Bassetlaw Renewable and Low Carbon Energy Study

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Non Technical Summary

Non Technical Summary

This study recommends planning policy to reduce the impact of development in Bassetlaw on climate change. It also considers other mechanisms which the Council can use to promote energy efficiency and a decentralised renewable and low carbon energy supply in the district. The recommendations are based on the available evidence regarding local opportunities and constraints. The policies proposed are considered to be technically feasible and financially viable in general terms.

Purpose of the Study

- This study is intended to contribute to the evidence base for Bassetlaw District Council's planning policies on climate change mitigation and adaptation. It has been prepared in accordance with national guidance, primarily the PPS1 Supplement on Planning and Climate Change (the PPS1 Supplement, 2007).

Bassetlaw in Context

Policy Context

- International, European and national policy commit the UK to reducing its impact on climate change and increasing the supply of energy from renewable and low carbon sources. These commitments are reflected in emerging regional policy and need to be translated into local policy and action.
- Planning has a significant role to play in achieving these commitments, by:
    - Understanding the local feasibility and potential for renewable and low-carbon technologies
    - Identifying suitable areas for renewable and low-carbon energy sources, and supporting infrastructure
    - Setting standards for new development
- The PPS1 Supplement and PPS22 (2004) define the role of planning in the response to climate change and the development of renewable and low carbon energy supplies. A new PPS, due to be published in draft by the end of 2009, is expected to combine and update these statements of national policy.
- The Council as a whole has a broader role to lead and facilitate action across the district. It enforces the provisions of the Building Regulations and is responsible for promoting energy efficiency in the existing building stock. It can also provide financial incentives and support. In addition, the Council has a duty to manage the climate change impacts of its own estate and services.
- The 2004 and 2008 Planning Acts, PPSs and other legislation empower local authorities to fulfil this role. The Well-being Power, introduced in 2000, is particular significant, enabling local authorities to "do anything they consider likely to promote the economic, social and environmental well-being of their area unless explicitly prohibited elsewhere in legislation."
- Policy relating to new development will need to be set in the context of the proposed amendments to Part L of the Building Regulations. These amendments will introduce a zero carbon requirement for new homes and schools in 2016, and other types of non-residential building in 2019.
- The definition of zero carbon used throughout this study, and our assumptions about related mechanisms including allowable solutions, are based on the Government's draft proposals, set out in a series of consultation documents. The details have not yet been finalised and the zero carbon requirements could change substantially in future years, in which case this report and its recommendations should be reviewed.
- *Bassetlaw*
- Per capita CO_2 emissions in the district are high compared to the national average.
- A significant proportion of existing housing is in private ownership. 20% of socially rented housing is in local authority ownership.

- Future development may offer opportunities to improve performance of existing development. Areas of high energy demand and related CO_2 emissions from existing buildings are concentrated in the higher density areas of the major settlements. New development tends to be focused on edge-of-settlement sites rather than town centre areas.

Energy Efficiency

- Energy use in Bassetlaw's existing building stock is likely to be much greater than from new development, due to its extent, age and condition.
- Energy performance of homes has increased, particularly since the introduction of Part L of the Building Regulations, but Bassetlaw is one of the worst performing authorities for improving the energy efficiency of existing housing in the Defra National HECA Report for 2006-07. It is falling well short of its 30% improvement target by 2011.
- Bassetlaw has good opportunities to influence its own housing stock (around 20% of total), but also that of the private rented sector by setting up a green landlord scheme.
- Improving energy efficiency of housing in rural areas should be prioritised as there is a significant proportion of homes with a SAP rating of less than 30.
- Improved thermal performance of homes can lead to a rebound effect, where CO_2 savings are nullified by changes in occupier behaviour .
- Appropriate specification of new buildings or renovations can reduce energy demand and improve thermal comfort, including overheating.
- Bassetlaw has large areas of housing without access to the gas network where biomass could replace existing high carbon heating fuels, such as coal or oil.

Opportunities for District Heating

- District heating and CHP increases the efficiency of heat and power generation compared with conventional generation and can contribute to renewable energy targets if powered by biomass or biogas.
- Potential for district heating and CHP in Bassetlaw is likely to be limited due to its largely rural nature and relatively low development density. However, important opportunities do exist, particularly in the town centres of Worksop and Retford.
- 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.
- The main benefit of moving to district heating networks is the carbon savings that they can deliver.
- 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.
- 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.

Opportunities for Renewable and Low Carbon Energy

- Despite some constraints, Bassetlaw has resource for large scale wind turbines across around 280km^2 of land. If less than 10% of this were used, it could provide 200MW of installed capacity, comprising around 100 large turbines in addition to those already in planning. This would generate 473,000 MWh annually, saving nearly 270,000 tonnes CO_2. This is equivalent to that emitted by over 75,000 typical detached homes, well over the total number of dwellings in the district including new development.
- Smaller scale turbines of around 15m tip height could be a significant opportunity. 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 district's capacity and assuming a

capacity factor of 15% would generate around 1,971 MWh annually.

- The district can generate around 800,000 MWh per year from energy crops on grade 3 and 4 land. This is equivalent to 267,800 tonnes CO_2, or carbon emitted from around 75,000 typical detached homes.
- Potential annual arboriculture arisings are around 13,500 oven dried tonnes, equating to 35,000 MWh and displacing 20,000 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 1,188 oven dried tonnes annually, equating to 5,200 MWh and reducing CO_2 emissions by 130 tonnes.
- 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 hydro has been identified.
- Several opportunities exist for utilising waste heat waste heat either now or in future, including an existing landfill gas site, existing electricity generation using coal mine methane and the proposed power station at High Marnham.
- The analysis of potential locations for CHP and district heating indicated that there are areas in Retford and Tuxford which may be suitable.
- As the global warming potential of coal mine methane is 25 times that of CO_2 over a 100 year horizon, its use as a fuel for heat and power generation should be encouraged from the three existing sites of Harworth, Wellbeck and Bevercotes.
- Bassetlaw 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 and there would be particular benefit in encouraging fuel switching in areas in the south and east of the district currently powered by oil and coal
  - 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
  - Fuel cells can be used as CHP systems in buildings but are considered to be an emerging technology and costs are high

Energy Opportunities Map

An Energy Opportunities Map has been prepared, showing opportunities for renewable and low carbon energy generation in Bassetlaw.

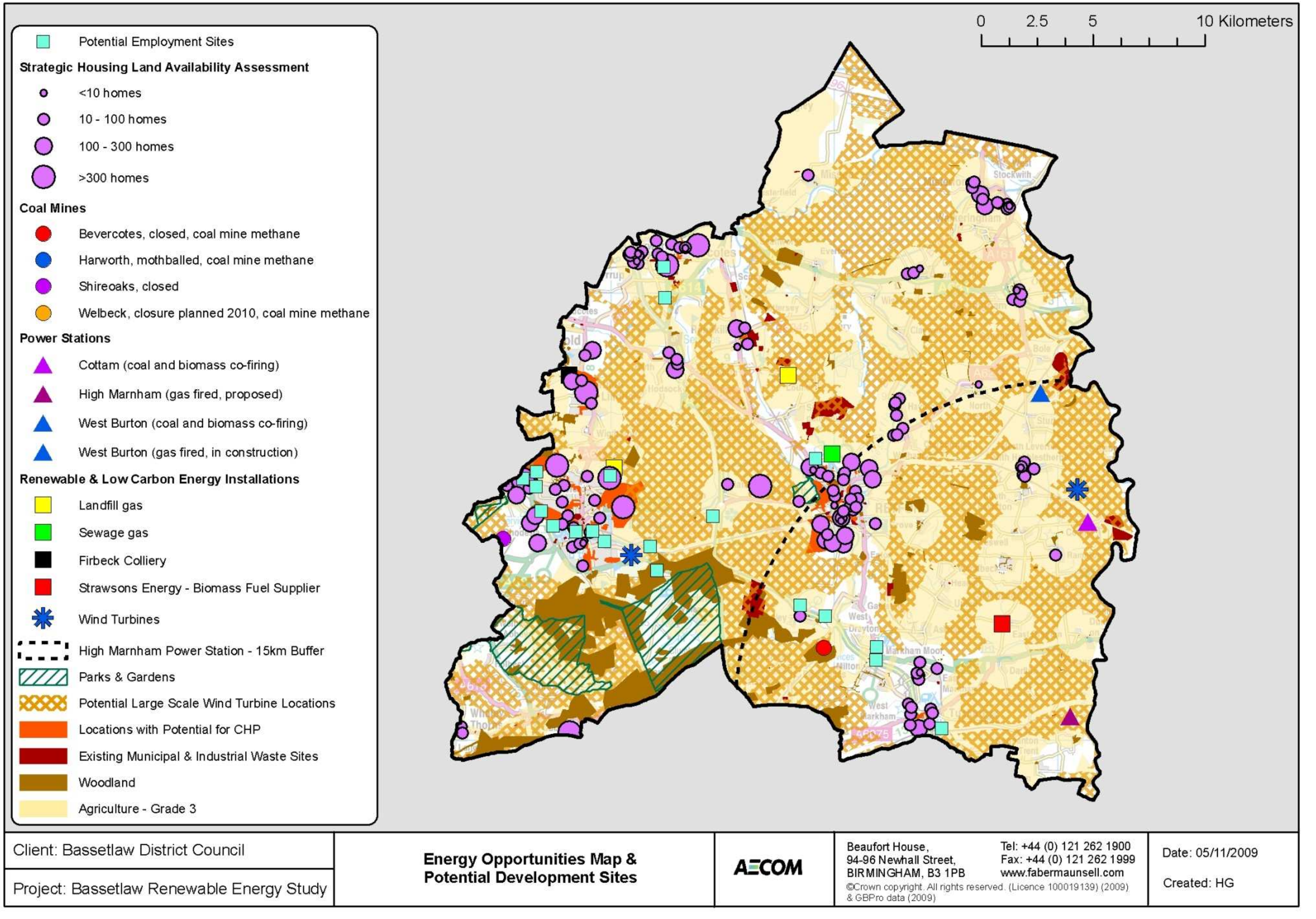


Figure 1 Energy Opportunities map for Bassetlaw

Code for Sustainable Homes and BREEAM

- Requirements through planning for Code for Sustainable Homes or BREEAM standards overall environmental performance of new development. Go some way towards addressing the potential future impacts of climate change by setting water consumption, flood risk management and ecology standards.
- Further work is recommended to establish the local circumstances which may affect a development's ability to deliver a policy requiring a minimum Code or BREEAM rating.
- A significant proportion of the costs of delivering Code levels is in meeting the standards for CO_2 emissions, which will become part of Building Regulations from 2010 and therefore not an additional cost. Modelled costs indicate that the uplift in build costs arising from the remaining Code requirements is around 3% for flats and 5% for houses for Code Level 4.
- There is a significant jump in cost when moving from Code Level 4 to Code Level 5 due to the need for water re-use and recycling systems: around 4.5% for flats and nearly 12% for houses.
- 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.
- Based on the SHMA and Affordable Housing Viability Study we have concluded that the additional financial burden imposed by Code and/or BREEAM targets would not be a viable option.

Testing Targets

Headline Conclusions

- The main driver of improvement in energy efficiency and increasing contribution from renewable and low carbon energy technologies is the progressive tightening of the Building Regulations, up to and including the introduction of the zero carbon requirement for homes in 2016 and for other buildings in 2019. It is also likely to be a major factor in increasing construction costs faced by developers.
- Our analysis indicates that all of the development types considered could feasibly achieve additional CO_2 savings over and above the Building Regulations requirements, prior to the introduction of the zero carbon requirement.
- Based on the outcomes of our modelling, there is likely to be little difference in the energy strategies proposed for developments if additional targets were imposed through planning, in terms of the technologies proposed and the CO_2 savings these deliver. This is because the standard size renewable and low carbon energy systems that have been selected by the model as the cheapest option for achieving compliance with the Building Regulations have the capacity to offer CO_2 savings over and above the basic regulatory requirements, allowing them to achieve compliance with the higher targets being considered.
- Our analysis is based on standard assumptions about the CO_2 savings which different combinations of energy technologies and energy efficiency improvements could deliver for different types of building. We have assumed a typical size of technology, according to the size of dwelling or floor area in case of non-residential, which is not scaled up or down according to the target emissions savings that are intended to be achieved. The CO_2 savings and cost of each technology are therefore also fixed for each dwelling type. This means, for example, that a detached house would have the same size of solar hot water system with the same cost, whether the target is compliance with the 2010 Building Regulations or an additional 15% CO_2 saving on top of that. Because installation and tank costs would remain, a smaller system to comply with lower targets would still cost a similar amount. If the Building Regulations requirements can be assumed to be viable, and additional savings over and above this could be delivered with no or minimal increase in cost, then it could be argued that a planning target which requires these additional savings is also viable.
- Solar water heating may be a common choice for residential developments to comply with targets in the earlier years, however it may not offer sufficient CO_2 savings to comply with later versions of the Building Regulations. This may be a particular issue for large

developments, where different phases are required to comply with different versions of the regulations, as later phases may require an alternative energy strategy. In addition, installation of solar water heating would take roof space which would not be available in future for retrofitting of PV, which offers greater potential for CO_2 savings and may become more affordable with time.

- Biomass heating was identified in our analysis as the cheapest option for commercial buildings to comply with the various policy options up to 2016, when we have assumed tighter interim standards will be introduced in the updated Building Regulations. The biomass supply chain may need to be developed further to cope with the potential increase in demand if a large proportion of new developments opt to install boilers on-site, although it is encouraging that there is already a local supplier in the district. In addition, major growth in the use of biomass fuel could have implications for air quality. Bassetlaw District Council should seek to ensure appropriate mitigation of emissions from new installations.
- Where available, connection to an existing district heating network could provide a cost effective option for compliance for all types of development. Although the commercial developments considered tend to have lower heat demand than dwellings, they could be cheaper to connect as the individual buildings could only require one main connection to the heat network, while each residential unit would require a separate connection. Establishment of district heating networks also has potential benefits for existing buildings in the vicinity, which may be able to connect. Installation of gas-fired CHP on-site has not been identified as a preferred choice for the typical developments we considered, as it offers lower CO_2 savings than other technologies at higher cost. Further work should be carried out to assess the impact that connecting to existing communities would have on CO_2 savings and viability of energy systems delivered as part of new development. Chapter 10 considers some of the likely delivery implications.
- In suitable locations, wind turbines could offer the cheapest option for compliance. Large wind turbines are a particular opportunity for large commercial sites located away from residential areas, such as industrial estates or business parks, where multiple developments could share the installation costs. One or more large wind turbines could generate sufficient electricity to offset all of the emissions from such developments and would make a real contribution to achieving the district's renewable and low carbon energy targets. Small wind turbines could also make a significant contribution to emissions savings on more constrained types of development.
- Although our analysis suggests that there are technically feasible options for complying with the various targets considered, they will lead to an increase in the cost of construction, which could affect viability. Cost increases will be particularly significant in later years when the Building Regulations requirements are strengthened. It is recommended that the Affordable Housing Viability Assessment (2009) is revisited in future to consider the impact of the compliance costs presented here on development viability. It could also be worth considering whether the variation in property value across the district justifies different energy and climate change targets depending on location, or whether affordable housing targets could be adjusted to offset the cost of compliance where viability is a concern.
- The costs presented in this report are based on general benchmarks and are likely to differ on a case by case as developments come forward, for example due to variation in local installation costs and changes in the price of technologies. The figures and associated conclusions in this report should therefore be considered in light of other data provided by developers on a case by case basis at time of application.
- The compliance costs tend to be lower as a proportion of overall construction costs for the commercial developments considered. As there is no viability assessment for these types of building, as there is for housing, viability will need to be addressed on a case by case basis at the planning application stage.
- Of the policy options considered, the Nottinghamshire policy framework targets are the most stringent. As the Nottinghamshire targets apply to all site CO_2

emissions, including unregulated emissions, and these targets are required to be achieved using renewable or low carbon technologies only, compliance will be more difficult to assess. This is because a Building Regulations compliance certificate would not include all of the figures necessary to demonstrate that the Nottinghamshire targets had been achieved and additional documentation would be needed. Without a good understanding of energy strategies, planners may be less likely to insist on or enforce compliance with the targets, leading to lower installed capacity than would result from the lower but simpler targets presented in options 2 and 3.

- It should be noted that using planning policy to set targets for additional CO_2 savings from new developments is only likely to have a short term impact, as the targets would effectively be superseded by the Building Regulations zero carbon requirement from 2016 and 2019.

- Whether or not on-site energy and climate change targets are set through planning policy, the planning system has an important role to play in identifying and delivering community and large scale energy opportunities which go beyond site boundaries. It may be necessary to develop planning policy which requires an appropriate financial or physical contribution from developers towards this. If Bassetlaw District Council takes a leading role now, it could reduce the burden on developers when the zero carbon requirement is introduced because coordination of community and large-scale renewable and low carbon energy opportunities would enable them to access a broader range of allowable solutions for Building Regulations compliance. A coordinated, strategic approach to community and large scale energy infrastructure could also benefit the district by attracting local investment including potentially expenditure of allowable solutions funds.

Residential Development

The key findings from the analysis of the policies for new residential development are:

- For residential developments, there are feasible options for complying with all targets on energy constrained sites, with the exception of the Nottinghamshire target proposed for the period from 2013 – 2016.
- The technologies that might be proposed are similar for both small and large residential development on energy constrained sites.
- On energy constrained sites, solar water heating was selected by our model as the cheapest option for complying with the Building Regulations from 2010 onwards, with a standard size system providing sufficient contribution from renewable energy to achieve over 15% CO_2 savings beyond the Building Regulations. This would cost on average £4,320 per dwelling, or around 8% of construction costs.
- A combination of advanced energy efficiency and PV would enable residential developments to comply with the Building Regulations from 2013, providing over 10% savings beyond the Building Regulations for a standard size system. This combination of technologies could be required from 2010 to comply with the Nottinghamshire policy, costing around 30% more than solar water heating. The cost of this option represents an increase of around 12% in the typical construction costs for residential development.
- The main difference between the large and small residential site is that the larger site is theoretically of a sufficient size to justify an on-site gas-fired CHP system with district heating, even if there is no established district heating network to connect to outside of the site boundary. However, this offers a lower CO_2 saving than might be achieved with other options, at more than double the cost.
- Our modelling indicates that where residential developments are able to connect to an existing district heating network, supplying waste heat from another source such as a large power station, this could reduce CO_2 emissions from residential development by around 44%. This would be more expensive than solar water heating for a similar CO_2 saving, resulting in an estimated 11% increase in construction costs. Costs of a heat network vary with the density of development; it is more cost effective for flats and terraced houses than for detached properties.

- For small residential developments, a small wind turbine has the potential to deliver higher CO_2 savings than all other technological options selected, for a lower cost, although this option will only be feasible in limited locations due to the spatial requirements. Installing one small turbine for a site with 10 new dwellings would cost around £1,900 per dwelling, equating to around 3% of typical construction costs.
- Large residential developments in suitable locations may find that investment in a large wind turbine is a cheaper option for achieving the zero carbon requirement post 2016. However, due to the requirement for an 800m distance between these turbines and the nearest residential property, few if any residential developments may be able to install one on-site and opportunities to install a turbine on adjacent land may also be limited. Chapter 10 explores options for community ownership. In such circumstances it may be possible to relax some of the spatial criteria.
- The cost of complying with the Building Regulations requirements from 2016 onwards may be significantly greater than the cost of complying with any of the planning targets considered in the preceding years.
- The Bassetlaw Affordable Housing Viability Assessment (2009), prepared by Three Dragons, considered the viability of a range of development sizes and densities, in different areas of the district, in order to inform affordable housing targets. The assessment was based on current benchmark construction costs for new housing and did not include any allowance for additional costs associated with energy and climate change targets beyond the minimum Building Regulations requirements, such as an allowance for installing renewable energy systems on-site.
- The Affordable Housing Viability Assessment allowed for £5,000 per dwelling for all Section 106 contributions other than affordable housing. This is at the bottom end of the range of typical values observed by the authors of the assessment, which range from “£5,000 per dwelling to Milton Keynes tariff levels of £18,000 plus free land”. Section 106 contributions would need to cover a range of potential costs including contributions to improving local transport infrastructure, education provision, public realm and other community facilities, in addition to anything that might be required on energy and climate change. Even with this low level of Section 106 costs, the Affordable Housing Viability Assessment recommended targets for affordable housing that fell short of the Strategic Housing Market Assessment recommendation due to questions over the impact on development viability.
- The assessment found that house prices varied across the district, with the highest values in the northern rural area and the lowest in Worksop and Carlton. On this basis, more stringent energy and climate change targets could be viable in the higher value areas of the district and concessions on targets may be justified for the lowest value areas. However, a significant proportion of proposed development is planned to take place in these urban, lower value areas, so the cumulative impact of relaxing standards in these locations could be large. An alternative option would be to reduce the affordable housing target in these areas to offset the cost of complying with energy and climate change targets.
- Although it may be technically feasible for housing developments to achieve emissions savings over and above the Building Regulations requirements prior to 2016, the cost of this has not been taken into account in the Affordable Housing Viability Study. There could therefore be implications for viability in some cases, depending on when and where the development comes forward. This should be taken into account on a case by case basis, as developments come forward for planning.
- It is recommended that the figures in the Affordable Housing Viability Assessment are revisited in future updates to take into account potential future costs of compliance with Building Regulations and planning policy, particularly from 2016 onwards. This should consider an appropriate balance between affordable housing provision and energy and climate change targets for different parts of the district.
- Viability will depend on a range of factors which are beyond the scope of this study. These include land and market values of properties at the time of the

planning application and the method of financing the renewable and low carbon energy technologies. Financing mechanisms are discussed further in chapter 10 and appendix E.

Non-Residential Development

- For all the non-residential development types considered in this analysis, there are feasible technology options for complying with all of the policies considered for the period from 2010-2016. If higher energy efficiency standards are introduced for non-residential buildings with the 2016 update of the Building Regulations, achieving an additional saving from renewable or low carbon technologies on top of this may not be feasible.
- No technology options have been identified which would allow non-residential developments on a constrained site to achieve the zero carbon requirement under the Building Regulations from 2019 onwards, based on the current definition of zero carbon for dwellings. However, it should be noted that since this analysis was undertaken, the Government has published a consultation on the definition of zero carbon for non-domestic buildings, which sets out variable targets for different types of building, takes into account their relative ability to reduce CO_2 emissions and should ensure that all buildings are able to comply with the regulations as a minimum.[1]
- The technologies that might be proposed on energy constrained sites are similar for all types of non-residential development considered in this analysis. Because the scale of development and the relative heat and electricity demand differs for an office compared to a workshop or storage facility, the percentage CO_2 savings that these technologies could deliver varies.
- Biomass heating is the preferred option for complying with all policies in the period from 2010-2016, as the capital cost is relatively low and it is able to deliver high CO_2 savings. This would cost in the region of £50/m^2 to install for the non-residential developments, although there are fuel costs to consider in addition. This equates to an increase of around 4% in construction costs for a typical office development, and around 9% for a workshop or storage facility.
- A combination of advanced energy efficiency and PV could achieve a higher CO_2 reduction, potentially sufficient to comply with tighter standards if they are introduced for non-residential developments in later years. PV would be significantly more expensive than a biomass boiler. A PV system and advanced energy efficiency could cost in the region of 7% of construction costs for a typical office development. For workshops and storage facilities, which are cheaper to construction, it could add around 40% to construction costs.
- Connection to district heating, where an established network is available, would offer similar CO_2 savings at potentially lower capital cost than biomass heating on-site. For the office development we have assessed this would add around 3% to construction costs, and around 7% for the workshop and storage facility.
- For smaller commercial developments, small wind turbines have the potential to deliver higher CO_2 savings than all other technological options selected, although they will only be feasible in limited locations due to the spatial requirements. A small wind turbine in an appropriate location could save around 42% of the CO_2 emissions from the office development we have modelled, at around 1.5% of construction costs. A larger development like the storage facility may justify investment in a 2MW wind turbine, particularly to ensure compliance with the requirements in later years when the cost of providing sufficient PV is greater than the cost of a large turbine. This would result in CO_2 savings well in excess of the likely emissions from a development of this size and make a real contribution to renewable energy installed capacity. This option may also be available to large clusters of commercial development, such as industrial estates or business parks, where the cost of a wind turbine could be shared between a number of buildings.
- For commercial developments there is no viability assessment to compare the costs of the different compliance options with. It may therefore be

[1] Zero Carbon for New Non-domestic Buildings: Consultation on Policy Options (Department for Communities and Local Government, November 2009)

necessary to assess viability on a case by case basis, as applications come forward. On the basis of this analysis, commercial buildings which are able to connect to a district heating network or large developments which are able to accommodate wind turbines may be able to achieve higher CO_2 reductions at lower cost than other developments. It could therefore be possible to set higher targets for developments which do have access to these opportunities.

Policy Recommendations

There is a compelling evidence base for Bassetlaw District Council to take action to address climate change and increase decentralised renewable and low carbon energy supply in the district. In identifying and appraising planning policy options for Bassetlaw, we have started from the basis that this cannot and should not be delivered through planning alone.

Bassetlaw District Council have started the process of addressing climate change and looking to reduce energy usage and carbon. The signing of the Nottinghamshire Declaration and development of a climate change strategy with workplans covering areas such as energy usage, transport, fuel poverty and education are the beginnings of a very proactive approach to addressing climate change.

Understanding the role of planning as part of a wider set of national, regional and local delivery mechanisms is crucial to delivering a cohesive approach to the climate change problem. This 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. See chapter 10 for an overview of the other delivery mechanisms which may be employed in Bassetlaw.

Planning is unique in that it is 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. The Energy Opportunities Map described in chapter 6 is the result of this process.

Planning policy should support delivery of these energy opportunities. There are several options for the type of policy which could be used to achieve this objective. Using the Energy Opportunities Map and the evidence reviewed in this study as the starting point, a series of potential policies are proposed for further consideration by Bassetlaw District Council. It is important that policies are incorporated in the appropriate parts of the LDF to ensure they have sufficient weight to support their implementation. We have indicated where we think policy is suitable for incorporation in the Core Strategy or other local development documents, such as supplementary planning documents (SPD). The suggested policy wordings will be subject to review and revision as part of the LDF process.

Targets have been assessed for their impact on both new and existing development (chapter 8). 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 opportunity areas have been identified to reflect this local variation, as described in chapter 6. The policy recommendations and targets are based on the assumption that the trajectory to zero carbon continues as described in section 2.2 and that as-built development matches design. Changes to national policy and regulation could alter the relative impact of the policies described here; in this event, policy recommendations should be reviewed.

Policy Recommendation 1: Delivering Energy Opportunities in the District (Core Strategy)

Reducing CO_2 emissions and increasing the supply of decentralised renewable and low carbon energy is a priority for Bassetlaw Council. Planning applications for new development will need to contribute to delivery of the opportunities identified in the current Energy Opportunities Map. Applications for all types of decentralised renewable and low carbon energy will be considered favourably by the Council.

The Council recognises that different energy technologies and CO_2 reduction strategies will suit different parts of the district and different types of development. To reflect this we have designated three Energy Opportunity Areas, with variation in the policy applicable to each:

- Energy constrained
- District heating opportunity areas
- Wind opportunity areas

Policy Justification

The Energy Opportunities Map acts as the key spatial plan for energy projects in Bassetlaw. It underpins the policies and targets described here and sets out where money raised through mechanisms such as the CIL could be spent or priorities for the proposed allowable solutions. It should be used to inform policy making in the Sustainable Community Strategy and other corporate strategies, and investment decisions taken by the local authority and local strategic partnership (see chapter 10 for further detail on delivery mechanisms). It should be incorporated into the Core Strategy and corporate strategies and should be readily updated to reflect new opportunities and changes in feasibility and viability.

Principal energy opportunities in Bassetlaw include commercial and community scale wind; district heating powered by waste heat from power stations and other sources, or possibly from community scale CHP if development is led by the District Council; biomass boilers and other microgeneration technologies. Bassetlaw Council is keen to maximise the installation of all of these technologies where they are appropriate. However, the policy does not seek to rule out any other technology if it will deliver reductions in CO_2 or will increase the supply of decentralised renewable and low carbon energy.

The Energy Opportunity Areas approach is designed to help applicants determine which types of technology are likely to be most suited to a given area. It also seeks to encourage energy installations that will contribute to Bassetlaw Council's objective of delivering all opportunities identified in the current Energy Opportunities Map in the most effective way. The Council understands, 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 Council's intention to restrict this kind of innovation and we are prepared to discuss proposals that deviate from the Energy Opportunities Map and Energy Opportunity Areas with applicants at the pre-application stage.

Policy Recommendation 2: Improvements to Existing Homes (Core Strategy or SPD)

The Council recognises the importance of improving the energy performance of Bassetlaw's existing building stock. Therefore, installation of energy efficiency measures and renewable and low carbon technologies is encouraged.

Planning applications for changes to existing dwellings will be required to undertake reasonable improvements to the energy performance of the entire dwelling. This will be in addition to the requirements of Part L of the Building Regulations applicable to the changes for which planning permission is sought. Improvements will include, but not be restricted to loft and cavity wall insulation, draught-proofing, improved heating controls and replacement boilers.

Applicants will be asked to complete a checklist to identify which measures are appropriate to their home. The total cost should be no more than 10% of the total build cost.

Policy Justification

The purpose of the policy is to reduce CO_2 emissions from existing buildings. However, opportunities within planning are limited and much of the focus will need to be on a wider local authority and stakeholder initiatives (discussed further in chapter 10). Since consequential improvements for non-domestic buildings are required for the Building Regulations this policy focuses solely on housing.

The policy applies to all householder applications for planning permission to extend or materially alter a home, in any Energy Opportunity Area. The approach aims to make the most of any straightforward opportunities for improvement that exist. These include loft and cavity wall insulation, draught-proofing, improved heating controls and replacement boilers.

The checklist approach should be simple to implement. All of the measures on the list should pay for themselves in energy cost savings in less than seven years, based on estimates of costs and savings for the average home provided by the Energy Saving Trust. If any of the measures on the list are suitable for the home in question, and their combined cost does not exceed 10% of the cost of the building works, they are required. If no measures are suitable, none are required.

Uttlesford District Council included "consequential improvements" as part of an SPD over three years ago and has been successful in implementing it through planning conditions, reporting that it has been well received by householders. According to the Council, around 1,400 extensions have been affected by the policy so far, and the total projected savings from measures required as a result are £72,600 and 398,000kg of CO_2 per year.[2]

Policy Recommendation 3: Additional Energy and CO_2 Potential of New Developments (Core Strategy) (Option A)

Several options are presented for the following policy. Option A represents the basic policy considered; additions to this are highlighted in bold text and elements which have been removed are crossed out in the subsequent policy options.

All new buildings in Bassetlaw will be expected to achieve a target CO_2 emission saving over and above the requirements of the version of the Building Regulations current at the time. The target will vary by Energy Opportunity Area. Specific requirements will also be applied to new buildings to support delivery of the local energy opportunities. Details of the specific requirements are provided in [insert link to relevant policy or guidance document].

The following reductions in Dwelling or Building Emission Rate will be required, compared to the Target Emission Rate defined by the Building Regulations:

- Energy constrained - 10%
- District heating - 10%
- Wind - 15%

These requirements will apply to a development unless the applicant can demonstrate that compliance with the target or the specific requirements on a particular site is either not feasible or not viable.

Policy Recommendation 3: Additional Energy and CO_2 Potential of New Developments (Core Strategy) (Option B)

All new buildings in Bassetlaw will be expected to achieve a target CO_2 emission saving over and above the requirements of the version of the Building Regulations current at the time. The target will vary by Energy Opportunity Area. Specific requirements will also be applied to new buildings to support delivery of the local energy opportunities. Details of the specific requirements are provided in [insert link to relevant policy or guidance document].

The following reductions in Dwelling or Building Emission Rate will be required, compared to the Target Emission Rate defined by the Building Regulations:

- Energy constrained - 10%
- District heating - 10%
- Wind - 15%

If an applicant can demonstrate that compliance with the target or the specific requirements is either not feasible or not viable, a payment into the Carbon Fund will be required.

Policy Recommendation 3: Additional Energy and CO_2 Potential of New Developments (Core Strategy) (Option C)

All new buildings in Bassetlaw will be expected to achieve a target CO_2 emission saving over and above the requirements of the version of the Building

[2] Source: Uttlesford District Council, News: Uttlesford Urges Government to Rethink Energy Efficiency [WWW], from www.uttlesford.gov.uk/main.cfm?Type=n&MenuId=0&Object=3105

Regulations current at the time. The target will vary by Energy Opportunity Area. Specific requirements will also be applied to new buildings to support delivery of the local energy opportunities. Details of the specific requirements are provided in [insert link to relevant policy or guidance document].

The following reductions in Dwelling or Building Emission Rate will be required, compared to the Target Emission Rate defined by the Building Regulations:

- Energy constrained - 10%
- District heating - 10%
- Wind - 15%

All new buildings in Bassetlaw will be required to make a payment into the Carbon Fund, to support delivery of the opportunities identified in the Energy Opportunities Map.

Policy justification

Changes to the Building Regulations in 2010, 2013 and 2016 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. Several options are available for a combination of targets and/or payments into the Carbon Fund, represented by the policy options above.

The targets proposed here seek to accelerate the move towards zero carbon ahead of Building Regulations. All new buildings, both residential and non-residential, would be expected to achieve an additional percentage reduction on the residual CO_2 emissions after Building Regulations compliance. This should be met through a combination of energy efficiency measures, incorporation of energy efficiency, on-site renewable and low carbon energy technologies and directly connected heat or power (not necessarily on-site).

The proposed policy provides flexibility in proposing low carbon and renewable solutions. The policy recognises that different opportunity 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 opportunity areas.

The proposed policy should be simple to operate for both development managers and developers. Development Control offices can assess compliance with the targets by asking for design stage and as-built Building Control Compliance documentation. This should be more straightforward than assessing compliance with the targets set out in the Nottinghamshire policy framework, which would require information to be provided in addition to that required for Building Regulations compliance.

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 Fund, with contributions derived from a levy that would apply to every building constructed within Bassetlaw at a flat rate. Ideally, the amount to be paid would be linked to the CO_2 emitted per square metre over the building lifetime of 30 years, to encourage CO_2 emissions to be reduced as far as possible on-site. However, if the fund were introduced as part of the proposed Community Infrastructure Levy to fund energy infrastructure identified in the Energy Opportunities Map, the levy would need to be charged at a flat rate per m^2 of the development and not linked to emissions.

Uncertainties remain around the relationship between the Community Infrastructure Levy and the proposed allowable solutions that will form part of the Building

Regulations. Both of these could potentially be used to operate a Carbon Fund and the mechanics will need to be explored further once we have clarity on the Government's proposals.

Diverting payments into a Carbon Fund could provide the district with funds for investment in renewable and low carbon energy projects identified in the Energy Opportunities Map. The fund should allow Bassetlaw District Council to strategically coordinate and phase the infrastructure required to deliver community scale energy generation installations such as district heating networks. The Carbon Fund and a possible mechanism for coordinating spending is described further in chapter 10.

Recommendation 4: District Heating Opportunity Areas (policy or guidance)

This policy could be included as part of the Core Strategy, however, it could also sit within a suitable development plan document, including the site allocations DPD or the Harworth or Worksop Area Action Plans. Elements of it might also be suited to an SPD.

The Council is keen to take advantage of opportunities to install district heating across the district. 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 requirements of Policy 3. The Council recognises 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, power stations, or coalmine methane facilities.
- Small developments (less than 100 dwellings or non-residential developments less than 10,000m^2) should connect 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.
- Large and mixed-use developments (over 100 dwellings) should consider installing a district heating network to serve the site. The council's ambition is 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.

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

OR

If an applicant can demonstrate that compliance with the target or the specific requirements is either not feasible or not viable, a payment into the Carbon Fund will be required.

Policy justification

The PPS1 Supplement actively encourages opportunities to be sought 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 and to take advantage of the availability in some parts of the district of waste heat from power stations, coalmine methane facilities and waste management sites.

The long-term ambition is to deliver a strategic district heating network across the district heating opportunity areas. Developments within district heating opportunity areas will need to show in a design and access statement or other supporting document 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. The council recognises 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. This has the benefit of reducing CO_2 emissions in new development or 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 designated for the district heating opportunity areas.

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

- New development:
  - Residential development of at least 55 dwellings per hectare and at least 100 dwellings
  - Large scale mixed use development – enables good anchor load
  - Proximity to high heat density areas of existing buildings – enables extension into existing development
  - Proximity to existing heat sources (e.g. High Marnham proposed power station)
- Existing development:
  - Heat demand density of at least 3,000kW/km^2 and residential density of at least 55 dwellings per hectare or presence of a public sector building to provide a good anchor load
  - 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.

Recommendation for Policy 5: Wind Opportunity Areas (policy or guidance)

This policy could be included as part of the Core Strategy, however, it could also sit within a suitable development plan document, including the site allocations DPD or the Harworth or Worksop Area Action Plans. Elements of it might also be suited to an SPD.

The Council recognises the important role that wind power will play in reducing CO_2 emissions and increasing installed renewable and low carbon energy capacity. While the Council will consider favourably all applications for wind turbines, the Energy Opportunities Map identifies two principal opportunities:

- Large wind turbines delivered by commercial developers
- New development in Wind Opportunity Areas. These should consider wind as their first option for meeting the requirements of Policy 3. Wind Opportunity Areas have been designated to encourage applications for large and small 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.

OR

If an applicant can demonstrate that compliance with the target or the specific requirements is either not feasible or not viable, a payment into the Carbon Fund will be required.

Policy justification

The planning policy approach represents the application of national policy to the specific Bassetlaw 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 and legally binding 34% reduction in CO2 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 evident therefore at every available opportunity for wind power needs to be taken advantage of.

Despite there being good wind speeds across all parts of the district it is recognised that commercial opportunities for turbines are likely to be limited. The Energy Opportunities Map identifies what these constraints are. However, opportunities for individual large turbines or smaller turbines exist across the district and the council is keen to take advantage of these and has designated Wind Opportunity Areas 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.

Delivery Mechanisms

There are a wide range of delivery mechanisms that can be employed to support planning for energy. Not all will be suitable for Bassetlaw and a mix is likely to 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 Council explores further the potential for using Carbon Trust Low Carbon Building Strategic Design Advice money to undertake the following next steps:

Leadership and skills

- The Council must take strategic leadership role with the LSP to ensure the necessary political and stakeholder buy-in.
- It must develop skills across the Council and its partners.

Priority actions and projects

- The Council needs to set out a clear framework which gives relative certainty. Action should be prioritised on strategic sites, council and public sector property and assets.
- The Council should work with eligible partners to develop a micro-generation retrofit strategy based on the opportunities presented by the LCBP.
- A set of priority district heating schemes should be drawn up by the Council and its partners and further feasibility work carried out. This should be based on factors such as financing options, planning, phasing and type of development. Options include a heat

network in Retford from the EON power station serving new and existing development. This could be done in partnership with EON who will have to consider CHP as part of their Section 36 licence application.

