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Cleaner, Greener Energy Study: Report 1 - LDF Evidence base

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Contents

Executive Summary

Introduction

The Cleaner Greener Energy Study has been conducted on behalf of the authorities of Amber Valley, Derby City, Erewash and South Derbyshire. The study aims were three-fold, resulting in three individual reports:

- Prepare an 'evidence base' for the partner authorities' Local Development Frameworks, establishing the potential for the decentralised and renewable or low-carbon sources of energy and recommending carbon standards for future development
- Prepare recommendations on key carbon reduction opportunities (responding to the NI 186 performance targets), including analysis of options for the delivery of renewable energy generation. This work has a particular focus on Derby City.
- Providing guidance on sustainable construction issues (for Development Control officers and the developer community)

This report focuses on the first of the aims, i.e. the planning evidence base.

The study area forms the Derby Housing Market Area (HMA) plus Erewash Borough Council area and is covered by the Three Cities Sub-Regional Strategy in the East Midlands Regional Spatial Strategy (RSS). Erewash Borough is located within Derbyshire but falls under the jurisdiction of the Nottingham Core HMA, for which a study was recently conducted by the Nottingham Energy Partnership[1], and which largely considered the carbon targets for the new development. We compare the conclusions of the two studies and draw out implications for the borough in section 13.

The adopted East Midlands Regional Spatial Strategy (RSS), published in March 2009, sets out that between 2006-2026 provision for 36,600 dwellings should be made within Derby HMA, broken down between Amber Valley (10,200), Derby City (14,400) and South Derbyshire (12,000). Along with 7,200 new dwellings in Erewash.

In terms of renewable energy the Regional Spatial Strategy in its Priorities for Energy state that "the scale of development in the Three Cities Sub-area offers opportunities for local distribution networks for electricity and heat using CHP. Micro-generation also has the biggest potential here. Large scale wind generation is limited, but there are opportunities for smaller scale at business park level, contributing to carbon neutral developments. There may be opportunities for generating energy from waste through a variety of different technologies." The Proposed Changes to the RSS also set ambitious targets for low carbon energy generation across the region.

In Building a Greener Future the government has announced that all new homes in England and Wales must meet zero carbon standards by 2016, with interim reductions in CO_2 emissions of 25% below current Building Regulations by 2010 and 44% by 2013. There are similar ambitions to cut carbon emissions from new non-domestic buildings by 2019. The government has also identified that the planning system has a key role to play in supporting the delivery of this timetable for reducing carbon emissions from domestic and non-domestic buildings by providing evidence for and helping to secure the delivery of low or zero carbon development, in areas that will be subject to significant levels of development in the coming years.

[1] *Towards a countywide sustainable energy policy for Nottinghamshire: Consultation Draft, 2009*

The aim of this element of the Cleaner Greener Energy Study is to provide an evidence base for the partner authorities' Local Development Frameworks. The analysis completed and the report herein is designed to be consistent with the requirements of Planning Policy Statement 1 – Climate Change Supplement, PPS1 - Developing Practice Guidance, PPS22 Renewable Energy, Planning for Renewable Energy: A Companion Guide to PPS22 and the East Midlands Regional Spatial Strategy (RSS). The report covers the following key elements: policy analysis / context, analysis of the relevant policy background and recent trends, renewable energy assessment and target setting. Opportunities, in terms of location or mix of land use, to exceed development carbon targets proposed are identified. Recommendations include justification of how the targets have been derived and guidance is provided on the how the targets might be achieved.

Key Findings

This report has been structured to provide a logical narrative of the analysis leading to proposed targets and policy recommendations.

Current and Future Energy Consumption

It begins with an assessment of baseline current and projected energy consumption and carbon emissions across the study area, broken down by authority and illustrated spatially where appropriate.

This found that overall energy consumption within the study area is approximately 15,000 GWh per annum, creating 4.5 million tonnes CO_2 per annum.

Energy consumption is dominated by heat whereas CO_2 emissions are more balanced between heat and electricity. Not surprisingly, Derby City is the highest consuming authority in the study area, reflecting the high density of commercial and industrial activities as well as the large number of dwellings.

Baseline consumption is likely to increase in the absence of policy levers. However, the Low Carbon Transition Plan[2] sets a path for lower consumption as a result of a series of binding and non-binding policy levers leading to the deployment of energy efficiency. A recent regional study commissioned by EMRA[3] takes this into account in forecasting the implementation of viable energy efficiency initiatives in both residential and non-residential buildings. This forms the projected baseline consumption against which our calculations of renewable energy potential are measured.

Existing Renewable Energy Capacity

Existing renewable energy capacity is then described on the basis of evidence assembled for this study. It was found that the availability of information about existing or planned installations is patchy; however, information has been drawn from a range of different sources with data based on a combination of hard information and estimates. Estimated installed capacity within the study area is around 13MW, equating to less than 0.5% of energy demand across the study area, with a further 4MW described as being "planned". Landfill gas and biomass heat

[2] *The UK Low Carbon Transition Plan - National strategy for climate and energy, DECC, July 2009*

[3] *Reviewing Renewable Energy and Energy Efficiency Targets for the East Midlands - Final report, EMRA, June 2009*

dominate current installed capacity whilst large wind turbines account for 80% of renewable energy currently being planned.

Low carbon policies and targets

We then go on to explore the relevant low carbon policies and targets at national, regional and local levels. These include both those related to renewable energy generally and low carbon development more specifically. Of particular relevance are the government's Low Carbon Transition Plan, the proposed changes to building regulations setting out a path to zero carbon development, the regional renewable assessment carried out by EMRA and local low carbon policies in place to date.

The Low Carbon Transition Plan and the Renewable Energy Strategy[4] present significant policy changes relevant to this study. The statements represent key milestones in the development of new policy, setting out long term aspiration and policy direction and specific commitments. However, there are a number of issues relevant to this study that remain unresolved or are likely to change in the near future, for example, the definition of the zero carbon homes (and non-residential buildings).

A range of policy and market mechanisms will potentially support building integrated and other decentralised energy projects and therefore reduce the burden on developers of delivering low and zero carbon buildings as well as supporting standalone wind and biomass projects. These include 'Clean energy cash-back' schemes: Renewable Heat Initiative (RHI) and Feed-in Tariffs (FITs). The Renewable Energy Strategy announced the establishment of The Office for Renewable Energy Deployment (ORED) which will drive delivery of these targets.

It is worth noting that zero carbon homes (which become a mainstream requirement from 2016) are predicted to make a relatively minor contribution to the overall carbon reduction targets, which are expressed over the LDF plan period up to 2026. This highlights the importance of supporting low carbon decentralised renewable energy projects as these are expected to deliver greater gains than zero carbon development policies for new build development. Over a longer time period clearly zero carbon development has a much greater impact as it continues to displace existing housing.

Zero carbon definition

One key area of policy development for the built environment relates to the changing building regulations that are planned to deliver zero carbon homes from 2016.

The Government has set out its aspirations for improving the carbon performance of new developments into the future with its announcement of the tightening of Building Regulations for new homes along the following lines:

- 2010 – a 25% carbon reduction beyond current (2006) requirements;
- 2013 – a 44% carbon reduction beyond current (2006) requirements; and,
- 2016 – a 100% carbon reduction beyond current (2006) requirements.

[4] *The UK Renewable Energy Strategy, DECC, July 2009*

In the March 2008 budget the Government also announced its intentions for all non-domestic buildings to be zero carbon by 2019. Therefore, the various phases of development in the district will face increasingly stringent mandatory requirements, and all development after 2016 is likely to need to meet zero carbon standards. However, the aspiration for zero carbon development by 2016 is very challenging and will require innovative approaches from both the public sector as well as the development industry.

The government is proposing to introduce a more flexible definition of 'zero carbon' to guide building policy, but this has yet to be fully agreed and may not be so for a number of years. In simple terms it will allow the removal of all carbon (regulated and unregulated) from a mixture of 'on-site' energy efficiency and renewable energy measures, together with an number of 'allowable solutions' which could include large scale 'off-site' renewable energy infrastructure, investment in energy efficiency measures for existing building stock, energy efficient white goods and building controls, or development tariffs , e.g. Section 106 contributions.

Whilst it seems likely that these costs of achieving these standards will ultimately be reflected in land values, in the short term, the cost of delivering zero carbon could potentially place a great burden on developers. The study considers this further in terms of the assessment of viability.

Renewable energy assessment

The next stage of the project has been an assessment of the local renewable energy potential. This is the heart of the evidence base, looking in particular at the major opportunities surrounding standalone decentralised wind and biomass development, opportunities in new build property and technologies within existing buildings. For each, we set out the methodology we have used including key assumptions and reference sources, the analysis results and the overall potential for two scenarios – a Base Case and an Elevated Case – representing a range of opportunities that we believe is defensible and reflects current and future policy options. Our work is presented for each local authority and in total for the study area, expressed in a range of ways including energy generated, percentage of heat and power needs that could be met from renewable sources and the tonnes of CO_2 that could be abated.

Wind

Wind energy resources and constraints have been mapped using GIS. These have been overlaid to form composite maps of 'constrained' and 'less constrained' areas of possible development, which have then been used to calculate the technical potential for wind energy development.

This technical potential has then been discounted to reflect development viability. Standalone development has been deemed viable for all sites with the potential for at least two large turbines where development costs and risks can potentially be justified. Smaller single-turbine projects are also deemed possible when developed on a 'merchant wind power' basis when sited on industrial land, normally with power sold on site.

For both scales of development, the potential number of turbines has been discounted further to reflect potential planning approval rates.

Modelling has been carried out for two scenarios representing a range of potential, called Base Case and Elevated Case:

The Base Case is considered to be broadly representative of the current situation taking into account development economics, existing market mechanisms, typical UK planning approval rates, etc. The Elevated Case is considered to be a reasonable scenario of elevated potential, primarily as a result of increased planning approval rates.

The GIS mapping shows that the wind resource is generally reasonably good, with much of the study area experiencing average wind speeds[5] in excess of 6 metres per second at a height of 45m above ground. This has been taken as a simplistic benchmark of project viability. The majority of the 'less constrained' areas identified lie in the south of the study area, in South Derbyshire.

Under Base Case conditions, around seven wind turbines could be developed by 2025 in Amber Valley, meeting 6% of its predicted electricity demand. Derby also has the potential to see wind development around the edge of the city including up to around four wind turbines by 2025, meeting just under 2% of the city's predicted electricity demand. Erewash has the potential for a similar number of wind turbines but due to its lower settlement density this could provide over 3% of its predicted electricity demand.

South Derbyshire has by far the greatest wind energy potential of all the authorities in the study area. This is due to its low settlement density, relatively high wind speeds and relatively low constraints. We estimated that forty seven wind turbines could be accommodated which would provide over 47% of its predicted electricity demand

It is worth noting that our analysis does not include a qualitative assessment of 'Landscape Carrying Capacity' but does model a buffer zone around existing or planned wind farms and models a maximum development density for new sites. These numbers should therefore be viewed as a maximum number that we see potentially coming forward under Base Case conditions.

With enhanced planning approval rates, wind energy could potentially supply over 10% of Amber Valley's electricity from around 12 turbines. Derby fairs slightly better with higher planning approval rates but is still unlikely to see more than a handful of large turbines being accommodated within the authority's boundary. Under the enhanced case conditions, around 6.5% of Erewash's electricity needs could be supplied from local wind projects by 2025/26, equivalent to around six large turbines. South Derbyshire could potentially meet almost 45% of its electricity needs from wind by 2020/21 and over two thirds by 2025/26. As stated before, this should be viewed as a likely upper limit as in practice it would mean around ten wind farms of 5-7 turbines each. This has been considered further when recommending targets.

Much of the study is within the zones of 'air safeguarding' consultation for East Midlands Airport and small civil airfields. Whilst this is not an 'absolute constraint' to the development of wind energy it is likely to have some influence on uptake, however, this is hard to predict since physical and communications interference will be assessed on a case by case basis. Furthermore, over the plan period it is anticipated that technical solutions could well overcome many concerns in this respect. For these reasons, in this study, the assessed potential for wind energy has not been artificially reduced to account for the potential impact of 'air safeguarding'.

Biomass

The overall approach to assessing the biomass resource potential has been to assess the resource information provided by the local authorities, DEFRA and other cited sources then

[5] *Annual Mean Wind Speed (using data from the NOABL database)*

apply resource uptake curves produced for DECC to define the likely roll-out of generation capacity across the study area. The assessment covers a range of feedstocks available for bio-energy in the region including: Crop residues, Animal manures, Energy crops, Residues from forestry operations, Sawmill co-products, Waste components of biogenic origin (wood waste, food/kitchen waste, green waste, paper and card).

Just one scenario is assumed for biomass development, based on all of the available local biomass resource being used according to the market uptake curves. It is assumed that this increase in use of biomass resources also reflects an increase in planning approval rates for biomass power and CHP projects, maturing of the supply chain and reduction / management of development and planning risk. The assessment also assumes that there is no net import of biomass fuels from beyond the study area. In practice it is likely that some larger projects will source biomass from outside the study area.

The conclusion from this work is that there is good potential for biomass development in Amber Valley, with over 3.3% of energy needs potentially met by 2025/26. This is equivalent to around 5 MWe of biomass power generation and $22MW_{th}$ of heat generation from biomass boilers. There is also good potential for biomass heat and power serving the city of Derby. The 2025/26 capacity is equivalent to around 30MWe of biomass CHP with half the heat used within a district heating system. Erewash could meet 2-3% of its energy needs from biomass heat and power by the end of the study period. As is the case for the wind analysis, South Derbyshire has the greatest biomass potential of the four authorities. By 2020/21 biomass could meet just under 4% of its energy needs, rising to nearly 5.5% by 2025/26.

New build development

The precise nature of the technical solution for a specific new build development will vary depending on the scale, density and mix of the development. However, in order to assess the potential carbon standards that could be appropriate for the proposed new development in the study area, it is necessary to identify the characteristics of the developments and their suitability for installing low to zero carbon technologies. To enable this analysis we have characterised each of the main development locations into one of five development types: Urban infill; Rural infill; Settlement extension; Urban extension and Large urban extension/ new settlement

The smaller developments that constitute urban and rural infill are typically not appropriate for communal systems and therefore the optimum energy strategy will consist of highly energy efficient buildings with individual building integrated technologies. The urban extensions are at the larger size and density necessary to support a communal system in some or all of their development areas, and are large enough potentially to establish a long term power purchase or co-development agreement with a wind turbine developer or justify the creation of a local community owned ESCo on behalf of the future development. It is deemed that projects over 1,000 dwellings could have the potential for biomass CHP serving the highest density zones. These are general rule of thumb categorisations and there will often be overlap between these development types within the characteristics of any specific development site.

The viability of meeting carbon standards needs to be considered in the context of changing building regulations that are intended to set increasingly stringent compliance standards during the plan period. For the purposes of this study, these changing standards have been accepted as representing a Base Case that will be viable for the property developer, either through adjusted land values or through the new support mechanisms such as the Feed in Tariff.

Exceeding changing Building Regulations

At present urban infill projects can potentially support 20% renewables given the right land values or through exploitation of the new Feed-in Tariff and up-coming Renewable Heat Incentive, which have been proposed to support development, and set a level to provide a reasonable rate of return. Capitalising this revenue from FIT/RHI at the point of sale of a property will be important for reducing the burden on developers. Financial arrangements such as Pay As You Save[6] also offer the potential to support micro-generation in new build development. 20% renewables provides a reasonable benchmark of what might be possible as an aspirational target.

Larger scale developments are more likely to be able to utilise biomass CHP or wind energy development in windy locations.

Modelling has been carried out for two scenarios representing a range of carbon standards, called Base Case and Elevated Case:

The Base Case assumes that all new developments meet the changing building regulations including achieving zero carbon through on site and off-site measures from 2016 for domestic measures and 2019 non-domestic measures. Renewable energy technologies are applied based upon what is deemed suitable for the expected 'type' of development

The Elevated Case assumes that all development has 20% renewables in the period 2010-2013. After this date, Code Level 4 (44% regulated carbon reduction) is assumed to be required for residential schemes which will supersede the Elevated Case target. Large urban extensions / new settlements (residential & non-residential) are assumed to be able to achieve zero carbon as of 2013.

It was found that, on average, the renewable energy potential associated with meeting the changing building regulations is equivalent to meeting 1-2% of the authorities' energy needs by 2025. This rises slightly for the Elevated Case but not dramatically, since all development is assumed to be zero carbon from 2016/2019.

With regards to Erewash Borough an earlier study[7] was produced for the Nottinghamshire Energy Partnership (NEP) on a Nottinghamshire basis. This is clearly relevant as the authority is within the Nottingham HMA. There is a good level of consistency in the conclusions from the two studies. Both studies recommend seeking at least a 20% contribution from renewable energy from all developments, although it is not explicit within the NEP study whether this applies to just unregulated emission or the combination of regulated and unregulated. However, the Camco study also recommends higher standards for the larger schemes beyond 2013, because of their greater carrying capacity. It is also worth noting that the NEP report (and the underlying modelling) does not take account of new national policy, including the implementation of heat and power tariffs, because it pre-dates this.

