in the County support and justify the additional expense that would be incurred may be necessary for any policy requiring these higher levels.

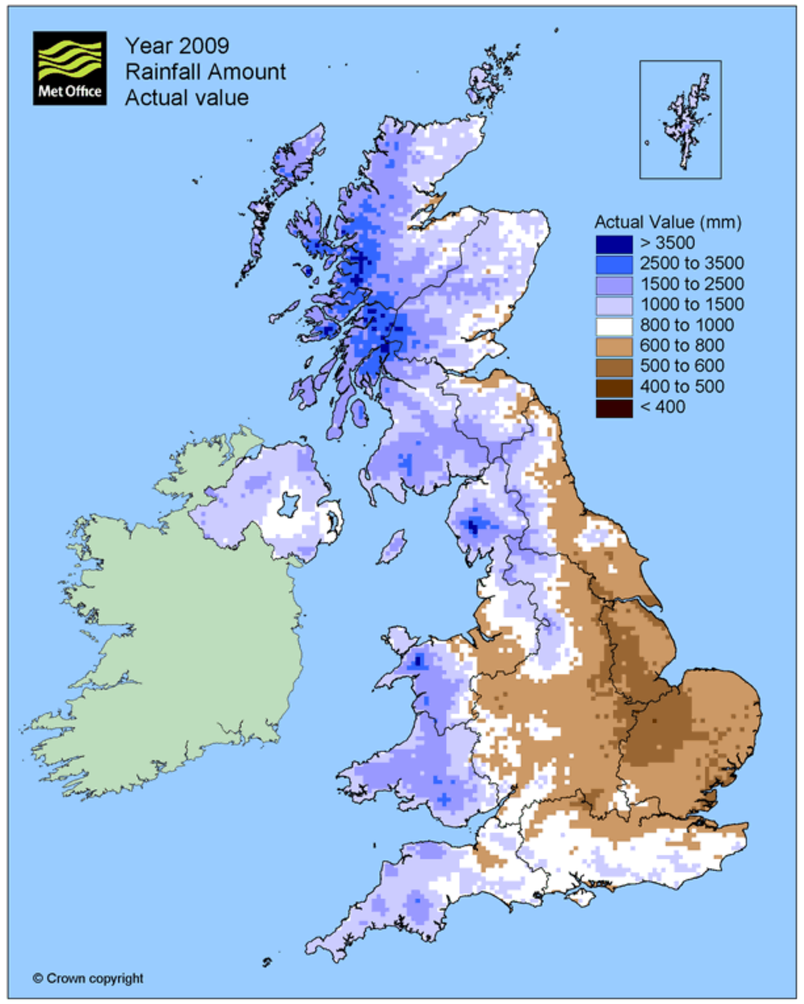


Figure 7.1: Annual average rainfall in the UK for 2009, the Met Office.

7.3.2 Flood risk

There are credits available in the Code for using sustainable drainage systems (SUDS) to reduce flood risk and the risk of groundwater contamination. Approximate costs for SUDs on individual homes are approximately £450 (based on one infiltration swale for every 2 units). The costs of incorporating flood resilience measures and materials on the ground floor of a 2 bed mid terraced house are around £17,000. If standard infiltration techniques cannot be used due to ground conditions, additional costs may be incurred for attenuation measures such as permeable surfaces and/or rainwater harvesting. Other Code credits are available for building in a low flood risk area, or where flood resilience measures are incorporated into design in medium or high flood risk areas. Targeting these credits is not mandatory but is recommended when taking into account the long term vulnerability of buildings to the effects of climate change in flood risk areas. It should be noted that developments in any medium and high flood risk zones in the County may be limited in their potential to achieve these credits.

7.3.3 Ecology

Non-mandatory credits are available in the Code to protect ecological features and where possible enhance a site's ecological value. Although LPAs are generally resistant to developing Greenfield / greenbelt land, stringent housing provision targets may mean that some future Greenfield / greenbelt development in Hertfordshire is likely. It should be noted that developments in these locations may be less able to achieve credits in this section of the Code.

7.3.4 Waste and recycling:

The Code has a mandatory requirement for all developments to implement a Site Waste Management Plan that monitors and reports on waste generated on site in defined waste groups, complies with legal requirements and includes the setting of targets to promote resource efficiency in accordance with guidance from WRAP, Envirowise, BRE and DEFRA. This is now a legal requirement for all construction projects over £300,000 in value so will be achieved by the majority of developments. Additional credits are available in the Code for including procedures and commitments to reduce waste and divert waste from landfill, according to best practice. Ability to achieve these credits will depend to some extent on local municipal waste management services.

7.3.5 Energy

The credits within the 'Energy and CO2' section of the Code are often regarded by developers as the most challenging to achieve, in terms of design and cost. However, this section is also fundamental in optimising CO_2 emission reductions by reducing the overall carbon footprint of the development, and helping to achieve the national timetable for reducing carbon emissions from domestic buildings (a requirement of the PPS1 Supplement).

The Code mandatory credit ENE1 "Dwelling Emission Rate" is aligned with Building Regulations Part L and the trajectory towards 'zero carbon' homes. This is set out in Table 7.1 opposite.

Part L of the Building Regulations is due to change in 2010 and developments will need to achieve an improved dwelling emission rate to that of a 2006 Building Regulations compliant building. In effect, this change will see development needing to achieve Code level 3 of the energy section in order to comply with Building Regulations. It may be appropriate therefore for LPA policy to require a standard to be met in order to encourage development to go beyond Building Regulations in terms of reducing CO_2 emissions. This is supported by the PPS1 Supplement which states *"There will be situations where it could be appropriate for planning authorities to anticipate levels of building sustainability in advance of those set out nationally."*

Code Level	Percentage improvement over 2006 Part L	When change to regulations takes place
1	10%	
2	18%	
3	25%	2010
4	44%	2013
5	100% (regulated emissions only)	
6	Net Zero Carbon (includes unregulated energy i.e. appliances, etc)	2016

Table 7.1: Part L trajectory towards zero carbon, with corresponding Code levels

7.3.6 Remaining sections

Other sections of the Code, including management, health & wellbeing, and materials depend more on the design and construction of the proposed development, or the specific constraints of a given site. It has been assumed that since the majority of these credits are tradable and can be targeted at the discretion of the developer, sufficient credits can be sought in order to for a development to achieve a Code rating.

7.4 Testing Policy on Code Energy Targets

In Chapter 8 of this report we have used notional development case studies (based on actual developments coming forward in Hertfordshire) to model and test potential policies relating to the Code that could be considered by Hertfordshire LPAs. Based on a 2011 scenario (allowing for a one year lag time from 2010), we have looked at advancing the introduction of the Code by one level over Building Regulations Part L (i.e. Code level 4) naming this "Code+1", and by two levels (i.e. Code level 5) or "Code+2". We have not tested Code level 3 since from the end of 2010 the energy requirements of Code level 3 will be aligned with Part L and will therefore become a legal requirement for all development.

The outputs and conclusions from the policy testing will assist in identifying if it would be appropriate and viable to enforce a specific Code level rating and what the uplift to 2016 (zero carbon homes) could be. This could then form part or all of a policy requirement aimed at achieving sustainable buildings in Hertfordshire.

The Code+1 and Code+2 policy tests are discussed in Chapter 8, whilst the results and conclusions are presented in Chapter 9. The findings from this analysis, together with the discussion in this chapter, will assist in determining whether applying Code standards in policy is viable, and if so, what the minimum standard and uplift should be.

7.5 Key Conclusions on the Technical Viability of Achieving Code

Based on the above technical discussion, and not yet accounting for the policy testing, it would be a practical option for Hertfordshire LPAs to adopt the Code as a method in which to achieve sustainable buildings, as required by the PPS Supplement. The most challenging credits for a developer would be those for internal water use. However, it is considered that a maximum use rate of 105 l/p/d can be achieved without major cost implications. In terms of consideration for reducing environmental impacts and resource pressure, it could be argued that a policy limiting water use rates should be applied to new development due to water resource constraints in the East of England.

The majority of the other credits are tradable, i.e. voluntary, so it would be the responsibility of the developer and design team to determine the appropriate credits to target in order to score sufficient points to achieve the desired Code level. The PPS1 Supplement supports LPAS in setting standards in advance of those set nationally where local circumstances warrant and allow this. Given the increasing pressure on water resources in the region it would be reasonably justified therefore for a minimum Code rating of Level 3 or 4 (both require a mandatory maximum rate of 105 l/p/d) to be applied to new residential development through planning policy.

It should be noted however, that it may not be appropriate to apply this policy to all developments. Minor residential schemes of less than10 dwellings may be able to achieve credits under the water section, but be financially constrained in meeting other elements of the Code. It may therefore be appropriate to apply a threshold limitation and this could be better determined once the energy requirements of the Code have been tested (see Chapter 8). Additionally, some development may be physically constrained in their ability to achieve certain credits due to location, topography, etc and this would need to also be considered when setting standards on sustainability. In these circumstances, it may be appropriate to consider applications on a site by site basis.

In terms of BREEAM (the environmental assessment method for non-domestic buildings), the credits are similar to that of the Code. Indeed, the Code evolved from 'Ecohomes' which was formally the BREEAM assessment method for new domestic buildings. Ecohomes is still available but cannot be used to assess new buildings, only residential refurbishment projects. In regards to BREEAM ratings (given on a scale of Pass, Good, Very Good and Excellent) a rating of 'Very Good' is the most comparable with a Code rating of Level 3 to 4, and is often the minimum rating used by LPAs that have adopted BREEAM in policies for non-residential development and domestic refurbishments.

7.6 The Code and Associated Costs

In this section we have provided information relating to the costs associated to the Code for Sustainable Homes (current version). This research was conducted on behalf of CLG and published in March 2010. It should be noted however, that the Code is currently under review following a consultation and is therefore likely to change over the course of 2010. The energy section in particular will see significant amendments as it is aligned with Part L of the Building Regulations and with the definition of zero carbon. Therefore the current cost review will only remain valid until the new version of the Code is published (anticipated in October 2010). An updated cost review will accompany the release of the updated Code and it is recommended that the data from this research eventually replaces the information in this section.

Additionally the current research does not take into account local factors such as land value, policy on S106 contributions, etc. We therefore encourage Hertfordshire LPAs to take these factors into consideration when addressing the costs associated with the different Code levels.

Data from the Code for Sustainable Homes Cost Review, March 2010[47] published by CLG has been used to show the financial implications of achieving different levels of the Code by different house types on different sites. Costs are those currently applicable to building to the existing version of the Code, with no assumptions regarding potential future revisions. The information in the section has been taken directly from the Cost Review.

The modelling methodology used by the Cost Review has been designed to identify the lowest cost means of achieving each Code level in each scenario (i.e. each combination of dwelling type and development scenario). This is achieved by first applying all measures required to achieve the mandatory standards (some of which are credited with points, others have no points attached) and then adding further measures in order of cost-effectiveness (i.e. £/point) until enough points have been scored to achieve a particular Code rating. The minimum costs associated with achieving each level of the Code are presented in Table 7.2 for each dwelling type and in a range of development scenarios. The costs are reported as the extra-over cost from a baseline of building a 2006 Building Regulation compliant dwelling.

There is significant variation in the extra-over costs at each Code Level between the dwelling types and across the development scenarios. Typically, however, the extra-over costs expressed as a percentage of base build cost are < 1% for Code level 1, 1–2% at Level 2, 3–4% at level 3, 6–8% at Level 4, 25–30% at Level 5 and anything from 30 to 40 % at Level 6.

The most critical factor in determining the total cost of building to the Code is the approach taken to meeting the mandatory reduction in carbon emissions. At the lower Code levels (up to Code level 3) fabric improvement measures may be sufficient to achieve the required reduction in Dwelling Emission Rate (note that calculation of Dwelling Emissions Rates have been performed using SAP 2005 which will be superseded by an updated version in October 2010). However, from Code level 4 and above it becomes necessary to employ some form of low or zero carbon technology to meet some or all of the dwelling's thermal and / or electrical demands. These costs tend to dominate the overall expense of meeting a given Code level for all dwelling types.

The variation in Code costs between development scenarios is largely a result of the variation in energy strategy costs, which can be dependent on the development's scale and density. This is particularly the case when the energy strategy is based around some common, site-wide infrastructure, such as a district heating system. Furthermore, development scale and / or density may restrict the technology options available. For example an attractive means of meeting the very high DER reductions required at Code Levels 5 and 6 can be to utilise a biomass CHP system connected to a district heating network but, due to current limitations

[47] http://www.communities.gov.uk/publications/planningandbuilding/codecostreview

on technology availability, a large heat load (i.e. a significant scale development) is required for this strategy to be available. Limited availability of biomass CHP technology at smaller scales and the constraints on installation of medium to large-scale wind turbines in many development sites mean that the Code Level 6 energy strategy is very challenging.

Extra-over costs (E/O) costs are measured from a baseline of constructing a 2006 Building Regulation compliant dwelling and are tabulated as an absolute cost and as a % increase over the base build cost. The table opposite (Table 7.2) summarises extra-over costs of building to each level of the Code in each of the dwelling types and for a range of development scenarios.

7.7 Future Code

The Code will be revised this year in order to align it with changes to Part L and other regulations and standards, and to incorporate the definition of zero carbon homes and the new energy efficiency standard. The proposed revisions being put forward were recently consulted on and it is anticipated that a revised version of the Code will be published towards the end of 2010. The proposals focus mainly on the energy section and issues regarding Lifetime Homes, inclusive design and sustainable drainage. A cost review will be conducted to take account of the changes as a result of the consultation.

As discussed previously, credit Ene1, which addresses CO_2 emission reductions, is aligned with Part L of the Building Regulations and mirrors the trajectory towards zero carbon homes in 2016. This means that in 2016 Code level 6 will be mandatory, but only in terms of credit Ene1. Subsequently, although all homes will need to be zero carbon, they won't necessarily have to achieve a Code Level 6 certificate, because most of the other credits in Code will still be voluntary. Therefore planning still has a role to play in requiring developments to achieve a Code level 6 certificate to ensure that sustainability is addressed in a holistic way and not just through energy.

CLG is currently considering the role of the Code energy section come 2016 through work on 'future thinking'.

7.8 BREEAM and Associated Costs

Figure 7.6 shows the percentage increase on the base build cost to deliver 'Good', 'Very Good' and 'Excellent' ratings under BREEAM Offices (2004) and BREEAM Schools. [48],[49] The cost analysis shows that the 'Very Good' level of BREEAM is achievable with a small increase to build costs, while the costs associated with BREEAM 'excellent' are much more significant.

We are not aware of any published cost data on meeting BREEAM office targets since 2004, certainly none is yet available showing the costs of delivering BREEAM Offices 2008, which contains a number of fairly significant changes, compared with earlier BREEAM versions.

[48] Putting a price on sustainability (BRE Trust and Cyril Sweett, 2005)
[49] Putting a price on sustainable schools (BRE Trust and Faithful & Gould, 2008

Code Level	2b-Flat		2b-Terrace		3b-Semi		4b-Detached	
	E/O cost	%	E/O cost	%	E/O cost	%	E/O cost	%
Small brownfield (20 dwellings at 80 dph)								
1	£310	0.5%	£230	0.3%	£360	0.4%	£310	0.3%
2	£1,670	2.8%	£1,620	1.9%	£1,040	1.1%	£970	1.0%
3	£2,460	4.1%	£2,420	2.8%	£3,020	3.2%	£2,680	2.7%
4	£5,610	9.4%	£7,360	8.5%	£8,140	8.7%	£6,030	6.0%
5	£17,740	29.7%	£24,370	28.2%	£26,830	28.6%	£30,130	30.1%
6	£28,510	47.7%	£34,810	40.3%	£38,730	41.2%	£42,770	42.8%
Medium Urban (350 dwellings at 80 dph)								
1	£260	0.4%	£170	0.2%	£260	0.3%	£270	0.3%
2	£1,560	2.6%	£1,500	1.7%	£890	0.9%	£810	0.8%
3	£2,340	3.9%	£2,000	2.3%	£2,900	3.1%	£2,510	2.5%
4	£5,440	9.1%	£7,190	8.3%	£7,970	8.5%	£5,860	5.9%
5	£17,570	29.4%	£24,200	28.0%	£26,650	28.4%	£29,960	30.0%
6	£19,580	32.8%	£26,550	30.7%	£28,390	30.2%	£31,230	31.2%
Large Urban (3600 dwellings at 80 dph)								
1	£250	0.4%	£160	0.2%	£250	0.3%	£260	0.3%
2	£1,550	2.6%	£1,490	1.7%	£890	0.9%	£810	0.8%
3	£2,340	3.9%	£2,000	2.3%	£2,890	3.1%	£2,510	2.5%
4	£6,360	10.6%	£6,200	7.2%	£6,580	7.0%	£6,470	6.5%
5	£16,640	27.9%	£23,210	26.8%	£25,580	27.2%	£28,790	28.8%
6	£23,210	38.9%	£29,920	34.6%	£32,390	34.5%	£36,040	36.0%
Small greenfield (10 dwellings at 40dph)								
1	£320	0.5%	£230	0.3%	£330	0.4%	£320	0.3%
2	£1,620	2.7%	£1,560	1.8%	£990	1.1%	£880	0.9%
3	£2,160	3.6%	£2,120	2.5%	£2,720	2.9%	£2,380	2.4%
4	£5,350	9.0%	£7,150	8.3%	£7,860	8.4%	£6,910	6.9%
5	£17,310	29.0%	£26,970	31.2%	£29,260	31.1%	£32,270	32.3%
6	£27,650	46.3%	£37,400	43.3%	£40,800	43.4%	£45,230	45.2%
Medium edge of town (650 dwellings at 40 dph)								
1	£270	0.5%	£190	0.2%	£370	0.4%	£290	0.3%
2	£1,550	2.6%	£1,500	1.7%	£920	1.0%	£810	0.8%
3	£2,090	3.5%	£2,050	2.4%	£2,650	2.8%	£2,310	2.3%
4	£5,280	8.8%	£7,080	8.2%	£7,800	8.3%	£6,840	6.8%
5	£17,240	28.9%	£26,900	31.1%	£29,190	31.1%	£32,200	32.2%
6	£24,080	40.3%	£31,250	36.1%	£33,090	35.2%	£36,180	36.2%
Large edge of town (3,300 dwellings at 40 dph)								
1	£270	0.5%	£180	0.2%	£370	0.4%	£290	0.3%
2	£1,550	2.6%	£1,490	1.7%	£920	1.0%	£810	0.8%
3	£2,090	3.5%	£2,050	2.4%	£2,640	2.8%	£2,310	2.3%
4	£5,280	8.8%	£7,080	8.2%	£7,790	8.3%	£6,830	6.8%
5	£17,230	28.8%	£26,890	31.1%	£29,190	31.1%	£32,200	32.2%
6	£27,710	46.4%	£34,620	40.0%	£37,090	39.5%	£40,990	41.0%

Table 7.2: Summary of E/O costs of building to each level of the Code (*The Code for Sustainable Homes - Cost Review, CLG, March 2010)*

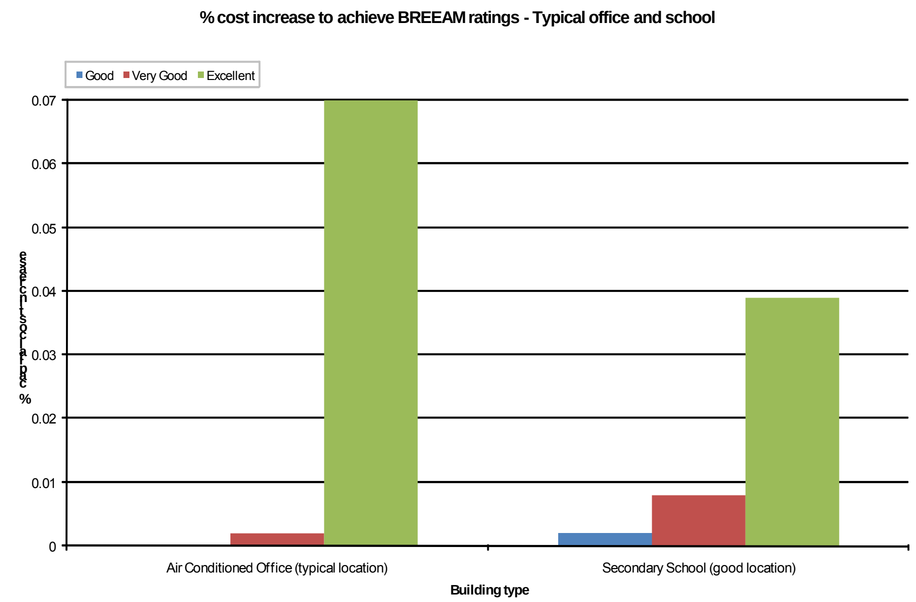


Figure 7.6: Costs (over base construction cost) for delivering BREEAM Offices (2004) and BREEAM schools ratings. (Source: Putting a price on sustainable schools (BRE Trust and Faithful & Gould, 2008)

7.9 Key Considerations Emerging from this Chapter

There are a number of key considerations that have emerged from assessing the technical (and to some extent the financial) viability of adopting Code as a policy standard. Setting requirements through policy for the use of Code (and potentially BREEAM) would:

- Meet the objectives of PPS Planning and Climate Change in terms of local requirements for sustainable buildings
- Improve the overall environmental performance of new development providing both environmental and social benefits on a local and national scale
- Go some way towards addressing the potential future impacts of climate change through the reduction of CO2 emissions and adaptation measures
- Support developers and the supply chain in gearing up to zero carbon
- Assist development control officers in assessing and validating compliance with policies and targets though the use of 3rd party certification

In addition:

- The Code Cost Review indicates that a significant proportion of the costs of delivering current Code levels arise in meeting the standards for energy and CO_2 emissions.
- The Code is under review and the energy section is likely to change significantly. The costs associated with the updated energy section are

still to be determined. However there is unlikely to be any major changes to other sections of the Code.

- The Code level 3 mandatory 25% Dwelling Emission Rate (DER) improvement is due to become a legal requirement through Building Regulations from the end of 2010 and therefore should not be considered as an additional build cost.
- There is a jump in cost when moving from Code Level 4 to Code Level 5 due to the associated improvement to the DER, but also the need for water re-use and recycling systems to achieve the 80 l/p/d maximum water use rate.
- Although it could be reasonably justified for an LPA to require a Code rating of Level 3 or 4, and potentially a BREEAM rating of ‘Very Good’ for non-domestic development, a development’s ability to deliver this rating may need to be assessed on a case by case basis, taking into account the physical site constraints which may affect achievement of some credits.
- Come 2016, planning will still have a role to play in requiring developments to consider and achieve sustainable buildings in a holistic way and not just through zero carbon.

8 Policy Testing

8.1 Introduction

Policy and targets for decentralised renewable and low carbon energy should be based on sound evidence of the local opportunities and constraints. They should also be technically feasible and financially viable for the range of developments which are expected to come forward over the period of a Core Strategy.

This chapter describes how policy options for Hertfordshire have been tested for feasibility and viability, in the context of the range of opportunities presented in the Energy Opportunities Plan (Figure 6.2) and the type of development expected in the County's districts and boroughs.

Domestic and non-domestic buildings have been modelled separately due to their different characteristics and the different methodologies used to model energy demand (i.e. SAP for domestic and SBEM for non-domestic). More details are provided in Appendix B.

It should be noted that polices based on domestic CO_2 emission reduction targets will only be valid up until 2016. At this point all homes will need to be 'zero carbon' and this will be enforced through building regulations. However there will still be opportunities for planning policy to set requirements based on maximising appropriate energy opportunities, such as district heating, wind, biomass, etc, and for sustainable design and construction i.e. the use of the Code for Sustainable Homes.

8.2 Policy Options for New development

A range of policy options have been chosen for testing. We have used Building Regulations 2006 as the baseline for regulated CO_2 reduction targets. A summary of the policies tested is provided below with a full set of options provided in Table 8.3.

- Policy 0 corresponds to the Building Regulations 2006 and sets the baseline against which other policy options are compared.
- Policy 1 requires a further 10% reduction in CO_2 emissions over the Building Regulations.
- Policy 2 requires a further 15% reduction in CO_2 emissions over the Building Regulations.
- Policy 3 requires new development to achieve CO_2 emissions reductions one step ahead of the Building Regulations Code Level equivalent.
- Policy 4 requires new development to achieve CO_2 emissions reductions two steps ahead of the Building Regulations Code Level equivalent (but not exceeding 100% reduction in regulated CO_2 emissions compared to PartL 2006 before Building Regulations requirement of Zero Carbon for new developments*).
- Policy 5 requires new development to achieve CO_2 emissions reductions in line with Building Regulations but with a specified contribution from a renewable energy technology.

*It has been assumed that where a policy requires a regulated CO_2 reduction target greater than 70% compared to PartL of BR 2006, allowable solutions in the form of a fund will be available to the property developers. It should be noted that it is not yet clear what form allowable solutions within Building Regulations would take. Therefore assumptions regarding allowable solutions should be reviewed, especially for non-domestic buildings where there is the greatest uncertainty, when there is more clarity over the Building Regulations trajectory.

Where the CO_2 reduction target is greater than 70%, developers would have to achieve a 70% reduction on site (through energy efficiency and renewable or low carbon technologies, including direct link to an off-site heat source. The remaining CO_2 reductions could then be offset by paying money into a fund (options are discussed further in chapter 10).

8.2.1 Policy 0 – Building Regulations Baseline

It should be noted that there is currently some uncertainty over what the Building Regulations requirements will be in the coming years, particularly since a new electoral cycle is due to begin in a few months. Therefore, for the purpose of setting a baseline against which policies can be tested, assumptions about changes to Building Regulations up to 2019 have been made. These assumptions are based on our knowledge about the current proposed Building Regulation trajectory up to 2019.

At the time of writing, PartL of Building Regulations follows CO_2 reduction targets that are in line with Code for Sustainable Homes CO_2 targets. Table 8.1 shows the assumed Building Regulations baseline between 2010 and 2019.

	Regulated CO_2 reduction required over PartL 2006			
	2010	**2013**	**2016**	**2019**
Policy 0 (Residential)	25%	44%	ZeroCarbon	ZeroCarbon
Policy 0 (Non-residential)	25%	44%	70%	ZeroCarbon

Table 8.1: Assumed Building Regulations baseline between 2010 and 2019

8.2.2 Policy 1 – 10% reduction in CO_2 emissions over Building Regulations

This policy requires new development to achieve a 10% reduction in the remaining regulated CO_2 emissions after meeting Building Regulations.

For example, in 2010 Building Regulations will stipulate a 25% reduction in regulated emissions over PartL 2006. To calculate the 10% reduction, 10% of the remaining 75% of regulated emissions (7.5%) is added to the Building Regulations baseline.

Therefore Policy 1 in 2010 is:

= 25% + (10/100) x (100% - 25%)

= 25% + (10/100) x 75%

= 25% + 7.5% = 32.5%

In 2013, Building Regulations requires a 44% reduction over PartL 2006. The remaining emissions are 100% - 44% = 56%

Therefore Policy 1 in 2013 is

= 44% + (10/100) X 56% = 44% + 5.6% = 49.6%

In 2016, new residential development will have to be Zero Carbon. At this time, Policy 1 will follow the Building Regulations baseline.

For new non-residential development in 2016, Policy 1 is:

= 70% + (10/100) x 30% = 73%

In 2019, new non-residential development will have to be Zero Carbon. At this time, Policy 1 will follow the Building Regulations baseline.

8.2.3 Policy 2 – 15% reduction in CO_2 emissions over Building Regulations

The methodology for specifying this policy is as for Policy 1 above.

For example in 2013, Policy 2 is:

= 44% + (15/100) x 56% = 52.4%

8.2.4 Policy 3 – Code +1

The Code mandatory credit ENE1 “Dwelling Emission Rate” is aligned with Building Regulations Part L and the trajectory towards ‘zero carbon’ homes. This is set out in Table 8.2 below.

The Code+1 policy requires new development to achieve a regulated CO_2 emission reduction one Code level above the current Building Regulations.

In 2010, Building Regulations stipulates a 25% reduction in CO_2 emissions over PartL2006. This corresponds with the CO_2 reduction target of CSH Level 3.

Therefore, in 2010 Code+1 policy requires a CO_2 reduction equivalent to the CO_2 reduction target of CSH Level 4.

In 2013, BR is equivalent to the Code Level 4 emissions reduction target. Code+1 policy therefore requires CSH Level 5 CO_2 emission reduction between 2013 and 2016.

The Code+1 policy does not require a CO_2 reduction greater than 100% before BR requires Zero Carbon for new development. When BR requires the Zero Carbon standard, the Code+1 policy falls in line with BR.

Code Level	Percentage improvement over 2006 Part L	When change to regulations takes place
1	10%	
2	18%	
3	25%	2010
4	44%	2013
5	100% (regulated emissions only)	
6	Net Zero Carbon (includes unregulated energy i.e. appliances, etc)	2016

Table 8.2 – Part L trajectory towards zero carbon, with corresponding Code levels

8.2.5 Policy 4 – Code +2

The policy for specifying this policy is similar to that for Code+1 policy, except that new development needs to achieve a regulated CO_2 emission reduction <u>two</u> Code levels above the current Building Regulations. Therefore, in 2010 Code+2 policy requires a CO_2 reduction equivalent to the CO_2 reduction target of CSH Level 5. From 2013 up to the year that BR requires new development to be Zero Carbon, the Code+2 policy target is a 100% reduction in regulated emissions compared to BR PartL 2006.

8.2.6 Policy 5 – Renewables Mandatory to meet Building Regulations

Policy 5 requires a percentage contribution from on-site renewables to meet BR. In 2010, this is a 10% contribution towards meeting BR. The remaining 15% to reach the necessary 25% CO_2 reduction can come from energy efficiency or other renewable or low carbon energy measures. In 2013, a renewable technology must provide a 20% contribution (remaining 24% from energy efficiency and/or other RLC measures). From 2016, for new residential developments, policy 5 will follow BR. From 2019, for new non-residential developments, policy 5 will follow BR.

Policy	Policy description	Development type	2010	2013	2016	2019
Policy 0	BR 2006 Baseline	Residential	25%	44%	ZeroCarbon	ZeroCarbon
Policy 0	BR 2006 Baseline	Non-residential	25%	44%	70%	ZeroCarbon
Policy 1	BR 2006 +10%	Residential	32.5%	49.6%	ZeroCarbon	ZeroCarbon
Policy 1	BR 2006 +10%	Non-residential	32.5%	49.6%	73%	ZeroCarbon
Policy 2	BR 2006 +15%	Residential	36.25%	52.4%	ZeroCarbon	ZeroCarbon
Policy 2	BR 2006 +15%	Non-residential	36.25%	52.4%	74.5%	ZeroCarbon
Policy 3	Code +1 (CO_2 target)	Residential	44%	100%	ZeroCarbon	ZeroCarbon
Policy 3	Code +1 (CO_2 target)	Non-residential	44%	100%	100%	ZeroCarbon
Policy 4	Code +2 (CO_2 target)	Residential	100%	100%	ZeroCarbon	ZeroCarbon
Policy 4	Code +2 (CO_2 target)	Non-residential	100%	100%	100%	ZeroCarbon
Policy 5	Policy 5 (renewables mandatory)	Residential	25% (10% from renewables, 15% from any other means)	44% (20% from renewables, 24% from any other means)	ZeroCarbon	ZeroCarbon
Policy 5	Policy 5 (renewables mandatory)	Non-residential	25% (10% from renewables, 15% from any other means)	44% (20% from renewables, 24% from any other means)	70% (20% from renewables, 50% from any other means)	ZeroCarbon

Table 8.3 Policy options tested for this study

8.3 Case Studies

The size and type of development proposed are important factors to take into account when considering the level of energy performance that may be feasible and viable. For the purpose of this study, the different policy options have been tested against 17 development scenarios which are based on actual development case studies which were put forward for consideration by the LPAs and represent the range of development which is expected to come forward over the period of the LPAs' Core Strategy period. Additionally, we have suggested several notional case studies of development types/sizes that haven't been represented by the LPA case studies but which are likely to occur in Hertfordshire.

20 development scenarios have been used as case studies and these are briefly described in Table 8.4 below. Please note that where very similar development types and sizes have been provided by LPAs, we have approximated the number of homes/total sqm commercial area to ensure all are captured by a suitable threshold.

It should also be noted that Policy 5 has only been tested for 6 development scenarios as it is considered that the results from these scenarios give a clear indication about the implications of such a Policy. Therefore, Policy 5 was not tested for the remaining development scenarios as it is deemed that there would be no additional benefit to the study.

The results and brief analysis is provided for each in Chapter 9.

Case Study Ref.	Development Type	Total no. Homes	Total sqm non-Residential	Local Authority or Notional	Policy 5 tested?
1	Housing – small (1 house) city infill	1	-	Notional	Yes
2	Housing – small (1 house) rural	1	-	Local authority	No
3	Housing – small (10 flats) city infill	10	-	Local authority	Yes
4	Housing - small (10 flats) rural	10	-	Local authority	No
5	Housing - small (10 houses) rural	10	-	Local authority	No
6	Housing - small (10 houses) City infill	10	-	Local authority	No
7	Housing – medium mixed (50 flats and houses) rural	50	-	Local authority	No
8	Housing – medium mixed (50 flats and houses) urban	50	-	Local authority	No
9	Housing – medium mixed (200-500 flats and houses) urban	350	-	Local authority	Yes
10	Urban office development (100 sqm)	-	100	Notional	Yes
11	Urban office development (1,000 sqm)	-	1,000	Notional	No
12	Office development (approx 8,000 sqm)	-	7,800	Local authority	Yes
13	Medium mixed commercial (approx 4,000 sqm)	-	3,700	Local authority	No
14	Large mixed commercial (approx 35,000 sqm)	-	35,000	Local authority	No
15	Light industrial (100,000 sqm)	-	100,000	Local authority	No
16	Urban retail (approx 11,000 sqm)	-	11,000	Local authority	No
17	Small mixed use - housing, office, school, retail	400	5,000	Local authority	No
18	Medium mixed use - housing, retail, commercial	1,000	3,400	Local authority	No
19	Medium to Large mixed use – housing, schools, commercial	2,700	58,500	Local authority	No
20	Large mixed use - housing, office, industrial, hotel	12,000	194,660	Local authority	Yes

Table 8.4: Local authority and notional development type case studies used to test potential policies

9 Policy Recommendations

9.1 Analysing the Impact of Policy

The impact of the policy options being considered for new development has been tested by considering the energy strategies that may be proposed for the typical case study developments (Table 8.4, Chapter 8) to demonstrate compliance. The model developed for this study compares a range of technology options and selects the cheapest option (in terms of capital cost) which will comply with the target in question. The modelling approach is described in detail in Appendix B

The impact of each policy, in terms of technologies selected, CO_2 emissions saved and cost per unit of development, depends on which year a development comes forward for planning permission and which energy opportunities are available.

The results are summarised for each of the case study development types in this chapter, comparing the potential outcomes in each of the case studies and for each of the policy options proposed.

Note: The technologies listed in the model outputs are only proposals for technologies/technology mixes that could be viable in order to meet the policy target. These are for reference only and may not always be exhaustive. The Energy Opportunities Plan should be cross-checked against all development locations and used to make recommendations on the energy strategy for that site.

9.2 Summary of Policy Testing and Analysis

The following pages summarise the results of the modelling for the 20 case study development types. They set out an indicative technology choice to comply with the policy option in place at the time, together with the associated cost and percentage CO_2 saving over and above the Building Regulations requirement. The results are given for each policy and for each step change in the Building Regulations requirements (2010, 2014, 2016, 2019).

The RLC technologies are described in Appendix C, whilst details of the modelling approach and the assumptions used are explained in Appendix B. An explanation of the role of “EE1” and “EE2” is also provide in Appendix B.

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9.3 Case Study x – Explanatory example

- Development type: Housing – small city infill
- Development size: Provides information about development size in terms of numbers of dwellings and sqm of non-residential
- Source: Stipulates where case study development originated

Discussion

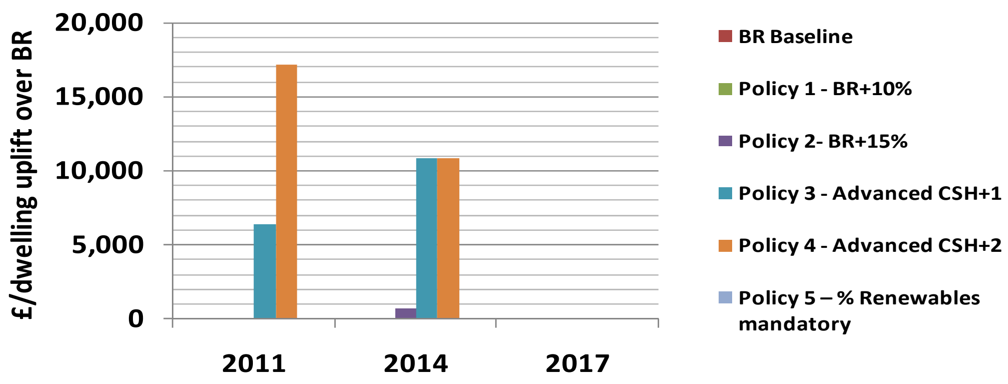

Figure 9.1a - capital cost uplift of Policy Options above BR baseline (Case Study x)

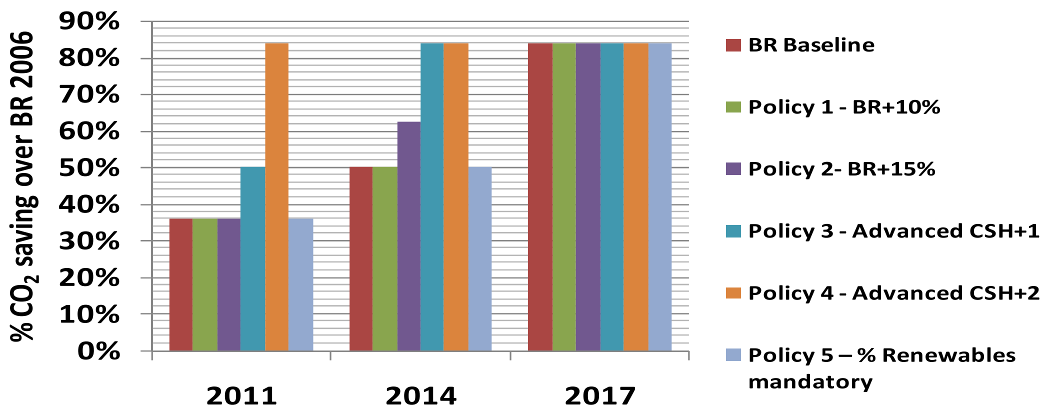

Figure 9.1b - %CO_2 saving above BR 2006

Where the same technology option as the Building Regulations baseline is chosen by the model to comply with a policy, (e.g. solar water heating +EE1), with the same capital cost and CO_2 saving, this does not mean that the capital cost and CO_2 saving cannot vary for the given technology option. Rather, it is assumed that a standard sized module (e.g. standard sized solar panel) would be installed to meet Building Regulations, regardless of whether the size of installation exceeded Building Regulations requirements, rather than opting for a bespoke panel size to just comply Building Regulations. In other words, technologies or approaches adopted by developers to achieve Building Regulations compliance may give greater than ‘necessary’ CO_2 savings.

For graphs that show £/sqm uplift and £/dwelling uplift over Building Regulations, if no capital cost uplift is given, this means that the modelling shows that there is no cost uplift required to meet the given policy.

‘Allowable solutions’ contributions – although there is no certainty around the final list of solutions it is assumed that there will be a pathway to allow all development types to achieve CO_2 reductions in excess of the 70% ‘carbon compliance’ that will be required below the equivalent PartL of Building Regulations 2006.