- Should the Council agree to lead installation of a district heating network then it is recommended that they explore the option of establishing an LDO in order to add certainty to the development process and potentially speed up delivery.
- For all potential wind sites the Council and its partners should identify delivery opportunities, considering available financial mechanisms, publically owned land, community involvement and ownership and the role of schools.
- The Council should work with Strawsons Energy and other regional and sub-regional partners to ensure that biomass supply chains develop that are appropriate to the energy opportunities.
- The Council and its 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 Council and its 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 Bassetlaw 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.
  - Both the CIL and allowable solutions could potentially be used to operate a Carbon Fund and the mechanics will need to be explored further once we have clarity on the Government's proposals.
- 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 Bassetlaw.

1 Introduction

1 Introduction

AECOM has been commissioned by Bassetlaw District Council to undertake a renewable and low carbon energy study, to support the reduction of carbon dioxide (CO_2) emissions from residential and non-domestic buildings and an increase in the supply of renewable and low carbon energy in the district. The study is part of the evidence base for the emerging Core Strategy and other local development documents. It is also intended to inform the Council's corporate response to climate change.

1.1 Project Scope

AECOM (formerly Faber Maunsell) has been commissioned by the planning department of Bassetlaw District Council to undertake a Renewable and Low Carbon Energy Study, in order to support the reduction of carbon dioxide (CO_2) emissions from residential and non-domestic buildings and an increase in the supply of renewable and low carbon energy in the district. The study is part of the evidence base for the emerging Core Strategy, and is also intended to inform future development of other local development documents.

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

- The distribution and extent (with mapping) of existing and potential renewable energy resources (e.g. wind, biomass, hydro, solar, ground/air source and hydrogen fuel cells) within Bassetlaw and how they can be exploited, in relation to specific new developments and larger scale heat and power generation
- Feasibility and viability of setting a target percentage contribution from decentralised renewable and low carbon energy sources in new development
- Potential policies for inclusion in the Core Strategy, set in the context of future requirements of the Code for Sustainable Homes and BREEAM measures for non-domestic buildings
- How Bassetlaw District Council can implement and monitor the recommended approach, including an assessment of the feasibility of establishing an Energy Service Company, guidance on the development control process for planners, and guidance for developers

1.2 The Need for a Renewable and Low Carbon Energy Study

Planning Policy Statement 1: Delivering Sustainable Development (PPS1) (2005) emphasises the need to promote more sustainable development. The PPS1 Supplement 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."

This reflects a growing recognition of the crucial role the local authorities must play in delivering low carbon communities and the challenges identified above. The Government's draft Heat and Energy Saving Strategy sets out the need for a more co-ordinated approach to streets or neighbourhoods to deliver significant improvements in energy performance. It is anticipated that local authorities will be at the heart of this. This is endorsed by a recent Audit Commission report into the role of local council in reducing domestic CO_2 emissions[3], 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 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.

[3] Audit Commission (October 2009) 'Lofty Ambitions: The Role of Councils in Reducing Domestic CO_2 Emissions: Local Government'

1.3 Structure of the Report

The report is structured as follows:

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

2. Bassetlaw in Context: Summary of the national, regional and local policy context and background on other locally important studies and initiatives in this sector. This also includes a brief description of the existing building stock in the district and the nature of future development.

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

8. Testing Targets: Describes the targets that have been considered for incorporation in planning policy and the analysis of their potential impacts.

9. Policy Recommendations: Sets out recommendations for policies that could be applied across the district and opportunities for varying policy according to location or type of development.

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

11. Recommendations: Summary of recommendations made throughout the study and suggestions for next steps and further work.

12. References: Summary of references used in the report.

Appendix A: Detailed review of policy drivers at the international, national, regional and local scale.

Appendix B: Details of workshop held to present interim results of study and harness views of stakeholders on appropriate policy for Bassetlaw.

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

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

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

Appendix F: Detailed results of the target testing.

2 Bassetlaw in Context

2 Bassetlaw in Context

Planning policy needs to be derived from a robust evidence base, which takes into account local opportunities and constraints. The wider policy context defines what the Council is required and empowered to do, while the physical environment of the district and socio-economic factors such as property values will affect feasibility and viability of policies and targets.

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. An overview has been provided below, with a detailed description of policy drivers provided in Appendix A.

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^{o}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, 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 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. Proposed mechanisms for achieving this include a new focus on district heating in suitable communities, 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 **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** and the **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 has announced that it will review the PPS1 Supplement and PPS22 and consult on a **new combined PPS** by the end of 2009, although it is not expected that the broad policy goals will change significantly.

The **East Midlands Regional Plan (2009)** identifies resource efficiency, renewable energy generation and sustainable design as the key measures for delivering sustainable development and minimising CO_2 emissions. It includes a policy on the role of new developments in reducing CO_2 emissions through energy efficiency, passive design and decentralised renewable or low carbon energy technologies, and sets targets for renewable and low carbon energy generation in the region. The plan is currently undergoing a partial review, which is expected to lead to revision of the renewable and low carbon energy targets. To inform this review, a study has recently been completed reviewing renewable and low carbon energy targets and resource in the region.[4]

The current **Bassetlaw Local Plan** was adopted in 2001 and as such does not reflect the more recent developments in national and regional policy. The recent consultation on the **Core Strategy: Issues and Options (2009)** set the climate change and energy debate in the local context, highlighting Bassetlaw's high per-capita CO_2 emissions and below average contribution from renewable energy. When complete, the Local Development Framework is expected to include four Development Plan Documents (DPDs): Core Strategy and Development Management Policies; Site Allocations; Worksop Area Action Plan (AAP); and Harworth AAP.

Towards a Sustainable Energy Policy for Nottinghamshire (2009) describes proposals for a planning policy framework, developed by a partnership of local authorities in the county including Bassetlaw. In terms of energy, it proposes a target percentage of annual CO_2 emissions which a proposed development needs to save using low or zero carbon energy technologies. The target increases in stages up to 100% by 2016 for domestic buildings and 2019 for non-domestic buildings. Bassetlaw has identified a need for work to understand the basis for policies and targets in the district, including analysis of the commercial viability, extent of local renewable and low carbon energy sources and the factors limiting their use. In addition, the Government's more recent proposals for the Building Regulations and the definition of zero carbon should be taken into account (see Section 2.2).

Bassetlaw District Council has signed the **Nottingham Declaration**. This commits the local authority to reducing emissions from its own operations, adapting to the impacts of climate change and encouraging all sectors of the local community to take similar action. Bassetlaw District Council has a sustainability group which is leading the development of a corporate strategy on energy and climate change, covering the range of facilities and services managed by the Council. The group agree the following:

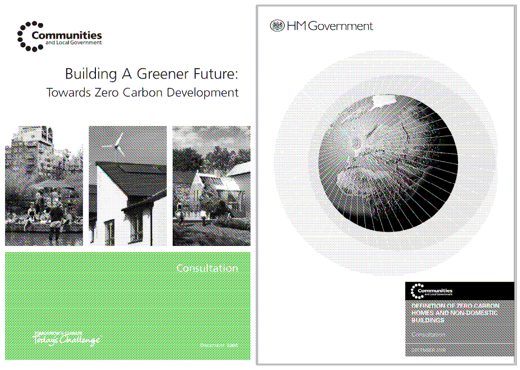
- To agree the content of the Council's Climate Change Strategy for approval by Cabinet.
- To approve energy saving projects, which provide value for money, based on whole life costing.
- To ensure that the Council works corporately to implement the climate change strategy.
- To review climate change performance indicators and agree improvement targets.
- To ensure that green issues are fully considered in the procurement process including contractor selection.

[4] Faber Maunsell AECOM – Reviewing Renewable Energy and Energy Efficiency Targets for the East Midlands (March 2009)

- To provide a link with A1 Housing to discuss partnership projects/performance.
- To consider new technologies/products and innovative ideas including best practice examples from other local authorities.
- To consider new development projects, which are considered, by Property and Regeneration Group in respect of climate change issues.
- To review and monitor grant funding opportunities.
- To approve schemes to promote environmental issues outside businesses.

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[5] that all new homes will be zero carbon from 2016. The following interim changes to the Building Regulations for homes are likely to be introduced:

[5] Building A Greener Future: Policy Statement (Department for Communities and Local Government, July 2007)

- 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 and 2013 will only apply to emissions that are regulated (heating, hot water, lighting, ventilation and cooling (where installed)) inside the dwelling. From 2016, the requirements will apply to all emissions associated with energy use in the dwelling, including cooking and other appliances.

In the Budget 2008, the Government also announced its ambition that all new non-domestic buildings will be zero carbon from 2019 and all new schools and other public buildings will be zero carbon from 2016. A further consultation in 2008[6], followed by a Government statement in July 2009 confirmed the definition of zero carbon that will be applied and set out how it will be taken forward (Figure 2). Achieving zero carbon will include three elements:

- **Energy Efficiency** – A minimum level of energy efficiency will be required in the design of the building fabric. This will set a standard for energy demand for heating and cooling (if installed). It will focus on the use of passive measures such as insulation and shading, which will have a long term impact on energy use in the home and do not rely on maintenance or correct operation to achieve savings. The energy efficiency standard will not include requirements for the energy efficiency of the equipment used to provide heating or cooling, such as boilers, nor will it take into account other uses of energy such as lighting or appliances. These are covered by the carbon compliance and allowable solutions elements.[7] The energy efficiency

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

[7] Sustainable New Homes – The Road to Zero Carbon Consultation on the Code for Sustainable Homes and the Energy Efficiency standard for Zero Carbon Homes (Department for Communities and Local Government, December 2009)

requirements for non-domestic buildings will vary for different types of building, such as offices, supermarkets and warehouses, to reflect the significant variation in how they use energy.[8]

- **Carbon Compliance** – New buildings will be required to achieve a minimum carbon saving, either on-site or by using a low carbon source of heat supplied by connection to a district heating network outside of the site boundary. For homes a 70% saving in regulated emissions will be required, compared to a dwelling which complies with the 2006 Building Regulations. The carbon compliance target will vary for different types of non-domestic building.[8] The savings contributing towards carbon compliance will include any savings made to comply with the energy efficiency requirement. On-site measures for achieving carbon compliance would include any further savings that could be made through energy efficiency of the building fabric over and above the minimum requirement, efficient design of the building services (including boilers, lighting, ventilation and cooling equipment) and use of micro-renewable or low carbon technologies on-site.
- **Allowable Solutions** – These will cover all of the remaining carbon emitted from a building over a 30 year period, including emissions from unregulated energy uses such as appliances. Unregulated energy uses can be responsible for a significant proportion of emissions from a building; even though a dwelling's regulated emissions will need to be reduced by 70% to achieve carbon compliance, allowable solutions could be expected to cover over half of the total emissions from a typical home (Figure 2). The final list has yet to be confirmed but may include:

- Further carbon reductions on site, through energy efficiency or on-site renewable or low carbon energy generation
- Energy efficient appliances which are installed as fittings
- Advanced forms of building control system which reduce the level of energy use in the building
- Exports of low carbon or renewable heat from the development to other developments
- Investments in low and zero carbon community heat infrastructure

Other allowable solutions remain under consideration by the Government, such as investment in community or large scale renewable electricity generation. The Government has announced that it intends to have a common approach to allowable solutions for homes and non-domestic buildings. It has also confirmed that it intends to set a guideline maximum price that developers will be expected to pay to cover their allowable solutions obligations. Proposals are being developed for how allowable solutions will operate in practice. Issues being considered include whether it will be possible for allowable solutions to be implemented through third parties, what role local authorities should have in influencing what allowable solutions are chosen, and how compliance will be confirmed. It is possible that developers may have the option of paying a fixed amount per tonne of carbon into an allowable solutions fund, to be invested in community infrastructure by a third party, although this has not been confirmed by Government.

The definition of zero carbon used throughout this study, and our assumptions about related mechanisms including allowable solutions, are based on the Government's draft proposals, set out in a series of consultation documents. The details have not yet been finalised and the zero carbon requirements could change substantially in future years, in which case this report and its recommendations should be reviewed.

The consultations on the energy efficiency standard for homes[7] and the definition of zero carbon for non-domestic buildings[8] were both published after the bulk of the work for this study had been completed and the initial draft of this report had been issued. The modelling and analysis in this report are therefore based on assumptions drawn from previous consultations and have not been updated to reflect the latest Government proposals. This is not likely to have a significant impact on the findings of the report and the policy recommendations should still be considered to be valid.

[8] Zero Carbon for New Non-domestic Buildings: Consultation on Policy Options (Department for Communities and Local Government, November 2009)

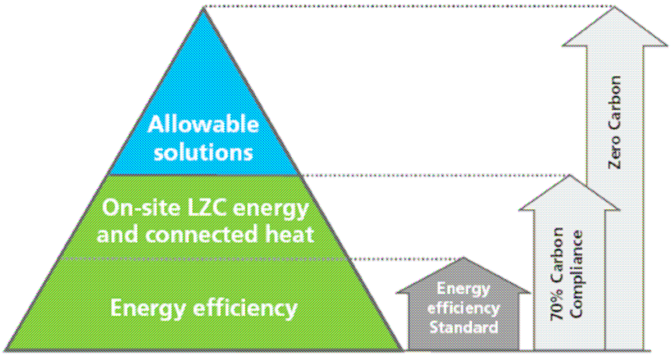


Figure 2 Zero carbon hierarchy, showing the elements of compliance 7. LZC stands for low or zero carbon energy

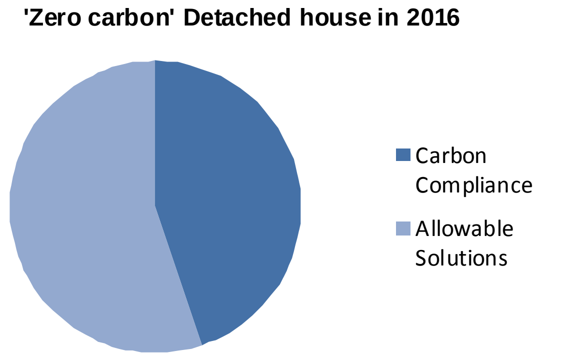


Figure 3 Proportion of CO2 emissions dealt with through carbon compliance (on site energy efficiency and renewable energy generation) compared to allowable solutions, for a typical detached house.

2.3 Measuring Sustainability

2.3.1 Code for Sustainable Homes

The Code for Sustainable Homes (the Code) is an environmental assessment system for new housing in England, introduced 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 1).

Since May 2008 it has been compulsory for new homes to have a Code rating. Residential developments supported by Homes and Communities Agency funding are currently required to achieve Code level 3, expected to rise to Code level 4 from 2010.

The Government has published a consultation on future amendments to the Code for Sustainable Homes.[7] The consultation was published after the bulk of the work for this study had been completed and the initial draft of this report had been issued. Where the Code is mentioned in this report, it refers to the current version of the scheme and the report has not been updated to reflect the latest Government proposals. This is not likely to have a significant impact on the findings of the report and the policy recommendations should still be considered to be valid.

Table 1 Minimum requirements for the six levels of the Code

	Mandatory Requirements		
Code Levels	Energy Improvement over TER[9]	Water litres/person/day	Total Points Score out of 100
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

[9] TER refers to the target emission rate which dwellings are required to achieve under Part L of the Building Regulations.

2.3.2 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.[10]

2.4 Bassetlaw District

Bassetlaw is part of the East Midlands region and is the most northerly district in Nottinghamshire. It has close links with Yorkshire and Humber and is also part of the Sheffield City Region.

The district has a land area of just over 637 square kilometres, which is predominantly rural. It has a population of 112,000, with over half located in the two main towns of Worksop and Retford.

Manufacturing, storage and distribution operations are important elements of the local economy, in addition to agriculture. The district also has strengths in the energy sector, with a history of coal mining in the west of the district and two large existing coal and biomass-fired power stations in the east.

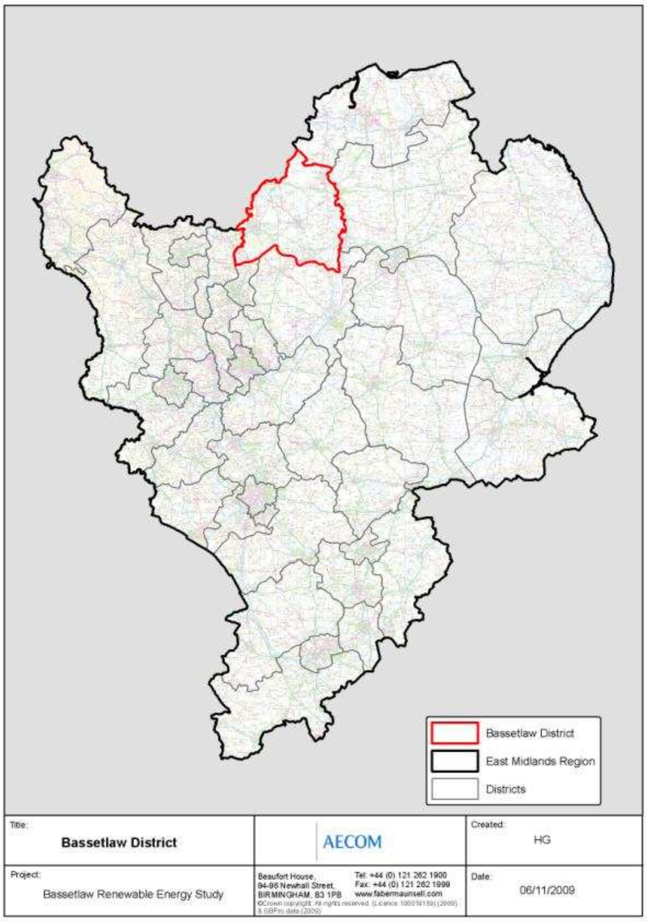


Figure 4 Bassetlaw District and the East Midlands region

[10] An introduction to Building Schools for the Future (produced for department of Children, Schools and Families by 4ps and Partnerships for Schools, 2008)

2.5 Existing Building Stock

2.4.1 Housing

There were almost 45,000 homes in Bassetlaw at the time of the last Census (2001) and the majority are owner-occupied. Most of the socially rented housing is owned by Bassetlaw District Council and managed by A1 Housing Ltd.

A1 Housing has shown their commitment to the carbon reduction agenda by implementing a number of renewable installations on their properties, including air and ground source heat pumps and are the first in the UK to provide a training centre for renewable technologies.

A1 have already reached their recommended 2020 target for loft and cavity installations in all but a few of their properties.

Housing Tenure	Number of households	Proportion
Owned	31,780	71%
Social rented	8,780	20%
Private rented/other	4,130	9%
Total	**44,690**	**100%**

Table 2 Housing Stock in Bassetlaw by Tenure (Source: Office of National Statistics, based on the 2001 census)

The majority of dwellings in the area are detached or semi-detached.

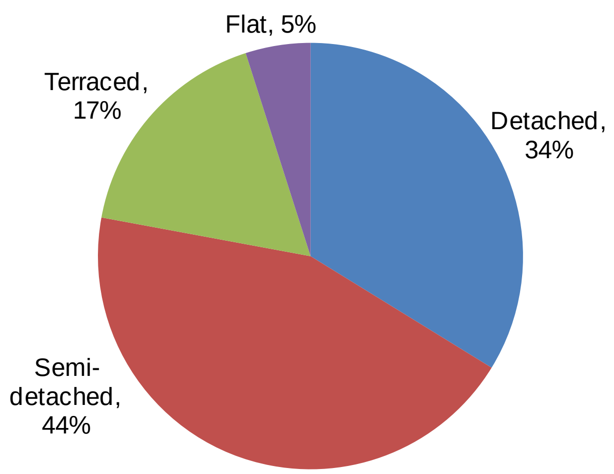


Figure 5 Housing stock by type (Source: Office of National Statistics, 2001 Census)

2.4.2 Non-residential

Warehouses and factories comprise the majority (over 96%) of the commercial building stock, located primarily on industrial estates and business parks. In addition there are some commercial offices, which tend to be small (less than 475m^2) and located in Worksop and Retford town centres and some business parks.[11]

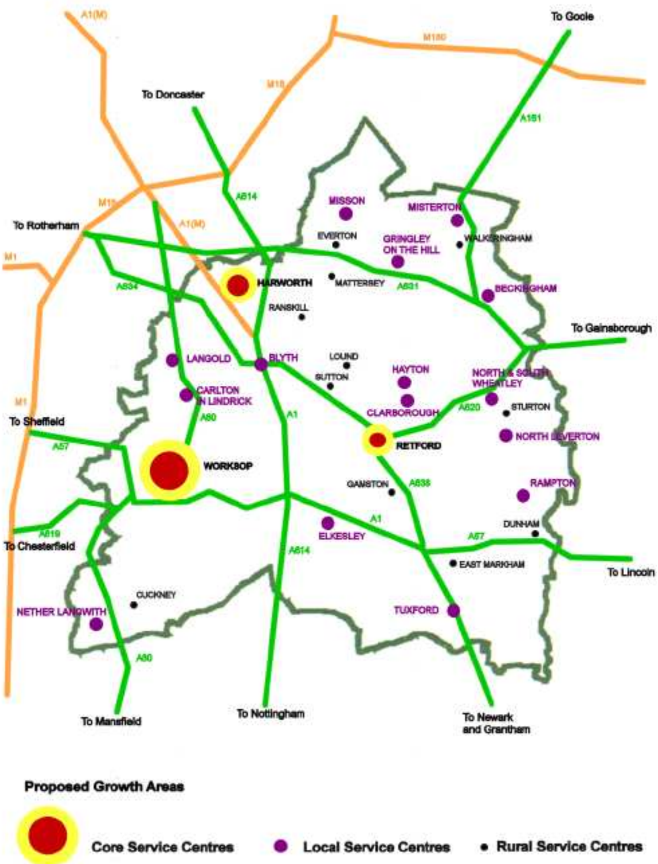
In terms of retail and leisure space, Worksop town centre features small, high street shops while there are two large out-of-centre supermarkets and a retail park. Retford town centre has a historic high street with a range of retail and two supermarkets. There are leisure centres in Worksop, Retford and Harworth-Bircotes.

2.5 Future Development

[11] Source: Bassetlaw Employment Land Capacity Study, Nathaniel Lichfield and Partners (2009)

The Government, through its regional plans, sets minimum housing targets for each local authority. The East Midlands Regional Plan (2009) set Bassetlaw a target of 7,000 new homes between 2006 and 2026. Of this, 1,204 dwellings have been delivered since 2006 and 2,290 completions are projected up to 2015, based on permissions and existing allocations. Bassetlaw also has a target of 79.5 to 92.5 hectares of additional new employment land over the same period, based on the Northern Sub-Region Employment Land Review (2008). There is also a need for a small amount of new retail development in the town centres of Worksop and Retford, according to the Bassetlaw Retail Study (2009).

The Core Strategy: Issues and Options Consultation (2009) sets out the spatial options under consideration for delivering the housing and employment land targets for the district. Three main options are being considered:



Spatial Option 1: New development distributed according to a settlement hierarchy, which would concentrate development around the three Core Service Centres of Worksop, Retford and Harworth-Bircotes. Some smaller housing and employment allocations would be made in 14 Local Service Centres. Development in other parts of the district would be largely restricted to that required to meet the needs of the local community, by providing affordable housing or other essential services and facilities.

Spatial Option 2: All growth concentrated in Worksop and Retford.

Spatial Option 3: All growth focused in the former coal-mining settlements in west Bassetlaw, namely Worksop, Harworth-Bircotes, Carlton in Lindrick and Langold.

The Strategic Housing Land Availability Assessment (2009) identified potential housing land in Bassetlaw, to inform future allocations. An employment land study was also completed in 2009. The location of potential sites is shown in Figure 6.

Figure 6 Bassetlaw proposed growth areas, Spatial Option 1 (Source: Core Strategy Issues and Options Consultation, 2009)

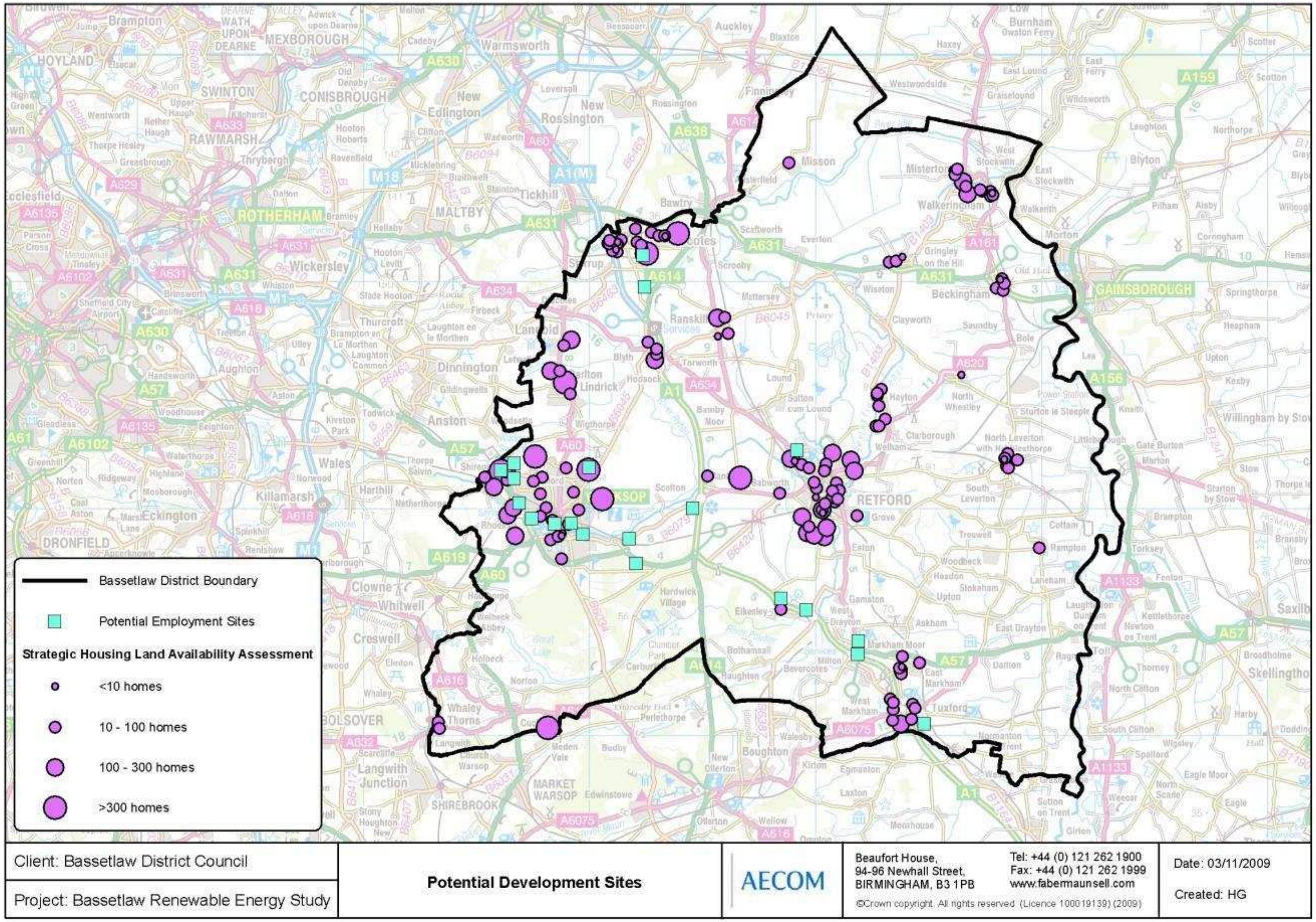


Figure 7 Potential development sites in Bassetlaw (Source: Bassetlaw Strategic Housing Land Availability Assessment (2009) and Employment Land Study 2009

2.6 Baseline Energy Demand and CO_2 Emissions

CO_2 emissions per capita in Bassetlaw were 16% higher than average for the UK in 2006. The breakdown of emissions by sector can be seen in Table 3.

In 2008/09 the district reported a 4.4% reduction in per capita CO_2 emissions, compared to the previous year.[12] Average energy consumptions and CO_2 emissions from households in Bassetlaw are shown in Figure 7, alongside data for England.

Tonnes CO_2 per annum in 2006	UK	Proportion	Bassetlaw	Proportion
Industry & Commercial	245,076,000	46.1%	450,000	39.6%
Domestic	153,605,000	28.9%	275,000	24.2%
Road Transport	135,007,000	25.4%	386,000	33.9%
Land Use, Land Use Change and Forestry	1,953,000	0.37%	26,000	2.3%
Total Emissions	531,736,000		1,138,000	
Emissions Per Capita	8.78		10.22	

Table 3 Baseline CO2 emissions in the UK and Bassetlaw (Source: Emissions of CO2 for local authority areas, Defra)

[12] Performance indicator year-end data, Bassetlaw Annual Report 2008/09 (2009)

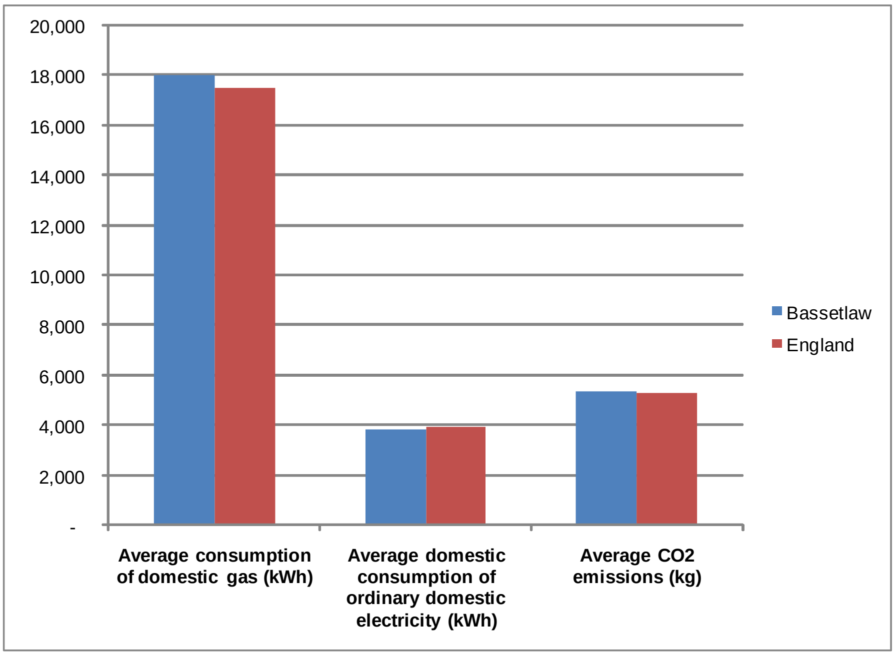


Figure 8 Average domestic energy use per capita in Bassetlaw compared to the UK in 2009. Only domestic emissions are shown. (Source: Domestic Energy Consumption, Neighbourhood Statistics website)

To test and monitor the effects of national, regional and local targets on the district, a model was developed to estimate energy demand and CO_2 emissions from existing buildings, and from potential new development in the district, assuming it is built to minimum standards in line with anticipated changes to the Building Regulations (i.e. a business as usual scenario). Further details of the modelling are contained in Appendix D.

Figure 9 and Figure 10 show density of average heat and electricity demand from existing buildings across Bassetlaw, based on the model. Figure 9 shows modelled CO_2 emissions per unit area related to energy use in existing buildings.

2.7 Key Considerations Emerging from this Chapter

Policy Context

- International, European and national policy commit the UK to reducing its impact on climate change and increasing the supply of energy from renewable and low carbon sources. These commitments are reflected in emerging regional policy and need to be translated into local policy and action.
- Planning has a significant role to play in achieving these commitments, by:
  - Understanding the local feasibility and potential for renewable and low-carbon technologies
  - Identifying suitable areas for renewable and low-carbon energy sources, and supporting infrastructure
  - Setting standards for new development
- The PPS1 Supplement and PPS22 (2004) define the role of planning in the response to climate change and the development of renewable and low carbon energy supplies. A new PPS, due to be published in draft by the end of 2009, is expected to combine and update these statements of national policy.
- The Council as a whole has a broader role to lead and facilitate action across the district. It enforces the provisions of the Building Regulations and is responsible for promoting energy efficiency in the existing building stock. It can also provide financial incentives and support. In addition, the Council has a duty to manage the climate change impacts of its own estate and services.
- The 2004 and 2008 Planning Acts, PPSs and other legislation empower local authorities to fulfil this role. The Well-being Power, introduced in 2000, is particular significant, enabling local authorities to "do anything they consider likely to promote the economic, social and environmental well-being of their area unless explicitly prohibited elsewhere in legislation."
- Policy relating to new development will need to be set in the context of the proposed amendments to Part L of the Building Regulations. These amendments will introduce a zero carbon requirement for new homes and schools in 2016, and other types of non-residential building in 2019.
- The definition of zero carbon used throughout this study, and our assumptions about related mechanisms including allowable solutions, are based on the Government's draft proposals, set out in a series of consultation documents. The details have not yet been finalised and the zero carbon requirements could change substantially in future years, in which case this report and its recommendations should be reviewed.

Bassetlaw

- Per capita CO_2 emissions in the district are high compared to the national average.
- A significant proportion of existing housing is in private ownership. 20% of socially rented housing is in local authority ownership.
- Future development may offer opportunities to improve performance of existing development. Areas of high energy demand and related CO_2 emissions from existing buildings are concentrated in the higher density areas of the major settlements. New development tends to be focused on edge-of-settlement sites rather than town centre areas.

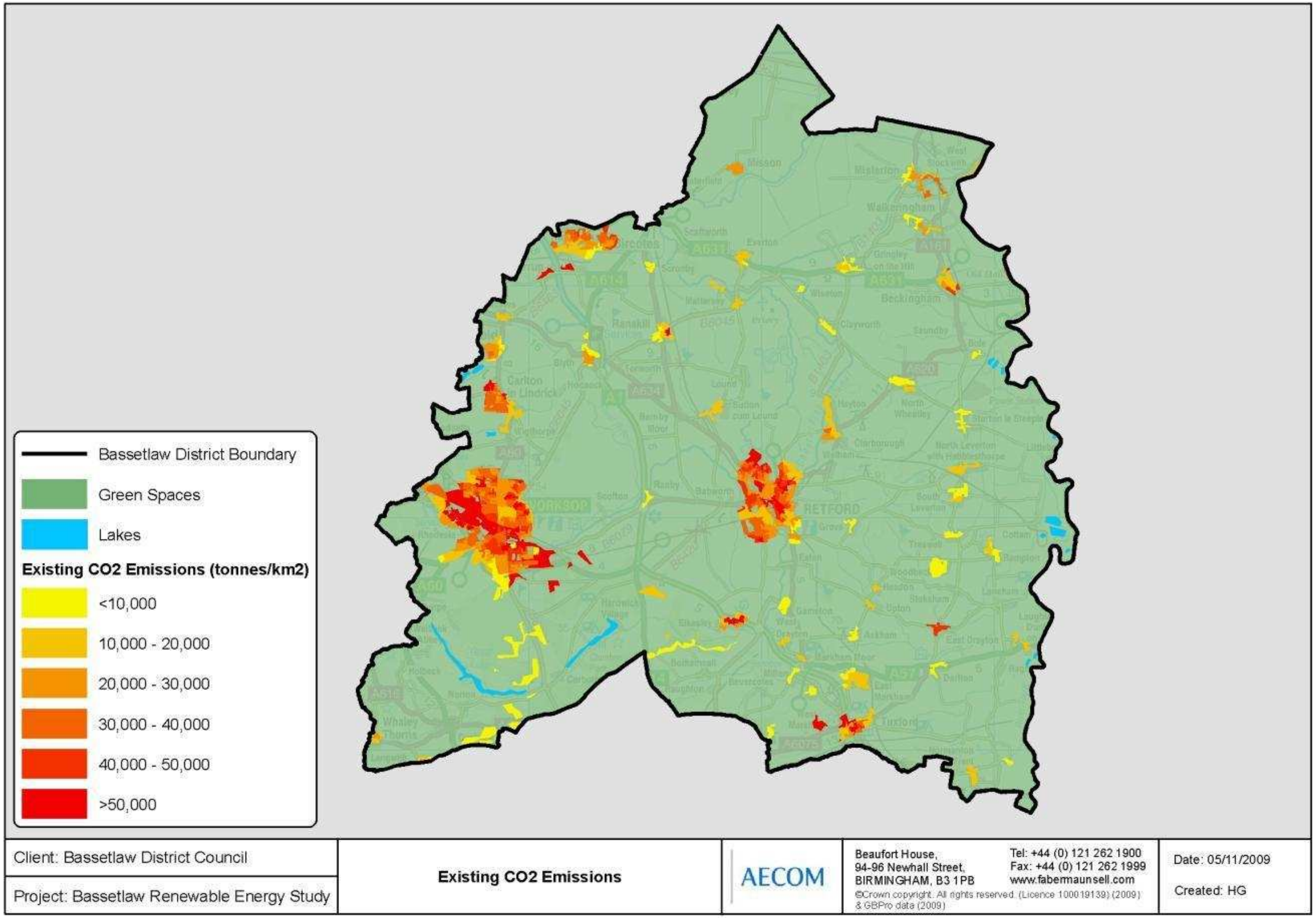


Figure 9 Average heat demand density map for existing buildings in Bassetlaw, 2009, in kW/km2 (Source: Bassetlaw District energy model, AECOM)

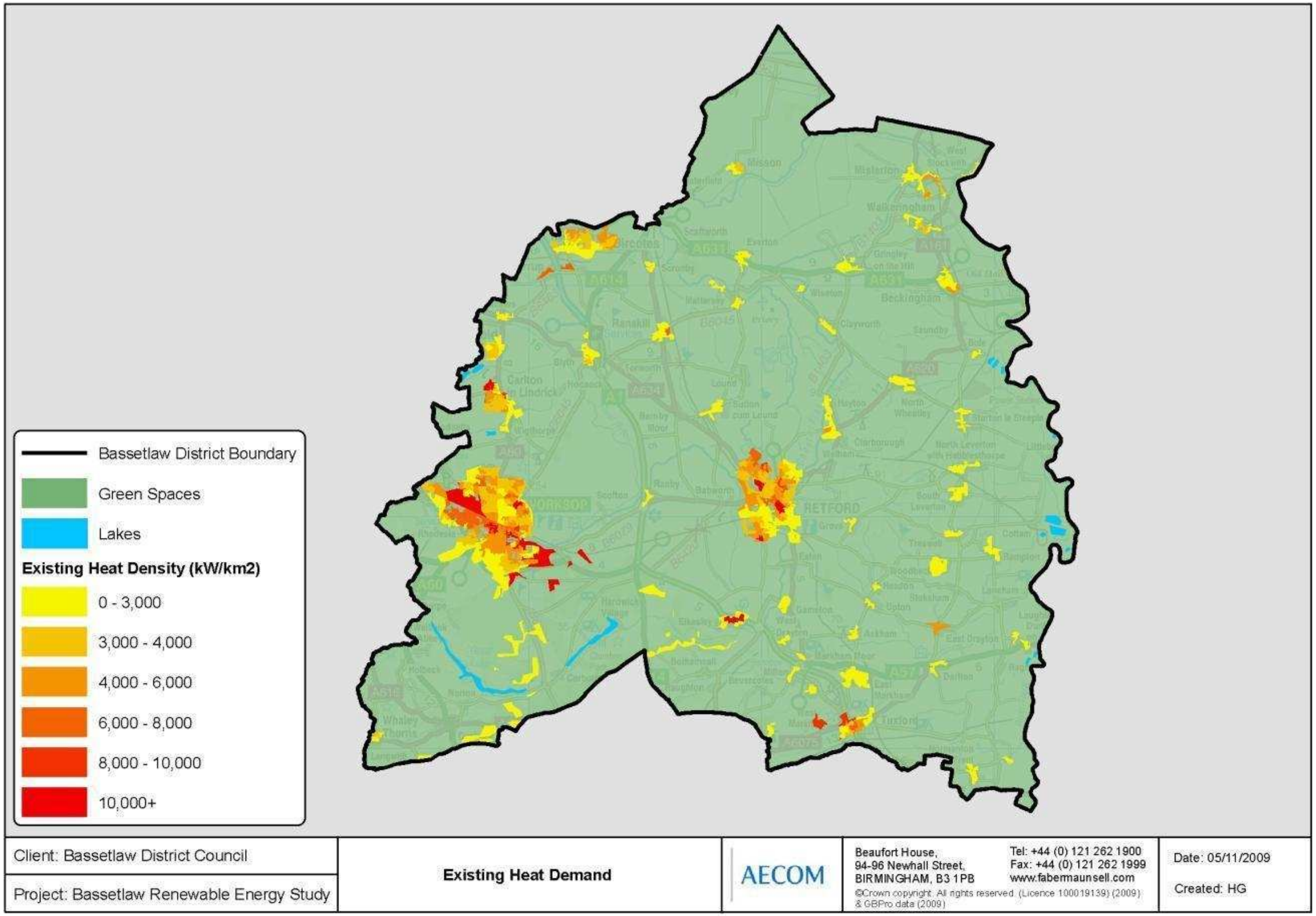


Figure 10 Average electricity demand density map for existing buildings in Bassetlaw, 2009, in kW/km2 (Source: Bassetlaw District energy model, AECOM)