Uptake in the existing built environment

To assess the potential within the existing built environment, i.e. retrofit into existing buildings/land, within the study area, our assessment is informed by a recent study[8] commissioned by regional and central government, which considered the potential for microgeneration uptake in a number of regions including the East Midlands. Our analysis takes,

[6] *www.uk-gbc.org*
[7] *Towards a countywide sustainable energy policy for Nottinghamshire: Consultation Draft, 2009*
[8] *The growth potential for Microgeneration in England, Wales and Scotland, Element Energy, June 2008*

as our Base Case scenario, assessment of uptake based on the policy scenario of implementing both power and heat tariffs at a national level, which is currently in train. These tariffs are likely to be the key drivers in this market sector. The Elevated Case is a 30% increase on the Base Case to reflect additional local and regional support programmes that could potentially be provided.

The results of this analysis are that by 2025, micro generation can typically meet 1 to 2.5% of the authorities' heat and power energy in the base case, rising to 2 to 3.3% of energy in the Elevated Case scenario.

Bringing it all together

The overall results have then been benchmarked against regional targets for 2021. This date has been chosen as it approximately coincides with the national 2020 target for renewable energy so further comparison can reasonably be drawn.

The results show that, for the study area, under Base Case conditions, around 4% of heating energy could come from renewable source whilst 14% of electricity could be renewable as a result of the good wind resource in South Derbyshire. Overall, 7% of heat and electricity needs could be met from renewables, significantly exceeding the 4% target in the regional baseline scenario. In contrast, the Elevated Case could deliver around 5% of heating energy from renewable sources and 19% of electricity. Overall, 9% of heat and electricity needs could be met from renewables, meeting with the 9% target in the regional 'energy efficiency and high renewables' scenario.

On average for the two scenarios, around a quarter of a million tonnes CO_2 per annum could be saved in 2021 compared with 2006 baseline emissions for the study area. This is a saving of around 6% when including transport emissions, or 9% when only considering emissions from thermal or electrical energy consumption.

Proposed targets

Overall, the analysis demonstrates that the wind and biomass resources in the study area are significant and greatly exceed the equivalent carbon saving required for achieving the zero carbon development. In high density city centre sites, 70% on-site carbon compliance, required for the zero carbon standard will be challenging for logistical reasons, and this highlights the need for developing zero carbon district heating schemes, where possible.

In general the Elevated Case carbon standards should be technically feasible and financially viable as described in the scenario definitions. Whilst they include targets, in some areas ahead of the stated 'road map' for zero carbon, they reach the same zero carbon milestones and so merely serve to accelerate progress. This has proved elsewhere as an important measure to encourage preparedness in the development market and within Planning Authorities. The recommended targets are also designed to encourage the adoption of Low and Zero Carbon technologies (rather than simply energy efficiency) since this will facilitate the early development of local supply chains and the hence more rapidly deliver cost reductions, reducing the financial burden on future development.

The targets are proposed to apply to projects at the point of completion, rather than planning determination. In this way targets are being applied as they are through the application of building regulations. This has a two key consequences, firstly, on many schemes a range of standards could apply to different elements of the development and, secondly, their will be a strong onus on Development Control to ensure standard are met in practice. The first point should be resolved through providing clarity around the policy, negotiating reasonable conditions linked to the changing targets. The second issue will require development of the in-house capabilities and would suggest the need for additional monitoring and assessment practices.

The proposed carbon targets are summarised in the table below with proposed changes in the relation to the UK zero carbon 'road map' identified below that.

	Residential			**Non-residential**		
	Regulated emission reduction against Part L 2006 *(CSH equivalent[10])*	*Un-regulated*	Proposed % reduction by LZC[11]	Regulated emission reduction against Part L 2006	*Un-regulated*	Proposed % reduction by LZC
2010-13						
	35% *(Code 3-4)*	*0%*	20%	0%	*0%*	10%
2013-16						
Smaller development types	44% *(Code 4)*	*0%*	26%	25%	*0%*	10%
Large developments types including mixed use	100%[12] *(Code 4-5)*	*100%*	50%	44%	*0%*	*26%*
2016-19						
Smaller development types	100%[12] *(Code 4-5)*	*100%*	50%	44%	*0%*	*26%*
Large developments types	100% [12] *(Code 4-5*	*100%*	50%	100%[12]	*100%*	50%

Key changes against the UK 'road map':

- Requirement for a 35% carbon reduction for residential development between 2010 and 2013 (10% ahead of the 'road map') with 20% renewables from 2010 (for residential development)
- The targets for non-residential development (where its not part of a large mixed use scheme) are not proposed to be accelerated ahead of Building Regulations other than the 10% renewable requirements which is an obligation set by the Regional Spatial Strategy

[10] *Code for Sustainable Homes - for energy credits only*
[11] *LZC – Low and zero carbon technologies*
[12] *This assumes 70% of the carbon reduction is achieved "on-site" as per recent government announcements.*

- From 2013 onwards the development standards remain consistent with the 'road map' for smaller development types (rural and urban infill and smaller settlement extension)
- For the period 2013-2016 the development standards for larger development (urban extension, major urban regeneration and large urban extension / new settlement), both residential and mixed use, are accelerated ahead of the 'road map'
- The targets for residential development from 2016 is consistent with the roadmap.
- For the period 2016-2019 large non-residential schemes (whether solely non-residential of mixed use) are accelerate to the zero carbon standard.

It is proposed that these targets be set as aspirational performance-based targets to be accompanied by a viability test that is applied when reviewing planning applications. We have set out a series of recommended policy approaches that could be included with the emerging LDFs within the Study Area.

Finally, it is important to note that Erewash Borough falls under the auspices on the Nottingham Core Housing Market Area (HMA) and a similar study commissioned by the Nottingham Energy Partenership (NEP)[13] conducted in early 2009 proposed carbon targets which are to some extent at variance to the recommendations we make here. The differences are discussed in Section 13, but in summary:

- The NEP report recommends targets to be applied against regulated and unregulated carbon emission[14], which essentially significantly raises the carbon reduction burden from 2010 onwards.
- The NEP report does not propose acceleration of targets for larger residential and mixed use development unlike the Camco report
- The Camco recommendations qualify the zero carbon standard as requiring 50% renewables, a total regulated carbon reduction of 70% and allowing offsetting via "allowable" solutions of the unregulated emissions, whilst the NEP study does not.
- The NEP report does not take account of new national policy, including the implementation of heat and power tariffs, because it pre-dates this. The financial benefits gained from these measures underpin the Camco case for accelerated targets.

Clearly there is potential for some discontinuity between Erewash and neighbouring authorities, which ever set of targets is chooses to adopt.

Policy Recommendations

It is proposed that the authorities set aspirational wind and biomass energy targets per district, based on the Elevated Case scenario and establish protocols for the wind energy planning consideration process, such as those developed by REA[15]/BWEA[16]. These could be aggregated targets for large decentralised generation or more specific to each technology. Either way, targets could set a level of expectations that might be helpful when determining applications.

[13] Towards a countywide sustainable energy policy for Nottinghamshire: Consultation Draft, 2009
[14] Regulated is carbon emissions associated with fuel and energy consumption due to those items regulated under Building Regulations, which are largely due to the operation of a building, Unregulated emissions are those associated to the uses in the building which are independent of the building, largely catering and the small power consumptions not associated to the building operation
[15] Renewable Energy Association
[16] British Wind Energy Association

For new build development, it is proposed that the authorities set out the trajectory to zero carbon as baseline expectation to be considered alongside the intended phasing of the development. Each authority should seek evidence from developers as to how they intend to meet these increasingly stringent baseline targets, including:

- Proportion of the target to be met from on-site measures
- Infrastructure to be provided in support of on-site measures (e.g. district heating)
- Exploration of opportunities to exceed the target
- Strategy for safeguarding opportunities to exceed the target
- Strategy for anticipating policy and technology changes over the development plan period
- Exploration of opportunities for off-site measures to be developed in the district and wider study area
- Exploration of opportunities to support the development of low and zero carbon infrastructure serving existing development

Beyond this, we propose that the authorities should set Elevated Case targets as aspirational performance-based targets and seek evidence of a viability assessment to accompany planning applications. This should include:

- Technical feasibility – including space availability, integration with building energy systems, impact on townscape, running hours of plant
- Financial viability – including capital cost and whole life cost over plant lifetime taking into account market mechanisms such as feed in tariffs. Measure using indices such as Internal Rate of Return for benchmarking against typical investment hurdle rates for delivery by ESCos.
- Deliverability – including opportunities and requirements for delivery of infrastructure through Energy Services Companies
- Impact on overall viability of the development using an assessment method such as the Three Dragons model that will examine factors such as land value, sale value, construction costs and other S106 contributions

It is proposed that performance targets be expressed in terms of CO_2 reduction to be consistent with the Code for Sustainable Homes. If the achievement of advanced targets is deemed viable then set these targets as planning conditions and agree these as part of the planning approval process. If the achievement of these targets through on-site measures alone is not possible then the authorities should test the viability of the development with a “buy out” price for off-site solutions. They should set a formula for updating this “buy out” price periodically in line with emerging government policy.

In the absence of a fixed “buy out” price a minimum of £100/tonne CO_2 and a 30 years project life should be set in line with current thinking in the industry. Furthermore, in the absence of a standard national mechanism for securing off-site solutions, the authorities should support the identification of potential off-site solutions for direct investment by the developer.

They should also consider the establishment of a local-authority controlled Carbon Investment Fund to channel S106 contributions for off-site solutions into local low carbon projects. If such a mechanism were to be used then it will be important to choose projects that are demonstrably “additional” to current activity, i.e. projects that wouldn’t have gone ahead without the investment. This might include wind energy projects on marginal sites or advanced energy efficiency measures in existing buildings that are not already subsidised through CERT. Examples of this approach exist in other authorities such as Milton Keynes. Note that the rules on “additionality” of allowable solutions to meet the zero carbon definition have yet to be agree and will be examined by a working group of the Zero Carbon Hub over the coming months.

For micro generation in existing buildings, it is recommended that the LDFs be updated to acknowledge the permitted development status now being granted for small scale technologies. Simple protocols should set out the planning information required in support of biomass boiler installations and other non-permitted development. The development of micro generation technologies in existing buildings could potentially be supported further through channelling S106 contributions for off-site allowable solutions

In summary our recommendations from the study are as follows:

Recommendation 1: To require developers to achieve carbon reduction targets for new development as set out in Table 56, and to consider the development of community heating and CHP.

Recommendation 2: Establish a regime of target and viability assessment suitable to support compliance to elevated targets

Recommendation 3: The authorities to consider the establishment of a Carbon Investment Fund, either unilaterally, or as a group, to support delivery of local carbon reduction measures.

Recommendation 4: Conduct high resolution heat mapping to consider potential for the community heating, particularly around areas of major growth

Recommendation 5: Conduct analysis of the potential for fuel switching in off-gas grid locations.

Recommendation 6: Set out Permitted Development rights through Local Development Orders as part of the LDF for renewable energy and provide specific and clear planning protocols for those small-scale technologies not classed as Permitted Development

Recommendation 7: The authorities develop clear criteria-based planning policy for the key standalone generation technologies, notably wind energy and bio-energy projects

Recommendation 8: The authorities provide maps showing indicative areas of potential for wind energy development

Recommendation 9: Publish, within each authority's LDF documents, summaries of the renewables energy resource potential and its potential long terms contribution in comparison to national and regional benchmarks

Recommendation 10: Conduct detailed annual monitoring of renewable energy uptake in each authority.

Recommendation 11: The authorities should consider the establishment of an expert enforcement assessments service, ideally servicing all authorities in the Derby HMA or similar collection of authorities

Recommendation 12: The authorities should provide training for Development Control officers to conduct sustainable energy assessments (unless authorities are relying on an external assessment service), and support information sharing with developers

Recommendation 13: Require suitable on-site carbon monitoring to be installed in major new development to enable assessment of long-term (carbon) performance compliance

Recommendation 14: Alongside Recommendation 13 the authorities, should consider establishing a requirement for a financial bond returnable on achievement of long term (carbon) performance compliance

Non-Planning Delivery Mechanisms

It is proposed that a series of non-planning delivery support mechanisms also be put in place to encourage renewable energy development. The authorities are in a prime position to see the “big picture” of development in their area and would be well placed to coordinate the development of low carbon infrastructure between developments. This could be a brokering role or something more substantial. Given the challenges of meeting the likely target of 70% on site carbon compliance from 2016, the local authorities should continue to evaluate the potential for development of a low carbon community energy system with strong local authority involvement. This is particularly important for dense city centre schemes that may struggle establish biomass energy centres within the ‘redline’ of their planning application.

The authorities could go further in seeking to secure structural funds to enable the delivery of low carbon infrastructure both capital funds and development funds to mitigate early stage development risk. Examples of this include European Regional Development Funds (that have been used to support the development of biomass CHP in the East of England), European Investment Bank investment (such as being sought for low carbon refurbishment of existing buildings in the South East) and Housing Growth Funds from CLG (that may be able to support the development of low carbon infrastructure projects in support of growth projects).

Finally, the authorities should continue to demonstrate leadership by developing low carbon projects on council land and buildings and providing public buildings to be anchor projects for low carbon district heating schemes.

1 Introduction

This report has been prepared by Camco for Derby City Council (DCC) Amber Valley Borough Council (AVBC), South Derbyshire District Council (SDDC) and Erewash Borough Council (EBC).

The Derby Housing Market Area (HMA) is made up of DCC, AVBC and SDDC. EBC, although located in the County of Derbyshire, is within the Nottingham Core Housing Market Area. The four councils along with Derbyshire County Council have appointed Camco to undertake the Cleaner, Greener Energy Study, looking at:

- Preparing an 'evidence base' for the partner authorities' Local Development Frameworks, establishing the potential for the decentralised and renewable or low-carbon sources of energy and recommending carbon standards for future development
- Preparing recommendations on key carbon reduction opportunities (responding to the NI 186 performance targets), including analysis of options for the delivery of renewable energy generation. This work has a particular focus on Derby City.
- Providing guidance on sustainable construction issues (for Development Control officers and the developer community)

This report focuses on the evidence base for LDF development.

All the local authorities involved in the study are signatories of the Nottingham Declaration on Climate Change. NI186 has also been adopted by the two Local Area Agreements covering Derbyshire and Derby City which again provides an element of commonality between partner authorities.

A glossary of term use in the study is included in Appendix I.

1.1 Study Area Context

The study area covers the administrative areas of Amber Valley Borough Council, Derby City Council, Erewash Borough Council and South Derbyshire District Council which collectively cover an area of around 79,000ha, with a population of just under 560,000.

The study area forms the Derby Housing Market Area (HMA) plus Erewash Borough Council area and is covered by the Three Cities Sub-Regional Strategy in the East Midlands Regional Spatial Strategy (RSS). The Sub-area has now received Growth Point status over the period 2006-2021. This agreement will help to secure investment in the necessary infrastructure to ensure that the level of housing envisaged in the RSS can be developed.

1.1.1 Regional context and energy considerations

The adopted East Midlands Regional Spatial Strategy (RSS), published in March 2009, sets out that between 2006-2026 provision for 36,600 dwellings should be made within Derby HMA, broken down between Amber Valley (10,200), Derby City (14,400) and South Derbyshire (12,000). Along with 7,200 new dwellings in Erewash.

Because the need for new housing cannot entirely be met within the City of Derby boundaries, the RSS states that 24,760 of these houses should be built within or adjoining the built up area of Derby (the Principal Urban Area), including 6,430 dwellings in South Derbyshire and 630 dwellings in Amber Valley.

The regional housing requirements for Erewash are set out under the Nottingham Core HMA and Hucknall section of the RSS. This states that between 2001-2026, 8,650 should be provided within Erewash, with 1,640 within or adjoining the Nottingham Principal Urban Area. Development in the remainder of the District will be located mainly at Ilkeston.

The forecasted housing numbers, which have subsequently used for analysis, are shown in Appendix II.

In terms of renewable energy the Regional Spatial Strategy in its Priorities for Energy state that "the scale of development in the Three Cities Sub-area offers opportunities for local distribution networks for electricity and heat using CHP. Micro-generation also has the biggest potential here. Large scale wind generation is limited, but there are opportunities for smaller scale at business park level, contributing to carbon neutral developments. There may be opportunities for generating energy from waste through a variety of different technologies. The Proposed Changes to the RSS also set ambitious targets for low carbon energy generation across the region.

In "Building a Greener Future" the government has announced that all new homes in England and Wales must be zero carbon by 2016, with interim reductions in CO_2 emissions of 25% below current Building Regulations by 2010 and 44% by 2013. There are similar ambitions to cut carbon emissions from new non-domestic buildings by 2019. The government has also identified that the planning system has a key role to play in supporting the delivery of this timetable for reducing carbon emissions from domestic and non-domestic buildings by providing evidence for and helping to secure the delivery of low or zero carbon development, in areas that will be subject to significant levels of development in the coming years.

The proposed scale of development within the Derby Housing Market Area (HMA), particularly the area around the edge of Derby and the Sub-regional centres of Alfreton, Belper, Heanor, Ripley and Swadlincote is set for more significant growth, will have a significant demand for energy that may provide the opportunity for energy solutions at a scale that would not be viable if each part of the HMA was considered separately. The development of an integrated decentralised, renewable and low carbon energy strategy for the area, particularly those areas identified for significant growth, therefore has the potential to deliver significant additional CO_2 savings, and reduce the level of cost to the developer. This may also be relevant to the Borough of Erewash, although development in this area is directed towards the Nottingham conurbation.