DOMESTIC	Year*	BR (2006) Baseline	Policy 1 – BR+10%	Policy 2 – BR+15%	Policy 3 – Code+1	Policy 4 – Code+2	Policy 5 – % Renewables mandatory
Technology Option	2011	Lowest Capital Cost Technology Option that complies with BR policy in 2011	Lowest Capital Cost Technology Option that complies with BR policy in 2011	Lowest Capital Cost Technology Option that complies with BR policy in 2011	Lowest Capital Cost Technology Option that complies with BR policy in 2011	Lowest Capital Cost Technology Option that complies with BR policy in 2011	Lowest Capital Cost Technology Option that complies with BR policy in 2011
	2014	Lowest Capital Cost Technology Option that complies with BR policy in 2014	Lowest Capital Cost Technology Option that complies with BR policy in 2014	Lowest Capital Cost Technology Option that complies with BR policy in 2014	Lowest Capital Cost Technology Option that complies with BR policy in 2014	Lowest Capital Cost Technology Option that complies with BR policy in 2014	Lowest Capital Cost Technology Option that complies with BR policy in 2014
	2017	ZeroCarbon all policies to comply with BR (ZeroCarbon is 2019 for non-resi	ZeroCarbon all policies to comply with BR (ZeroCarbon is 2019 for non-resi	ZeroCarbon all policies to comply with BR (ZeroCarbon is 2019 for non-resi	ZeroCarbon all policies to comply with BR (ZeroCarbon is 2019 for non-resi	ZeroCarbon all policies to comply with BR (ZeroCarbon is 2019 for non-resi	ZeroCarbon all policies to comply with BR (ZeroCarbon is 2019 for non-resi
Technically Viable?		Yes	Yes	Yes	Yes	Yes	Yes
% CO_2 saving uplift (regulated emissions, over PtL2006)	2011	% regulated CO_2 reduction over PartL of BR2006	% regulated CO_2 reduction over PartL of BR2006	% regulated CO_2 reduction over PartL of BR2006	% regulated CO_2 reduction over PartL of BR2006	% regulated CO_2 reduction over PartL of BR2006	% regulated CO_2 reduction over PartL of BR2006
	2014	% regulated CO_2 reduction over PartL of BR2006	% regulated CO_2 reduction over PartL of BR2006	% regulated CO_2 reduction over PartL of BR2006	% regulated CO_2 reduction over PartL of BR2006	% regulated CO_2 reduction over PartL of BR2006	% regulated CO_2 reduction over PartL of BR2006
	2017	% regulated CO_2 reduction over PartL of BR2006	% regulated CO_2 reduction over PartL of BR2006	% regulated CO_2 reduction over PartL of BR2006	% regulated CO_2 reduction over PartL of BR2006	% regulated CO_2 reduction over PartL of BR2006	% regulated CO_2 reduction over PartL of BR2006
£/dwelling uplift over BR Baseline	2011	Capital cost uplift over BR cost required to meet Policy	Capital cost uplift over BR cost required to meet Policy	Capital cost uplift over BR cost required to meet Policy	Capital cost uplift over BR cost required to meet Policy	Capital cost uplift over BR cost required to meet Policy	Capital cost uplift over BR cost required to meet Policy
	2014	Capital cost uplift over BR cost required to meet Policy	Capital cost uplift over BR cost required to meet Policy	Capital cost uplift over BR cost required to meet Policy	Capital cost uplift over BR cost required to meet Policy	Capital cost uplift over BR cost required to meet Policy	Capital cost uplift over BR cost required to meet Policy
	2017	ZeroCarbon	ZeroCarbon	ZeroCarbon	ZeroCarbon	ZeroCarbon	ZeroCarbon
£/tonne CO_2 uplift	2011	Capital cost of technology option/tonnes CO_2 saved	Capital cost of technology option/tonnes CO_2 saved	Capital cost of technology option/tonnes CO_2 saved	Capital cost of technology option/tonnes CO_2 saved	Capital cost of technology option/tonnes CO_2 saved	Capital cost of technology option/tonnes CO_2 saved
	2014	Capital cost of technology option/tonnes CO_2 saved	Capital cost of technology option/tonnes CO_2 saved	Capital cost of technology option/tonnes CO_2 saved	Capital cost of technology option/tonnes CO_2 saved	Capital cost of technology option/tonnes CO_2 saved	Capital cost of technology option/tonnes CO_2 saved
	2017	ZeroCarbon	ZeroCarbon	ZeroCarbon	ZeroCarbon	ZeroCarbon	ZeroCarbon

9.4 Case Study 1

- Development type: Housing – small city infill
- Development size: 1 house
- Source: Notional

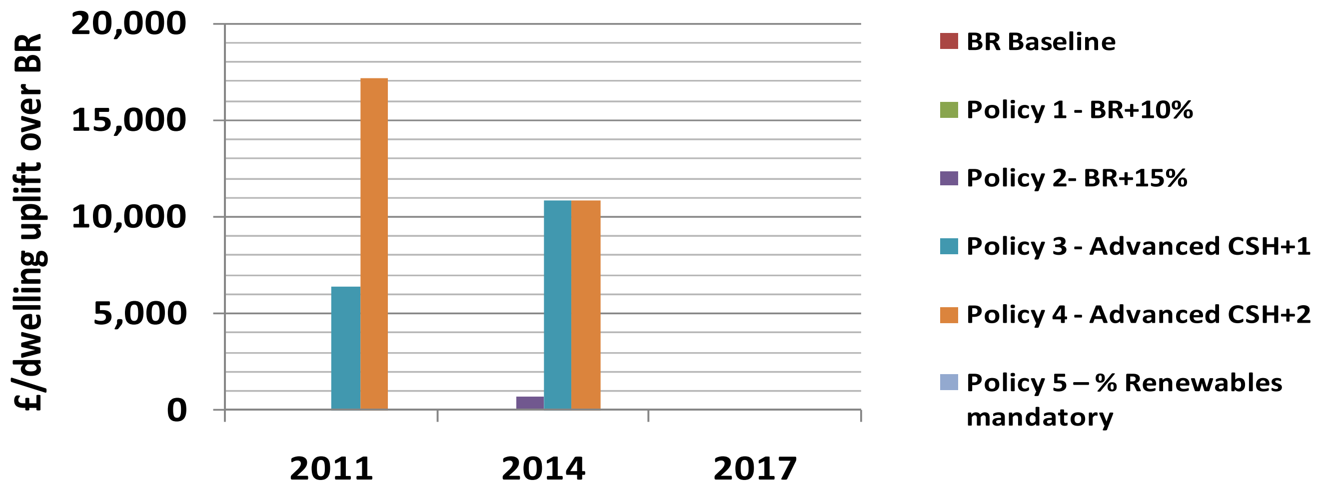

Figure 9.2b - capital cost uplift of Policy Options above BR baseline (Case Study 1)

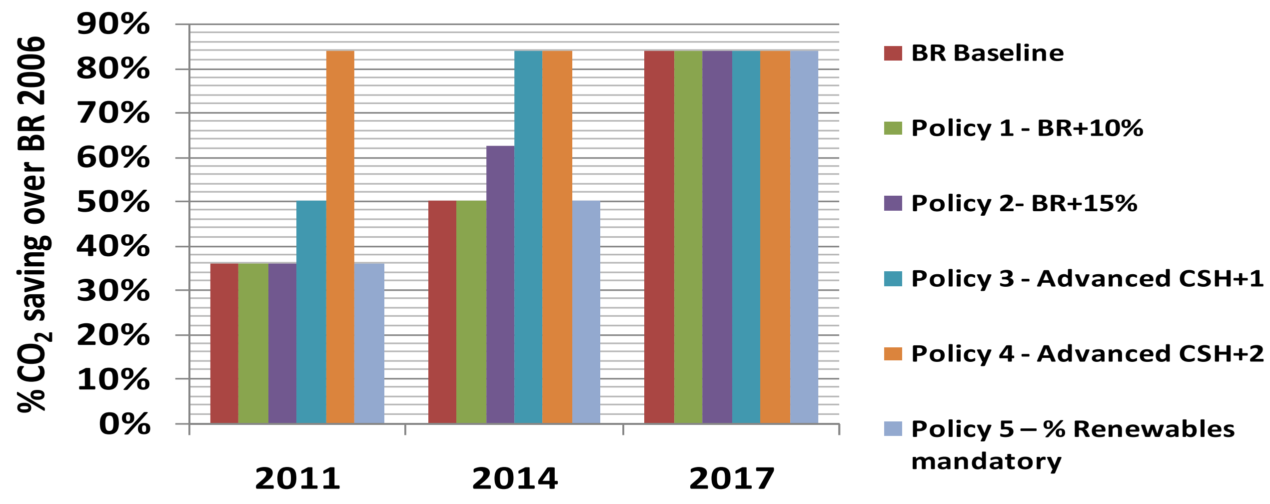

Figure 9.2b - %CO_2 saving above BR 2006

Discussion

Policy 1 has no cost uplift over BR for all years modelled (since the CO_2 savings are the same as BR 2006 which is a legal minimum requirement) whereas Policy 2 shows a modest cost uplift in 2014 over BR (at 2011 the CO_2 savings are the same as BR 2006). It can be surmised therefore that Policies 1 and 2 will require little or no capital cost increase over BR for this type of development.

Policies 3 and 4 however show cost uplifts of approximately £6,000 and £17,000 respectively in 2011 and approximately £10,000 each in 2014.

Policy 5 costs the same and saves the same amount of CO_2 as BR. This is because a renewable technology makes a significant contribution to meeting BR in the years up to 2017.

DOMESTIC Case Study1	Year*	BR Baseline	Policy 1 – BR+10%	Policy 2 – BR+15%	Policy 3 – Code+1	Policy 4 – Code+2	Policy 5 – % Renewables mandatory
Technology Option	2011	Solar Water Heating + EE1	Solar Water Heating + EE1	Solar Water Heating + EE1	PV - medium installation + EE1	PV (maximum) + EE1 + Allowable Solutions Contribution	Solar Water Heating + EE1
	2014	PV - medium installation + EE1	PV - medium installation + EE1	PV - medium installation + EE2	PV (maximum) + EE1 + Allowable Solutions Contribution	PV (maximum) + EE1 + Allowable Solutions Contribution	PV - medium installation + EE1
	2017	PV (maximum) + EE1 + Allowable Solutions Contribution	PV (maximum) + EE1 + Allowable Solutions Contribution	PV (maximum) + EE1 + Allowable Solutions Contribution	PV (maximum) + EE1 + Allowable Solutions Contribution	PV (maximum) + EE1 + Allowable Solutions Contribution	PV (maximum) + EE1 + Allowable Solutions Contribution
Technically Viable?		Yes	Yes	Yes	Yes	Yes	Yes
% CO_2 saving uplift (regulated emissions, over PtL2006)	2011	36%	36%	36%	50%	84%	36%
	2014	50%	50%	62%	84%	84%	50%
	2017	84%	84%	84%	84%	84%	84%
£/dwelling uplift over BR Baseline	2011	0	0	0	6,361	17,199	0
	2014	0	0	708	10,839	10,839	0
	2017	0	0	0	0	0	0
£/tonne CO_2 uplift	2011	0	0	0	20,510	16,347	0
	2014	0	0	2,695	14,608	14,608	0
	2017	0	0	0	0	0	0

Table 9.2 - Case Study 1 Results Summary

9.5 Case Study 2

- Development type: Housing – small rural
- Development size: 1 house
- Source: Local authority

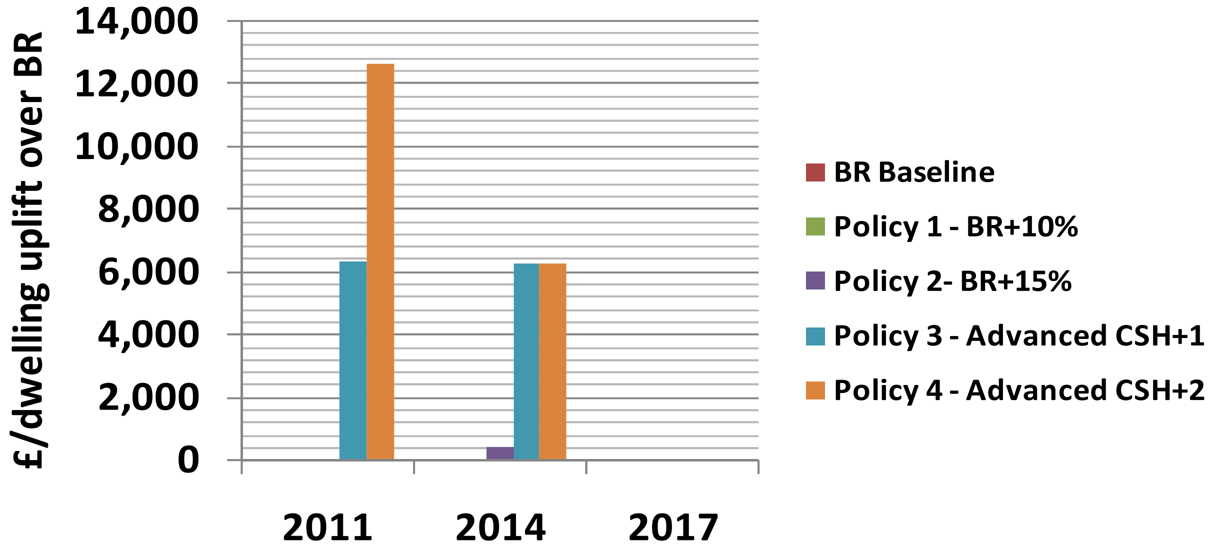

Figure 9.3a capital cost uplift of Policy Options above BR baseline (Case Study 2)

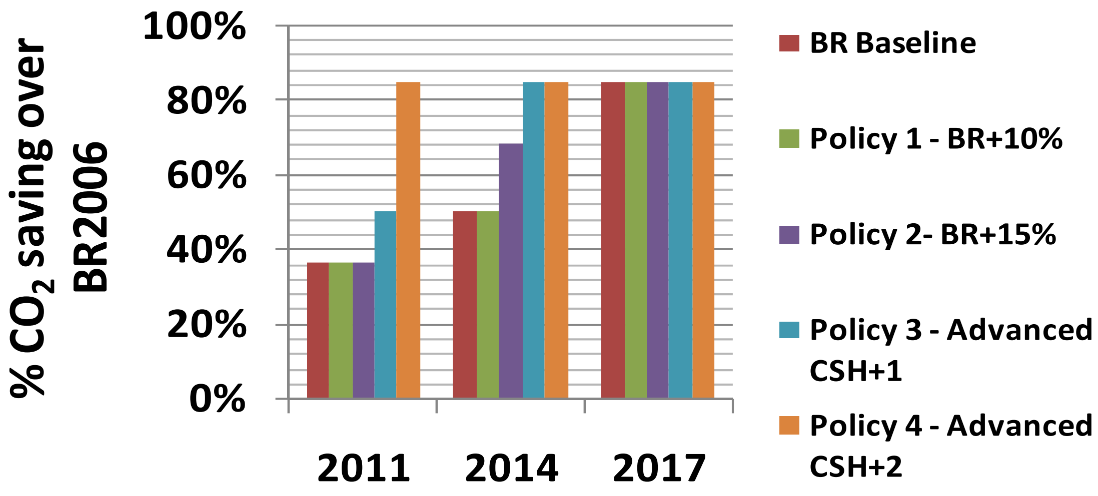

Figure 9.3b %CO_2 saving above BR 2006

Discussion

Policy 1 has no cost uplift over BR for all years modelled (since the CO_2 savings are the same as BR 2006 which is a legal minimum requirement) whereas Policy 2 shows a modest cost uplift in 2014 over BR (at 2011 the CO_2 savings are the same as BR 2006). It can be surmised therefore that Policies 1 and 2 will require little or no capital cost increase over BR for this type of development.

Policies 3 and 4 however show cost uplifts of approximately £6,000 and £13,000 respectively in 2010 and approximately £6,000 each in 2014.

From 2017 onwards, a mixture of energy efficiency, biomass heating, PV and allowable solutions would be needed to comply with BR.

Policy 5 has not been tested for this case study.

DOMESTIC Case Study2	Year*	BR Baseline	Policy 1 – BR+10%	Policy 2 – BR+15%	Policy 3 – Code+1	Policy 4 – Code+2
Technology Option	2011	Solar Water Heating + EE1	Solar Water Heating + EE1	Solar Water Heating + EE1	PV - medium installation + EE1	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution
	2014	PV - medium installation + EE1	PV - medium installation + EE1	Biomass heating + EE1	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution
	2017	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution
Technically Viable?		Yes	Yes	Yes	Yes	Yes
% CO_2 saving uplift (regulated emissions, over PtL2006)	2011	36%	36%	36%	50%	85%
	2014	50%	50%	68%	85%	85%
	2017	85%	85%	85%	85%	85%
£/dwelling uplift over BR Baseline	2011	0	0	0	6,361	12,635
	2014	0	0	402	6,275	6,275
	2017	0	0	0	0	0
£/tonne CO_2 uplift	2011	0	0	0	20,510	11,760
	2014	0	0	1,022	8,209	8,209
	2017	0	0	0	0	0

Table 9.3 - Case Study 2 Results Summary

9.6 Case Study 3

- Development type: Housing – small city infill
- Development size: 10 flats
- Source: Local authority

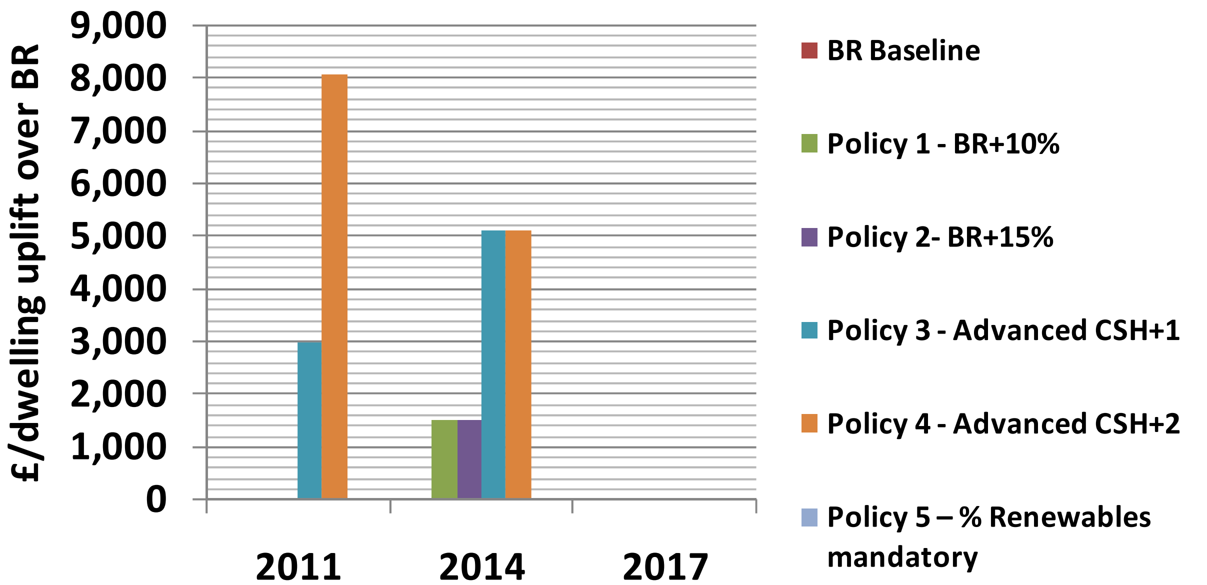

Figure 9.4a capital cost uplift of Policy Options above BR baseline (Case Study 3)

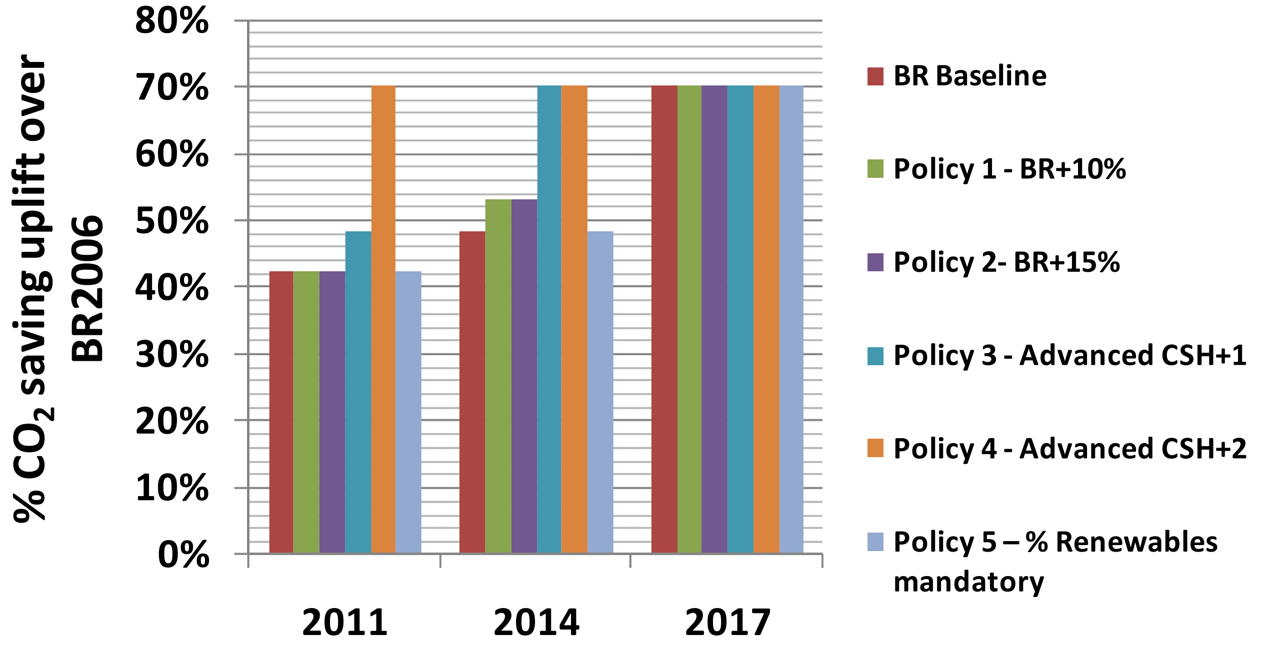

Figure 9.4b %CO_2 saving above BR 2006

Discussion

Policies 1 and 2 have no cost uplift over BR in 2011(since the CO_2 savings are the same as BR 2006 which is a legal minimum requirement), but show a modest cost uplift of £1,500 per dwelling in 2014. Policy 3 shows a cost uplift of £3,000 in 2011 and an uplift of £5,000 in 2014. Policy 4 shows a capital cost uplift of £8,000 per dwelling in 2011 and an uplift of £5,000 in 2014.

Policy 5 costs the same and saves the same amount of CO_2 as BR. This is because a renewable technology makes a significant contribution to meeting BR in the years up to 2017.

From 2017 onwards, a mixture of energy efficiency, biomass heating, PV and allowable solutions would be needed to comply with BR.

DOMESTIC Case Study3	Year*	BR Baseline	Policy 1 – BR+10%	Policy 2 – BR+15%	Policy 3 – Code+1	Policy 4 – Code+2	Policy 5 – % Renewables mandatory
Technology Option	2011	Solar Water Heating + EE1	Solar Water Heating + EE1	Solar Water Heating + EE1	PV - maximum installation + EE1	Biomass heating + PV (medium) + EE1 + Allowable Solutions Contribution	Solar Water Heating + EE1
	2014	PV - maximum installation + EE1	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + PV (medium) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (medium) + EE1 + Allowable Solutions Contribution	PV - maximum installation + EE1
	2017	Biomass heating + PV (medium) + EE1 + Allowable Solutions	Biomass heating + PV (medium) + EE1 + Allowable Solutions	Biomass heating + PV (medium) + EE1 + Allowable Solutions	Biomass heating + PV (medium) + EE1 + Allowable Solutions	Biomass heating + PV (medium) + EE1 + Allowable Solutions	Biomass heating + PV (medium) + EE1 + Allowable Solutions
Technically Viable?		Yes	Yes	Yes	Yes	Yes	Yes
% CO_2 saving uplift (regulated emissions, over PtL2006)	2011	42%	42%	42%	48%	70%	42%
	2014	48%	53%	53%	70%	70%	48%
	2017	70%	70%	70%	70%	70%	70%
£/dwelling uplift over BR Baseline	2011	0	0	0	2,970	8,073	0
	2014	0	1,518	1,518	5,103	5,103	0
	2017	0	0	0	0	0	0
£/tonne CO_2 uplift	2011	0	0	0	37,421	22,647	0
	2014	0	25,911	25,911	18,415	18,415	0
	2017	0	0	0	0	0	0

Table 9.4 - Case Study3 Results Summary

9.7 Case Study 4

- Development type: Housing – small rural
- Development size: 10 flats
- Source: Local authority

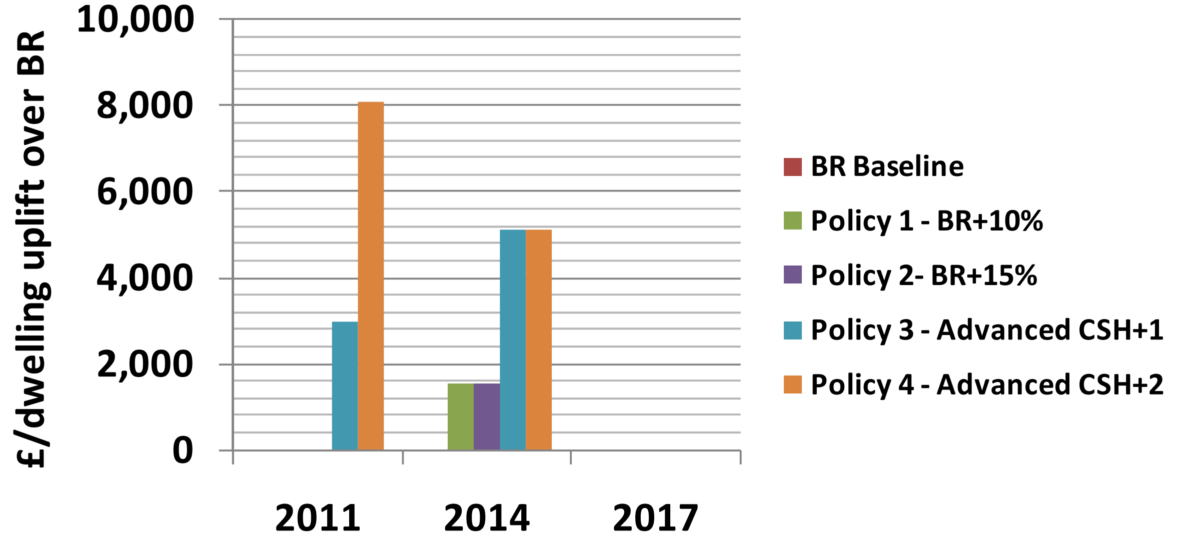

Figure 9.5a capital cost uplift of Policy Options above BR baseline (Case Study 4)

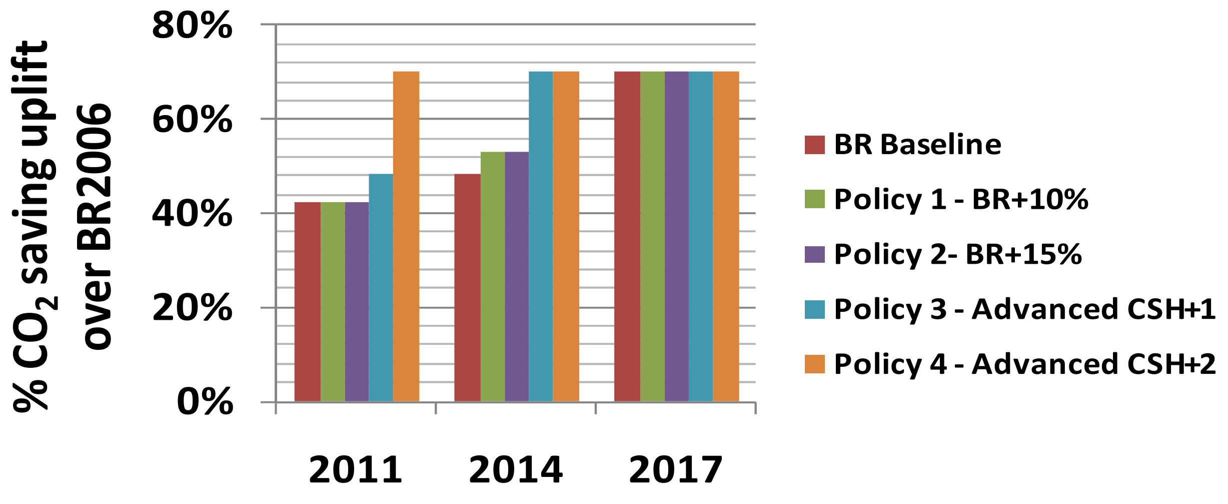

Figure 9.5b %CO_2 saving above BR 2006

Discussion

Policies 1 and 2 show a relatively small cost uplift of about £1,500 in 2014, otherwise the costs of these policies are the same as the BR baseline.

Policies 3 and 4 however show cost uplifts of approximately £3,000 and £8,000 respectively in 2011 and approximately £5,000 for both in 2013.

From 2017 onwards, a mixture of energy efficiency, biomass heating, PV and allowable solutions would be needed to comply with BR. The selection of biomass heating for this type of development is based on an assumption that there is no limitation imposed by air quality requirements.

Policy 5 has not been tested for this case study.

DOMESTIC Case Study 4	Year*	BR Baseline	Policy 1 – BR+10%	Policy 2 – BR+15%	Policy 3 – Code+1	Policy 4 – Code+2
Technology Option	2011	Solar Water Heating + EE1	Solar Water Heating + EE1	Solar Water Heating + EE1	PV - maximum installation + EE1	Biomass heating + PV (medium) + EE1 + Allowable Solutions Contribution
	2014	PV - maximum installation + EE1	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + PV (medium) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (medium) + EE1 + Allowable Solutions Contribution
	2017	Biomass heating + PV (medium) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (medium) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (medium) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (medium) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (medium) + EE1 + Allowable Solutions Contribution
Technically Viable?		**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
% CO_2 saving uplift (regulated emissions, over PtL2006)	2011	42%	42%	42%	48%	70%
	2014	48%	53%	53%	70%	70%
	2017	70%	70%	70%	70%	70%
£/dwelling uplift over BR Baseline	2011	0	0	0	2,970	8,073
	2014	0	1,518	1,518	5,103	5,103
	2017	0	0	0	0	0
£/tonne CO_2 uplift	2011	0	0	0	37,421	22,645
	2014	0	25,911	25,911	18,413	18,413
	2017	0	0	0	0	0

Table 9.5 - Case Study4 Results Summary

9.8 Case Study 5

- Development type: Housing – small rural
- Development size: 10 houses
- Source: Local authority

Discussion

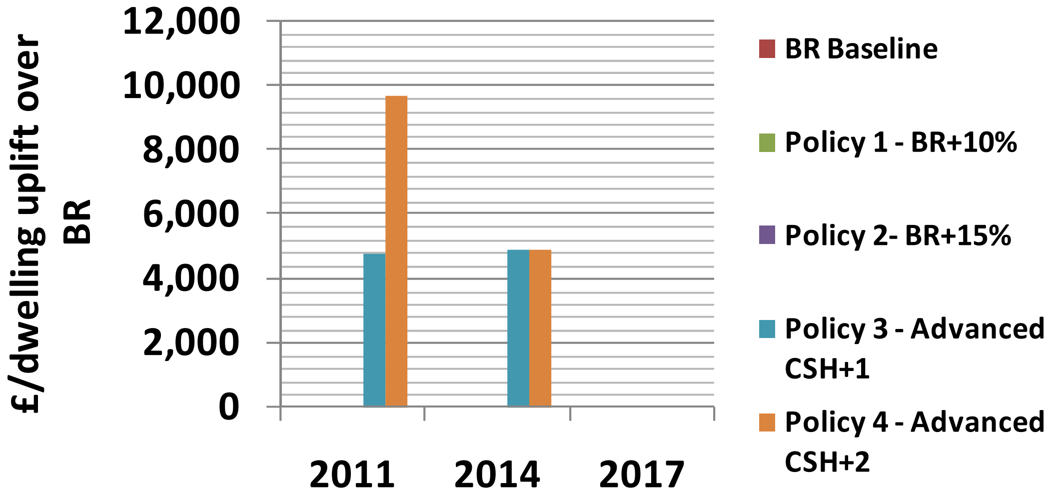

Figure 9.6a capital cost uplift of Policy Options above BR baseline (Case Study 5)

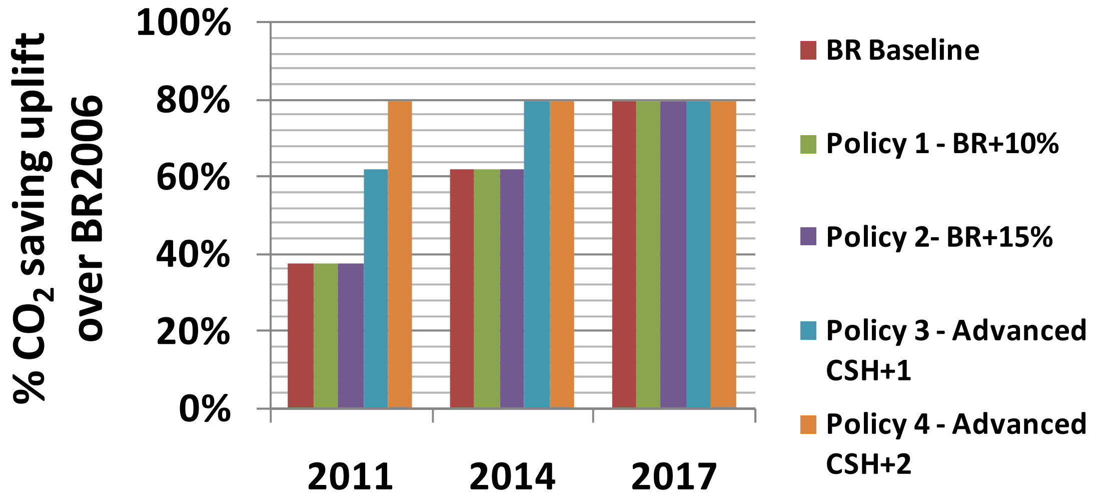

Figure 9.6b %CO_2 saving above BR 2006

Policies 1 and 2 show no cost uplift over BR for all years modelled (since the CO_2 savings are the same as BR 2006 which is a legal minimum requirement) whereas Policy 3 shows a cost uplift over BR of approximately £5,000 per dwelling in 2014 and 2014. Although there is no cost uplift over BR for Policies 1 and 2, there is also no additional benefit in terms of CO_2 reduction.

Policy 4 shows a cost uplift of approximately £9,000 and £5,000 respectively in 2011 and 2014.

From 2017 onwards, a mixture of energy efficiency, biomass heating, PV and allowable solutions would be needed to comply with BR.

The selection of biomass heating for this type of development is based on an assumption that there is no limitation imposed by air quality requirements.

Policy 5 has not been tested for this case study.

DOMESTIC Case Study5	Year*	BR Baseline	Policy 1 – BR+10%	Policy 2 – BR+15%	Policy 3 – Code+1	Policy 4 – Code+2
Technology Option	2011	Solar Water Heating + EE1	Solar Water Heating + EE1	Solar Water Heating + EE1	Biomass heating + EE1	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution
	2014	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution
	2017	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution
Technically Viable?		Yes	Yes	Yes	Yes	Yes
% CO_2 saving uplift (regulated emissions, over PtL2006)	2011	38%	38%	38%	62%	80%
	2014	62%	62%	62%	80%	80%
	2017	80%	80%	80%	80%	80%
£/dwelling uplift over BR Baseline	2011	0	0	0	4,793	9,725
	2014	0	0	0	4,931	4,931
	2017	0	0	0	0	0
£/tonne CO_2 uplift	2011	0	0	0	11,761	13,800
	2014	0	0	0	16,596	16,596
	2017	0	0	0	0	0

Table 9.6 - Case Study5 Results Summary

9.9 Case Study 6

- Development type: Housing – small city infill
- Development size: 10 houses
- Source: Local authority

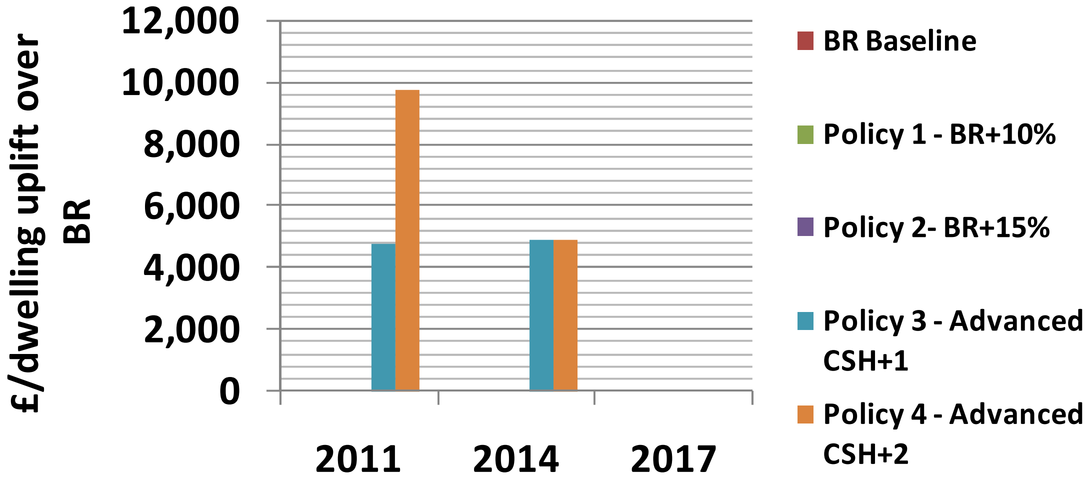

Figure 9.7a -capital cost uplift of Policy Options above BR baseline (Case Study 6)

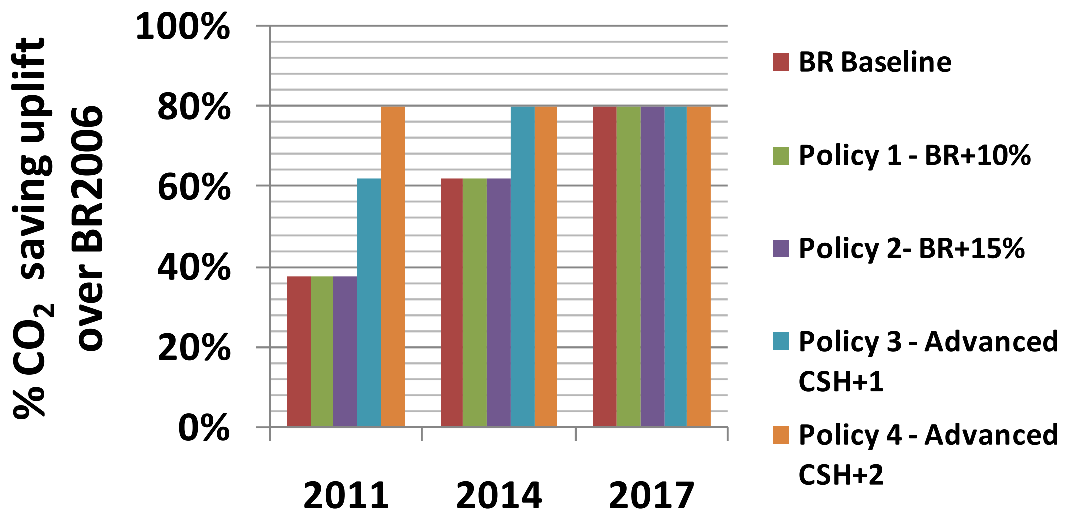

Figure 9.7b-%CO_2 saving above BR 2006

Discussion

Policies 1 and 2 show no cost uplift over BR for all years modelled (since the CO_2 savings are the same as BR 2006 which is a legal minimum requirement) whereas Policy 3 shows a cost uplift over BR of approximately £5,000 per dwelling in 2014 and 2014. Although there is no cost uplift over BR for Policies 1 and 2, there is also no additional benefit in terms of CO_2 reduction.

Policy 4 shows a cost uplift of approximately £9,000 and £5,000 respectively in 2011 and 2014. Policy 5 has not been tested for this case study.

The selection of biomass heating for this type of development is based on an assumption that there is no limitation imposed by air quality requirements.

From 2017 onwards, a mixture of energy efficiency, biomass heating, PV and allowable solutions would be needed to comply with BR.