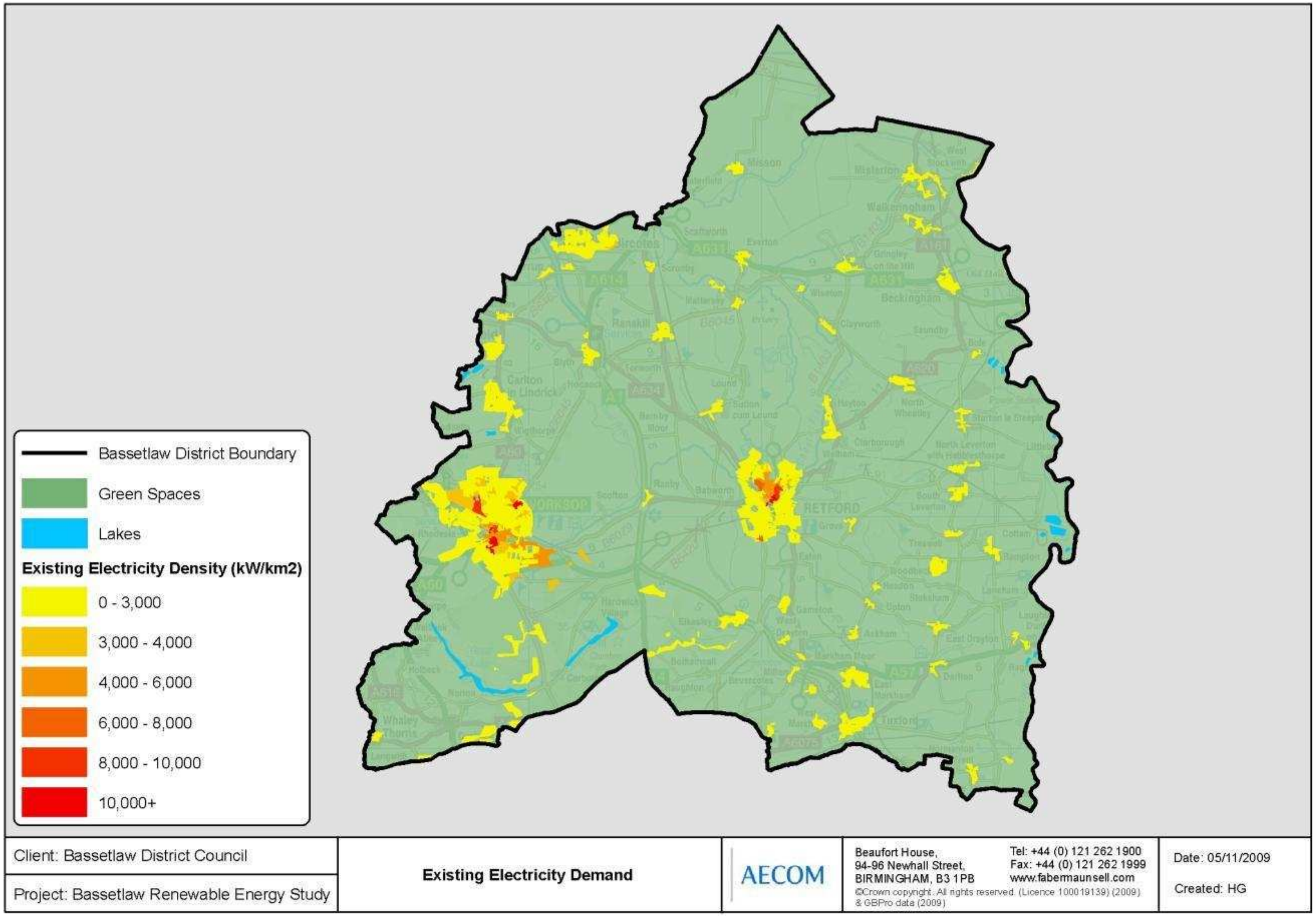


Figure 11 Annual CO_2 emissions map for existing buildings in Bassetlaw, 2009, in tonnes/km2 (Source: Bassetlaw District energy model, AECOM)

3 Opportunities for Energy Efficiency

3 Opportunities for Energy Efficiency

In spite of the significant housing and employment land growth proposed over the next 20 years, energy use in Bassetlaw's existing building stock is likely to be much greater than from new development, due to its extent, age and condition. Although this study is primarily intended to inform planning policy for new development, it 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 type: Dense development is less energy intensive. Large detached homes have a much greater heat loss and heating demand than terraced homes or flats due to their higher external surface area. A development with a greater proportion of apartments and terraced houses will have a lower energy demand than a development dominated by detached houses. Compact masterplans also facilitate more options for delivering decentralised renewable and low carbon heat and power. The higher density helps to make district heating more economically viable, and reduced building footprint may also make more space available to locate energy technologies such as wind turbines onsite. Energy considerations will need to be weighed up against other factors influencing density.
- 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. Although energy efficiency of older buildings can be improved, opportunities can be restricted by the structure or fabric of the building, such as the use of solid rather than cavity wall construction.
- 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. In 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, the Council 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 Defra National HECA Report for 2006-07 lists Bassetlaw as one of the worst performing local authorities for improving the energy efficiency of existing housing. The district reported a total 9% improvement in household energy efficiency since 1996, compared to a target of 30% by 2011. This suggests there has been a lower than average recorded uptake of efficiency measures in the existing housing stock. Information is not readily available on improvements to non-residential buildings in the district, however, the Council is working on a website and literature which may improve access to information.

The energy efficiency of a dwelling can be measured by its SAP (Standard Assessment Procedure) rating, which ranges from 0 (least efficient) to 100 (most efficient). SAP is the Government's standard methodology for demonstrating compliance with Part L of the Building Regulations for new dwellings and can be used to estimate energy demand. SAP ratings of existing homes in Bassetlaw were assessed as part of a survey carried out in 2006. A map has been produced showing the proportion of houses in Bassetlaw which have a SAP rating of less than 30, which is defined by CLG as the threshold for very energy in-efficient housing. Figure 11 indicates that a greater emphasis is required on energy efficiency of housing in rural areas.

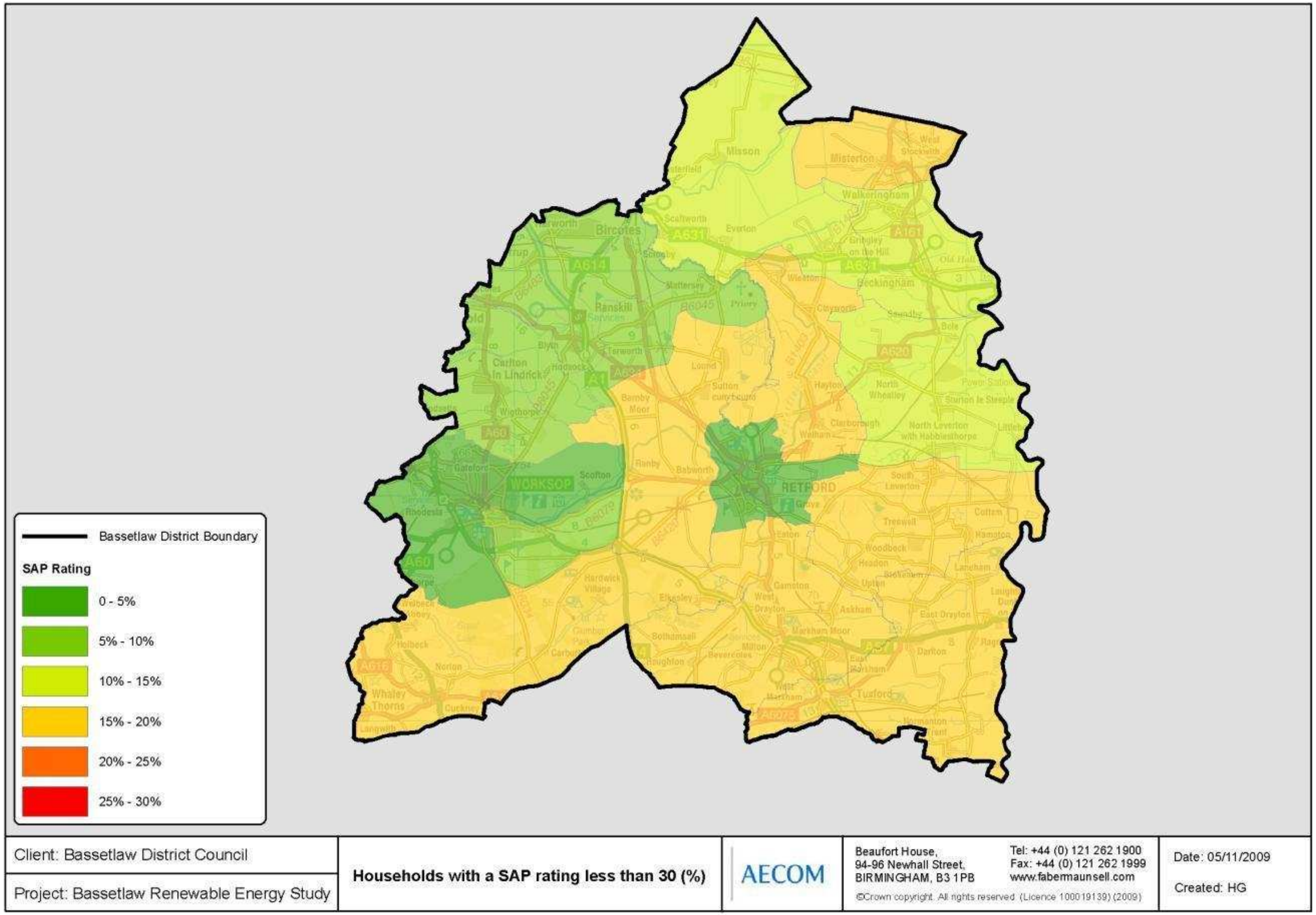


Figure 12 Households with a SAP rating less than 30 (%) (Source: www.hi4em.org.uk)

3.2 Improving Energy Efficiency of Homes

Measures that could be implemented 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 reduction in energy consumption. A “rebound effect” has been identified where any CO2 savings from energy efficiency improvements are nullified by changes in occupier behaviour. A better insulated house needs less fuel to maintain a given temperature but as fuel costs decline, people seem to be inclined to turn up the thermostat. Cheaper fuels can create affordable warmth, but also lead to increased energy consumption.

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. Data from the Home Energy Efficiency Database indicates that the majority of homes in Bassetlaw with cavity walls already have insulation, and loft insulation is also widespread. Insulation of older buildings with solid walls is more challenging. A survey of the existing housing stock in 2006 showed that almost half of houses have solid walls in some parts of Bassetlaw (Figure 12). Insulation can be applied internally, but this can reduce the size of rooms (by up to 200mm on each wall in extreme cases) and can be very disruptive to occupants. Alternatively, insulation can be applied externally, which can be costly, may require units in blocks of flats to be treated simultaneously, and may be restricted by planning constraints due to visual impacts. Improved window glazing is also effective.

Reducing U-values can affect the construction of new buildings. Achieving lower U-values for walls can result in them being thicker than conventional specifications, although this will depend upon the insulation type that is being used. Similarly, reducing floor U-values will have an impact on the floor levels.

3.2.2 Air Tightness and Thermal Bridging

In existing buildings, draught-proofing of the building envelope, for example sealing joints around service pipes and at junctions, will reduce heat loss through air infiltration.

The type of construction used in new building design affects how straightforward it is to achieve improvements in air tightness. For timber construction and other pre-fabricated constructions, an air tightness barrier can be incorporated into the panels so that the construction team only need to seal joints between panels. Structurally insulated panelised systems can also achieve good standards of air tightness. Conventional wisdom suggests that achieving this air tight membrane is more difficult in traditional masonry build, although air leakage rates of less than 3 m^3/m^2hr @ 50 Pa have been recorded.

Homes with very low air permeability levels will generally require mechanical ventilation in order to achieve adequate ventilation. Such systems should incorporate heat recovery wherever possible, where heat from the air extracted from kitchens and bathrooms is used to warm incoming fresh air, thus reducing the energy demands for heating. Additional electrical energy is required to operate the fans but if the fan power is low and the efficiency of heat recovery is high then the system should provide a net benefit in terms of reducing CO_2 emissions over the course of a year.

Thermal bridging can be designed out through attention to design detailing and careful construction. Accredited and enhanced construction details allow designers to reduce the number of thermal bridges.

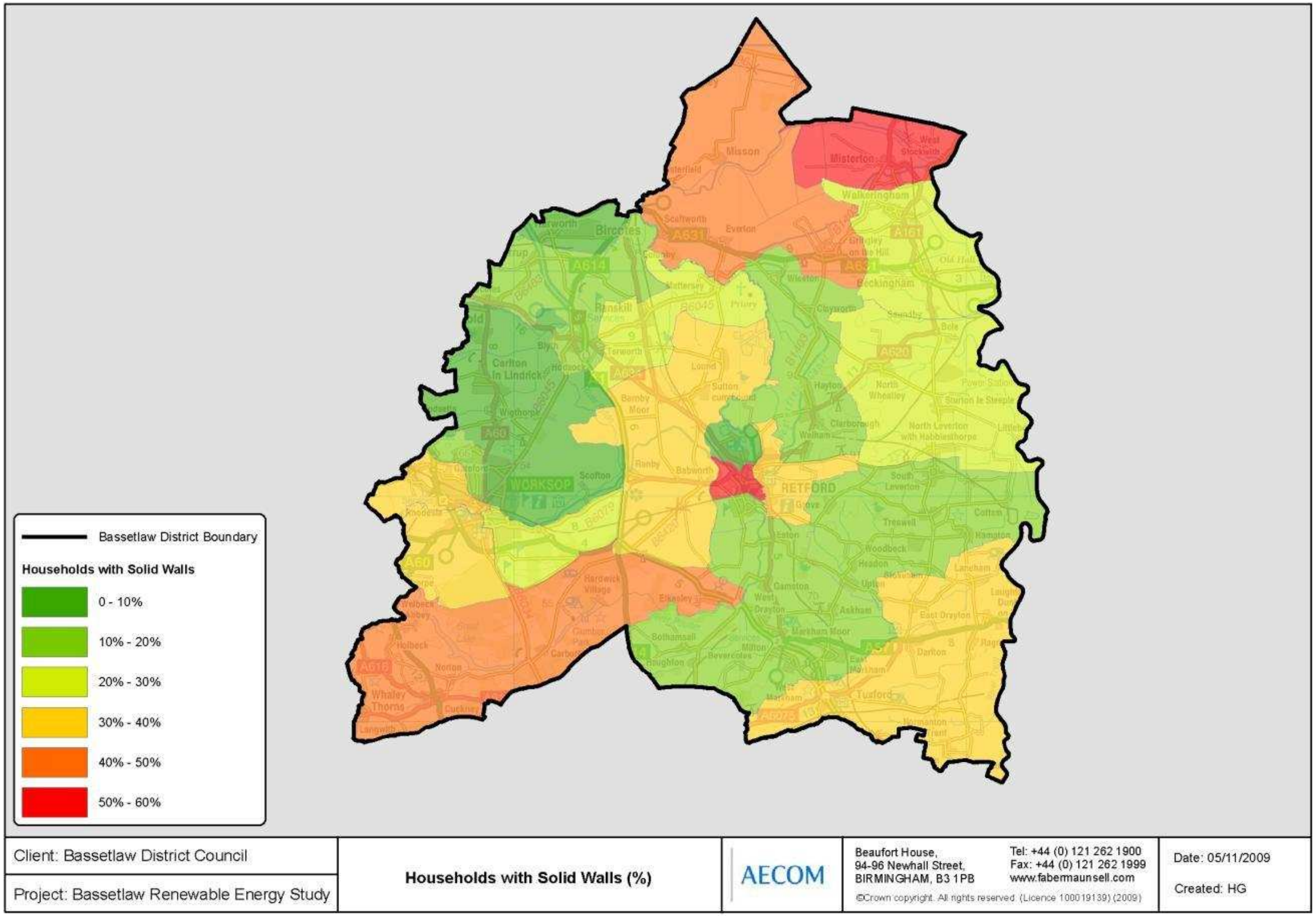


Figure 13 Households with solid walls (%) (Source: www.hi4em.org.uk)

3.2.3 Lighting

The penetration of natural daylight should always be enhanced to reduce the use of artificial lighting within buildings. For new buildings, the design should take advantage of south facing orientations and consider shading, internal layouts and window dimensions and specifications, all of which influence the levels of daylight and energy consumption for artificial lighting.

All buildings could make use of dedicated low energy light fittings (i.e. fittings which only accept low energy lamps), 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.

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. There are large areas of housing in Bassetlaw which do not have access to the gas grid (Figure 13). In these locations, sustainably sourced biomass may be a suitable alternative.

Improving the boiler will also reduce energy use for domestic hot water. Efficiency can also be improved by using more efficient fittings such as showers and taps, to reduce hot water use.

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 high angle and intensity sun during summer. Mechanical cooling is often used to avoid overheating, which can increase CO2 emissions. Passive approaches include building orientation, shading (e.g. external louvres, shutters, or overshading from balconies) 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.

3.2.6 PassivHaus

PassivHaus is a 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. Such buildings are high maintenance and need commitment, technical understanding and skill from occupants to operate to their intended performance. The standard is generally only targeted at new buildings. Recent research from suggests that once initial design and construction skills have developed, it is possible to construct PassivHaus buildings more easily and for less money than conventional buildings of similar types. There is currently considerable interest in this building technique in the UK, as evidenced by its mention in the recent zero carbon consultation. It remains to be seen whether it will take off as a viable option for new development.

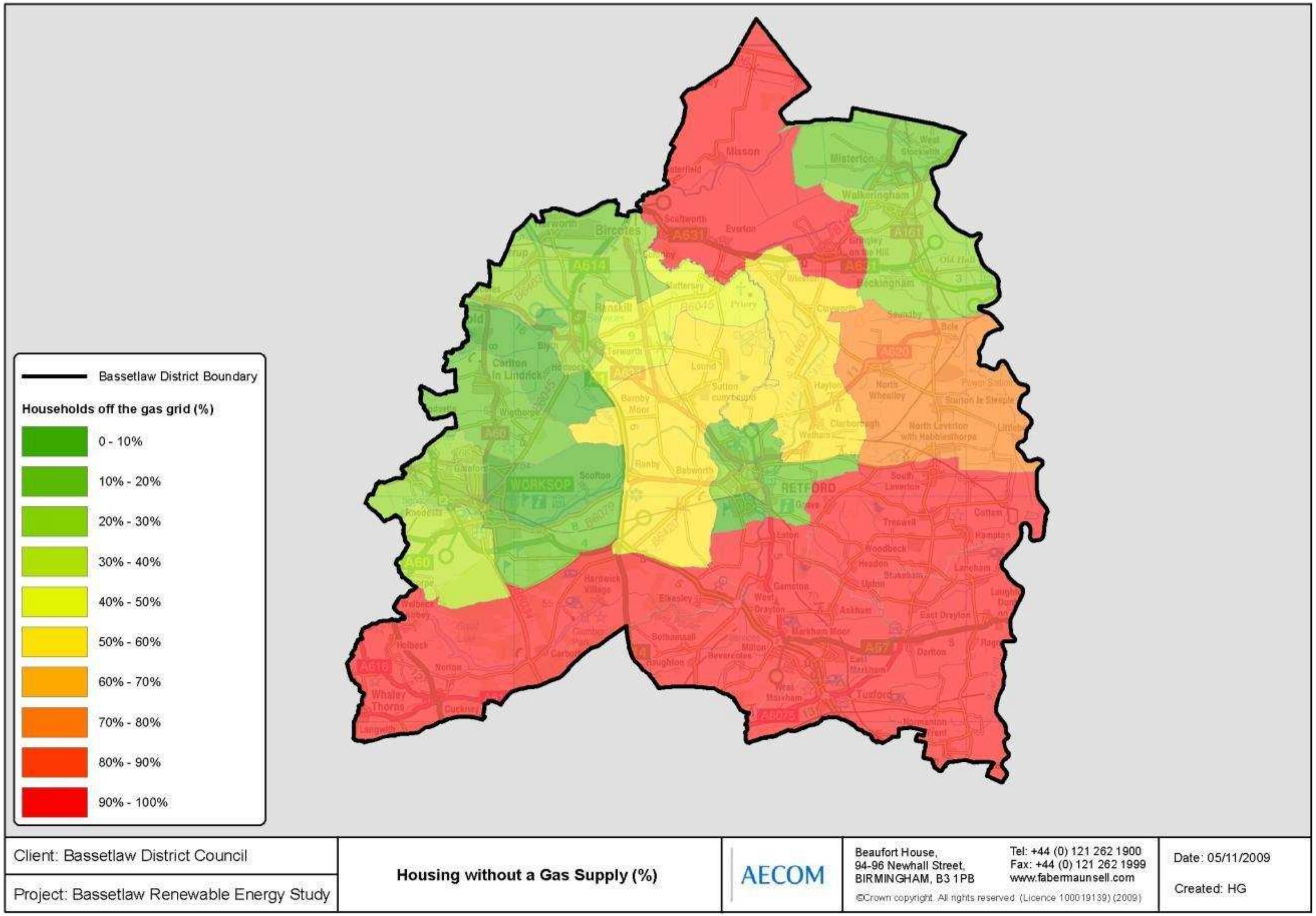


Figure 14 Households with no access to the gas grid (%) (Source: www.hi4em.org.uk)

3.3 Energy Efficiency in Non-domestic Buildings

Many of the options for reducing CO2 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.12

We have described below the principles that should be adopted when improving energy efficiency in non-domestic buildings.

- Excessive areas of glazing should be avoided. CIBSE TM23 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.
- 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 . 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 buildings16.

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) and night ventilation to reduce peak temperatures
- Providing effective natural ventilation
- Shading devices for the windows
- Using task lighting to reduce background illuminance 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

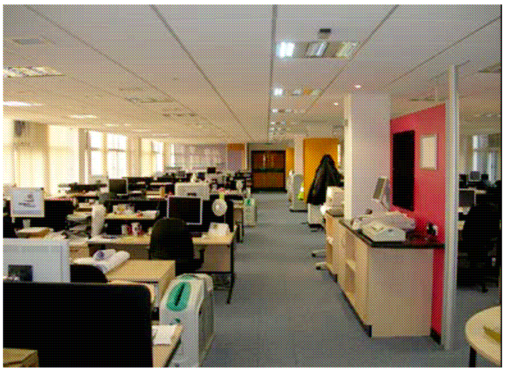


Figure 15 Strategies to improve energy efficiency in non-domestic buildings. Shading devices fitted to Lycée Chevrollier, a high school in France (left) and office layout of Stevenage Council offices after Accommodation Review. The existing cellular offices wereschool in France (left) and office layout of Stevenage Council offices after Accommodation Review. The existing cellular offices were converted into modern IT based 'open plan' office areas, with new modular desks and high efficiency layouts to improve occupancy levels. The number of unoccupied desks was reduced, and CRTs were replaced with pole mounted, flat screen computer monitors to reduce the desk area used by each employee. (right). (Source: REVIVAL project, AECOM)

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.

3.4 Key Considerations Emerging from this Chapter

The sections above have considered the opportunities for reducing CO2 emissions through increased energy efficiency in the existing stock and in new development. Key considerations emerging from this chapter are:

- Energy use in Bassetlaw's existing building stock is likely to be much greater than from new development, due to its extent, age and condition
- Energy performance of homes has increased, particularly since the introduction of Part L of the Building Regulations, but Bassetlaw is one of the worst performing authorities for improving the energy efficiency of existing housing in the Defra National HECA Report for 2006-07. It is falling well short of its 30% improvement target by 2011
- Bassetlaw has good opportunities to influence its own housing stock (around 20% of total), but also that of the private rented sector by setting up a green landlord scheme
- Improving energy efficiency of housing in rural areas should be prioritised as there is a significant proportion of homes with a SAP rating of less than 30
- Improved thermal performance of homes can lead to a rebound effect, where CO2 savings are nullified by changes in occupier behaviour
- Appropriate specification of new buildings or renovations can reduce energy demand and improve thermal comfort, including overheating
- Bassetlaw has large areas of housing without access to the gas network where biomass could replace existing high carbon heating fuels, such as coal or oil

4 Opportunities for District Heating

4 Opportunities for District Heating

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 and heat at a community scale from local sources (referred to as decentralised energy). This section discusses the opportunities in Bassetlaw for establishing such 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, which replaces individual boilers for space heating and hot water. This is a more efficient method of supplying heat than individual boilers and consequently, district heating is considered to be a low carbon technology that can contribute towards meeting CO_2 reduction targets.

4.2 Combined Heat and Power (CHP)

The traditional method of generating electricity at power stations is inefficient, with at least 50% of the energy in the fuel being wasted. A CHP plant is essentially a local, smaller version of a power station and is more efficient as the system generates electricity but also makes use of the heat that is usually wasted through cooling towers. This heat can be pumped through district heating networks for use in buildings. Since it is generated closer to where it is needed, electricity losses in transmission are reduced (Figure 16).

A standard, gas-fired CHP typically achieves a 35% reduction in fuel use compared with conventional power stations and gas boilers. CHP can also run on biomass or biogas, reducing CO_2 emissions by almost 100% and contributing towards renewable energy targets.

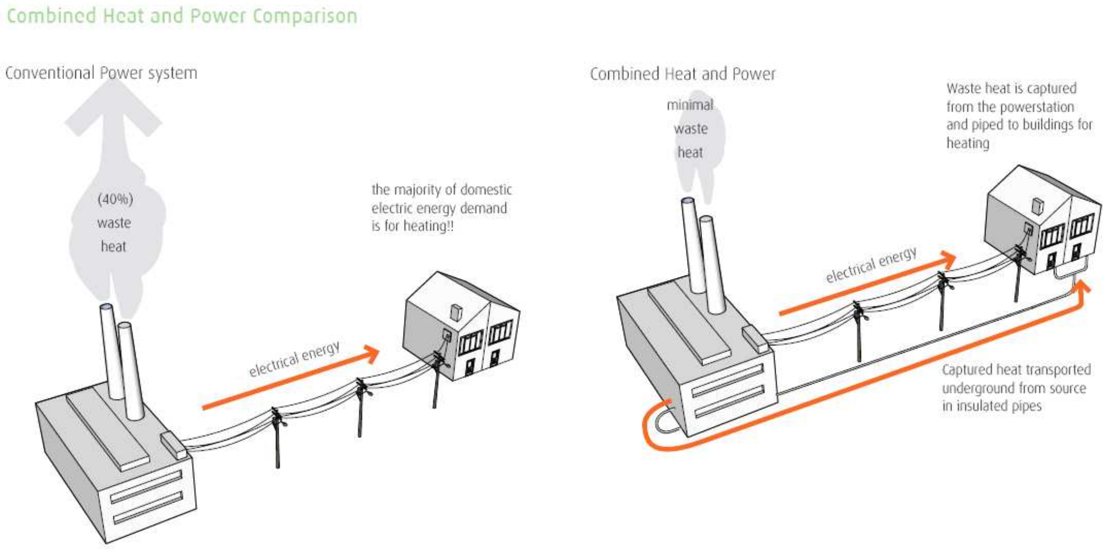


Figure 16 Relationship between district heating and CHP, compared to conventional energy generation

4.3 Local Potential for District Heating and CHP

Due to its largely rural nature and relatively low density of development, the potential for district heating and CHP in Bassetlaw is likely to be limited. We have identified some areas where there may be sufficient heat demand from existing buildings to support a commercially viable district heating or CHP system and have also considered on-site district heating and CHP as an option for major new development. We have not found any existing district heating or CHP schemes in Bassetlaw.

4.3.1 Heat Mapping of Bassetlaw

Heat demand in Bassetlaw has been mapped to identify locations with high heat demand which may be suitable for district heating and CHP (Figure 17). Further details of the heat mapping process are provided in Appendix C. As expected, the areas of highest demand are concentrated in the town centres of Worksop and Retford. It is expected that there will also be significant heat demand created by the major new developments expected over the next 20 years. However, the scale of heat demand in these new developments will depend on which version of the Building Regulations is applicable at the time; beyond 2016, demand for space heating and hot water should have been minimised.

4.3.2 Locations with Potential for CHP

It is theoretically possible to develop a district heating network with CHP anywhere that there are multiple heat consumers. The economics of such a network are determined several factors, including the size of the CHP engine and annual hours of operation. Ideally, a system would run for at least 4,500 hours per year for a reasonable return on investment. This 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.

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. Experience indicates that housing density greater than 55 dwellings per hectare (dph) is desirable, which can be found in areas of flats or terraced housing.[13]

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.

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.[13]

Locations in Bassetlaw with potential for CHP are indicated in Figure 17. The map shows areas where average heating demand exceeds 3,000 kW/km^2 (equivalent to annual heating demand of 26,280 MWh/km^2) and housing density exceeds 55dph or there is a public sector building to provide an anchor load.

Assessing the feasibility for district heating networks with CHP in new development containing only residential elements can be problematic. As noted above, improving insulation standards mean the requirement for space heating is very low and demand is present during the winter months. The only constant source of heat demand will be for domestic hot water and in terms of reducing CO_2 emissions, and much of this demand could be met by solar water heating. New housing or office developments would be able to make use of networks serving existing buildings, if these were developed. If this solution is

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

adopted then the Council should take a strategic approach to the planning and phasing of district heating infrastructure so that new developments that are within range of planned networks can be required to connect into the schemes.

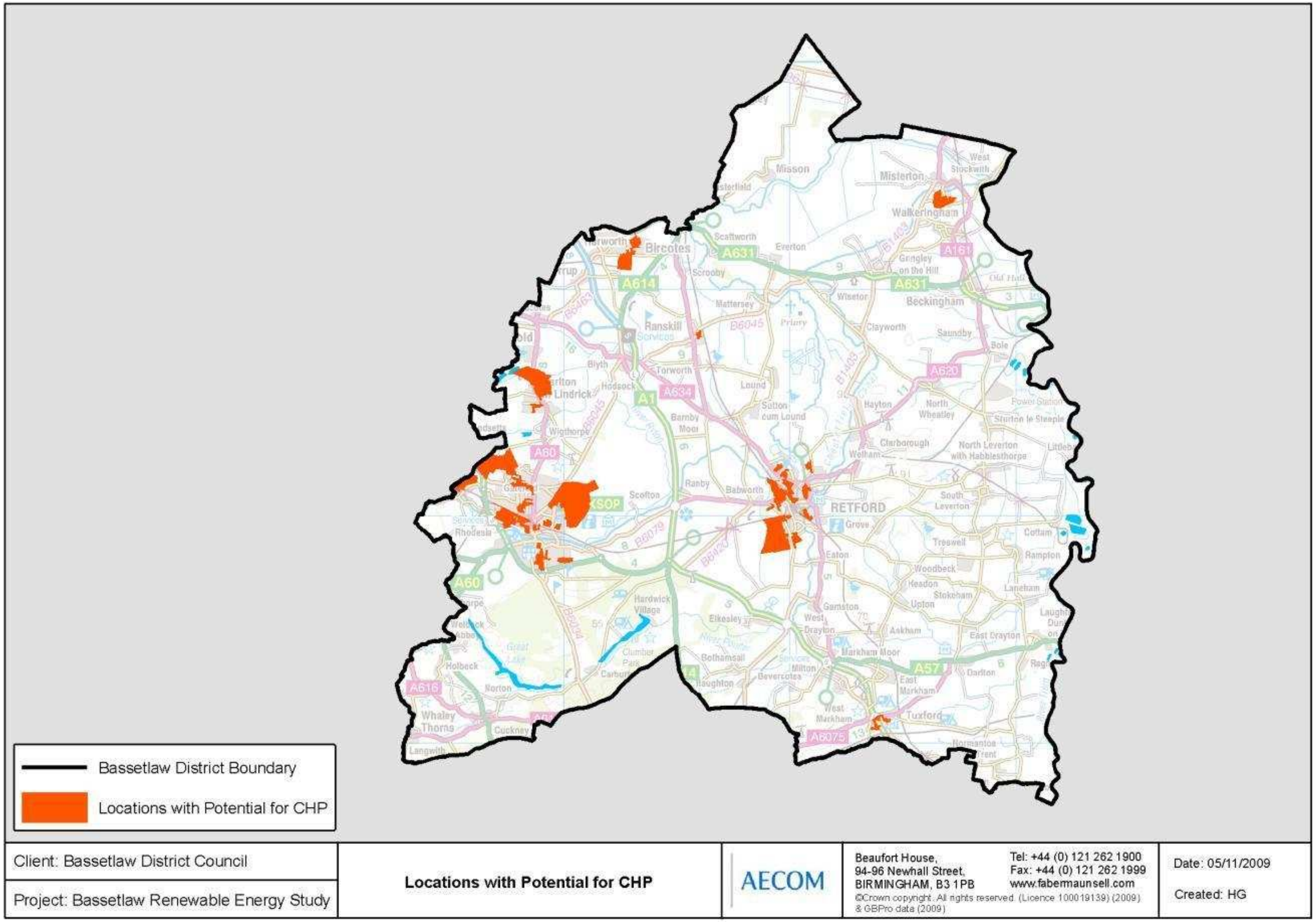


Figure 17 Locations in Bassetlaw with potential for CHP (Source: Bassetlaw Energy Model and AECOM analysis)

4.3.3 Financial Implications of District Heating with CHP

Figure 18 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.

These costs assume no prior district heat network infrastructure in the area and that existing dwellings are fitted with individual heating systems.provides the cost of providing district heating with CHP to non-domestic buildings.