1.1.2 South Derbyshire District Council

Introduction

The district of South Derbyshire covers an area of nearly 34,000 hectares (112 square miles) and is bounded by the City of Derby to the north, Burton on Trent to the West and Ashby-de-la-Zouch to the East. The urban area making up Swadlincote has a population of around 35,000 and is the largest settlement and commercial centre for the District which had a total population of 92,700 at 2008.

Housing Growth

The Adopted Regional Spatial Strategy requires that 600 homes be built in South Derbyshire each year (12,000 between 2006-2026).

Of these 320 per annum minimum (6,400 over plan period) are required to be within or adjoining Derby City. Around 2,700 homes have already been granted outline consent at 3 sites: Highfields Farm, (near Littleover), Stenson Fields (near Sinfin), Boulton Moor (near Alveston).

In essence therefore there is a need for an additional 3,700 homes (minimum) in the plan period. Due to a lack of brownfield sites in this area it is likely that these sites will be greenfield, urban extensions. Greenbelt covers around 12% of the District.

Elsewhere in South Derbyshire the RSS requires 5,600 homes be built mainly at Swadlincote, including sustainable urban extensions as required. A relative lack of brownfield land will mean that sustainable urban extensions to Swadlincote will need to be provided on greenfield sites.

The RSS does not rule out development at large brownfield sites such as Drakelow or modest extensions to larger villages but most growth would have to be 'mainly' at Swadlincote to conform with the Adopted RSS. Should new development in the villages be required, it is possible that these would be relatively lower density (compared to developments in the PUA or Swadlincote).

Likely future Combined Cycle Gas Turbine power stations offer potential for CHP at Centrum Burton On Trent, (just outside the District), Willington and Drakelow.

Around half of the District falls within the National Forest. This area is a potential constraint to wind power, but offers significant potential for woody biomass.

Other issues which may be of relevance include:

- the indication, in the Regional Spatial Strategy, of the need for a rail served storage and distribution depot in the HMA. To date the District Council has received a planning application for such a site (comprising of 108,000 m^3 of commercial space at Burnaston Cross, near Willington). This application will be considered at appeal from 20 October 2009.
- Works towards progressing an application for a similar scheme at Egginton Common (immediately South of Toyota) on a 200 hectare site is understood to be ongoing. Any potential employment development in this area may offer potential to exploit CHP from the proposed Willington CCGT power station.
- Similarly an Application for Drakelow Park (2239 homes) is well related to Burton on Trent and CHP from Drakelow or Centrum could offer potential for this and wider developments within or around Burton.

1.1.3 Amber Valley Borough Council

Introduction

Amber Valley Borough is located to the east of Derbyshire, between the city of Derby to the south and Chesterfield to the north, the area gets its name from the River Amber, which flows, through its boundaries. The Borough can be described as "significant rural" (Defra 2005 classification system) having a mixture of urban and rural settlements. It consists of four main market towns and is divided into twenty-three wards and rural parishes. Its four market towns all have very distinct character, environmental and socio-economic profiles, with Belper being the largest, followed by Heanor, Ripley and Alfreton consecutively. Amber Valley covers over 265 square kilometres and apart from its four main market towns, it is largely rural in character.

Housing Growth

The Adopted Regional Spatial Strategy requires that 510 homes be built in Amber Valley each year (10,200 between 2006-2026).

The RSS requires that at least 30 dwellings per annum are to be located within or adjoining the Derby PUA which could be in the form of sustainable urban extensions as required. The remaining dwellings will be located mainly at Alfreton, Belper, Heanor and Ripley, including sustainable urban extensions as required.

It should however be noted that in the last 5yrs 87% of dwellings built in Amber Valley have been built on brownfield land and though highly desirable this pace cannot be sustained and it is very likely that sustainable urban extensions to four market towns in Amber Valley will need to be provided on greenfield sites.

Other Issues

A substantial area of the borough's built and natural environment has been accorded international, national and locally protected status, the most significant of which is the Derwent Valley Mills WHS and associated buffer zones. The boundary of the DVMWHS encloses an area of approximately 1229 hectares and the site measures some 24km stretching from Masson Mill in the north to Derby Silk Mill in the south, with a buffer zone of approximately 4363 hectares. A significant portion of the site falls within Amber Valley Borough, much of it is a multi-functional space with distinctive physical and cultural landscapes and architecture, which are of outstanding universal value. It is therefore a very sensitive area within the Borough and a key constraint to any major renewable energy and low energy development in the Borough.

Similarly, its Green Belt makes up approximately 30% of its total area and designated conservation areas are dotted across the borough. All these pose significant constraints to the uptake of renewable and low-carbon energy resources.

The physical landscape of the borough is quite varied with valleys, flat plains and hilly areas, which potentially are amenable to different renewable and low carbon technologies.

The Authority has witnessed a gradual increase in applications for small renewable energy and low carbon developments and it is envisaged that the number of applications for small, localised and disaggregated renewable or low carbon assets will increase. There is therefore a need to ensure that appropriate technologies are used in the most efficient way and most appropriate sites.

Other important constraints include:

- Tree Preservation orders dispersed across the whole of the Borough
- Areas susceptible to Flood Risk in the Borough often associated with the local hydrology

1.1.4 Erewash Borough Council

Introduction

Located within south-east Derbyshire, Erewash lies between the cities of Derby and Nottingham, with 72% of the Borough accordingly protected by green belt policy. Rural landscapes and villages occupy western and central areas with Erewash being dominated by the two market towns of Ilkeston and Long Eaton which are located in the east of the Borough. Erewash has a population of around 110,700 with 90% of households residing in the urban areas. Due to the easterly concentration of population and patterns of commuting, the Borough has been grouped as part of the Nottingham Core Housing Market Area as a regional mechanism to co-ordinate long-term growth.

Housing Growth

The Adopted East Midlands Regional Spatial Strategy requires that a minimum 360 homes be built in Erewash each year (7,200 between 2006-2026). Of these 360 homes per annum, a minimum of 100 homes p.a. will be needed within or adjoining Long Eaton, Sandiacre and

Sawley (i.e. Erewash's proportion of the Nottingham Principal Urban Area 'PUA'). The Regional Spatial Strategy also recognises Ilkeston as a Sub Regional Centre and as such a focus of new growth.

Largely owing to the presence of the Green Belt, areas of future growth in Erewash is constrained especially around the PUA. As such, it is likely that there will be a large amount of urban infill development whilst new development in the villages will likely only be modest. However, sites at Stanton and Pewit within Erewash have both been identified as possible locations for large-scale sustainable urban extensions (SUE). Both sites adjoin the Sub-Regional Centre of Ilkeston and their development avoids any intrusion into the Green Belt. Most notably, the regeneration of Stanton ironworks could produce as many as 4,000 new homes as well as the generation of new employment premises and other community infrastructure. These strategic sites present numerous opportunities for renewable energy which need to be maximised.

1.1.5 Derby City

Introduction

Located at the heart of the study area, Derby is a compact city extending to some 7,803 ha with a population of 242,582 (2007). The city is the third largest regional centre in the East Midlands, with links to nearby Nottingham and Leicester as part of the 'Three Cities' sub region. Derby provides jobs and services for a wide area outside its boundaries and has close connections with communities in the adjoining districts of South Derbyshire, Amber Valley and Erewash. Two-thirds of the city is built up. The remainder is open and undeveloped, providing parks and green space, wildlife areas and farmland. The dominant natural feature is the Derwent Valley which runs through the heart of the city.

Housing Growth

The Adopted Regional Spatial Strategy requires that 720 homes be built within the Derby principal urban area (PUA) each year (14,400 between 2006-2026). Housing growth will need to balance the need to regenerate parts of the existing urban areas with the sustainable expansion of the city, particularly to the south into South Derbyshire.

1.2 Aims and objectives of this report

The aim of this study it to provide an evidence base for the partner authorities' Local Development Frameworks that is consistent with the requirements of Planning Policy Statement 1 - Climate Change Supplement, PPS1 - Developing Practice Guidance, PPS22 Renewable Energy, Planning for Renewable Energy: A Companion Guide to PPS22 and the East Midlands Regional Spatial Strategy.

The study (and this report) covers the following key elements:

- Policy Analysis / Context - an up to date analysis of decentralised, renewable and low carbon energy policy at the national and regional level to set out the context for local policy
- Analysis of the relevant policy background and recent trends and assess their impact on the study area and where relevant individual authorities
- Renewable Energy Assessment - an assessment of the potential, including mapping, for decentralised and renewable or low carbon energy technologies within the study area, taking into account opportunities currently available and those that will arise through future development. The assessment takes into account all relevant technologies and considers feasibility, viability and opportunities / constraints for delivery.
- Target Setting - following on from the assessment, recommendations are made to for decentralised generation targets and carbon targets for new development, identifying where we consider it appropriate to accelerate beyond nationally proposed targets
- Guidance as to how the targets can be achieved

1.3 Structure of this report

This report has been structured to provide a logical narrative of the analysis leading to proposed targets and policy recommendations. It begins with an assessment of baseline and projected energy consumption, as well as carbon emissions across the study area, broken down by authority and illustrated spatially where appropriate. Existing renewable energy capacity is then described on the basis of evidence assembled for this study.

We then go on to explore the relevant low carbon policies and targets at national, regional and local levels. These include both those related to renewable energy generally and low carbon development more specifically. Of particular relevance are the government's Low Carbon Transition Plan, the proposed changes to building regulations setting out a path to zero carbon development, the regional renewable assessment carried out for EMRA[17] and local low carbon policies in place to date.

An assessment of the local renewable energy potential then follows. This is the heart of the evidence base, looking in particular at the major opportunities surrounding standalone decentralised wind and biomass development, opportunities in new build property and technologies within existing buildings. For each, we set out the methodology we have used including key assumptions and reference sources, the analysis results and the overall potential for two scenarios – a Base Case and an Elevated Case – representing a range of opportunities that we believe is defensible and reflects current and future policy options. Our work is presented for each local authority and in total for the study area, expressed in a range of ways including energy generated, percentage of heat and power needs that could be met from renewable sources and the tonnes of CO_2 that could be abated.

[17] *Reviewing Renewable Energy and Energy Efficiency Targets for the East Midlands - Final report, EMRA, June 2009*

Conclusions are drawn on the viability – technical, financial and in planning terms – of setting particular targets and recommendations are made. These include high level 2020/21 renewable energy scenarios for the study area (for comparison against pro-rata national targets) which cover wind, biomass, new build and existing buildings and carbon standards for specific types of new build development. We also make recommendations for where and when it might be appropriate to set standards that exceed the minimum required as part of national building regulations.

We then make a series of recommendations for policy formation in support of these targets. These include recommendations on the structure of performance-based targets, the evidence to be sought from developers in demonstrating a thorough exploration of the opportunities and constraints of each site, tests for viability and proposals for how the local authorities should respond depending on the results of these viability tests. We have anchored the recommendations in precedents from other local authorities as well as sign posting other best practice guidance. We also propose some best practice approaches to monitoring the effectiveness of the policies. Finally we propose some non-planning delivery support mechanisms for consideration by the local authorities as accompanying actions to complement effective planning policies.

A glossary of terms used in the study is included in Appendix I.

2 Energy Consumption and Carbon Emissions

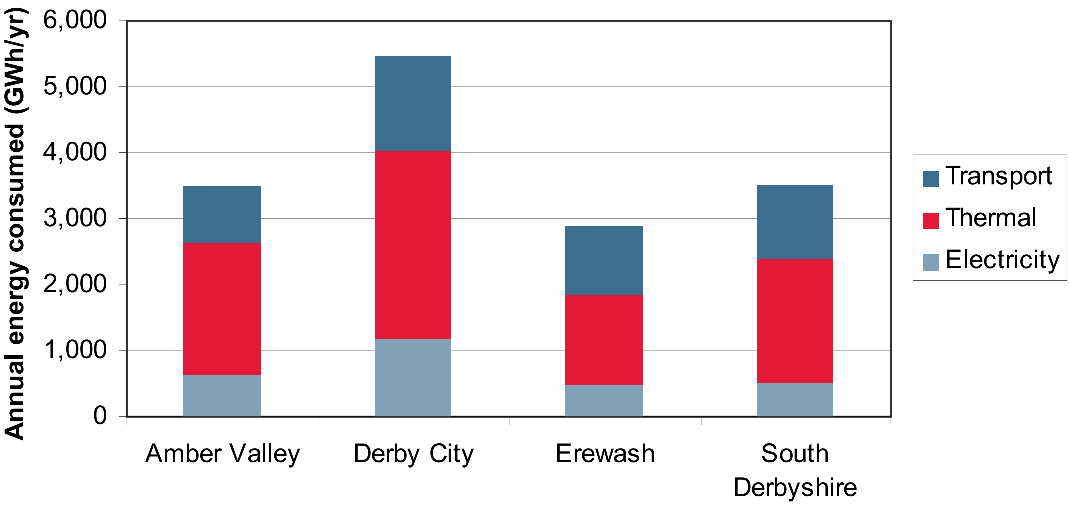
It is essential firstly to understand current and future energy consumption and carbon emissions of each of the Local Authorities within the study area. Emissions are measured in terms of "kilo tonnes of carbon dioxide emitted per year", or $ktCO_2/yr$. Energy is shown in Gigawatt hours (GWh). This study concentrates its analysis on the built environment, however, transport carbon emissions are shown to enable comparison of total energy consumption against renewable energy generation, which is how the UK target is presently expressed. Transport itself is outside of the scope of this study.

2.1 Current energy consumption

Figure 1 shows that energy consumption is dominated by heat whereas Figure 2 shows that CO_2 emissions are more evenly split between the three source categories[18]. Not surprisingly, Derby City accounts is the highest consuming authority in the study area, reflecting the high density of commercial and industrial activities as well as large number of dwellings.

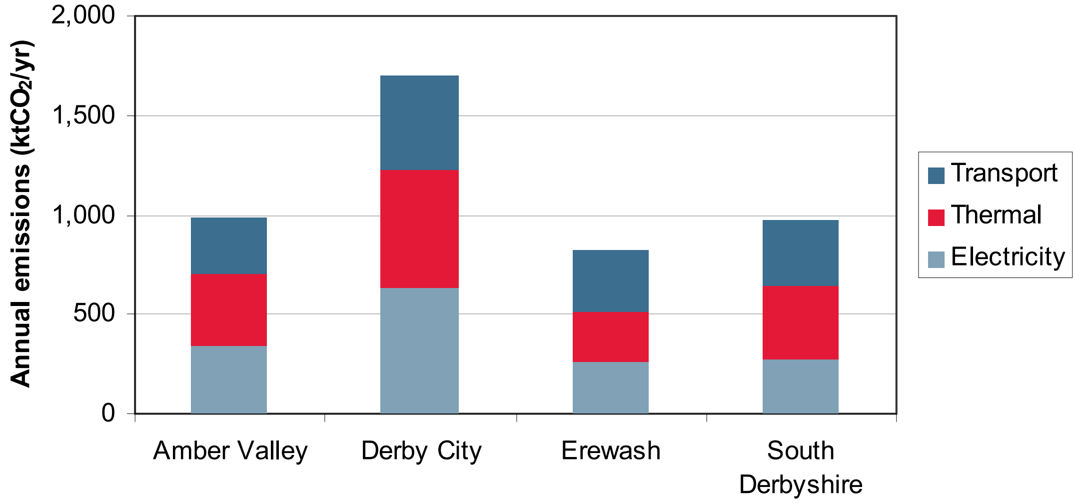
It is important to note that DECC, who publish the source data, seek to protect the identity of very large consumers and so these are sometimes excluded from the data sets, with no indication of the scale of additional consumption. For the study area, this only affects Derby and these figures are a conservative illustration of consumption.

Figure 1: Estimated energy consumption for 2007 (Source: BERR and DECC)



[18] *Defra 2009 conversion factors show that, at present, one unit of grid electricity is over 2.5 times more carbon intensive than one unit of natural gas (0.541 klgCO_2/kWh for grid electricity consumed (2007), and 0.204 kgCO_2/kWh for natural gas (net))*

Figure 2: CO_2 emissions for 2007 (Source: DECC NI186 data release[19])



Although Derby City has the highest CO_2 emissions, Table 1 demonstrates that it is in fact the most 'carbon efficient' on a per capita basis for its domestic component. Each Local Authority in the study area performs better than the overall East Midlands region except for Amber Valley.

Table 1: Per capita emissions based upon domestic energy use only, 2007 (Source: DECC NI186 release)

Per capita emissions (2007)			
	Emissions from domestic energy ($ktCO_2$)	**Population ('000s, mid-year estimate)**	**Per capita emissions (tCO_2)**
Amber Valley	**293**	**120.4**	**2.43**
Derby City	**514**	**237.9**	**2.16**
Erewash	**253**	**110.7**	**2.28**
South Derbyshire	**205**	**91.2**	**2.25**
East Midlands	***10,094***	***4,399***	***2.29***

2.2 Spatial distribution of energy consumption

Figure 3 to Figure 8 demonstrate the spatial distribution of gas consumption, and clearly illustrates that the developed areas of each authority are the most energy intensive. These maps help to visualise the spatial distribution of energy consumption, allowing us to begin to identify areas for intervention and develop strategies for targeting effort. Figure 3 also shows the location of a number of potentially large thermal energy users[20] as listed in Table 2, which provides some useful reference points and also helps explain apparent energy consumption anomalies, such as the very large gas consumption in the Northwest corner of South Derbyshire (predominantly rural), which is explained by the presence of the Toyota manufacturing plant.