DOMESTIC Case Study6	Year*	BR Baseline	Policy 1 – BR+10%	Policy 2 – BR+15%	Policy 3 – Code+1	Policy 4 – Code+2	Policy 5 – % Renewables mandatory
Technology Option	2011	Solar Water Heating + EE1	Solar Water Heating + EE1	Solar Water Heating + EE1	PV - maximum installation + EE1	Biomass heating + PV (medium) + EE1 + Allowable Solutions Contribution	Solar Water Heating + EE1
	2014	PV - maximum installation + EE1	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + PV (medium) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (medium) + EE1 + Allowable Solutions Contribution	PV - maximum installation + EE1
	2017	Biomass heating + PV (medium) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (medium) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (medium) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (medium) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (medium) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (medium) + EE1 + Allowable Solutions Contribution
Technically Viable?		Yes	Yes	Yes	Yes	Yes	Yes
% CO_2 saving uplift (regulated emissions, over PtL2006)	2011	42%	42%	42%	48%	70%	42%
	2014	48%	53%	53%	70%	70%	48%
	2017	70%	70%	70%	70%	70%	70%
£/dwelling uplift over BR Baseline	2011	0	0	0	2,970	7,133	0
	2014	0	1,518	1,518	4,163	4,163	0
	2017	0	0	0	0	0	0
£/tonne CO_2 uplift	2011	0	0	0	37,421	20,008	0
	2014	0	25,911	25,911	15,022	15,022	0
	2017	0	0	0	0	0	0

Table 9.7 - Case Study6 Results Summary

Case Study 7

- Development type: Housing – medium mixed rural
- Development size: 50 flats and houses (25 flats and 25 houses)
- Source: Local authority

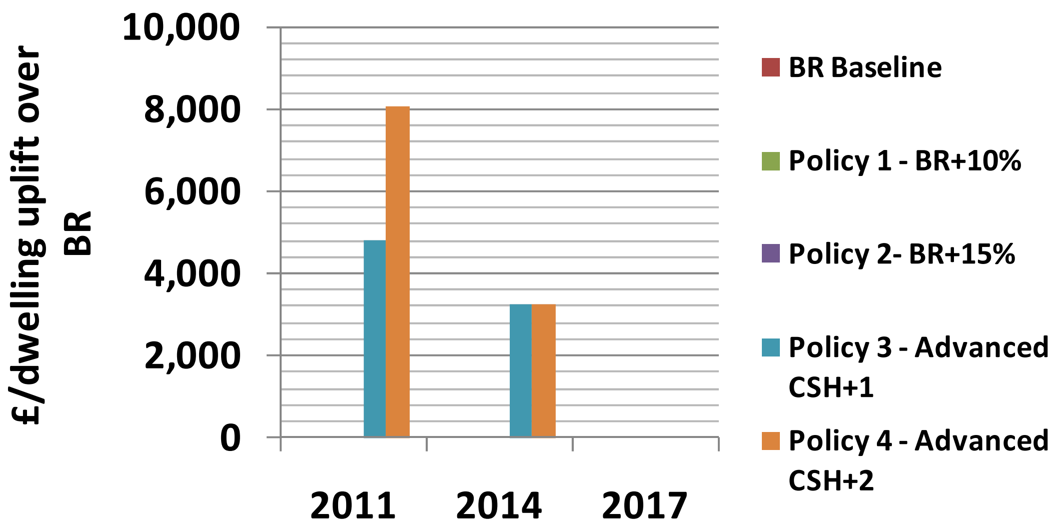

Figure 9.8a- capital cost uplift of Policy Options above BR baseline (Case Study 7)

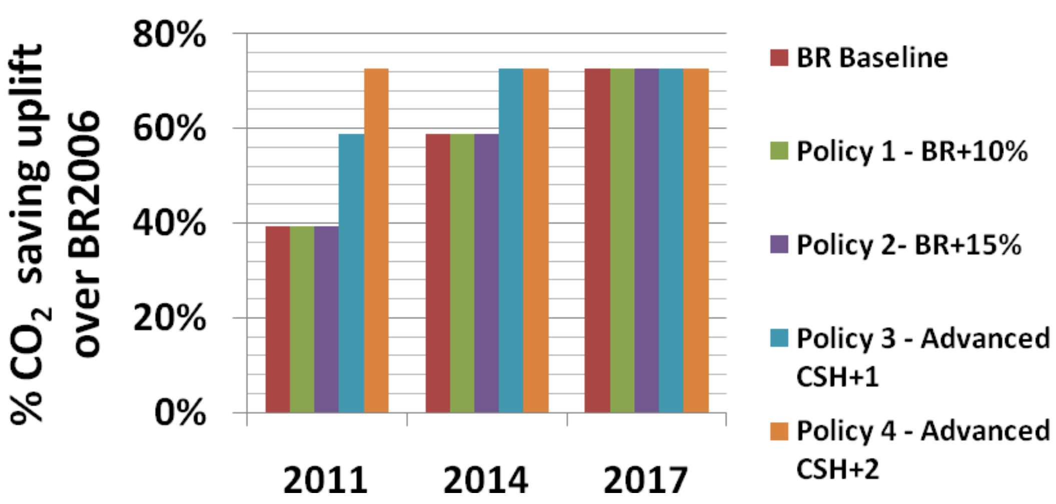

Figure 9.8b %CO_2 saving above BR 2006

Discussion

Policies 1 and 2 show no cost uplift over BR for all years modelled (since the CO_2 savings are the same as BR 2006 which is a legal minimum requirement) whereas Policy 3 shows a cost uplift over BR of approximately £5,000 per dwelling in 2011 and £3,000 per dwelling in 2014. Although there is no cost uplift over BR for Policies 1&2, there is likely to be no significant benefit in terms of CO_2 reduction.

Policy 4 shows a cost uplift of approximately £8,000 and £3,000 respectively in 2011 and 2014. Policy 5 has not been tested for this case study.

The selection of biomass heating for this type of development is based on an assumption that there is no limitation imposed by air quality requirements.

From 2017 onwards, a mixture of energy efficiency, biomass heating, PV and allowable solutions would be needed to comply with BR.

DOMESTIC Case Study7	Year*	BR Baseline	Policy 1 – BR+10%	Policy 2 – BR+15%	Policy 3 – Code+1	Policy 4 – Code+2
Technology Option	2011	Solar Water Heating + EE1	Solar Water Heating + EE1	Solar Water Heating + EE1	Biomass heating + EE1	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution
	2014	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution
	2017	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution
Technically Viable?		Yes	Yes	Yes	Yes	Yes
% CO_2 saving uplift (regulated emissions, over PtL2006)	2011	39%	39%	39%	59%	73%
	2014	59%	59%	59%	73%	73%
	2017	73%	73%	73%	73%	73%
£/dwelling uplift over BR Baseline	2011	0	0	0	4,809	8,063
	2014	0	0	0	3,254	3,254
	2017	0	0	0	0	0
£/tonne CO_2 uplift	2011	0	0	0	16,225	15,970
	2014	0	0	0	15,607	15,607
	2017	0	0	0	0	0

Table 9.8 - Case Study7 Results Summary

9.10 Case Study 8

- Development type: Housing – medium urban
- Development size: 50 flats and houses (25 flats and 25 houses)
- Source: Local authority

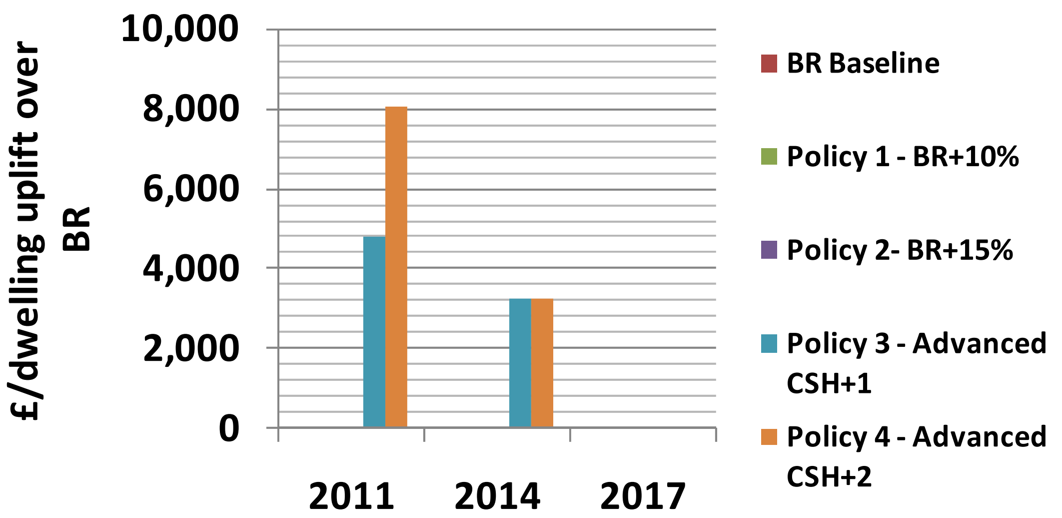

Figure 9.9a- capital cost uplift of Policy Options above BR baseline (Case Study 8)

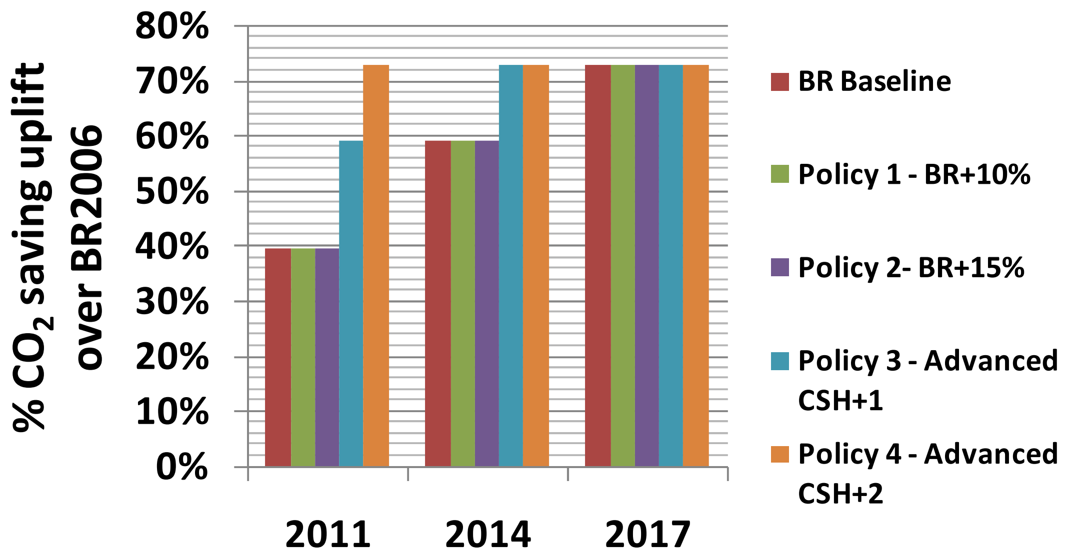

Figure 9.9b- %CO_2 saving above BR 2006

Discussion

Policies 1 and 2 show no cost uplift over BR for all years modelled (since the CO_2 savings are the same as BR 2006 which is a legal minimum requirement) whereas Policy 3 shows a cost uplift over BR of approximately £5,000 per dwelling in 2011 and £3,000 per dwelling in 2014. Although there is no cost uplift over BR for Policies 1 and 2, there is also likely to be no significant additional benefit in terms of CO_2 reduction.

Policy 4 shows a cost uplift of approximately £8,000 and £3,000 respectively in 2011 and 2014. Policy 5 has not been tested for this case study.

The selection of biomass heating for this type of development is based on an assumption that there is no limitation imposed by air quality requirements.

From 2017 onwards, a mixture of energy efficiency, biomass heating, PV and allowable solutions would be needed to comply with BR

DOMESTIC Case Study8	Year*	BR Baseline	Policy 1 – BR+10%	Policy 2 – BR+15%	Policy 3 – Code+1	Policy 4 – Code+2
Technology Option	2011	Solar Water Heating + EE1	Solar Water Heating + EE1	Solar Water Heating + EE1	Biomass heating + EE1	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution
	2014	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution
	2017	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution
Technically Viable?		Yes	Yes	Yes	Yes	Yes
% CO_2 saving uplift (regulated emissions, over PtL2006)	2011	39%	39%	39%	59%	73%
	2014	59%	59%	59%	73%	73%
	2017	73%	73%	73%	73%	73%
£/dwelling uplift over BR Baseline	2011	0	0	0	4,809	8,063
	2014	0	0	0	3,254	3,254
	2017	0	0	0	0	0
£/tonne CO_2 uplift	2011	0	0	0	16,225	15,970
	2014	0	0	0	15,607	15,607
	2017	0	0	0	0	0

Table 9.9 - Case Study8 Results Summary

9.11 Case Study 9

- Development type: Housing – medium mixed urban
- Development size: 350 flats and houses
- Source: Local authority

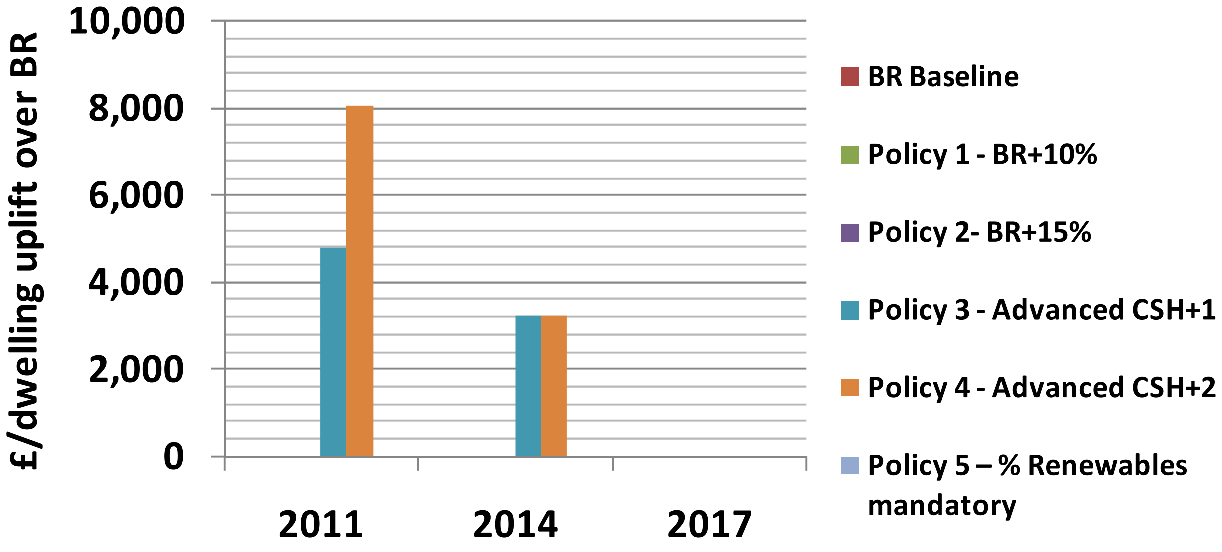

Figure 9.10a- capital cost uplift of Policy Options above BR baseline (Case Study 9)

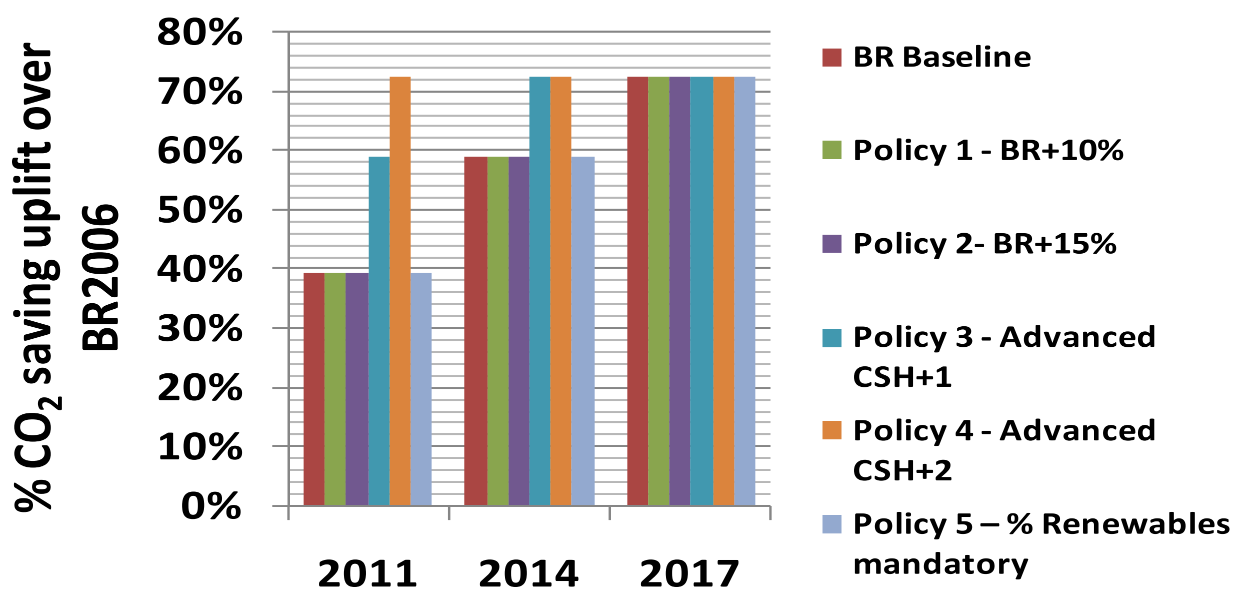

Figure 9.10b- %CO_2 saving above BR 2006

Discussion

Policies 1 and 2 show no cost uplift over BR for all years modelled (since the CO_2 savings are the same as BR 2006 which is a legal minimum requirement) whereas Policy 3 shows a cost uplift over BR of approximately £5,000 per dwelling in 2011 and £3,000 per dwelling in 2014. Although there is no cost uplift over BR for Policies 1 and 2, there is also likely to be no significant additional benefit in terms of CO_2 reduction.

Policy 4 shows a cost uplift of approximately £8,000 and £3,000 respectively in 2011 and 2014.

The selection of biomass heating for this type of development is based on an assumption that there is no limitation imposed by air quality requirements.

From 2017 onwards, a mixture of energy efficiency, biomass heating, PV and allowable solutions would be needed to comply with BR

DOMESTIC Case Study9	Year*	BR Baseline	Policy 1 – BR+10%	Policy 2 – BR+15%	Policy 3 – Code+1	Policy 4 – Code+2	Policy 5 – % Renewables mandatory
Technology Option	2011	Solar Water Heating + EE1	Solar Water Heating + EE1	Solar Water Heating + EE1	Biomass heating + EE1	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution	Solar Water Heating + EE1
	2014	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution	Biomass heating + EE1
	2017	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution
Technically Viable?		Yes	Yes	Yes	Yes	Yes	Yes
% CO_2 saving uplift (regulated emissions, over PtL2006)	2011	39%	39%	39%	59%	73%	39%
	2014	59%	59%	59%	73%	73%	59%
	2017	73%	73%	73%	73%	73%	73%
£/dwelling uplift over BR Baseline	2011	0	0	0	4,809	8,063	0
	2014	0	0	0	3,254	3,254	0
	2017	0	0	0	0	0	0
£/tonne CO_2 uplift	2011	0	0	0	16,225	15,970	0
	2014	0	0	0	15,607	15,607	0
	2017	0	0	0	0	0	0

Table 9.10 - Case Study9 Results Summary

9.12 Case Study 10

- Development type: Urban office development
- Development size: 100 sqm
- Source: Notional

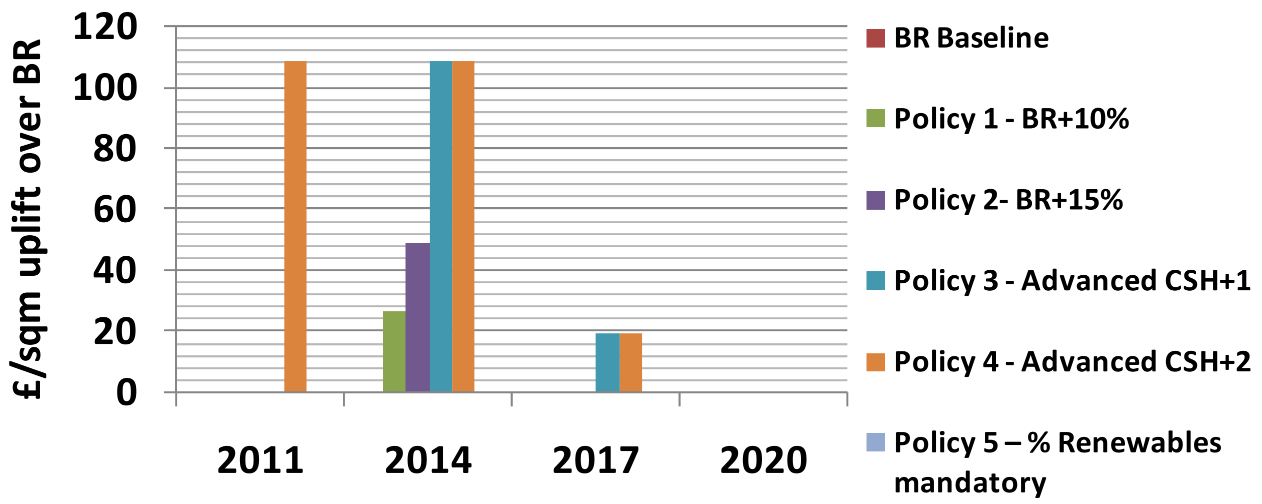

Figure 9.11a capital cost uplift of Policy Options above BR baseline (Case Study 10)

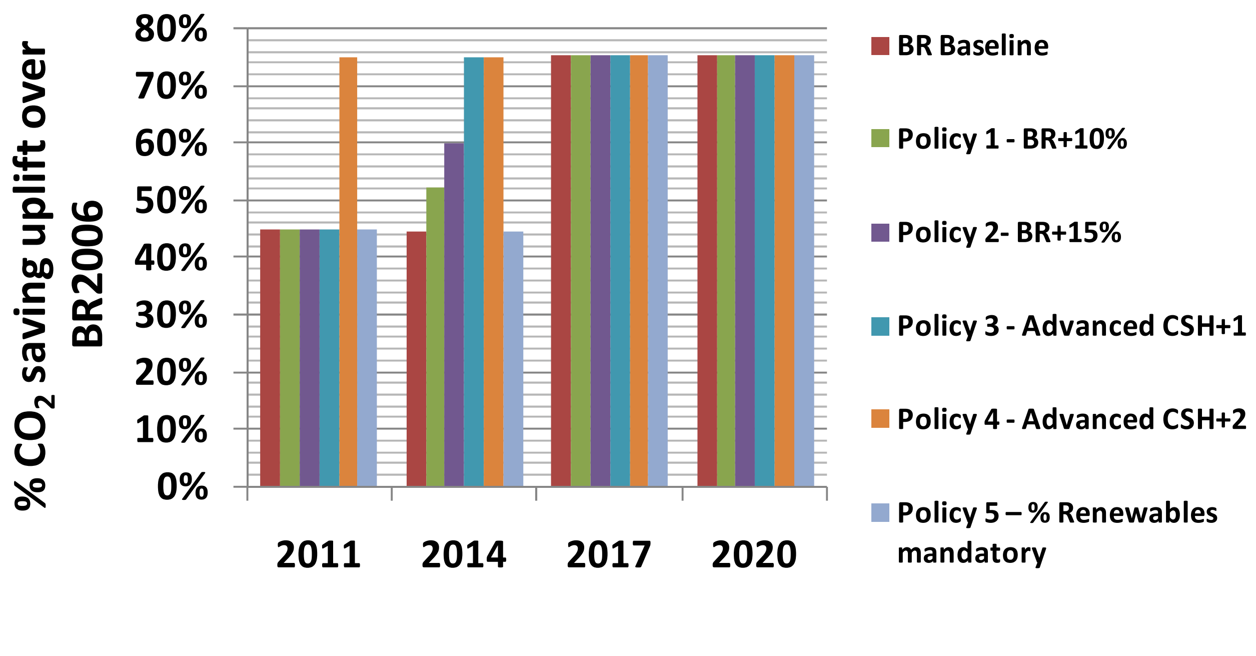

Figure 9.11b %CO_2 saving above BR 2006

Discussion

In 2011, Policies 1, 2 and 3 have no cost uplift over the BR baseline (since the CO_2 savings are the same as BR 2006 which is a legal minimum requirement) whereas Policy 4 has a cost uplift of £110 per sqm.

In 2014, the cost uplift increases as the required CO_2 reduction increases, up to a cost uplift of £110 per sqm for Policies 3 and 4. Policy 5 shows no cost uplift over BR for any of the years modelled. This is because a renewable or low carbon technology makes a significant contribution to meeting BR in the years up to 2020.

In 2017 only Policies 3 and 4 show a cost uplift over BR (£20 per sqm). The selection of biomass heating for this type of development is based on an assumption that there is no limitation imposed by air quality requirements. From 2017 onwards, a mixture of energy efficiency, biomass heating, PV and allowable solutions would be needed to comply with BR.

Non Domestic Case Study10	Year*	BR Baseline	Policy 1 – BR+10%	Policy 2 – BR+15%	Policy 3 – Code+1	Policy 4 – Code+2	Policy 5 – % Renewables mandatory
Technology Option	2011	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + PV (maximum) + EE1 + Allowable Solutions	Biomass heating + EE1
	2014	Biomass heating + EE1	Biomass heating + PV (minimum) + EE1	Biomass heating + PV (medium) + EE1	Biomass heating + PV (maximum) + EE1 + Allowable Solutions	Biomass heating + PV (maximum) + EE1 + Allowable Solutions	Biomass heating + EE1
	2017	Biomass heating + PV (maximum) + EE1	Biomass heating + PV (maximum) + EE1	Biomass heating + PV (maximum) + EE1	Biomass heating + PV (maximum) + EE1 + Allowable Solutions	Biomass heating + PV (maximum) + EE1 + Allowable Solutions	Biomass heating + PV (maximum) + EE1
	2020	Biomass heating + PV (maximum) + EE1 + Allowable Solutions	Biomass heating + PV (maximum) + EE1 + Allowable Solutions	Biomass heating + PV (maximum) + EE1 + Allowable Solutions	Biomass heating + PV (maximum) + EE1 + Allowable Solutions	Biomass heating + PV (maximum) + EE1 + Allowable Solutions	Biomass heating + PV (maximum) + EE1 + Allowable Solutions
Technically Viable?		Yes	Yes	Yes	Yes	Yes	Yes
% CO_2 saving uplift (regulated emissions, over PtL2006)	2011	45%	45%	45%	45%	75%	45%
	2014	45%	52%	60%	75%	75%	45%
	2017	75%	75%	75%	75%	75%	75%
	2020	75%	75%	75%	75%	75%	75%
£/sqm uplift over BR Baseline	2011	0	0	0	0	109	0
	2014	0	27	49	109	109	0
	2017	0	0	0	20	20	0
	2020	0	0	0	0	0	0
£/tonne CO_2 uplift	2011	0	0	0	0	13,416	0
	2014	0	13,204	12,104	13,416	13,416	0
	2017	0	0	0	0	0	0
	2020	0	0	0	0	0	0

Table 9.11 - Case Study10 Results Summary

9.13 Case Study 11

- Development type: Urban office development
- Development size: 1,000 sqm
- Source: Notional

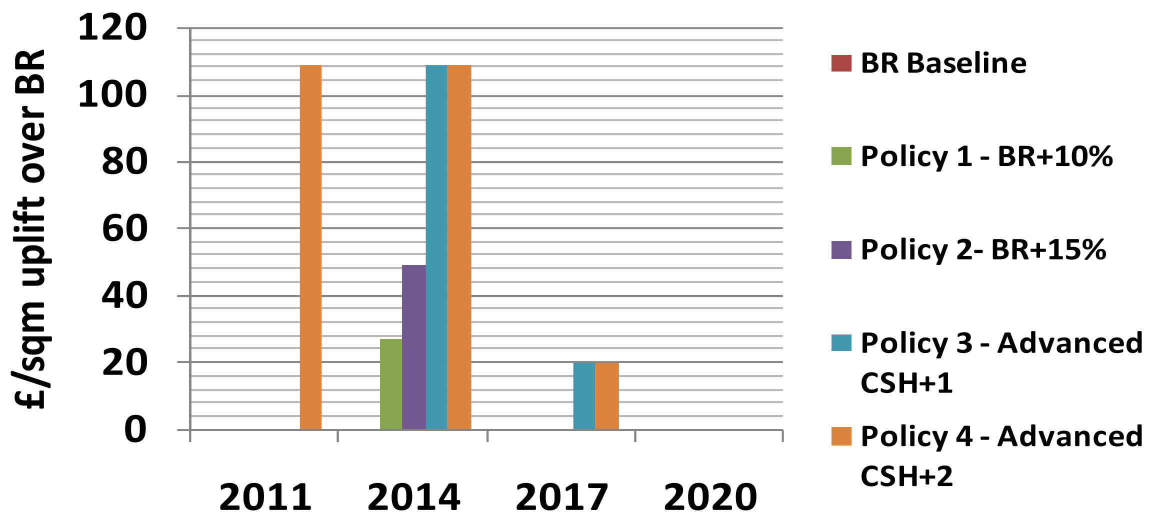

Figure 9.12a capital cost uplift of Policy Options above BR baseline (Case Study 11)

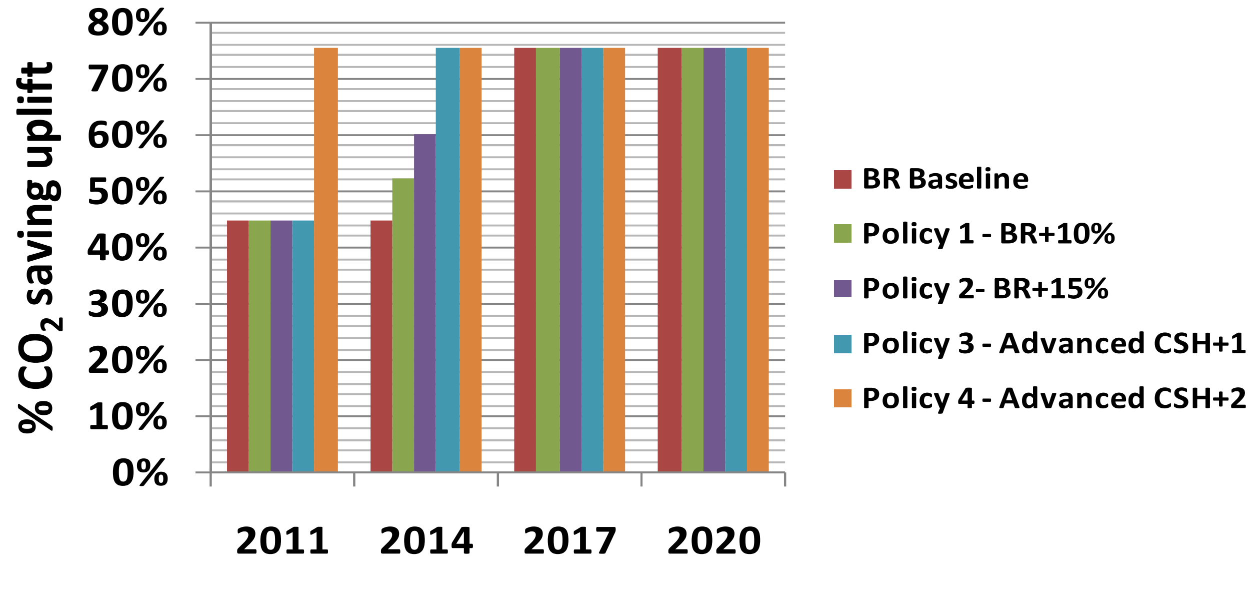

Figure 9.12b %CO_2 saving above BR 2006

Discussion

In 2011, Policies 1, 2 and 3 have no cost uplift over the BR baseline (since the CO_2 savings are the same as BR 2006 which is a legal minimum requirement) whereas Policy 4 has a cost uplift of £110 per sqm.

In 2014, the cost uplift increases as the required CO_2 reduction increases, up to a cost uplift of £110 per sqm for Policies 3 and 4. Policy 5 shows no cost uplift over BR for any of the years modelled. This is because a renewable or low carbon technology makes a significant contribution to meeting BR in the years up to 2020.

In 2017 only Policies 3 and 4 show a cost uplift over BR (£20 per sqm). Policy 5 has not been tested for this case study.

The selection of biomass heating for this type of development is based on an assumption that there is no limitation imposed by air quality requirements.

From 2017 onwards, a mixture of energy efficiency, biomass heating, PV and allowable solutions would be needed to comply with BR.

Non Domestic Case Study11	Year*	BR Baseline	Policy 1 – BR+10%	Policy 2 – BR+15%	Policy 3 – Code+1	Policy 4 – Code+2
Technology Option	2011	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + PV (maximum) + EE1 + Allowable Solutions
	2014	Biomass heating + EE1	Biomass heating + PV (minimum) + EE1	Biomass heating + PV (medium) + EE1	Biomass heating + PV (maximum) + EE1 + Allowable Solutions	Biomass heating + PV (maximum) + EE1 + Allowable Solutions
	2017	Biomass heating + PV (maximum) + EE1	Biomass heating + PV (maximum) + EE1	Biomass heating + PV (maximum) + EE1	Biomass heating + PV (maximum) + EE1 + Allowable Solutions	Biomass heating + PV (maximum) + EE1 + Allowable Solutions
	2020	Biomass heating + PV (maximum) + EE1 + Allowable Solutions	Biomass heating + PV (maximum) + EE1 + Allowable Solutions	Biomass heating + PV (maximum) + EE1 + Allowable Solutions	Biomass heating + PV (maximum) + EE1 + Allowable Solutions	Biomass heating + PV (maximum) + EE1 + Allowable Solutions
Technically Viable?		Yes	Yes	Yes	Yes	Yes
% CO_2 saving uplift (regulated emissions, over PtL2006)	2011	45%	45%	45%	45%	75%
	2014	45%	52%	60%	75%	75%
	2017	75%	75%	75%	75%	75%
	2020	75%	75%	75%	75%	75%
£/sqm uplift over BR Baseline	2011	0	0	0	0	109
	2014	0	27	49	109	109
	2017	0	0	0	20	20
	2020	0	0	0	0	0
£/tonne CO_2 uplift	2011	0	0	0	0	13,418
	2014	0	13,204	12,104	13,418	13,418
	2017	0	0	0	0	0
	2020	0	0	0	0	0

Table 9.12 - Case Study11 Results Summary

9.14 Case Study 12

- Development type: Urban office development
- Development size: 8,000 sqm
- Source: Local authority

Discussion

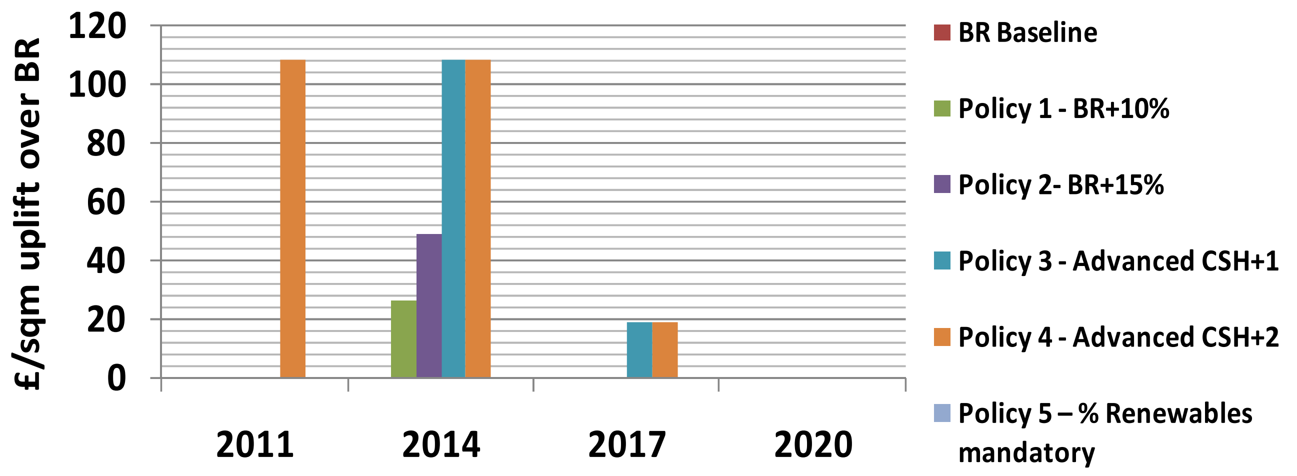

Figure 9.13a capital cost uplift of Policy Options above BR baseline (Case Study 12)

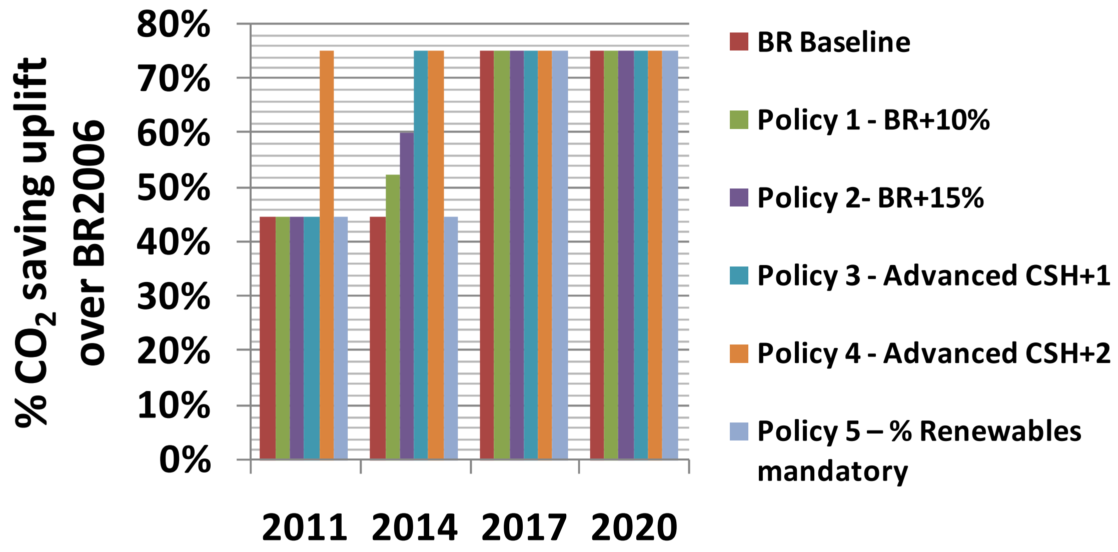

Figure 9.13b %CO_2 saving above BR 2006

In 2011, Policies 1, 2 and 3 have no cost uplift over the BR baseline (since the CO_2 savings are the same as BR 2006 which is a legal minimum requirement) whereas Policy 4 has a cost uplift of £90 per sqm.

In 2014, the cost uplift increases as the required CO_2 reduction increases, up to a cost uplift of £110 per sqm for Policies 3 and 4. Policy 5 shows no cost uplift over BR for any of the years modelled. This is because a renewable or low carbon technology makes a significant contribution to meeting BR in the years up to 2020.

In 2017 only Policies 3 and 4 show a cost uplift over BR (£20 per sqm).

The selection of biomass heating for this type of development is based on an assumption that there is no limitation imposed by air quality requirements.

From 2017 onwards, a mixture of energy efficiency, biomass heating, PV and allowable solutions would be needed to comply with BR.