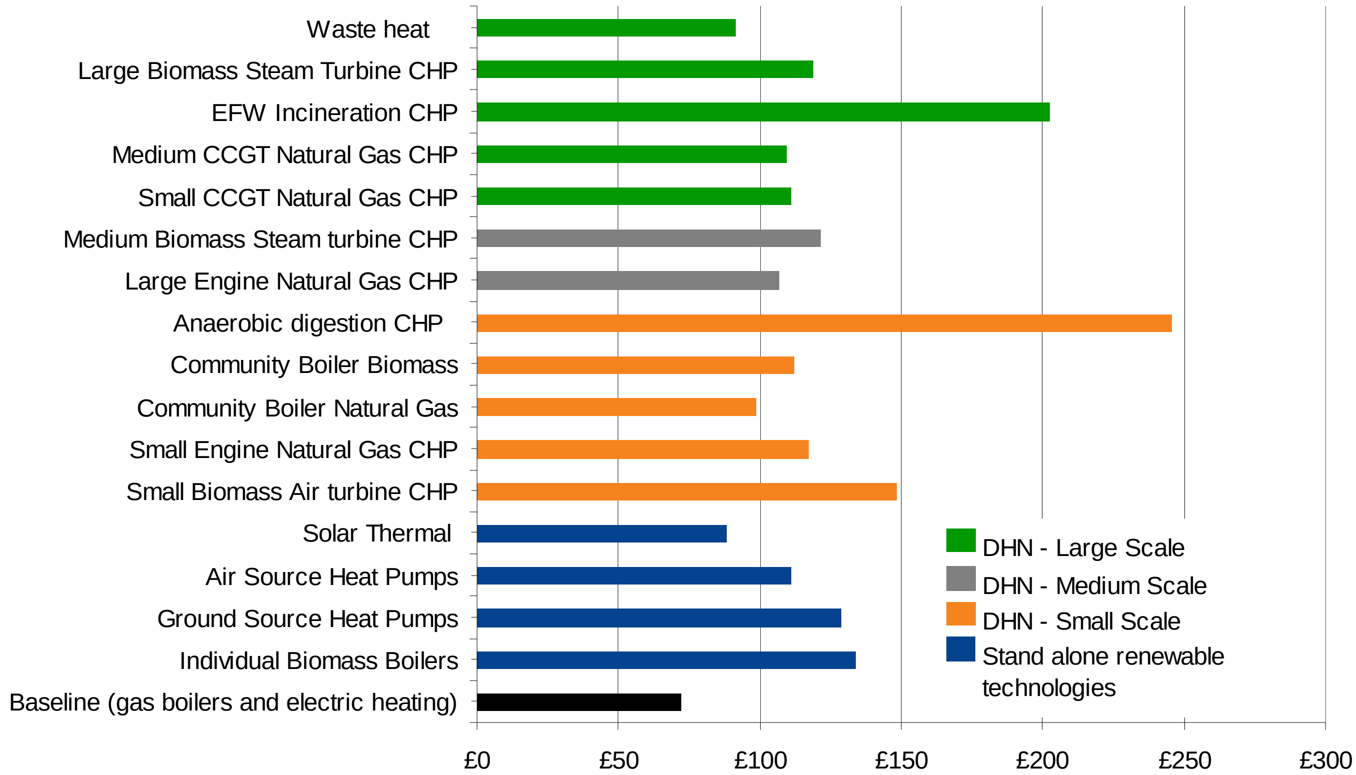


Figure 18 Cost of heat provision by technology in £/MWh, based on current market conditions. Waste heat is heat obtained at very low wholesale cost from power plants or industrial processes. Community Boiler refers to district heating, DHN in legend refers to District Heating Network. Solar thermal heating provides domestic hot water only. (Source: The potential and costs of district heating networks, Faber Maunsell AECOM and Poyry)13

The main benefit of moving to district heating networks is the carbon savings that they can deliver. 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

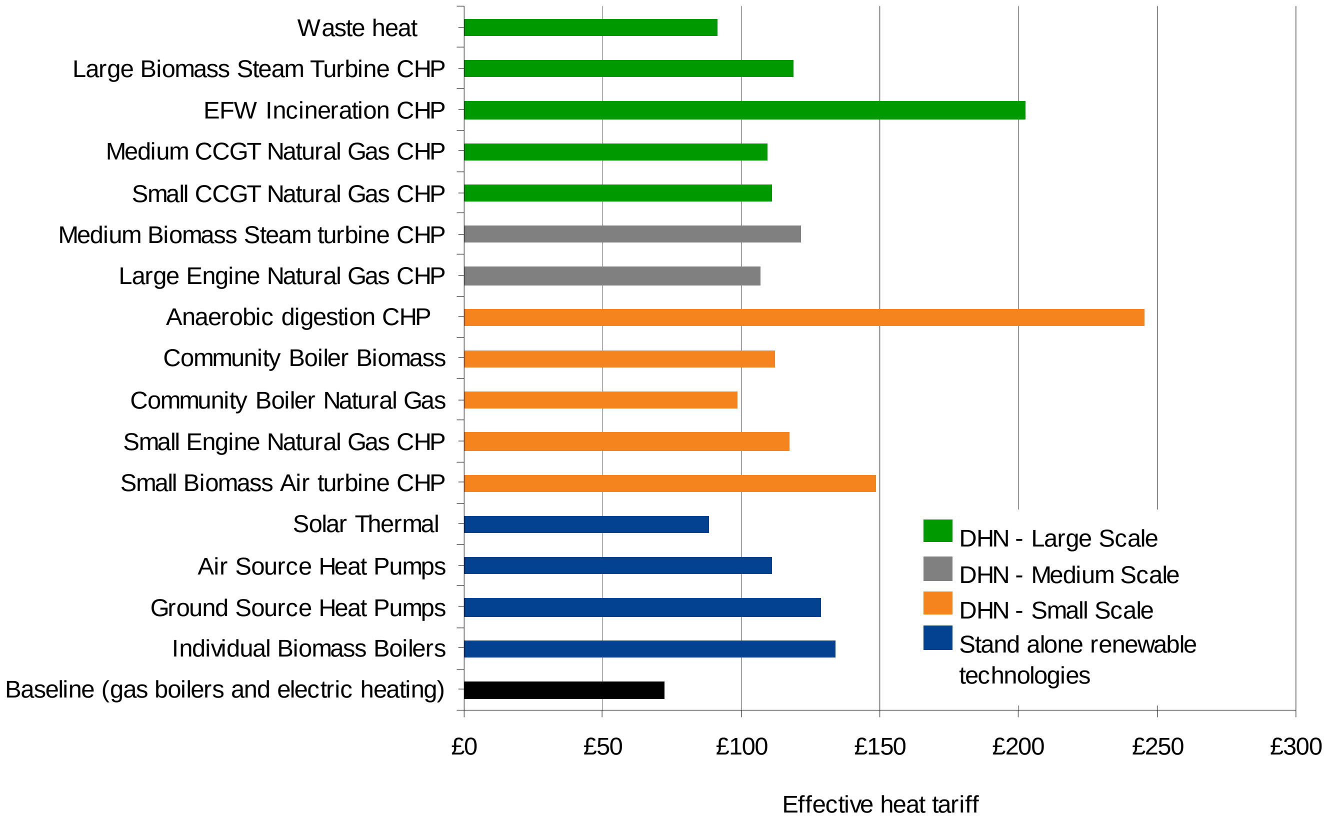


Figure 19 Cost compared to CO2 saved by heat provision technology, in £/tonneCO2 saved. Waste heat is heat obtained at very low wholesale cost from power plants or industrial processes. Community Boiler refers to District Heating, DHN in legend refers to District Heating Network. Solar thermal heating applies to water-heating only. (Source: The potential and costs of district heating networks, Faber Maunsell AECOM and Poyry) 13

Dwelling Type	District Heating Infrastructure Cost	District Heating Branch 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	£5,300

			installation)	
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 District heating network costs for non-domestic buildings. 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 n networks, Faber Maunsell AECOM and Poyry) 13

Type of Area	Total District Heating Network 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 5 District heating network costs for non-domestic buildings. 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) 13

4.4 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 and can contribute to renewable energy targets if powered by biomass or biogas
- Potential for district heating and CHP in Bassetlaw is likely to be limited due to its largely rural nature and relatively low development density. However, important opportunities do exist, particularly in the town centres of Worksop and Retford
- 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
- The main benefit of moving to district heating networks is the carbon savings that they can deliver
- 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

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

5 Opportunities for Renewable and Low Carbon Technologies

5 Opportunities for Renewable and Low Carbon Technologies

This chapter reviews the potential for decentralised, renewable and low carbon energy installations in Bassetlaw, at a range of scales. It identifies a number of opportunities, particularly for large scale wind energy and biomass.

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

There is currently one large scale wind turbine installed in Bassetlaw, at the B&Q Distribution Centre at Manton Wood. A planning application has been made for a wind farm at Cottam, east of Retford with 12 turbines, each rated at 2.3MW. The wind farm is estimated to generate almost 63,000MWh of electricity per year, which is enough to meet the average demand of around 13,400 homes.[14]

5.1.2 Local Potential for Large Scale Wind Energy

Bassetlaw has a good potential wind resource, with wind speeds of at least 6m/s across the district, according to the UK Wind Speed Database (Figure 20). These wind speeds are often overestimated in comparison to actual measured wind speeds; however, they are modelled at 45m height whereas the large scale wind turbines modelled in this study are 80m to hub height, where wind speeds are likely to be significantly higher.

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. The following constraints were included:

- Exclusion of wind speeds below 5.5 m/s. This is generally considered to be the minimum wind speed at which large scale wind energy generation becomes financially viable
- Buffer of 120m from major carriageways, railway lines and major overhead transmission lines
- Robin Hood airport air traffic zone and area of intense activity. The airport operator should be consulted during the planning of specific wind turbine sites to agree precise details of the constraints
- 800m noise buffer around urban settlements
- 320m buffer around other wind turbines to avoid adverse turbulence effects;
- Exclusion of other designated sites of ecological or landscape significance
- Exclusion of undesignated woodland and forest
- As this is a high level study, looking at broad locations for large scale wind, we have not included microwave links as a constraint. The data sets on these are out of date and buffer zones are variable, depending on negotiations with telecoms operators. This is a matter which should be consulted on with the relevant operators during the planning of specific wind turbine sites.

Areas that are unaffected by these constraints are indicated as potential locations for large scale wind in Figure 21.

[14] Environmental Statement for the Cottam Wind Energy Project: Non-Technical Summary Volume 1 (2009)

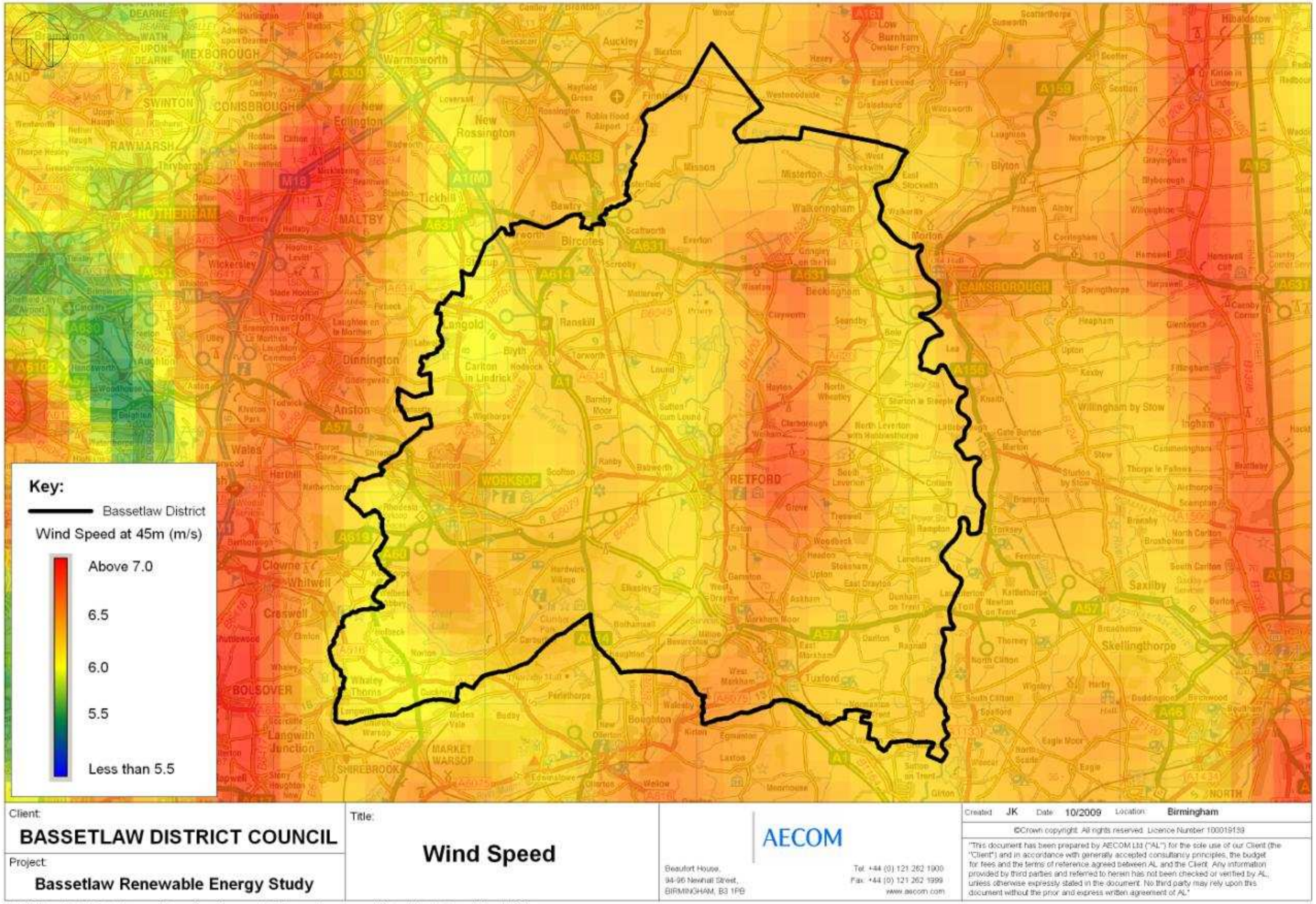


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Figure 20 Wind Speeds in Bassetlaw (Source: UK Wind Speed Database)

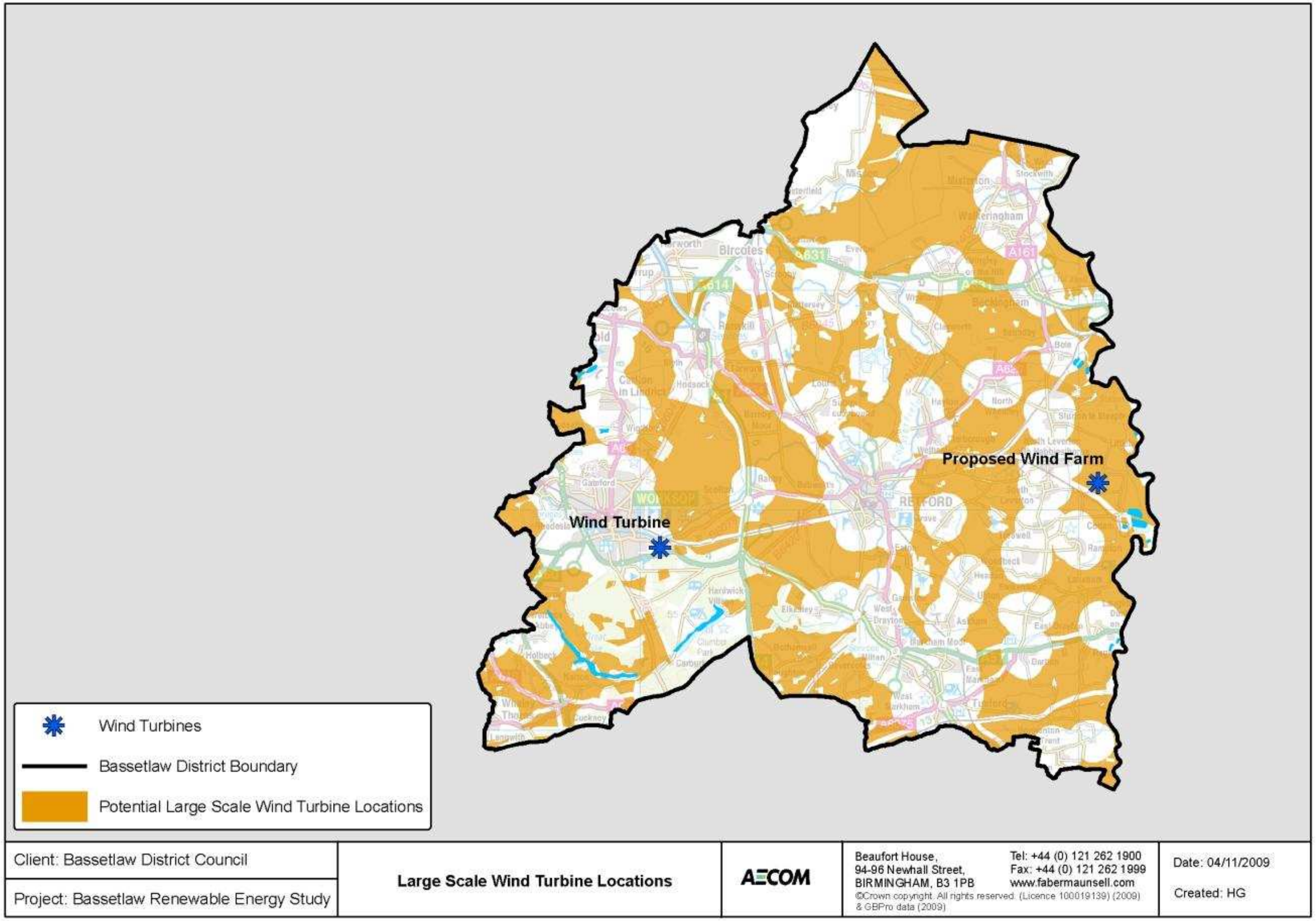

Figure 21 Potential large scale wind turbine locations in Bassetlaw

The total area of land in Bassetlaw that is potentially suitable for large scale wind turbines is approximately 280km^2, according to this analysis. Around 9MW of large scale wind capacity can be installed per square kilometre of available land. The average wind farm is around 20MW in capacity, requiring about 2.2km^2 of land. If less than 10% of the potentially suitable land were used for wind farms, it could provide 200MW of installed capacity, comprising around 100 large scale wind turbines in addition to those already in planning.

Resource	Large Scale Wind Turbines
Number of turbines	100
Hub Height	80 metres
Rotor Diameter	80 metres
Installed capacity	200 MW
Annual generation	350,050 MWh
Potential for CO_2 savings	198,828 tonnes
Number of homes equivalent	56,007

Table 6 Large scale wind energy resource in Bassetlaw

5.1.3 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. As of February 2009, large scale wind power is projected to cost around £800,000 per megawatt installed[15]. A typical cost breakdown is provided in Figure 22.

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

Detailed feasibility studies should be carried out to confirm the suitability of these areas and precise locations for turbines.

Assuming a capacity factor of 27%, this would have an annual generation of around 473,000 MWh. This is sufficient to save nearly 270,000 tonnes CO_2, equivalent to that emitted by over 75,000 typical detached homes, well over the total number of dwellings in the district including new development. These results are summarized in Table 6.

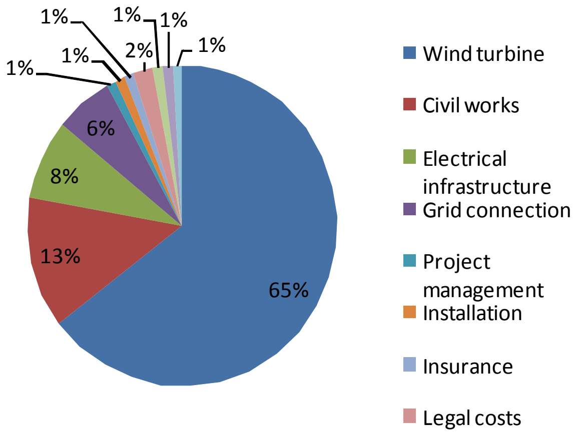

Figure 22 Capital cost breakdown for a large scale wind turbine. (Source: The economics of onshore wind energy; wind energy fact sheet 3, DTI) 16

5.2 Small Scale Wind Energy Resource

5.2.1 Local Potential for Small Scale Wind

The relatively high 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 Figure 23. 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. Any locations for small scale wind turbines that are around 15m tip height should incorporate a 20m buffer zone from all roads and railways and a 150m buffer zone from residential areas. The air traffic zone around Robin Hood airport has also been excluded from the locations suitable for small wind turbines.

The total area of land potentially suitable for small scale wind turbines is around 220km^2 in addition to the land that could be suitable for large scale wind.

For the purpose of estimating the potential resource, it has been assumed that 100 small scale turbines could be accommodated, for example, on farms, in parks, near municipal buildings, community centres, schools or industrial estates, although there is potential to install many more. Installation of 100, 15 kW turbines would add 1.5MW to the district's renewable energy capacity and assuming a capacity factor of 15% would generate approximately 1,971 MWh annually. The contribution from 100 small scale turbines is around 42% 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 are in the region of £1,267,000 per megawatt installed. These costs are based on an installed cost of £19,000 for one 15 kW turbine and include civil works for an average site. These results are summarised in the following table.

Resource	Small Scale Wind Turbines
Number of turbines	100
Hub Height	15 metres
Rotor Diameter	9 metres
Installed capacity	1.5 MW
Annual generation	1,971 MWh
Potential for CO_2 savings	1,120 tonnesCO_2
Number of homes equivalent	315

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

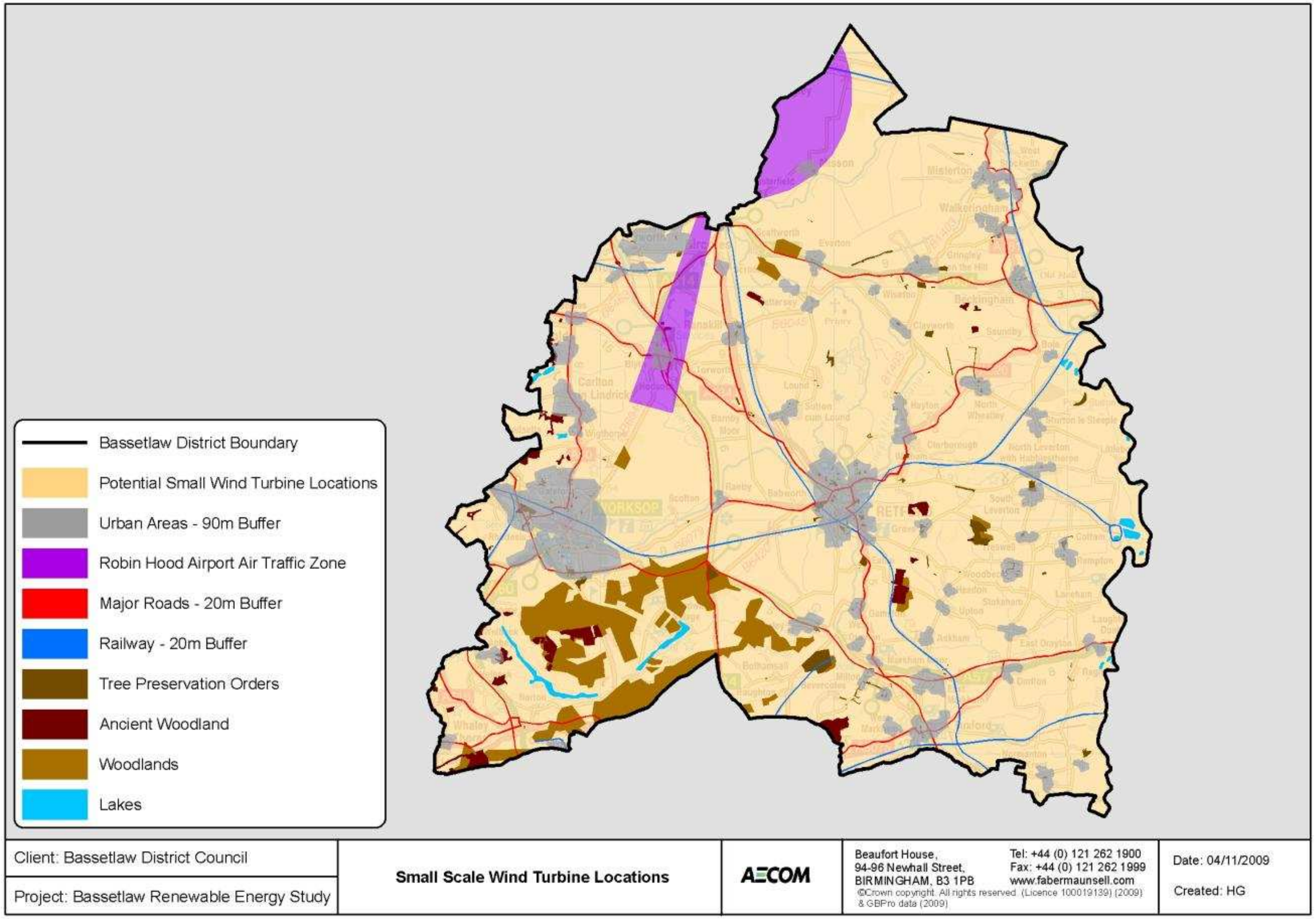

Figure 23 Small scale wind turbine locations in Bassetlaw

5.3 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.

5.3.1 Existing Biomass Energy Generation Sites

Cottam and West Burton power stations in east Bassetlaw co-fire biomass with coal. Each power station has a generating capacity of 2,000MW. Biomass used at the power stations includes short rotation coppice (SRC) willow grown locally.

Other smaller scale biomass boilers used for heating are located in the district, according to the Renewables Planning Database (2008). They include a biomass boiler at the CORE centre near Retford, which supplies heat to the Manor Business Park.

Local biomass producer, Strawson's Energy, supplies biomass to the power stations and the CORE centre. It provides wood pellets and woodchip produced from willow SRC grown locally.

5.3.2 Local Potential for Biomass

GIS mapping has been carried out to estimate the biomass resource . 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 cover 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

Details of the assessment methodology are provided in the following sections. Each type of biomass brings its own set of constraints and these should be explored in detail before finalising locations.

5.3.3 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 have been used to delineate appropriate soil types (Figure 24).

The following criteria have been used to assess capacity:

- Grades 1 and 2 land have been omitted as being reserved for food production
- The total energy crop potential includes use of 75% of grade 3 land and 20% of grade 4 land
- Short rotation coppice (SRC) willow as the main energy crop. It has been assumed that 12 oven dried tonnes of willow SRC could be derived per hectare of grade 3 land, or 10 per hectare of grade 4.[17]

The assessment suggests that the district can generate around 800,000 MWh per year from energy crops (equivalent to 267,800 tonnes CO_2, or carbon emitted from around 75,000 typical detached homes). As indicated above, some of this land is already used for growning energy crops in the district.

5.3.4 Arboriculture

Locations of woodland have been mapped (Figure 24) and their areas calculated. The assessment included areas under Forestry Commission management in the south west of the district. A realistic figure for biomass yield has been derived from these areas, using assumptions from the Biomass Energy Centre.

If all potential arisings were collected, around 13,500 oven dried tonnes would be available annually for energy generation equating to 35,000 MWh and displacing 20,000 tonnesCO_2 annually (equivalent to that emitted by 5,500 typical detached homes).

[17] Biomass-related facts, figures and statistics (Biomass Energy Centre website, accessed October 2009)

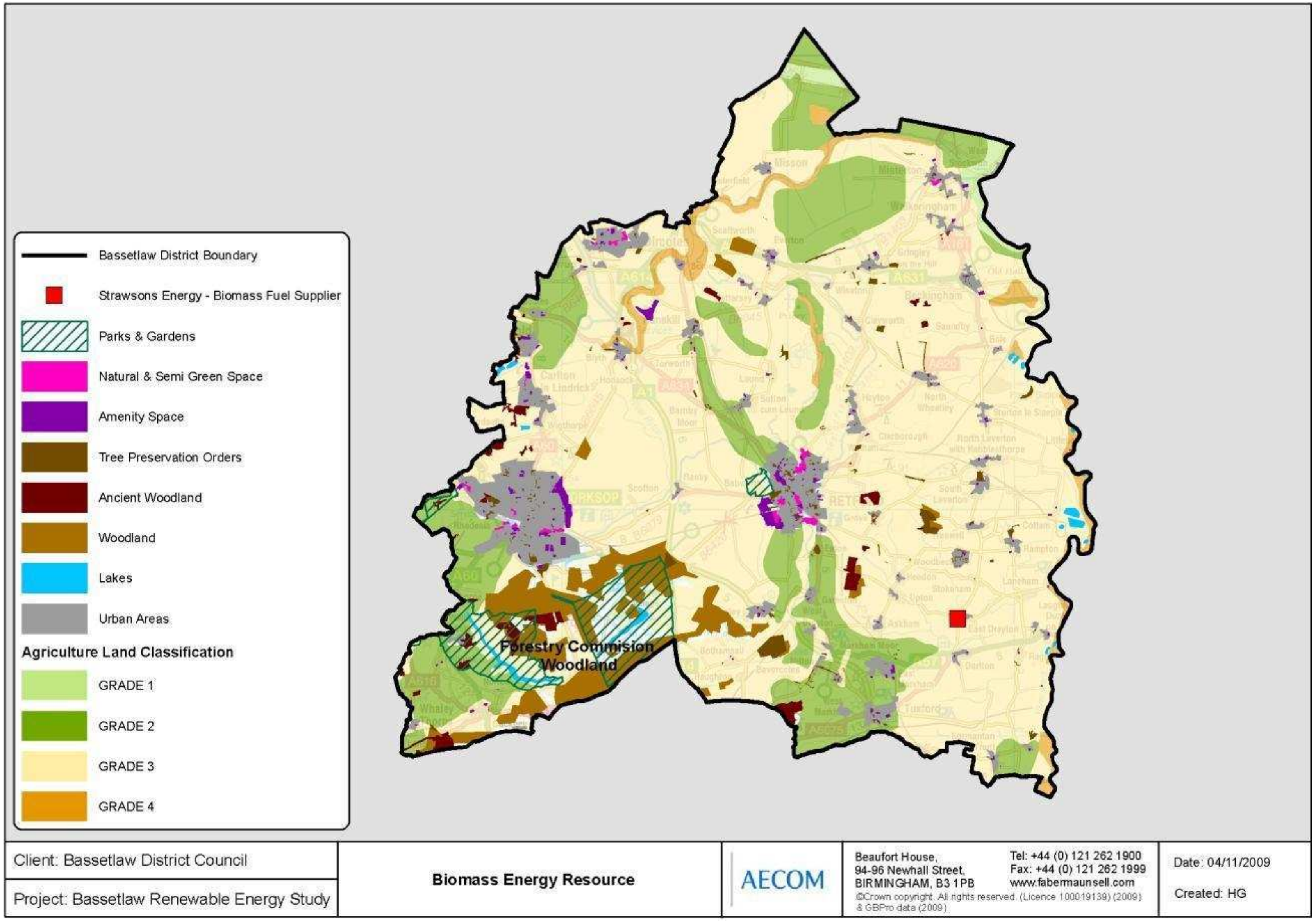

Figure 24 Classification of agricultural land for biomass resource in Bassetlaw

5.3.5 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. Bassetlaw District Council is responsible for the management of over 860 acres of amenity land, including two parks in the town centres of Worksop and Retford, Kilton Forest Golf Course and Langold Country Park.

To estimate the potential resource from pruning and cuttings we have used GIS mapping, the Generalised Land Use Database and information from the Council. The total area of parks and gardens in Bassetlaw has been estimated to be 2,928 hectares and there are 42 hectares of allotments. It was assumed that cuttings from 20% of the total area could be gathered for biomass fuel. This would provide 1,188 oven dried tonnes for annual energy generation equating to 5,200 MWh, reducing CO_2 emissions by 130 tonnes.

5.3.6 Wet Biomass Resource

Other sources of biomass include animal waste, such as poultry litter and manures. . We have used Defra NUTS data and made the following assumptions to estimate the potential resource from wet biomass:

- There are 23,696 poultry, 11,877 cattle and 23,430 pigs in the district;
- Potential energy generation from animal waste is based on number of animals in the district and standard energy conversion figures for anaerobic digestion. [18], [19]

Assuming that all of this can be supplied to a biomass plant, this would be expected to generate around 612,700 MWh per year of heat (saving 15,300 tonnesCO_2, equivalent to that emitted by 4,315 homes).

5.3.7 Summary of Biomass Resource

The total biomass resource in the district, based on this assessment, is summarised in the following table.

5.3.8 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 7). Detail on grants available for establishing crops are presented in Chapter 10.

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

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 7 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) 20, 21

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.[21] Energy crops are relatively expensive compared to some other biomass fuels but do have the potential to provide very significant volumes of fuel

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

Type of Biomass	Source	Recoverable Biomass	Area/Number in Bassetlaw	Useful Proportion	Useful Amount	Moisture Content	Calorific Value	Annual Generation	CO_2 Savings
		odt/hectare	hectares or number of animals	%	odt/tonnes	%	GJ/odt	MWh	tonnes
Energy Crops	Agricultural Land Grade 1 (Willow SRC)	9	553	0%	-	30%	18.60	-	0
Energy Crops	Agricultural Land Grade 2 (Willow SRC)	9	12,009	0%	-	30%	18.60	-	0
Energy Crops	Agricultural Land Grade 3 (Willow SRC)	9	44,499	75%	300,366	30%	18.60	1,552,015	38,800
Energy Crops	Agricultural Land Grade 4 (Willow SRC)	9	1,672	20%	3,010	30%	18.60	15,551	389
Energy Crops	Agricultural Land Grade 5 (Willow SRC)	9	-	0%	-	30%	18.60	-	0
Aboriculture	Woodland	2	3,334	100%	6,668	45%	9.28	17,189	430
Park and Highways Waste	Country Parks, Historic Parks and Gardens	2	2,928	20%	1,171	n/a	15.76	5,127	128
Park and Highways Waste	Allotments	2	42	20%	17	n/a	15.76	74	2
Wet Biomass	Poultry (Layers)	-	23,696	-	18,380	70%	25.00	127,647	3,191
Wet Biomass	Cattle	-	11,877	-	52,620	88%	24.00	350,830	8,771
Wet Biomass	Pigs	-	23,430	-	21,010	91%	23.00	134,243	3,356
TOTAL								**2,202,676**	**55,067**

5.4 Geothermal Energy

Geothermal energy is derived from the very high temperatures at the Earth's core (and is a different type of technology to ground source heat pumps). 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."*[22] This technology has therefore not been considered further.

5.5 Marine Energy

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

5.6 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 the East Midlands was reviewed in 2001.[23] This study did not identify any existing or potential for hydro generation in Bassetlaw. Hydro energy has therefore not been considered in more detail for this study.

5.7 Waste Heat

Waste heat from large scale power stations or industrial processes can be a low carbon source of heat for district heating networks. Several locations have been identified where sources of waste heat may be available either now or in future (Figure 25), including an existing landfill gas site, existing electricity generation using coal mine methane and the proposed power station at High Marnham.

The viability of using waste heat depends in part on the proximity and suitability of buildings in the area for district heating. The main opportunity is the proposed 1.6MW combined cycle gas turbine power station at the site of the former High Marnham power station, east of Retford. Proposals are currently being developed for the site, leading to an application in 2010 under the Electricity Act (1989) and section 14(1) of the Energy Act (1976).

As part of this process, the developer E.ON, is looking at opportunities to supply heat from the proposed power station to district heating schemes within a 15km radius of the site. As the site is located in the rural east of the district, where density of development is low, such opportunities are limited. Tuxford is approximately 8km away from the proposed site and Retford is around 15km away. The analysis of potential locations for CHP and district heating indicated that there are areas in Retford and Tuxford which may be suitable (Figure 25). However, as the distances are large and the settlements relatively small, further detailed study would be required to determine whether extending a heat network from the High Marnham site would be feasible or viable.

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

[23] Viewpoints on Sustainable Energy in the East Midlands, Land Use Consultants and IT Power (2001)

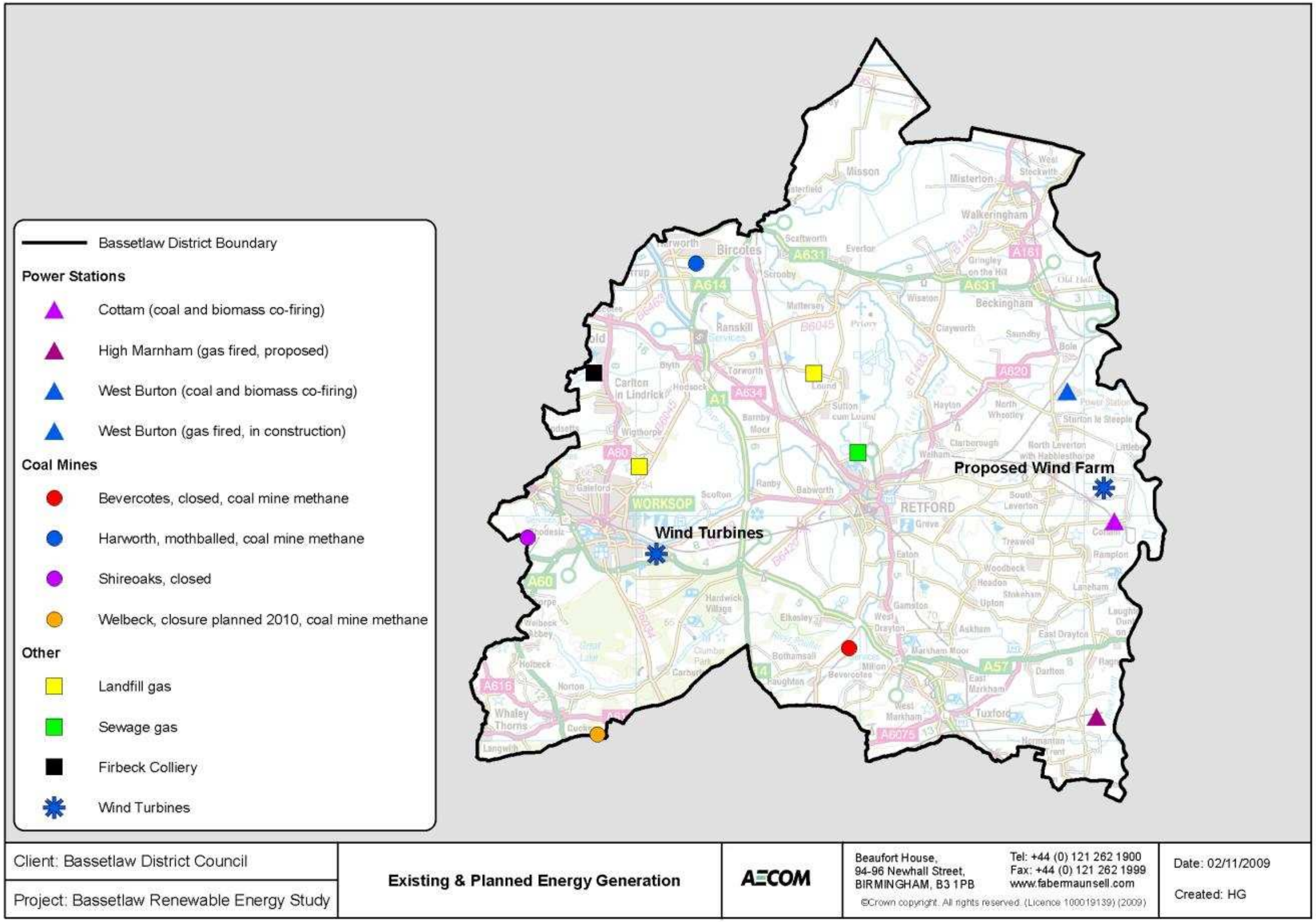


Figure 25 Existing energy generation in Bassetlaw

5.8 Coal Mine Methane

With its mining heritage, Bassetlaw has several sites that may have potential for coal mine methane, particularly along the western edge of the district.

Coal mine methane is natural gas stored in the coal bed, which would gradually escape to the atmosphere if not captured. As the global warming potential of methane is 25 times that of CO_2, over a 100 year horizon its use as a fuel for heat and power generation should be encouraged.

The existing coal mine methane sites in Bassetlaw are as follows:

- Harworth: the colliery had an 18 MWe gas turbine combined cycle generator providing electricity for colliery use and a flare. The status of this is not clear now that the colliery has been mothballed. UK Coal has indicated that there is a 2-3MWe generator still in operation on the site feeding power to the national grid
- Wellbeck: this colliery has two generators, a flare and boilers which use coal mine methane. According to operator UK Coal, the mine is expected to close in first quarter of 2010
- Bevercotes: the colliery is closed, however there is a 4MWe coal mine methane generator at the site operated by Alkane Energy

No further information was available at the time of this study on the potential capacity and lifetime of coal mine methane extraction at these sites. We are therefore not able to quantify the available resource and calculate its potential contribution to energy supply in the district within the scope of this study.

Other former coal mines in the Bassetlaw area include Firbeck and Shireoaks. We are not aware of any coal mine methane extraction at these sites and are not able to determine whether there is potential to supply energy from these sites, as we have not found any information on this.

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.

Deleterious effects 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 26 shows potential combinations of high conflict (red), no conflict (green) and conflicts that can be avoided through appropriate design (yellow).

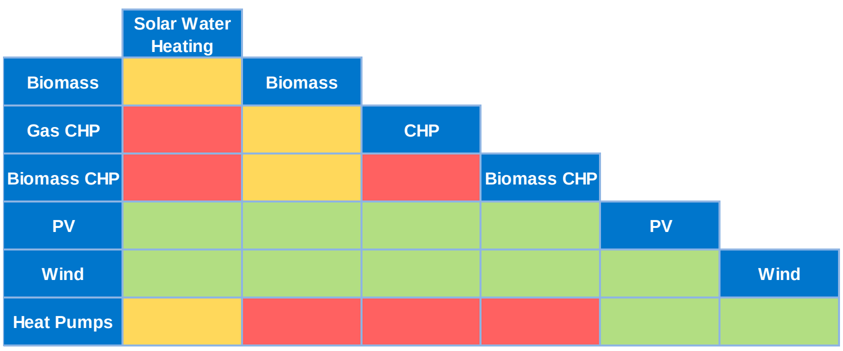


Figure 26 Potential conflicts between microgeneration technologies

Feed-in-tariffs are to be introduced in April 2010 to replace the support provided by the Low Carbon Buildings Programme (see Appendix E). The technologies must be below 5MW and include wind, solar PV, hydro, anaerobic digestion, biomass and biomass CHP, and non-renewable micro CHP. The tariff levels are to be set at a level that encourages investment in small scale, low carbon electricity generation and should ensure that as well as the energy saving benefits, the installation will provide a reasonable rate of return on the initial investment.

5.9.1 Solar Energy

The two main solar microgeneration technologies 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 Bassetlaw in the middle of the range experienced across the UK. Table 8 shows the potential for CO_2 savings from solar energy technologies.

Figure 27 shows how the output of solar systems varies by orientation and tilt of the installation. Panels should be mounted in a south-facing location, although south-east/south-west orientations will generate with only a small reduction in performance. 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.