[19] Some assumptions have been made to establish which components of the NI186 data relates to thermal. Both the background data and assumptions are clearly set out in Appendix III. Note also that this data includes point source emissions, i.e. it will include those sites exclude for the DECC energy data.
[20] Sites / companies identified on www.industrialheatmap.com/index.php. No definition of the criteria used for inclusion or non-inclusion of sites within this data set, hence they are simply included as points of reference

Table 2: Legend of large energy users shown on Figure 3

Organisation	Legend
Derbyshire Royal Infirmary	1
Toyota (manufacturing plant)	2
Acordis Acetate	3
Rolls Royce	4
Derby City General Hospital	5
Rolls Royce	6
Rockwood Electronic Materials	7

By overlaying the potential pattern of new development we can begin to identify areas of opportunity to link new build community energy infrastructure with high energy consuming existing settlements. Figure 9 overlays the Strategic Housing Land Allocation Assessments (SHLAA) that have been completed to date by each authority, against the background of heat consumption density. From this it is possible to identify numerous incidences of potential new development in areas of high energy density such as in the centre of Derby, around Swadlincote and around the edge of Derby boundary.

It is recommended that further examination of those specific areas where high heat density and large new development coincide is conducted to explore the potential for district heating and interconnection between the two, particularly where each on their own would not justify investment.

Finally, Figure 10 illustrates the distribution of non-gas connected domestic properties. We have taken the comparison of the numbers of domestic electricity meters to gas meters in each MLSOA of the study area, as a reasonable proxy, i.e., the difference between the two is assumed to be the number of domestic properties which do not have a gas connection. Consequently, care should be taken interpreting this analysis. In rural areas, many buildings will be located where it is uneconomic to invest in gas grid connections, and so the majority of these properties can be deemed to be ‘off-gas-grid’, with limited (and often costly) heating alternatives. However, in urban areas the properties identified are more likely to not be using gas for other reasons, principally because electricity was preferred at the time the building was being developed or the communal heating is being used in multiple-occupancy buildings. It is the rural properties we are most interested in because they offer the greater potential to fuel switch to biomass heating, small wind turbines and the other microgeneration, particular once Feed-in-tariff and the Renewable Heat Incentive are operational. It is recommended that further consideration be given to the rural clusters of the non-gas connection to explore opportunities for the fuel switching (and energy efficiency support).

The analysis suggests that there are in the region of 15,000 non-gas domestic properties, which is equivalent to 6% of the total number of domestic properties in the study area. Table 3 shows these numbers by authority. It is worth noting that these numbers vary significantly to those reported in the Housing Stock Condition Survey data[21], which suggests approximately 40% of domestic properties in the study area are ‘off-gas-grid’, with 50% of those in Derby being classified as such. During the course of the study it has not been possible to discover the reasons for this discrepancy, however, from experience it is very unlikely that an urban area like Derby would have such as high level ‘off-gas-grid’ properties and so we believe it reasonable to disregard the existing data for Derby and by extension for the rest of the study area.

[21] *www.hi4em.org.uk/*

Table 3: Estimated non-gas connected properties

LA	Total number of dwellings	Estimated Number of dwellings off-gas grid	Proportion of dwellings off-gas grid
Amber Valley	53,183	3,498	7%
Derby	103,196	5,083	5%
Erewash	48,722	1,754	4%
South Derbyshire	37,646	4,391	12%
Total	**242,747**	**14,726**	**6%**