Non Domestic Case Study12	Year*	BR Baseline	Policy 1 – BR+10%	Policy 2 – BR+15%	Policy 3 – Code+1	Policy 4 – Code+2	Policy 5 – % Renewables mandatory
Technology Option	2011	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + PV (maximum) + EE1 + Allowable Solutions	Biomass heating + EE1
	2014	Biomass heating + EE1	Biomass heating + PV (minimum) + EE1	Biomass heating + PV (medium) + EE1	Biomass heating + PV (maximum) + EE1 + Allowable Solutions	Biomass heating + PV (maximum) + EE1 + Allowable Solutions	Biomass heating + EE1
	2017	Biomass heating + PV (maximum) + EE1	Biomass heating + PV (maximum) + EE1	Biomass heating + PV (maximum) + EE1	Biomass heating + PV (maximum) + EE1 + Allowable Solutions	Biomass heating + PV (maximum) + EE1 + Allowable Solutions	Biomass heating + PV (maximum) + EE1
	2020	Biomass heating + PV (maximum) + EE1 + Allowable Solutions	Biomass heating + PV (maximum) + EE1 + Allowable Solutions	Biomass heating + PV (maximum) + EE1 + Allowable Solutions	Biomass heating + PV (maximum) + EE1 + Allowable Solutions	Biomass heating + PV (maximum) + EE1 + Allowable Solutions	Biomass heating + PV (maximum) + EE1 + Allowable Solutions
Technically Viable?		Yes	Yes	Yes	Yes	Yes	Yes
% CO_2 saving uplift (regulated emissions, over PtL2006)	2011	45%	45%	45%	45%	75%	45%
	2014	45%	52%	60%	75%	75%	45%
	2017	75%	75%	75%	75%	75%	75%
	2020	75%	75%	75%	75%	75%	75%
£/sqm uplift over BR Baseline	2011	0	0	0	0	109	0
	2014	0	27	49	109	109	0
	2017	0	0	0	20	20	0
	2020	0	0	0	0	0	0
£/tonne CO_2 uplift	2011	0	0	0	0	13,418	0
	2014	0	13,204	12,104	13,418	13,418	0
	2017	0	0	0	0	0	0
	2020	0	0	0	0	0	0

Table 9.13 - Case Study12 Results Summary

9.15 Case Study 13

- Development type: Medium Mixed commercial development
- Development size: 4,000 sqm of B1,B2 and B8 uses
- Source: Local authority

Discussion

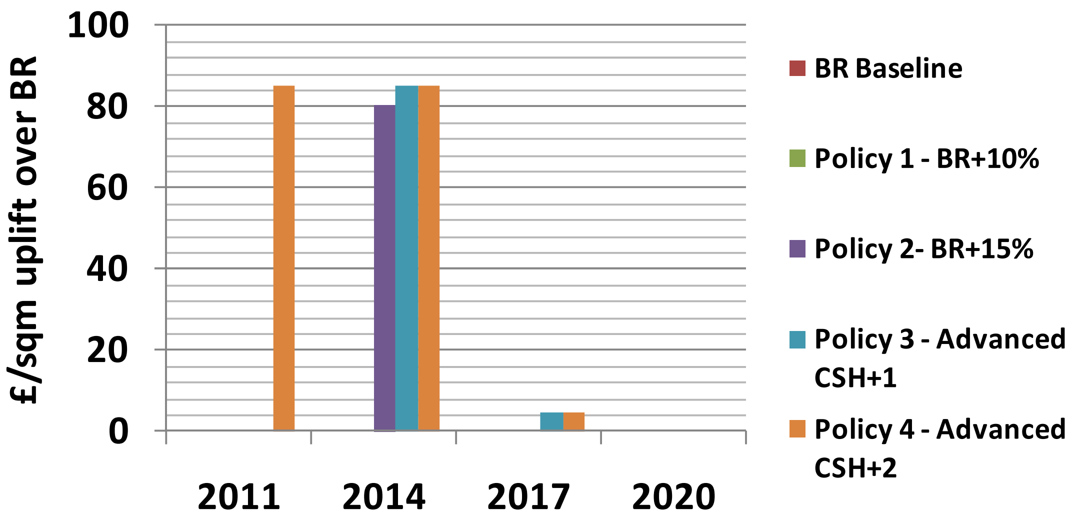

Figure 9.14a capital cost uplift of Policy Options above BR baseline (Case Study 13)

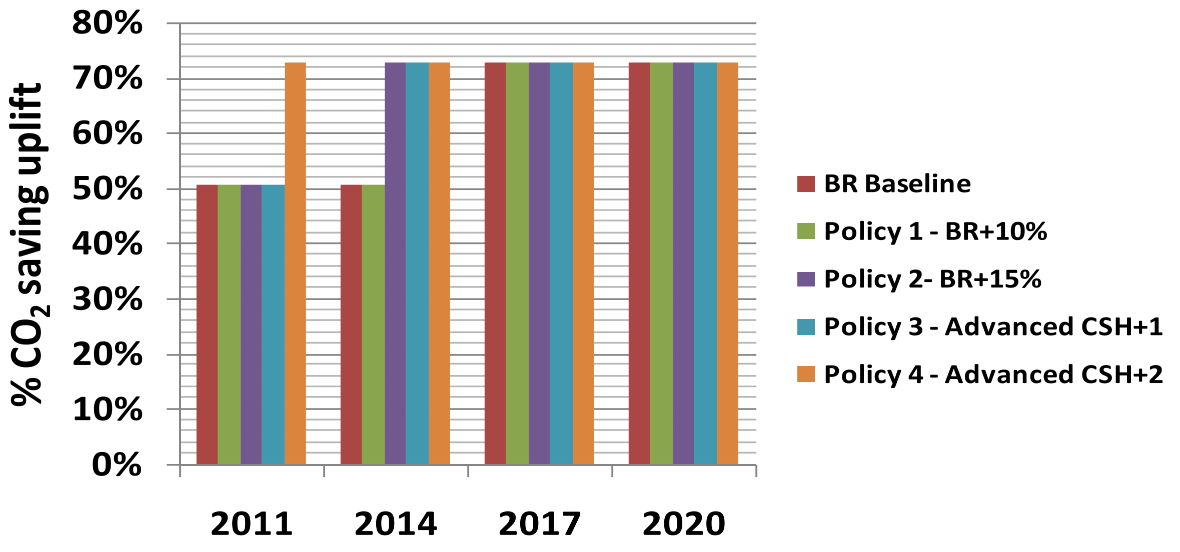

Figure 9.14b- %CO_2 saving above BR 2006

In 2011, Policies 1, 2 and 3 have no cost uplift over the BR baseline (since the CO_2 savings are the same as BR 2006 which is a legal minimum requirement) whereas Policy 4 has a cost uplift of £90 per sqm.

In 2014, Policy 1 has no cost uplift, while Policies 2, 3 and 4 have a similar cost uplift (approx. £90 per sqm).

In 2017 only Policies 3 and 4 show a cost uplift over BR (£5 per sqm).

The selection of biomass heating for this type of development is based on an assumption that there is no limitation imposed by air quality requirements.

From 2020 onwards, a mixture of energy efficiency, biomass heating, PV and allowable solutions would be needed to comply with BR.

Non Domestic Case Study13	Year*	BR Baseline	Policy 1 – BR+10%	Policy 2 – BR+15%	Policy 3 – Code+1	Policy 4 – Code+2
Technology Option	2011	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + PV (minimum) + EE1 + Allowable Solutions
	2014	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + PV (minimum) + EE1	Biomass heating + PV (minimum) + EE1 + Allowable Solutions	Biomass heating + PV (minimum) + EE1 + Allowable Solutions
	2017	Biomass + PV (min)	Biomass + PV (min)	Biomass + PV (min)	Biomass heating + PV (minimum) + EE1 + Allowable Solutions	Biomass heating + PV (minimum) + EE1 + Allowable Solutions
	2020	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (minimum) + EE1 + Allowable Solutions	Biomass heating + PV (minimum) + EE1 + Allowable Solutions	Biomass heating + PV (minimum) + EE1 + Allowable Solutions	Biomass heating + PV (minimum) + EE1 + Allowable Solutions
Technically Viable?		Yes	Yes	Yes	Yes	Yes
% CO_2 saving uplift (regulated emissions, over PtL2006)	2011	51%	51%	51%	51%	73%
	2014	51%	51%	73%	73%	73%
	2017	73%	73%	73%	73%	73%
	2020	73%	73%	73%	73%	73%
£/sqm uplift over BR Baseline	2011	0	0	0	0	85
	2014	0	0	80	85	85
	2017	0	0	0	5	5
	2020	0	0	0	0	0
£/tonne CO_2 uplift	2011	0	0	0	0	14,025
	2014	0	0	13,204	14,025	14,025
	2017	0	0	0	0	0
	2020	0	0	0	0	0

Table 9.14 - Case Study13 Results Summary

9.16 Case Study 14

- Development type: Large Mixed commercial development
- Development size: 35,000 sqm of retail, leisure, catering
- Source: Local authority

Discussion

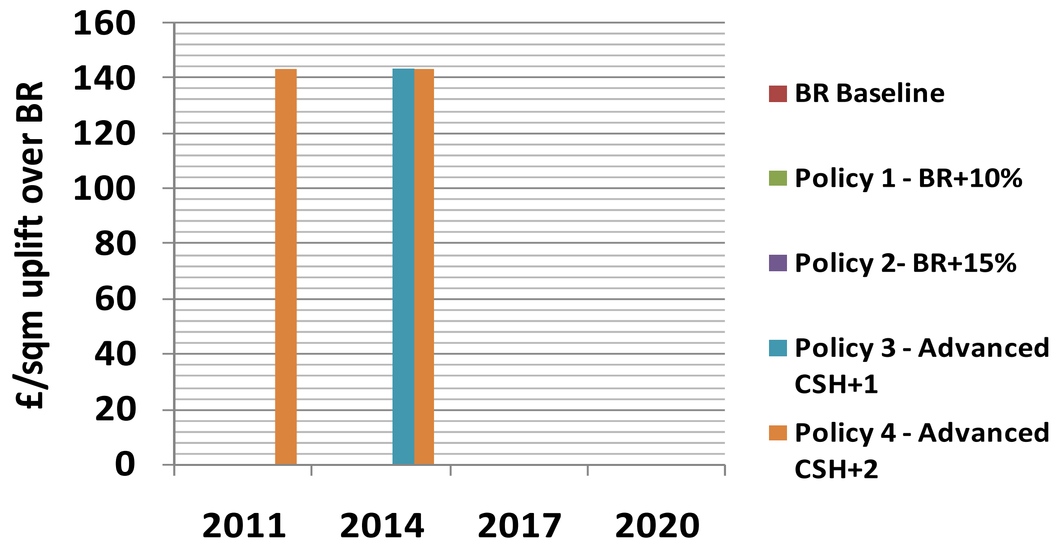

Figure 9.15a capital cost uplift of Policy Options above BR baseline (Case Study 14)

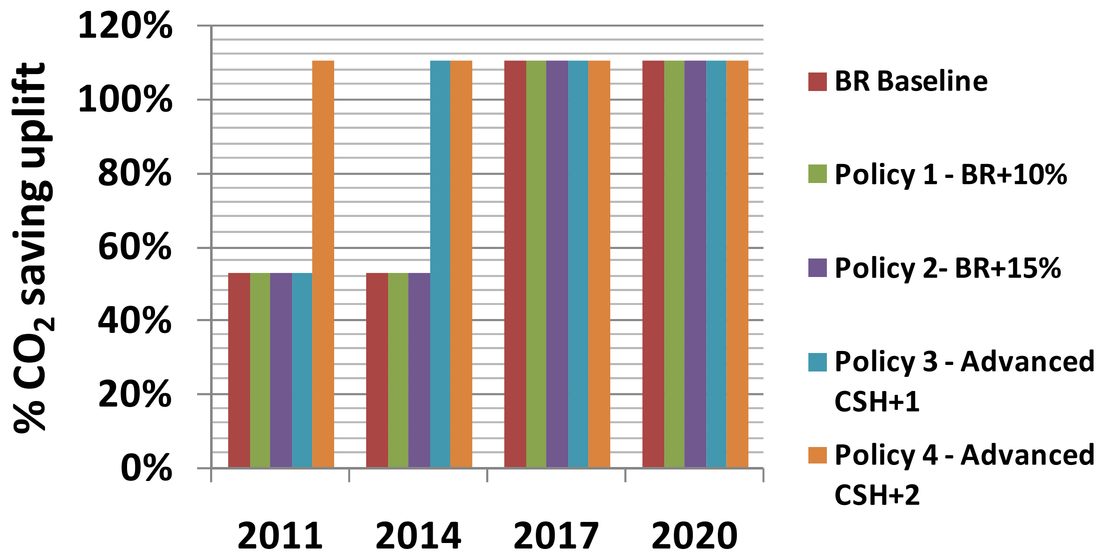

Figure 9.15b %CO_2 saving above BR 2006

In 2011, Policies 1, 2 and 3 have no cost uplift over the BR baseline (since the CO_2 savings are the same as BR 2006 which is a legal minimum requirement) whereas Policy 4 has a cost uplift of £140 per sqm.

In 2014, Policies 1 and 2 have no cost uplift, while Policies 3 and 4 have a similar cost uplift (approx. £140 per sqm).

In 2017 all Policies cost the same to achieve as the BR baseline.

The selection of biomass heating for this type of development is based on an assumption that there is no limitation imposed by air quality requirements.

From 2020 onwards, a mixture of energy efficiency, gas CHP with biomass backup, PV and allowable solutions would be needed to comply with BR.

Non Domestic Case Study14	Year*	BR Baseline	Policy 1 – BR+10%	Policy 2 – BR+15%	Policy 3 – Code+1	Policy 4 – Code+2
Technology Option	2011	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + EE1	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1
	2014	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + EE1	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1
	2017	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1
	2020	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1 + Allowable Solutions Contribution	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1 + Allowable Solutions Contribution	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1 + Allowable Solutions Contribution	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1 + Allowable Solutions Contribution	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1 + Allowable Solutions Contribution
Technically Viable?		**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
% CO_2 saving uplift (regulated emissions, over PtL2006)	2011	52%	52%	52%	52%	110%
	2014	52%	52%	52%	110%	110%
	2017	110%	110%	110%	110%	110%
	2020	110%	110%	110%	110%	110%
£/sqm uplift over BR Baseline	2011	0	0	0	0	143
	2014	0	0	0	143	143
	2017	0	0	0	0	0
	2020	0	0	0	0	0
£/tonne CO_2 uplift	2011	0	0	0	0	4,110
	2014	0	0	0	4,110	4,110
	2017	0	0	0	0	0
	2020	0	0	0	0	0

Table 9.15 - Case Study14 Results Summary

9.17 Case Study 15

- Development type: Large Industrial development
- Development size: 100,000 sqm
- Source: Local authority

Discussion

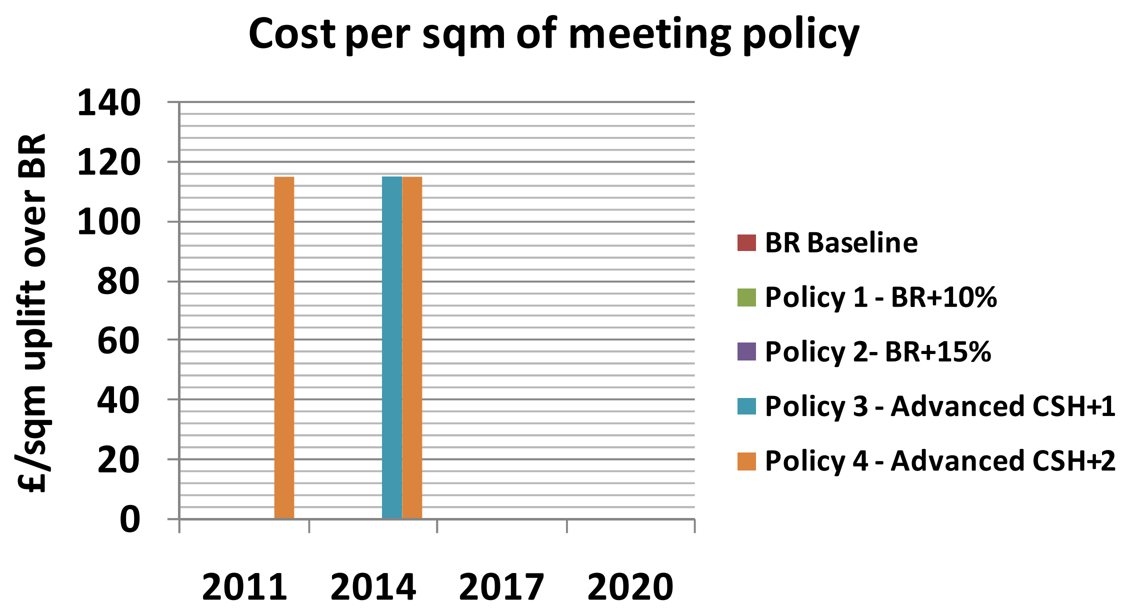

Figure 9.16a- capital cost uplift of Policy Options above BR baseline (Case Study 15)

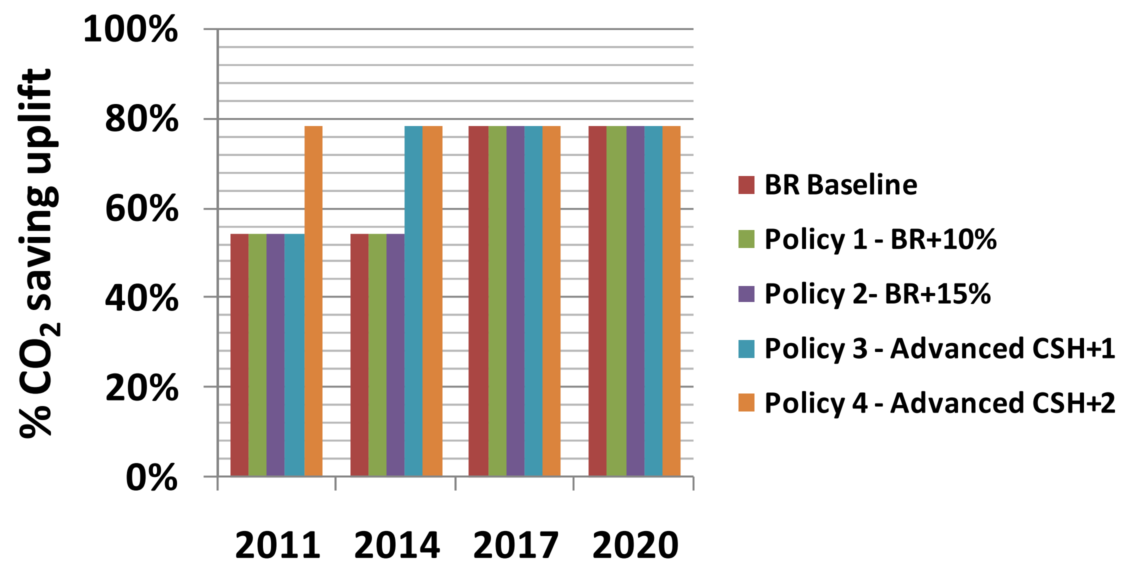

Figure 9.16b %CO_2 saving above BR 2006

In 2011, Policies 1, 2 and 3 have no cost uplift over the BR baseline (since the CO_2 savings are the same as BR 2006 which is a legal minimum requirement) whereas Policy 4 has a cost uplift of £115 per sqm.

In 2014, Policies 1 and 2 have no cost uplift, while Policies 3 and 4 have a similar cost uplift (approx. £115 per sqm).

In 2017 all Policies cost the same to achieve as the BR baseline.

The selection of biomass heating for this type of development is based on an assumption that there is no limitation imposed by air quality requirements.

From 2020 onwards, a mixture of energy efficiency, biomass heating, PV and allowable solutions would be needed to comply with BR.

Non Domestic Case Study15	Year*	BR Baseline	Policy 1 – BR+10%	Policy 2 – BR+15%	Policy 3 – Code+1	Policy 4 – Code+2
Technology Option	2011	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution
	2014	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution
	2017	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution	Biomass heating + PV (minimum) + EE1 + Allowable Solutions Contribution
	2020	Biomass + PV (min) + Al.Sol.	Biomass + PV (min) + Al.Sol.	Biomass + PV (min) + Al.Sol.	Biomass + PV (min) + Al.Sol.	Biomass + PV (min) + Al.Sol.
Technically Viable?		Yes	Yes	Yes	Yes	Yes
% CO_2 saving uplift (regulated emissions, over PtL2006)	2011	54%	54%	54%	54%	78%
	2014	54%	54%	54%	78%	78%
	2017	78%	78%	78%	78%	78%
	2020	78%	78%	78%	78%	78%
£/sqm uplift over BR Baseline	2011	0	0	0	0	115
	2014	0	0	0	115	115
	2017	0	0	0	0	0
	2020	0	0	0	0	0
%/tonne CO_2 uplift	2011	0	0	0	0	14,215
	2014	0	0	0	14,215	14,215
	2017	0	0	0	0	0
	2020	0	0	0	0	0

Table 9.16 - Case Study15 Results Summary

9.18 Case Study 16

- Development type: Urban Retail development
- Development size: 11,000 sqm
- Source: Local authority

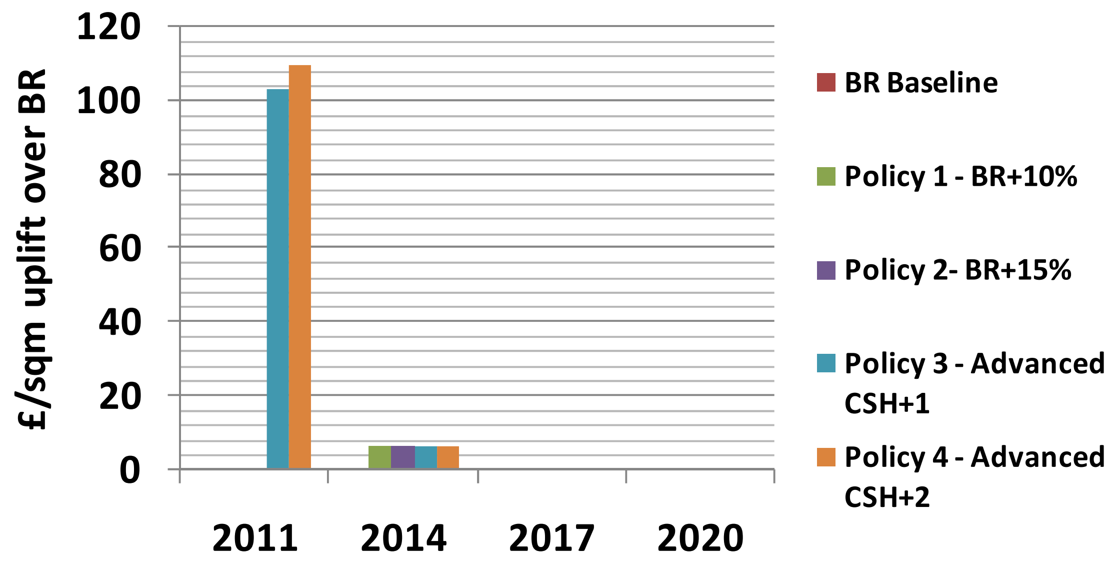

Figure 9.17a- capital cost uplift of Policy Options above BR baseline (Case Study 16)

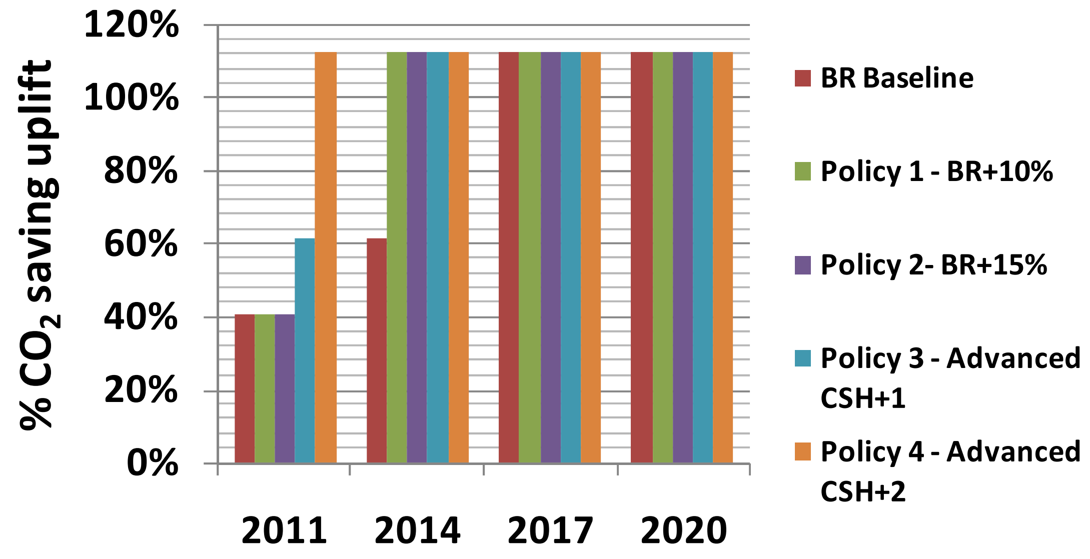

Figure 9.17b- %CO_2 saving above BR 2006

Discussion

In 2011, Policies 1 and 2 have no cost uplift over the BR baseline (since the CO_2 savings are the same as BR 2006 which is a legal minimum requirement) whereas Policies 3 and 4 have a similar cost uplift of approximately £105 per sqm.

In 2014, all Policies have a cost uplift of £5 per sqm over the BR baseline.

From 2017, all Policies cost the same to achieve as the BR baseline.

The selection of biomass heating for this type of development is based on an assumption that there is no limitation imposed by air quality requirements.

From 2020 onwards, a mixture of energy efficiency, gas CHP with biomass backup, PV and allowable solutions would be needed to comply with BR.

Non Domestic Case Study 16	Year*	BR Baseline	Policy 1 – BR+10%	Policy 2 – BR+15%	Policy 3 – Code+1	Policy 4 – Code+2
Technology Option	2011	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + EE1	Biomass + PV (min)	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1
	2014	Biomass + PV (min)	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1
	2017	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1
	2020	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1 + Allowable Solutions	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1 + Allowable Solutions	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1 + Allowable Solutions	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1 + Allowable Solutions	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1 + Allowable Solutions
Technically Viable?		**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
% CO_2 saving uplift (regulated emissions, over PtL2006)	2011	41%	41%	41%	62%	112%
	2014	62%	112%	112%	112%	112%
	2017	112%	112%	112%	112%	112%
	2020	112%	112%	112%	112%	112%
£/sqm uplift over BR Baseline	2011	0	0	0	103	109
	2014	0	6	6	6	6
	2017	0	0	0	0	0
	2020	0	0	0	0	0
£/tonne CO_2 uplift	2011	0	0	0	12,214	3,773
	2014	0	309	309	309	309
	2017	0	0	0	0	0
	2020	0	0	0	0	0

Table 9.17 - Case Study16 Results Summary

9.19 Case Study 17

- Development type: Small mixed use development
- Development size: 400 houses, 500 sqm retail, 2,000 sqm office, 2,500 school
- Source: Local authority

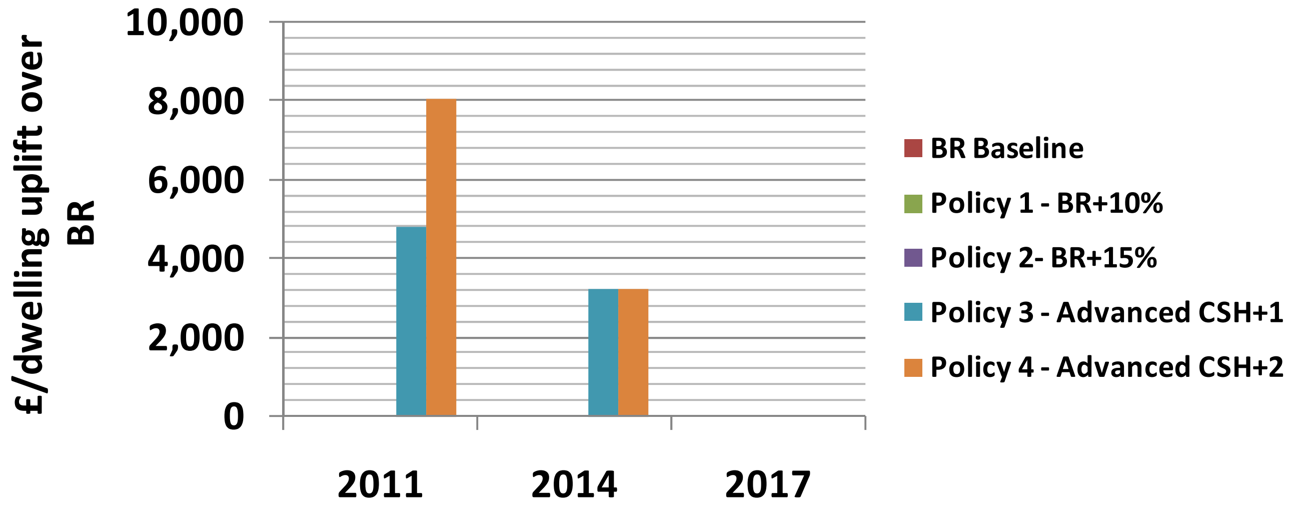

Figure 9.18a- capital cost uplift of Policy Options above BR baseline (Case Study 17)

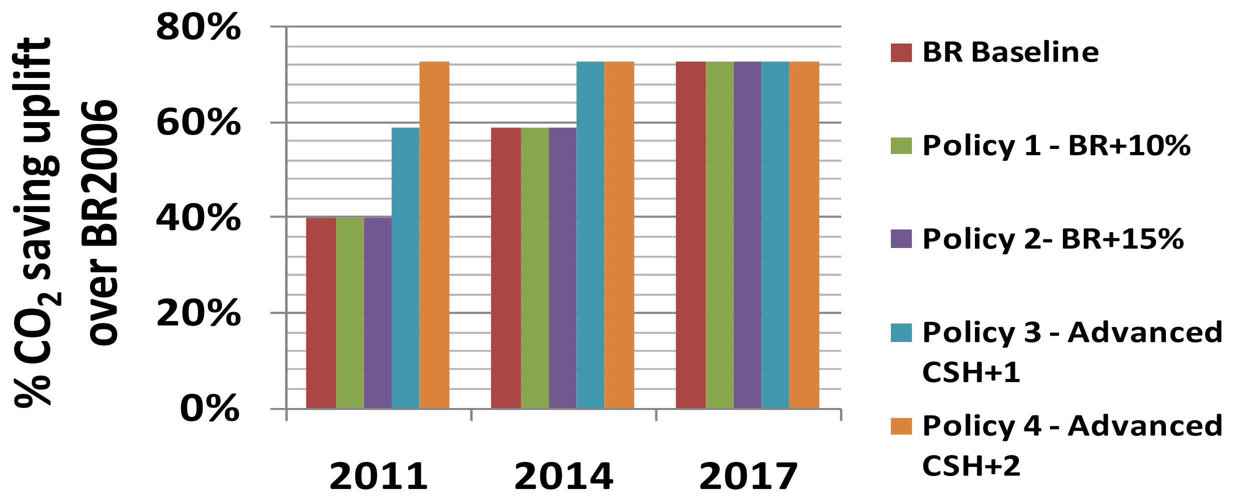

Figure 9.18b- %CO_2 saving above BR 2006

Discussion (Part 1 – Domestic)

In 2011, Policies 1 and 2 have no cost uplift over the BR baseline (since the CO_2 savings are the same as BR 2006 which is a legal minimum requirement) whereas Policies 3 and 4 have a cost uplift of approximately £5,000 and £8,000 respectively per dwelling.

In 2014, only Policies 3 and 4 have a cost uplift of £3,000 per dwelling over the BR baseline.

The selection of biomass heating for this type of development is based on an assumption that there is no limitation imposed by air quality requirements.

From 2017 onwards, a mixture of energy efficiency, biomass heating, PV and allowable solutions would be needed to comply with BR.

DOMESTIC Case Study17	Year*	BR Baseline	Policy 1 – BR+10%	Policy 2 – BR+15%	Policy 3 – Code+1	Policy 4 – Code+2
Technology Option	2011	Solar Water Heating + EE1	Solar Water Heating + EE1	Solar Water Heating + EE1	Biomass heating + EE1	Biomass heating + PV (minimum) + EE1 + Allowable Solutions
	2014	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + PV (minimum) + EE1 + Allowable Solutions	Biomass heating + PV (minimum) + EE1 + Allowable Solutions
	2017	Biomass heating + PV (minimum) + EE1 + Allowable Solutions	Biomass heating + PV (minimum) + EE1 + Allowable Solutions	Biomass heating + PV (minimum) + EE1 + Allowable Solutions	Biomass heating + PV (minimum) + EE1 + Allowable Solutions	Biomass heating + PV (minimum) + EE1 + Allowable Solutions
Technically Viable?		Yes	Yes	Yes	Yes	Yes
% CO_2 saving uplift (regulated emissions, over PtL2006)	2011	40%	40%	40%	59%	73%
	2014	59%	59%	59%	73%	73%
	2017	73%	73%	73%	73%	73%
£/dwelling uplift over BR Baseline	2011	0	0	0	4,809	8,063
	2014	0	0	0	3,254	3,254
	2017	0	0	0	0	0
£/tonne CO_2 uplift	2011	0	0	0	16,225	15,970
	2014	0	0	0	15,607	15,607
	2017	0	0	0	0	0

Table 9.18a - Case Study17 Results Summary (Domestic)

9.20 Case Study 17

- Development type: Small mixed use development
- Development size: 400 houses, 500 sqm retail, 2,000 sqm office, 2,500 school
- Source: Local authority

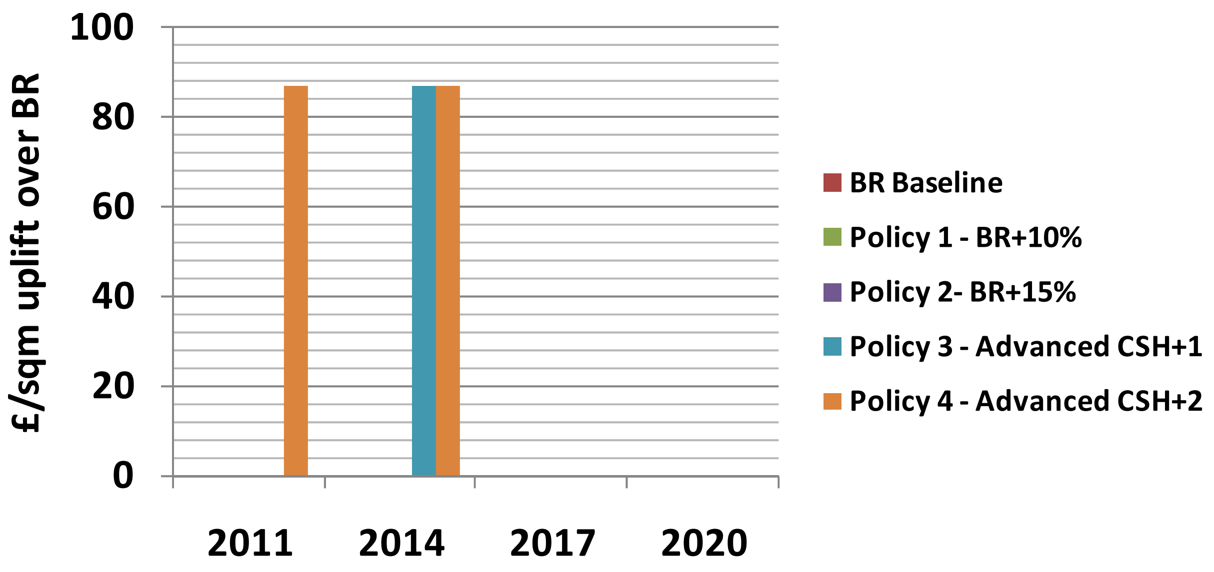

Figure 9.18c- capital cost uplift of Policy Options above BR baseline (Case Study 17)

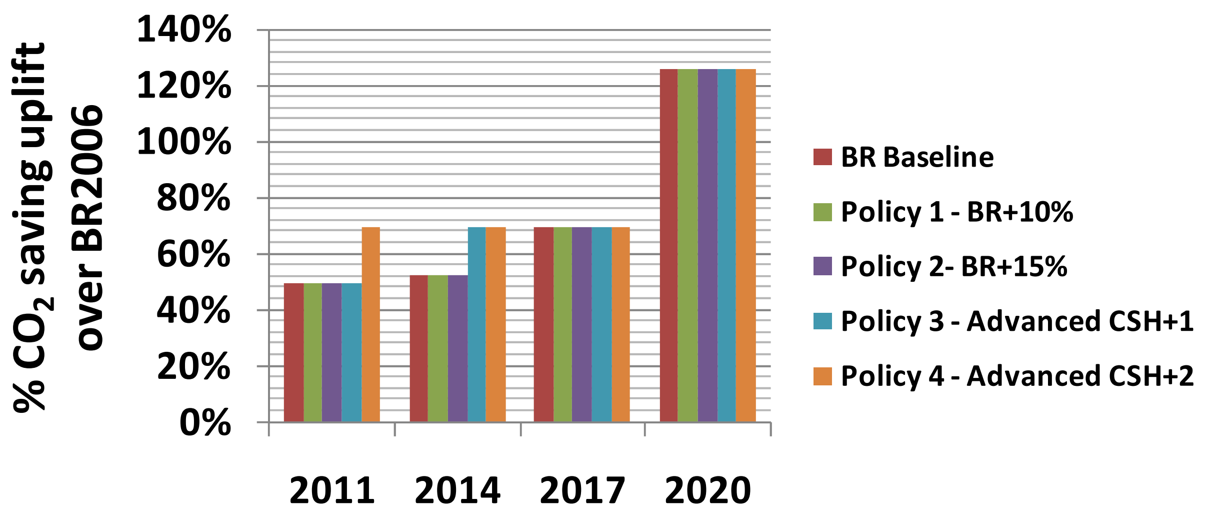

Figure 9.18d- %CO_2 saving above BR 2006

Discussion (Part 2 – Commercial)

In 2011, Policies 1, 2 and3 have no cost uplift over the BR baseline (since the CO_2 savings are the same as BR 2006 which is a legal minimum requirement) whereas Policy 4 has a cost uplift of approximately £90 per sqm.

In 2014, Policies 3 and 4 have a cost uplift of £90 per sqm over the BR baseline. The selection of biomass heating for this type of development is based on an assumption that there is no limitation imposed by air quality requirements.

From 2017 onwards, a mixture of energy efficiency, gas CHP and/ biomass heating, PV and allowable solutions would be needed to comply with BR.

Summary

Although different technology options have been chosen for the residential and non-residential parts of this development, the same technology choice could in practice be chosen to take advantage of economies of scale and/or simplicity of implementation.