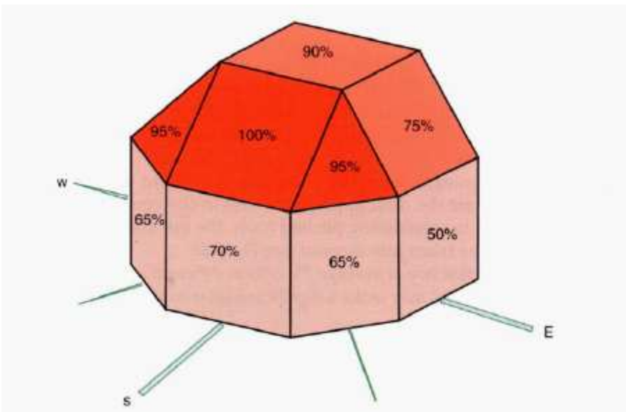


Figure 27 Optimum orientation for solar panels in the UK (Source: Sustainability at the Cutting Edge) 24[24]

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 are often one of the only on-site solutions to mitigate CO_2 reductions associated with electricity use.

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 8)

[24] 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 8 Potential CO2 savings for solar energy technologies. Buildings are assumed to have good energy efficiency (Bassetlaw Energy Model, AECOM)

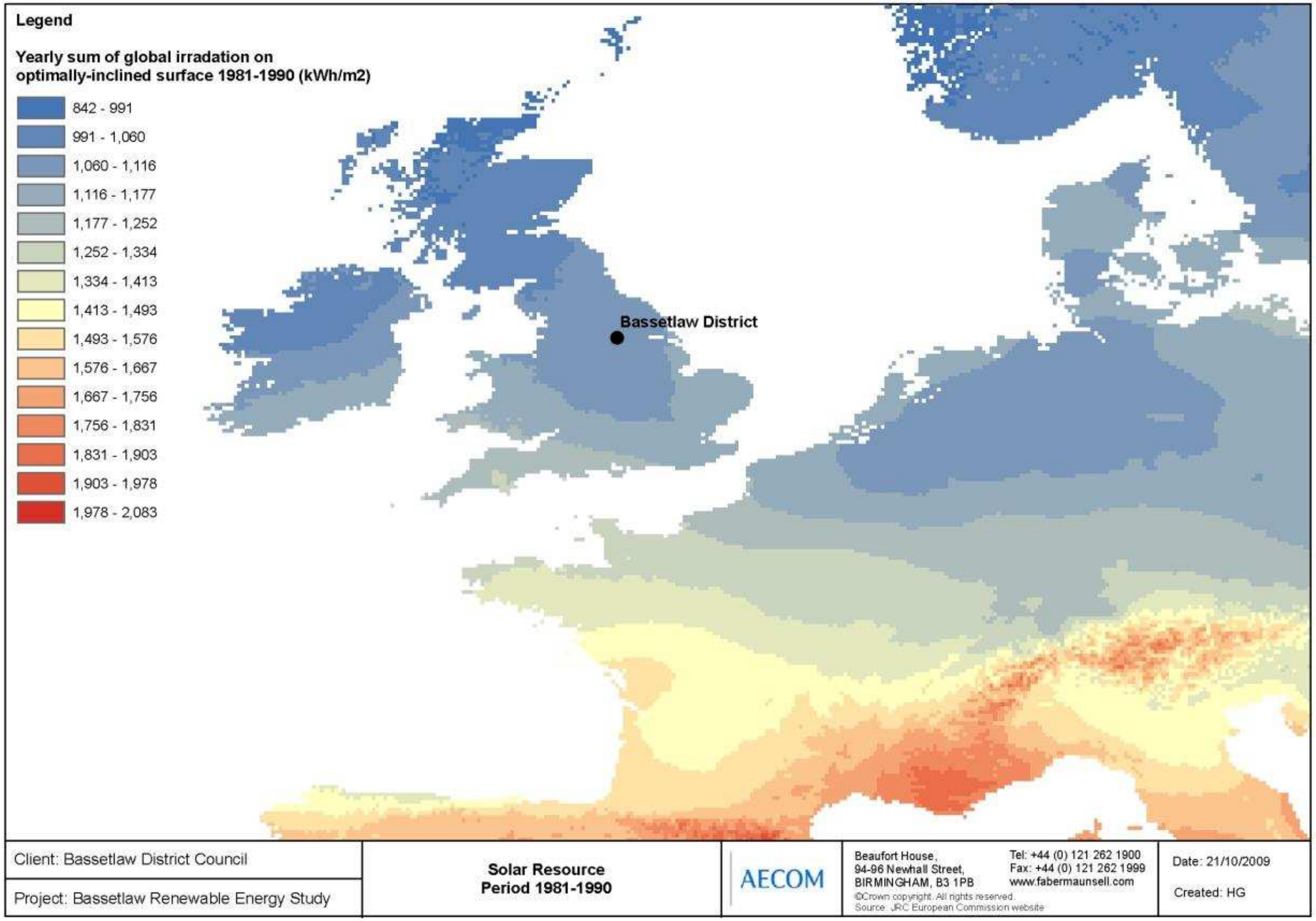


Figure 28 Solar Resource in Bassetlaw (Source: Photovoltaic Geographical Information System (PVGIS), JRC European Commission)

5.9.2 Heat Pumps

Heat pumps are low carbon rather than renewable devices since they require electricity to run. 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 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. In such cases, heat pumps might be well 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 9 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 9 CO2 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) [25]

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

5.9.3 Biomass Heaters

Biomass heating is most appropriate lower density situations due to fuel supply and storage issues. 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. There would be particular benefit in encouraging fuel switching to biomass in areas in the south and east of the district which are off the gas grid, and where oil and coal are more commonly used for heating Table 10. These rural areas of the district are also likely to have better access to local biomass fuel. There are no formal Air

Quality Management Areas designated in Bassetlaw at present, so this will not be a constraint on the use of small scale biomass boilers, however some controls may be preferred in urban areas to prevent the emergence of air quality issues in future.

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 29)

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 10 CO2 savings from biomass technologies[26]

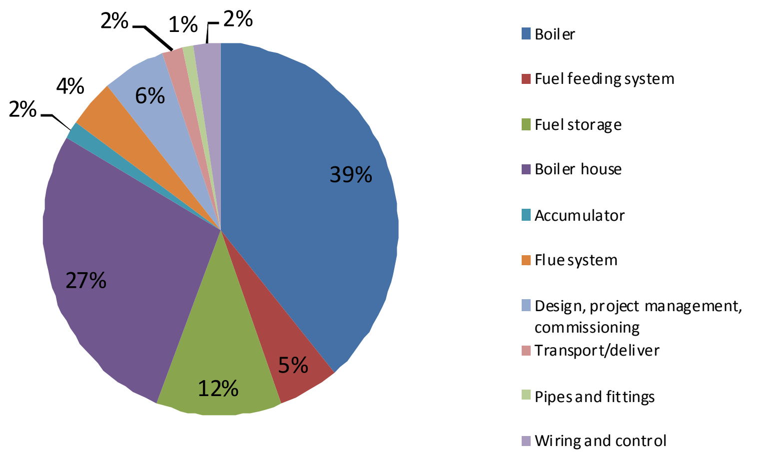


Figure 29 Capital cost/kW breakdown for example biomass heating project, based on a recently designed project of 500 kWth capacity. The total system cost was £187,000. (Source: Biomass heating A practical guide for potential users) 1

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

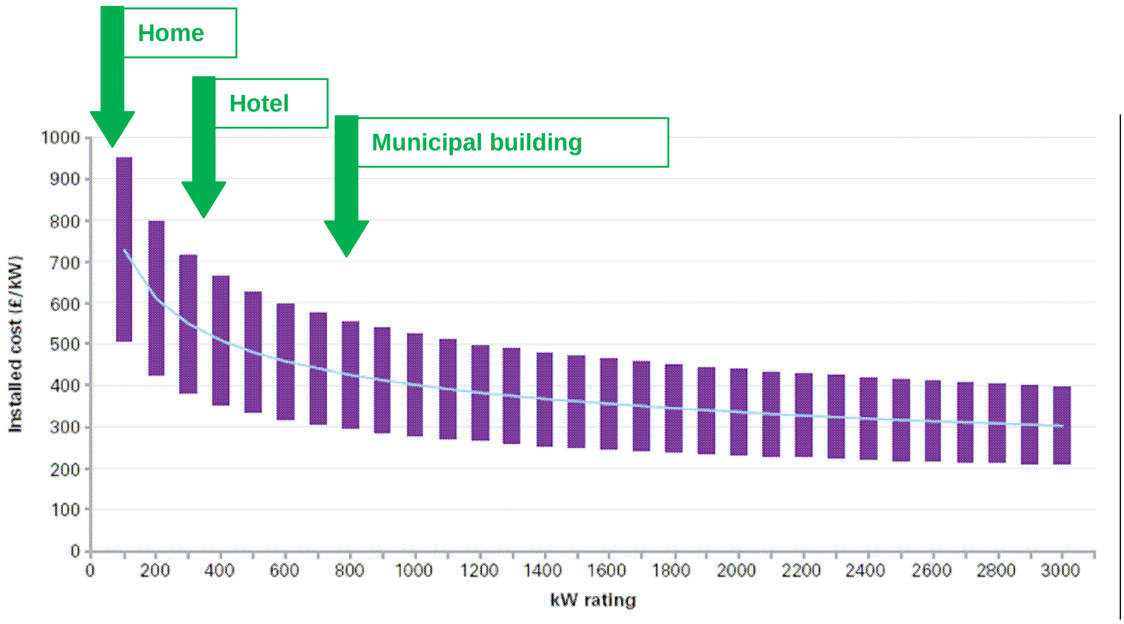


Figure 30 Capital cost ranges for a biomass heating system. Graph is inclusive of all required construction and other balance of plant. (Source: Biomass heating: A practical guide for potential users, Biomass Energy Centre website).

5.9.4 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. The relatively high wind speeds in Bassetlaw mean that turbines should perform well. However, early feedback suggests that building mounted turbines located in urban areas suffer from lower and much more disrupted wind speeds than larger turbines mounted in open sites and this has a significant impact on their energy generation potential.[27] 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. This is not necessarily a problem if costs can be reduced to a level where lower performance is balanced by their low cost.

AECOM are following the progress of monitoring studies and intend to include building mounted 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.

5.9.5 Fuel Cells

Fuel cells can be used as CHP systems in buildings but are considered to be an emerging technology. They 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; this is currently natural gas which is reformed to produce hydrogen.

There is debate as to whether electricity generation from hydrogen is better than generating electricity directly from renewable sources such as PV and wind. The virtue of fuel cells is that they guarantee continuity of supply and clean, quiet, and very efficient electricity generation.

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

The capital cost of fuel cells is currently much higher than most other competing micro-generation technologies. Commercial models 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.[25]

5.10 Key Considerations Emerging from this Chapter

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

- Despite some constraints, Bassetlaw has resource for large scale wind turbines across around 280km^2 of land. If less than 10% of this were used, it could provide 200MW of installed capacity, comprising around 100 large turbines in addition to those already in planning. This would generate 473,000 MWh annually, saving nearly 270,000 tonnes CO_2. This is equivalent to that emitted by over 75,000 typical detached homes, well over the total number of dwellings in the district including new development
- Smaller scale turbines of around 15m tip height could be a significant opportunity. 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 district's capacity and assuming a capacity factor of 15% would generate around 1,971 MWh annually
- The district can generate around 800,000 MWh per year from energy crops on grade 3 and 4 land. This is equivalent to 267,800 tonnes CO_2, or carbon emitted from around 75,000 typical detached homes
- Potential annual arboriculture arisings are around 13,500 oven dried tonnes, equating to 35,000 MWh and displacing 20,000 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 1,188 oven dried tonnes annually, equating to 5,200 MWh and reducing CO_2 emissions by 130 tonnes
- 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 hydro has been identified
- Several opportunities exist for utilising waste heat waste heat either now or in future, including an existing landfill gas site, existing electricity generation using coal mine methane and the proposed power station at High Marnham
- The analysis of potential locations for CHP and district heating indicated that there are areas in Retford and Tuxford which may be suitable
- As the global warming potential of coal mine methane is 25 times that of CO_2 over a 100 year horizon, its use as a fuel for heat and power generation should be encouraged from the three existing sites of Harworth, Wellbeck and Bevercotes
- Bassetlaw 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 and there would be particular benefit in encouraging fuel switching in areas in the south and east of the district currently powered by oil and coal
  - 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
  - Fuel cells can be used as CHP systems in buildings but are considered to be an emerging technology and costs are high

6 Energy Opportunities Map

6 Energy Opportunities Map

An Energy Opportunities Map has been prepared which shows the opportunities for renewable and low carbon energy supply in the district, in relation to potential locations for future development. From this it emerges that some future development sites will be energy constrained, while others may have access to opportunities for district heating or wind energy.

6.1 The Energy Opportunities Map

An Energy Opportunities Map has been prepared, showing opportunities for renewable and low carbon energy generation in Bassetlaw (Figure 31 to Figure 34). It shows the spatial distribution of the following opportunities:

- Existing communities and potential new residential and commercial development sites
- Locations with potential for CHP and district heating
- Potential locations for large scale wind turbines
- Areas where energy crops could be grown as biomass for energy generation (Grade 3 and 4 agricultural land)
- Areas of forestry where biomass could be sourced through woodland management
- Parks and open spaces where biomass could be sourced through waste arisings
- Existing energy from waste sites which could be used for low carbon energy generation or sorting of biomass waste arisings
- Sources of waste heat, including the proposed power station at High Marnham
- Coal mine methane sites

The Plan has informed proposed planning policies, targets and delivery mechanisms and should be treated as a corporate as well as planning resource.

6.2 Opportunity Areas

As demonstrated by the Energy Opportunities Map, developments in some parts of the district will have access to options for renewable or low carbon energy supply which are not afforded to developments elsewhere in the district. To reflect this local variation, three opportunity areas have been defined:

- **Energy Constrained:** No community or large scale renewable or low carbon energy resources are available in the vicinity of the site. Options for complying with the policy options are limited to what can be achieved on-site, namely microgeneration technologies or CHP systems for larger sites, or payment to a Carbon Buyout Fund.
- **District Heating:** The site is in an area where district heating beyond the site boundary may be a suitable 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 at High Marnham or a coal mine methane CHP engine.
- **Wind:** 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 ability of a new development to achieve the different policy options has been considered for each of these opportunity areas.

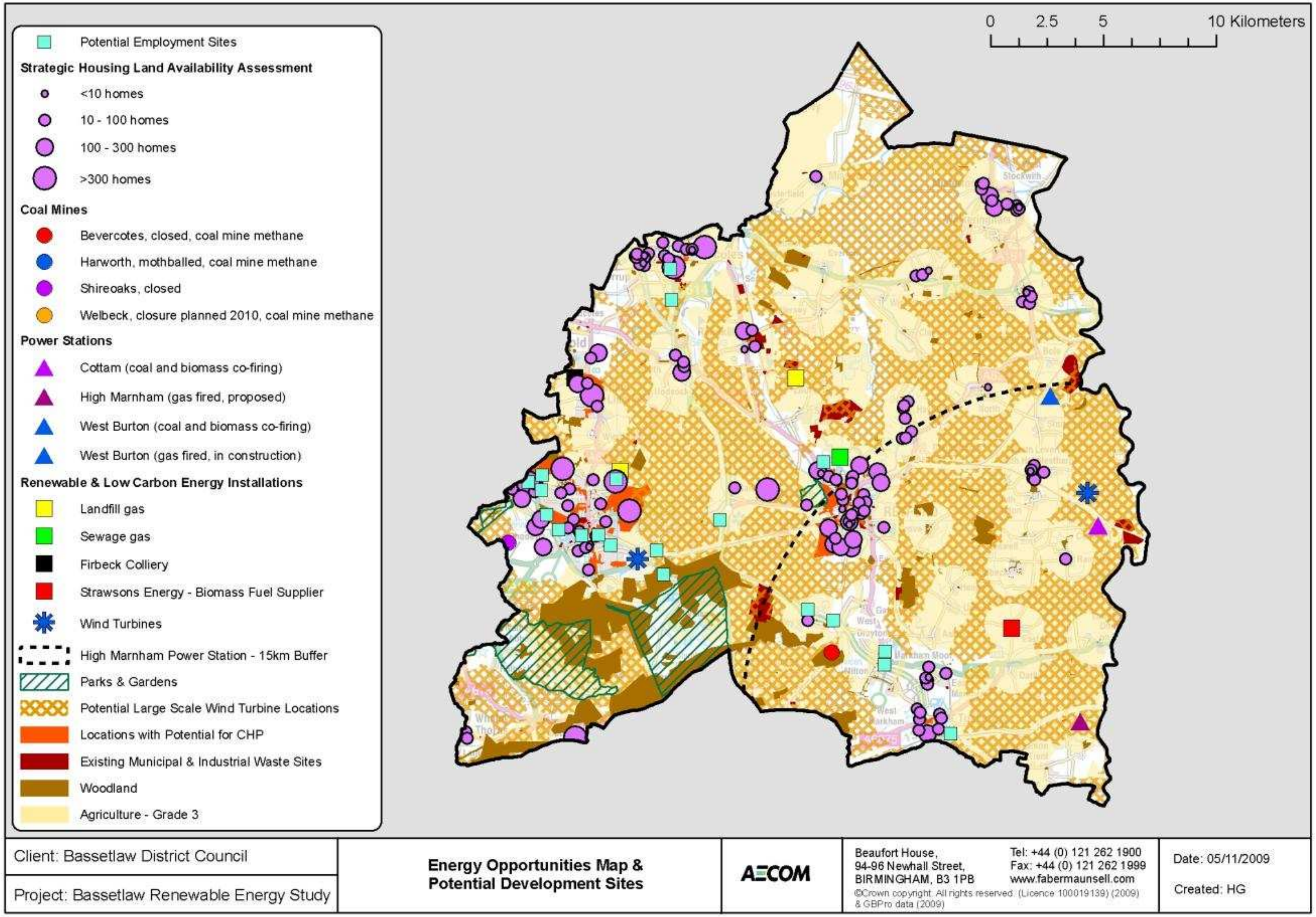


Figure 31 Bassetlaw Energy Opportunities Plan

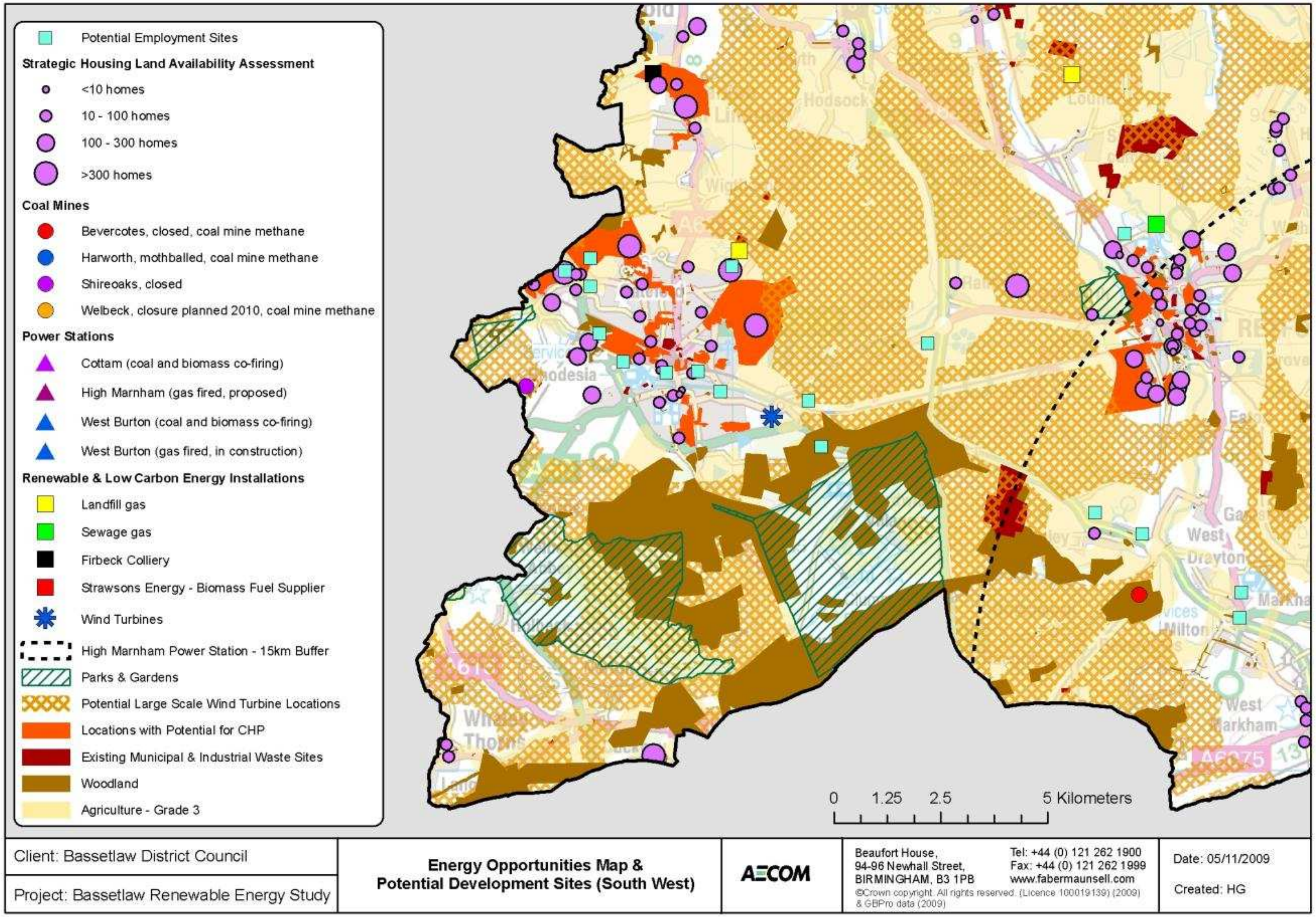


Figure 32 Bassetlaw Energy Opportunities Plan: South West section with potential development sites

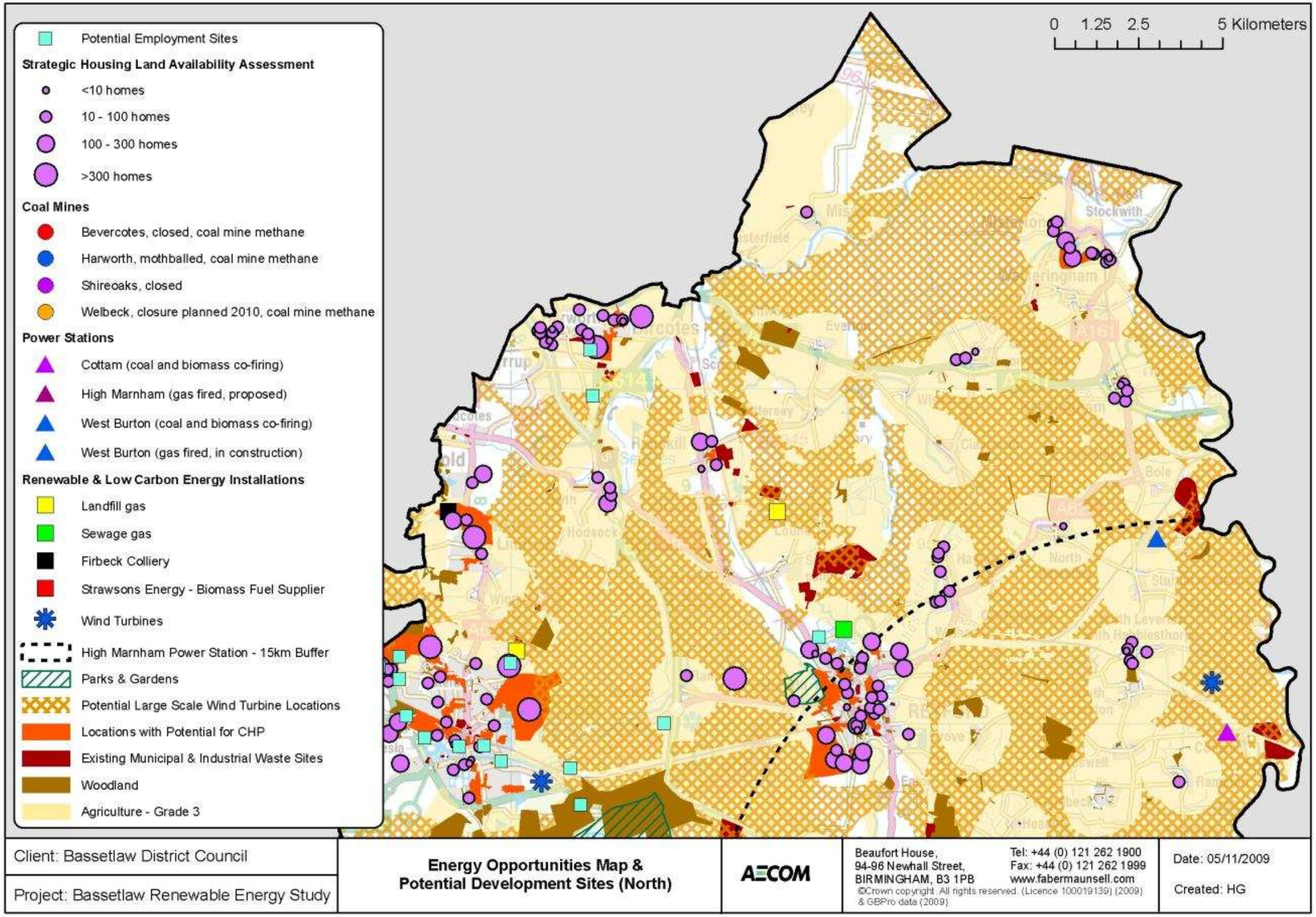


Figure 33 Bassetlaw Energy Opportunities Plan: North section with potential development sites

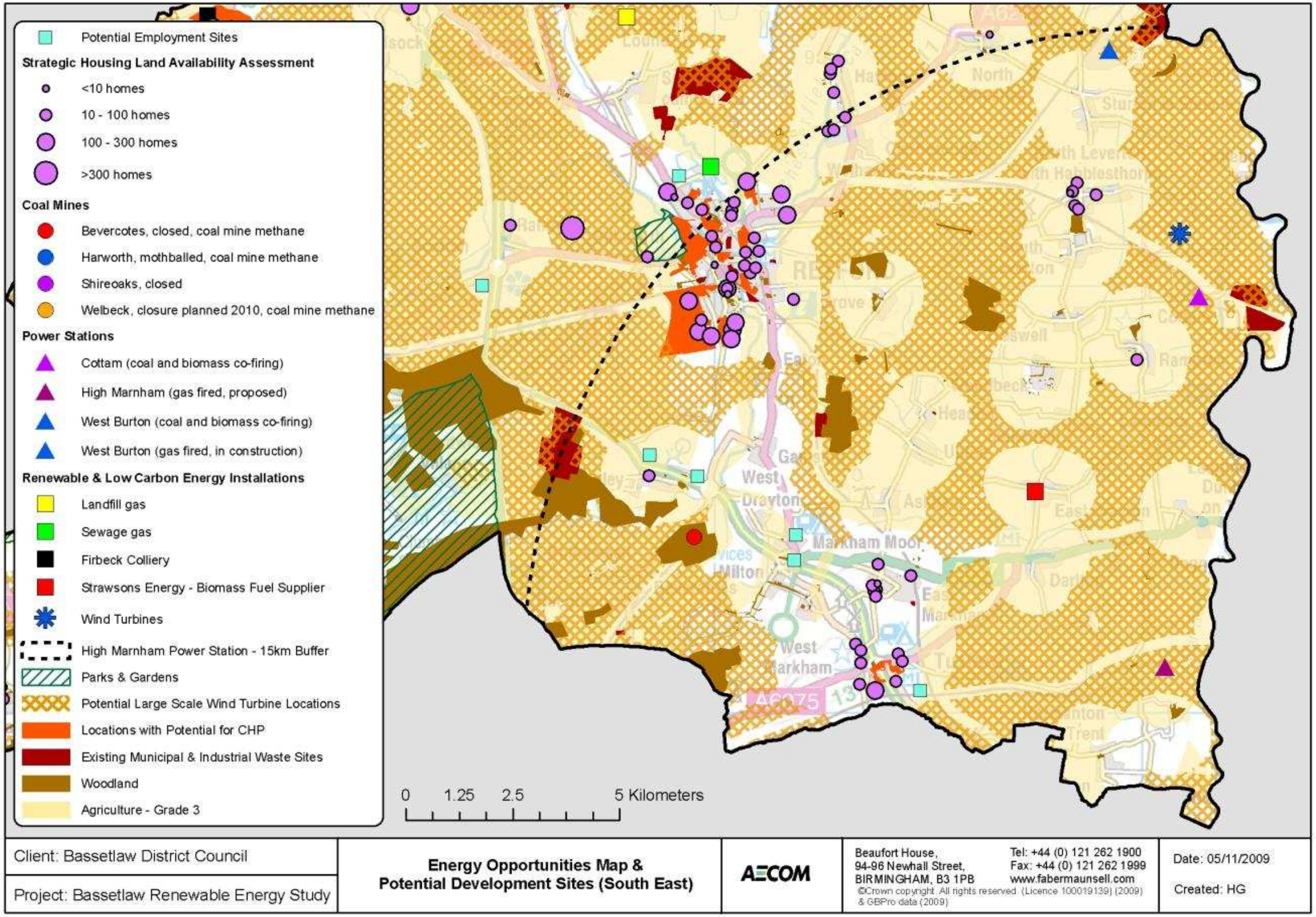


Figure 34 Bassetlaw Energy Opportunities Plan: South East section with potential development sites

7 Code for Sustainable Homes and BREEAM

7 Code for Sustainable Homes and BREEAM

This chapter considers the potential to require developments to achieve a specified level of the Code and BREEAM. These assessment schemes consider other environmental and social impacts of buildings beyond energy, including water use, materials, waste and ecology. We have reviewed the implications of setting standards in these other areas for developments in Bassetlaw.

The PPS1 Supplement states that requirements for sustainable building should be specified in terms of achievement of national standards such as the Code for Sustainable Homes or BREEAM. This requirement 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 and BREEAM measures for non-domestic buildings.

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 Bassetlaw, 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 for Sustainable Homes and BREEAM as the basis for planning policies and targets for new development. Firstly, requiring developments to achieve a minimum Code level or BREEAM rating would improve the overall environmental performance of new development in the district. Secondly, and 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.

Thirdly, the 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 managers to monitor new development and provide assurance that planning requirements are being met in practice.

To justify a policy requiring a minimum Code or BREEAM rating, further work is recommended to establish the local circumstances which may affect a development's ability to achieve credits in the following sections:

- **Water use:** targets are set for average water consumption per building occupant. As a mandatory standard, 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 is likely to 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. The evidence base for a policy requiring levels 5 or 6 of the Code would need to demonstrate that water shortages in the district justify this additional expense.
- **Flood risk:** there are credits available in the Code and BREEAM for using SUDS to reduce flood risk and risk of groundwater contamination. Approximate costs for SUDs on individual homes are £450 (based on one infiltration swale for every 2 units). The costs of incorporating flood resilience 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 a flood risk area. Developments in the flood risk zones in the north, centre and east of the district may be limited in their potential to achieve these credits.

- **Ecology:** credits are available in the Code and in BREEAM to encourage development on brownfield sites, avoid use of greenfield land where possible and enhance a site's ecological value. Based on the SHLAA and Employment Land Study, it is understood that some future greenfield development in Bassetlaw is likely. Developments in these locations may be less able to achieve credits in this section of the Code and BREEAM.
- **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 both the Code and BREEAM 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.
- **Transport:** BREEAM includes credits which relate to the accessibility of sites by public transport, for staff commuting and business travel. Locations in rural parts of Bassetlaw may be constrained in this respect. Credits for both the Code and BREEAM relating to cycle storage are more dependent on site layout and design, and are within the control of a developer to achieve.

Other sections of the Code and BREEAM, including management, health and 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 these credits can be achieved at the discretion of the developer.

A recent AECOM and Cyril Sweet study has been used to show the financial implications of achieving different levels of the Code. The costs were predicted and are not yet fully supported by the development industry. There is not yet sufficient published data on the actual costs of achieving the higher Code levels to establish robust cost benchmarks.

The results demonstrate that the costs associated with meeting advanced Code levels are relatively modest for most elements. A significant proportion of the costs of delivering Code levels is in meeting the standards for CO_2 emissions, which after 2010 will become necessary for meeting Building Regulations. It is likely that these costs could be reduced further through effective supply chain management, economies of scale from the bulk purchase of materials and fittings, and innovation in design within the housing sector, as the Code becomes standard practice. There is potentially a role for the local authority here.

The percentage uplift in build costs arising from the additional Code requirements (i.e. all Code criteria excluding the energy and CO_2 requirement) is around 3% for flats and around 5% for houses for Code Level 4. This relates to achieving all additional Code credits; homes must actually achieve 57% of available credits to achieve Code Level 3 and 68% of available credits to achieve Code Level 4. There is a significant jump in cost when moving from Code Level 4 to Code Level 5 due to the need for water re-use and recycling systems.[28] The percentage uplift in build costs for Code Level 5 (excluding the mandatory energy criteria) is around 4.5% for flats and nearly 12% for houses.

[28] Cost analysis of the Code for Sustainable Homes (produced for department for Communities Local Government by Cyril Sweett , July 2008)

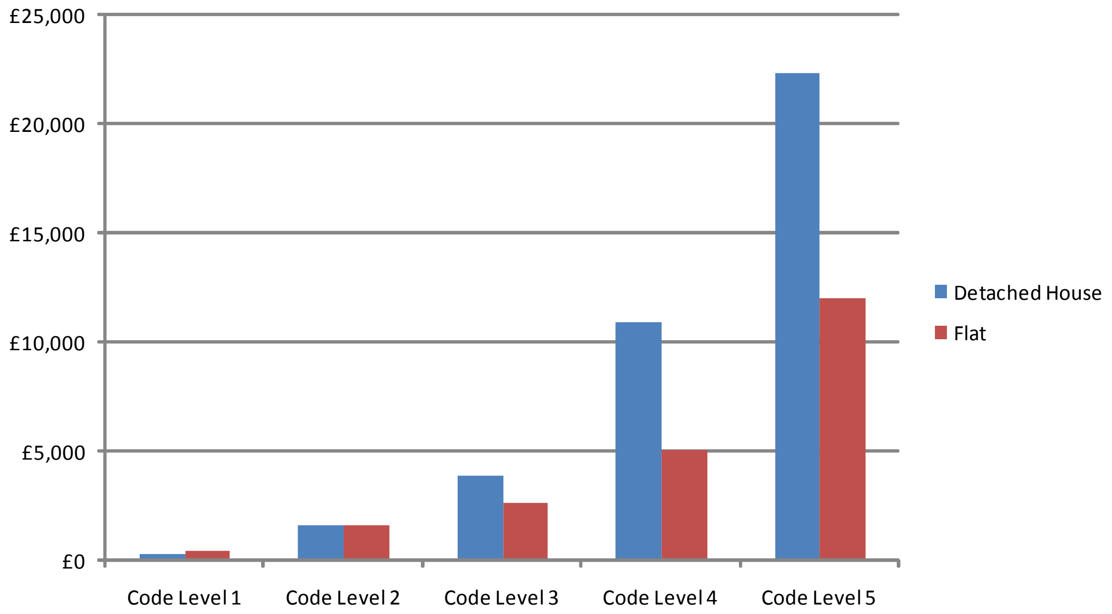


Figure 36 Cost of meeting the mandatory Energy criteria in the Code for a detached house and a flat. Code Level 6 has been excluded (Source: Cost Analysis of The Code for Sustainable Homes, Faber Maunsell AECOM and Cyril Sweett, 2008)

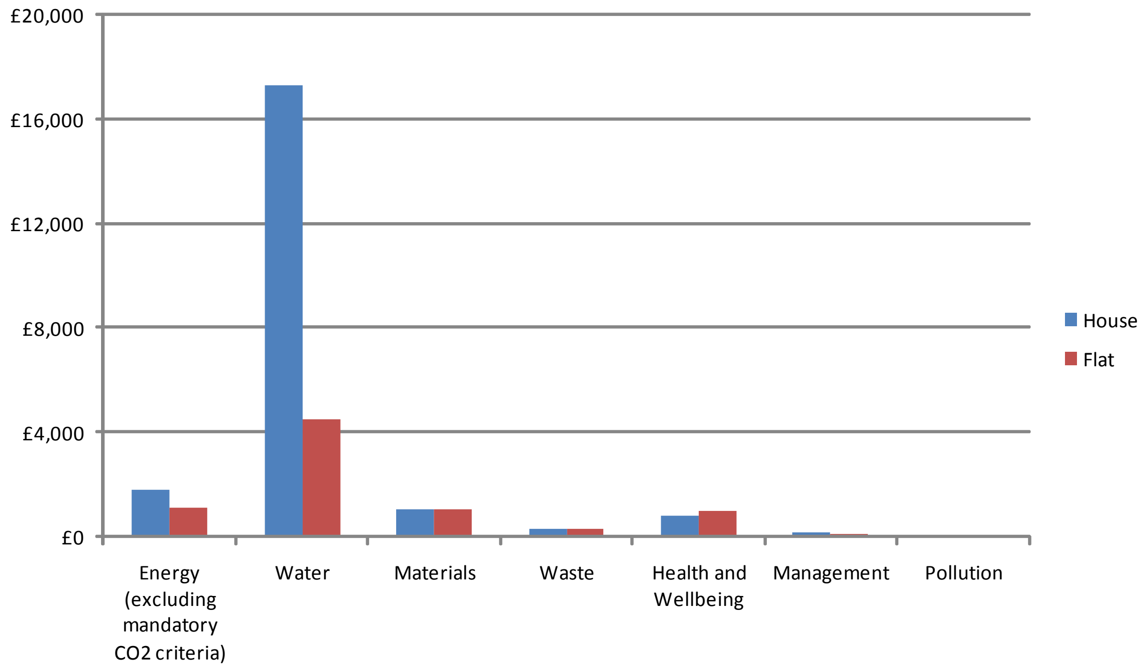


Figure 35 Cost of meeting all Code credits in each issue excluding the mandatory Energy for a detached house and a flat Homes must achieve 57% of available credits to achieve Code Level 3 and 68% of available credits to achieve Code Level 4 (Source: Cost Analysis of The Code for Sustainable Homes, Faber Maunsell AECOM and Cyril Sweett, 2008

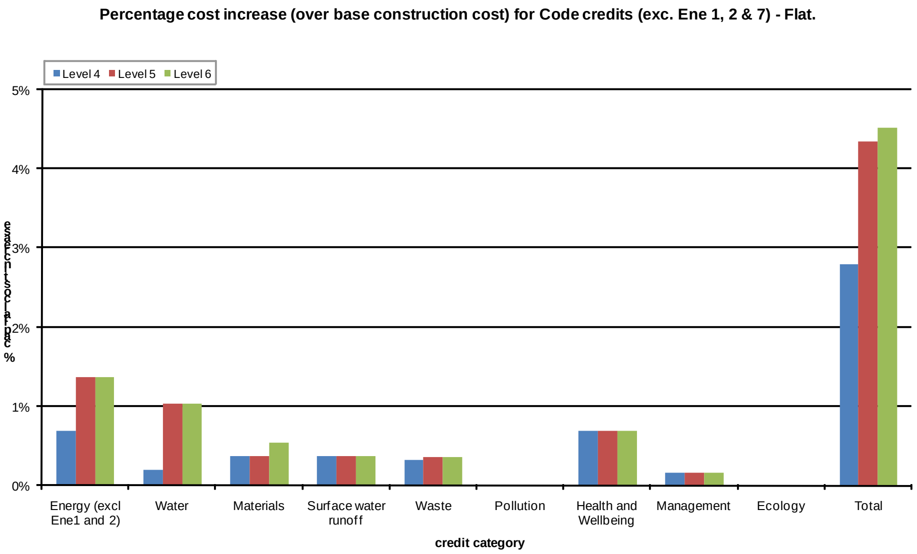


Figure 37 Costs (over base construction cost) for delivering Code credits as required to levels 4, 5 & 6 for a flat. (Source: Cost Analysis of The Code for Sustainable Homes, Faber Maunsell AECOM and Cyril Sweett, 2008)

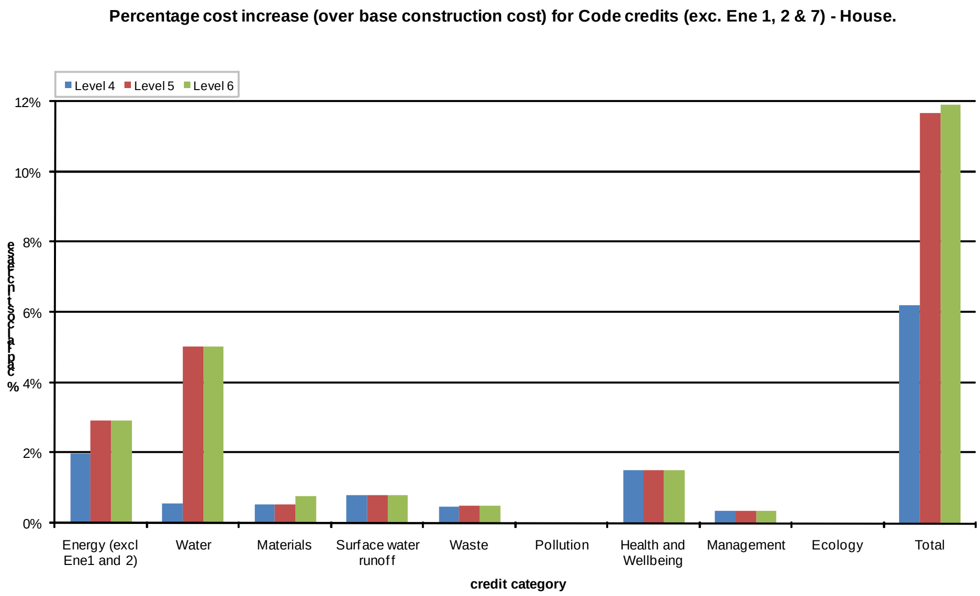


Figure 38 Costs (over base construction cost) for delivering Code credits as required to levels 4, 5 & 6 for a house. (Source: Cost Analysis of The Code for Sustainable Homes, Faber Maunsell AECOM and Cyril Sweett, 2008).