Figure 3: Total Gas Consumption - Domestic and Commercial & Industrial

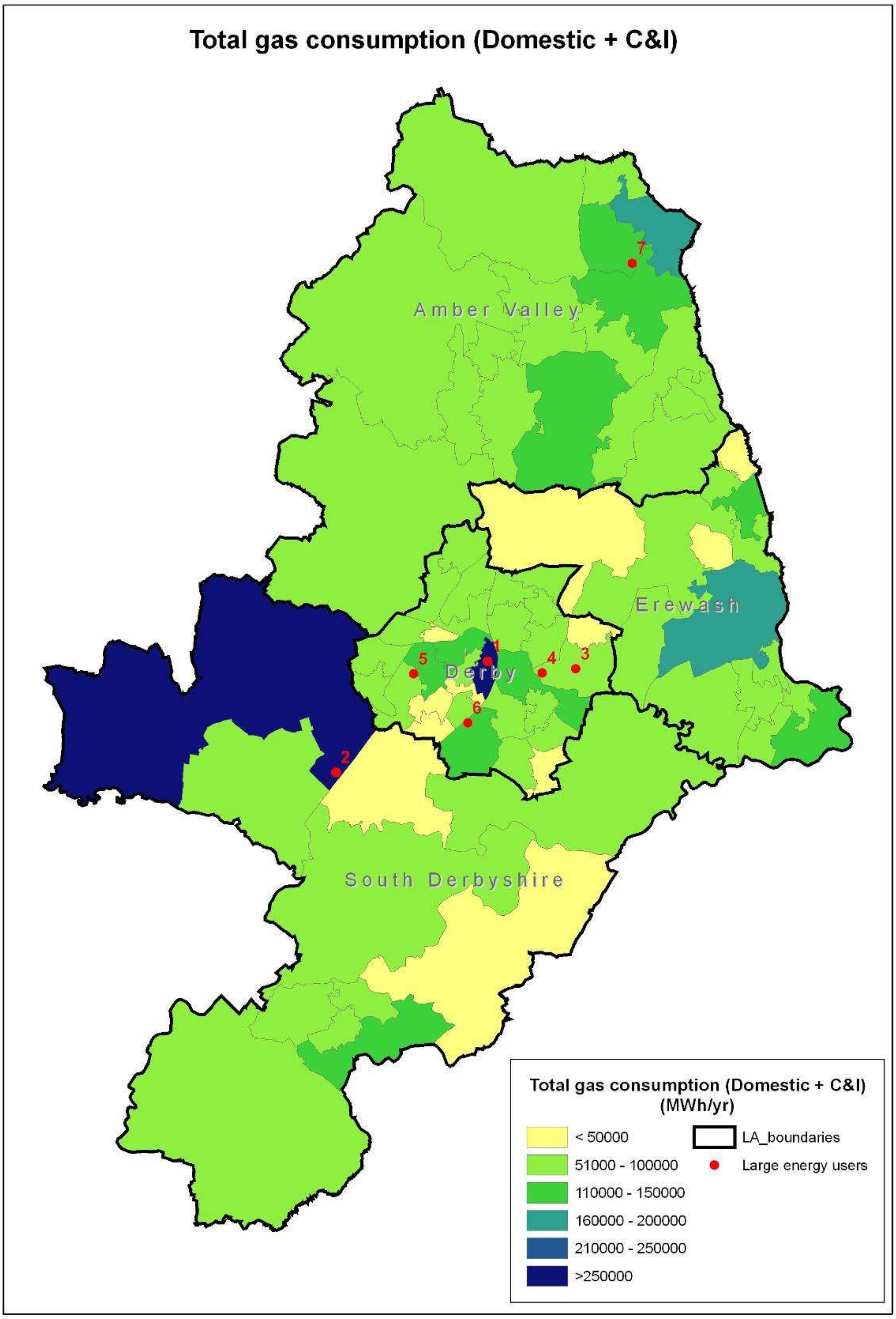


Figure 4: Total gas consumption per km²

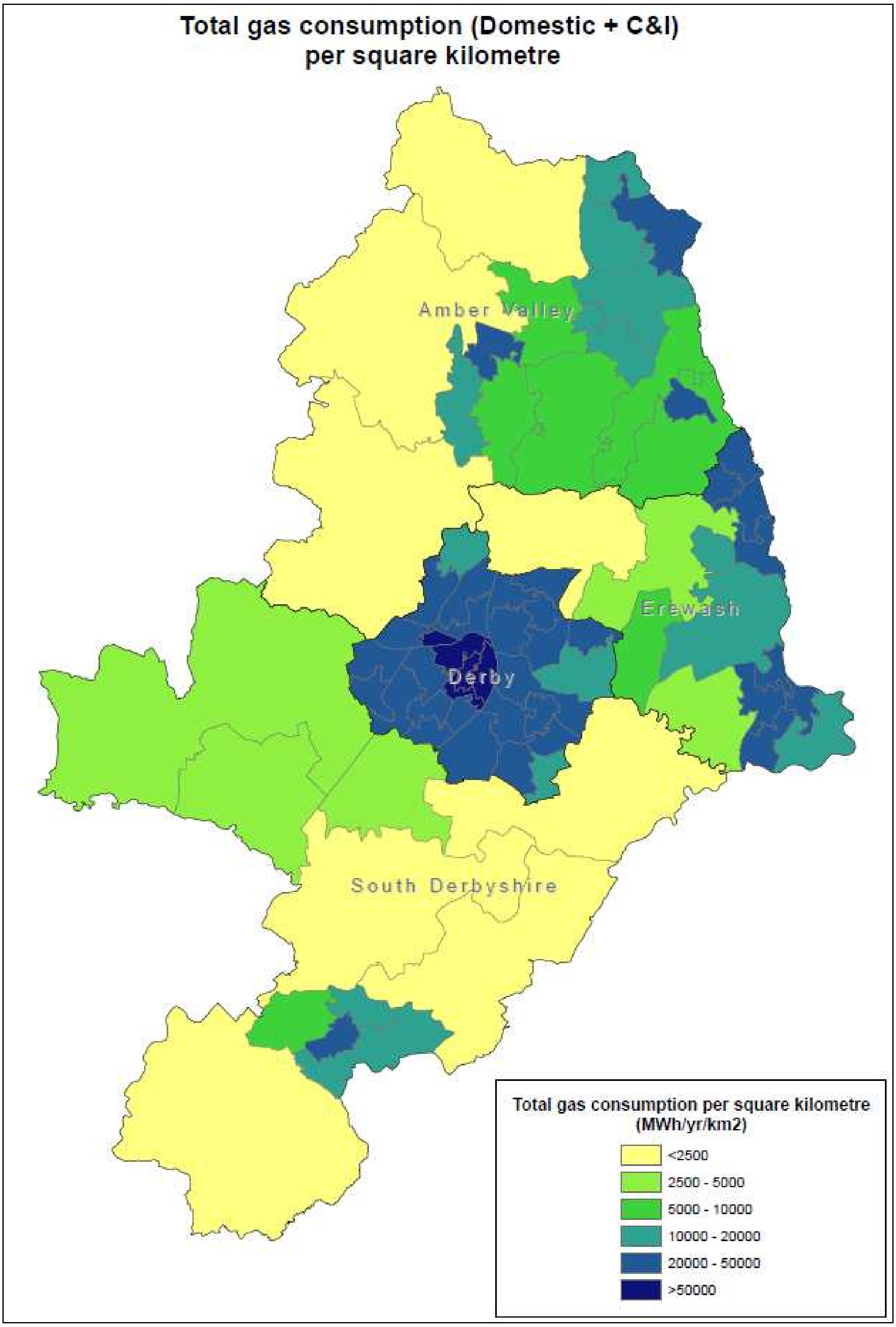


Figure 5: Commercial & Industrial Gas Consumption

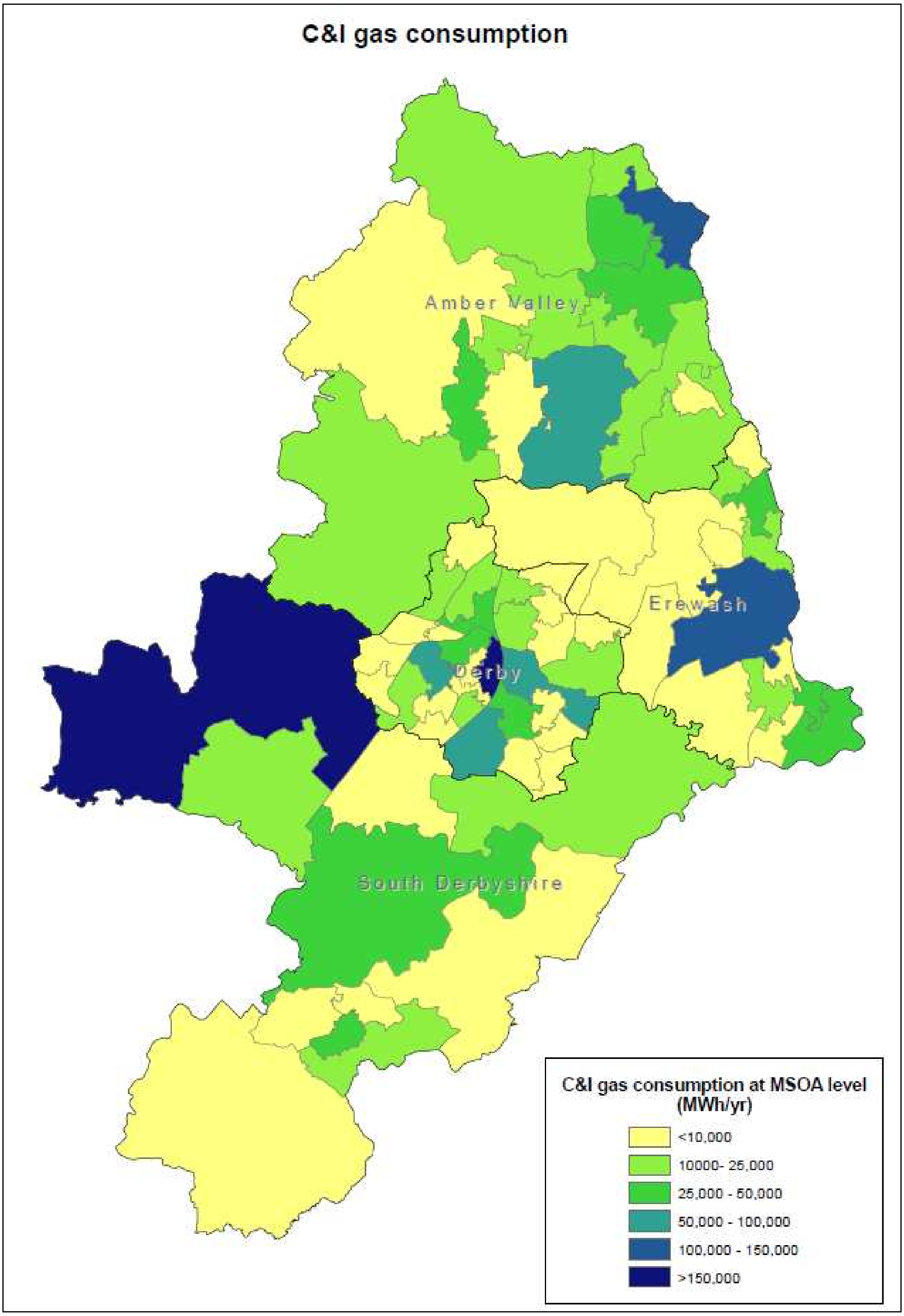


Figure 6: Commercial & Industrial Gas Consumption per km²

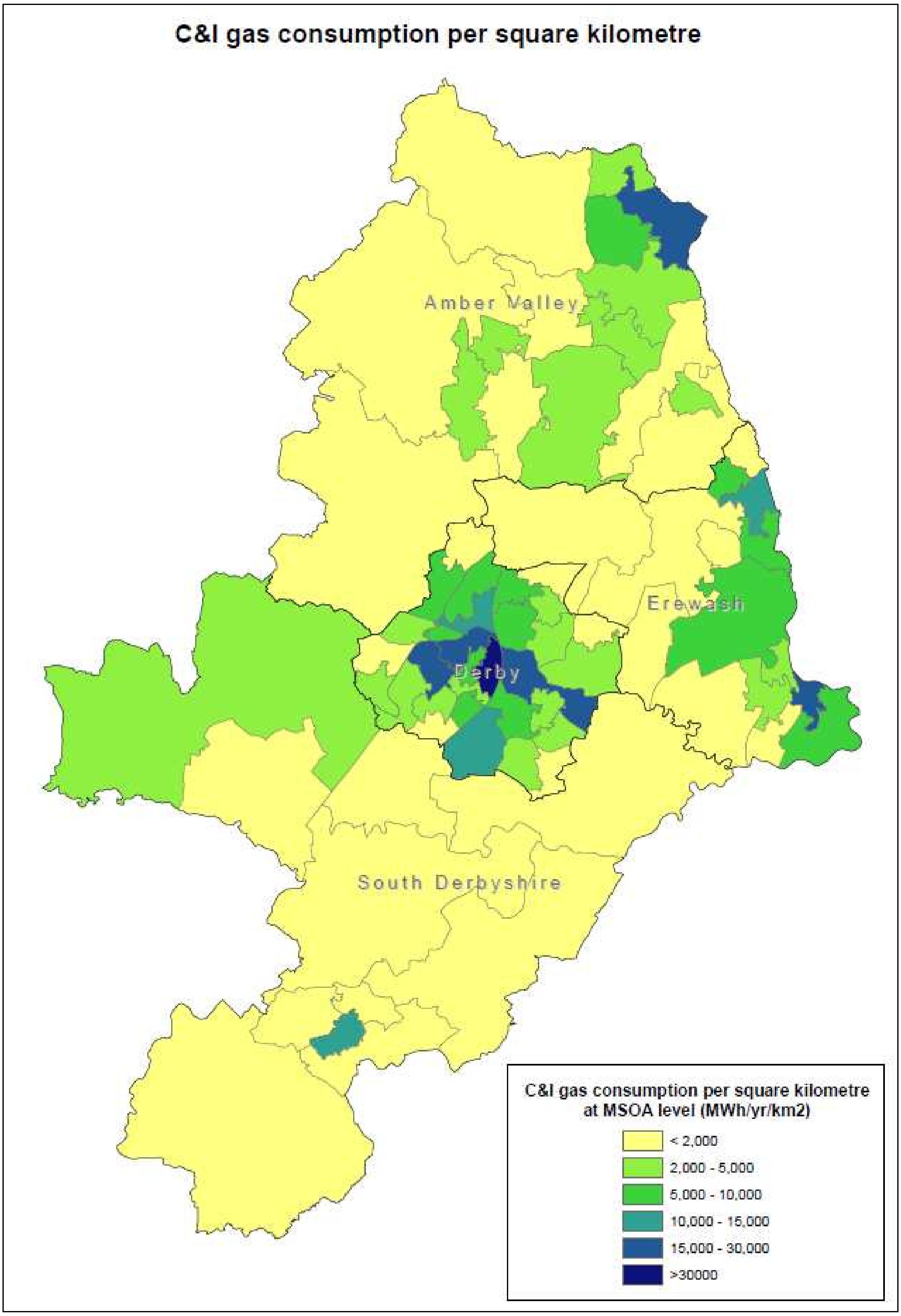


Figure 7: Domestic Gas Consumption

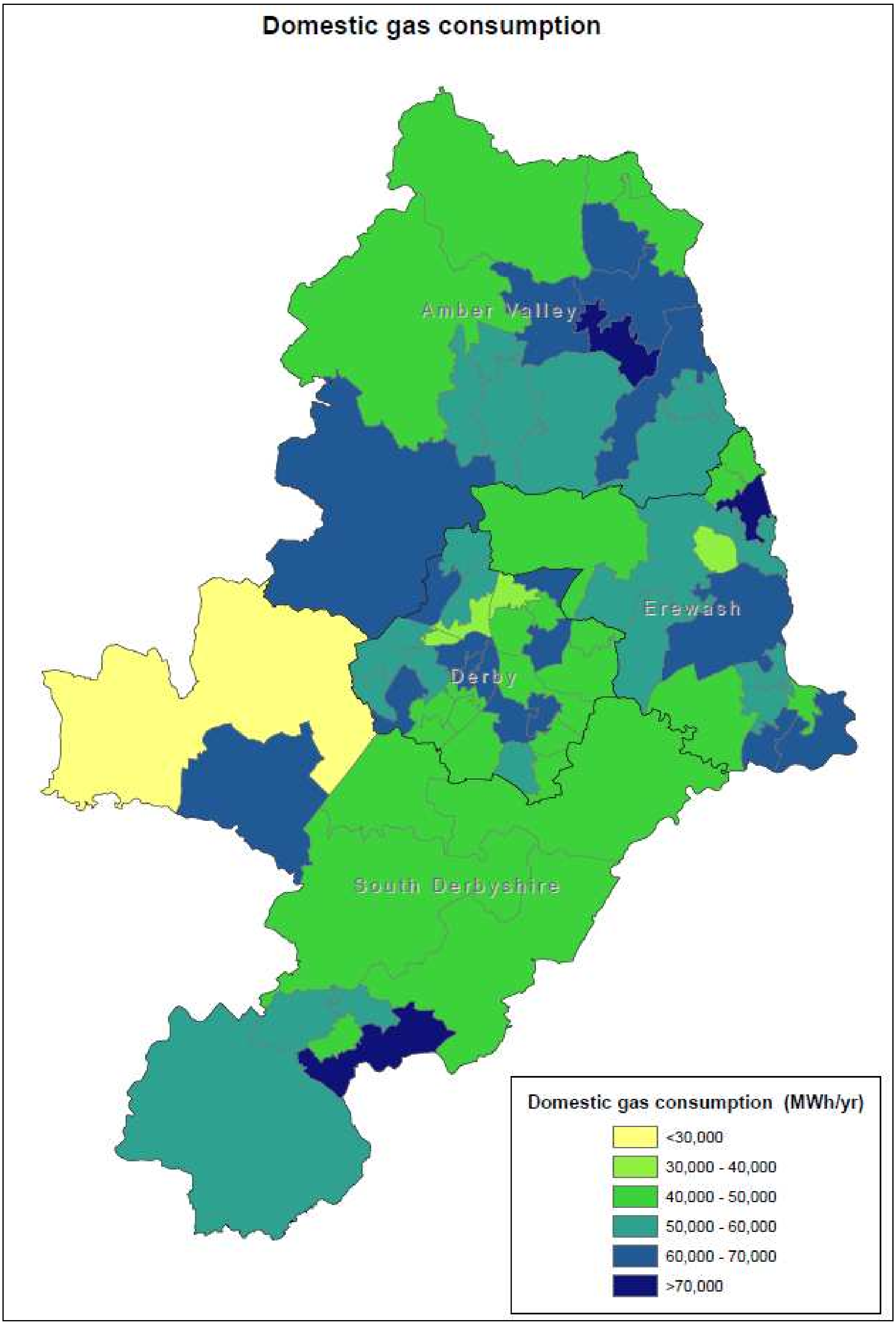


Figure 8: Domestic Gas Consumption per km²

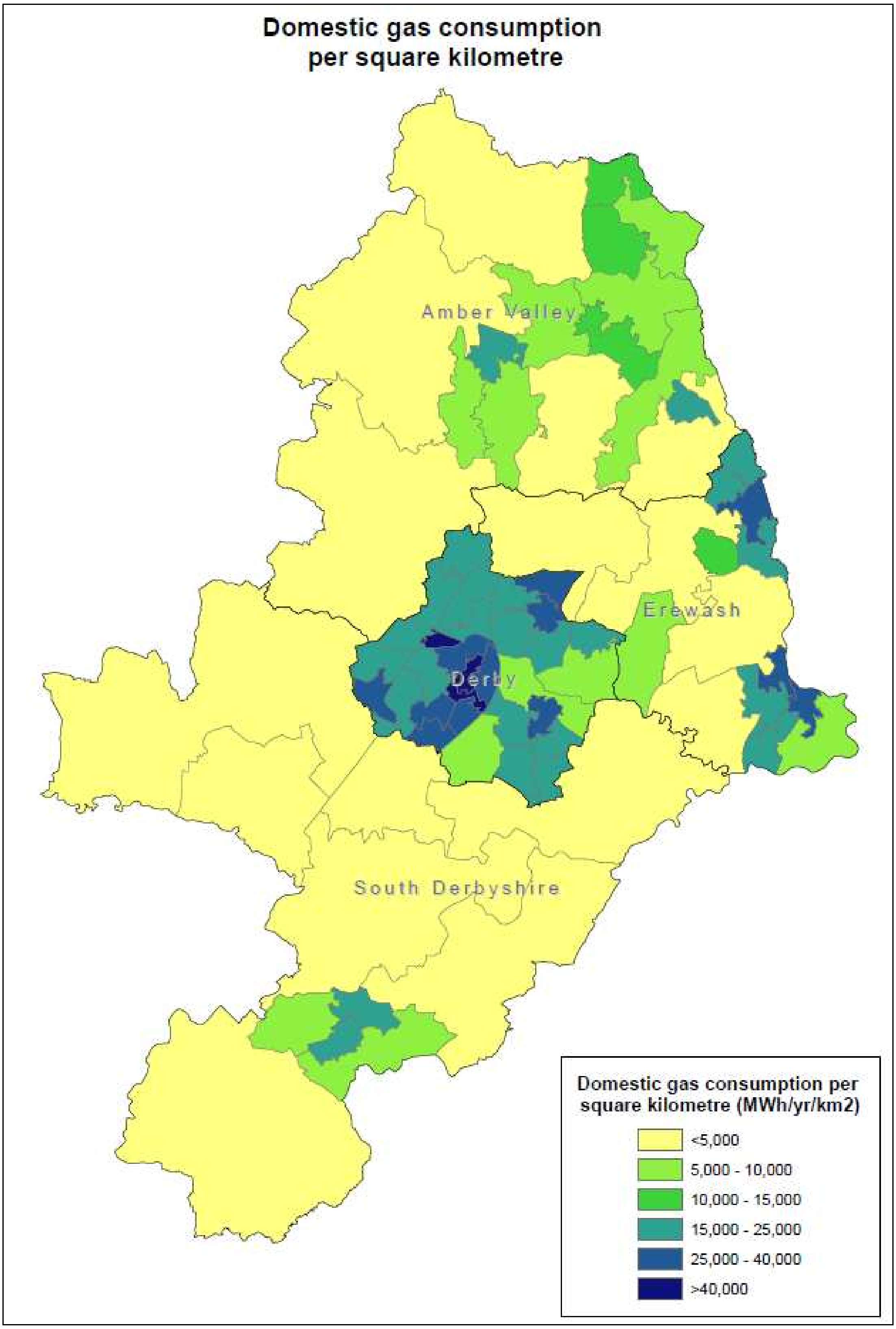


Figure 9: Proximity of SHLAA sites to areas of high heat demand

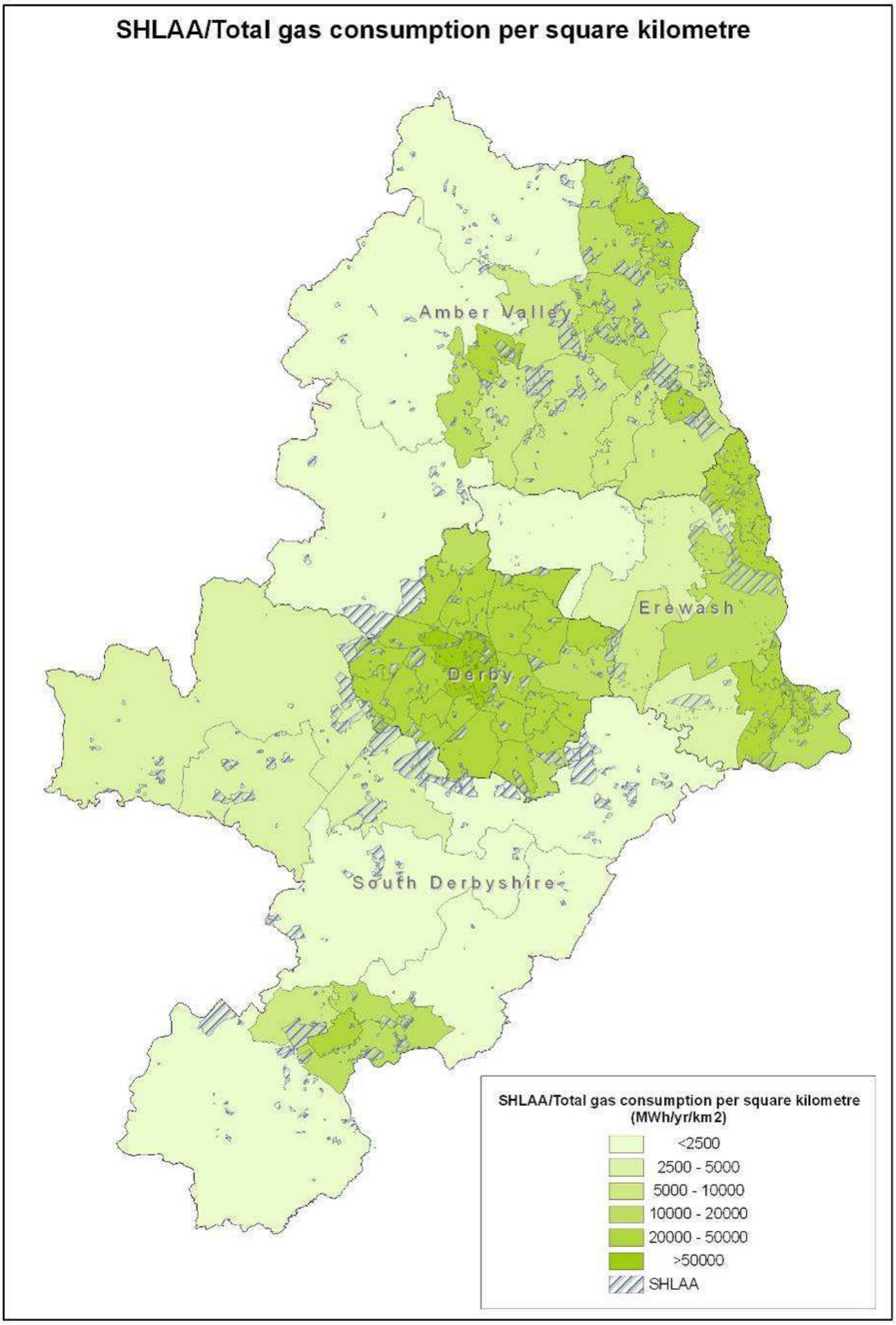
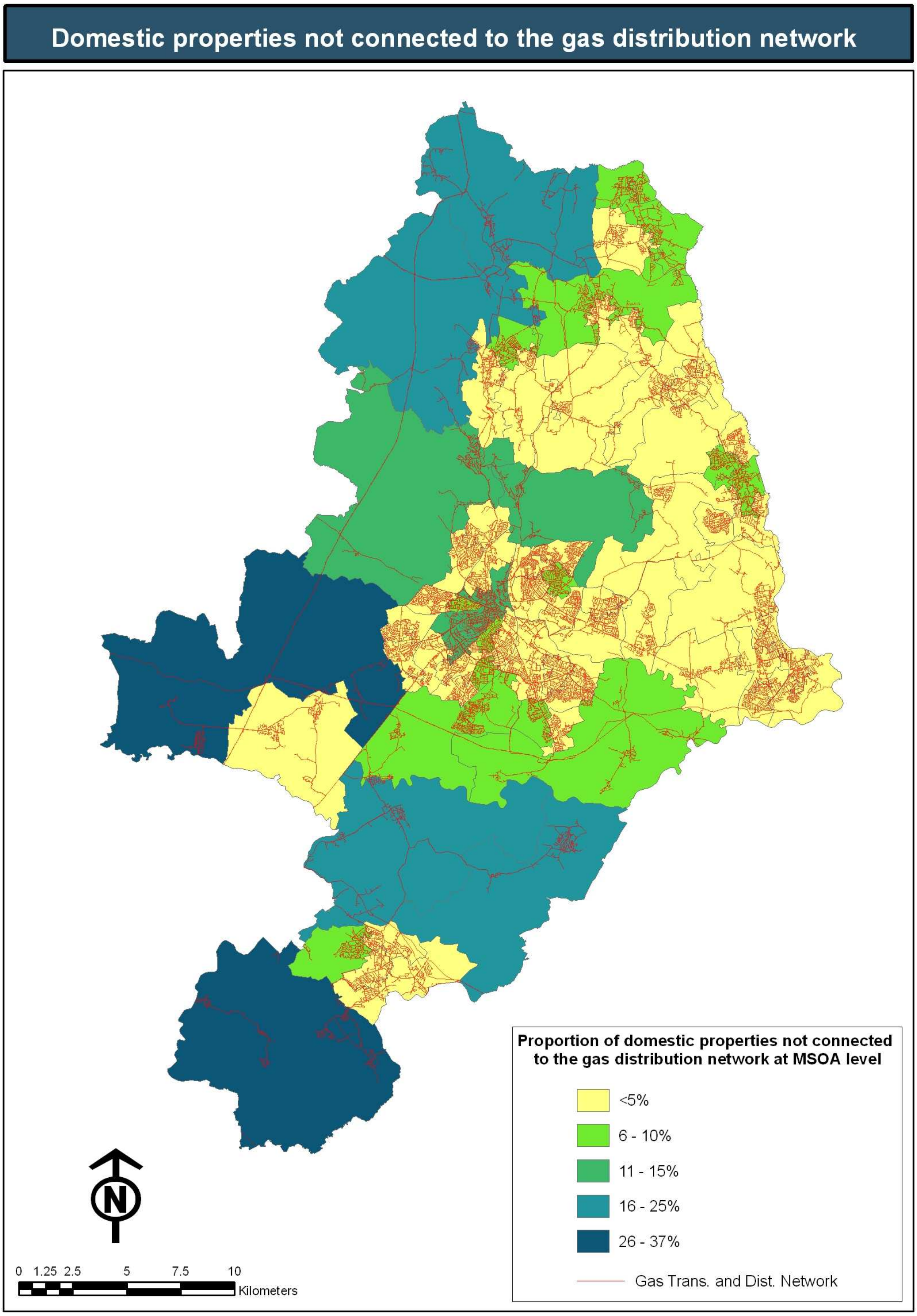


Figure 10: Number of dwellings assessed as non-gas heated



2.3 Breakdown of 2007 emissions baseline by fuel type and sector

It is important to consider each authority's carbon emissions arising from the built environment, as this is the key focus of the study. It can be seen that oil consumption in the commercial and industrial sector is higher than the national average, suggesting that this could potentially be an opportunity for cost-effective intervention to reduce emissions. Electricity consumption is greater than average in Derby, perhaps reflecting the use of air conditioning, lighting and small power associated with city centre offices and retail units. Domestic gas and electricity consumption is broadly in line with the national average but gas is a little higher, perhaps balancing the below-average use of oil for domestic usage. This suggests overall, that the study area has relatively good connectivity with the gas network.