Non Domestic Case Study17	Year*	BR Baseline	Policy 1 – BR+10%	Policy 2 – BR+15%	Policy 3 – Code+1	Policy 4 – Code+2
Technology Option	2011	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + PV (minimum) + EE1 + Allowable Solutions
	2014	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + PV (minimum) + EE1 + Allowable Solutions	Biomass heating + PV (minimum) + EE1 + Allowable Solutions
	2017	Biomass heating + PV (minimum) + EE1 + Allowable Solutions	Biomass heating + PV (minimum) + EE1 + Allowable Solutions	Biomass heating + PV (minimum) + EE1 + Allowable Solutions	Biomass heating + PV (minimum) + EE1 + Allowable Solutions	Biomass heating + PV (minimum) + EE1 + Allowable Solutions
	2020	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1 + Allowable Solutions	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1 + Allowable Solutions	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1 + Allowable Solutions	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1 + Allowable Solutions	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1 + Allowable Solutions
Technically Viable?		Yes	Yes	Yes	Yes	Yes
% CO_2 saving uplift (regulated emissions, over PtL2006)	2011	50%	50%	50%	50%	70%
	2014	52%	52%	52%	70%	70%
	2017	70%	70%	70%	70%	70%
	2020	126%	126%	126%	126%	126%
£/sqm uplift over BR Baseline	2011	0	0	0	0	87
	2014	0	0	0	87	87
	2017	0	0	0	0	0
	2020	0	0	0	0	0
£/tonne CO_2 uplift	2011	0	0	0	0	14,884
	2014	0	0	0	14,884	14,884
	2017	0	0	0	0	0
	2020	0	0	0	0	0

Table 9.18b - Case Study17 Results Summary (Commercial)

9.21 Case Study 18

- Development type: Medium mixed use development
- Development size: 1,000 houses, 1,000 sqm retail, 2,000 sqm primary school, 400 sqm community facility
- Source: Local authority

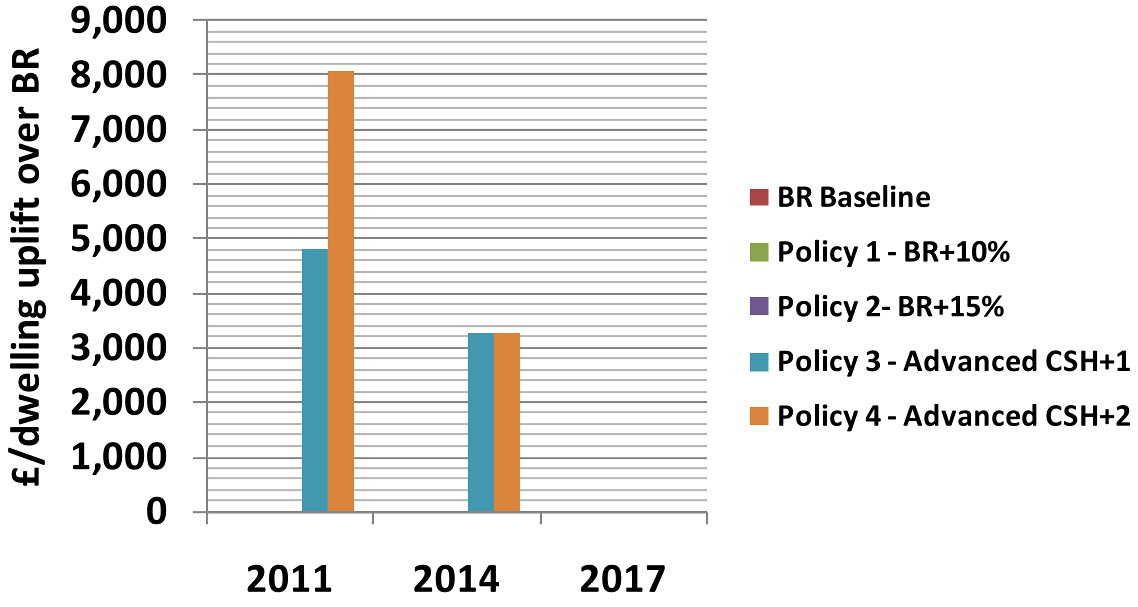

Figure 9.19a- capital cost uplift of Policy Options above BR baseline (Case Study 18)

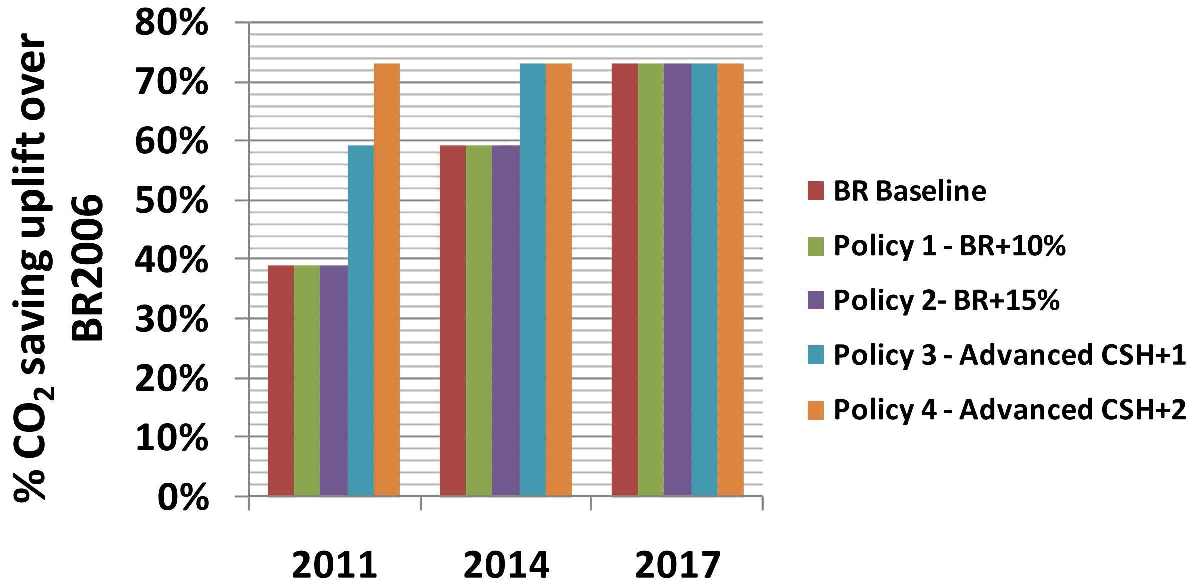

Figure 9.19b- %CO_2 saving above BR 2006

Discussion (Part 1 – Domestic)

In 2011, Policies 1 and 2 have no cost uplift over the BR baseline (since the CO_2 savings are the same as BR 2006 which is a legal minimum requirement) whereas Policies 3 and 4 have a cost uplift of approximately £5,000 and £8,000 respectively per dwelling.

In 2014, only Policies 3 and 4 have a cost uplift of £3,000 per dwelling over the BR baseline.

The selection of biomass heating for this type of development is based on an assumption that there is no limitation imposed by air quality requirements.

From 2017 onwards, a mixture of energy efficiency, biomass heating, PV and allowable solutions would be needed to comply with BR.

DOMESTIC Case Study18	Year*	BR Baseline	Policy 1 – BR+10%	Policy 2 – BR+15%	Policy 3 – Code+1	Policy 4 – Code+2
Technology Option	2011	Solar Water Heating + EE1	Solar Water Heating + EE1	Solar Water Heating + EE1	Biomass heating + EE1	Biomass heating + PV (minimum) + EE1 + Allowable Solutions
	2014	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + PV (minimum) + EE1 + Allowable Solutions	Biomass heating + PV (minimum) + EE1 + Allowable Solutions
	2017	Biomass heating + PV (minimum) + EE1 + Allowable Solutions	Biomass heating + PV (minimum) + EE1 + Allowable Solutions	Biomass heating + PV (minimum) + EE1 + Allowable Solutions	Biomass heating + PV (minimum) + EE1 + Allowable Solutions	Biomass heating + PV (minimum) + EE1 + Allowable Solutions
Technically Viable?		Yes	Yes	Yes	Yes	Yes
% CO_2 saving uplift (regulated emissions, over PtL2006)	2011	39%	39%	39%	59%	73%
	2014	59%	59%	59%	73%	73%
	2017	73%	73%	73%	73%	73%
£/dwelling uplift over BR Baseline	2011	0	0	0	4,810	8,065
	2014	0	0	0	3,255	3,255
	2017	0	0	0	0	0
£/tonne CO_2 uplift	2011	0	0	0	16,224	15,970
	2014	0	0	0	15,608	15,608
	2017	0	0	0	0	0

Table 9.19a - Case Study18 Results Summary (Domestic)

9.22 Case Study 18

- Development type: Medium mixed use development
- Development size: 1,000 houses, 1,000 sqm retail, 2,000 sqm primary school, 400 sqm community facility
- Source: Local authority

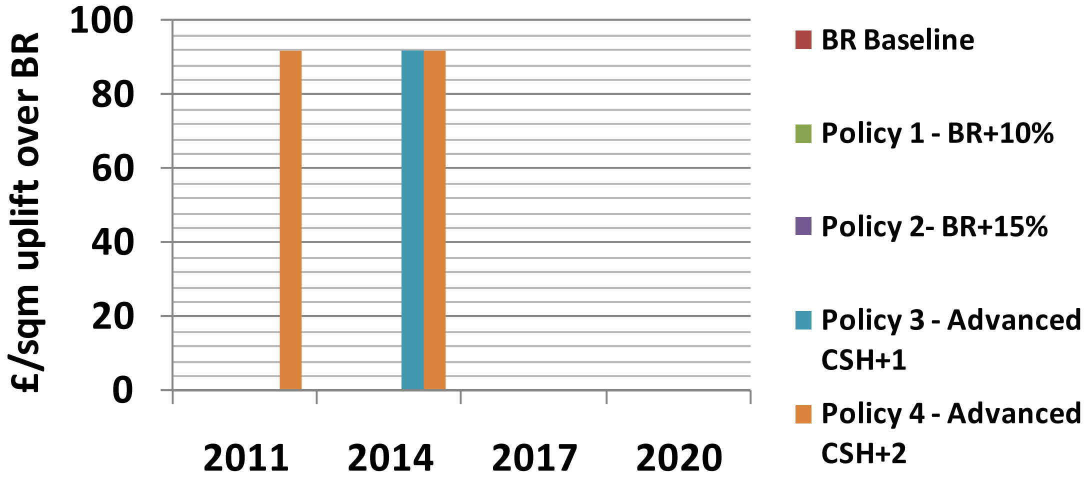

Figure 9.19c capital cost uplift of Policy Options above BR baseline (Case Study 18)

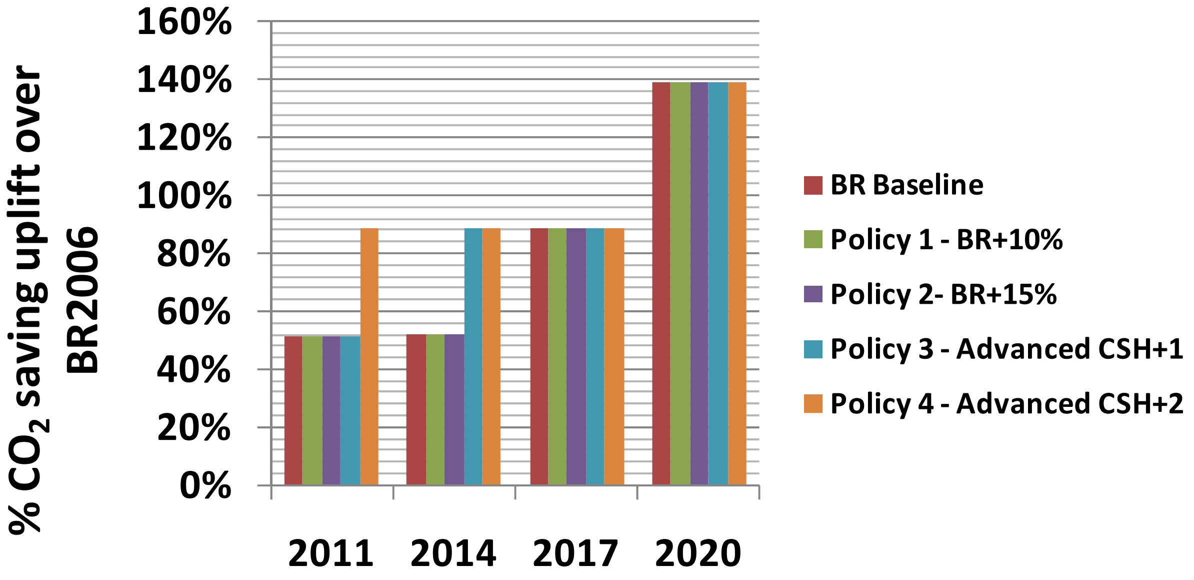

Figure 9.19d- %CO_2 saving above BR 2006

Discussion (Part 2 – Commercial)

In 2011, Policies 1, 2 and 3 have no cost uplift over the BR baseline (since the CO_2 savings are the same as BR 2006 which is a legal minimum requirement) whereas Policy 4 has a cost uplift of approximately £90 per sqm.
In 2014, Policies 3 and 4 have a cost uplift of £90 per sqm over the BR baseline. The selection of biomass heating for this type of development is based on an assumption that there is no limitation imposed by air quality requirements. From 2017 onwards, a mixture of energy efficiency, gas/biomass CHP and/ biomass heating, PV and allowable solutions would be needed to comply with BR.

Summary
Although different technology options have been chosen for the residential and non-residential parts of this development, the same technology choice could in practice be chosen to take advantage of economies of scale and/or simplicity of implementation.

Non Domestic Case Study18	Year*	BR Baseline	Policy 1 – BR+10%	Policy 2 – BR+15%	Policy 3 – Code+1	Policy 4 – Code+2
Technology Option	2011	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + EE1	Biomass Fired CHP + EE1
	2014	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + EE1	Biomass Fired CHP + EE1	Biomass Fired CHP + EE1
	2017	Biomass Fired CHP + EE1	Biomass Fired CHP + EE1	Biomass Fired CHP + EE1	Biomass Fired CHP + EE1	Biomass Fired CHP + EE1
	2020	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1 + Allowable Solutions	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1 + Allowable Solutions	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1 + Allowable Solutions	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1 + Allowable Solutions	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1 + Allowable Solutions
Technically Viable?		Yes	Yes	Yes	Yes	Yes
% CO_2 saving uplift (regulated emissions, over PtL2006)	2011	52%	52%	52%	52%	89%
	2014	52%	52%	52%	89%	89%
	2017	89%	89%	89%	89%	89%
	2020	139%	139%	139%	139%	139%
£/sqm uplift over BR Baseline	2011	0	0	0	0	92
	2014	0	0	0	92	92
	2017	0	0	0	0	0
	2020	0	0	0	0	0
£/tonne CO_2 uplift	2011	0	0	0	0	5,766
	2014	0	0	0	5,766	5,766
	2017	0	0	0	0	0
	2020	0	0	0	0	0

Table 9.19b - Case Study18 Results Summary (Commercial)

9.23 Case Study 19

- Development type: Medium/Large mixed use development
- Development size: 2,700 houses, 10,000 sqm retail, 20,000 sqm office 20,000 B2/B8 uses, 7,500 sqm primary school, 1,000 sqm community facility
- Source: Local authority

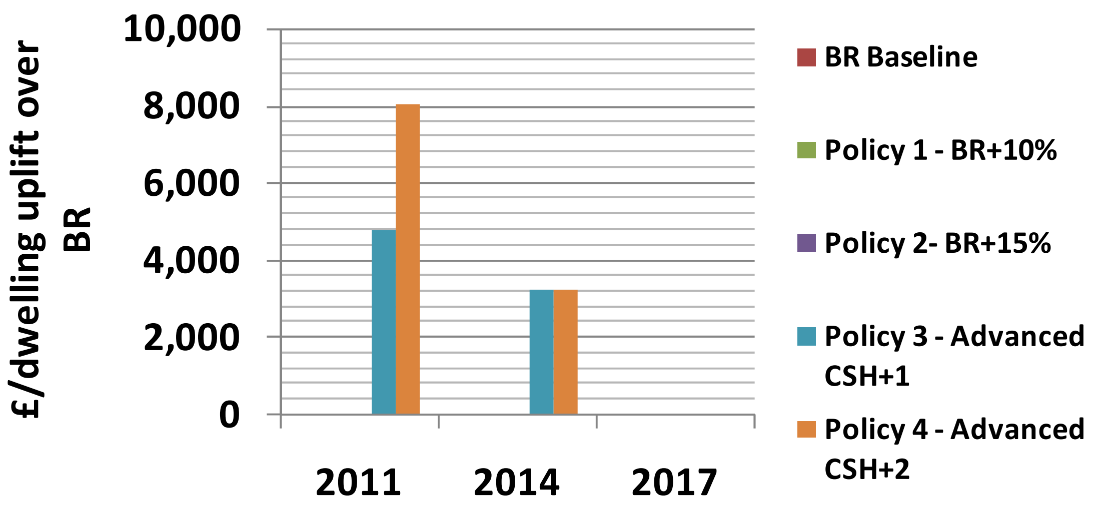

Figure 9.20a- capital cost uplift of Policy Options above BR baseline (Case Study 19)

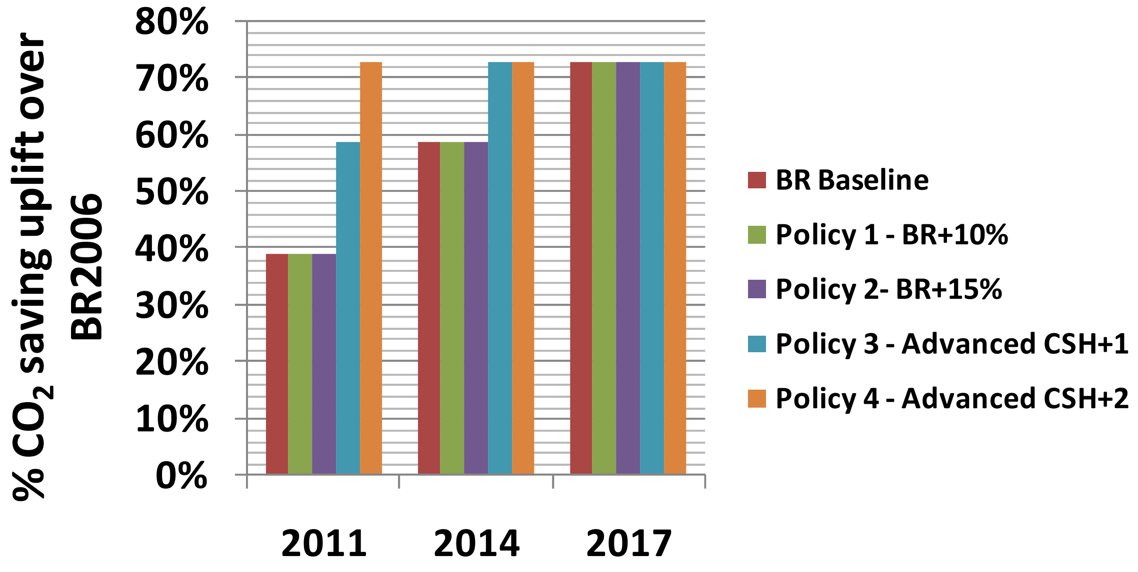

Figure 9.20b- %CO_2 saving above BR 2006

Discussion (Part 1 – Domestic)

In 2011, Policies 1 and 2 have no cost uplift over the BR baseline (since the CO_2 savings are the same as BR 2006 which is a legal minimum requirement) whereas Policies 3 and 4 have a cost uplift of approximately £5,000 and £8,000 respectively per dwelling.
In 2014, only Policies 3 and 4 have a cost uplift of £3,000 per dwelling over the BR baseline.
The selection of biomass heating for this type of development is based on an assumption that there is no limitation imposed by air quality requirements.
From 2017 onwards, a mixture of energy efficiency, biomass heating, PV and allowable solutions would be needed to comply with BR.

DOMESTIC Case Study19	Year*	BR Baseline	Policy 1 – BR+10%	Policy 2 – BR+15%	Policy 3 – Code+1	Policy 4 – Code+2
Technology Option	2011	Solar Water Heating + EE1	Solar Water Heating + EE1	Solar Water Heating + EE1	Biomass heating + EE1	Biomass heating + PV (minimum) + EE1 + Allowable Solutions
	2014	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + PV (minimum) + EE1 + Allowable Solutions	Biomass heating + PV (minimum) + EE1 + Allowable Solutions
	2017	Biomass heating + PV (minimum) + EE1 + Allowable Solutions	Biomass heating + PV (minimum) + EE1 + Allowable Solutions	Biomass heating + PV (minimum) + EE1 + Allowable Solutions	Biomass heating + PV (minimum) + EE1 + Allowable Solutions	Biomass heating + PV (minimum) + EE1 + Allowable Solutions
Technically Viable?		Yes	Yes	Yes	Yes	Yes
% CO_2 saving uplift (regulated emissions, over PtL2006)	2011	39%	39%	39%	59%	73%
	2014	59%	59%	59%	73%	73%
	2017	73%	73%	73%	73%	73%
£/dwelling uplift over BR Baseline	2011	0	0	0	4,809	8,063
	2014	0	0	0	3,254	3,254
	2017	0	0	0	0	0
£/tonne CO_2 uplift	2011	0	0	0	16,224	15,970
	2014	0	0	0	15,608	15,608
	2017	0	0	0	0	0

Table 9.20a - Case Study19 Results Summary (Domestic)

9.24 Case Study 19

- Development type: Medium/Large mixed use development
- Development size: 2,700 houses, 10,000 sqm retail, 20,000 sqm office 20,000 B2/B8 uses, 7,500 sqm primary school, 1,000 sqm community facility
- Source: Local authority

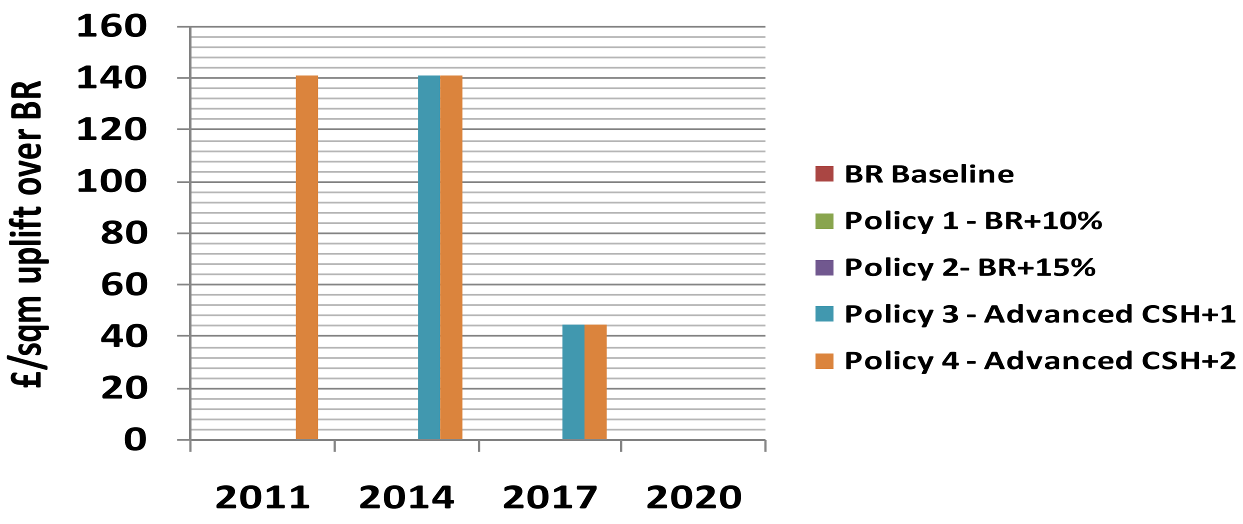

Figure 9.20c- capital cost uplift of Policy Options above BR baseline (Case Study 19)

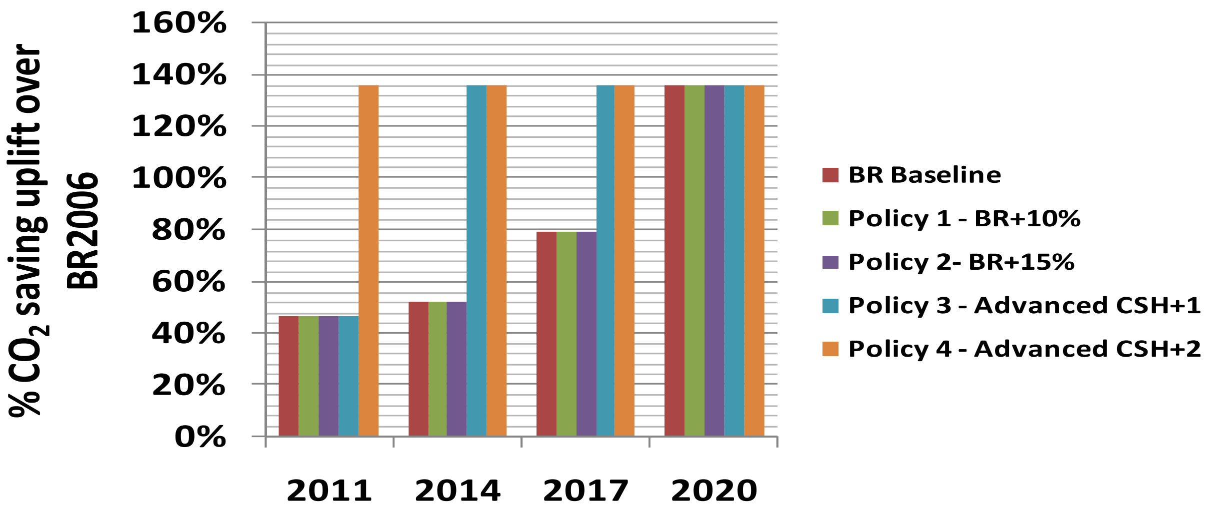

Figure 9.20d- %CO_2 saving above BR 2006

Discussion (Part 2 – Commercial)

In 2011, Policies 1, 2 and 3 have no cost uplift over the BR baseline (since the CO_2 savings are the same as BR 2006 which is a legal minimum requirement) whereas Policy 4 has a cost uplift of approximately £140 per sqm.
In 2014, Policies 3 and 4 have a cost uplift of £140 per sqm over the BR baseline.
The selection of biomass heating for this type of development is based on an assumption that there is no limitation imposed by air quality requirements.
From 2017 onwards, a mixture of energy efficiency, gas CHP and/or biomass heating, and PV would be needed to comply with BR.
Depending on the specific building type, there may be a need for an allowable solutions pathway to achieve "Zero Carbon".

Summary

Although different technology options have been chosen for the residential and non-residential parts of this development, the same technology choice could in practice be chosen to take advantage of economies of scale and/or simplicity of implementation.

Non Domestic Case Study19	Year*	BR Baseline	Policy 1 – BR+10%	Policy 2 – BR+15%	Policy 3 – Code+1	Policy 4 – Code+2
Technology Option	2011	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + EE1	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1
	2014	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + EE1	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1
	2017	Biomass CHP	Biomass CHP	Biomass CHP	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1
	2020	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1
Technically Viable?		Yes	Yes	Yes	Yes	Yes
% CO_2 saving uplift (regulated emissions, over PtL2006)	2011	47%	47%	47%	47%	136%
	2014	52%	52%	52%	136%	136%
	2017	80%	80%	80%	136%	136%
	2020	136%	136%	136%	136%	136%
£/sqm uplift over BR Baseline	2011	0	0	0	0	141
	2014	0	0	0	141	141
	2017	0	0	0	45	45
	2020	0	0	0	0	0
£/tonne CO_2 uplift	2011	0	0	0	0	5,301
	2014	0	0	0	5,301	5,301
	2017	0	0	0	2,651	2,651
	2020	0	0	0	0	0

Table 9.20b - Case Study19 Results Summary (Commercial)

9.25 Case Study 20

- Development type: Large mixed use development
- Development size: 12,000 houses, 165,000 sqm office, 20,000 B2/B8 uses, 9,500 sqm hotel
- Source: Local authority

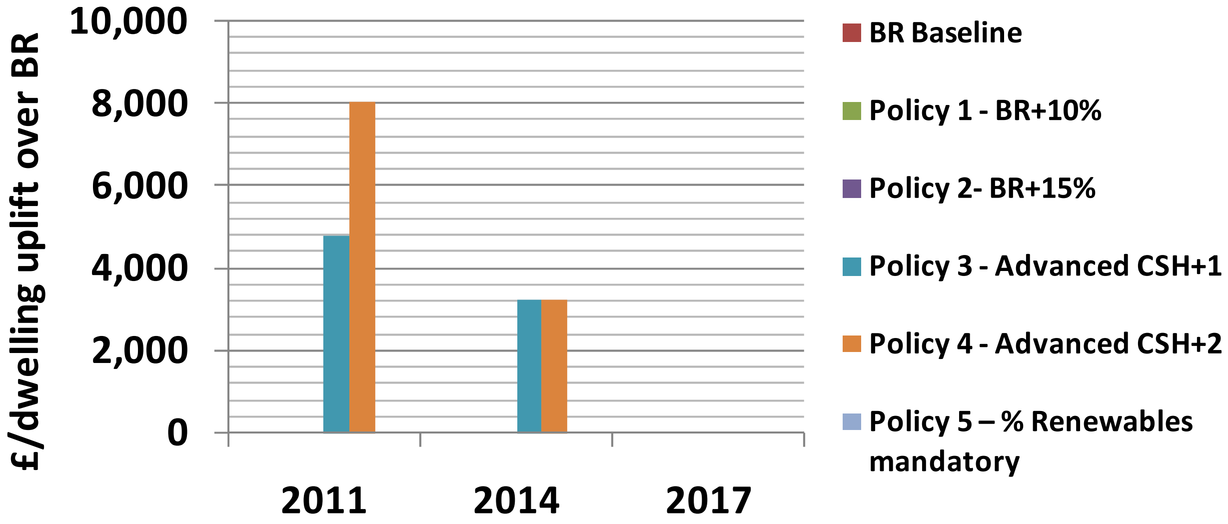

Figure 9.21a capital cost uplift of Policy Options above BR baseline (Case Study 20)

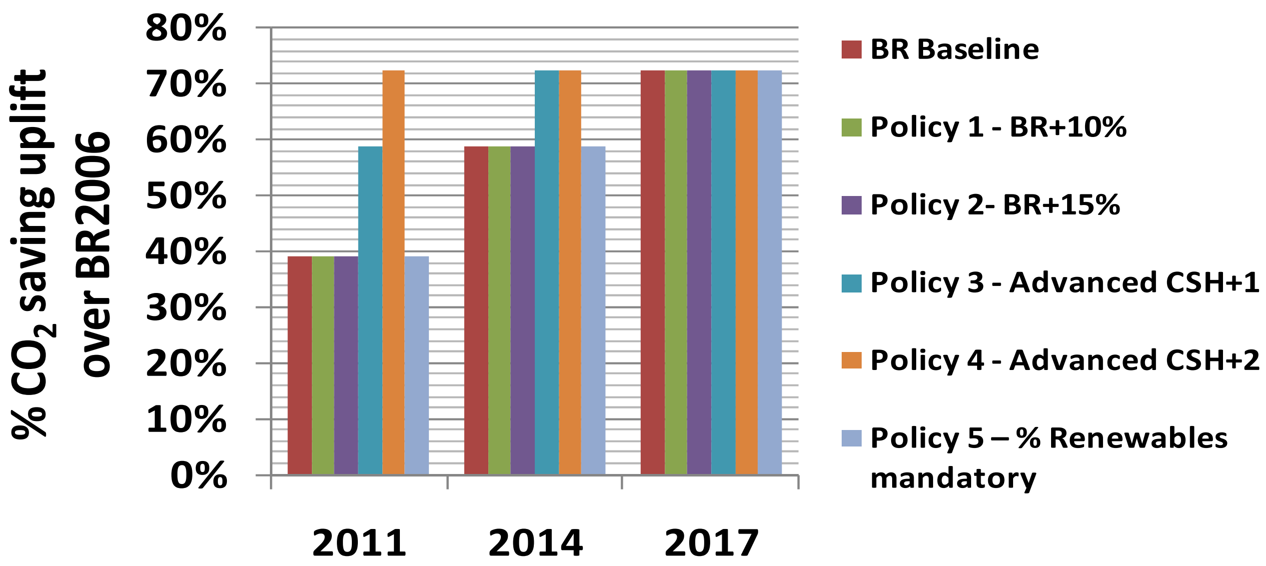

Figure 9.21b %CO_2 saving above BR 2006

Discussion (Part 1 – Domestic)

In 2011, Policies 1, 2 and 5 have no cost uplift over the BR baseline (since the CO_2 savings are the same as BR 2006 which is a legal minimum requirement) whereas Policies 3 and 4 have a cost uplift of approximately £5,000 and £8,000 respectively per dwelling.
In 2014, only Policies 3 and 4 have a cost uplift of £3,000 per dwelling over the BR baseline.
The selection of biomass heating for this type of development is based on an assumption that there is no limitation imposed by air quality requirements.
From 2017 onwards, a mixture of energy efficiency, biomass heating, PV and allowable solutions would be needed to comply with BR.

DOMESTIC Case Study20	Year*	BR Baseline	Policy 1 – BR+10%	Policy 2 – BR+15%	Policy 3 – Code+1	Policy 4 – Code+2	Policy 5 – % Renewables mandatory
Technology Option	2011	Solar Water Heating + EE1	Solar Water Heating + EE1	Solar Water Heating + EE1	Biomass heating + EE1	Biomass heating + PV (minimum) + EE1 + Allowable Solutions	Solar Water Heating + EE1
	2014	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + PV (minimum) + EE1 + Allowable Solutions	Biomass heating + PV (minimum) + EE1 + Allowable Solutions	Biomass heating + EE1
	2017	Biomass heating + PV (minimum) + EE1 + Allowable Solutions	Biomass heating + PV (minimum) + EE1 + Allowable Solutions	Biomass heating + PV (minimum) + EE1 + Allowable Solutions	Biomass heating + PV (minimum) + EE1 + Allowable Solutions	Biomass heating + PV (minimum) + EE1 + Allowable Solutions	Biomass heating + PV (minimum) + EE1 + Allowable Solutions
Technically Viable?		Yes	Yes	Yes	Yes	Yes	Yes
% CO_2 saving uplift (regulated emissions, over PtL2006)	2011	39%	39%	39%	59%	73%	39%
	2014	59%	59%	59%	73%	73%	59%
	2017	73%	73%	73%	73%	73%	73%
£/dwelling uplift over BR Baseline	2011	0	0	0	4,809	8,063	0
	2014	0	0	0	3,254	3,254	0
	2017	0	0	0	0	0	0
£/tonne CO_2 uplift	2011	0	0	0	16,225	15,970	0
	2014	0	0	0	15,607	15,607	0
	2017	0	0	0	0	0	0

Table 9.21a - Case Study20 Results Summary (Domestic)

9.26 Case Study 20

- Development type: Large mixed use development
- Development size: 12,000 houses, 165,000 sqm office, 20,000 B2/B8 uses, 9,500 sqm hotel
- Source: Local authority

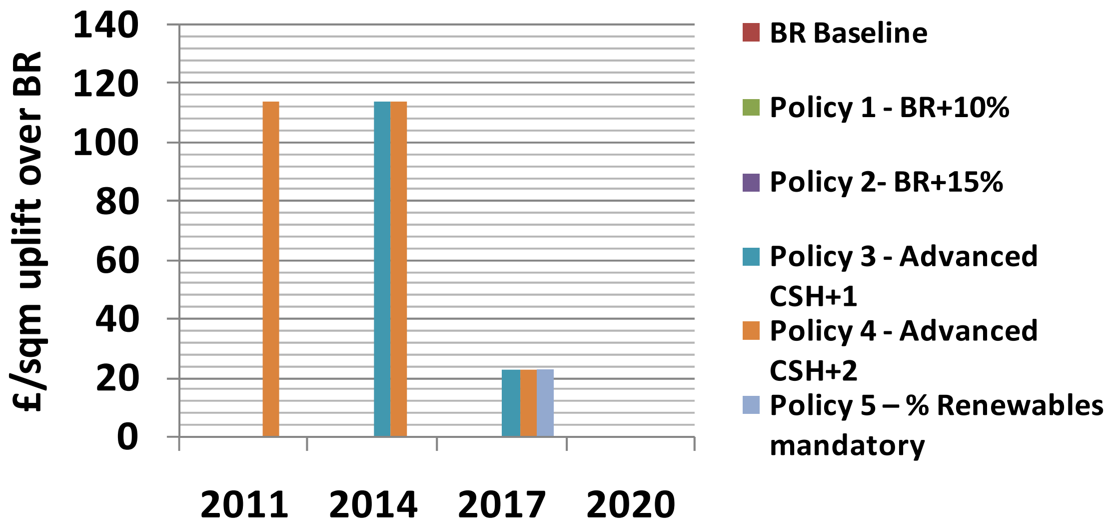

Figure 9.21c- capital cost uplift of Policy Options above BR baseline (Case Study 20)

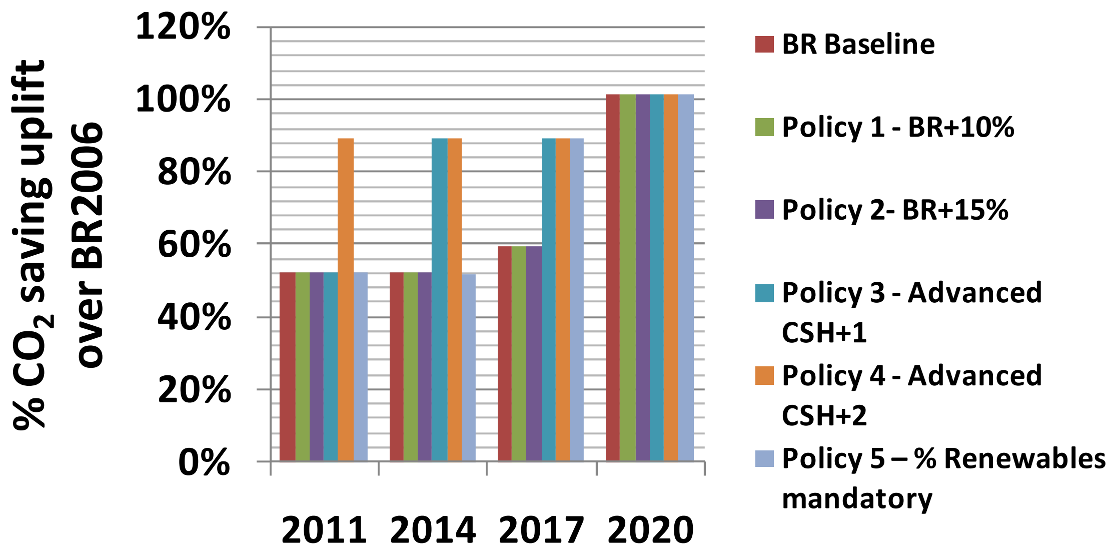

Figure 9.21d- %CO_2 saving above BR 2006

Discussion (Part 2 – Commercial)

In 2011, Policies 1, 2 and 3 have no cost uplift over the BR baseline (since the CO_2 savings are the same as BR 2006 which is a legal minimum requirement) whereas Policy 4 has a cost uplift of approximately £110 per sqm.

In 2014, Policies 3 and 4 have a cost uplift of £110 per sqm over the BR baseline. In 2017, Policies 3, 4 and 5 show a cost uplift of approximately £20 per sqm over the BR baseline. The selection of biomass heating for this type of development is based on an assumption that there is no limitation imposed by air quality requirements.

From 2017 onwards, a mixture of energy efficiency, gas/biomass CHP and/or biomass heating, and PV would be needed to comply with BR. Depending on the specific building type, there may be a need for an allowable solutions pathway to achieve "Zero Carbon".

Summary

Although different technology options have been chosen for the residential and non-residential parts of this development, the same technology choice could in practice be chosen to take advantage of economies of scale and/or simplicity of implementation.

Non Domestic Case Study20	Year*	BR Baseline	Policy 1 – BR+10%	Policy 2 – BR+15%	Policy 3 – Code+1	Policy 4 – Code+2	Policy 5 – % Renewables mandatory
Technology Option	2011	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + EE1	Biomass Fired CHP + EE1	Biomass heating + EE1
	2014	Biomass heating + EE1	Biomass heating + EE1	Biomass heating + EE1	Biomass Fired CHP + EE1	Biomass Fired CHP + EE1	Biomass heating + EE1
	2017	Gas Fired CHP (Biomass Back Up) + EE1	Gas Fired CHP (Biomass Back Up) + EE1	Gas Fired CHP (Biomass Back Up) + EE1	Biomass Fired CHP + EE1	Biomass Fired CHP + EE1	Biomass Fired CHP + EE1
	2020	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1 + Allowable Solutions	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1 + Allowable Solutions	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1 + Allowable Solutions	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1 + Allowable Solutions	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1 + Allowable Solutions	Gas Fired CHP (Biomass Back Up) + PV (minimum) + EE1 + Allowable Solutions
Technically Viable?		Yes	Yes	Yes	Yes	Yes	Yes
% CO_2 saving uplift (regulated emissions, over PtL2006)	2011	52%	52%	52%	52%	89%	52%
	2014	52%	52%	52%	89%	89%	52%
	2017	59%	59%	59%	89%	89%	89%
	2020	101%	101%	101%	101%	101%	101%
£/sqm uplift over BR Baseline	2011	0	0	0	0	114	0
	2014	0	0	0	114	114	0
	2017	0	0	0	23	23	23
	2020	0	0	0	0	0	0
£/tonne CO_2 uplift	2011	0	0	0	0	9,576	0
	2014	0	0	0	9,576	9,576	0
	2017	0	0	0	2,730	2,730	2,730
	2020	0	0	0	0	0	0

Table 9.21b - Case Study20 Results Summary (Commercial)

9.27 Summary of Model Findings

9.27.1 Residential Development

For the case studies looking at 1 house, the city infill house has a higher cost uplift than the rural house for Policies 3 and 4 as the urban house is assumed to be constrained so that it will not be practically possible to receive biomass deliveries. The city infill house therefore has a more expensive technology option chosen (PV) to comply with Policies 3 and 4.

For housing developments between ranging from 10 to 12,000 dwellings, the modelling suggests that the costs of meeting Policies 3 and 4 would be broadly similar, whether in a rural or urban location. This is estimated at £3,000 per dwelling for Policy 3 and £8,000 per dwelling for Policy 4. This is based on an assumption that biomass heating is a practical technology option for all these sites as it is calculated to have the cheapest capital cost.

However, if biomass heating were not possible for a given development (e.g. if there are significant air quality issues), the costs of achieving Policies 3 and 4 would vary. For example, if the next cheapest capital cost option for meeting these Policies was gas-fired CHP this may not be suitable for smaller development, therefore developments of 50 dwellings or less may require a more expensive technology option to achieve compliance. This point raises the question of setting threshold targets for new development.

Compliance with Policies 1 and 2 often costs the same and saves as much CO_2 as simply complying with BR. In reality, it may be possible to scale a given technology to produce CO_2 savings to exactly comply with a given policy. However, where the same technology option is shown to comply with BR and Policies 1 and 2, it is assumed that a standard sized module (e.g. solar hot water panel) available on the market is used: this may result in CO_2 savings that exceed BR to the point where the energy generating capacity of the technology option chosen to meet BR could also comply with Policy 1 and maybe even Policy 2.

Overall the residential modelling suggests that there would only be a modest cost uplift (if any) in meeting Policies 1 and 2.

In 2010, for Policies 1 and 2, solar water heating is often the technology option chosen, usually in line with the BR compliance option. Solar PV is typically chosen for Policy 3 and biomass heating with allowable solutions for Policy 4.