The figure below shows the percentage increase on the base build cost to deliver ‘Good’, ‘Very Good’ and ‘Excellent’ ratings under BREEAM Offices (2004) and BREEAM Schools. [29],[30] 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

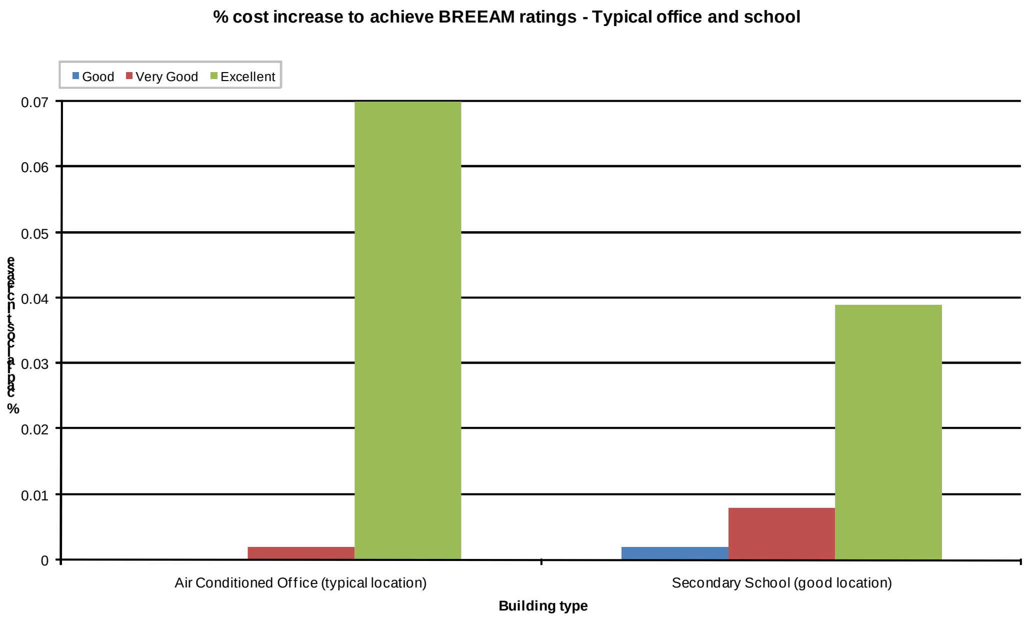


Figure 39 Costs (over base construction cost) for delivering BREEAM Offices (2004) and BREEAM schools ratings. (Source: Putting a price on sustainable schools (BRE Trust and Faithful & Gould, 2008)

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

According to the Strategic Housing Market Assessment for the Northern Sub-Region (September 2007), Bassetlaw's housing market is performing at 73.5% of the average for England and Wales, with an average house price of £141,588. Clearly, market conditions have changed considerably since this study was carried out (at the peak of the market before the crash), but we can crudely assume that the relative performance remains similar between areas. Based on this study and the 2009 Affordable Housing Viability Study, which suggests a significant need for affordable housing, we have concluded that the additional financial burden imposed by Code and/or BREEAM targets would not be a viable option.

7.1 Key Considerations Emerging from this Chapter

Key considerations emerging from the assessment of sustainability issues of particular relevance to Bassetlaw are:

- Requirements through planning for Code for Sustainable Homes or BREEAM standards overall environmental performance of new development. Go some way towards addressing the potential future impacts of climate change by setting water consumption, flood risk management and ecology standards
    - Be relatively simple to show compliance with policies and targets
- Further work is recommended to establish the local circumstances which may affect a development's ability to deliver a policy requiring a minimum Code or BREEAM rating
- A significant proportion of the costs of delivering Code levels is in meeting the standards for CO_2 emissions, which will become part of Building Regulations from 2010 and therefore not an additional cost. Modelled costs indicate that the uplift in build costs arising from the remaining Code requirements is around 3% for flats and 5% for houses for Code Level 4.
- There is a significant jump in cost when moving from Code Level 4 to Code Level 5 due to the need for water re-use and recycling systems: around 4.5% for flats and nearly 12% for houses
- 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

Based on the SHMA and Affordable Housing Viability Study we have concluded that the additional financial burden imposed by Code and/or BREEAM targets would not be a viable option

8 Testing Targets

8 Testing Targets

The PPS1 Supplement states that planning authorities should set targets for new developments that are properly tested for feasibility and viability. This chapter explains the range of targets which have been tested and their implications, based on the results of modelling.

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 feasible and viable for the range of developments which are expected to come forward over the period of the Core Strategy.

This chapter describes how policy options for Bassetlaw have been tested for feasibility and viability in the context of the range of opportunities presented in the Energy Opportunities Plan (Table 11) and the type of development expected in the district.

8.2 Options for Targets

8.2.1 Existing Buildings

Opportunities to influence the energy performance of existing buildings through planning are limited and there is potentially more scope to affect change in this area through other services provided by the Council. Requirements can be placed on existing buildings when they come forward for planning permission for an alteration or change of use. In relation to this, the following option has been considered in this study:

- Planning applications for changes to existing dwellings will be required to undertake reasonable improvements to the energy performance of the existing parts of the building. The total cost should be no more than 10% of the total build cost.

As non-domestic buildings are already required to undertake consequential improvements to the energy efficiency of the existing parts of the building under the Building Regulations, this policy would not apply to them.

8.2.2 New Development

All new development will be required to comply with the Building Regulations. The targets considered for new development have been defined relative to the Building Regulations requirements. The Building Regulations requirements shown in Table 11 define the base case against which the other targets have been tested. Future requirements for non-domestic buildings had not yet been confirmed at the time of this study, so the targets shown have been assumed in line with a trajectory towards zero carbon in 2019.

New development		
Option 0: Building Regulations compliance		
Year	Domestic	Non-domestic
2010 -	25%[1]	25%[1]
2013 -	44%[1]	44%[1]
2016 -	100%[2]	60%[1]

2019 -	100%[2]	100%[2]

Notes:

1. These targets are defined as a % saving in emissions compared to a building compliant with the 2006 Building Regulations. This applies to regulated emissions only (heating, ventilation, cooling, lighting, pumps and controls). The savings must be achieved on site, through energy efficiency or use of renewable or low carbon technologies.
2. These targets apply to all of the emissions from the building, including cooking and use of appliances (currently unregulated). They are also defined relative to a building compliant with the 2006 Building Regulations. It has been assumed that a 70% saving in regulated emissions must be achieved on site through energy efficiency or use of renewable or low carbon technologies. The remaining emissions savings can also be made on site or achieved through allowable solutions (see Section 2.2).

Table 11 Building Regulations requirements and assumptions about future changes

Three potential planning targets have been tested, in comparison with the Building Regulations base case.

These are summarised in Table 12. We have assumed that the targets would remain in place until the zero carbon requirement is introduced in the Building Regulations for dwellings in 2016 and for other buildings from 2019.

New development
Option 1: Nottinghamshire targets
■ A **target percentage** of **all site CO_2 emissions** to be achieved through **renewable or low carbon energy**, in addition to Building Regulations current at the time. ■ For **homes**, the following targets would apply: – **Up to 2010: 20%** – **2010 – 2013: 23.5%** – **2013 – 2016: 27%** – **2016 onwards:** zero carbon, as per Building Regulations ■ For **non-domestic** buildings, the following targets would apply: – **Up to 2019: 10%** – **2019 onwards:** zero carbon, as per Building Regulations
Option 2: 10% savings beyond Building Regulations
10% of **regulated** site CO_2 emissions to be saved **by any means**, in addition to Building Regulations current at the time.
Option 3: 15% savings beyond Building Regulations
15% of **regulated** site CO_2 emissions to be saved **by any means**, in addition to Building Regulations current at the time.

Table 12: Target options tested for new development

Option 1 represents the targets proposed in the Towards a Sustainable Energy Policy for Nottinghamshire report (2009). The logic is that a requirement for 20% CO_2 savings from renewable or low carbon energy is the preferred policy for developments that are built now. As CO2 emission rates for new dwellings will decrease as stricter energy efficiency requirements are introduced by the Building Regulations in 2010 and 2013, the 23.5% and 27% targets have been proposed to ensure that the same amount of renewable or low carbon energy supply is installed on site to comply with the policy.

Of the targets tested, only the Nottinghamshire targets apply to regulated and unregulated emissions, making them significantly more stringent than the alternatives considered prior to 2016. The Nottinghamshire targets also require CO_2 savings to be made solely through the use of renewable or low carbon technologies, without the use of enhanced energy efficiency measures or the proposed allowable solutions.

Target options 2 and 3 have been tested to consider whether there is scope for developments to go beyond the Building Regulations requirements whilst being less onerous than option 1. They are defined as percentages over and above the Building Regulations targets and can be achieved through energy efficiency or renewable or low carbon technologies. This ensures ease of monitoring and enforcement, as the same documentation can be used to demonstrate compliance with these targets as with the Building Regulations, as a building control certificate includes the relevant figures.

The consultations on the energy efficiency standard for homes[31] and the definition of zero carbon for non-domestic buildings[32] were both published after the bulk of the work for this study had been completed and the initial draft of this report had been issued. The modelling and analysis in this report are therefore based on assumptions drawn from previous consultations and have not been updated to reflect the latest Government proposals. This is not likely to have a significant impact on the findings of the report and the policy recommendations should still be considered to be valid.

The potential has also been considered for major sites to achieve higher levels of carbon reduction, where justified by the evidence base.

8.3 Development Types

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 targets have been tested for several notional development types, which represent the range of development which is expected to come forward over the period of the Bassetlaw District Council Core Strategy. These are listed in Table 13.

[31] Sustainable New Homes – The Road to Zero Carbon Consultation on the Code for Sustainable Homes and the Energy Efficiency standard for Zero Carbon Homes (Department for Communities and Local Government, December 2009)

[32] Zero Carbon for New Non-domestic Buildings: Consultation on Policy Options (Department for Communities and Local Government, November 2009)

Development Type	Description
Small residential	10 dwellings[33]
Large residential	150 dwellings
Office	1,000m^2 standard office
Workshop	5,000m^2 small industrial unit
Storage facility	10,000m^2 warehouse, providing an equal mix of general storage and cold storage

Table 13 Development types modelled

8.4 Analysing the Impact of Targets

8.4.1 Existing Buildings

To understand the potential impact of the policy proposed for existing buildings, this study has taken into account the number of planning applications which may be made for alterations to existing dwellings and the extent of the works that they may be required to carry out to improve energy efficiency of the existing parts of the building.

[33] The dwelling mix for the residential developments has been based on the housing needs set out in the Northern HMA Strategic Housing Market Assessment (2007), which stated that the need is for one or two bedroom properties or larger detached family homes. The assumption has been made that all 1 bedroom properties are flats, all 4+ bedroom properties are detached houses and 2 bedroom properties are split between terraced houses and flats.

Energy Efficiency Improvement	% of Houses which may be Suitable	CO_2 Saving per House (tonnes)	Cost per House
Cavity wall insulation	9%	0.6	£500
New condensing boiler and heating controls	36%	1.3	£2,200
Draught-proofing	89%	0.1	£200
Insulation of hot water tank and pipes	99%	0.3	£22
Loft insulation (0-270mm)	5%	0.8	£350
Loft insulation (increase from 50mm-270mm)	13%	0.2	£300
Total (Maximum)		**3.3**	**£3,272**

Table 14 Efficiency measures, associated costs and CO2 savings (Source: Energy Savings Trust, HEED Database and AECOM analysis)

The key findings from the analysis of this policy are as follows:

- Around 400 dwellings could be affected each year, based on planning application numbers for the previous three years;
- At this rate, an additional 370 tonnes of CO_2 could be saved from existing dwellings for every year the policy is in place;
- The maximum average cost per dwelling would be £3,272, if all of the improvements on the list were required and this was less than 10% of the build cost of the planned alteration. No figures on average build cost of extensions and other alterations to dwellings in Bassetlaw were available at the time of this analysis;
- As the proportion of existing dwellings that have already been improved increases with time, the relative impact of this policy will decrease.

8.4.2 New Development

The impact of the targets being considered for new development has been tested by considering the energy strategies that may be proposed by the typical developments listed above to demonstrate compliance. The model developed for this study compares a range of technology options and selects the cheapest option which will comply with the target in question. The modelling approach is described in detail in Appendix C.

The impact of each target, 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.

Approximate cost of compliance has also been calculated as a percentage of the average construction costs for each type of development considered. Construction costs have been estimated using the RICS BCIS Online database of construction cost benchmarks, which was accessed in December 2009.

The results are summarised for each of the development types in Appendix F, comparing the potential outcomes in each of the opportunity areas and for each of the policy options proposed.

Headline Conclusions

- The main driver of improvement in energy efficiency and increasing contribution from renewable and low carbon energy technologies is the progressive tightening of the Building Regulations, up to and including the introduction of the zero carbon requirement for homes in 2016 and for other buildings in 2019. It is also likely to be a major factor in increasing construction costs faced by developers.

- Our analysis indicates that all of the development types considered could feasibly achieve additional CO_2 savings over and above the Building Regulations requirements, prior to the introduction of the zero carbon requirement.
- Based on the outcomes of our modelling, there is likely to be little difference in the energy strategies proposed for developments if additional targets were imposed through planning, in terms of the technologies proposed and the CO_2 savings these deliver. This is because the standard size renewable and low carbon energy systems that have been selected by the model as the cheapest option for achieving compliance with the Building Regulations have the capacity to offer CO_2 savings over and above the basic regulatory requirements, allowing them to achieve compliance with the higher targets being considered.
- Our analysis is based on standard assumptions about the CO_2 savings which different combinations of energy technologies and energy efficiency improvements could deliver for different types of building. We have assumed a typical size of technology, according to the size of dwelling or floor area in case of non-residential, which is not scaled up or down according to the target emissions savings that are intended to be achieved. The CO_2 savings and cost of each technology are therefore also fixed for each dwelling type. This means, for example, that a detached house would have the same size of solar hot water system with the same cost, whether the target is compliance with the 2010 Building Regulations or an additional 15% CO_2 saving on top of that. Because installation and tank costs would remain, a smaller system to comply with lower targets would still cost a similar amount. If the Building Regulations requirements can be assumed to be viable, and additional savings over and above this could be delivered with no or minimal increase in cost, then it could be argued that a planning target which requires these additional savings is also viable.
- Solar water heating may be a common choice for residential developments to comply with targets in the earlier years, however it may not offer sufficient CO_2 savings to comply with later versions of the Building Regulations. This may be a particular issue for large developments, where different phases are required to comply with different versions of the regulations, as later phases may require an alternative energy strategy. In addition, installation of solar water heating would take roof space which would not be available in future for retrofitting of PV, which offers greater potential for CO_2 savings and may become more affordable with time.
- Biomass heating was identified in our analysis as the cheapest option for commercial buildings to comply with the various policy options up to 2016, when we have assumed tighter interim standards will be introduced in the updated Building Regulations. The biomass supply chain may need to be developed further to cope with the potential increase in demand if a large proportion of new developments opt to install boilers on-site, although it is encouraging that there is already a local supplier in the district. In addition, major growth in the use of biomass fuel could have implications for air quality. Bassetlaw District Council should seek to ensure appropriate mitigation of emissions from new installations.
- Where available, connection to an existing district heating network could provide a cost effective option for compliance for all types of development. Although the commercial developments considered tend to have lower heat demand than dwellings, they could be cheaper to connect as the individual buildings could only require one main connection to the heat network, while each residential unit would require a separate connection. Establishment of district heating networks also has potential benefits for existing buildings in the vicinity, which may be able to connect. Installation of gas-fired CHP on-site has not been identified as a preferred choice for the typical developments we considered, as it offers lower CO_2 savings than other technologies at higher cost. Further work should be carried out to

assess the impact that connecting to existing communities would have on CO_2 savings and viability of energy systems delivered as part of new development. Chapter 10 considers some of the likely delivery implications.

- In suitable locations, wind turbines could offer the cheapest option for compliance. Large wind turbines are a particular opportunity for large commercial sites located away from residential areas, such as industrial estates or business parks, where multiple developments could share the installation costs. One or more large wind turbines could generate sufficient electricity to offset all of the emissions from such developments and would make a real contribution to achieving the district's renewable and low carbon energy targets. Small wind turbines could also make a significant contribution to emissions savings on more constrained types of development.
- Although our analysis suggests that there are technically feasible options for complying with the various targets considered, they will lead to an increase in the cost of construction, which could affect viability. Cost increases will be particularly significant in later years when the Building Regulations requirements are strengthened. It is recommended that the Affordable Housing Viability Assessment (2009) is revisited in future to consider the impact of the compliance costs presented here on development viability. It could also be worth considering whether the variation in property value across the district justifies different energy and climate change targets depending on location, or whether affordable housing targets could be adjusted to offset the cost of compliance where viability is a concern.
- The costs presented in this report are based on general benchmarks and are likely to differ on a case by case as developments come forward, for example due to variation in local installation costs and changes in the price of technologies. The figures and associated conclusions in this report should therefore be considered in light of other data provided by developers on a case by case basis at time of application.
- The compliance costs tend to be lower as a proportion of overall construction costs for the commercial developments considered. As there is no viability assessment for these types of building, as there is for housing, viability will need to be addressed on a case by case basis at the planning application stage.
- Of the policy options considered, the Nottinghamshire policy framework targets are the most stringent. As the Nottinghamshire targets apply to all site CO_2 emissions, including unregulated emissions, and these targets are required to be achieved using renewable or low carbon technologies only, compliance will be more difficult to assess. This is because a Building Regulations compliance certificate would not include all of the figures necessary to demonstrate that the Nottinghamshire targets had been achieved and additional documentation would be needed. Without a good understanding of energy strategies, planners may be less likely to insist on or enforce compliance with the targets, leading to lower installed capacity than would result from the lower but simpler targets presented in options 2 and 3.
- It should be noted that using planning policy to set targets for additional CO_2 savings from new developments is only likely to have a short term impact, as the targets would effectively be superseded by the Building Regulations zero carbon requirement from 2016 and 2019.
- Whether or not on-site energy and climate change targets are set through planning policy, the planning system has an important role to play in identifying and delivering community and large scale energy opportunities which go beyond site boundaries. It may be necessary to develop planning policy which requires an appropriate financial or physical contribution from developers towards this. If Bassetlaw District Council takes a leading role now, it could reduce the burden on developers when the zero carbon requirement is introduced because coordination of community and large-scale renewable and low carbon energy opportunities would enable them to access a broader range of allowable solutions for Building

Regulations compliance. A coordinated, strategic approach to community and large scale energy infrastructure could also benefit the district by attracting local investment including potentially expenditure of allowable solutions funds.

Residential Development

The key findings from the analysis of the policies for new residential development are:

- For residential developments, there are feasible options for complying with all targets on energy constrained sites, with the exception of the Nottinghamshire target proposed for the period from 2013 – 2016.
- The technologies that might be proposed are similar for both small and large residential development on energy constrained sites.
- On energy constrained sites, solar water heating was selected by our model as the cheapest option for complying with the Building Regulations from 2010 onwards, with a standard size system providing sufficient contribution from renewable energy to achieve over 15% CO_2 savings beyond the Building Regulations. This would cost on average £4,320 per dwelling, or around 8% of construction costs.
- A combination of advanced energy efficiency and PV would enable residential developments to comply with the Building Regulations from 2013, providing over 10% savings beyond the Building Regulations for a standard size system. This combination of technologies could be required from 2010 to comply with the Nottinghamshire policy, costing around 30% more than solar water heating. The cost of this option represents an increase of around 12% in the typical construction costs for residential development.
- The main difference between the large and small residential site is that the larger site is theoretically of a sufficient size to justify an on-site gas-fired CHP system with district heating, even if there is no established district heating network to connect to outside of the site boundary. However, this offers a lower CO_2 saving than might be achieved with other options, at more than double the cost.
- Our modelling indicates that where residential developments are able to connect to an existing district heating network, supplying waste heat from another source such as a large power station, this could reduce CO_2 emissions from residential development by around 44%. This would be more expensive than solar water heating for a similar CO_2 saving, resulting in an estimated 11% increase in construction costs. Costs of a heat network vary with the density of development; it is more cost effective for flats and terraced houses than for detached properties.
- For small residential developments, a small wind turbine has the potential to deliver higher CO_2 savings than all other technological options selected, for a lower cost, although this option will only be feasible in limited locations due to the spatial requirements. Installing one small turbine for a site with 10 new dwellings would cost around £1,900 per dwelling, equating to around 3% of typical construction costs.
- Large residential developments in suitable locations may find that investment in a large wind turbine is a cheaper option for achieving the zero carbon requirement post 2016. However, due to the requirement for an 800m distance between these turbines and the nearest residential property, few if any residential developments may be able to install one on-site and opportunities to install a turbine on adjacent land may also be limited. Chapter 10 explores options for community ownership. In such circumstances it may be possible to relax some of the spatial criteria.
- The cost of complying with the Building Regulations requirements from 2016 onwards may be significantly greater than the cost of complying with any of the planning targets considered in the preceding years.
- The Bassetlaw Affordable Housing Viability Assessment (2009), prepared by Three Dragons, considered the viability of a range of development sizes and densities, in different areas of the

district, in order to inform affordable housing targets. The assessment was based on current benchmark construction costs for new housing and did not include any allowance for additional costs associated with energy and climate change targets beyond the minimum Building Regulations requirements, such as an allowance for installing renewable energy systems on-site.

- The Affordable Housing Viability Assessment allowed for £5,000 per dwelling for all Section 106 contributions other than affordable housing. This is at the bottom end of the range of typical values observed by the authors of the assessment, which range from "£5,000 per dwelling to Milton Keynes tariff levels of £18,000 plus free land". Section 106 contributions would need to cover a range of potential costs including contributions to improving local transport infrastructure, education provision, public realm and other community facilities, in addition to anything that might be required on energy and climate change. Even with this low level of Section 106 costs, the Affordable Housing Viability Assessment recommended targets for affordable housing that fell short of the Strategic Housing Market Assessment recommendation due to questions over the impact on development viability.
- The assessment found that house prices varied across the district, with the highest values in the northern rural area and the lowest in Worksop and Carlton. On this basis, more stringent energy and climate change targets could be viable in the higher value areas of the district and concessions on targets may be justified for the lowest value areas. However, a significant proportion of proposed development is planned to take place in these urban, lower value areas, so the cumulative impact of relaxing standards in these locations could be large. An alternative option would be to reduce the affordable housing target in these areas to offset the cost of complying with energy and climate change targets.
- Although it may be technically feasible for housing developments to achieve emissions savings over and above the Building Regulations requirements prior to 2016, the cost of this has not been taken into account in the Affordable Housing Viability Study. There could therefore be implications for viability in some cases, depending on when and where the development comes forward. This should be taken into account on a case by case basis, as developments come forward for planning.
- It is recommended that the figures in the Affordable Housing Viability Assessment are revisited in future updates to take into account potential future costs of compliance with Building Regulations and planning policy, particularly from 2016 onwards. This should consider an appropriate balance between affordable housing provision and energy and climate change targets for different parts of the district.
- Viability will depend on a range of factors which are beyond the scope of this study. These include land and market values of properties at the time of the planning application and the method of financing the renewable and low carbon energy technologies. Financing mechanisms are discussed further in chapter 10 and appendix E.

Non-Residential Development

- For all the non-residential development types considered in this analysis, there are feasible technology options for complying with all of the policies considered for the period from 2010-2016. If higher energy efficiency standards are introduced for non-residential buildings with the 2016 update of the Building Regulations, achieving an additional saving from renewable or low carbon technologies on top of this may not be feasible.
- No technology options have been identified which would allow non-residential developments on a constrained site to achieve the zero carbon requirement under the Building Regulations from 2019 onwards, based on the current definition of zero carbon for dwellings. However, it should be noted that since this analysis was undertaken, the Government has published a consultation on the definition of zero carbon for non-domestic buildings, which sets out variable targets for

different types of building, takes into account their relative ability to reduce CO_2 emissions and should ensure that all buildings are able to comply with the regulations as a minimum.[34]

- The technologies that might be proposed on energy constrained sites are similar for all types of non-residential development considered in this analysis. Because the scale of development and the relative heat and electricity demand differs for an office compared to a workshop or storage facility, the percentage CO_2 savings that these technologies could deliver varies.
- Biomass heating is the preferred option for complying with all policies in the period from 2010-2016, as the capital cost is relatively low and it is able to deliver high CO_2 savings. This would cost in the region of £50/m^2 to install for the non-residential developments, although there are fuel costs to consider in addition. This equates to an increase of around 4% in construction costs for a typical office development, and around 9% for a workshop or storage facility.
- A combination of advanced energy efficiency and PV could achieve a higher CO_2 reduction, potentially sufficient to comply with tighter standards if they are introduced for non-residential developments in later years. PV would be significantly more expensive than a biomass boiler. A PV system and advanced energy efficiency could cost in the region of 7% of construction costs for a typical office development. For workshops and storage facilities, which are cheaper to construction, it could add around 40% to construction costs.
- Connection to district heating, where an established network is available, would offer similar CO_2 savings at potentially lower capital cost than biomass heating on-site. For the office development we have assessed this would add around 3% to construction costs, and around 7% for the workshop and storage facility.
- For smaller commercial developments, small wind turbines have the potential to deliver higher CO_2 savings than all other technological options selected, although they will only be feasible in limited locations due to the spatial requirements. A small wind turbine in an appropriate location could save around 42% of the CO_2 emissions from the office development we have modelled, at around 1.5% of construction costs. A larger development like the storage facility may justify investment in a 2MW wind turbine, particularly to ensure compliance with the requirements in later years when the cost of providing sufficient PV is greater than the cost of a large turbine. This would result in CO_2 savings well in excess of the likely emissions from a development of this size and make a real contribution to renewable energy installed capacity. This option may also be available to large clusters of commercial development, such as industrial estates or business parks, where the cost of a wind turbine could be shared between a number of buildings.

For commercial developments there is no viability assessment to compare the costs of the different compliance options with. It may therefore be necessary to assess viability on a case by case basis, as applications come forward. On the basis of this analysis, commercial buildings which are able to connect to a district heating network or large developments which are able to accommodate wind turbines may be able to achieve higher CO_2 reductions at lower cost than other developments. It could therefore be possible to set higher targets for developments which do have access to these opportunities

[34] Zero Carbon for New Non-domestic Buildings: Consultation on Policy Options (Department for Communities and Local Government, November 2009)

9 Policy Recommendations

9 Policy Recommendations

A suite of planning policies is recommended to assist in delivering the energy opportunities identified in this study. The policies have been developed based on the outcomes of the policy testing and in terms of feasibility and impact on development cost.

There is a compelling evidence base for Bassetlaw District Council to take action to address climate change and increase decentralised renewable and low carbon energy supply in the district. In identifying and appraising planning policy options for Bassetlaw, we have started from the basis that this 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. This 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. See chapter 10 for an overview of the other delivery mechanisms which may be employed in Bassetlaw.

Planning is unique in that it is 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. The Energy Opportunities Map described in chapter 6 is the result of this process.

Planning policy should support delivery of these energy opportunities. There are several options for the type of policy which could be used to achieve this objective. Using the Energy Opportunities Map and the evidence reviewed in this study as the starting point, a series of potential policies are proposed for further consideration by Bassetlaw District Council. It is important that policies are incorporated in the appropriate parts of the LDF to ensure they have sufficient weight to support their implementation. We have indicated where we think policy is suitable for incorporation in the Core Strategy or other local development documents, such as supplementary planning documents (SPD). The suggested policy wordings will be subject to review and revision as part of the LDF process.

Targets have been assessed for their impact on both new and existing development (chapter 8). 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 opportunity areas have been identified to reflect this local variation, as described in chapter 8.

The policy recommendations and targets are based on the assumption that the trajectory to zero carbon continues as described in section 2.2 and that as-built development matches design. Changes to national policy and regulation could alter the relative impact of the policies described here; in this event, policy recommendations should be reviewed.

Policy Recommendation 1: Delivering Energy Opportunities in the District (Core Strategy)

Reducing CO_2 emissions and increasing the supply of decentralised renewable and low carbon energy is a priority for Bassetlaw Council. Planning applications for new development will need to contribute to delivery of the opportunities identified in the current Energy Opportunities Map. Applications for all types of decentralised renewable and low carbon energy will be considered favourably by the Council.

The Council recognises that different energy technologies and CO_2 reduction strategies will suit different parts of the district and different types of development. To reflect this we have designated three Energy Opportunity Areas, with variation in the policy applicable to each:

- Energy constrained
- District heating opportunity areas
- Wind opportunity areas

Policy Justification

The Energy Opportunities Map acts as the key spatial plan for energy projects in Bassetlaw. It underpins the policies and targets described here and sets out where money raised through mechanisms such as the CIL could be spent or priorities for the proposed allowable solutions. It should be used to inform policy making in the Sustainable Community Strategy and other corporate strategies, and investment decisions taken by the local authority and local strategic partnership (see chapter 10 for further detail on delivery mechanisms). It should be incorporated into the Core Strategy and corporate strategies and should be readily updated to reflect new opportunities and changes in feasibility and viability.

Principal energy opportunities in Bassetlaw include commercial and community scale wind; district heating powered by waste heat from power stations and other sources, or possibly from community scale CHP if development is led by the District Council; biomass boilers and other microgeneration technologies. Bassetlaw Council is keen to maximise the installation of all of these technologies where they are appropriate. However, the policy does not seek to rule out any other technology if it will deliver reductions in CO_2 or will increase the supply of decentralised renewable and low carbon energy.

The Energy Opportunity Areas approach is designed to help applicants determine which types of technology are likely to be most suited to a given area. It also seeks to encourage energy installations that will contribute to Bassetlaw Council's objective of delivering all opportunities identified in the current Energy Opportunities Map in the most effective way. The Council understands, 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 Council's intention to restrict this kind of innovation and we are prepared to discuss proposals that deviate from the Energy Opportunities Map and Energy Opportunity Areas with applicants at the pre-application stage.

Policy Recommendation 2: Improvements to Existing Homes (Core Strategy or SPD)

The Council recognises the importance of improving the energy performance of Bassetlaw's existing building stock. Therefore, installation of energy efficiency measures and renewable and low carbon technologies is encouraged.

Planning applications for changes to existing dwellings will be required to undertake reasonable improvements to the energy performance of the entire dwelling. This will be in addition to the requirements of Part L of the Building Regulations applicable to the changes for which planning permission is sought. Improvements will include, but not be restricted to loft and cavity wall insulation, draught-proofing, improved heating controls and replacement boilers.

Applicants will be asked to complete a checklist to identify which measures are appropriate to their home. The total cost should be no more than 10% of the total build cost.

Policy Justification

The purpose of the policy is to reduce CO_2 emissions from existing buildings. However, opportunities within planning are limited and much of the focus will need to be on a wider local authority and stakeholder initiatives (discussed further in chapter 10). Since consequential improvements for non-domestic buildings are required for the Building Regulations this policy focuses solely on housing.

The policy applies to all householder applications for planning permission to extend or materially alter a home, in any Energy Opportunity Area. The approach aims to make the most of any straightforward opportunities for improvement that exist. These include loft and cavity wall insulation, draught-proofing, improved heating controls and replacement boilers.

The checklist approach should be simple to implement. All of the measures on the list should pay for themselves in energy cost savings in less than seven years, based on estimates of costs and savings for the average home provided by the Energy Saving Trust. If any of the measures on the list are suitable for the home in question, and their combined cost does not exceed 10% of the cost of the building works, they are required. If no measures are suitable, none are required.

Uttlesford District Council included “consequential improvements” as part of an SPD over three years ago and has been successful in implementing it through planning conditions, reporting that it has been well received by householders. According to the Council, around 1,400 extensions have been affected by the policy so far, and the total projected savings from measures required as a result are £72,600 and 398,000kg of CO_2 per year.[35]

Policy Recommendation 3: Additional Energy and CO_2 Potential of New Developments (Core Strategy) (Option A)

Several options are presented for the following policy. Option A represents the basic policy considered; additions to this are highlighted in bold text and elements which have been removed are crossed out in the subsequent policy options.

All new buildings in Bassetlaw will be expected to achieve a target CO_2 emission saving over and above the requirements of the version of the Building Regulations current at the time. The target will vary by Energy Opportunity Area. Specific requirements will also be applied to new buildings to support delivery of the local energy opportunities. Details of the specific requirements are provided in [insert link to relevant policy or guidance document].

The following reductions in Dwelling or Building Emission Rate will be required, compared to the Target Emission Rate defined by the Building Regulations:

- Energy constrained - 10%
- District heating - 10%
- Wind - 15%

These requirements will apply to a development unless the applicant can demonstrate that compliance with the target or the specific requirements on a particular site is either not feasible or not viable.

Policy Recommendation 3: Additional Energy and CO_2 Potential of New Developments (Core Strategy) (Option B)

All new buildings in Bassetlaw will be expected to achieve a target CO_2 emission saving over and above the requirements of the version of the Building Regulations current at the time. The target will vary by Energy Opportunity Area. Specific requirements will also be applied to new buildings to support delivery of the local energy opportunities. Details of the specific requirements are provided in [insert link to relevant policy or guidance document].

The following reductions in Dwelling or Building Emission Rate will be required, compared to the Target Emission Rate defined by the Building Regulations:

- Energy constrained - 10%
- District heating - 10%
- Wind - 15%

If an applicant can demonstrate that compliance with the target or the specific requirements is either not feasible or not viable, a payment into the Carbon Fund will be required.

Policy Recommendation 3: Additional Energy and CO_2 Potential of New Developments (Core Strategy) (Option C)

~~All~~ new buildings in Bassetlaw will be expected to achieve a target CO_2 emission saving over and above the requirements of the version of the Building Regulations current at the time. The target will vary by Energy Opportunity Area. Specific requirements will also be applied to new buildings to support delivery of the local energy opportunities. Details of the specific requirements are provided in [insert link to relevant policy or guidance document].

[35] Source: Uttlesford District Council, News: Uttlesford Urges Government to Rethink Energy Efficiency [WWW], from www.uttlesford.gov.uk/main.cfm?Type=n&MenuId=0&Object=3105

The following reductions in Dwelling or Building Emission Rate will be required, compared to the Target Emission Rate defined by the Building Regulations:

- Energy constrained - 10%
- District heating - 10%
- Wind - 15%

All new buildings in Bassetlaw will be required to make a payment into the Carbon Fund, to support delivery of the opportunities identified in the Energy Opportunities Map.

Policy justification

Changes to the Building Regulations in 2010, 2013 and 2016 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. Several options are available for a combination of targets and/or payments into the Carbon Fund, represented by the policy options above.

The targets proposed here seek to accelerate the move towards zero carbon ahead of Building Regulations. All new buildings, both residential and non-residential, would be expected to achieve an additional percentage reduction on the residual CO_2 emissions after Building Regulations compliance. This should be met through a combination of energy efficiency measures, incorporation of energy efficiency, on-site renewable and low carbon energy technologies and directly connected heat or power (not necessarily on-site).

The proposed policy provides flexibility in proposing low carbon and renewable solutions. The policy recognises that different opportunity 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 opportunity areas.

The proposed policy should be simple to operate for both development managers and developers. Development Control offices can assess compliance with the targets by asking for design stage and as-built Building Control Compliance documentation. This should be more straightforward than assessing compliance with the targets set out in the Nottinghamshire policy framework, which would require information to be provided in addition to that required for Building Regulations compliance.

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 Fund, with contributions derived from a levy that would apply to every building constructed within Bassetlaw at a flat rate. Ideally, the amount to be paid would be linked to the CO_2 emitted per square metre over the building lifetime of 30 years, to encourage CO_2 emissions to be reduced as far as possible on-site. However, if the fund were introduced as part of the proposed Community Infrastructure Levy to fund energy infrastructure identified in the Energy Opportunities Map, the levy would need to be charged at a flat rate per m^2 of the development and not linked to emissions.

Uncertainties remain around the relationship between the Community Infrastructure Levy and the proposed allowable solutions that will form part of the Building Regulations. Both of these could potentially be used to operate a Carbon Fund and the mechanics will need to be explored further once we have clarity on the Government's proposals.