This data is illustrated for each Authority over the following pages with a detailed split by authority shown in Appendix III. Unlike the energy consumption data shown earlier, the carbon emissions data includes large point sources.

Table 4: Proportion of CO_2 emissions arising from key energy sources

Proportion of CO_2 emissions arising from key energy sources				
	Coal	**Petroleum (Oil)**	**Gas**	**Electricity**
Commercial & Industrial				
National average	*4.1%*	*22.2%*	*20.9%*	*52.8%*
Amber Valley	5.7%	30.4%	18.4%	45.5%
Derby City	0.2%	9.4%	28.3%	62.2%
Erewash	0.5%	21.5%	21.0%	56.9%
South Derbyshire	11.8%	33.9%	17.7%	36.6%
Dwellings				
National average	*0.9%*	*4.7%*	*50.8%*	*43.6%*
Amber Valley	0.4%	2.1%	55.7%	41.8%
Derby City	0.1%	0.5%	55.8%	43.7%
Erewash	0.2%	1.2%	57.0%	41.6%
South Derbyshire	1.0%	4.7%	50.9%	43.4%

Figure 11: Annual built environment CO_2 emissions for Amber Valley (2007) (Source: BERR)

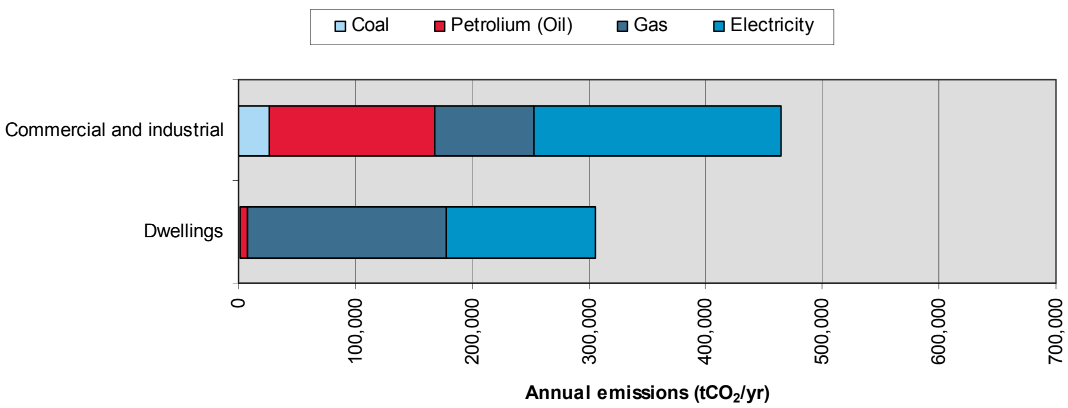


Figure 12: Annual built environment CO_2 emissions for Derby City (2007) (Source: BERR)

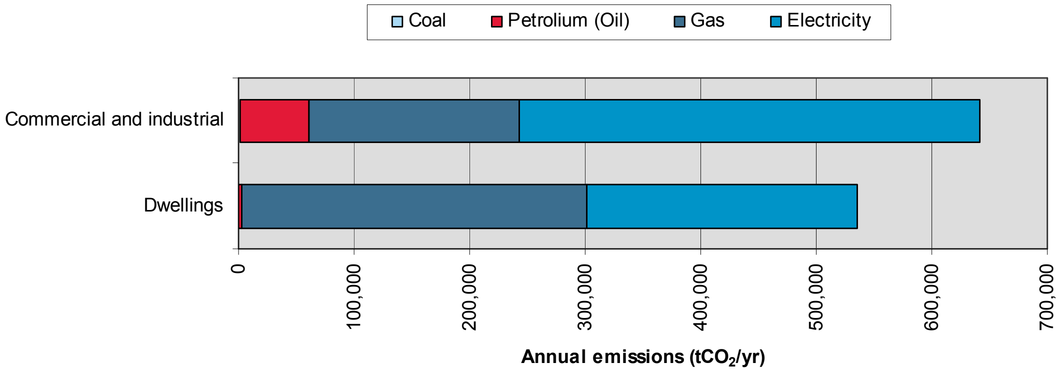


Figure 13: Annual built environment CO_2 emissions for Erewash (2007) (Source: BERR)

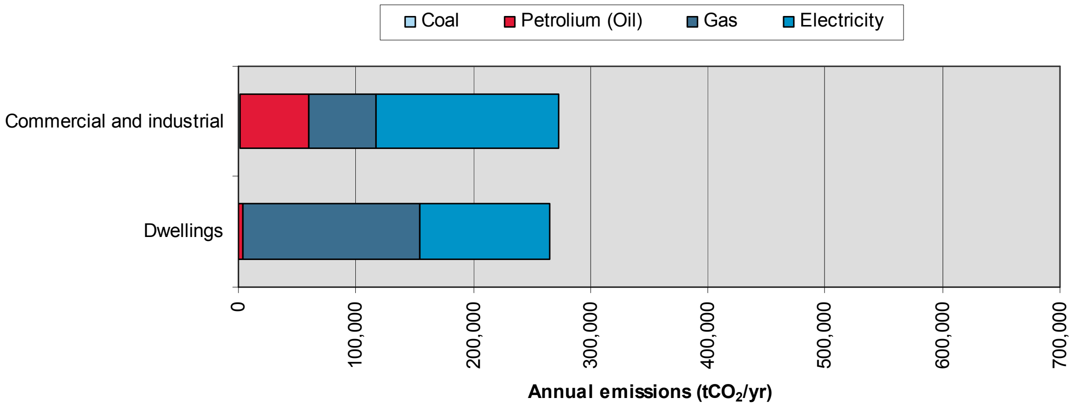
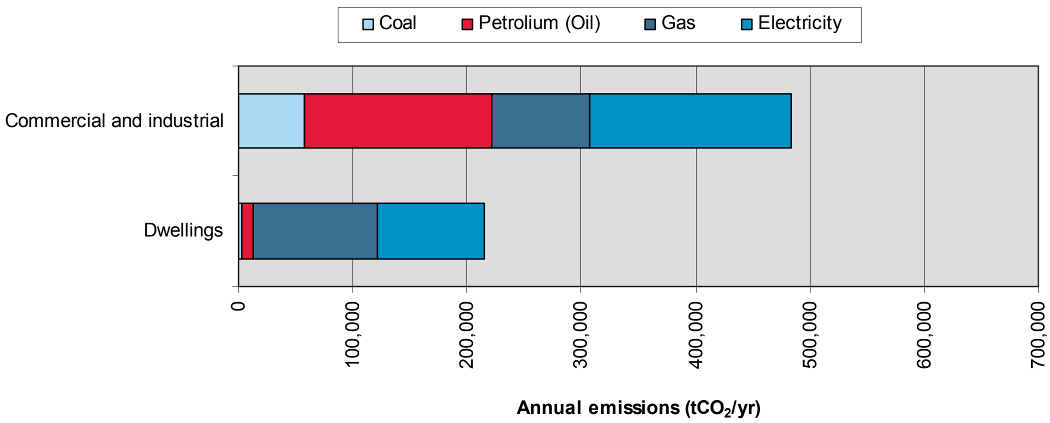


Figure 14: Annual built environment CO_2 emissions for South Derbyshire (2007) (Source: BERR)



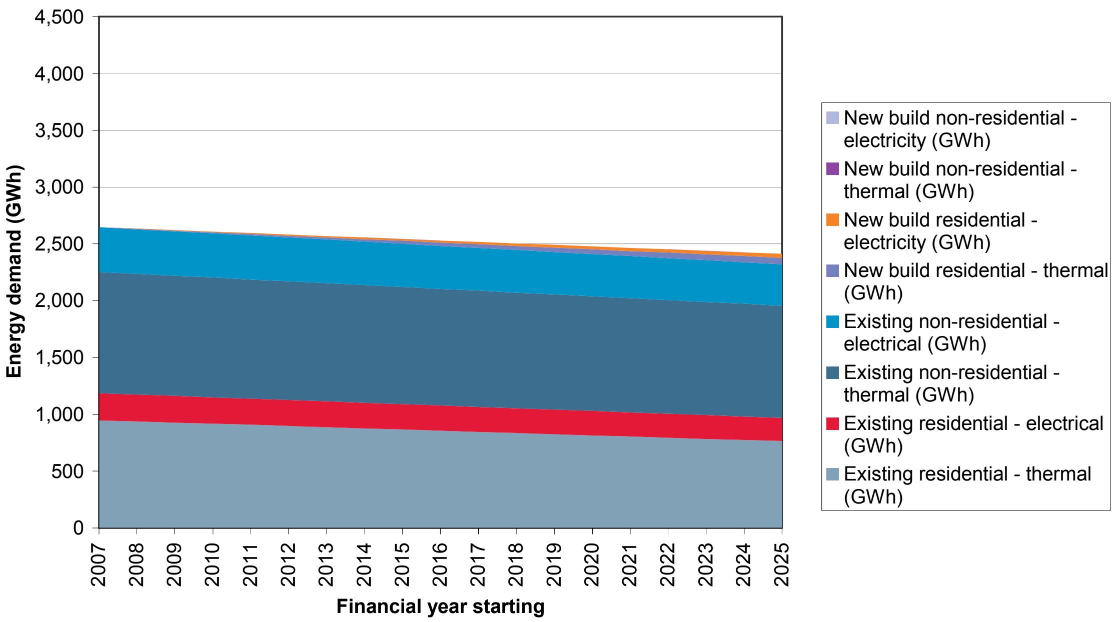
2.4 Projected consumption including energy efficiency baseline

Baseline consumption is likely to increase in the absence of policy levers. However, the Low Carbon Transition Plan sets a path for lower consumption as a result of a series of binding and non-binding policy levers leading to the deployment of energy efficiency technologies and systems and the better management of energy through behavioural change and careful use of controls.

A recent study commissioned by East Midlands Regional Assembly (EMRA)[22] takes into account these kind of policies in forecasting the implementation of viable energy efficiency initiatives in both residential and non-residential buildings and so we have used these trends to project forward the baseline energy data for the study area across the RSS period. Energy demands of new buildings are included by applying benchmarks and estimated floor areas to projected residential and non-residential buildings. This forms the baseline consumption against which our calculations of renewable energy potential are measured. Overall energy demand is predicted to fall by 4-8% under these policies.

Figure 15 to Figure 18 below show the energy consumption projects for each authority and background data for each is included in the Appendix IV. The graphs, which include growth in demand from forecasted new development, are shown by authority, with the same vertical scale to aide comparison.

Figure 15: Projected energy demand for both new and existing buildings in Amber Valley



[22] *Reviewing renewable energy and energy efficiency targets for the East Midlands, EMRA, June 2009, tables 28 & 29*

Figure 16: Projected energy demand for both new and existing buildings in Derby City

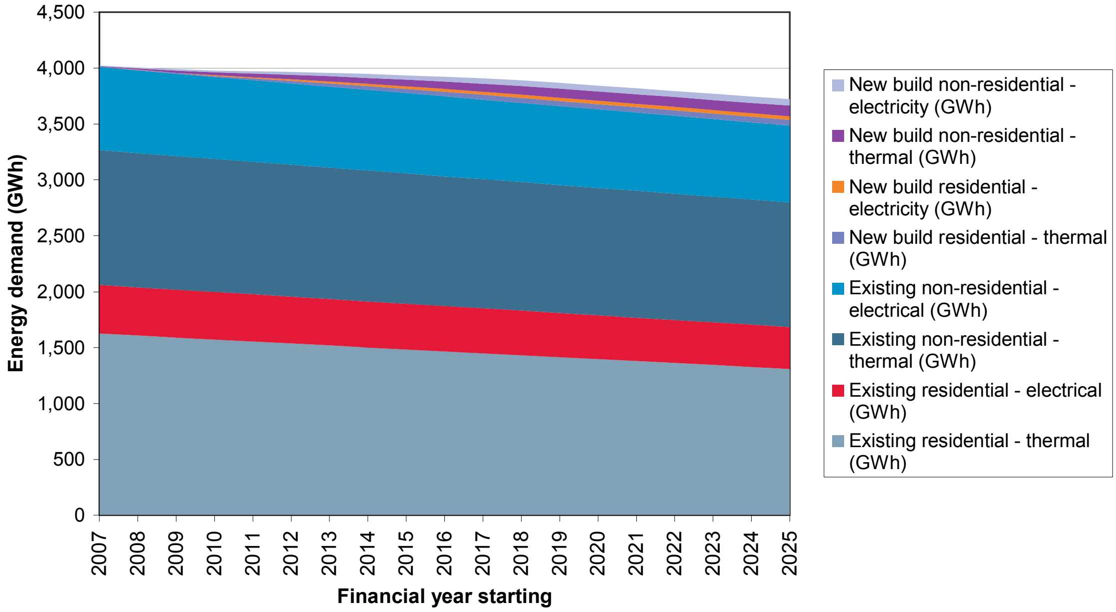


Figure 17: Projected energy demand for both new and existing buildings in Erewash

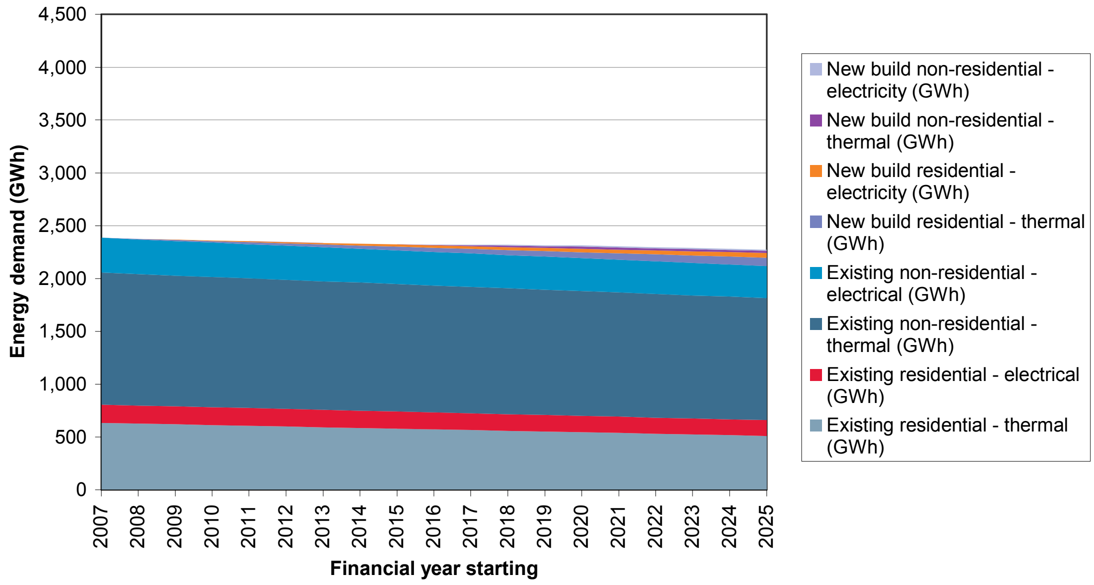
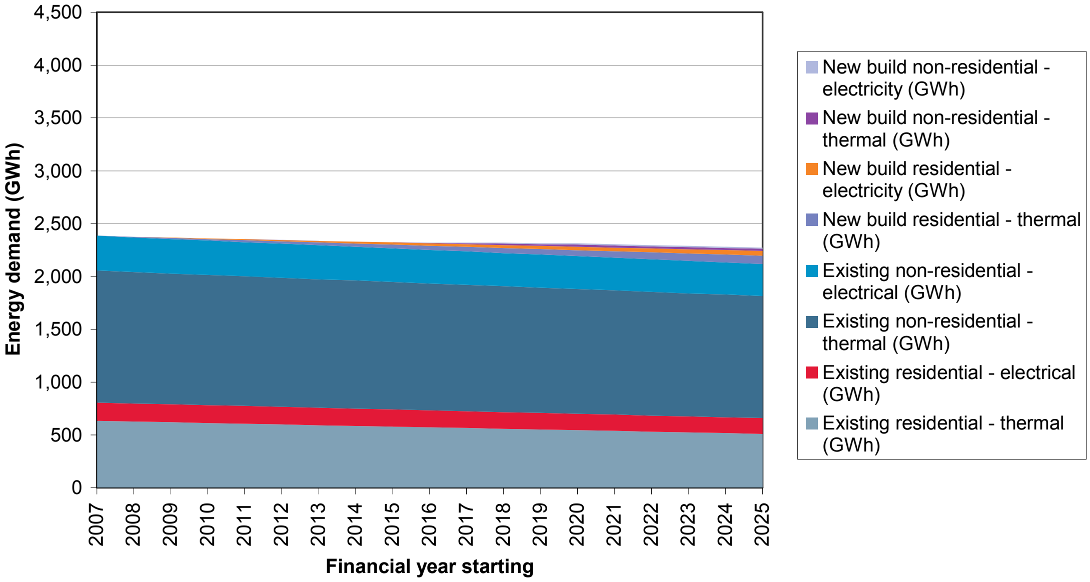


Figure 18: Projected energy demand for both new and existing buildings in South Derbyshire



3 Existing Renewable Energy Capacity

This section summarises the current information available regarding capacity of renewable energy in operation or currently known to be under development. There are no comprehensive local monitoring programmes in existence. The data is drawn from a variety of sources, with varying degrees of confidence regarding its accuracy. Data associated with those systems requiring some form of formal authorisation, e.g. grid connection agreement or planning permission, has greater certainty. Many renewable energy technologies, particularly those used in the domestic / microgeneration applications, do not require planning or other regulatory approval and the significance of these will be under estimated. This issue is likely to become more significant as the number of smaller installations increases and also as the proposed amendment to Permitted Development rules come into play, requiring fewer technologies to apply for planning permission in future. In contrast, the existence in the near future of heat and electricity sale tariffs may provide a basis for future monitoring.