In 2014, technology options chosen range from PV to biomass heating for BR and Policies 1 and 2. For Policy 3, the technology choice is usually PV and/or biomass heating. To comply with Policy 4, a combination of PV, biomass and allowable solutions is usually chosen.

For all developments, the modelling suggests that some form of allowable solutions pathway would be needed to meet Zero Carbon requirements in 2017.

9.27.2 Office Development

For the three office development sizes modelled (100, 1,000 and 8,000 sqm), there was no difference shown by the modelling in terms of the capital cost uplift over BR to meet all Policy targets. In 2010, Policies 1, 2 and 3 show no cost uplift, whereas in 2014 the cost uplift was approximately £30 per sqm for Policy 1, £50 per sqm for Policy 2 and £110 per sqm for Policy 3. Policy 4 has a cost uplift of £110 per sqm in 2010 and 2014. In 2017, only Policies 3 and 4 have cost uplifts over BR of £20 per sqm.

As with residential development, if the use of biomass heating was not possible for a given development, the costs of achieving Policies 3 and 4 would vary between the offices. In particular, if biomass were not available, the next cheapest cost option of gas CHP may not be viable for a smaller 100 sqm office (and perhaps the 1,000 sqm office).

9.27.3 Non-residential Development

Modelling suggests that there would be no cost uplift in the years modelled to comply with Policies 1 and 2. Policy 3 only shows a cost uplift in 2014 (apart from urban retail development where an uplift is shown in 2011). Policy 3 shows a cost uplift ranging from £90 to £140 per sqm in 2014 for most of the non-residential developments, whereas Policy 4 shows a cost uplift of between £90 to £140 in both 2011 and 2014.

9.27.4 Mixed (residential and non-residential development)

Although separate and sometimes different technology options are chosen for the residential and non-residential parts, in reality there may be a one technology option chosen on a development for both parts regardless of whether this results in a cheaper capital cost options compared to two technology options. This could be for reasons of simplicity of installation/management of the renewable or low carbon technology.

9.27.5 Site constraints

If a rural site is not on the gas grid, the use of gas-fired CHP is unlikely to be a feasible. The use of solar thermal and PV will be site specific. In urban areas in particular, overshading issues and the orientation of panels will have to be given serious consideration.

9.28 Target Recommendations

The analysis and discussion in this section allows recommendations to be made on the type and extent of policy which can be applied to new development across Hertfordshire. In doing so it is important to recognise that the proposed changes to Building Regulations leading to zero carbon are very challenging in themselves and are based on extensive at technical and financial viability analysis. Alongside this, the rapid changes in proposed regulations means that any locally implemented policies will only impact on the shorter term (the next 6 years for homes) and then be overtaken by national regulation. Therefore, the recommended policy options should provide greater CO_2 reductions where possible but in a way which does not significantly impact on development viability.

When interpreting the model findings it is important to note that the cost uplifts above business as usual reflect constructions costs only and do not themselves constitute a viability assessment. To make a judgement on the viability or otherwise of particular targets these numbers should be included in a full viability assessment, perhaps undertaken alongside an assessment of affordable housing viability. The recommendations set out here will need to be considered again following such an assessment.

The two policy options based around percentage improvements on Building Regulations provide small CO_2 savings. Policy 1 (BR+10%) often shows the same capital cost uplift savings as Policy 2 (BR + 15%) but can often be met with the same or similar measures required for Building Regulations. Therefore, Policy 2 is considered preferable to Policy 1.

The Advanced Code +2 Policy (Policy option 4) has been shown to be significantly more expensive than the Advanced Code +1 Policy (Policy option 3) and it is considered that the technology and allowable solutions costs required to meet the 100% reduction in regulated emissions in 2011 could be too financially demanding for developers. Therefore Policy option 3 is considered further in preference over Policy option 4.

The Advanced Code +1 Policy (Policy option 3) shows a capital cost of between zero and £6,000 per dwelling before 2017 and zero and £140 per sqm for non-domestic buildings before 2020. This may be challenging but is considered achievable for most sites, and is currently required for all publicly funded social housing by the Homes and Communities Agency. The higher CO_2 reduction requirements of Policy option 3 (Advanced Code+1) could promote earlier adoption of district heating networks as a means to achieving compliance before 2017. This has the advantage of building capacity and helping develop a supply chain for the construction of zero carbon homes prior to 2017. Furthermore, the use of allowable solutions before 2017can provide a potential route for reducing CO_2 emissions in the existing building sector.

Policy option 5, which promotes renewable energy in meeting Building Regulations targets, does not result in higher CO_2 savings, but can increase construction costs. The nature of this policy is also against the aims of PPS1 by stipulating the technologies should be renewable and not simply low or zero carbon, and it is therefore not justifiable. The requirement to deliver the target CO_2 reduction via specific technologies also makes demonstrating compliance more complicated since it involved calculating the proportion that has come from the renewable technologies.

In summary, a policy requiring CO_2 standards one step ahead of the Building Regulations based on the Code for Sustainable Homes mandatory CO_2 standards (Policy option 3) is considered to be the most suitable type of policy for large developments in district heating and wind opportunity areas. This provides relatively large CO_2 reductions beyond national standards in the period up to 2016 (and 2019 for non domestic), and helps to promote measures which support future improvements in CO_2 reduction, but with relatively small additional costs. For development in energy constrained areas, it is considered more appropriate to apply either the Code for residential or Building Regulations Part L for non-residential at the equivalent level to Building Regulations current at that time. This conclusion is based on guidance emerging through the draft PPS. These standards are reflected in the proposed policy wording in section 9.29 below.

9.29 Proposed Policy Wording

A suite of planning policies is recommended to assist in delivering the Energy Opportunities Plan. The policies have been developed based on the outcomes of the policy testing and in terms of feasibility and impact on development cost.

In identifying and appraising policy options we have started from the basis that meeting the challenges of climate change and increasing renewable and low carbon energy capacity cannot and should not be delivered through planning alone. Understanding the role of planning as part of a wider set of national, regional and local delivery mechanisms is crucial. That said, planning is unique in being the only activity that is able to build up a comprehensive spatial understanding of the opportunities and constraints for decentralised renewable and low carbon energy.

Using the Energy Opportunities Plan as the starting point, potential policy and delivery mechanisms have been assessed for their impact on both existing and new development (Chapter . The evidence demonstrates that the energy technologies available and the CO_2 reductions that may be achieved differ according to the type of development and its location in the district. Three different character areas have been identified to reflect this local variation.

This approach allows us to take advantage of the distinct merits of the planning system in promoting decentralised renewable and low carbon energy without unnecessarily stretching its remit where other regulatory or support regimes may be better placed to take a lead. Importantly, the focus on delivery mechanisms also allows us to address the difficult issue of developer viability by potentially shifting much of the additional cost burden away from developers and onto third parties.

Policy recommendations and predicted CO_2 savings are based on the assumption that the trajectory to zero carbon continues as proposed and that as-built development matches design. Changes to national policy, including future proposals for the Building Regulations, would alter the relative impact of the policies described here. In this event, the policy recommendations described here should be reviewed.

The following policy recommendations are made either for incorporation into Core Strategies or other local development documents or guidance.

9.30 The Energy Opportunities Plan

The district or borough specific Energy Opportunities Plan should be incorporated into Core Strategies and should be reviewed regularly to ensure they remain up-to-date.

Core Strategy Recommendation 1: The Energy Opportunities Plan

Planning applications for new development will need to demonstrate how they contribute to delivery of the opportunities identified in the current Energy Opportunities Plan. Different energy technologies and CO_2 reduction strategies will suit different parts of the district/borough and different types of development. To reflect this we have identified three character areas: as shown in the Energy Policy Map (*LPA to insert reference to the EOP*):

- Energy constrained – Areas where district heating or energy from wind is either not feasible or viable. Due to the constrained nature of the site, developers will be required to achieve CO_2 emissions reductions in line with Building Regulation Part L (non domestic buildings) and the Code for Sustainable Homes (Domestic Buildings). However, developments would still be expected to explore the feasibility of other opportunities for renewable or low carbon energy generation, from microgeneration or biomass for example. Larger development sites that come forward within energy constrained areas may be suitable to support renewable and low carbon technologies that would allow higher carbon reduction targets to be met. This will be assessed on a site-by-site basis.
- District heating – the Council's ambition is to develop networks across each district heating priority area. New development in these areas should, where possible, contribute to this objective by considering district heating as their first option for the heat supply to the site.
- Wind – wind priority areas have been identified to encourage consideration of wind turbines as stand-alone projects or turbines linked to new and existing development.

A district/borough-wide Supplementary Planning Document will be prepared for each character area to help developers understand what is expected of them for the different development types set out in these Character Areas.

Policy Justification

The Energy Opportunities Plan acts as the key spatial map for energy projects in Hertfordshire. It underpins the policies described here and sets out where money raised through mechanisms such as the Community Infrastructure Levy (CIL) could be spent. It should be used to inform the Sustainable Community Strategy and other corporate strategies, and investment decisions taken by the local authority and local strategic partnership (see Appendix D for further detail on delivery mechanisms).

The energy opportunities include commercial and community scale wind; district heating using waste heat from local sources or from community scale CHP, particularly if development is led by the Council; biomass boilers and other microgeneration technologies. However, the policy does not seek to rule out any other technology if it is in-line with council objectives to deliver reductions in CO_2 or increase the supply of decentralised renewable and low carbon energy.

The character area approach is designed to help applicants determine which technologies are likely to be most suited to a given area. It also seeks to encourage energy installations that will contribute to delivering all opportunities identified in the current Energy Opportunities Plan in the most effective way. The policy recognises, however, that the pace of change is rapid in this field and new technologies are likely to become viable and feasible within the lifetime of this plan and that the applicability of existing technologies to different development types is also likely to change. This could mean the technologies not currently considered suitable to particular areas may become so. It is not the intention to restrict this kind of innovation and LPAs should be prepared to discuss proposals that deviate from the Energy Opportunities Plan and character areas with applicants at the pre-application stage. The SPD will provide information to inform pre-application discussions, including which technologies work well together and which do not.

The policy recognises that different character areas and development types will have different opportunities for achieving CO_2 reductions. For example, developments in energy constrained areas will have fewer opportunities for delivering CO_2 reductions cost effectively than those in the other two character areas. Similarly, small developments are also likely to have fewer opportunities than major development (i.e. applications for development over 10 residential units, 1,000 sqm of commercial).

Core Strategy Policy Recommendation 2: Energy and CO_2 Reductions for New Developments in Energy Constrained Areas

All new residential developments in **Energy Constrained Areas** will be required to achieve the following levels of the Code for Sustainable Homes (Code) as a minimum. This requirement will not come into effect until successive updates to Part L of the Building Regulations become mandatory:

- 2010 –Code level 3 as a minimum will be required for all new homes once updates to Part L come into effect (currently scheduled for October 2010).
- 2013 - Code level 4 as a minimum will be required for all new homes once updates to Part L come into effect.
- 2016 - Code level 6 will be required for all new homes once updates to Part L and the national Zero Carbon Homes policy come into effect.

All new non domestic buildings in Energy Constrained Areas will be expected as a minimum to achieve CO_2 emissions reductions in-line with the Building Regulations Part L. This requirement will not come into effect until successive updates to Part L of the Building Regulations become mandatory:

- 2010 – 25% reduction in the Building Emission Rate compared to the Target Emission Rate defined by the Building Regulations (currently scheduled for October 2010).
- 2013 – 44% reduction in the Building Emission Rate compared to the Target Emission Rate defined by the Building Regulations (reductions above 70% can be delivered using allowable solutions).
- 2019 Zero Carbon – no additional requirement.

Where the proposed new development is located within an Energy Constrained Area, the local authority expects the Energy Opportunities Plan to be used to explore other opportunities for renewable and low carbon energy generation (other than wind or district heating) in order to help meet Building Regulation minimum levels and / or Code for Sustainable Homes. Other opportunities could include microgeneration or heat from biomass for example.

Core Strategy Policy Recommendation 3: Energy and CO_2 Reductions for New Developments in District Heating Opportunity Areas

All new residential developments of 10 dwellings or more in **District Heating Opportunity Areas as a minimum** will be required to achieve the following levels of the Code for Sustainable Homes (Code). This requirement will not come into effect until successive updates to Part L of the Building Regulations become mandatory:

- 2010 –Code level 4 as a minimum will be required for all new homes once updates to Part L come into effect (currently scheduled for October 2010).
- 2013 - Code level 5 as a minimum will be required for all new homes once updates to Part L come into effect.
- 2016 - Code level 6 will be required for all new homes once updates to Part L and the national Zero Carbon Homes policy come into effect.

All new non domestic buildings of 1000 sqm ore more in **District Heating Opportunity Areas** as a minimum will be expected to achieve the following CO_2 emissions reductions in advance of the Building Regulations Part L. This requirement will not come into effect until successive updates to Part L of the Building Regulations become mandatory:

- 2010 – 44% reduction in the Building Emission Rate compared to the Target Emission Rate defined by the Building Regulations.
- 2013 – 100% reduction in the Building Emission Rate compared to the Target Emission Rate defined by the Building Regulations (reductions above 70% should be delivered using allowable solutions).
- 2019 - Zero Carbon – no additional requirement.

New development in District Heating Opportunity Areas should, where possible, contribute to this objective by considering district heating as their first option for meeting the target. It is important to recognise that different development types will have different opportunities, therefore:

- All developments should seek to make use of available heat from district heating networks, including those supplied by heat from waste management sites or power stations.
- Larger developments should consider installing a district heating network to serve the site. The ambition should be to develop strategic area wide networks and so the design and layout of site-wide networks should consider the future potential for expansion into surrounding communities. Where appropriate, applicants may be required to provide land, buildings and/or equipment for an energy centre to serve existing or new development.
- New development should be designed to maximise the opportunities to accommodate a district heating solution, considering: density, mix of use, layout, phasing and specification of heating, cooling and hot water systems.

An SPD will be prepared and will set out the approaches that developers might adopt to deliver the target.

These requirements will apply to a development in or adjacent to a District Heating Opportunity Area or located close to potential sources of waste heat unless the applicant can demonstrate that compliance with these requirements on a particular site is either not feasible or not viable.

(Note for LPAs: If a Carbon Buyout Fund is to be created then the following text is recommended)

If an applicant can demonstrate that compliance with the target or the specific requirements is not feasible on site, a payment into the Carbon Buyout or ‘Allowable Solutions’ Fund will be required.

Small Developments

Small developments (under 10 residential units or 1,000 sqm of commercial) should consider connection to available district heating networks. Where a district heating network does not yet exist, applicants should consider installing heating and cooling equipment that is capable of connection at a later date.

Core Strategy Policy Recommendation 4: Energy and CO_2 Reductions for New Developments in Wind Opportunity Areas

All new residential developments of 10 dwellings or more in **Wind Opportunity Areas** as a minimum will be required to achieve the following levels of the Code for Sustainable Homes (Code). This requirement will not come into effect until successive updates to Part L of the Building Regulations become mandatory:

- 2010 –Code level 4 as a minimum will be required for all new homes once updates to Part L come into effect (currently scheduled for October 2010).
- 2013 - Code level 5 as a minimum will be required for all new homes once updates to Part L come into effect.
- 2016 - Code level 6 will be required for all new homes once updates to Part L and the national Zero Carbon Homes policy come into effect.

All new non domestic buildings of 1000 sqm or more in **Wind Opportunity Areas** as a minimum will be expected to achieve the following CO_2 emissions reductions in advance of the Building Regulations Part L. This requirement will not come into effect until successive updates to Part L of the Building Regulations become mandatory:

- 2010 – 44% reduction in the Building Emission Rate compared to the Target Emission Rate defined by the Building Regulations.
- 2013 – 100% reduction in the Building Emission Rate compared to the Target Emission Rate defined by the Building Regulations (reductions above 70% should be delivered using allowable solutions).
- 2019 - Zero Carbon – no additional requirement.

New development in wind opportunity areas should consider wind as their first option for meeting the requirements of Policy 4. Wind Opportunity Areas have been designated to encourage applications for all scales of wind turbines, particularly but not exclusively:

- From community groups, co-operatives and individuals
- Related to new domestic and non-domestic developments. Large and mixed-use developments in appropriate locations should consider installing a wind turbine or turbines to serve the site’s energy needs.

These requirements will apply to a development in a Wind Opportunity Area unless the applicant can demonstrate that compliance with these requirements on a particular site is either not feasible or not viable.

(Note for LPAs: If a Carbon Buyout Fund is to be created then the following text is recommended)

If an applicant can demonstrate that compliance with the target or the specific requirements is not feasible on site, a payment into the Carbon Buyout or ‘Allowable Solutions’ Fund will be required.

Wind power will play an important role in reducing CO_2 emissions and increasing installed renewable and low carbon energy capacity. Criteria policies should be prepared to guide applicants and development management decisions.

Policy justification – targets

Changes to the Building Regulations in 2010, 2013, 2016 and 2019 are expected to bring in tighter standards for CO_2 emissions. After 2016 it will be necessary for all new residential buildings to be delivered as zero carbon homes, with the equivalent standard for non-residential buildings due to be introduced in 2019. The role of planning in requiring new development to incorporate such technologies should therefore be limited to a supporting one.

The intention is to encourage applicants to reduce CO_2 emissions from proposed development beyond the Building Regulations requirements, where feasible and viable, and to obtain financial contributions towards community scale renewable and low carbon energy infrastructure. Three target options are recommended for a combination of targets and/or payments into a Carbon Fund, represented by the policy options above.

The targets proposed seek to accelerate the move towards zero carbon ahead of Building Regulations. All new buildings over a set threshold - both residential and non-residential - would be expected to achieve CO_2 emissions reductions one step ahead of the Building Regulations Code Level equivalent with the exception of developments in Energy Constrained Areas. This should be met through a combination of passive energy efficiency measures, incorporation of active energy efficiency, on-site renewable and low carbon energy technologies and direct connection to heat or power (not necessarily on-site).

The proposed policy provides flexibility in proposing renewable and low carbon solutions. The policy recognises that different opportunity areas and development types will have different opportunities for achieving CO_2 reductions. For example, new residential development in energy constrained areas will have fewer opportunities for delivering CO_2 reductions cost effectively than those in the other two opportunity areas.

The proposed policy should be simple to operate for both development managers and developers. Development managers can assess compliance with the targets by asking for design stage and as-built Building Control Compliance documentation.

The evidence base produced in support of this policy demonstrates that the targets should be achievable with minimal impact on overall development costs compared to the Building Regulations base case. It is up to the applicant to demonstrate this to the contrary on a case-by-case basis. However, it is recognised that there may be circumstances when it is not possible or desirable. An example might be in an energy constrained conservation area, where microgeneration technologies may be considered unacceptably intrusive. For such cases there is the option of introducing a Carbon Buyout or ‘Allowable Solutions’ Fund, with contributions based on the residual carbon emissions after any energy efficiency or on-site generation measures. The Carbon Buyout Fund would act as a ‘stop-gap’ before ‘Allowable Solutions’ are brought in through the Building Regulations (note – the Allowable Solutions mechanism is still out to consultation).

Policy justification – district heating

The PPS1 Supplement and the draft PPS actively encourage seeking opportunities to set higher standards on specific sites where it can be justified on viability and feasibility grounds. The purpose of this policy is to prioritise district heating in areas where opportunities are the greatest.

The long-term ambition should be to deliver a strategic district heating network across the district heating opportunity areas. Developments will need to show in a design and access statement or energy statement their assessment of the potential to deliver a reduction in the development’s CO_2 emissions to the target level using a district heating network. It is recognised that the opportunities for installing such a network across existing communities are, for the most part, beyond the scope of planning. Therefore, the policy requires development to be able to connect once such a network is in place and to be designed to be compatible with future networks, in terms of layout, density and so on. The policy requires larger more strategic new developments to install their own network, which can later be connected up to a larger network or incorporate existing nearby buildings. This has the benefit of reducing CO_2 emissions in new development and contributing to the longer term objective.

Where appropriate, applicants may be required to provide land, buildings and/or equipment for an energy centre to serve proposed or multiple developments. Such a requirement will be important for ensuring availability of the necessary space in the right location for an energy centre designed to serve more than one development. It is expected that requirements will be discussed in pre-application discussions and will be included as part of a planning condition. In order to provide additional certainty to the installation of district heating networks it is recommended that a Local Development Order be considered for the district heating opportunity areas.

This policy supports the approach of building up large scale networks over time. This barriers and challenges associated with developing large scale networks can hinder their development. Therefore by using policy to support smaller scale schemes in different developments and areas, opportunities are provided for combining these into larger scale networks at a later date.

Criteria that have been used to define the district heating opportunity areas are set out below.

- New development:
    - Large scale mixed use development – enables good anchor load and diversity of heat demand
    - Proximity to high heat density areas of existing buildings – enables extension into existing development
    - Proximity to existing heat sources
- Existing development:
    - Heat demand density of at least 3,000kW/km^2. These areas generally have higher density residential or commercial buildings. The presence of large public sector buildings can assist with acting as a catalyst for schemes.
    - Proximity to sources of heat (e.g. industrial processes) – enables zero carbon energy source

The final wording of this policy and its justification will need to be based on decisions taken about the wider role of the local authority and its partners. Options and their implications for planning policy are discussed in more detail in Chapter 10.

Policy justification – wind

The planning policy approach represents the application of national policy to the Hertfordshire context. The PPS1 Supplement on Planning and Climate Change and PPS22 (Renewable Energy) are both supportive of wind power and this policy has been worded accordingly. The primary driver for such a strongly worded supportive policy for wind are the twin challenges of achieving the national legally binding 34% reduction in CO_2 emissions over 1990 levels by 2020 and the equally binding requirement for the UK to generate 15% of its total energy from renewable sources, also by 2020. The Government's Renewable Energy Strategy expects a significant proportion of this to be delivered from onshore wind. It is evident therefore that every available opportunity for wind power needs to be taken advantage of.

The Energy Opportunities Plan is likely to be more directed at opportunities for community scale wind turbines since commercial developers looking to install large scale wind turbines are likely to develop their own constraints maps. Therefore policies should be prepared to guide applicants and development management decisions for community scale turbines.

The wind opportunity areas seek to promote community scale turbines. As such, the designation is based on the following criteria:

- Good local wind resource, consider hilltops, avoid forested areas.
- Close to electricity infrastructure (e.g. 10-30kV power lines, substations) to connect to grid.
- Close to roads, railways for easier transport of components to site.
- Close to the community involved (but not close enough to cause noise issues).
- Consideration of environmentally and archaeologically sensitive areas.
- Consideration of areas of high landscape quality (e.g. AONBs).
- Consideration of local airports and defence structures (e.g. radars and flight paths).
- Consideration of local residential areas.

Clearly some of these criteria are the same as those used by commercial wind developers. An important distinction is the proximity to the community involved. Here we have assumed that communities investing in their own wind turbine would be keen to be able to see it, but equally these locations are less likely to be of interest to commercial developers.

Developers within wind opportunity areas will need to show in a design and access statement that they have fully considered the potential to deliver the required targets using a wind turbine or turbines on site. Where no opportunities exist on-site applicants should demonstrate that they have considered off-site opportunities.

The final wording of this policy and its justification will need to be based on decisions taken about the wider role of the local authority and its partners. Options and their implications for planning policy are discussed in more detail in Chapter 10.

9.31 Carbon Buyout / Allowable Solutions Fund

The planning policy wording recommendations above include allowance for a 'Carbon Buyout / Allowable Solutions Fund' where applicants can demonstrate that compliance with the proposed target or the specific requirements is not technically feasible using 'on-site' energy efficiency or low/zero carbon energy solutions alone. Payment into the fund would be made per tonne of carbon emitted by the development, depending on the predicted carbon emissions for each building (based on the Building Regulations energy model).

The intention of the Carbon Buyout fund would be to act as a 'stop-gap' before the expected 'Allowable Solutions' mechanism is introduced through Building Regulations. The proceeds of the fund could be spent on low carbon infrastructure and energy efficiency initiatives across the district/borough or the County, as identified within the Energy Opportunities Plan (EOP). Potential investment opportunities from the proceeds of the fund could follow those identified in the Consultation on the Definition of Zero Carbon Homes and Non-Domestic Buildings[50]. The final list has yet to be confirmed but may include:

- Energy efficient appliances
- Advanced forms of building control systems which reduce the level of energy use in the home
- Exports of low carbon or renewable heat from the development to other developments
- Investments in Renewable and Low Carbon community heat infrastructure

Other 'allowable solutions' remain under consideration. A final Government announcement is expected towards the end of 2010.

Whilst this study has not tested the potential impact on viability of different levy contributions, the Impact Assessment that accompanied the definition of Zero Carbon Homes[51] suggested a cap of £100 per tonne of CO_2 emitted. The levy would be charged on any residual CO_2 emissions remaining after taking into account reductions from energy efficiency and 'on-site' low and zero carbon energy generation. The £100 contribution level would need to be reviewed following further publication of any consultation documents or approved regulations in relation to 'Allowable Solutions'.

Milton Keynes Council has pioneered the introduction of Carbon Buyout Funds in the UK (see case study below). Similar schemes are also planned for Ashford in Kent, Reigate and Banstead in Surrey, and Brighton.

Case Study: Milton Keynes – Carbon Offset Fund

Milton Keynes Council introduced a 'Carbon Offset Fund' in 2007 which raises money by taxing new development which emits carbon dioxide. The money raised is spent on upgrading the energy efficiency of existing homes.

Under the initiative, developers pay into a fund according to the carbon emissions generated by their buildings in return for planning permission. Developers pay a one-off tax at a rate of £200 per tonne of carbon dioxide generated by the scheme each year. This works out at £400 for a typical new home but if a scheme is carbon neutral, developers do not pay anything. The money is collected using a section 106 agreement and is payable on completion of the scheme.

The scheme was introduced in April 2007 with payment required when the development is completed. The council has set up a not-for-profit company to administer the scheme, which offers cavity wall and loft insulation at the subsidised price of £95 per item.

[50] Definition of Zero Carbon Homes and Non Domestic Buildings, Dec 2008, DCLG
[51] Definition of Zero Carbon Homes – Impact Assessment, Dec 2008, DCLG

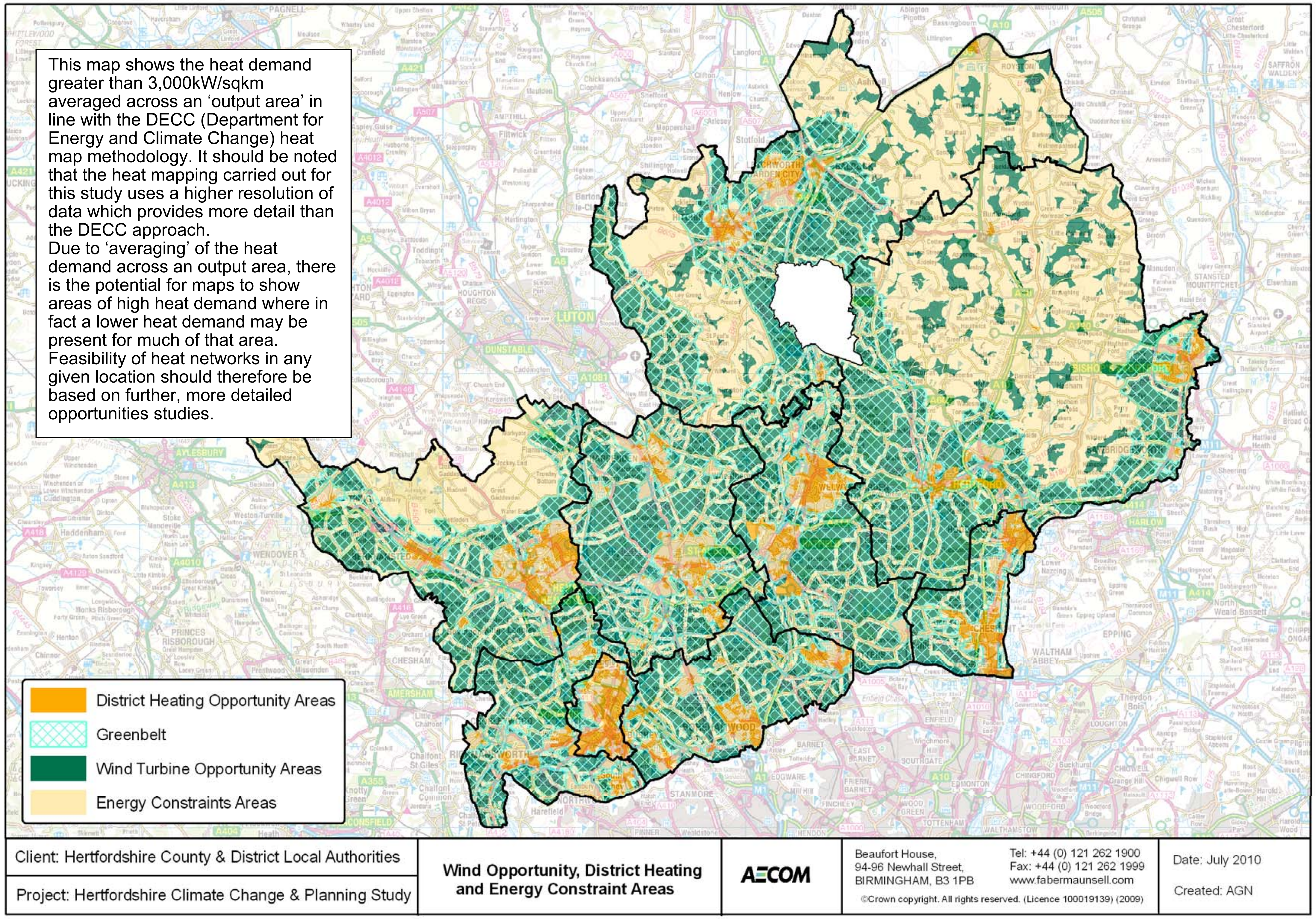

Figure 9.22 – Map showing large scale wind opportunity, district heating opportunity and "energy constrained" areas

10 Delivering Renewable & Low Carbon Energy in Hertfordshire

10.1 Introduction

Along with planning policy, targets provide a useful mechanism for articulating to stakeholders the extent of the challenge around achieving maximum carbon savings through low carbon and renewable energy solutions. They also enable us to assess progress and, if necessary, to revise targets in order to meet agreed objectives. However, to be effective, policies and targets need to have a strategy for delivery. This strategy will need to address:

- What the objectives of the policy or targets are
- What is the appropriate mechanism for delivery
- Who is responsible for their delivery
- An action plan

This chapter describes some of the mechanisms available to Hertfordshire to deliver the principal opportunities for decentralised renewable and low carbon energy opportunities identified in the Energy Opportunities Plan. It is not intended to be an exhaustive list, nor does it reach definitive conclusions about which mechanisms are most suited to the Hertfordshire LPAs. Rather it seeks to clarify the importance of considering delivery at the same time as planning policy and provide guidance on what opportunities exist and where further work is required. Making clear recommendations on what approach will be suitable for Hertfordshire will require a more detailed study involving discussions across the LPAs and with partners.

Using the Energy Opportunities Plan this chapter considers delivery mechanisms across three character areas:

- Energy constrained areas
- District Heating opportunity areas
- Wind opportunity areas

It addresses both new and existing development, and different scales of development.

10.2 Character Area 1: Energy Constrained

10.2.1 Existing development

The CO_2 savings that can be achieved through improvements to existing buildings are substantial and this should be a priority across all areas. In addition to energy efficiency measures, there is potential to retrofit low carbon and renewable energy microgeneration technologies within existing development. This cannot easily be required by planning, but can be encouraged by the Council, which can seek to engage communities and highlight the benefits of microgeneration, especially with the introduction of the Feed-in-Tariff for electricity and the Renewable Heat Incentive for heat. (Appendix D)

There are funding sources already available to homeowners and businesses to assist with the capital cost of installing CO_2 reduction solutions. These include Warm Front, Carbon Emissions Reduction Target (CERT), the Big Lottery Fund Community Sustainable Energy Programme (CSEP) and the Energy Saving Trust Low Carbon Communities Challenge. Further details are contained in Appendix D.

Most funding for improving the energy performance of the existing stock, including Community Energy Saving Programme and CERT, are coordinated through utility companies. The government's recently published Household Energy Management Strategy suggests that more co-ordinated approach to the street or neighbourhood level will be necessary to deliver the level improvements necessary to meet the demanding CO_2 emission reduction targets required through the Climate Change Act. It is expected that local authorities will assume this responsibility.

In the meantime, local authorities have the powers to deliver energy opportunities in the existing stock using the Wellbeing Power. There are examples of the use of this power for this purpose by local authorities around the country: South Hams Council used the power as the basis of a District/County agreement to establish a waste transfer station; Nottinghamshire County Council use it to set up a non-profit wood fuel distribution company limited by guarantee; and Torbay Council used it to set up a public-private partnership regeneration company.

Other potential mechanisms that could be used individually or as a package by Hertfordshire's LPAs to stimulate the uptake of energy efficiency measures and microgeneration technologies are described below. Responsibility for delivery and management of these mechanisms could be assumed by each Council itself. Alternatively, it is possible to enter into a partnership with a third-party provider or to set up a special purpose vehicle.

- *Discount provision* – available finance could be used by the Council to bulk buy technologies, enabling them be sold on at a discount to households and businesses.
- *Householder or business hire purchase* – Local authorities could establish an initiative to lease appropriate technologies to householders and businesses. For microgeneration, rental costs could be charged as a proportion of the feed-in-tariff received by the beneficiary. After a period of time, ownership of the technology would transfer to the householder or business.
- *Householder or business rental* – a third model could be for each Council, consortium of councils, or another delivery vehicle of choice, to retain ownership of the technologies and to rent roof or other suitable space from homeowners, businesses and other organisations. Again, rental costs would be set as a proportion of income from the feed-in-tariff. As with the hire purchase option, this approach would give benefits of low carbon and renewable energy to communities without the up-front expense. The advantage of this option would be the retention of control over phasing and technology choice, and greater flexibility to respond to changes in technology and demand.

Delivery options for CO_2 reductions in existing development

CO_2 reduction measures	Delivery option
Increased energy efficiency	Provision of discounted CO_2 reduction solutions
	Hire purchase of CO_2 reduction solutions
	Rental of space for CO_2 reduction solutions
	Awareness and education campaign for householders and businesses.
	Salix Finance
Increased microgeneration	Warm Front
	Carbon Emissions Reduction Target
	Big Lottery Fund Community Sustainable Energy Programme (CSEP)
	Energy Saving Trust Low Carbon Communities Challenge

Table 10.1: Delivery options for existing development. Details of schemes mentioned above are provided in Appendix D.

10.2.2 New development

Building Regulations are the primary drivers for higher energy performance standards and renewable and low carbon energy generation in new developments. The role of the Hertfordshire LPAs is therefore limited beyond specifying more stringent planning policies to achieve this.

Another option is to apply conditions to sales of local authority owned land, whereby a lower than market value sale price is agreed with the developer in return for a commitment to meet higher specified sustainability standards. Rules governing this are contained within the Treasury Green Book which governs disposal of assets and in within the Best Value - General Disposal Consent 2003 'for less than best consideration' without consent. It is our understanding that undervalues currently have a cap of £2 million without requiring consent from Secretary of State.

10.3 Character Area 2: District Heating Opportunity Areas

Large area wide district heat and power schemes in both new and existing development may be sufficiently large to contribute to local authority, regional or national energy generation targets rather than primarily mitigating increases in CO_2 emissions resulting from new development. The government proposals for allowable solutions post 2016 will place emphasis on local authorities to identify and support delivery of community scale solutions, and developing district heating networks in suitable areas is potentially one of the key solutions for which this investment could be used.

Table 10.2 illustrates the potential value of allowable solutions investment based on a value of £100 per tonne CO_2 over a 30 year lifetime for a number of different development sizes under Code level 5 and level 6. This assumes that all CO_2 reductions above carbon compliance are met through allowable solutions off-site.

Number of dwellings	Code level 5 (30% CO_2 reduction through allowable solutions) Potential allowable solutions contribution £	Code level 6 (80% CO_2 reduction through allowable solutions) Potential allowable solutions contribution £
10	£4,800	£12,800
50	£24,000	£64,000
200	£96,000	£256,000
1000	£480,000	£1,280,000
5000	£2,400,000	£6,400,000

Table 10.2: Potential local investment from allowable solutions funding for different scale developments.

To maximise the benefit of community heating schemes, the scale of the system needs to be maximised, therefore requiring the involvement of potentially many bodies and structures across both the new build and existing sectors. The drivers for district heating networks in the new and existing sectors are different, with regulation and planning acting on the new sector, and markets acting on the existing sector, and it is the role of the local authority to strategically drive forwards the delivery of schemes by providing the necessary support and coordination to the relevant parties.

De-risking of district heating schemes is a key requirement for attracting interest in developing schemes. There are a number of ways in which the public sector can assist with this process:

- Providing initial input into the assessment of potential schemes and developing strategies for the delivery of schemes.
- Providing support through planning to mandate the connection of new developments and for planning applications associated with the development of the scheme infrastructure (for example, energy centres, and road works).
- Providing material support in terms or the provision of land.
- Providing long term contractual support through signing long term energy purchase contracts with the scheme provider.
- Providing finance into the scheme in the form of low cost loans or subsidises, potentially from allowable solutions money.
- Providing coordination and marketing support, by promoting the scheme to other local public and private organisations to encourage connection uptake.

There are a number of ways in which the public sector can provide this support. One extreme is that the scheme is entirely developed by a third party developer of Energy Services Company (ESCo), and the public sector provides support to this commercial organisation. The other extreme is that the public sector (most likely the local authority) becomes the ESCo itself, and develops and operates the scheme, selling heat and power. A more commonly discussed option is where the local authority forms a partner in a joint venture for developing schemes, becoming a partner in an arm's length company which owns and operates the schemes. The advantages of this are that the local authority maintains a degree of ownership and control over the scheme, and private sector finance and expertise can be levered. One example of this is the Aberdeen CHP scheme which was set up initially to deliver heat and power to high rise block of flats containing a mix of social and private housing [52]. The role of an ESCo is discussed further under Section 10.5.

10.3.1 Existing development

Proposed delivery mechanisms for existing development in this character area will be the same as the Character Area 1.

10.3.2 New development

Some of the options for delivering the energy opportunities plan are described in the following sections and listed in Table 10.3, with more detail provided in Appendix D.

Delivery options for CO_2 reductions in new development	
CO_2 reduction measures	**Delivery option**
Lower CO_2 emissions standards Higher sustainability standards	Conditions attached to local authority owned land sales Policy requiring high sustainability standards Policy requiring connection to district heating networks Policy requiring lower CO_2 emissions

Table 10.3: Delivery options for new development

Many of the options for funding offer relatively small amounts of money which are unlikely to make significant inroads into delivery of the Energy Opportunities Plan. One possible solution, which is both a planning and a delivery mechanism, is to prioritise delivery of energy opportunities through spending of money raised through a Carbon Buyout Fund. It is likely that such a fund will be operated through the Community Infrastructure Levy (CIL), which unlike Section 106 contributions can be used 'to support the development of an area' rather than to support the specific development for which planning permission is being sought. Therefore, contributions collected from development in one part of the charging authority can be spent anywhere in the borough. It is our understanding that CIL money can be spent on infrastructure projects (the definition of infrastructure includes renewable and low carbon energy technologies) delivered by the public or private sectors or partnership between the two. This flexibility will enable a Council, as a 'charging' authority, to fund energy infrastructure identified in the energy opportunities plan.

[52] More information on this and other ESCo schemes can be found in "Making ESCos work" – London Energy Partnership 2007.

To progress this opportunity Hertfordshire LPAs would need to:

- Develop a charging schedule that is subject to the same level of scrutiny as a development plan document.
- Set out the proposed amount to be levied, expressed as a cost per meter squared.
- Consider the impact of a levy on scheme viability.

10.3.3 Establishing a biomass supply chain

This study has identified biomass as a good potential resource for delivering CO_2 reductions in the County. Similar studies for neighbouring counties are likely to reach the same conclusions and since the available resource is finite and relatively limited, it is useful to take a County or even region-wide approach to sourcing and supply to ensure that sufficient biomass is available, but also that its use is managed and sustainable. There is a potential role for the local authorities or County to help develop a biomass supply chain, to coordinate the collection and growth of biomass across the County. A structured approach along these lines will help de-risk the uncertainties about biomass supply to energy scheme developers, so that guaranteed and regular biomass supplies are available. Developing the supply chain will require the coordination of a number of bodies including forestry companies, private land owners, and waste management companies.