Diverting payments into a Carbon Fund could provide the district with funds for investment in renewable and low carbon energy projects identified in the Energy Opportunities Map. The fund should allow Bassetlaw District Council to strategically coordinate and phase the infrastructure required to deliver community scale energy generation installations such as district heating networks. The Carbon Fund and a possible mechanism for coordinating spending is described further in chapter 10.

Recommendation 4: District Heating Opportunity Areas (policy or guidance)

This policy could be included as part of the Core Strategy, however, it could also sit within a suitable development plan document, including the site allocations DPD or the Harworth or Worksop Area Action Plans. Elements of it might also be suited to an SPD.

The Council is keen to take advantage of opportunities to install district heating across the district. 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 requirements of Policy 3. The Council recognises 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, power stations, or coalmine methane facilities.
- Small developments (less than 100 dwellings or non-residential developments less than 10,000m^2) should connect 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.
- Large and mixed-use developments (over 100 dwellings) should consider installing a district heating network to serve the site. The council's ambition is 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.

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

OR

If an applicant can demonstrate that compliance with the target or the specific requirements is either not feasible or not viable, a payment into the Carbon Fund will be required.

Policy justification

The PPS1 Supplement actively encourages opportunities to be sought 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 and to take advantage of the availability in some parts of the district of waste heat from power stations, coalmine methane facilities and waste management sites.

The long-term ambition is to deliver a strategic district heating network across the district heating opportunity areas. Developments within district heating opportunity areas will need to show in a design and access statement or other supporting document 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. The council recognises 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. This has the benefit of reducing CO_2 emissions in new development or 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 designated for the district heating opportunity areas.

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

- New development:
  - Residential development of at least 55 dwellings per hectare and at least 100 dwellings
  - Large scale mixed use development – enables good anchor load
  - Proximity to high heat density areas of existing buildings – enables extension into existing development
  - Proximity to existing heat sources (e.g. High Marnham proposed power station)
- Existing development:
  - Heat demand density of at least 3,000kW/km^2 and residential density of at least 55 dwellings per hectare or presence of a public sector building to provide a good anchor load
  - 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.

Recommendation for Policy 5: Wind Opportunity Areas (policy or guidance)

This policy could be included as part of the Core Strategy, however, it could also sit within a suitable development plan document, including the site allocations DPD or the Harworth or Worksop Area Action Plans. Elements of it might also be suited to an SPD.

The Council recognises the important role that wind power will play in reducing CO_2 emissions and increasing installed renewable and low carbon energy capacity. While the Council will consider favourably all applications for wind turbines, the Energy Opportunities Map identifies two principal opportunities:

- Large wind turbines delivered by commercial developers
- New development in Wind Opportunity Areas. These should consider wind as their first option for meeting the requirements of Policy 3. Wind Opportunity Areas have been designated to encourage applications for large and small 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.

OR

If an applicant can demonstrate that compliance with the target or the specific requirements is either not feasible or not viable, a payment into the Carbon Fund will be required.

Policy justification

The planning policy approach represents the application of national policy to the specific Bassetlaw 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 and 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 evident therefore at every available opportunity for wind power needs to be taken advantage of.

Despite there being good wind speeds across all parts of the district it is recognised that commercial opportunities for turbines are likely to be limited. The Energy Opportunities Map identifies what these constraints are. However, opportunities for individual large turbines or smaller turbines exist across the district and the council is keen to take advantage of these and has designated Wind Opportunity Areas 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.

10 Delivering Renewables and Low Carbon Energy in Bassetlaw

10 Delivering Renewable and Low Carbon Energy in Bassetlaw

The Council will need to take a leading role in delivering the decentralised renewable and low carbon infrastructure shown on the Energy Opportunities Map. This role will need to go beyond planning.

Along with planning policy, targets provide a useful mechanism for articulating to stakeholders the extent of the challenge around low carbon and renewable energy. 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
- A clear action plan

This chapter describes some of the mechanisms available to Bassetlaw to deliver the principal opportunities for decentralised renewable and low carbon energy opportunities identified on the Energy Opportunities Map. It is not intended to be an exhaustive list, nor does it reach definitive conclusions about which mechanisms are most suited to Bassetlaw. 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 Bassetlaw will require a more detailed study involving discussions across the Council and with partners.

Potentially the most immediate opportunity is the Low Carbon Building Strategic Design Advice service offered by the Carbon Trust. Up to £50,000 of matched funding can be obtained for scoping works for CO_2 reductions and could, initially be used to prioritise next steps and to develop an action plan. Although there is no defined product, money is available to large multi-site organisations, including but not limited to local authorities, which could enable the Council to act on the recommendations set out in this section and to roll out area based programmes. AECOM is an accredited consultant and able to explore this process further with you.

The chapter is structured in the same way as the chapter on planning policy (chapter 9). It considers delivery mechanisms across the three character areas, new and existing development and for different scales of development.

10.1 Opportunity Area 1: Energy Constrained

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 (Appendix E)

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, 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 E.

Most funding for improving the energy performance of the existing stock, including Community Energy Saving Programme and the Carbon Emissions Reduction Target, are coordinated through utility companies. The government's recent consultation on its forthcoming heat and energy saving strategy (the final strategy is due shortly and likely to be called the Household Energy Management Strategy) suggests that a more co-ordinated approach to the street or neighbourhood level will be necessary to deliver the level of 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 authority 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 Bassetlaw to stimulate the uptake of energy efficiency measures and microgeneration technologies are described below. The initiative could be financed using a combination of SALIX and CESP and could be co-ordinated through the Council, possibly in partnership with the private sector and energy companies for finance and with installation companies for delivery:

- *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* – appropriate technologies could be leased to householders and businesses. Rental costs could be charged as a proportion of the generation income received by the beneficiary. After a period of time, ownership of the kit would transfer to the householder or business.

Householder or business rental – a third model could be for the Council, or its delivery vehicle of choice, to retain ownership of the technologies and to rent roof or other suitable space. Again, rental costs would be set as a proportion of generation income. 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	**Potential Partners**	**Delivery option**
Increased energy efficiency Increased microgeneration	• Local authority • Energy companies • Community groups • Private installation companies	• 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 • Community Sustainable Energy Programme • Warm Front • Carbon Emissions Reduction Target • Big Lottery Fund • Energy Saving Trust • Low Carbon Communities Challenge • Low Carbon Buildings Programme

Table 15 Delivery options for existing development. Details of schemes mentioned above are provided in Appendix E

10.2 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 Bassetlaw Council is therefore limited beyond specifying more stringent planning policies to achieve this (chapter 9).

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.

A third opportunity is to prioritise delivery of energy opportunities through spending of money raised through a Community Infrastructure Levy (CIL) or the proposed allowable solutions. Contributions collected through CIL from development in one part of the charging authority can be spent anywhere in that authority area. This flexibility will enable the Council, as the 'charging' authority, to fund energy infrastructure identified in the energy opportunities map.

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. Therefore, a local authority led delivery vehicle, partnership or joint venture could be established to manage and co-ordinate delivery of energy infrastructure to support new development and to help enable developers meet the requirements of planning and Building Regulations, including future allowable solutions. Should CIL not come into force it may be possible to set up a local tariff, similar to that in Milton Keynes.

The proposed allowable solutions, linked to Building Regulations and higher levels of the Code for Sustainable Homes, are likely to play an important delivery role. A final list of allowable solutions is expected from Government shortly, but early indications are that developers will have two broad routes:

- Increased on-site energy efficiency or generation either within the site boundary or through connection of heat technologies directly to the site. Generally, district heating and wind energy will provide excellent and cost effective allowable solution opportunities, but often the integration of these technologies cannot be delivered solely within the boundary of the site since there may be restricted space or heat networks may be more viable when connecting into heat loads off site.
- Alternatively, developers can achieve the remaining CO_2 reductions through off-site reductions. For example, by contribution to the installation or expansion of district heating networks or wind energy elsewhere in the local area.
- The latter is of most interest to Bassetlaw since it has some control, through planning and the delivery mechanisms identified above, over the nature and location of off-site allowable solutions. The energy opportunities map can be used to identify possible locations. Further work is needed to develop a Carbon Fund based on CIL, Section 106 or allowable solutions.

10.3 Opportunity Area 2: District Heating

10.3.1 Existing development

Proposed delivery mechanisms for existing development in this opportunity area will be the same as opportunity area 1.

10.3.2 New development

Many of the opportunities for delivering district heating do not need to be directly associated with new non-energy related development, although the two are not mutually exclusive. Large area wide district heat and power schemes 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. It should be noted that post 2016, the proposed ‘allowable solutions’ will place emphasis on local authorities to identify and support delivery of community scale solutions.

Some of the options for delivering the energy opportunities plan are described in the following sections and listed in Table 16, with more detail provided in Appendix E. 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 Map.

Delivery options for CO_2 reductions in new development

CO_2 reduction measures	Potential Partners	Delivery option
Lower CO_2 emissions standards Higher sustainability standards	• Local authority • Energy companies • Community groups • Private installation companies • Homes and Communities Agency	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 16: Delivery options for new development.

A district heating network of the scale identified in the energy opportunities plan would not be deliverable through individual developments or planning applications. A strategic approach will be necessary to successfully manage and co-ordinate delivery. The local authority would be ideally placed to plan, deliver and operate part or all of a district heating network through establishment of a special purpose vehicle (for example an energy service company, ESCo), partnership arrangement or joint-venture.

- *Financing* – the different elements of a network can be treated differently. The operating costs of the insulated pipes that move heat between the energy centre and customers are relatively low. The main cost is installing the pipeline at the start. The pipe work, therefore, could be competitively tendered by a local authority-led vehicle partnership and, since the Council may have access to low interest rates and repayments over a long time period using prudential borrowing, repayments can be kept to a minimum.

Repayments could be serviced by energy sales and income from the renewable heat incentive and for a CHP system generating both heat and electricity, from ROCs and/or the proposed feed-in-tariff. It needs to be recognised however the ability of the public sector to raise finances is likely to be severely hampered for the foreseeable future by the current economic crisis. Alternative sources of funding may need to be considered, including: bond financing; local asset-backed vehicles; and accelerated development zones or tax increment financing.

Energy centres tend to have lower upfront costs. The expense comes with ongoing operation and maintenance, a shorter life span (around 15 years) and exposure to fluctuations in energy prices. While ownership of the sites and buildings may be retained by the local authority, the plant itself could be operated by a private sector ESCo. To simplify things further for the Council, the billing and customer service elements could be contracted out to a third party.

Delivery of networks as part of new development could also be undertaken by a local authority-led delivery vehicle or partnership, leaving the secondary network to be installed by the developer. The developer could then be charged a connection fee to the primary network. This option would necessitate redrafting the proposed planning policy.

The PPS1 Supplement presents opportunities at the local level in the form of an LDO, which can be applied by local authorities to extend permitted development rights across whole local authority areas or to grant permission for certain types of development. Although there is little experience of local planning authorities having used LDOs, the PPS suggests that the government is keen on them being used stating that: "*planning authorities should give positive consideration to the use of Local Developments Orders to secure renewable and low-carbon energy supply systems*". Should the Council agree to lead installation of a district heating network then it is recommended that they explore the option of establishing an LDO in order to add certainty to the development process and potentially speed up delivery.

- *Phasing* –the energy opportunities plan gives an indication of potential anchor loads around which to start a district heating system. Installing a district heating network is a major capital investment. The cost depends on the number of buildings to be connected, how close together they are and how much heat they require. District heating infrastructure also requires long-term investment to maintain the network over a period of at least 25 years.

In order to minimise risk, a general strategy for developing a scheme would be to secure the connection of a large anchor load within close proximity to the generating plant. Suitable anchor loads are often public sector owned facilities such as swimming pools and leisure centres, therefore much of the co-ordination will fall upon the Council. Further work on prioritising schemes for more detailed feasibility work should be identified, potentially using Strategic Design Advice support.

Establishing a biomass supply chain

This study has identified biomass as a resource for delivering CO_2 reductions in the district. Similar studies for nearby areas 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.

Greater use of biomass as fuel raises some concerns which need addressing. Biomass is generally transported by lorry, and therefore transport CO_2 emissions should be taken into account. There is conflicting evidence as to the environmental impact of transporting biomass. 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 district, and an established supply chain for wood chip and wood pellets produced from locally grown energy crops, transport-related emissions may not be a concern in Bassetlaw.

The Council should work with Strawsons Energy and other regional and sub-regional partners to ensure that supply chains develop that are appropriate to the energy opportunities.

10.4 Opportunity Area 3: Wind Opportunity Areas

10.4.1 Existing development

Proposed delivery mechanisms for existing development in this opportunity area will be the same as opportunity area 1.

10.4.2 New development

As with waste heat and district heating there are stand-alone wind opportunities as well as opportunities that relate to proposed development. The local capacity for large scale wind turbines is unlikely to be significant, with many opportunities likely to be too small to attract commercial developers. In such instances, the Council could take forward the opportunities, perhaps in partnership with the community. Project finances could be raised by the issuing of bonds to residents and businesses. Returns on investments could be based on energy sales, ROCs and feed-in-tariffs. Further community incentives could include discounts on council tax.

A co-operative venture, possibly with the involvement of the local authority is another option that should be explored. Merchant wind is a wind-specific mechanism that the Council could use for delivering large scale wind energy. Alternatively, to ensure that sufficient expertise and resource is devoted to making local authority-led delivery initiative a success, Bassetlaw could explore establishing a local authority-led delivery vehicle partnership.

<table>
<tr><th colspan="3">Delivery options for community energy solutions</th></tr>
<tr><th>CO_2 reduction measure</th><th>Potential Partners</th><th>Delivery Option</th></tr>
<tr><td>Wind energy</td><td rowspan="3">• Local authority
• Carbon Trust
• Regional and sub-regional bodies
• Energy companies
• Homes and Communities Agency
• Partnerships for Renewables
• NHS
• Developers
• Community groups</td><td rowspan="3">• Community Infrastructure Levy or local carbon buyout fund
• ‘Allowable solutions’ or off-site opportunities
• Local authority led delivery company, partnerships and joint ventures
• Merchant wind
• Development and coordination of biomass supply chains
• ROCs and feed-in-tariff (April 2010) and possibly renewable heat incentive in 2011
• District heating priority areas
• Wind priority areas
• Cooperatives and community involvement
• EDF Renewable Energy Fund
• Carbon Emissions Reduction Target
• Building Schools for the Future</td></tr>
<tr><td>District Heating with CHP</td></tr>
<tr><td>Biomass energy</td></tr>
</table>

Table 17 Delivery options for community-wide CO2 reduction solutions. Details of the schemes mentioned above are provided in Appendix E

10.5 Delivery Partners

It is clear that a planned approach is necessary, with
It is clear that a planned approach is necessary, with
targets complemented by spatial and infrastructure planning. The implications of this for the Council 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.

The two central documents for coordinating delivery of low carbon and renewable energy projects at the local level are the Bassetlaw Sustainable Community Strategy, "Moving Forward", and Local Development Frameworks (LDF) prepared by the planners. Moving Forward makes insufficient mention of energy and climate change and no firm commitments or targets. Both 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, Bassetlaw Council 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.

Dialogue between AECOM and the Council has indicated that there is enthusiasm for exploring options for setting up a local authority delivery vehicle or partnership. The skills needed to do this are likely to need to be developed. 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 put in place 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 18 Advantages and disadvantages of ESCo models

10.6 Recommendations and Next Steps

There are a wide range of delivery mechanisms that can be employed to support planning for energy. Not all will be suitable for Bassetlaw and a mix is likely to 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 Council explores further the potential for using Carbon Trust Low Carbon Building Strategic Design Advice money to undertake the following next steps:

Leadership and skills

- The Council must take strategic leadership role with the LSP to ensure the necessary political and stakeholder buy-in.
- It must develop skills across the Council and its partners.

Priority actions and projects

- The Council needs to set out a clear framework which gives relative certainty. Action should be prioritised on strategic sites, council and public sector property and assets.
- The Council should work with eligible partners to develop a micro-generation retrofit strategy based on the opportunities presented by the LCBP.
- A set of priority district heating schemes should be drawn up by the Council and its partners and further feasibility work carried out. This should be based on factors such as financing options, planning, phasing and type of development. Options include a heat network in Retford from the EON power station serving new and existing development. This could be done in partnership with EON who will have to consider CHP as part of their Section 36 licence application.
- Should the Council agree to lead installation of a district heating network then it is recommended that they explore the option of establishing an LDO in order to add certainty to the development process and potentially speed up delivery.
- For all potential wind sites the Council and its partners should identify delivery opportunities, considering available financial mechanisms, publically owned land, community involvement and ownership and the role of schools.
- The Council should work with Strawsons Energy and other regional and sub-regional partners to ensure that biomass supply chains develop that are appropriate to the energy opportunities.
- The Council and its 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 Council and its 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 Bassetlaw 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.
  - Both the CIL and allowable solutions could potentially be used to operate a Carbon Fund

and the mechanics will need to be explored further once we have clarity on the Government's proposals.

- 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 Bassetlaw.

Appendices

Appendix A: Detailed Policy Context

At the international level, governments are negotiating a new international framework for reducing greenhouse gas emissions, to follow the first commitment period of the Kyoto Protocol which ends in 2012. This is due to be agreed in Copenhagen in December 2009. It is expected to commit the UK to further binding targets for greenhouse gas emissions reductions, as well as measures to promote development and financial investment in low carbon technologies.

There is already a range of policies, strategies and legislation in the UK intended to address both the causes and impacts of climate change. They define the responsibilities of local authorities in this area and establish a range of powers to enable local action to reduce emissions and adapt to the changes in climate which are already occurring or are projected to emerge over the course of this century. The role of regional and local planning bodies includes:

- Setting policies and targets for energy generation and CO_2 reduction that enable the UK to meet its national targets;
- Setting policies and targets for new developments that are more stretching than national regulations, where local conditions make this feasible and viable;
- Identifying and enabling spatial opportunities, such as promoting suitable locations for renewable energy generation or taking into account climate change risks when making spatial planning decisions;
- Enabling the development of community infrastructure, including district heating networks;
- Providing organisational and financial delivery mechanisms.

The following sections review relevant national, regional and local policy context and summarise the implications for planning and the wider role of local authorities in addressing climate change.

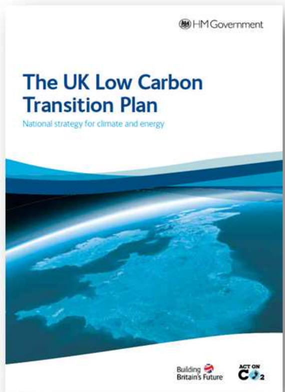
1 National Policy Context

Climate change is now an established area of Government policy making. The following sections summarise national policy and legislation of significance for this study and, where known, the Government's future plans.

1.1 The Climate Change Act (2008)

The Climate Change Act[36] sets a legally binding target for reducing UK CO_2 emissions by least 80% on 1990 levels by 2050. It established the Committee on Climate Change, which is responsible for setting binding interim carbon budgets for the Government over successive five year periods. The first three carbon budgets were announced in the Budget 2009, resulting in an interim target of a 34% reduction in CO_2 equivalent emissions on 1990 levels by 2020. A target of a 42% reduction by 2020 will come into effect if a global deal can be reached at the Copenhagen Climate Change Conference in December 2009.

1.2 UK Low Transition Carbon Plan (2009)



The Department of Energy and Climate Change (DECC) published a White Paper, the UK Low Carbon Transition Plan[37] in July 2009. The plan sets out how the UK will achieve a 34% cut in CO_2 equivalent emissions by 2020.

The Plan is accompanied by a suite of documents, including:

- The UK Renewable Energy Strategy,
- The UK Low Carbon Industrial Strategy,
- Consultation on Renewable Electricity Financial Incentives,
- Low Carbon Transport: A Greener Future.

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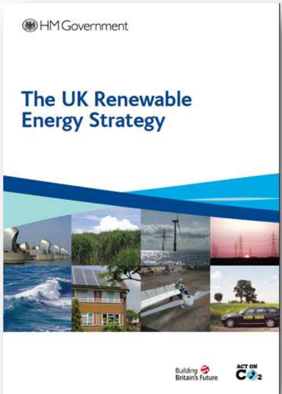
[36] Climate Change Act 2008

[37] The UK Low Carbon Transition Plan (DECC, July 2009)

As it is of particular importance to this study, further information is provided on the Renewable Energy Strategy below.

1.3 UK Renewable Energy Strategy (2009)



The UK Renewable Energy Strategy [38] describes how the UK will meet its legally binding target to supply 15% of all of the energy it uses from renewable sources by 2020. It anticipates that this will be achieved by using renewable energy technologies to supply:

- Over 30% of our electricity,
- 12% of the heat we use, and
- 10% of energy for transport.

The strategy includes the following actions to help achieve these targets:

- *Planning process:* establishing a new planning process for nationally significant infrastructure projects (as introduced in the Planning Act 2008, see below); support for English regions to develop evidence-based strategies for achieving 2020 renewable energy targets; developing skills and providing resources to support swifter development and implementation of regional and local energy planning policy; helping to resolve environmental impacts of renewable energy technologies and address spatial conflicts with other uses such as radar and navigation.
- *Establishing the Office of Renewable Energy Deployment*: to work with other Government departments and stakeholders to remove barriers in the planning system, strengthen the supply chain and stimulate investment.
- *Financial mechanisms:* extended Renewables Obligation for large scale renewable electricity generation; amended Renewable Transport Fuel Obligation; renewable heat incentive and feed-in-tariffs to pay a guaranteed premium for each unit of renewable heat or small-scale renewable electricity generation.
- *Investing in emerging technologies:* supporting offshore wind, marine energy and advanced biofuels; and investing in the Severn Estuary tidal power project.

1.4 Draft Heat and Energy Saving Strategy (February 2009)

The Draft Heat and Energy Saving Strategy was published for consultation by DECC in February 2009. It aims to ensure that emissions from all existing buildings approach zero by 2050.

The draft strategy proposes a new focus on district heating in suitable communities, removal of barriers to the development of networks, and encourages the development of combined heat and power and better use of surplus heat through carbon pricing mechanisms. It also suggests a new way of coordinating improvements to homes and communities, house-by-house and street-by-street. This would take the form of a ‘whole house’ package of improvements for all existing homes by 2030, which would provide energy saving measures such as insulation, renewable heat and renewable electricity technology as appropriate.

1.5 Planning Acts (1990, 1991, 2004 and 2008)

The Planning and Compulsory Purchase Act 2004, which supplements the 1990 and 1991 Acts, places sustainable development at the heart of the planning system. Implementation of the Act is guided by Planning Policy Statements (PPSs) covering a range of issues. Those of particular relevance to this study are:

- PPS1 Delivering Sustainable Development,
- PPS1 Planning and Climate Change - Supplement to Planning Policy Statement 1,
- PPS11 Regional Spatial Strategies,

[38] The UK Renewable Energy Strategy (DECC, July 2009)

- PPS12 Local Spatial Planning, and
- PPS22 Renewable Energy.

The most relevant statements, on Planning and Climate Change and Renewable energy, are discussed below. The Government has announced that it will review these policy statements and consult on a new combined PPS by the end of 2009. It is not expected that the broad policy goals will change significantly, but the Council should keep policies under review.

Issues addressed in other PPSs, including planning for housing, industrial and commercial uses, waste management, noise and flood risk, are also relevant to this study.

The Planning Act 2008 established a single development consent regime and a new planning process for nationally significant infrastructure projects. It created a new independent Infrastructure Planning Commission (IPC), which will be able to independently grant permission for nationally significant infrastructure projects and energy schemes, such as the construction or extension of power stations of over 50MW and the installation of electricity lines above ground. District heating networks are not currently classed as nationally significant infrastructure, although other types of pipeline are included.

The Planning Act 2008 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. Section 205(2) of the Act details that the overall purpose of the CIL will be to ensure that costs incurred in providing infrastructure to support the development of an area can be funded (wholly or partly) by owners or developers of land. According to the Act, the CIL may only be used to pay for infrastructure. The definition of infrastructure for this purpose is broad, to allow local authorities flexibility to account for local needs. In the context of this study, it could also include district heat networks or other energy supply infrastructure. CIL funds may be pooled across local authority areas to provide sub-regional infrastructure, provided that it supports development in the area. Local authorities will not be required to introduce the CIL, however where it is introduced it will be a mandatory charge. The levy will be calculated using formulae based on the size and character of a development.

This Planning Act establishes the role of planning authorities in setting energy targets and empowers local planning authorities to set requirements for energy use and energy efficiency in development plans.

1.6 PPS1: Planning and Climate Change – Supplement to PPS1: Delivering Sustainable Development (2007)

The Planning Policy Statement 1 (PPS1) Supplement has a specific focus on planning and climate change. It seeks to ensure that spatial strategies integrate climate change issues into all planning decisions. Local planning authorities are required to develop policies which employ a strategic approach to identifying existing decentralised energy networks and planning for new ones, and to identify appropriate locations for renewable energy infrastructure and developments.

An important requirement of the PPS1 Supplement is the need for policies within Development Plan Documents (DPDs) to expect a proportion of the energy supply for new development to be secured from decentralised and renewable or low carbon sources, and for area based opportunities for such infrastructure to be identified through the planning process.

All policies relating to low carbon or renewable energy generation must be underpinned by a robust evidence base. A key objective of this study is to meet that requirement.

1.7 PPS22: Renewable Energy (2004)

Planning Policy Statement 22 (PPS22) sets out principles which regional planning bodies and local authorities should adhere to in planning for renewable energy, including the following:

- Regional spatial strategies and local development documents should encourage rather than restrict renewable energy development. Renewable energy developments should be located where they are viable and where environmental, economic and social impacts can be addressed satisfactorily.

- Planning authorities should set out criteria that will be used to assess applications for renewable energy development. These should not rule out or constrain all, or specific types of renewable energy development without sufficient justification.
- The wider environmental and economic benefits of renewable energy should be material considerations in determining applications.

PPS22 does not apply to offshore renewables or to combined heat and power (unless fuelled by a renewable resource). Some of its requirements have now been superseded by the PPS1 Supplement.

The Well-being Power

The Well-being Power, introduced in 2000, enables local authorities in England and Wales to “do anything they consider likely to promote the economic, social and environmental well-being of their area unless explicitly prohibited elsewhere in legislation.” This provides the basis for a local authority to take a broad range of actions to achieve climate change policy objectives, such as:

- Setting up companies, contracts, joint ventures, trusts and take shares;
- Agreeing lower land receipts from developers in return for improved energy standards;
- Taking climate change impacts into account in their own procurement decisions;
- Initiatives such as affordable warmth programmes and those aimed at influencing behaviour.
- Linked to this, the Local Government Act (2003) enabled local authorities to use prudential borrowing to fund capital investment in fixed assets. This allows authorities to be more innovative in the services and facilities they offer. In relation to this study, it could be used for example to fund community energy infrastructure or energy efficiency improvements to the existing building stock.

2 Regional Policy Context

The East Midlands Regional Plan (2009) identifies resource efficiency, renewable energy generation and sustainable design as the key measures for delivering sustainable development and minimising CO_2 emissions. It places responsibility for reducing emissions within the planning system, reflecting the requirements of the PPS1 Supplement. It includes a policy on the role of new developments to reduce CO_2 emissions through energy efficiency, passive design and decentralised, renewable or low carbon energy technologies, and sets targets for renewable and low carbon energy generation in the region. The plan is currently undergoing a partial review, which is expected to lead to revision of the renewable and low carbon energy targets. To inform this review, a study has recently been completed on the renewable and low carbon energy resource in the region.[39]

3 Local Policy Context

The current Bassetlaw Local Plan was adopted in 2001 and as such does not reflect the more recent developments in national and regional policy. The recent consultation on the Core Strategy: Issues and Options (2009) set the climate change and energy debate in the local context, highlighting Bassetlaw’s high per-capita CO_2 emissions and below average contribution from renewable energy. When complete, the Local Development Framework will include four Development Plan Documents (DPDs): Core Strategy and Development Management Policies; Site Allocations; Worksop Area Action Plan (AAP); and Harworth AAP.

Towards a Sustainable Energy Policy for Nottinghamshire (2009) describes proposals for a draft planning policy framework, developed by a partnership of local authorities in the county including Bassetlaw District Council. It proposes target percentage of annual CO_2 emissions which a proposed development needs to save by using low or zero carbon energy technologies on-site. The target increases in stages up to 100% by 2016 for domestic buildings and 2019 for non-domestic buildings. This is

[39] Faber Maunsell – Reviewing Renewable Energy and Energy Efficiency Targets for the East Midlands (March 2009)

based on the assumption that when the Building Regulations require all new buildings to be zero carbon from these dates, compliance will need to be achieved by using low or zero carbon technologies to offset all emissions from the development, and does not take into account the Government's more recent proposals for allowable solutions. The local authorities involved in this study, including Bassetlaw, have identified a need for further development of the basis for their policies and targets in this area, including analysis of the commercial viability, extent of local renewable energy sources and the factors limiting their use. In addition, the Government's more recent proposals for the Building Regulations and the definition of zero carbon should be taken into account (see Section 2.2).

Bassetlaw District Council has signed the Nottingham Declaration. This commits the local authority to reducing emissions from its own operations, adapting to the impacts of climate change, and encouraging all sectors of the local community to take similar action. Bassetlaw District Council has a sustainability group which is leading the development of corporate strategy on energy and climate change, covering the range of facilities and services managed by the Council

Appendix B: Workshop

Interim findings for this study were tested with stakeholders at a workshop held at Bassetlaw District Council on 6 October 2009. 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 workshop:

Tim Dawson	Planning Officer (Policy), Bassetlaw District Council
Richard Schofield	Planning Policy and Conservation Manager, Bassetlaw District Council
Neil Taylor	Director of Resources, Bassetlaw District Council
Kerri Ellis	Sustainability Officer, Bassetlaw District Council
John Bowler	Engineering Services Manager, Bassetlaw District Council
Cllr. Keith Isard	Portfolio Holder – Community Prosperity, Bassetlaw District Council
David Armiger	Bassetlaw District Council
Don Spittlehouse	A1 Housing
John Strawson	Managing Director, Strawson Energy
Stuart Ashton	UK Coal
Alex Morrell	EdF Energy
Helen Pearce	Senior Consultant, AECOM
Rob Shaw	Associate Director, AECOM

Following an initial introduction to the purpose of the study and its scope, a discussion was held to identify ideas for achieving energy related CO_2 reductions in the district. Initial findings of the study were then presented and feedback encouraged. The comments from the workshop were used to inform the study and have been incorporated throughout this report.

Appendix C: Energy Modelling

To test and monitor the effects of national, regional and local targets on the district, we have developed a 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 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 low and zero 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 thumb' 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.

The Government has published consultations on future Building Regulations requirements for the energy efficiency of new homes[7] and the definition of zero carbon for non-domestic buildings.[8] Both were both published after the bulk of the work for this study had been completed and the initial draft of this report had been issued. The modelling and analysis in this report are therefore based on assumptions drawn from previous consultations and have not been updated to reflect the latest Government proposals. This is not likely to have a significant impact on the findings of the report and the policy recommendations should still be considered to be valid.

1 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 19 Conversion factors for different fuels

2 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.

2.1 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.

2.2 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[40], 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 records of planning applications and data supplied by the Council.

3 Building Type Assumptions

The 76 building categories that were modelled comprise;

12 existing dwelling types, comprising;

- o 4 types – semi detached (dense), semi detached (less dense), small terrace and flat/apartment
- o Modelled in three different age bands - pre 1919, 1919-1975 and post 1975
- ▪ 6 new dwellings types (i.e. post 2006), comprising;
- o 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)

[40] CIBSE TM46:2008 Energy Benchmarks (CIBSE, 2009)

The house types selected were considered representative for the district (existing and proposed housing development) based on the draft SHLAA, 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 20 below

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 20 Modelled house type basic assumptions

Information on public buildings and buildings not eligible for business rates was obtained from the Council and from the local authority website. 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 21 Commercial building types basic assumptions.

3.1 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 1 and 2 above.

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.

4 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 22 Commercial building energy demand splits – regulated and unregulated.

5 Heat Mapping

Heat mapping has 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.

The resolution of the heat map is limited by the Middle Layer Super Output Area boundaries, which is the format in which address data is provided. The results only provide an average of each Middle Layer Super Output Area and do not highlight point sources which may have a high heat demand.

6 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)		
		References
Buildings applied	**All residential buildings plus all commercial buildings**	
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.	▪ AP 2005 ▪ AECOM
Costing assumptions	£15/m^2 residential £20/m^2 commercial	▪ From unpublished work undertaken by AECOM for Energy Savings Trust

Energy Efficiency Level 2 (EE2)		
		References
Buildings applied	**All residential buildings plus all commercial buildings**	
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/m^2 residential £40/m^2 commercial	▪ From unpublished work undertaken by AECOM for Energy Savings Trust

▪ Solar Water Heating		
		References
Buildings applied	**Residential buildings only.**	
Technology sizing assumptions	Assumed to deliver 50% Domestic Hot Water. Domestic Hot Water consumption in homes taken from SAP (1). SAP models were run using data from the English House Condition survey for existing homes. For commercial buildings hot water use has been assumed at 20% of the fossil fuel benchmark (2). Evacuated tube Solar Water Heating panels assumed to deliver 520kW per m^2 panel (3)	1. SAP 2005 2. CIBSE TM46 3. Ofgem
Costing assumptions	Evacuated tube system assumed to be £1000 per m^2. **Note:** Full system cost including hot water storage tanks etc	▪ Supplier quotes

▪ PV – minimum installation		
		References
Buildings applied	**All residential buildings plus all commercial buildings**	
Technology sizing assumptions	Assumed kWp taken to be ¼ of maximum possible panel based on the assumed roof areas Panel area assumed to be $7m^2$/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		
		References
Buildings applied	**All residential buildings plus all commercial buildings**	
Technology sizing assumptions	Assumed kWp taken to be ½ of 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 £5500 per kWp. **Note:** Full system cost including invertors etc **Note:** Costs fall as system size gets larger.	▪ Supplier quotes (2004 – 2008).

▪ PV – maximum installation		
		References
Buildings applied	**All residential buildings plus all commercial buildings**	
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	
		References
Buildings applied	New (post 2006) residential and post 2006 commercial buildings only. Different assumptions for new detached and semi detached homes.	
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. **<u>Note:</u>** 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		
		References
Buildings applied	New (post 2006) residential and post 2006 commercial buildings only. Different assumptions for new detached and semi detached homes.	
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		
		References
Buildings applied	All residential buildings and all commercial buildings	
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		
		References
Buildings applied	New residential and new commercial buildings only.	
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		
		References
Buildings applied	New residential and new commercial buildings only.	
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		
		References
Buildings applied	New residential and new commercial buildings only.	
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).

7 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 LZC 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 LZC technology for every option, except where the advanced energy efficiency standard is applied.

8 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 us 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 D: Renewable and 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.

1 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.

2 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 40: 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[41]. 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."[42]

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"[43]. 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." [44] A distance of 3 rotor diameters should be maintained from power transmission lines.[45]

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

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41 Guidance Notes for Wind Turbine Site Suitability (London Energy Partnership, London Renewables, October 2006)

42 The Assessment and Rating of Noise from Wind Farms (Noise Working Group report EtSU-R-97, 2007)

43 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)

44 Advisory Statement on Wind Farms AROW20s08/1 (The British Horse Society)

45 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)

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[46]. 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.

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.

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[46] Planning Policy Consultation – Consultation on proposed amendments to Planning Policy Statement 25: Development and flood risk, paragraphs 3.31-3.38 (DCLG, August 2009)

Figure 41: Building mounted wind turbines. Windsave turbine (left, photo courtesy of Windsave) and Swift Turbine installed in East London (right)

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.

3 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

Table 23 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 23 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.

	Percentage 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 24 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[47]. 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%)[48], although waste wood from arboriculture management usually has higher moisture content and requires drying before use.

4 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.

4.1 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.

[47] Biomass for London: wood fuel demand and supply chains (BioRegional Development Group, SE Wood Fuels and Creative Environmental Networks, December 2008)
[48] Waste wood as a biomass fuel, market Information report (DEFRA, April 2008)

Figure 42 Solar hot water installations. Schuco flat plate system providing domestic hot water (left, photo courtesy of Ecolution Renewables) and Solar water evacuated tube system, Ottbergen (right)

4.2 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.V 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 43 Solar PV panels. PV panels angled at 10º on flat roofs (left) and Kalzip AluplusSolar standing seam roof (right)

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.

5 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.

5.1 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.

Figure 44 Typical layout of residential air source heat pump system

5.2 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℃; 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.

Appendix E: Funding mechanisms for Renewable and Low Carbon technologies

1 Renewables Obligation 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[49]. 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. However, on the most recent auction day (7 April 2009) the average value of a ROC was £52.65.

[49] 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)

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 [50]
Sewage Gas	0.5		

[50] Renewable Obligation Certificate (ROC) Banding (DECC websites http://chp.defra.gov.uk/cms/roc-banding/, accessed August 2009)

2 Feed-in-tariffs

These are due to come into action in April 2010[51] for installations not exceeding 5 MW[52]. The following low-carbon technologies are expected to be eligible:

- Biomass and biofuels
- Fuel cells
- Solar power, including photovoltaics
- Water (including waves and tides)
- Wind
- Geothermal
- CHP with an electrical capacity of 50 kW or less

The electricity produced by these technologies will be bought by the utilities at above market prices. These prices 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[53].

3 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[54].

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.

4 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.

5 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

[51] 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)
[52] Energy Act 2008 Section 41.4.b
[53] Feed in tariffs (Action Renewables website http://www.actionrenewables.org/uploads_documents/SolarcenturyFeedTariffguide.pdf, accessed August 2009)
[54] Loans section (Salix website http://www.salixfinance.co.uk/loans.html, accessed August 2009)

- 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 connection to a district heating scheme. Local authorities are likely to be key delivery partners for the energy companies in delivering these schemes.[55]

The Community Sustainable Energy Programme has two grant initiatives. Both are only available to not-for-profit community based organisations in England.

6 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.

7 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.

[55] Funding section (Energy Saving Trust website http://www.energysavingtrust.org.uk/business/Business/Local-Authorities/Funding, accessed August 2009)

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.

8 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.

9 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.

10 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.

11 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

12 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.

13 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 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. [38]

14 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.

Appendix F: Results

The following pages summarise the results of the modelling for each of the notional 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, which underpin every policy option.

For ease of reference, a summary of the policy options considered is also provided below.

Of the policies tested, only the Nottinghamshire policy applies to regulated and unregulated emissions, making it a significantly more stringent target than the alternatives considered prior to 2016. The Nottinghamshire policy also requires CO_2 savings to be made solely through the use of renewable or low carbon technologies, without the use of enhanced energy efficiency measures or allowable solutions.