The availability of information about existing or planned installations is an important issue. Poor availability of information affects authorities' willingness to establish targets, since it is hard to accurately monitor performance against these. This will potentially become more important in the future as government is considering the introduction of a National Indicator for renewable energy, which will be in addition to the existing Planning Authority reporting requirements (through the AMR process). Approaches to data collection for future reporting, is discussed in the recommendations section of the report.

At a regional level, the East Midlands has an existing estimated renewable energy production capacity of 713MW (includes heat, offshore wind, waste to energy and biomass co-firing)[23]. Of this estimated capacity, Derbyshire is estimated in the EMRA report to contribute 10.5MW and Nottinghamshire, 138MW (101MW, of which is biomass co-firing).

With regards to the study area only Table 5 provides existing capacity data by authority and by technology in kilowatts. This table compiles data from EMRA, RESTATS[24] and each of the local authorities and clearly shows the patchy nature of current data. The biomass figures are from estimates produced by Natural England, which were also used as underlying data within the recent EMRA review of regional renewable energy[25].

It can be seen that biomass heat dominates current installed capacity whilst large wind turbines account for 80% of renewable energy currently being planned.

Table 6 shows the capacity data converted to estimated energy generation (Megawatt hours) to enable easier comparison with energy consumption[26]. For South Derbyshire the estimated current generation equates to approximately 0.5% of annual energy consumption (excludes transport energy). For the other three, current generation equates to approximately 0.1%.

[23] *Reviewing Renewable Energy and Energy Efficiency Targets for the East Midlands, for EMRA, June 2009*
[24] *www.restats.org.uk*
[25] *Reviewing Renewable Energy and Energy Efficiency Targets for the East Midlands, for EMRA, June 2009*
[26] *Energy generation estimated using typical load factors, availabilities and operating hours and the applying a 25% confidence (reduction) factor*

Table 5: Current installed or planned renewable energy capacity within the study area (kW)

	South Derbyshire		Amber Valley		Derby		Erewash		Total	
	Installed	*Planned*	Installed	*Planned*	Installed	*Planned*	Installed	*Planned*	**Installed**	***Planned***
Small wind	64		15	*27*		*69*	15		**94**	***96***
Large wind				*1,500*		*3,000*			**0**	***4,500***
Solar PV						*31*			**0**	***31***
Landfill gas	1,550								**1,550**	***0***
Biomass heat	1,704		2,434		4,633		2301		**11,072**	***0***
Hydro			200				170	*952*	**370**	***952***
Total	**3,318**	**-**	**2,649**	***1,527***	**4,633**	***3,100***	**2486**	***952***	**13,086**	***5,579***

Table 6: Current installed or planned renewable energy capacity within the study area (MWh)

	South Derbyshire		Amber Valley		Derby		Erewash		Total	
	Installed	*Planned*	Installed	*Planned*	Installed	*Planned*	Installed	*Planned*	**Installed**	***Planned***
Small wind	42		10	*18*		*45*	10		**62**	***63***
Large wind				*2,957*		*5,913*				***8,870***
Solar PV						*23*				***23***
Landfill gas	9,674								**9,674**	***0***
Biomass heat	2,173		3,103		5,907		2,934		**14,117**	***0***
Hydro			683				581	*3,252*	**1,264**	***3,252***
Total	**11,889**	**0**	**3,796**	**2,974**	**5,907**	**5,982**	**3,524**	**3,252**	**25,117**	***12,208***

4 Low Carbon Policy and Targets

This section provides an introduction to current and developing policy relevant to the study. Further information can also be found in Cleaner, Greener Energy Study: Report 2 - Preparing for NI186 & Options for Local Authority power generation.

4.1 Emerging National Policy

Published in July 2009, The Low Carbon Transition Plan and the Renewable Energy Strategy present significant policy changes relevant to this study. Whilst the statements represent key milestones in the development of new policy, setting out long term aspiration and policy direction and specific commitments, there are a number of issues of relevance to this study that remain unresolved or are likely to change in the near future, for example, the definition of zero carbon homes (and non-residential buildings) and re-classification of organic wastes (to enable greater use for energy purposes). This section summarises those elements of relevant to this study.

The Low Carbon Transition Plan sets out the UK's plan for becoming a low carbon country, with a headline goal to cut emissions by 18% on 2008 levels by 2020 (112 Mt CO_2e – Million Tonnes of Carbon Dioxide equivalent). This strategy is framed by the Climate Change Act (2008) which introduced legally-binding targets to cut carbon dioxide (CO_2) emissions by at least 34% on 1990 levels by 2020 (264 $MtCO_2e$) and at least 80% by 2050 (622 $MtCO_2e$), compared to 1990 levels.

To achieve these targets, the Government has created three five-year 'carbon budgets' to 2022, which mark a cap on the total quantity of GHG emissions released in the UK over a specified time. The budget system allows an element of 'banking' and 'borrowing' between carbon budget periods to increase the system's flexibility. Potentially this could affect the overall carbon target within a set period, however, we have assumed here that the government's 15% renewable energy target by 2020 will not change as this responds to the relevant European Directive which carries more weight.

Figure 19 below shows how these carbon budgets compare to the 1990 and 2008 emissions baselines, while Figure 20 shows how different sectors are expected to make reductions over each of the three carbon budgets.

The Power and Heavy Industry sector is estimated to provide 54% of the emissions savings by 2022, followed by homes and communities at 13%, workplaces and jobs at 9%, transport at 19%, and farming, land and waste at 4%. This study focuses on local planning which has most influence in the carbon emissions associated with homes and communities.

- It can be seen that the largest contribution to reduced emissions is likely to be low carbon generation and heavy industry
- Low carbon generation will have an impact within the study area through pressure to deliver renewable energy schemes
- Homes and communities and obviously relevant to this study

Figure 19: National greenhouse gas emission reduction timeline (Source: Low Carbon Transition Plan)

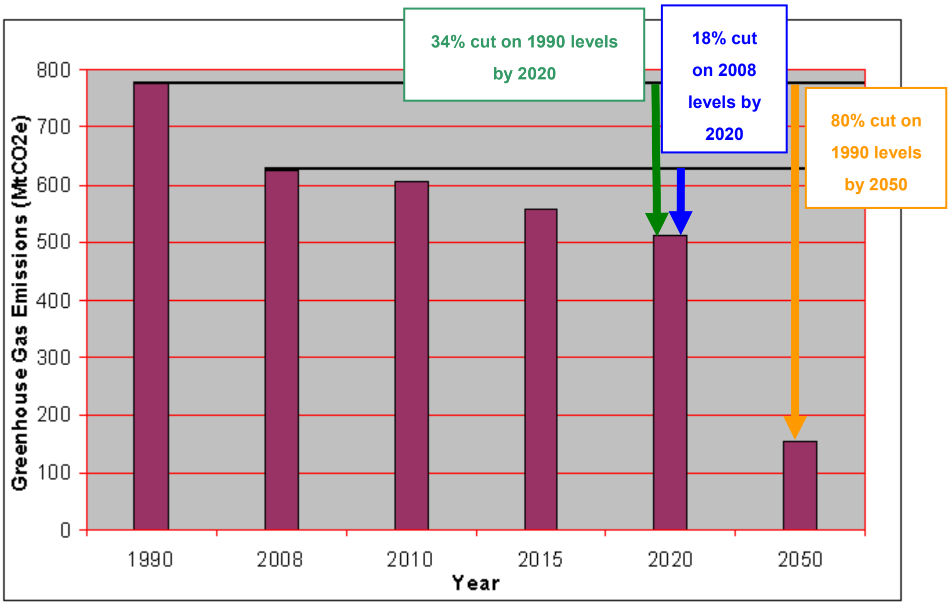
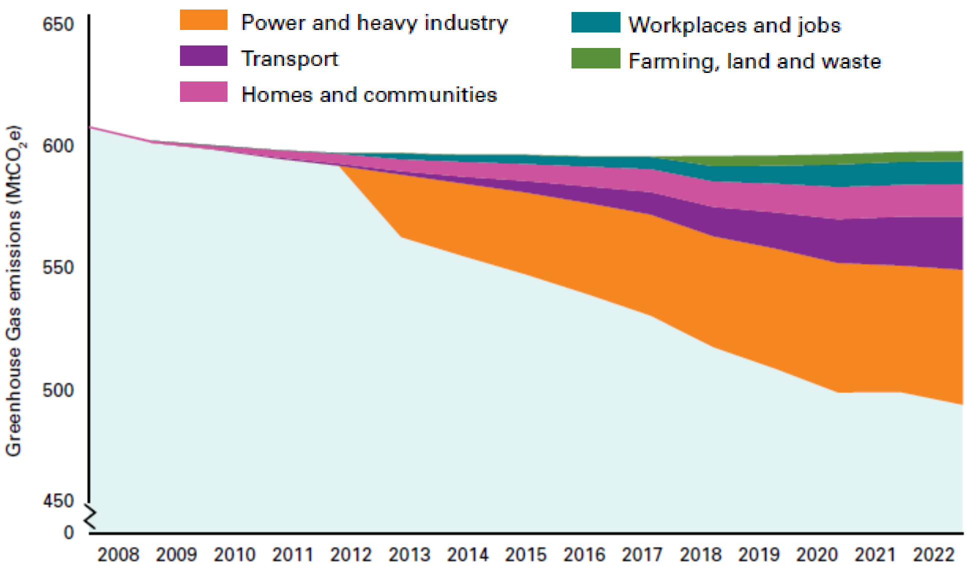


Figure 20: Estimated emissions savings ($MtCO_2e$) in different sectors of the UK resulting from the measures set in the Low Carbon Transition Plan from 2008 to 2022 (Source: Low Carbon Transition Plan)



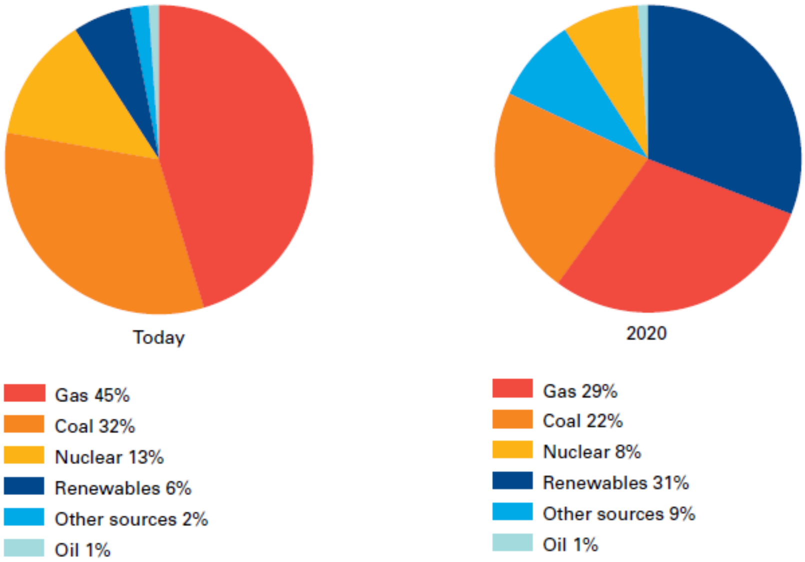
4.1.1 Power Sector

Figure 21 illustrates the anticipated changes in the UK energy mix in the coming decade:

- gas and coal power generation dramatically tailing off
- renewables increasing to around 30% of UK generation (111 TWh)
- reduced Nuclear supply, although from 2018 the proportion of supply is predicted to rapidly increase

The 2020 electricity mix is based an overall electricity consumption of 240 TWh.

Figure 21: Estimated electricity mix – today and 2020 (Source: Low Carbon Transition Plan)



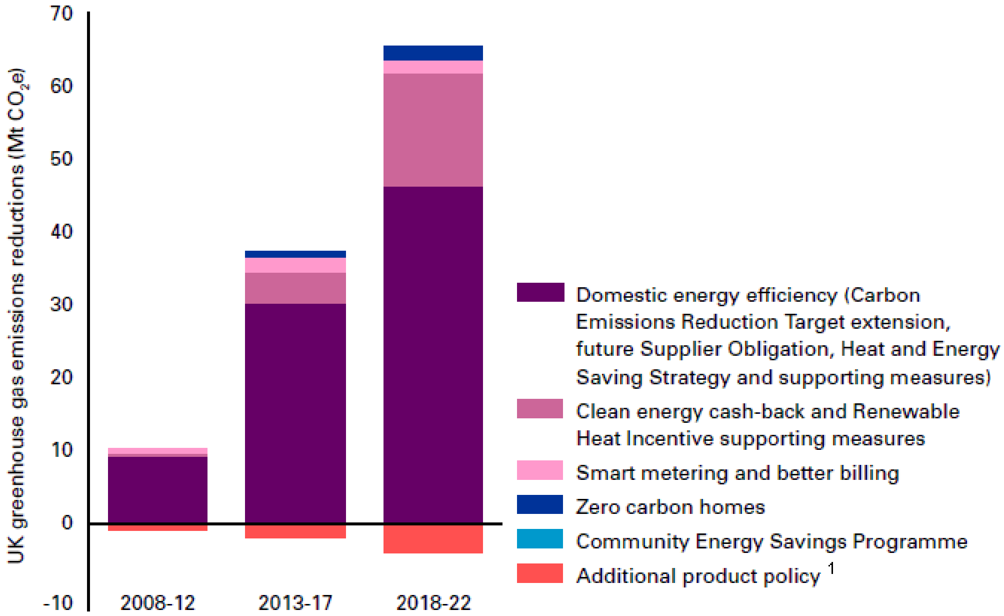
Delivery of this low carbon mix is expected through the following key measures:

- Increasing the supply of renewable electricity five-fold to around 30% by 2020, principally through the Renewables Obligation (RO) but also implementation of new tariff structures for smaller renewable power systems (Feed in Tariff)
- The planning and regulatory approvals processes for new nuclear power stations will be streamlined to enable the first new nuclear power stations to be operating from around 2018.
- Piloting and roll out of carbon capture and storage (CCS)
- Plans for a smarter, more flexible grid to manage electricity generated from new technologies and respond to changes in energy demand.
- The Government proposes to consult later this year on banning certain materials or types of waste from landfill. This has important implications for support of emerging biomass energy markets.
- A rapid increase in renewables is likely to have an impact within the study area

4.1.2 Homes and Communities

The plan to 2020 requires an emissions reduction from both existing and homes of 29% on 2008 levels (27 $MtCO_2e$). The expected emissions savings from this sector from 2008 to 2022 is shown at Figure 22, which shows that domestic energy efficiency is expected to deliver over two-thirds of emissions savings from homes.

Figure 22: Estimated carbon savings in the homes and communities sector (Source: Low Carbon Transition Plan)



The following measures highlight the steps that will be taken towards achieving this target:

- Carbon Emissions Reduction Target (CERT) – an obligation placed on energy suppliers to help households reduce emissions and save energy
- The 'Great British Refurb': All homes are projected to have undergone a 'whole house' refurbishment by 2030
- Developing 'pay as you save' (PAYS) models of long-term financing for domestic energy saving.
- 'Clean energy cash-back' schemes:
    - Renewable Heat Initiative (RHI): providing payment for using heat from renewable sources, from April 2011.
    - Feed-in Tariffs (FITs): providing financial rewards for small-scale low carbon electricity generation, from April 2010.
- 'Zero carbon' status is planned for all new homes (from 2016), new public sector buildings (from 2018), new schools (from 2016), and new non-domestic buildings (from 2019). The details defining 'zero carbon' are scheduled to be announced later in 2009.
- Deep cuts in the carbon emission from the Government Estate, including Local Authorities
- New powers and funding for Local Authorities to deliver new energy efficient homes.
- Smart metering initiatives
- A host of tax measures to help distributed low carbon energy, including: new zero carbon homes receiving stamp duty relief

The Renewable Energy Strategy announced the establishment of The Office for Renewable Energy Deployment (ORED) which will have the responsibility to drive delivery of the national targets, based on the 'lead scenario'[27], which anticipates:

[27] *Findings in the RES are based on a 'lead scenario', but the renewable energy goals may be met in different ways, depending on how the drivers to investment, supply chain and non-financial barriers evolve.*

- 30% of electricity sourced from renewable sources (117 TWh) by 2020, up from approximately 5.5% today, including 2% from small-scale sources (8 TWh). Approximately 10% of electricity will be from offshore wind, the remainder of the target being met from onshore renewables, potentially of relevance to this study.
- 12% of heat consumption generated from renewables (72 TWh), including biomass, biogas and solar. The Strategy suggests Heat Pumps could play a more important role than previously estimated, while Biomethane injection into the gas grid is also recognised as a technology which could offer significant levels of renewable heat.