A greater use of biomass as a fuel raises some concerns which need addressing. Biomass is generally transported by truck and therefore transport CO_2 emissions should be taken into account. There is conflicting evidence as to the environmental impact of transporting biomass against the CO_2 saved when used as a fuel. A recent report by the Environment Agency provides data which suggests an increase in CO_2 emissions of between 5% (wood chip) and 18% (wood pellets) for European imports, but the data is not clear for transport within the UK. As there is a good potential biomass resource in the County and therefore supply would be local, transport-related emissions may not be a concern in Hertfordshire. (Note –the CO_2 emissions factors used for biomass in Building Regulations include an allowance for transportation. This is clearly an average value and the actual value will depend on the supply chain used).

10.4 Character Area 3: Wind Opportunity Areas

There is considerable controversy over the development of large scale wind in the rural areas of Hertfordshire, as highlighted in the recent plans for a small scale wind farm of three turbines at Benington. Whilst the overall potential for Hertfordshire is relatively limited, the energy opportunities mapping in this report identifies a still significant potential for large scale wind which should be exploited. Objections around wind farm development tend to be based on poor science and misleading information which in many cases has no scientific basis and is not borne out by existing installations. In addition the fact that most applications are from large profit making commercial organisations does not tie in well with local communities since they are unlikely to see any of the benefits.

The local authorities therefore have a key role in encouraging the uptake of wind turbines in Hertfordshire, and potential delivery mechanisms include:

- Supporting communities to develop community owned project of a small number of turbines. There is anecdotal evidence from across Europe that community ownership of wind turbines, where a profit share is retailed by the local residents can increase the acceptance of wind turbines. Income is generated by electricity revenue and incentives such as ROCs. There is a potential role for local authorities to become a partner in delivering community wind project, thus providing support financing and planning.
- Education. The role of education in delivering low carbon energy schemes was seen as key in the workshops for this study, and the local authorities and education authority should coordinate activities in this areas. A range of education measures can be used to educate communities and school children to ensure to ensure than people have the real facts about wind and are not swayed misinformation.

In new developments based in areas identified as having potential for wind generation, the local authorities should support applications which make use of wind on or near these sites. In general, large scale turbines are far more effective and their installation should be encouraged over smaller scale systems which may provide negligible benefits. In new development, the potential for community ownership remains important (and may be encouraged through allowable solutions where shares in off-site turbines are provided to house owners to provide a real "link" between the turbines and development). In addition the role of education remains important for both the new development residents and surrounding areas.

Two examples of successful community wind projects are provided opposite:

Community owned wind farms – case study

Westmill Wind Farm, Oxfordshire

www.westmill.coop

Westmill is the first wind farm in the South East of England and the first 100% community owned scheme in the UK from commissioning. The scheme produces pollution-free electricity for over 2,500 average homes.

The wind farm has five towers erected in a straight line across an old airfield, near Watchfield, South Oxfordshire. The electricity generated is conveyed by an underground cable to a sub-station, where it is metered and fed into the local grid. Crop farming may continue as before with planting taking place right up to the base of the towers.

The turbines are run by Westmill Wind Farm Co-operative Ltd, an Industrial & Provident Society based on the highly successful wind farm run in Cumbria by Baywind Energy Co-operative Ltd. Westmill Co-op has 2,374 members. The co-op financed the purchase and construction of the five wind turbines through a 4.6m fundraising campaign that saw the public able to buy shares in the project and was supplemented by a bank loan.

The share launch and project development was managed by Energy4All established to provide support to co-operative wind farm projects around the UK. The land owner is Adam Twine, an organic farmer with an interest in community and environmental issues, who secured the required planning consents.

Westmill has been established to provide an opportunity for all who are concerned with the effects of climate change to become involved in the ownership and operation of a wind farm. It was especially, but not exclusively, aimed at groups and individuals local to the Wind Farm.

This is the first project of its kind in Southern England and its importance has been recognised by the award of a capital grant from South East England Development Agency (SEEDA).

Small scale wind turbine – case study

Beaumont Primary School, Suffolk

Beaumont Community Primary School opened in September 2003, located on a hill to the Western edge of Hadleigh in Suffolk. The single storey, cedar clad building has accommodation for 140 pupils.

The School installed a 6 kW Proven wind turbine that generates enough electricity to run all the computers in the IT suite. The turbine was partly funded by the government's Clear Skies initiative and SCC. A further 1kW is produced by a number of photovoltaic panels mounted on the roof, also part-funded by a grant from the DTI.

A computer in the school's reception area can tell pupils how much electricity is being generated at any particular moment.

"The children have quickly taken on board the whole concept of renewable energy," said the head teacher, Stella Burton. "We are sure that they will use the knowledge and understanding that they have gained to improve their future lives and the lives of those around them."

When more electricity is generated than the school needs, the surplus is sold back to the national grid.

Ref: Jessica Aldred
http://education.guardian.co.uk/pictures/0,8552,1595002,00.html

10.5 Delivery Partners

It is clear that a planned approach is necessary, with targets complemented by spatial and infrastructure planning. The implications of this for councils are significant. We are no longer simply talking about a set of planning policies; rather success depends on coordination between planners, other local authority departments (including the corporate level) and local strategic partners.

A coordinated relationship between planning, politicians, the local strategic partnership (LSP) and other local authority departments, including legal, finance, and environment and housing, will be crucial. To be effective, leadership will be needed by the LSP, the environment sub group and elected members to provide strategic direction for energy policy and delivery of the Energy Opportunities Plan. Opportunities for a County-wide partnership should also be explored.

The two central documents for coordinating delivery of low carbon and renewable energy projects at the local level are the local authority Community Strategies and Local Development Frameworks (LDF) prepared by the planners. The Community Strategy must make sufficient mention of energy and climate change and provide clarity on commitments or targets. Both documents need to set out a clear delivery plan for policies and targets.

Consideration will need to be given to the extent of private sector or community involvement. Where market delivery is not forthcoming, councils can lead delivery of energy infrastructure, potentially with support from the private sector, investors or even communities. Communities may also want to join together to deliver energy infrastructure, investing and in capital cost and receiving income from selling energy.

Delivery options for district heating and wind solutions	
CO_2 reduction measure	**Delivery Option**
Wind energy	Local authority-led delivery vehicle partnership established through Powers of Wellbeing Privately owned ESCo Merchant wind (e.g. Partnerships for Renewables, EDF) Local Development Orders Cooperatives CIL Allowable solutions
District Heating with CHP	Local authority-led delivery vehicle partnership established through Powers of Wellbeing Privately owned ESCo Local Development Orders Carbon Trust Investments Carbon Emissions Reduction Target CIL Cooperatives Allowable solutions
Biomass energy	LA-led delivery vehicle or partnership established through Powers of Wellbeing Privately owned ESCo District wide development and coordination of biomass supply chains Single Farm Payment DEFRA Grant Rural Development Programme Allowable solutions Cooperatives Renewable Energy Fund Carbon Emissions Reduction Target EST Low Carbon Communities Challenge

Table 10.4: Delivery options for community-wide CO_2 reduction solutions. Details of the schemes mentioned above are provided in Appendix D

When exploring options for setting up a local authority or County-wide delivery vehicle or partnership it is likely that skills will need to be developed to make this approach successful. This does not need to be an insurmountable barrier and there are a growing number of local authorities engaging in similar activities both in energy and other areas. They key to success is likely to be leadership: leadership from senior local authority management or, at least initially, from committed individuals in planning or other departments.

ESCo models range from fully public, through partnerships between public, private and community sectors to fully private. Broadly speaking, the greater the involvement of third parties the lower the risk to the authority but, importantly also, the less control the authority will have over the company. Whichever route is chosen, it is recommended that the ESCo should be created or involved as early on in the development process as possible, so that its technical and financial requirements can be fed through into negotiations with potential customers.

	Private Sector Led ESCo	Public Sector Led ESCo
Advantages	▪ Private sector capital ▪ Transfer of risk ▪ Commercial and technical expertise	▪ Lower interest rates on available capital can be secured through Prudential Borrowing ▪ Transfer of risk on a district heating network through construction contracts ▪ More control over strategic direction ▪ No profit needed ▪ Incremental expansion more likely ▪ Low set-up costs (internal accounting only)
Disadvantages	▪ Loss of control ▪ Most profit retained by private sector ▪ Incremental expansion more difficult ▪ High set-up costs	▪ Greater risk ▪ Less access to private capital and expertise, though expertise can be obtained through outsourcing and specific recruitment

Table 10.5: Advantages and Disadvantages of ESCo models

10.6 The role of education

The uptake of successful Renewable and Low Carbon energy schemes requires the full buy-in of local communities. Feedback from the workshops held for this study highlighted the fact that many residents, whilst potentially interested in issues around climate change and energy, are primarily driven by cost of energy and are either unwilling, or unable to accept changes to energy supply which may impact their local environments or energy costs. The key factor in this was identified as a lack of understanding of the issues around energy supply and climate change, and the role in which Renewable and Low Carbon technologies can take.

The local authorities and County Council should take an active role in educating Hertfordshire residents about the requirements for, and benefits of Renewable and Low Carbon technologies. This could be through both community engagement, and education through schools and colleges. In particular there is a need to provide accurate and reliable sources of information around controversial technologies such as wind turbines and energy from waste, to help dispel much of the unscientific research and information which is used by anti-campaigners.

At a grass roots level, a highly popular idea discussed by many workshop attendees was the use of schools as demonstration grounds, where suitable technologies are installed as an education aid to both parents and children. Perhaps the most appropriate option is to install small scale turbines (typically 10 – 20m tall) in school playing fields, and this has already been done at certain schools in Hertfordshire. Alongside this, the local authorities and County Council could encourage or enforce developers of energy schemes to engage with local communities and schools in an educational role, for example arranging site visits and open days. An example of where this can be achieved is requiring waste site operators with council waste contracts to meet certain educational criteria.

Appendix A: Workshops

Interim findings for this study were tested with stakeholders at two workshops held at Hertfordshire County Council on 1st March 2010. Its aims were to obtain the opinions of key stakeholders regarding obstacles and opportunities for realising the renewable and low carbon energy resource within the district and the types of planning policies that will be needed in order to facilitate their development.

The following people attended the two workshops

Andrew Dutton	Persimmon Homes
Andrew Turner	Hertfordshire County Council
Andy Beavan	North Herts Council
Anne Day	Welwyn Hatfield Council
Bob Chapman	Hertfordshire County Council
Catriona Ramsay	Watford Borough Council
Casimir Iwaszkiewicz	Inbuilt
Clare May	Three Rivers District Council
Claire Skeels	North Herts Council
Cllr Derrick Ashley	Hertfordshire County Council
Cllr Ian Reay	Dacorum Borough Council
Colin Haigh	Broxbourne Borough council
Cuma Ahmet	Broxbourne Borough Council
Damien Manhertz	Welwyn Hatfield Council
Danny Pollock	MACE
Cllr Derek Scudder	Watford Borough Council
Frank Maloney	Mouchel
Jed Griffiths	Griffiths Environmental Planning
Jerome Veriter	St Albans District Council
John Gavin	Dacorum Borough Council
Justin Weber	Watford Borough Council
Karen Walter	Hertfordshire County Council
Manpreet Kanda	St Albans District Council
Marcos Higueras	Hertfordshire County Council
Martin Paine	East Herts Council
Matt Fisher	MACE
Maureen Armantrading	
Max Sanders	Watford Borough Council
Nathalie Bateman	Dacorum Borough Council
Neil Walker	Watford Borough Council
Nigel Dent	Renewables East
Pat Gold	Mouchel
Paul Baxter	Watford Borough Council
Paul Donovan	Hertfordshire County Council
Paul Sandison	John Laing Partnership Homes
Peter Hill	Welwyn Hatfield Council
Peter Quaile	Broxbourne Borough Council
Petra Klemm	Watford Borough Council
Richard Blackburn	Dacorum Borough Council
Richard Brewster	MACE
Sian Finney MacDonald	Watford Borough Council
Simon Warner	Hertsmere Borough Council
Tony Hincks	St Albans District Council
Tracy Mannings	Broxbourne Borough Council
Yvonne Edwards	Dacorum Borough Council

The key points raised in the exercise were as follows:

Workshop 1: Resource Potential

Have all potential renewable resource been indentified?

Attendees consider that all large renewable resources have been identified. However absence of Hydro Power analysis and small scale renewables were questioned by almost all parties.

There were comments regarding the potential of unused weirs and utilising them for the new developments.

Visual impacts of the large turbines are creating very strong resistance in Hertfordshire.

Waste: It was recommended that we should get in touch with County Council Waste department to have an update on the waste policy especially about the large scale energy from waste plants (for electricity production).

Incineration has no alternative (such as CHP) currently this is because the waste plants are sited away from where the heat is needed. Therefore cost of pipework could be prohibitive.

Strong interest in AD. AECOM explained the cost of transport makes it unviable therefore smaller and local schemes (such as ADd's in farms) are more suitable rather than large central plants.

Energy from Waste pollution concerns – it was requested to please explain in the report to allay fears.

What barriers do local authorities envisage to RLC energy?

Visual impacts of the large turbines are creating very strong resistance in Hertfordshire.

Some suggested there is a large waste wood potential due to woodland trimmings and cuts, agricultural waste etc, however at the moment it is very badly managed due to no interest, funding etc.

Broxbourne Wood management –funding has been cut.

Human Challenge, hard to change people's perceptions, misconceptions etc. people are ignorant and sceptical about renewables and their contribution to overall energy need.

Education and awareness raising are key to the uptake of renewables (this was an overall conclusion)

Specific concerns about biomass waste wood - mixed views/comments/ recommendations on this.

Some suggested there is a large potential due to woodland trimmings and cuts, agricultural waste etc, hence it should be emphasised (potential and perhaps mismanagement in this country)

E.g. Broxbourne Wood management – however funding has been cut - and Hertfordshire hearts biomass management potential

HCC has a very large rural estate hence waste wood potential should be large.

Air quality – this is only a concern in urban areas and AQMA. However more important than this is the misconception about biomass and air pollution is a barrier.

There is no supply chain management of biomass fuel in Hertfordshire. Some don't believe there is a biomass potential and there is no funding to explore the potential and develop a supply chain.

People find the issue complicated (overall biomass including storage, supply chain etc)

Wind: there is a report for East of England – Whole Region Wind Assessment has been carried out and the recommendation is that south of the region (including Hertfordshire) is less windy therefore less viable compared to Cambridgeshire, Norfolk and Suffolk etc.

Human Challenge, hard to change people's perceptions, misconceptions etc.

Recommendations:

Ownership such as community owned wind turbines, promotions and marketing to change people's views

A short section on potential of unused weirs and utilising them for the new developments.

Waste wood potential due to HCC having a very large estate, Herts Hearth and other woodlands it should be emphasised (potential and perhaps mismanagement in this country)

Ownership such as community owned wind turbines, promotions and marketing to change people's views

Workshop 2: Policy formation for new development

Emphasise the usefulness of the study to upcoming Core Strategies. Specifically, the relevance of the energy opportunities map beyond 2016 and of setting policies tougher than Building Regulations before ZeroCarbon to encourage the installation of DH infrastructure. Earlier encouragement of DH infrastructure will allow capacity building and experience that will be crucial when buildings will need to be ZeroC. This will also allow existing buildings to be connected to DHN's, resulting in further CO_2 reductions.

Joined up thinking

Contribution from a developer – there needs to be more joined up thinking and coordination when it comes to building developments. There are a multitude of studies carried out independently, but findings aren't synthesised together to provide clear guidance. Studies carried out in isolation not useful, there is burden on developers to carry out this synthesis.

Viability

What determines viability?

Where will money come from for meeting of policies that exceed BR? (it was felt that money is a significant barrier)

What size of development makes the installation of DHN "viable"? (e.g 500 houses plus 10,000 sqm commercial?) Are there any guidelines?

Is there a need to be prescriptive about viability of installing RLCs? Otherwise the concept is ambiguous and open to interpretation.

If LA asks for CL5 and CL6, where will funding come from to achieve this?

Is there any benefit to developer in meeting policies that exceed BR? (one answer was marketability of property for lower fuel bills; another answer suggested that ESCOs could take the extra cost and risk of installing RLCs and receive payback over longer time period; another answer suggests that payback from RLCs could be shared with developers.

Will there be sufficient space under roads, pavements etc to install district heating pipework in areas of high heat density?

How will DHN's be funded? (currently uneconomic)

How far can you push a developer beyond BR? How can you justify targets beyond East of England Plan?

How can gap between 2013 and 2016 be bridged?

Technical viability

David McKay's book suggests ASHP are the way forward, not gas CHP powered DH (but this will only apply when grid is decarbonised, besides there is flexibility of fuel source with DH)

Policy Consistency

If one LA asks for targets on a development beyond BR, will the developer simply look to build in a less strict LA?

Can there be coordination between all Herts Boroughs and County Council to ensure consistency of targets for new developments?

The idea of making policy site specific was generally accepted.

Monitoring and standards

A number of people pointed out that energy studies for new developments are variable in terms of presentation and methodology. It would be useful if LA's in Hertfordshire had a standard format for energy studies (e.g Energy hierarchy in London Plan and associated CO2 savings calculation methodology)

How will monitoring be carried out to ensure CO2 reduction targets are met? Currently, there may be installation of RLCs but these may not be used! E.g solar PV not being plugged in, biomass boilers not being run because of economics. (one suggestion was to install smart meters as part of RLC installation and send data back to Council. Otherwise it is difficult for Development Control to determine whether RLCs are being used as promised)

Hearts and Minds

People's attitude to RLCs and climate change in general needs to considered, perhaps through education. It was suggested that this is the main obstacle to use of RLCs. People generally do not understand benefits of sustainable living and only see increased costs.

Workshop 3: Delivery of RLC measures in Hertfordshire

Local authority participation in Energy Services Companies (ESCos)

There is potential for collaboration between the public and private sector to set up local ESCOs to help deliver schemes in both the new build sector and the existing buildings sector.

Mixed views on financial input:

- Input from the public sector may need to be non-financial as funds are currently limited and likely to remain so into the future. So any finance will need to come from other parties or mechanisms, for example allowable solutions.
- Other views that finance could come from public sector or levered by public sector.

Public sector understanding and strategic supp[ort of schemes important to ensure that scale of schemes is maximised, for example strategically assessing sites with a view to linking new developments and existing opportunities. Council encouragement and support of schemes vital.

There is a role local authorities can make in supporting ESCos in non financial ways, for example the provision of land, planning policy support, and wayleave support for digging roads to install infrastructure.

The report should provide an outline discussion of, or links to case studies where local authority partnerships have been used to procure or set up ESCos.

Politics

A long term view of energy is necessary – does not necessarily fit in with current short term political structure and planning. There is a need to take a bottom up long term political view at local level which is independent of current national or local government.

It is important to engage well with local political groups. For example, the Hertfordshire Association of Parish and Town Council (HAPTC). Achieving buy-in with local political groups is vital to ensure community buy-in and acceptance of schemes.

District heating

District heating is generally seen as being viable in the new build sector due to drivers in the form of building regulations, and the cost benefits of installing DH network alongside other new infrastructure. However DH seen as expensive in the existing sector due to practicalities, for example, digging up roads, and encouraging existing buildings to connect although this has been achieved in places such as Sheffield and Southampton. Connections need to be seen as attractive to existing buildings, for example offering economically attractive heat tariffs.

The Carbon Reduction Commitment (CRC) seen as a big driver for public sector to reduce its own emissions, and potentially as a driver for energy schemes based around public sector portfolio. Large public buildings could act as a catalyst for DH networks.

Education

Education generally seen as vital to changing attitudes and views surrounding energy efficiency and renewable technologies.

One popular ideas was to make visual statements at educational facilities, for example, installing small scale wind turbines in all school playing fields. This would educate both the school children, but also parents.

There is a lot of misunderstanding about certain technologies, for example energy from waste. Education is required to target these technologies, perhaps by showing case studies etc of other successful installations.

Energy performance certificates seen as a method by which higher levels of improvement can be encouraged in both the commercial and domestic sectors. These in time may come to educate building owners and occupiers about energy efficiency.

Engaging with communities

Community based / owned energy projects could be one method of encouraging renewable uptake and by offering a local financial incentive, overcoming “Nimbyism”. Linking profits and economic return to local community an important step to increasing uptake.

Could council tax be linked to community ownership as an incentive. It would be difficult to assess who should and shouldn’t receive benefits and what the radius of effect is. There are examples of this in Europe, but usually in areas with isolated communities.

A general view was given that on the whole, people don’t care about climate change or renewable energy, and that the main driver is money. Perhaps a sustainable community strategy could be developed which communities could take up to provide local benefits both financially and non financially.

Wind turbines

Recent application for 3 turbines in Benington turned down to local opposition. It was generally seen that the local population in Herts are anti-wind with many vociferous activists setting up opposition groups. It is important that the people who may oppose turbines are educated with real facts and figures from reputable sources and the benefits of the turbines explained in the context of Hertfordshire’s energy supply and contribution to CO_2 reduction in the region.

It was noted that the community approach at Swaffham has been successful leading to the installation of a second turbine, and that the community approach can work.

Expertise within councils

It was acknowledged that the rise of energy and CO2 on the planning agenda has meant many planners and local authority stakeholders are not experts in this area and need support. A proposal was for an expert energy advisor to be employed by each or a group of local authorities who could assist planners on technical issues, but also act as a strategic advisor. Concerns were raised over how this could be funded by local authorities.

Appendix B: Energy Modelling

To test and monitor the effects of national, regional and local targets on the borough, we have developed Microsoft Excel® based model of the energy use and CO_2 emissions of buildings in the district covering the period of influence of the Core Strategy.
Integral to our model is an updateable input sheet which includes energy demands and CO_2 emissions for 76 different building types - both in the 'base case' (i.e. Part L 2006 compliant) and assuming a range of CO_2 reduction improvements (i.e. energy efficiency measures and Renewable and Low Carbon technologies). The outputs from the input sheet, although derived from only these 76 assumed building forms, are expressed in a form which can then be applied to the actual building stock.

It is recognised that there are a number of alternative approaches to sizing renewable and low carbon technologies and for calculating the likely energy and CO_2 savings. Technology costs also vary greatly between product and suppliers and are expected to fall in future at differing rates, as a result of technology 'learning'. For these reasons we felt it important to set out clearly what has been assumed at this stage, so that it will be possible to update the model input sheet as more robust data becomes available.

We have tended to use 'rules of thumb' to estimate installed technology capacities, annual energy generation, CO_2 savings and costs. Some, but not all, of these 'rules of thumbs' can be referenced to external and authoritative sources. Unreferenced assumptions are based on our experience of undertaking renewable and low carbon feasibility studies for a range of developer clients over the last 10 years.

It is recommended that the model input sheet' is updated in line with the future publications of:

- Part L of the Building Regulations – expected March 2010, and;
- Standard Assessment Procedure (SAP) – expected end 2009.

Drafts of these documents (for consultation) contain a number of changes which will need to be updated in the model input sheet.

CO_2 Emissions
Conversion factors used to calculate CO_2 emissions are shown below. These are based on the emissions factors included in the 2006 Building Regulations Part L, Conservation of Fuel and Power ADL2. It should be noted that revised emissions factors are expected to be published in the 2010 update to Building Regulations Part L. The revised factors could significantly affect the calculated emissions figures, however as they are not yet known it has not been possible to take this into account in this study.

Fuel	CO_2 emissions $kgCO_2/kWh$ delivered
Gas	0.194
Grid Supplied Electricity	0.422
Grid Displaced Electricity	0.568
Biomass	0.025
Waste Heat	0.018

Table B1 Conversion factors for different fuels

Calculating Energy Demand of Development
As far as possible the model aims to use locally specific data for the district (e.g. Census data, Valuations Office Agency (VOA) data) on the number, types and size of buildings. Although building numbers and floor areas in the model are informed directly by local data, in order to develop the modelling, and specifically to make assumptions relating to the types and likely cost of appropriate renewable and low carbon technologies, the buildings have been split into a manageable number of categories.

Residential

Data on the number of existing residential buildings in the district was taken from the 2001 Census in England and Wales and information from the Council regarding post-2001 developments. Both the age and dwelling type was taken into account to characterise differences in building fabric, occupant density, and the likelihood of building fabric improvements having been made.

Projected figures for location of new development, number of homes and non-domestic floor area were taken from records of planning applications. It has not been possible to model future development other than those sites where planning applications have already been submitted, due to a lack of information on the location and phasing. Residential development was modelled using benchmarks which take into account proposed changes to Building Regulations Part L requirements expected in 2010, 2013 and 2016.

Non-residential

Data was collected from the Valuation Office Agency (VOA) for existing, non-residential buildings. This provided floor areas of non-residential building types. Each building type was assigned to one of the benchmark categories set out in CIBSE TM46[53], which defines energy benchmarks to allow assumptions to be made of CO_2 emissions from a range of building types.

CIBSE TM46 benchmarks were used to model energy demand of future non-domestic buildings. The benchmarks are based on data from the existing non-domestic building stock. A 25% reduction was applied to account for higher energy efficiency standards in new buildings.

Projected figures for location of new development, number of homes and non-domestic floor area were taken from data supplied by the participating LPAs.

Building Type Assumptions
The 76 building categories that were modelled comprise;

- 12 existing dwelling types, comprising;
  - 4 types – semi detached (dense), semi detached (less dense), small terrace and flat/apartment
  - Modelled in three different age bands - pre 1919, 1919-1975 and post 1975
- 6 new dwellings types (i.e. post 2006), comprising;
  - Detached, semi detached, end terrace, 1 bed flat, 2 bed flat and 3 bed flat.
- 29 commercial building types (existing)
- 29 commercial building types (new, post 2006)

[53] CIBSE TM46:2008 Energy Benchmarks (CIBSE, 2009)

The house types selected were considered representative for the County(existing and proposed housing development) based on the SHLAA studies, Census information and the review of proposed development in the area. Residential floor areas were taken from existing building energy models and were cross checked with housing floor area assumptions used in earlier similarly strategic studies. The housing types and floor areas used for modelling are shown in Table B2.

House Type	Age	Floor Area	Storeys	Sources
Semi Detached (Dense)	pre 1919	104.65	2	Census Data + English House Condition Survey
Semi Detached (Dense)	1919-1975	83.89	2	Census Data + English House Condition Survey
Semi Detached (Dense)	post 1975	72.13	2	Census Data + English House Condition Survey
Semi Detached (Less Dense)	pre 1919	104.65	2	Census Data + English House Condition Survey
Semi Detached (Less Dense)	1919-1975	83.89	2	Census Data + English House Condition Survey
Semi Detached (Less Dense)	post 1975	72.13	2	Census Data + English House Condition Survey
Small Terrace	pre 1919	58.27	2	Census Data + English House Condition Survey
Small Terrace	1919-1975	60.40	2	Census Data + English House Condition Survey
Small Terrace	post 1975	54.32	2	Census Data + English House Condition Survey
Flat; maisonette or apartment	pre 1919	96.44	4	Census Data + English House Condition Survey
Flat; maisonette or apartment	1919-1975	84.76	4	Census Data + English House Condition Survey
Flat; maisonette or apartment	post 1975	89.21	4	Census Data + English House Condition Survey
Detached	post 2006	101.61	2	CLG Zero C. RIA (Hurstwood)
Semi	post 2006	76.32	2	CLG Zero C. RIA (Wessex)
End	post 2006	76.32	2	CLG Zero C. RIA (Wessex)
1 bed flat	post 2006	43.4	5	EST NBO Sirocco
2 bed flat	post 2006	76.6	5	EST NBO Sirocco
3 bed flat	post 2006	100.9	5	EST NBO Sirocco

Table B2 Modelled house type basic assumptions

Information on public buildings and buildings not eligible for business rates was obtained from Hertfordshire County Council. Commercial building categories were selected to match the energy benchmarks published in CIBSE TM46. Floor areas were assumed as below and are representative of floor areas for real buildings of these types within the district (verified using VOA data).

Commercial building type	Floor Area	Storeys
General office	1000	4
High street agency	200	1
General retail	400	1
Large non-food shop	500	1
Small food store	500	1
Large food store	7000	1
Restaurant	250	1
Bar, pub or licensed club	500	1
Hotel	5000	6
Cultural activities	500	3
Entertainment halls	300	1
Swimming pool centre	1000	1
Fitness and health centre	500	2
Dry sports and leisure facility	150	1
Covered car park	500	5
Public buildings with light use	200	3
Schools and seasonal public buildings	6000	2
University campus	500	2
Clinic	200	2
Hospital; clinical and research	500	2
Long term residential	500	2
General accommodation	500	2
Emergency services	500	1
Laboratory or operating theatre	500	1
Public waiting or circulation, e.g. local station or mall	500	1
Transport terminal, e.g. airport	500	1
Workshop	1000	1
Storage facility	10000	1
Cold storage	500	1

Table B3 Commercial building types basic assumptions.

Roof areas

Assumptions relating to available roof areas are important with respect to potential energy generation from solar technologies.

For all building types, the available roof area for the installation of solar technologies has been assumed to be total floor area divided by the number of storeys, multiplied by 45%. Floor areas and assumed storey heights for each of the building types are shown in tables B2 and B3.

On pitched roofs, only half of the roof will face south, whereas on flat roofs, panels are mounted on frames which need to be spaced apart to limit over shading. Some area is also required for circulation, maintenance etc. Therefore, the maximum roof area that can be used for mounting solar panels, whether on flat or pitch roofs, has been considered to be 90% of half the available roof area i.e. 45% of the total roof area.

Energy Demand Assumptions

Dwelling energy demands were modelled in SAP, input assumptions where altered to take account of the likely fabric and plant performance in homes of varying age. The new dwellings have been modelled to comply with Buildings Regulations Part L 2006 or later. Unregulated energy demand (i.e. from non fixed building services - small power) has been calculated using a formula published within the Code for Sustainable Homes. This approach (for the unregulated emissions) has been used for existing and post 2006 dwellings.

For commercial buildings energy demands have been estimated by multiplying the floor areas above with energy benchmarks from CIBSE TM46. Energy use benchmarks have not been altered to differentiate between existing and new (post 2006) commercial uses, as there are no robust sources of information on which to base this.

We have had to assume how the energy benchmarks breakdown according to the energy demands which are regulated under Part L (i.e. for fixed building services such as heating, hot water and lighting) and which are unregulated (i.e. for small power). This is clearly essential where proposed policies being tested are framed in these terms. There is no recognised method for splitting energy benchmarks according to the emissions which are regulated or unregulated, but we have used assumptions that were made in the development of an the energy strategy for a major and high profile development in London.

	Benchmarks			Assumptions for splitting benchmarks			
	All Fossil	All Electric	ALL CO_2	a.) Assumed % 'All Electric' (Regulated)	b.) Assumed % 'All Electric' used for space heat (where no Gas)	c.) Assumed % 'All Fossil' used for DHW	d.) Assumed % 'All Electric' used for DHW (where no Gas)
	kWh/m^2	kWh/m^2	$kgCO_2/m^2$	%	%	%	%
General office	120	95	75.1	30%	-	20%	-
High street agency	0	140	77	60%	20%	15%	10%
General retail	0	165	90.8	60%	20%	20%	10%
Large non-food shop	170	70	70.8	30%	-	15%	-
Small food store	0	310	170.5	60%	20%	20%	10%
Large food store	105	400	240	30%	-	20%	-
Restaurant	370	90	119.8	30%	-	25%	-
Bar, pub or licensed club	350	130	138	30%	-	25%	-
Hotel	330	105	120.5	30%	-	20%	-
Cultural activities	200	70	76.5	30%	-	20%	-
Entertainment halls	420	150	162.3	30%	-	15%	-
Swimming pool centre	1130	245	349.5	30%	-	20%	-
Fitness and health centre	440	160	171.6	30%	-	20%	-
Dry sports and leisure facility	330	95	115	30%	-	20%	-
Covered car park	0	20	11	60%	20%	0%	10%
Public buildings with light use	105	20	31	30%	-	15%	-
Schools and seasonal public buildings	150	40	50.5	30%	-	20%	-
University campus	240	80	89.6	30%	-	20%	-
Clinic	200	70	76.5	30%	-	20%	-
Hospital; clinical and research	420	90	129.3	30%	-	20%	-
Long term residential	420	65	115.6	30%	-	20%	-
General accommodation	300	60	90	30%	-	20%	-
Emergency services	390	70	112.6	30%	-	20%	-
Laboratory or operating theatre	160	160	118.4	30%	-	20%	-
Public waiting or circulation, e.g. local station or mall	120	30	39.3	30%	-	15%	-
Transport terminal, e.g. airport	200	75	79.3	30%	-	15%	-
Workshop	180	35	53.5	30%	-	10%	-
Storage facility	160	35	49.7	30%	-	10%	-
Cold storage	80	145	95	30%	-	20%	-

Table B4 Commercial building energy demand splits – regulated and unregulated.

Heat Mapping

Heat mapping as been conducted using gas supply data and assuming an average boiler efficiency of 80%. Heat density is defined as the annual heat demand in kWh, divided by the number of hours per year to give an annual average demand. This was then divided by the area under consideration. Potential issues with this method are:

The use of gas data ignores the use of other heating fuels such as electricity and oil, which is expected to make up a small proportion of heat demand. Heat maps produced show the heat demand averaged across an 'output area' in line with the DECC (Department for Energy and Climate Change) heat map methodology. It should be noted that the heat mapping carried out for this study uses a higher resolution of data which provides more detail than the DECC approach. Due to 'averaging' of the heat demand across an output area, there is the potential for maps to show areas of high heat demand where in fact a lower heat demand may be present for much of that area. The results only provide an average of each Output Area and do not highlight point sources which may have a high heat demand. Feasibility of heat networks in any given location should therefore be based on further, more detailed opportunities studies.

Assumptions for Renewable and Low Carbon Energy Packages

The model has been constructed to test different policy options and select the least cost technology option to meet the different policy requirements.

▪ **Energy Efficiency Level 1 (EE1)**		
Buildings applied	**All residential buildings plus all commercial buildings**	*References*
Modelled or assumed savings	*Energy savings* *Modelled* Existing residential units: ▪ Pre 1919 – 20% saving on heat demand (regulated) ▪ 1919-1975 – 15% saving on heat demand (regulated) ▪ Post 1975 – 10% saving on heat demand (regulated) New residential units: ▪ Package of measures designed to deliver a 15% - 20% reduction in the DER relative to TER (Part L 2006). ▪ Savings are split across regulated heat and regulated power – as modelled. *Assumed* Commercial: ▪ Between 5 – 15% (depending on building type) reduction in fossil fuel demand where fossil fuel used for heating and hot water. ▪ Between 5 – 10% (depending on building type) reduction in electricity use where electricity is used for heating and hot water.	▪ SAP 2005 ▪ AECOM
Costing assumptions	£15/m² residential £20/m² commercial	▪ From unpublished work undertaken by AECOM for Energy Savings Trust

▪ **Energy Efficiency Level 2 (EE2)**		
Buildings applied	**All residential buildings plus all commercial buildings**	*References*
Modelled or assumed savings	*Energy savings* *Modelled* Existing residential units: ▪ Pre 1919 – 30% saving on heat demand (regulated) ▪ 1919-1975 – 25% saving on heat demand (regulated) ▪ Post 1975 – 20% saving on heat demand (regulated) New residential units: ▪ Package of measures designed to deliver around a 25% reduction in TER relative to TER (Part L 2006). ▪ Savings are split across regulated heat and regulated power – as modelled. *Assumed* Commercial: ▪ Between 7 – 21% (depending on building type) reduction in fossil fuel demand where fossil fuel used for heating and hot water. ▪ Between 7 – 14% (depending on building type) reduction in electricity use where electric used for heating and hot water.	▪ SAP 2005 ▪ AECOM
Costing assumptions	£30/m² residential £40/m² commercial	▪ From unpublished work undertaken by AECOM for Energy Savings Trust

▪ **PV – minimum installation**		
Buildings applied	**All residential buildings plus all commercial buildings**	*References*
Technology sizing assumptions	Assumed kWp taken to be ¼ of maximum possible panel based on the assumed roof areas Panel area assumed to be 7m²/kWp Assumed output to be 800kWhkWp	▪ SAP 2005 ▪ Supplier data
Costing assumptions	Assumed to be £6000 per kWp **Note:** Full system cost including invertors etc	▪ Supplier quotes (2004 – 2008).

▪ **PV – medium installation**		
Buildings applied	**All residential buildings plus all commercial buildings**	*References*
1. Technology sizing assumptions	2. Assumed kWp taken to be ½ of maximum possible panel area based on the assumed roof areas 3. Panel area assumed to be 7m²/kWp 4. Assumed output to be 800kWh/kWp	▪ SAP ▪ Supplier data
5. Costing assumptions	6. Assumed to be £5500 per kWp. 7. **Note:** Full system cost including invertors etc 8. **Note:** Costs fall as system size gets larger.	▪ Supplier quotes (2004 – 2008).

▪ PV – maximum installation		
Buildings applied	**All residential buildings plus all commercial buildings**	*References*
Technology sizing assumptions	Assumed kWp taken to be maximum possible panel area based on the assumed roof areas Panel area assumed to be $7m^2$/kWp Assumed output to be 800kWh/kWp	▪ SAP ▪ Supplier data
Costing assumptions	Assumed to be £5000 per kWp. **Note:** Full system cost including invertors etc **Note:** Costs fall as system size gets larger.	▪ Supplier quotes (2004 – 2008).

▪ Biomass		
Buildings applied	New (post 2006) residential and post 2006 commercial buildings only. Different assumptions for new detached and semi detached homes.	*References*
Technology sizing assumptions	Biomass assumed to meet 80% of total heat demand, remainder met by gas. Biomass boiler efficiency assumed to be 76% Biomass demand based on energy generation of 3.85kWh/kg based on woodchips at 22% Moisture Content System size per unit assumed to be 50% of peak demand based on $60W/m^2$ Detached and semi detached homes are assumed to be fitted with a 10kW individual boiler. Terraced houses and flats assumed to be part of a communal system	▪ AECOM ▪ BSRIA 'rules of thumb' ▪ Supplier data
Costing assumptions	▪ £1020 per kW accounting for boiler, civils and communal heating infrastructure ▪ For the detached and semi detached homes – cost assumed £10,000 per dwelling for an individual boiler. **Note:** Costs exclude civils work in connection with the biomass installation – i.e. plant room, fuel storage room etc	▪ Supplier quotes (2004 – 2008). ▪ Department for Children, Schools, Families

▪ Ground Source Heat Pumps		
Buildings applied	New (post 2006) residential and post 2006 commercial buildings only. Different assumptions for new detached and semi detached homes.	*References*
Technology sizing assumptions	Replacing 90% efficient gas boiler (expect for in the case of commercial buildings which have no gas demand in the basecase and are assumed all electric) COP of 3.2 assumed for space heating COP of 2.24 assumed for water heating System sized to meet peak heat demand - based on $60W/m^2$ Detached and semi detached homes are assumed to be fitted with an individual heat pump of 10kW. Terraced houses and flats assumed to be part of a communal system	▪ SAP 2005 ▪ BSRIA 'rules of thumb'
Costing assumptions	▪ GSHP costs of £2000 per kW installed. **Notes:** Costs exclude costs for ground testing and for laying ground loops either horizontally or vertically. Heat pumps provide heating and hot water and therefore often negate the need for a gas connection to the building. Given the strategic nature of this study this is assumed to be covered within the cost benchmark above.	▪ Supplier quotes (2004 – 2008).

▪ Air Source Heat Pumps		
Buildings applied	All residential buildings and all commercial buildings	*References*
Technology sizing assumptions	Replacing 90% efficient gas boiler (expect for in the case of commercial buildings which have no gas demand in the base case and are assumed all electric) COP of 2.5 assumed for space heating COP of 1.75 assumed for water heating Assumed all individual systems for residential	▪ SAP 2005 ▪ BSRIA 'rules of thumb'
Costing assumptions	Residential – £6000 per system Commercial – £800 per kW	▪ Supplier quotes (2006 – 2008).