Period	Building Regulations	Nottinghamshire policy	10% beyond BR	15% beyond BR
Up to 2010	Defined by Building Regulations 2006	Homes: **20%** of **all** site CO_2 emissions to be saved through **renewable or low carbon energy**, in addition to Building Regulations current at the time. Non-domestic: **10%** of **all** site CO_2 emissions to be saved through **renewable or low carbon energy**, in addition to Building Regulations current at the time.	**10%** of **regulated** site CO_2 emissions to be saved **by any means**, in addition to Building Regulations current at the time.	**15%** of **regulated** site CO_2 emissions to be saved **by any means**, in addition to Building Regulations current at the time.
2010 – 2013	**25%** savings on regulated CO_2 emissions compared to 2006 levels	Homes: **23.5%** of **all** site CO_2 emissions to be saved through **renewable or low carbon energy**, in addition to Building Regulations current at the time. Non-domestic: **10%** of **all** site CO_2 emissions to be saved through **renewable or**	**10%** of **regulated** site CO_2 emissions to be saved **by any means**, in addition to Building Regulations current at the time.	**15%** of **regulated** site CO_2 emissions to be saved **by any means**, in addition to Building Regulations current at the time.

		low carbon energy, in addition to Building Regulations current at the time.		
2013 – 2016	**44%** savings on regulated CO_2 emissions compared to 2006 levels	Homes: **27%** of **all** site CO_2 emissions to be saved through **renewable or low carbon energy**, in addition to Building Regulations current at the time. Non-domestic: **10%** of **all** site CO_2 emissions to be saved through **renewable or low carbon energy**, in addition to Building Regulations current at the time.	**10%** of **regulated** site CO_2 emissions to be saved **by any means**, in addition to Building Regulations current at the time.	**15%** of **regulated** site CO_2 emissions to be saved **by any means**, in addition to Building Regulations current at the time.
2016 – 2019	Homes: **Zero carbon** compared to 2006 levels, comprising 70% savings on regulated CO_2 emissions through energy efficiency or renewable or low carbon technology, and remainder of savings (including unregulated emissions) to be achieved through further reductions or allowable solutions. Non-domestic: **60%** savings on regulated CO_2 emissions compared to 2006 levels	As per the Building Regulations for homes. Non-domestic: **10%** of **all** site CO_2 emissions to be saved through **renewable or low carbon energy**, in addition to Building Regulations current at the time.	As per the Building Regulations for homes. Non-domestic: **10%** of **regulated** site CO_2 emissions to be saved **by any means**, in addition to Building Regulations current at the time.	As per the Building Regulations for homes. Non-domestic: **15%** of **regulated** site CO_2 emissions to be saved **by any means**, in addition to Building Regulations current at the time.

2019 onwards	Homes: As for 2016-2019 Non-domestic: **Zero carbon** requirement, defined as for homes above.	As per the Building Regulations.	As per the Building Regulations.	As per the Building Regulations.

Table 25 Policy options modelled in feasibility and viability testing

The consultations on the energy efficiency standard for homes[56] and the definition of zero carbon for non-domestic buildings[57] were both published after the bulk of the work for this study had been completed and the initial draft of this report had been issued. The modelling and analysis in this report are therefore based on assumptions drawn from previous consultations and have not been updated to reflect the latest Government proposals. This is not likely to have a significant impact on the findings of the report and the policy recommendations should still be considered to be valid.

The technology options are explained in Appendix C, together with details of the modelling approach and the assumptions used therein.

[56] Sustainable New Homes – The Road to Zero Carbon Consultation on the Code for Sustainable Homes and the Energy Efficiency standard for Zero Carbon Homes (Department for Communities and Local Government, December 2009)
[57] Zero Carbon for New Non-domestic Buildings: Consultation on Policy Options (Department for Communities and Local Government, November 2009)

Typical Development 1: Small Residential

The small residential development comprises 10 dwellings, including some larger detached family homes and smaller one or two bedroom flats and terraced houses.[58]

Results

Opportunity Area 1: Energy Constraints

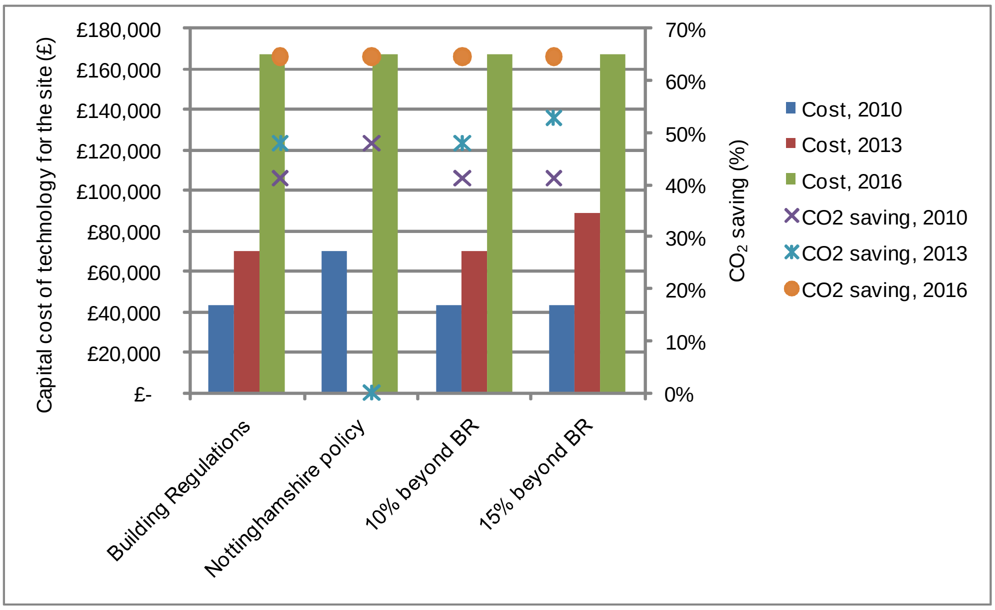

Figure 45 Comparison of indicative costs and savings on regulated CO2 emissions for a small residential development to comply with the different policy options (Source: AECOM analysis)

[58] The dwelling mix for the residential developments has been based on the housing needs set out in the Northern HMA Strategic Housing Market Assessment (2007), which stated that the need is for one or two bedroom properties or larger detached family homes. The assumption has been made that all 1 bedroom properties are flats, all 4+ bedroom properties are detached houses and 2 bedroom properties are split between terraced houses and flats.

Policy	Technology Choice		
	2010	2013	
Building Regulations	Solar Water Heating	Photovoltaics (med)+advanced energy efficiency (EE2)	GSHP + PV (max)
Nottinghamshire policy	PV (med)+EE2	No Tech Option Available	GSHP + PV (max)
10% beyond BR	Solar Water Heating	PV (med)+EE2	GSHP + PV (max)
15% beyond BR	Solar Water Heating	Biomass heating	GSHP + PV (max)

Table 26: Potential technology choices for a small residential development to comply with the different policy options (Source: AECOM analysis)

Opportunity Area 2: District Heating

For areas where there is a source of waste heat available, such as a large power station, it may be feasible for a small residential development to connect to it, provided a district heating network was already in place. The development on its own would not be of sufficient scale to justify development of the main heating network linked to the source of waste heat.

Our calculations indicate that connection of the small residential development to a source of waste heat would result in around 44% savings on regulated CO_2 emissions at a capital cost in the region of £63,300. This would be more expensive than the solar water heating option for a similar CO_2 saving. It is cheaper than the PV option, but the CO_2 saving is estimated to be less.

Opportunity Area 3: Wind

For areas suitable for wind development, a small 15kW wind turbine may be feasible for inclusion in a development of this size, provided there is sufficient room on site to allow for a 150m separation from the nearest residential properties and 20m from the nearest road or railway. This may be challenging to achieve on the majority of sites, although may be feasible in some locations, for example if edge of settlement developments are able to locate turbines on adjacent open land, off the site boundary.

Our calculations indicate that one small wind turbine could result in around 78% savings on regulated CO_2 emissions for a small residential development, at a cost of around £19,000 installed. Additional land and infrastructure costs would need to be factored in if the turbine were installed outside of the site boundary. Where feasible, this would be the cheapest option for reducing CO_2 emissions.

Conclusions

Our analysis indicates that there would be feasible options for complying with all policies on an energy constrained site, with the exception of the Nottinghamshire policy proposed for the period from 2013 – 2016 (Table 27).

A small wind turbine has the potential to deliver higher CO_2 savings than all other technological options selected, although this option will only be feasible in limited locations due to the spatial requirements.

Policy	Feasible?			Comments
	2010	2013	2016	
Building Regulations	✓	✓	✓	▪ Solar hot water or PV feature, so roof design would need to optimise orientation and minimise overshading to get the maximum output. ▪ GSHP features in compliance option from 2016 onwards. This would require significant earthworks and output may differ depending on geology and hydrogeology of the site.
Nottinghamshire policy	✓	×	✓	▪ No technological option identified to meet the higher target introduced with 2013 Building Regulations update
10% beyond BR	✓	✓	✓	▪ As per Building Regulations compliance.
15% beyond BR	✓	✓	✓	▪ As per Building Regulations compliance for compliance with the policy from 2010 – 2013. ▪ From 2013, biomass heating may be a preferred choice for achieving the 15% saving beyond Building Regulations. Feasibility of this option will depend on the site having suitable access for solid biomass deliveries and sufficient storage space for fuel. As there is no AQMA in the district currently, it is not anticipated that air quality will affect feasibility.

Table 27: Comparison of feasibility of complying with the different policy options for a small residential development (Source: AECOM analysis)

Table 28 shows the percentage uplift on base construction costs[59] in complying with the different policy options for a large residential development. The costs of compliance correspond to the technology options shown in Table 26.

[59] BIS Construction Costs and Cost Indices online, accessed December 2009

Policy	Potential Cost of Compliance (% of Construction Cost)		
	2010	2013	2016
Building Regulations	8%	12%	29%
Nottinghamshire policy	12%	-	29%
10% beyond BR	8%	12%	29%
15% beyond BR	8%	16%	29%

Table 28 Comparison of costs of complying with the different policy options for a small residential development. Construction cost for the small residential development is estimated to be £573,422. Blank cells represent scenarios where no low carbon solution has been identified to meet policy (Source: AECOM analysis)

Typical Development 2: Large Residential

The large residential development comprises 150 dwellings, including some larger detached family homes and smaller one or two bedroom flats and terraced houses.[60]

Results

Opportunity Area 1: Energy Constrained

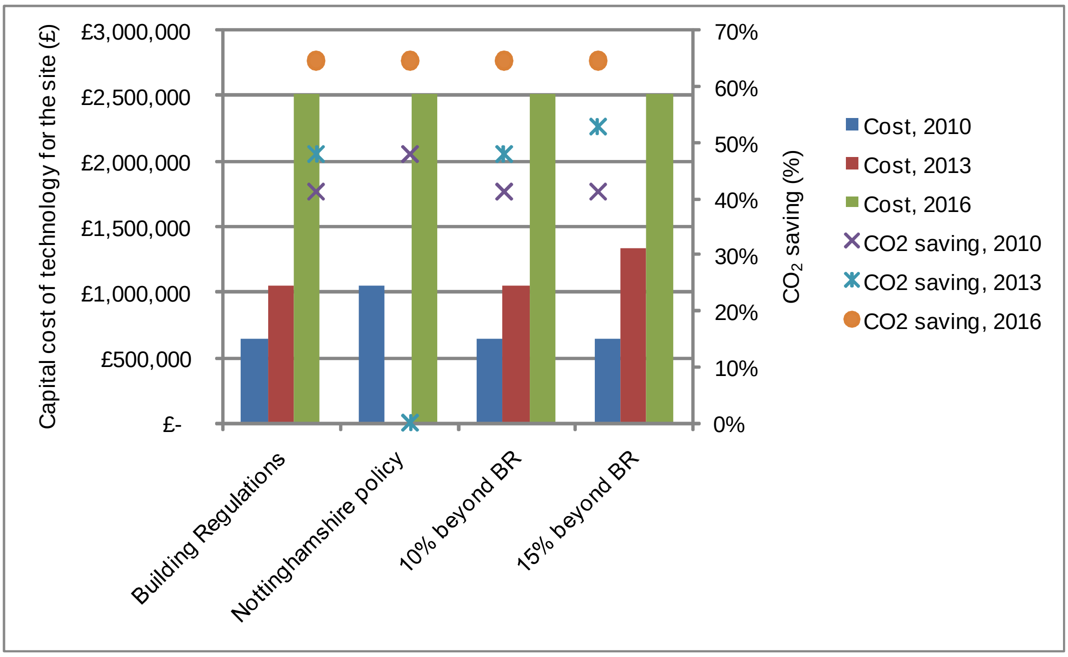

Figure 46: Comparison of indicative costs and savings on regulated CO_2 emissions for a large residential development to comply with the different policy options (Source: AECOM analysis)

[60] The dwelling mix for the residential developments has been based on the housing needs set out in the Northern HMA Strategic Housing Market Assessment (2007), which stated that the need is for one or two bedroom properties or larger detached family homes. The assumption has been made that all 1 bedroom properties are flats, all 4+ bedroom properties are detached houses and 2 bedroom properties are split between terraced houses and flats.

Policy	Technology Choice		
	2010	2013	
Building Regulations	Solar Water Heating	PV (med)+EE2	[illegible]
Nottinghamshire policy	PV (med)+EE2	No Tech Option Available to meet Policy within Assumed Site Constraints	[illegible]
10% beyond BR	Solar Water Heating	PV (med)+EE2	[illegible]
15% beyond BR	Solar Water Heating	Biomass heating	[illegible]

Table 29: Potential technology choices for a large residential development to comply with the different policy options (Source: AECOM analysis)

Opportunity Area 2: District Heating

For areas where there is a source of waste heat available, such as a large power station, it may be feasible for a large residential development to connect to it, provided a district heating network was already in place. Even the large residential development on its own would not be of sufficient scale to justify development of the main heating network linked to the source of waste heat.

Our calculations indicate that connection of the large residential development to a source of waste heat would result in around 44% savings on regulated CO_2 emissions at a capital cost in the region of £950,000. This would be more expensive than the solar water heating option for a similar CO_2 saving. It is cheaper than the PV option, but the CO_2 saving is estimated to be less.

The main difference between the large residential site and the small residential site is that the larger site is theoretically of a sufficient size to justify an on-site gas-fired CHP system with district heating, even if there is no established district heating network to connect to outside of the site boundary. However, our calculations indicate that this would cost in the region of £2,050,000 and CO_2 savings would only be 27% of regulated emissions. This is a lower saving than might be achieved with other options, at more than double the cost.

Opportunity Area 3: Wind

For areas suitable for wind development, one or more small 15kW wind turbines may be feasible for inclusion in a development of this size, provided there is sufficient room on site to allow for a 150m separation from the nearest residential properties and 20m from the nearest road or railway. This may be challenging to achieve on the majority of sites, although may be feasible in some locations, for example if edge of settlement developments are able to locate turbines on adjacent open land, off the site boundary.

Our calculations indicate that one small wind turbine could result in around 5% savings on regulated CO_2 emissions for a large residential development, at a cost of around £19,000 installed. Several turbines would be required to comply with the policy options under consideration. Additional land and infrastructure costs would need to be factored in if the turbine were installed outside of the site boundary. Where feasible, this would be the cheapest option for reducing CO_2 emissions.

A large, 2MW wind turbine could result in CO_2 savings well in excess of the emissions from a site of this size, saving around 2,687 tonnes of CO_2 for a cost in the region of £1,600,000. This is cheaper than the cost of complying with the zero carbon requirement using a combination of GSHP, PV and allowable solutions, as proposed above. However, a large wind turbine would need to be located at least 800m from the residential development it is linked to. This may not be feasible for this type of site.

Conclusions

There are feasible options for complying with all policies on an energy constrained site, with the exception of the Nottinghamshire policy proposed for the period from 2013 – 2016 (Table 27).

Small wind turbines have the potential to deliver higher CO_2 savings than all other technological options selected, although they will only be feasible in limited locations due to the spatial requirements. A large wind turbine would make a much greater contribution to CO_2 savings, but is unlikely to be feasible because of the separation distances required.

Policy	Feasible?			Comments
	2010	2013	2016	
Building Regulations	✓	✓	✓	▪ Solar hot water or PV feature, so roof design would need to optimise orientation and minimise overshading to get the maximum output. ▪ GSHP features in compliance option from 2016 onwards. This would require significant earthworks and output may differ depending on geology and hydrogeology of the site.

Nottinghamshire policy	✓	×	✓	▪ No technological option identified to meet the higher target introduced with 2013 Building Regulations update
10% beyond BR	✓	✓	✓	▪ As per Building Regulations compliance.
15% beyond BR	✓	✓	✓	▪ As per Building Regulations compliance for compliance with the policy from 2010 – 2013. ▪ From 2013, biomass heating may be a preferred choice for achieving the 15% saving beyond Building Regulatio

				ns. Feasibility of this option will depend on the site having suitable access for solid biomass deliveries and sufficient storage space for fuel. As there is no AQMA in the district currently, it is not anticipated that air quality will affect feasibility.

Table 30: Comparison of feasibility of complying with the different policy options for a large residential development (Source: AECOM analysis)

shows the percentage uplift on base construction costs [59] in complying with the different policy options for a large residential development. The costs of compliance correspond to the technology options shown in Table 29.

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Policy	Potential Cost of Compliance (% of Construction Cost)		
	2010	2013	2016
Building Regulations	8%	12%	29%
Nottinghamshire policy	12%	-	29%

10% beyond BR	8%	12%	29%
15% beyond BR	8%	16%	29%

Table 31 Comparison of costs of complying with the different policy options for a large residential development. Construction cost for the large residential development is estimated to be £8,601,330. Blank cells represent scenarios where no low carbon solution has been identified to meet policy requirements (Source: AECOM analysis)

Typical Development 3: Office Development

The office development comprises 1,000m^2 of floorspace, which is typical for the size of office development expected to come forward in Bassetlaw over the period of the Core Strategy.

Results

Opportunity Area 1: Energy Constrained

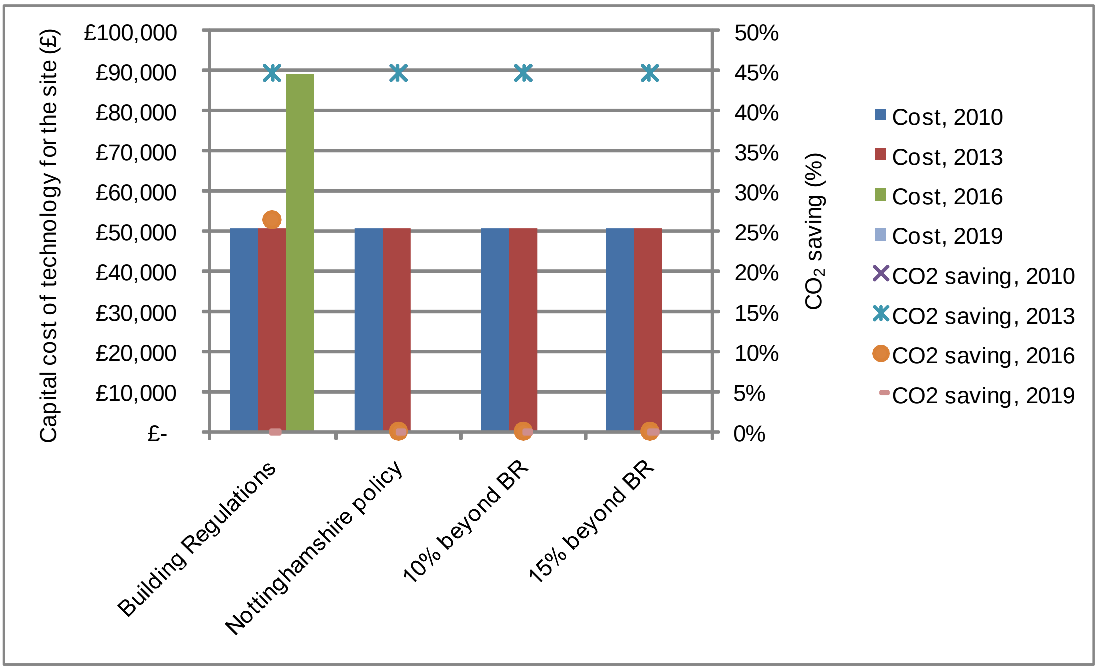

Figure 47: Comparison of indicative costs and savings on regulated CO_2 emissions for an office development to comply with the different policy options (Source: AECOM analysis)

Policy	Technology Choice			
	2010	2013	2016	2019
Building Regulations	Biomass heating	Biomass heating	PV (med)+EE2	No Tech Option Available to meet Policy within Assumed Site Constraints
Nottinghamshire policy	Biomass heating	Biomass heating	No Tech Option Available to meet Policy within Assumed Site Constraints	No Tech Option Available to meet Policy within Assumed Site Constraints
10% beyond BR	Biomass heating	Biomass heating	No Tech Option Available to meet Policy within Assumed Site Constraints	No Tech Option Available to meet Policy within Assumed Site Constraints
15% beyond BR	Biomass heating	Biomass heating	No Tech Option Available to meet Policy within Assumed Site Constraints	No Tech Option Available to meet Policy within Assumed Site Constraints

Table 32: Potential technology choices for an office development to comply with the different policy options (Source: AECOM analysis)

Opportunity Area 2: District Heating

For areas where there is a source of waste heat available, such as a large power station, it may be feasible for an office development to connect to it, provided a district heating network was already in place. This development on its own would not be of sufficient scale to justify development of the main heating network linked to the source of waste heat.

Our calculations indicate that connection of the office development to a source of waste heat would result in around 41% savings on regulated CO_2 emissions at a capital cost in the region of £40,500. This is in the region of 3% of typical construction costs for an office development of this size. This could be cheaper than the biomass heating option, but for a slightly lower CO_2 saving.

Opportunity Area 3: Wind

For areas suitable for wind development, one or more small 15kW wind turbines may be feasible for inclusion in a development of this size, provided there is sufficient room on site to allow for a 150m separation from the nearest residential properties and 20m from the nearest road or railway. This would be more feasible for office developments which are not located close to residential areas.

Our calculations indicate that one small wind turbine could result in around 42% savings on regulated CO_2 emissions for an office development of this size, at a cost of around £19,000 installed, or around 1.5% of construction costs. Additional land and infrastructure costs would need to be factored in if the turbine were installed outside of the site boundary. Where feasible, this would be the cheapest option for reducing CO_2 emissions.

Conclusions

There are feasible options for complying with all policies in earlier years on an energy constrained site. When higher energy efficiency standards are introduced for non-residential buildings with the 2016 update of the Building Regulations, achieving an additional saving from renewable or low carbon technologies is not considered feasible according to our analysis. No technology options have been identified which would allow an office development on a constrained site to achieve the zero carbon requirement under the Building Regulations from

2019 onwards, based on the current definition of zero carbon for dwellings.

Connection to district heating, where an established network is available, would offer similar CO_2 savings at potentially lower cost than biomass heating on-site.

Small wind turbines have the potential to deliver higher CO_2 savings than all other technological options selected, although they will only be feasible in limited locations due to the spatial requirements.

Policy	Feasible?				Comments
	2010	2013	2016	2019	
Building Regulations	✓	✓	✓	×	▪ For the earlier years, biomass heating may be a preferred choice. Feasibility of this option will depend on the site having suitable access for solid biomass deliveries and sufficient storage space for fuel. As there is no AQMA in the district currently, it is not anticipated that air quality will affect feasibility. ▪ PV may be proposed to meet higher standards, so roof design would need to optimise orientation and minimise overshading to get the maximum output.
Nottinghamshire policy	✓	✓	×	×	▪ See comments on biomass above. ▪ No options identified for compliance with higher standards after 2016.
10% beyond BR	✓	✓	×	×	▪ See comments on biomass above. ▪ No options identified for compliance with higher standards after 2016.
15% beyond BR	✓	✓	×	×	▪ See comments on biomass above. ▪ No options identified for compliance with higher standards after 2016.

Table 33: Comparison of feasibility of complying with the different policy options for an office development (Source: AECOM analysis)

Table 34 shows the percentage uplift on base construction costs [59] in complying with the different policy options for a typical office development. The costs of compliance correspond to the technology options shown in Table 32.

Policy	Potential Cost of Compliance (% of Construction Cost)			
	2010	2013	2016	2019
Building Regulations	4%	4%	7%	-
Nottinghamshire policy	4%	4%	-	-
10% beyond BR	4%	4%	-	-
15% beyond BR	4%	4%	-	-

Table 34 Comparison of costs of complying with the different policy options for a typical office development. Construction cost for the typical office development is estimated to be £1,249,000. Blank cells represent scenarios where no low carbon solution has been identified to meet policy (Source: AECOM analysis)

Typical Development 4: Workshop

The workshop development comprises 5,000m^2 of floorspace, which is typical for the size of industrial unit expected to come forward in Bassetlaw over the period of the Core Strategy.

Results

Opportunity Area 1: Energy Constrained

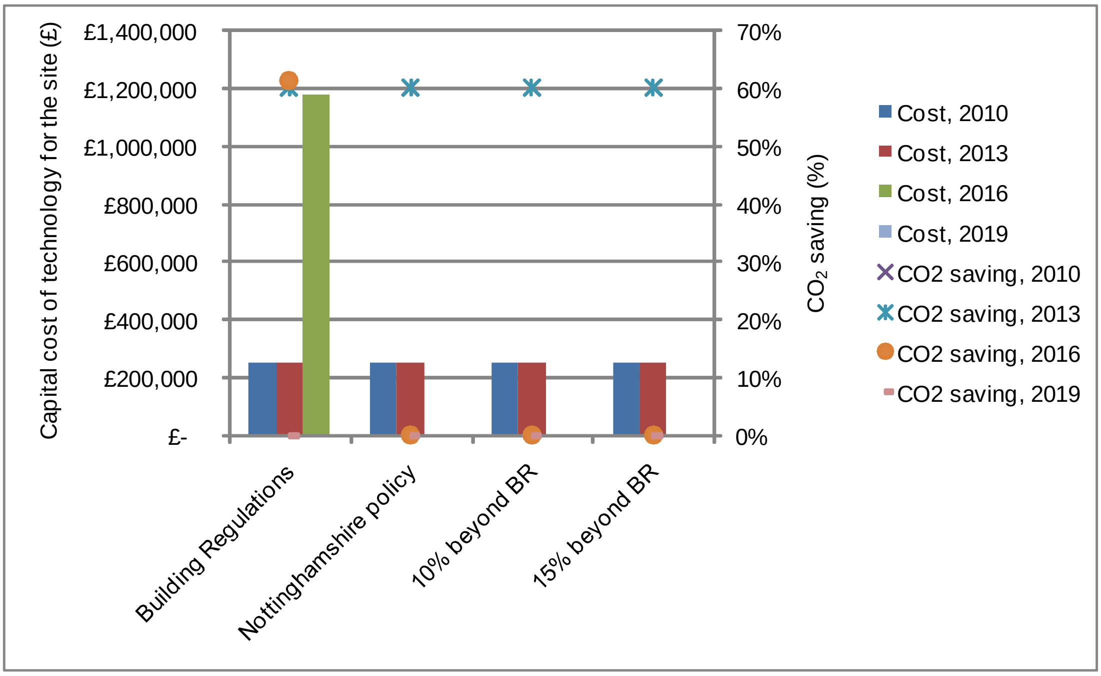

Figure 48 Comparison of indicative costs and savings on regulated CO_2 emissions for a workshop development to comply with the different policy options (Source: AECOM analysis)

Policy	Technology Choice			
	2010	2013	2016	2019
Building Regulations	Biomass heating	Biomass heating	PV (med)+EE2	No Tech Option Available to meet Policy within Assumed Site Constraints
Nottinghamshire policy	Biomass heating	Biomass heating	No Tech Option Available to meet Policy within Assumed Site Constraints	No Tech Option Available to meet Policy within Assumed Site Constraints
10% beyond BR	Biomass heating	Biomass heating	No Tech Option Available to meet Policy within Assumed Site Constraints	No Tech Option Available to meet Policy within Assumed Site Constraints
15% beyond BR	Biomass heating	Biomass heating	No Tech Option Available to meet Policy within Assumed Site Constraints	No Tech Option Available to meet Policy within Assumed Site Constraints

Table 35: Potential technology choices for a workshop development to comply with the different policy options (Source: AECOM analysis)

Opportunity Area 2: District Heating

For areas where there is a source of waste heat available, such as a large power station, it may be feasible for a workshop development of this nature to connect to it, provided a district heating network was already in place. This development on its own would not be of sufficient scale to justify development of the main heating network linked to the source of waste heat.

Our calculations indicate that connection of the workshop development to a source of waste heat would result in around 55% savings on regulated CO_2 emissions at a capital cost in the region of £202,000. This is around 7% of the typical construction costs for a workshop development of this size. This could be cheaper than the biomass heating option, but for a slightly lower CO_2 saving.

Opportunity Area 3: Wind

For areas suitable for wind development, one or more small 15kW wind turbines may be feasible for inclusion in a development of this size, provided there is sufficient room on site to allow for a 150m separation from the nearest residential properties and

20m from the nearest road or railway. This would be more feasible for developments such as this which are not likely to be located close to residential areas.

Our calculations indicate that one small 15kW wind turbine could result in around 8% savings on regulated CO_2 emissions for a workshop development of this size, at a cost of around £19,000 installed, or an additional 0.6% on construction costs. Several turbines would therefore be needed to comply with the policy requirements. Additional land and infrastructure costs would need to be factored in if the turbine were installed outside of the site boundary. Where feasible, this would be the cheapest option for reducing CO_2 emissions.

This type of development is unlikely to be large enough to justify investment in a large scale 2MW wind turbine alone, although it may be able to contribute to a shared system if it is co-located with other similar developments, for example on an industrial estate or business park.

Conclusions

There are feasible options for complying with all policies in earlier years on an energy constrained site. When higher energy efficiency standards are introduced for non-residential buildings with the 2016 update of the Building Regulations, achieving an additional saving from renewable or low carbon technologies is not considered feasible according to our analysis. No technology options have been identified which would allow a workshop development on a constrained site to achieve the zero carbon requirement under the Building Regulations from 2019 onwards, based on the current definition of zero carbon for dwellings (

Table 39).

Connection to district heating, where an established network is available, would offer similar CO_2 savings at potentially lower cost than biomass heating on-site.

Small wind turbines have the potential to deliver higher CO_2 savings than all other technological options selected, although they will only be feasible in limited locations due to the spatial requirements.

Policy	Feasible?				Comments
	2010	2013	2016	2019	
Building Regulations	✓	✓	✓	×	▪ For the earlier years, biomass heating may be a preferred choice. Feasibility of this option will depend on the site having suitable access for solid biomass deliveries and sufficient storage space for fuel. As there is no AQMA in the district currently, it is not anticipated that air quality will affect feasibility. ▪ PV may be proposed to meet higher standards, so roof design would need to optimise orientation and minimise overshading to get the maximum output.
Nottinghamshire policy	✓	✓	×	×	▪ See comments on biomass above. ▪ No options identified for compliance with higher standards after 2016.
10% beyond BR	✓	✓	×	×	▪ See comments on biomass above. ▪ No options identified for compliance with higher standards after 2016.
15% beyond BR	✓	✓	×	×	▪ See comments on biomass above. ▪ No options identified for compliance with higher standards after 2016.

Table 36: Comparison of feasibility of complying with the different policy options for a workshop development (Source: AECOM analysis)

Table 39 shows the percentage uplift on base construction costs [59] in complying with the different policy options for a typical workshop development.

Policy	Potential Cost of Compliance (% of Construction Cost)			
	2010	2013	2016	2019
Building Regulations	9%	9%	40%	-
Nottinghamshire policy	9%	9%	-	-
10% beyond BR	9%	9%	-	-
15% beyond BR	9%	9%	-	-

Table 37 Comparison of costs of complying with the different policy options for a typical workshop development. Construction cost for the “small residential development” is estimated to be £2.95 million. Blank cells represent scenarios where no low carbon solution has been identified to meet policy (Source: AECOM analysis)

Typical Development 5: Storage Facility

The storage facility comprises 10,000m^2 of floor space, which is typical for the size of unit expected to come forward in Bassetlaw over the period of the Core Strategy. It has been assumed for the purpose of modelling that this storage space is split equally between general storage and cold storage.

Results

Opportunity Area 1: Energy Constrained

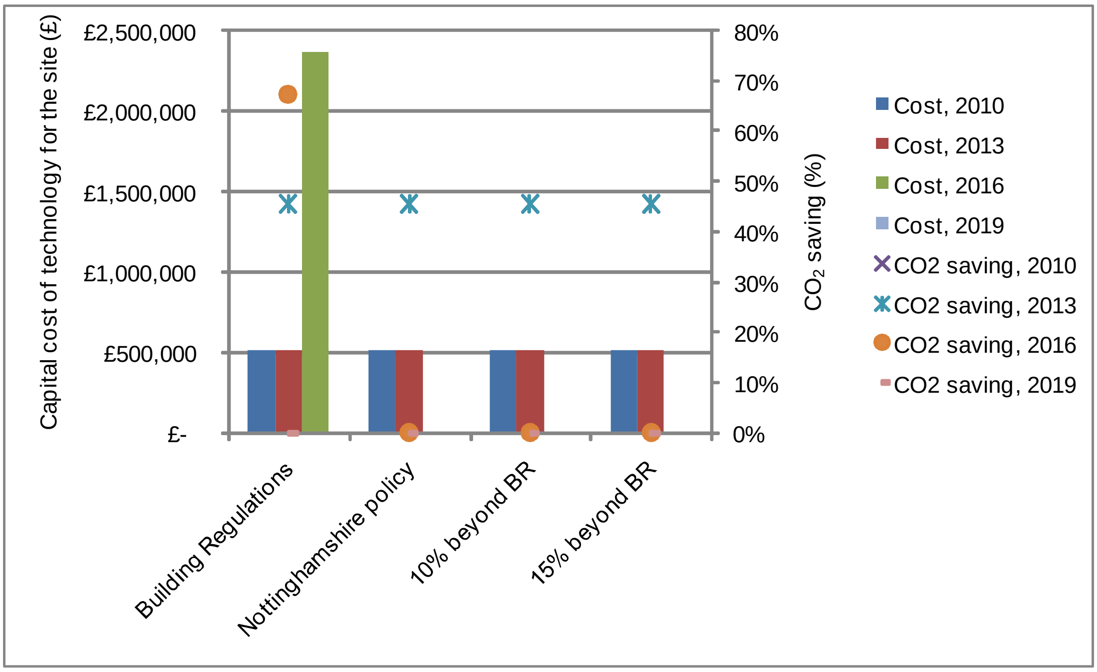

Figure 49 Comparison of indicative costs and savings on regulated CO_2 emissions for a storage facility to comply with the different policy options (Source: AECOM analysis)

Policy	Technology Choice			
	2010	2013	2016	2019
Building Regulations	Biomass heating	Biomass heating	PV (med)+EE2	No Tech Option Available to meet Policy within Assumed Site Constraints
Nottinghamshire policy	Biomass heating	Biomass heating	No Tech Option Available to meet Policy within Assumed Site Constraints	No Tech Option Available to meet Policy within Assumed Site Constraints
10% beyond BR	Biomass heating	Biomass heating	No Tech Option Available to meet Policy within Assumed Site Constraints	No Tech Option Available to meet Policy within Assumed Site Constraints
15% beyond BR	Biomass heating	Biomass heating	No Tech Option Available to meet Policy within Assumed Site Constraints	No Tech Option Available to meet Policy within Assumed Site Constraints

Table 38: Potential technology choices for a storage facility to comply with the different policy options (Source: AECOM analysis)

Opportunity Area 2: District Heating

For areas where there is a source of waste heat available, such as a large power station, it may be feasible for a storage facility to connect to it, provided a district heating network was already in place. This development on its own would not be of sufficient scale to justify development of the main heating network linked to the source of waste heat.

Our calculations indicate that connection of the storage facility to a source of waste heat would result in around 41% savings on regulated CO_2 emissions at a capital cost in the region of £409,000, or around 7% of construction costs. This could be cheaper than the biomass heating option, but for a lower CO_2 saving.

This size of site may be large enough to justify an on-site gas-fired CHP system. However, our calculations indicate that this would cost in the region of £1,300,000 and CO_2 savings would only be 33% of regulated emissions. This is a lower saving than might be achieved with biomass heating, at more than double the cost.

Opportunity Area 3: Wind

For areas suitable for wind development, one or more small 15kW wind turbines may be feasible for inclusion in a development of this size, provided there is sufficient room on site to allow for a 150m separation from the nearest residential properties and 20m from the nearest road or railway. This would be more feasible for developments such as this which are not likely to be located close to residential areas.

Our calculations indicate that one small 15kW wind turbine could result in around 4% savings on regulated CO_2 emissions for a workshop development of this size, at a cost of around £19,000 installed. Several turbines would therefore be needed to comply with the policy requirements. Additional land and infrastructure costs would need to be factored in if the turbine were installed outside of the site boundary. Where feasible, this would be the cheapest option for reducing CO_2 emissions to the level required by the policy options under consideration.

This type of development may be large enough to justify investment in a large scale 2MW wind turbine, particularly to ensure compliance with the requirements in later years when the cost of providing sufficient PV is greater than the cost of a large turbine. This would add about 29% to construction costs, but would result in CO_2 savings well in excess of the likely emissions from a development of this size.

Conclusions

There are feasible options for complying with all policies in earlier years on an energy constrained site. When higher energy efficiency standards are introduced for non-residential buildings with the 2016 update of the Building Regulations, achieving an additional saving from renewable or low carbon technologies is not considered feasible according to our analysis. No technology options have been identified which would allow a storage facility on a constrained site to achieve the zero carbon requirement under the Building Regulations from 2019 onwards, based on the current definition of zero carbon for dwellings (

Table 33).

Connection to district heating, where an established network is available, would offer lower CO_2 savings than biomass heating on-site, but could also be a cheaper option.

A large wind turbine may be feasible on the site of a new storage facility, such as the turbine at the B&Q site at Manton Wood. This would deliver the highest CO_2 savings of all the options. If a large turbine cannot be accommodated, several small turbines may be an appropriate alternative.

Policy	Feasible?				Comments
	2010	2013	2016	2019	
Building Regulations	✓	✓	✓	×	▪ For the earlier years, biomass heating may be a preferred choice. Feasibility of this option will depend on the site having suitable access for solid biomass deliveries and sufficient storage space for fuel. As there is no AQMA in the district currently, it is not anticipated that air quality will affect feasibility. ▪ PV may be proposed to meet higher standards, so roof design would need to optimise orientation and minimise overshading to get the maximum output.
Nottinghamshire policy	✓	✓	×	×	▪ See comments on biomass above. ▪ No options identified for compliance with higher standards after 2016.
10% beyond BR	✓	✓	×	×	▪ See comments on biomass above.

					▪ No options identified for compliance with higher standards after 2016.
15% beyond BR	✓	✓	✗	✗	▪ See comments on biomass above. ▪ No options identified for compliance with higher standards after 2016.

Table 39: Comparison of feasibility of complying with the different policy options for a storage facility (Source: AECOM analysis)

Table 40 shows the percentage uplift on base construction costs [59] in complying with the different policy options for a typical storage facility.

Policy	Potential Cost of Compliance (% of Construction Cost)			
	2010	2013	2016	2019
Building Regulations	9%	9%	42%	-
Nottinghamshire policy	9%	9%	-	-
10% beyond BR	9%	9%	-	-
15% beyond BR	9%	9%	-	-

Table 40 Comparison of costs of complying with the different policy options for a typical storage facility. Construction cost for the "storage facility is estimated to be £5,580,000. Blank cells represent scenarios where no low carbon solution has been identified to meet policy (Source: AECOM analysis)