▪ Gas fired CHP		
Buildings applied	New residential and new commercial buildings only.	*References*
Technology sizing assumptions	60% heat from CHP, 40% from gas fired boilers Distribution loss factor: 5% CHP Electrical Generation Efficiency assumed to be 33% CHP Heat Generation Efficiency assumed to be 45% System sized to meet 50% peak thermal demand, assumed to be $60W/m^2$.	▪ AECOM ▪ SAP 2005 ▪ Supplier system efficiencies ▪ BSRIA 'rule of thumb'
Costing assumptions	*Residential* £5000 per dwelling for fixed cost of district heating infrastructure plus £2000 per kWe. *Commercial* Fixed cost of $£20/m^2$ (floor area) for district heating infrastructure plus £2000 per kWe.	▪ Supplier quotes (2006 – 2008). ▪ The potential and costs of district heating networks (Faber Maunsell & Poyry, April 2009)

▪ Gas fired CHP plus Biomass top-up

Buildings applied	New residential and new commercial buildings only.	*References*
Technology sizing assumptions	60% of total heat requirements delivered by CHP Remaining heat from biomass (80%) and gas fired boilers (20%) Distribution loss factor: 5% CHP Electrical Generation Efficiency assumed to be 33% CHP Heat Generation Efficiency assumed to be 45% System sized to meet 50% peak thermal demand, assumed to be 60W/m^2.	▪ AECOM ▪ SAP 2005 ▪ Supplier system efficiencies ▪ BSRIA 'rule of thumb'
Costing assumptions	*Residential* £5000 per dwelling for fixed cost of district heating infrastructure plus £2000 per kWe. Biomass boiler cost assumed to be £200 per kW *Commercial* Fixed cost of £20/m^2 (floor area) for district heating infrastructure plus £2000 per kWe.	▪ Supplier quotes (2006 – 2008). ▪ The potential and costs of district heating networks (Faber Maunsell & Poyry, April 2009)

▪ **Biomass CHP**

Buildings applied	New residential and new commercial buildings only.	*References*
Technology sizing assumptions	60% heat from CHP, 40% from gas fired boilers Distribution loss factor: 5% CHP Electrical Generation Efficiency assumed to be 25% CHP Heat Generation Efficiency assumed to be 50% Biomass demand based on energy generation of 3.85kWh/kg based on woodchips at 22% Moisture Content System sized to meet 50% peak thermal demand, assumed to be 60W/m^2.	▪ AECOM ▪ SAP 2005 ▪ Supplier system efficiencies ▪ BSRIA 'rule of thumb'
Costing assumptions	*Residential* £5000 per dwelling for fixed cost of district heating infrastructure, biomass fuel store etc plus £4000 per kWe. *Commercial* Fixed cost of £25/m^2 (floor area) for district heating infrastructure plus £4000 per kWe.	▪ Supplier quotes (2006 – 2008).

Technology Combination Options

In addition to the 12 basic technology options outlined above, our model input sheet also includes a further 20 technology options made up from various combinations of the above. Allowable solutions are also introduced as a proxy technology measure to provide a way of using the model to help quantify money that could be raised using this mechanism.

For simplicity and because of the high level nature of the study – CO_2 savings and costs from the options outlined above are simply summed in the combined options. For example, where energy efficiency is specified with biomass boilers and PV, savings and costs from options 1, 5 and 7 above would be summed together. In actual fact the savings achieved from a range of measures would not be the sum of savings from three separate measures, however this approach is considered sufficiently robust for the purposes of this study. Combination options have been set up to group together only compatible technologies.

It was assumed that a basic level of energy efficiency should always be taken up – as a first step of a CO_2 reduction hierarchy, where low carbon energy supply and the use of renewable technologies come later in the hierarchy. Therefore savings from renewable technologies in the RLC sheet were calculated against the buildings where EE1 was already applied. Costs for the basic energy efficiency improvements have been added together with the cost of the RLC technology for every option, except where the advanced energy efficiency standard is applied.

Modelling the Impact of Targets

For each year in the study period, an appropriate scenario is chosen by the model for new or improved buildings on each development site, based on the lowest cost solution that achieves the policy target that is also compatible with the site specific constraints.

- The split between regulated and unregulated CO_2 emissions for commercial building types is assumed based on experience – in reality the split is highly variable. This could have implications in terms of the ability of technology options to deliver on policy targets within the model
- The same energy use benchmarks have been used for existing and new non-domestic buildings. There are no robust sources of information on variations in non-domestic building energy use by age or design characteristics.
- The size and form of commercial building types in the model is assumed. As a result the model does not deal well with commercial buildings that are integrated as part of mixed use developments (i.e. where the commercial element is one floor of a multi floor development). In these cases the calculated roof area available for solar panels will be greater than would be expected in reality and the model may assume an over reliance on solar technologies to deliver on policy targets
- Costs in the model input sheet are capital cost only. Our model does not consider maintenance and replacement costs over technology lifetime and allows no benefit for revenue gained from feed in tariffs or renewable heat incentives. These lifecycle costs and benefits are hugely important for some developers (housing associations and commercial owner occupiers) and need to be considered alongside results from the model.

Not every low carbon or renewable technology has been considered within this study – it has been assumed that building mounted wind turbines, hydro and fuel cells are either not technically feasible or financially viable at this stage. Discrete uses for these technology types have been considered as a separate exercise.

Appendix C: Renewable & Low Carbon Energy Technology Descriptions

This section introduces a range of decentralised, renewable and low carbon energy technologies. It focuses only on those that the evidence base study identifies as being feasible in the district.

Combined Heat and Power (CHP)
A CHP plant is an installation where there is simultaneous generation of useful heat and power in a single process. The heat generated in the process is utilised via suitable heat recovery equipment for a variety of purposes including industrial processes, district heating and space heating.

Because the heat from electricity generation is used rather than disposed of and the avoidance of transmission losses by generating electricity on site, CHP typically achieves a 35 per cent reduction in fuel usage compared with power stations and heat only boilers. This can allow economic savings where there is a suitable balance between the heat and power loads.

Wind Energy
The UK has a large wind resource which remains largely untapped. Wind turbines come in a variety of sizes and shapes but they all work in a similar way; the turbine blades are moved by the wind and this movement is captured by a generator to produce electricity.

The large scale, free standing wind turbines that are now produced commercially have been optimised over a number of decades to result in highly efficient, reliable machines that have the potential to generate large amounts of energy. However, there are significant time implications and costs involved in locating them appropriately in order to achieve optimum energy yields.

Free standing turbines are traditionally larger and more cost effective in terms of their electricity production, however they are very rarely suitable for urban locations as they require free stream, non turbulent wind to be effective.

Figure C1: Freestanding wind turbines, Vestas V29 225kW wind turbine at Beaufort Court, RES Ltd in Hertfordshire (left) and Proven 15kw wind turbine (right)

The following issues should be assessed when considering the installation of large scale wind turbines:

Landscape and visual impact - A large free standing wind turbine is highly visible in the landscape. The specific sites of the turbines should be carefully considered to ensure that they do not detrimentally impact key view corridors and that they are well integrated into the surrounding landscape.

Wind resource - Wind speeds of 5.5m/s or above at turbine hub height are typically needed to operate a large scale wind turbine efficiently. The energy output of wind turbines is extremely sensitive to the wind speed therefore before making this kind of investment it would be prudent to carry out accurate wind speed measurements (preferably at hub height) over a period of at least 12 months, to ensure that the correct wind turbine is selected for the site wind climate.

Site location - For optimum output, turbines should be located in areas with high wind speeds, with few obstacles to create turbulence, i.e. with limited trees and buildings. Turbines should also be spaced to avoid turbulence affecting each other.

Noise implications - There are currently no statutory requirements regarding distances that must be maintained between wind turbines and residences, but 400m is a guide that is used in London[54]. A separation distance of 5-10 rotor diameters from turbines to the nearest dwelling is usually sufficient to satisfy the recommendations set out in the Noise Working Group report ETSU-R-97 on "The Assessment and Rating of Noise from Wind Farms."[55]

Flora and fauna - It is important at the time of site assessment to identify any particular areas or species of nature conversation interest existing within the area under consideration. The presence of breeding birds on the site may affect the times of construction of the wind farm.

Shadow flicker - Rotating wind turbine blades can cast moving shadows that cause a flickering effect and can affect residents living nearby. This can be an issue at certain times of day when the wind is blowing, but effects can usually be mitigated.

Local infrastructure - It is advantageous if turbine sites have good access to roads, railway lines, rivers and canals, to enable delivery of components during construction and access for maintenance. An exclusion distance is observed to reduce the risks to property and human health in the unlikely event of a turbine failure. "Consideration should be given to reducing the minimum layback of wind turbines from overhead lines to three rotor diameters"[56]. Turbines should be at least 200m from blade tip to bridle paths; the British Horse Society recommends "a separation distance of four times the overall height should be the target for National Trails and Ride UK routes…and a distance of three times overall height from all other routes." [57] A distance of 3 rotor diameters should be maintained from power transmission lines.[58]

Aeronautical and defence impacts - Turbines above a certain height may interfere with the operation of local air traffic control or radar systems used for military purposes. Consultation with organisations such as the National Air Traffic Service (NATS) and the Ministry of Defence may result in constraints on potential turbine locations.

Telecommunication impacts – large wind turbines can interfere with radio signals, television reception and telecommunications systems including fixed radio links and scanning telemetry links, which are a vital component of UK telecommunications infrastructure. Wind turbines may also affect local television reception, although the pending switch from analogue to digital terrestrial transmission will make networks less vulnerable.

Impact upon land use and land management - The actual footprint of wind turbines is relatively small and adjacent land can still be used for grazing, farming, etc. Crane hard standings and access tracks are usually required at each turbine location

Grid connection and substation requirements - Large scale turbines will be connected to the National Grid by arrangement with the local electricity network operator. It is ideal to locate turbines close to a 10-30 kV power line. The electrical grid near the wind turbine should be able to receive the incoming electricity; if there are already many turbines connected to the grid, then the grid may need reinforcement.

Flood risk - Development of wind turbines on areas of high flood risk is currently restricted by PPS 25. Proposed revisions to the PPS suggest wind turbines be reclassified as essential infrastructure[59]. This would largely permit turbine development in flood zones and as such flood zones have not been considered a constraint in the above analysis.

Gas pipelines and other sub terrain analysis - The feasibility of the construction of a large turbine should be supported by geotechnical investigations.

Archaeological constraints - Any impacts on archaeology in the area will have to be assessed in more detailed studies.

Listed building and conservation areas – a detailed impact assessment has not been conducted at this stage and would be required for any further study.

54 Guidance Notes for Wind Turbine Site Suitability (London Energy Partnership, London Renewables, October 2006)
55 The Assessment and Rating of Noise from Wind Farms (Noise Working Group report EtSU-R-97, 2007)
56 NGET Technical Report TR(E) 453 A Review Of The Potential Effects Of Wind Turbine Wakes On National Grid's Overhead Transmission Lines (NGET, 2009)

57 Advisory Statement on Wind Farms AROW20s08/1 (The British Horse Society)
58 Review of the Potential Effects of Wind Turbine Wakes on Overhead Transmission Lines, TR (E) 453 Issue 1 (National Grid – internal use only, May 2009)
59 Planning Policy Consultation – Consultation on proposed amendments to Planning Policy Statement 25: Development and flood risk, paragraphs 3.31-3.38 (DCLG, August 2009)

There are benefits to choosing a turbine in the small to medium size range. This size of turbine is particularly well suited to direct connection to a development electrical network rather than to the National Grid. The electricity generated can then be used on site thus sparing costly distribution network development and avoiding distribution losses.

Transport access - Construction costs will be considerably less, since it is not necessary to use cranes or build a road strong enough to carry large-scale turbine components.

Landscape and visual impact - Aesthetical landscape considerations may also dictate the use of smaller machines. Large machines, however, will usually have a much lower rotational speed, which means that one large machine does not attract as much attention as many small, fast moving rotors.

Building mounted turbines tend to be cheaper, but despite considerable interest from developers and the media in recent years, they are still relatively unproven in urban locations. There is much debate about what can realistically be assumed in terms of their annual electrical output in turbulent, urban wind flows.

Building mounted turbines can be mounted either to a gable wall or on the ridge of the roof. If mounted to a gable wall, the mounting is relatively simple. If mounted to the ridge, the mast of the turbine can be bolted to the timber roof trusses. The mast would pass through a gland in a modified roof tile, to prevent water penetration around the mast.

So far, the turbines mounted on buildings have tended to be those with a horizontal axis (HAWTs) i.e. the familiar rotor on a tower, where the rotor needs to be positioned into the wind direction by means of a tail or active yawing by a yaw. HAWTs are very sensitive to sudden changes in wind direction and turbulence, which have a negative effect on the performance of the turbine. In an urban environment, vertical axis wind turbines (VAWTs) are perhaps a more suitable option, since they are less responsive to the variability of the wind and turbulence. These types of turbine can also often utilise the upward wind flows that are present around large buildings.

Biomass Energy

Biomass is a collective term for all plant and animal material. A number of different forms of biomass can be burned or digested to produce energy. Examples include wood, straw, poultry litter, putrescibles (kitchen and garden waste) and energy crops such as willow and poplar, grown on short rotation coppice, and miscanthus. Biomass is a virtually carbon neutral fuel, as the CO_2 emitted during energy generation has been recently absorbed from the atmosphere. A very low carbon emissions factor for biomass reflects the emissions related to production and transport.

Wood from forests, urban tree pruning, farmed coppices or farm and factory waste can be burnt directly to provide heat in buildings, although nowadays most of these wood sources are commercially available in the form of wood chips or pellets, which makes transport and handling on site easier. Pellets are produced from the compression of saw dust and, because they are drier and denser than wood chip, have a higher energy yield per tonne.

Biomass heating has seen a large increase in the public sector, especially in schools and colleges. The technology is potentially the lowest capital cost method of achieving planning targets for CO_2 reductions from low carbon or renewable energy on new developments.

A major factor that determines the energy content of a biomass material is its moisture content. The moisture content of material can vary greatly, from around 5-8% for wood pellets to 65% for freshly felled timber. The greater the moisture content the less energy is contained within the fuel, consequently the majority of raw biomass materials require some form of processing before they become biomass fuels. Processes can range from simple cutting and drying to more involved processes like producing pellets.

Modern systems can be fed automatically by screw drives from fuel hoppers. This typically involves daily addition of bagged fuel to the hopper, although this process can also be automated with use of augers or conveyors. Electric firing and automatic de-ashing are also available and systems are designed to burn without smoke to comply with the Clean Air Act.

The most common application of biomass heating is as one or more boilers in a sequenced (multi-boiler) installation where there is a communal block or district heating system.

Plant size (kW)	Footprint (m^2)	Length (m)	Width (m)	Height (m)
250	22	5.5	4	2.1
320	33	8.2	4	2.5
400	33	8.2	4	2.5
500	42.5	8.5	5	2.7
700	42.5	8.5	5	2.9
900	45	9	5	3.6
1500	47.5	9.5	5	4.3
2500	55	10	5.5	4.7
3500	60.5	11	5.5	5.6
4500	69	12.5	5.5	5.9

Source: B&V market data

Table C1 Indicative biomass plant sizes

Biomass systems generally need more physical space than fossil fuel systems of the same rated output. The spatial requirements of parts of biomass heating systems are described further below:

Size of plant - A biomass plant will also need a degree of clearance around certain areas to enable cleaning and such tasks as ash removal. Table C1 contains a range of typical biomass plant sizes.

Fuel storage – as biomass is a solid fuel, careful consideration needs to be given to the storage so as to enable straightforward delivery to the combustion chamber.

Vehicle access for fuel delivery – biomass plants need regular deliveries of a solid fuel and consideration needs to be given to the space available for delivery vehicles.

Issues which can prevent uptake of biomass boiler technology are:

On-site access for large lorries delivering wood chip, especially for urban locations;

Availability of space for a large fuel storage area adjacent to the plant area (the smaller the storage area the more frequent fuel deliveries);

Concerns over sustainable, reliable fuel supply chains being in place.

A move towards greater use of biomass will inevitably increase emissions in urban areas. The design of a biomass plant has a large impact on its combustion efficiency and emissions. A modern biomass plant should, with careful design, be able to meet all air pollution control standards at reasonable costs. Even so, siting of the plant must be carried out with care, and in particular it is important that biomass plants should not be located in areas where they would exacerbate existing poor air quality.

Energy crops

The suitability of a site for the cultivation of energy crops depends on factors including local landscape, environmental and social issues.

Different varieties of energy crops are suited to different soil types and have specific climatic and hydrological requirements. Agricultural land is divided into land classifications which provide a measure of the lands productivity and versatility. Grades 1 and 2 should be retained entirely for food crops.

	% of agricultural land	Description
Grade 1	3%	Excellent quality agricultural land. Land that produces consistently high yields from a wide range of crops such as fruit, salad crops and winter vegetables.
Grade 2	16%	Very good quality agricultural land. Yields may have some variability but are generally high, some factors may affect yield, cultivation or harvesting.
Grade 3	55%	Good to moderate quality land. Limitations of the land will restrict the choice of crops, timing and type of cultivation, harvesting. Yields are generally lower and fairly variable.
Grade 4	16%	Poor quality agricultural land. Severe growing limitations restrict the use of this land to grass and occasional arable crops.
Grade 5	10%	Very poor quality land. Land that is generally suitable only for rough grazing or permanent pasture.

Table C2 Agricultural land classifications in England and Wales. [Source: Biomass as a renewable energy source, Royal Commission on Environmental Pollution, 2004)

Arboriculture (woodland and forestry residues)

Forests under management can produce a sustainable yield of biomass and have the potential to supply a large volume of wood without compromising existing land uses. Reduced cover and cleared grounds can also bring ancillary environmental benefits. However, long term trends in timber prices have rendered forest management uneconomic[60]. A strengthened market for locally sourced biomass would encourage greater exploitation of the existing resource.

Parks, waste wood and highways waste

Local authorities produce large quantities of green waste, through management of parks, trees and community land. It is commonly composed of wood, trimmings, cuttings and grasses and biodegradable waste which is usually high in nitrogen.

Traditionally this green waste has been sent to landfill or used in composting. Instead green waste can be used as a fuel, creating a valuable resource.

Waste wood has been a largely overlooked resource to date, partly part due to it often arising as part of a mixed waste stream, with limited facilities for its segregation, and also a result of its predominantly contaminated nature, which often makes recycling impractical. Waste wood has a relatively low moisture content (18-25%), potentially making it preferable to forestry and biomass crops (approximately 40%)[61], although waste wood from arboriculture management usually has higher moisture content and requires drying before use.

Solar Energy

The sun's energy arrives at the earth's surface either as 'direct', from the sun's beam, or 'diffuse' from clouds and sky. The total or 'global' irradiation is the sum of these two components and, across the UK, the daily annual mean varies between 2.2kWh/m^2 to 3.0kWh/m^2 as measured on the horizontal plane. There is a very significant variation around this average value due to both seasonal and daily weather patterns.

There are two main technologies that can directly exploit the solar resource:

- Solar water heating - direct conversion of solar energy into stored heat;
- Photovoltaics (PV) - direct conversion of solar energy into electricity.

Solar water heating

Solar water heating systems use the energy from the sun to heat water, most commonly for hot water needs. Ideally the collectors should be mounted in a south-facing location, although south-east/south-west will also function successfully. The panels can be bolted onto the roof or walls or integrated into the roof.

The systems use a heat collector, generally mounted on the roof or façade in which a fluid is heated by the sun. This fluid is used to heat up water that is stored in either a separate hot water cylinder or more commonly a twin coil hot water cylinder with the second coil providing top up to heating from a conventional boiler.

The heat collector can be in the form of a flat plate array or evacuated tubes. Flat plate panels are cheaper but less efficient , while evacuated tubes have the advantage that they can be adjusted individually to achieve optimum pitch and have lower heat losses.

A conventional heat source is necessary because a standard solar system in the UK cannot provide sufficient heat to supply hot water at the desired temperature, throughout the year.

Apart from providing hot water, the other major use for the technology in the UK is for swimming pool heating, where it is particularly suited to pools used only between spring and autumn. These may be outdoor pools or enclosed pools where the air over the water is not conditioned.

Figure C2 Solar hot water installation. Schuco flat plate system providing domestic hot water (photo courtesy of Ecolution Renewables)

Solar photovoltaics

Solar photovoltaic panels (PV) use semi-conducting cells to convert sunlight into electricity. The panel produces electricity even in cloudy conditions, but power output increases with the intensity of the sun.

Modules are connected to an inverter to turn the direct current (DC) generated into alternating current (AC), which is usable in buildings. PV can supply electricity either to the buildings it is attached to, or, when the building demand is insufficient, electricity can be exported to the electricity grid.

PV is available in a number of forms, including mono-crystalline, poly-crystalline, amorphous silicon (thin film) or hybrid panels that can be mounted on or integrated into the roof or facades of buildings. Different types have different outputs per metre squared of panel, with hybrid and mono-crystalline producing the most and amorphous the least. PV system size is measured in kilowatt peak (kWp).

A flexible option for a variety of roof orientations is the Kalzip AluPlusSolar system, which involves a PV laminate (PVL) adhered to the surface of a specific Kalzip profiled standing seam roof, constructed in the normal manner and still retaining the full choice of structural decking, liner deck or tray. The system can be installed on roofs from 3.5º and 60º.

Figure C3 Solar PV panels. PV panels angled at 10º on flat roofs

For PV to work effectively, it should ideally face south and at an incline of 30º to the horizontal, although orientations within 45º of south are acceptable. It is essential that the system is not shaded, as even a small shadow may significantly reduce output.

Heat Pumps

Air source heat pumps use the refrigeration cycle to extract low grade heat from the outside air and deliver it as higher grade heat to a building. Ground source heat pump systems operate in a similar way by taking low grade heat from the ground and delivering it as higher grade heat to a building.

The measure of efficiency of a heat pump is given by the Coefficient of Performance (CoP). For example, if a heat pump has a CoP of 3 then for every three units of heat delivered, two units are from the renewable heat source and one from the electrical power supply.

Air source heat pumps

The ability of an air source heat pump to transfer heat from the outside air to the house depends on the outdoor temperature. If the air temperature falls below zero, moisture in the air may condense and form ice on the external heat exchanger. This will reduce the heat transfer coefficient, and must be melted periodically using a 'defrost cycle' which warms up the external heat exchanger using energy to no useful gain inside the building.

Below the outdoor ambient temperature, the heat pump can supply only part of the heat required to keep the living space comfortable, and supplementary heat is required (e.g. back up electric immersion heater). Unfortunately, the CoP is lowest when air temperatures are low – this coincides with the times when the heat pump is most used.

[60] Biomass for London: wood fuel demand and supply chains (BioRegional Development Group, SE Wood Fuels and Creative Environmental Networks, December 2008)
[61] Waste wood as a biomass fuel, market Information report (DEFRA, April 2008)

Ground source heat pumps

Ground source heat pumps make use of the constant temperature that the earth in the UK keeps throughout the year. This is related to the annual average air temperature for the site ±2°C; for the UK this is generally around 10^{o}C. Since the ground stays at a fairly constant temperature, annual seasonal COPs of 3.5 or more are achievable, giving good energy and running cost savings.

Ground source heat pumps can be used for both heating and cooling purposes. The water that circulates through the loop is cooled by the ground in the summer and heated in the winter. For cooling systems, water can be introduced directly in the building or if the capacity of the soil is inadequate, a refrigerator unit or a reversible heat pump can be used. When the system is used both for heating and cooling the building, the investment and running costs are particularly economical.

Detailed geological and geotechnical assessment is required on a site by site basis to ensure that sufficient energy can be extracted from the ground on each site. The yield of the open boreholes or limitations on space or number of piles can limit the amount of energy that can be extracted from the ground.

Assumptions used in Section 5 Opportunities for Renewable and Low Carbon Technologies

Biomass

Type of Biomass	Source	Recoverable Biomass	Area/Number in Hertfordshire	Useful Proportion	Useful amount	Moisture Content	Calorific Value
		odt/hectare	hectares or number of animals	%	odt/tonnes	%	GJ/odt
Energy Crops	Agricultural Land Grade 1 (SRC)	8		0%	-	30%	13.00
Energy Crops	Agricultural Land Grade 2 (SRC)	8		0%	-	30%	13.00
Energy Crops	Agricultural Land Grade 3 (SRC)	8	95,300	75%	571,800	9. 30%	10. 13.00
Energy Crops	Agricultural Land Grade 4 (SRC)	8	2,300	20%	3,680	30%	13.00
Energy Crops	Agricultural Land Grade 5 (SRC)	8	41	0%	-	30%	13.00
Arboriculture	Ancient Woodland	2	5,700	100%	11,400	45%	12.50
Arboriculture	Forestry Commission Woodland	2	5,316	100%	10,632	45%	12.50
Arboriculture	Park	2		100%	-	45%	9.28
Arboriculture	Woodland creation - Hertfordshire Forest	2	344	75%	516	45%	12.50
Park and Highways Waste	Country Parks, Historic Parks and Gardens	2	5,900	20%	2,360	n/a	15.76
Waste Wood	Household and Commercial waste	-	-	-	26,651	n/a	18.30
Waste Wood	Waste from agriculture	4	23,947	100%	88,604	20%	-
Wet Biomass	Poultry (Broilers)	-	381,375	-	11,144	40%	22.00
Wet Biomass	Poultry (Layers)	-	25,906	-	1,113	70%	25.00
Wet Biomass	Cattle	0	15,506	-	188,786	88%	
Wet Biomass	Pigs	0	8,024	-	10,657	91%	

Waste

Timber Waste

For construction wood waste - use national level data and disaggregate on the basis of new housing allocations.

timber waste by households - UK total	420,000	tonnes	
No of households in Hertfordshire	420,650		(UK government statistics)
no of households in the UK	24,700,000		(UK government statistics)
Total timber waste in Hertfordshire	7,153	tonnes	
total packaging + construction waste in the UK	1,420,000	tonnes	
total packaging + construction waste in Hertfordshire	46,150	tonnes	

Waste - Animal farming (manure, beddings etc)

Biogas Yield

cattle	25	m3/t
pigs	26	m3/t
food and drinks	46	m3/t

Wind

		Large Scale Turbine	Small Scale
Cost per turbine			39,000
Typical cost per installed MW		800,000	2,600,000
1 kmsq	9	MW wind turbine	
Wind Energy Resource			
area available - further constraints	m2	604	
turbine capacity in total	MW	5436	
turbine capacity 10%	MW	543.6	100
Rating	MW	2	0.02
no of turbines		271.8	
Capacity Factor	%	23%	10%
Manufacturer	-	Vestas	Proven
Model	-	V90	Proven 15
Approximate Cost	£	434,880,000	3,900,000
Rated wind speed	m/s	14.5	12.0
Cut-in wind speed	m/s	3.8	2.5
Hub Height	m	80	15.0
Rotor diameter	m	80	9.0
Recommended exclusion zone	m	800	54.0
Annual energy output	MWh/year	1,095,870	1,314
CO2 emissions saved	tonnesCO2/year	622,454.40	746.35
Homes equivalent (3bed detached)		177,844.11	210.24
Cost/tonne CO2 saved	£	£699	£5,225
Homes equivalent (3bed detached)	energy	192,258	231

Appendix D: Funding Mechanism for Low & Energy Carbon Technologies

Renewable Energy Certificates (ROCs)

The Renewables Obligation requires licensed electricity suppliers to source a specific and annually increasing percentage of the electricity they supply from renewable sources. The current level is 9.1% for 2008/09 rising to 15.4% by 2015/16[62]. The types of technology and the number of ROCs achieved per MWh are outlined in the table below. The value of a ROC fluctuates as it is traded on the open market. The value of a ROC fluctuates as it is traded on the open market but has an historical average of about £45 / MWh [63].

Technology	ROCs /MWh	Technology	ROCs/MWh
Hydro	1	Energy from Waste with CHP	1
Onshore wind	1	Gasification/Pyrolysis	2
Offshore wind	1.5	Anaerobic Digestion	2
Wave	2	Co-firing of Biomass	0.5
Tidal Stream	2	Co-firing of Energy crops	1
Tidal Barrage	2	Co-firing of Biomass with CHP	1
Tidal Lagoon	2	Co-firing of Energy crop with CHP	1.5
Solar PV	2	Dedicated Biomass	1.5
Geothermal	2	Dedicated energy crops	2
Geopressure	1	Dedicated Biomass with CHP	2
Landfill Gas	0.25	Dedicated Energy Crops with CHP	2 [64]
Sewage Gas	0.5		

Table D1

Feed-in-tariffs (FIT)

Feed-in-tariff's in the UK came into force in April 2010[65] for installations not exceeding 5 MW[66]. The following low-carbon technologies are eligible:

- Anaerobic Digestion
- Hydro
- Micro CHP (pilot trails)
- PV
- Wind

Feed-in tariffs are a per unit subsidy payment (p/kWh) for sub-5MW renewable electricity generation, Anaerobic digestion and micro CHP (pilot schemes only). The scheme will not initially support solid and liquid biomass technologies as they will be supported under the Renewable Obligations scheme.

The objective of FITs is to contribute to the UK's 2020 renewable energy target through greater take-up of electricity generation at the small scale and to achieve a level of public engagement that will engender widespread behavioural change.

Payments under the FIT scheme will include a Generation Tariff and an Export Tariff. The generation tariff will be fixed per kWh of energy generated. Electricity that is exported off site will also receive an income of 3p/kWh. The tariff will decrease over time to reflect the impact of increasing installation rates on end prices charged to consumers, the goal being to enable industries to "stand alone" at the end of the tariff period[67].

Renewable Heat Incentive (RHI)

This incentive follows a similar form to Feed-in-Tariffs (see previous section). Although out to consultation, it is proposed that the following technologies would be eligible for income from the tariff from April 2011:

- Solid biomass
- Bio-gas on site combustion
- Ground source heat pumps
- Air source heat pumps
- Solar thermal
- Bio-methane injection

Salix Finance

This is a publicly funded company designed to accelerate public sector investment in energy efficiency technologies through invest to save schemes. Funded by the Carbon Trust, Salix Finance works across the public sector including Central and Local Government, NHS Trusts and higher and further education institutions. It will provide £51.5 million in interest free loans, to be repaid over four years, to help public sector organisations take advantage of energy efficiency technology[68].

Salix launched its Local Authority Energy Financing (LAEF) pilot scheme in 2004. The success of this programme has allowed the pilot to be rolled out into a fully fledged local authorities programme.

The Community Infrastructure Levy

The CIL is expected to commence in April 2010 and unlike Section 106 contributions can be sought 'to support the development of an area' rather than to support the specific development for which planning permission is being sought. Therefore, contributions collected through CIL from development in one part of the charging authority can be spent anywhere in that authority area. This makes CIL potentially an ideal mechanism for operating the Carbon Buyout Fund proposed in the policy recommendations.

Carbon Emission Reduction Target (CERT)

The Carbon Emissions Reduction Target (CERT) is a legal obligation on the six largest energy suppliers to achieve carbon dioxide emissions reductions from domestic buildings in Great Britain. Local authorities and Registered Social Landlords (RSL) can utilise the funding that will be available from the energy suppliers to fund carbon reduction measures in their own housing stock and also to set up schemes to improve private sector housing in their area.

The main different types of measures that can receive funded under CERT are:

- Improvements in energy efficiency
- Increasing the amount of electricity generated or heat produced by microgeneration
- Promoting community heating schemes powered wholly or mainly by biomass (up to a size of three megawatts thermal)
- Reducing the consumption of supplied energy, such as behavioural measures.
- Section 106 Agreements
- Section 106 agreements are planning obligations in the form of funds collected by the local authority to offset the costs of the external effects of development, and to fund public goods which benefit all residents in the area
- The Community Energy Saving Programme

This is a £350million programme for delivering "whole house" refurbishments to existing dwellings through community based projects in defined geographical areas. This will be delivered through the major energy companies and aims to deliver substantial carbon reductions in dwellings by delivering a holistic set of measures including solid wall insulation, microgeneration, fuel switching and

62 What is the Renewables Obligation? (department for Business, Innovation and Skills website http://www.berr.gov.uk/energy/sources/renewables/policy/renewables-obligation/what-is-renewables-obligation/page15633.html, accessed August 2009)
63 http://www.e-roc.co.uk/trackrecord.htm
64 Renewable Obligation Certificate (ROC) Banding (DECC websites http://chp.defra.gov.uk/cms/roc-banding/, accessed August 2009)
65 Green feed-in tariff needs to maximise solar power (Guardian website http://www.guardian.co.uk/environment/2009/may/14/feed-in-tariff-solar-power, accessed August 2009)
66 Energy Act 2008 Section 41.4.b
67 Feed in tariffs (Action Renewables website http://www.actionrenewables.org/uploads_documents/SolarcenturyFeedTariffguide.pdf, accessed August 2009)
68 Loans section (Salix website http://www.salixfinance.co.uk/loans.html, accessed August 2009)

connection to a district heating scheme. Local authorities are likely to be key delivery partners for the energy companies in delivering these schemes.[69]

The Community Sustainable Energy Programme has two grant initiatives. Both are only available to not-for-profit community based organisations in England.

Prudential borrowing and bond financing

The Local Government Act 2003 empowered Local Authorities to use unsupported prudential borrowing for capital investment. It simplified the former Capital Finance Regulations and allows councils flexibility in deciding their own levels of borrowing based upon its own assessment of affordability. The framework requires each authority to decide on the levels of borrowing based upon three main principles as to whether borrowing at particular levels is prudent, sustainable and affordable. The key issue is that prudential borrowing will need to be repaid from a revenue stream created by the proceeds of the development scheme, if there is an equity stake, or indeed from other local authority funds (e.g. other asset sales).

Currently the majority of a council's borrowing, will typically access funds via the 'Public Works Loan Board'. The Board's interest rates are determined by HM Treasury in accordance with section 5 of the National Loans Act 1968. In practice, rates are set by Debt Management Office on HM Treasury's behalf in accordance with agreed procedures and methodologies. Councils can usually easily and quickly access borrowing at less than 5%.

The most likely issue for local authorities will be whether or not to utilise Prudential Borrowing, which can be arranged at highly competitive rates, but remains 'on-balance sheet' or more expensive bond financing which is off-balance sheet and does not have recourse to the local authority in the event of default.

Local Asset-Backed Vehicles

LABVs are special purpose vehicles owned 50/50 by the public and private sector partners with the specific purpose of carrying out comprehensive, area□based regeneration and/or renewal of operational assets. In essence, the public sector invests property assets into the vehicles which are matched in case by the private sector partner.

The partnership may then use these assets as collateral to raise debt financing to develop and regenerate the portfolio. Assets will revert back to the public sector if the partnership does not progress in accordance with pre□agreed timescales through the use of options.

Control is shared 50/ 50 and the partnership typically runs for a period of ten years. The purpose and long term vision of the vehicle is enshrined in the legal documents which protect the wide economic and social aims of the public sector along with pre□agreed business plans based on the public sector's requirements.

Many local authorities are now investigating this approach, with the London Borough of Croydon being the first LA to establish a LABV in November 2008. LABVs are still feasible if adapted to suit the current macro economy. The first generation of LABVs were largely predicated on a transfer of assets from the public sector to a 50/50 owned partnership vehicle in which a private sector developer/investor partner invested the equivalent equity usually in cash. The benefits were in some instances compelling.

This transfer of assets suited the public sector given yields and prices had never been stronger. There is now a need for a second generation of LABVs that deliver many of the recognised benefits of LABVs as set out above but protect the public sector from selling 'the family silver' at the bottom of the market.

The answer may lie in LABV Mark 2 – a new model that is emerging based on the use of property options that will act as incentives. A better acronym would be LIBVs (Local Incentive Backed Vehicle) in which the public sector offers options on a package of development and investment sites in close 'place-making' proximity. The private sector partner is procured, a relationship built, initial low cost 'soft' regeneration is commenced such as; understanding the context, local consultation, masterplanning, site specific planning consents etc. Thereafter, as and when the market returns, the sites and delivery process will be ready to respond, options will be exercised, ownership transferred and a price paid that reflects the market at the time

JESSICA

The Joint European Support for Sustainable Investment in City Areas (JESSICA) is a policy initiative of the European Commission and European Investment Bank that aims to support Member States to exploit financial engineering mechanisms to bring forward investment in sustainable urban development in the context of cohesion policy.

Under proposed new procedures, Managing Authorities in the Member States, which in the case of the UK is the RDAs, will be allowed to use some of their Structural Fund allocations, principally those supported by ERDF, to make repayable investments in projects forming part of an 'integrated plan for sustainable urban development' to accelerate investment in urban areas. The investments may take the form of equity, loads and/ or guarantees and will be delivered to projects via Urban Development Funds (UDFs) and, if required, Holding Funds (HF). The fund will recycle monies over time and series of projects.

Green Renewable Energy Fund

A example of this is operated by EDF. Customers on the Green Tariff pay a small premium on their electricity bills which is matched by EDF and used to help support renewable energy projects across the UK.

This money is placed in the Green Fund and used to award grants to community, non-profit, charitable and educational organisations across the UK.

The Green Fund awards grants to organisations who apply for funds to help cover the cost of renewable energy technology that can be used to produce green energy from the sun, wind, water, wood and other renewable sources.

Funding will be provided to cover the costs associated with the installation of small-scale renewable energy technology and a proportion of the funding requested may be used for educational purposes (up to 20%). Funding may also be requested for feasibility studies into the installation of small-scale renewable energy technology.

There is no minimum value for grants, with a maximum of £5,000 for feasibility studies, and £30,000 for installations. All kinds of small-scale renewable technologies are considered. The closing dates for the applications usually fall on the 28th February and the 31st August.

Intelligent Energy Europe

The objective of the Intelligent Energy - Europe Programme aims to contribute to secure, sustainable and competitively priced energy for Europe. It covers action in the following fields:

- Energy efficiency and rational use of resources (SAVE)
- New and renewable energy resources (ALTENER)
- Energy in transport (STEER) to promote energy efficiency and the use of new and renewable energies sources in transport

The amount granted will be: up to 75% of the total eligible costs for projects and the project duration must not exceed 3 years.

Merchant Wind Power

A scheme of this type is operated by Ecotricity who build and operate wind turbines on partner sites. Ecotricity take on all the capital costs of the project, including the turbine itself, and also conducts the feasibility, planning, installation, operation and maintenance of the wind turbines. MWP partners agree to purchase the electricity from the turbine and in return receive a dedicated supply of green energy at significantly reduced rates.

Partnerships for Renewables is a company that has been set up to deliver turbines on public sector land. In return for a turbine the recipient receives an annual return on its investment. Importantly, installation would be limited to local authority owned land. Ecotricity operate a scheme whereby they build and operate wind turbines on partner sites. Ecotricity take on all the capital costs of the project, including the turbine itself, and also conducts the feasibility, planning, installation, operation and maintenance of the wind turbines. Partners agree to purchase the electricity from the turbine and in return receive a dedicated supply of green energy at significantly reduced rates

Energy Saving Trust Low Carbon Communities Challenge

Local authorities can apply for up to £500,000 for energy efficiency and renewable energy measures across their locality. This could help deliver carbon-saving projects such as area-based insulation schemes or community renewables, The two year programme will provide financial and advisory support to 20 'test-bed' communities in England, Wales and Northern Ireland, support inward investment and foster community leadership. The programme is open to local authorities and community groups and the Challenge is focused on communities already taking action, or facing change in the area as a result of climate change and those looking to achieve deep cuts in carbon over the long term.

The programme will provide around £500,000 capital funding (up to 10% can be spent on project management). The timescale on the scheme is short with the capital money needing to be spent very soon. The challenge will be run in two phases with applicants able to apply for either of them. Phase 1 will be for green 'exemplar' communities that have already integrated community plans to tackle climate change and Phase 2 is for communities already taking some action or facing change in their area.

Biomass Grants

If grown on non-set-aside land then energy crops are eligible for £29 per hectare under the Single Farm Payment rules (set-aside payments can continue to be

[69] Funding section (Energy Saving Trust website http://www.energysavingtrust.org.uk/business/Business/Local-Authorities/Funding, accessed August 2009)

claimed if eligible). The Rural Development Programme for England's Energy Crops Scheme also provides support for the establishment of SRC and miscanthus. Payments are available at 40% of actual establishment costs, and are subject to an environmental appraisal to help safeguard against energy crops being grown on land with high biodiversity, landscape or archaeological value.

Local Authorities Carbon Management Programme

Through the Local Authority Carbon Management Programme, the Carbon Trust provides councils with technical and change management guidance and mentoring that helps to identify practical carbon and cost savings. The primary focus of the work is to reduce emissions under the control of the local authority such as buildings, vehicle fleets, street lighting and waste.

Participating organisations are guided through a structured process that builds a team, measures the cost and carbon baseline (carbon footprint), identifies projects and pulls together a compelling case for action to senior decision makers. Carbon Trust consultants are on hand throughout the ten months. Direct support is provided through a mixture of regional workshops, teleconferences, webinars and national events.

The Programme could provide a useful mechanism for the Council to address its carbon emissions of which energy planning and delivery will be an important part.

Report End