Energy efficiency is likely to give the greatest wins. Clean energy “cashback” / RHI also very important, particularly for existing applications. Note, zero carbon homes are predicted to make a relatively minor contribution to the overall carbon reduction targets. This highlights the importance of supporting low carbon decentralised renewable energy projects as these are expected to deliver greater gains than zero carbon development policies for new build development.

4.1.3 Planning policy

Planning is often cited a major constraint to the implementation of the renewable energy systems. The Renewable Energy Strategy specifically identified the need to speed up planning decisions and to make them more predictable, whilst ensuring future decisions are deemed to be appropriate.

Key aims identified for the planning process include:

- Establishing the Infrastructure Planning Commission, which will develop national policy and streamline decision-making for a range of infrastructure
- Planning applications for renewable energy projects over 50 MW will be determined by the Infrastructure Planning Commission from 2010.
- Ensuring a strategic approach to planning, working with all the English regions (Local Authorities are also mentioned in Renewable Energy Strategy) to help ensure they have robust evidence-based strategies for delivering their renewable potential in line with the UK 2020 target. £1.2m budget was identified to support these efforts.
- Support swifter delivery, helping the planning community as they develop and implement local and regional energy planning and handle renewable and low-carbon energy applications, for example through supporting skills development and by building capacity.
- Address the impacts of renewables deployment by doing more to resolve spatial conflicts and develop generic solutions to mitigate the impacts of renewable technologies, notably air quality, environmental, navigational and aviation radar impacts.
- To ensure a “clear and challenging” planning framework, Planning Policy Statements 1 and 22 (PPS1 & PPS22) will be reviewed and consultation will commence on a combined Climate Change PPS within 2009 (as stated in the Renewable Energy Strategy), with a view towards making them more complementary.
- The 2008 Killian Pretty Review considered improving the process of application determination and there were several recommendations relevant to renewable energy :
    - Overall reduce the number of small-scale developments that require full planning permission
    - Encourage the wider use of Planning Performance Agreements (PPAs) and specifically establish a Renewables and Low-Carbon Planning Performance Agreements demonstration project (this was recently established through ATLAS - Advisory Team for Large Applications - www.atlasplanning.com).

- It was found that 65% of appeals for renewable energy projects are successful. This suggested that priority should be given to appeals on renewable energy proposals.
- Revising the Cost Award procedure.
- Using Local Development Orders (LDO).
- Increasing flexibility for planning permissions.

- Generally ORED and CLG are set to support (including the announcement of £10 million funding over two years) the development of skills and knowledge within the planning community at local and regional level through, for example, the set up of an 'Expert Support Network'

As discussed above, the Renewable Energy Strategy confirmed the government's intention to review the principal national planning policy guidance (PPS1 and PPS22) to ensure they are more complementary. The following summarises the current principal requirements (relevant to Local Authorities) of this guidance:

Planning Policy Statement 22 (PPS22): Renewable Energy

PPS22 sets out the Government's policies for renewable energy, which planning authorities should have regard to when preparing Local Development Documents and when taking planning decisions.

Local policies should reflect paragraph 8 of PPS22 which says:

> *Local planning authorities may include policies in local development documents that require a percentage of the energy to be used in new residential, commercial or industrial developments to come from on-site renewable energy developments. Such policies:*
>
> *(i) should ensure that requirement to generate on-site renewable energy is only applied to developments where the installation of renewable energy generation equipment is viable given the type of development proposed, its location, and design;*
>
> *(ii) should not be framed in such a way as to place an undue burden on developers, for example, by specifying that all energy to be used in a development should come from on-site renewable generation.*
>
> *Further guidance on the framing of such policies, together with good practice examples of the development of on-site renewable energy generation, are included in the companion guide to PPS22.*

Planning Policy Statement 1 (PPS1): Delivering Sustainable Development

PPS1 expects new development to be planned to make good use of opportunities for decentralised and renewable or low-carbon energy. The supplement to Planning Policy Statement 1 'Planning and Climate Change' highlights situations where it could be appropriate for planning authorities to anticipate levels of building sustainability in advance of those set nationally. This could include where:

- there are clear opportunities for significant use of decentralised and renewable or low carbon-energy; or
- without the requirement, for example on water efficiency, the envisaged development would be unacceptable for its proposed location.

Most importantly PPS 1 requires local planning authorities to develop planning policies for new developments that are based on:

> *"….an evidence-based understanding of the local feasibility and potential for renewable and low-carbon technologies, including microgeneration".*

The PPS1 supplement also states that:

> *"….alongside any criteria-based policy developed in line with PPS22, consider identifying suitable areas for renewable and low-carbon energy sources, and supporting infrastructure, where this would help secure the development of such sources, but in doing so take care to avoid stifling innovation including by rejecting proposals solely because they are outside areas identified for energy generation".*

4.1.4 Local Authority powers / obligations

The existing restriction on Local Authorities to sell power (when not as a product of CHP), from Section 11 of the Local Government Act 1976, is to be reviewed. The current powers allow local authorities to lay heat networks and develop district heating schemes and produce electricity and heat, but not to sell electricity which is produced otherwise than in association with heat. The Renewable Energy Strategy suggested that this would be reviewed, which could open up many opportunities for Local Authorities to directly support local aspirations to develop renewable energy.

The Government intends to review the option of introducing a National Indicator for renewable energy into the Comprehensive Area Assessments process. Clearly this would have implications on the monitoring of local implementation rates and progress against established local targets.

Further information in can also be found in: Cleaner, Greener Energy Study: Report 2 - Preparing for NI186 & Options for Local Authority power generation.

4.1.5 Building a Greener Future: Towards zero carbon development

The Government has set out its aspirations for improving the carbon performance of new developments into the future with its announcement of the tightening of Building Regulations for new homes along the following lines:

- 2010 – a 25% carbon reduction beyond current (2006) requirements;
- 2013 – a 44% carbon reduction beyond current (2006) requirements; and,
- 2016 – a 100% carbon reduction beyond current (2006) requirements.

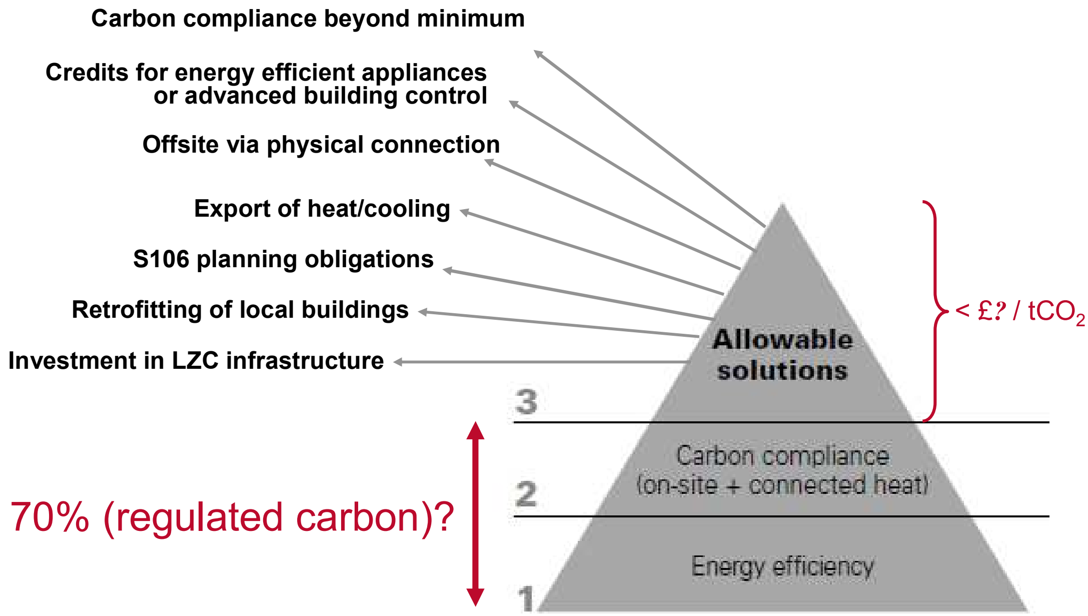
In the March 2008 budget Government also announced its intentions for all non-domestic buildings to be zero carbon by 2019. Therefore, the various phases of development in the district will face stricter and stricter mandatory requirements, and all development after 2016 is likely to need to be zero carbon. However, the aspiration for zero carbon development by 2016 is very challenging and will require innovative approaches from both the public sector as well as the development industry.

The government is proposing to introduce a more flexible definition of 'zero carbon' to guide building policy. The Zero Carbon consultation document published at the end of 2008 outlines various options that could potentially be used by house builders to ensure new homes are 'Zero Carbon' from 2016. It suggests that on-site requirements are capped at somewhere between the current Code for Sustainable Homes (CSH) Level 4 and 5 requirements with a minimum requirement for energy efficiency, and a set of off-site ‘allowable solutions’ developed to allow the residual emissions to be offset. The allowable measures have yet to be fully defined but could include large scale off-site renewable energy infrastructure, investment in energy efficiency measures for existing building stock, energy efficient white goods and building controls, or S106 contributions.

Government has proposed that a maximum cost of the ‘Allowable Solutions’ be set out. If costs stay high, more flexibility will be allowed in the future. The ‘allowable solutions’ will not be fully defined until 2012 so the total cost of carbon is likely to be capped at somewhere between £100 -£200 per annual tonne CO_2 to provide some cost certainty in the meantime.

In policy terms, currently, there is a high level of uncertainty with regard to both the level of on-site compliance required, anywhere between 44% and 100% of regulated emissions, as well as likely costs for allowable solutions to offset the remainder. Analysis of the technology options for on-site compliance presented in the consultation document suggests biomass based technologies are integral to achieving on-site carbon reduction targets at the higher end of this suggested range, and such a target cannot be achieved through micro-renewables alone.

Figure 23: Schematic of zero carbon policy options under consideration



Estimates based on published data[28] suggest a cost range of £10.5k – £15k per dwelling for 100% reduction in regulated emissions on-site depending on the dwelling type. Biomass CHP is a key technology in delivering this target along with energy efficiency measures and PVs. Based on the guideline figure of £100/tonne over 30 years in the consultation document, the total estimated costs for allowable solutions adds another £2,400 - £4,000 to the total for the different dwelling types. At £200/tonne, the costs will be double that indicative range. As a guideline, at the median figure of £150/tonne, the total cost of compliance with zero carbon including both on-site and off-site measures is £14.1-£21k per dwelling.

[28] *Costs and Benefits of Alternative Definitions of Zero Carbon Homes: Project report’ published as an update to the ‘*Definition of Zero Carbon Homes and Non-Domestic Buildings*’ consultation stage Impact Assessment*

Alternatively, given the significant cost of putting in the district heating infrastructure for such schemes, it can be argued that if the entire carbon reduction target was to be achieved solely through on-site measures, the cost of delivering the remainder of the carbon emission on-site will be marginal.

The cost range for compliance with 70% on-site carbon reduction target using micro-renewables is estimated at £8.7k – £11.6k depending on dwelling type. At the median figure of £150/tonne over 30 years, the cost of allowable solutions to achieve the remainder off-site ranges between £5.4k- £9.2k. This also suggests the total cost of compliance to be between £14.1- £20.8k as with the 100% on-site scenario above. However, this option would additionally require gas distribution infrastructure and gas boilers to be put in place, and therefore where these costs are taken into account, the total cost per dwelling would be significant higher for the overall delivery of low carbon energy.

4.2 Regional Planning Policy

There are two aspects of regional planning policy that are critical to this study – Better Design and Energy.

The East Midlands Regional Plan (March 2009) includes the following policy on design:

> ***Policy 2 (Promoting Better Design)***
>
> ***The layout, design and construction of new development should be continuously improved including the terms of reducing CO_2 emissions and providing resilience to future climate change….***

The Regional Plans states that new developments (over 10 dwellings and 1,000m^2) should be built with 10% of energy coming from decentralised and renewable or low carbon sources, unless this is proved to be unviable. This is the default position, since the Regional Plan also requires all authorities to produce Development Plan Documents with policies addressing this issue.

The Regional Plan also refers to national planning guidance PPS1 and the intended zero carbon development standards by 2016 (for housing). It also discussed the opportunities presented from the major development within the region and opportunities to go beyond the current carbon standards, but does not make an explicit requirement on Local Authorities.

Regarding energy, the East Midlands Regional Plan highlights the need to address the following issues:

- develop policies to reduce the need for energy
- enable a significant increase in CHP capacity
- meet minimum regional targets for renewable energy by 2010 and 2020
- develop policies to enable a significant increase in renewable energy microgeneration, and achieve Government's ambition of the zero carbon development and regeneration

The Regional Plan includes the following policy on energy efficiency:

> ***Policy 39 (Energy Reduction & Efficiency)***
>
> ***Local Authorities, energy generators and other relevant public bodies should:***
> ***- Promote a reduction of energy usage in line with the 'energy hierarchy'; and;***
> ***- Develop policies and proposals to secure a reduction in the need for energy through location of development, site layout and building design***

The following on energy generation:

Policy 40 (Low Carbon Energy Generation)

Local Authorities, energy generators and other relevant public bodies should promote:

- ***the development of CHP and district heating infrastructure necessary to achieve the regional target***
- ***the development of a distributed energy network using local low carbon and renewables resources***

Furthermore Local Authorities should:

- ***safeguard sites for coal mine methane***
- ***identify sites for CHP plant, related to existing or planned development***
- ***consider safeguarding from power generation sites for low carbon power generation***
- ***support the development of distributed local energy generation networks***
- ***develop the policies and proposal to achieve the indicative targets (6.4% by 2010, 23% by 2020 and 24% by 2025 (also distributed by technology)***

The regional-wide targets above are only for renewable electricity generation and are expressed as a percentage of regional electricity consumption.

Recently, as part of the partial review of the Regional Plan, a review of regional renewable energy targets was conducted for the East Midlands Regional Assembly (EMRA). This essentially reviewed existing resource data and conducted sensitivity analyses around a number of scenarios of technology implementation. It arrived at a range of future scenarios, which may, in turn be translated into regional targets, once the partial review is completed. These targets exclude transport:

Table 7: East Midlands regional renewable energy targets

	2011	2016	2021	2026	2031
Lowest	2%	3%	4%	5%	5%
Highest	3%	5%	9%	13%	17%

These targets express both heat and power generation, but as transport fuels are excluded they are not directly comparable to national renewable energy targets (currently 15% by 2020).

The Regional Plan also sets targets for Combined Heat and Power of 511MWe by 2010 and 1120MWe by 2020, against an estimated 2004 capacity of 237MWe.

5 Introduction to assessing the local potential for renewable energy

5.1 General approach to understanding the potential for the technology / application classifications

The assessment of renewable energy potential has been separated into four classifications of potential project:

1. Wind energy projects – standalone development of decentralised wind energy projects, assumed to be at least one turbine of megawatt scale.
2. Biomass energy projects – biomass power, biomass heat and CHP of a variety of scales typically up to a maximum of 30MWe. It includes a variety of feed stocks such as forestry residues, energy crops, sawmill residues, agricultural straw, agricultural animal waste, organic waste currently land-filled and green waste currently diverted from landfill. Conversion technologies include steam turbines, gasification systems, pyrolysis and anaerobic digestion.
3. New buildings – low carbon technologies integrated within new buildings or associated with new development, either being physically connected through infrastructure such as district heating or located nearby such as a local wind project. This category includes off-site allowable solutions to meet a proportion of a zero carbon target, regardless of specific location of the off-site project. Technologies include solar thermal, solar PV, ground source and air source heat pumps, biomass boilers, biomass CHP, micro wind and large wind. It could also include emerging conversion technologies such as fuel cells.
4. Existing buildings – micro generation heat and power projects integrated within existing buildings. This will include solar thermal, solar PV, ground source and air source heat pumps and small scale biomass boilers.

These categories have been chosen to reflect the full range of potential applications for renewable energy within the study area. Non-renewable energy from waste, offshore wind and nuclear power are excluded from the calculations. Background information, together with analysis methodology notes (where relevant) are included in Appendix V through to Appendix XII

Hydro has not been considered in detail in this study since the regional analysis carried out by EMRA indicates that the potential is fundamentally limited by the head of water available (mostly at existing weirs) and most installations will typically be relatively low capacity at 10s or 100s of kW. Two systems currently existing at Borrowash (Erewash) and Ambergate (Amber Valley) and a further five sites have previously be identified : Darley Abbey, Longbridge Weir, Millford Mill, East Mill, Trent Lock Weir. The site at a Trent Lock Mill (also known as Thrumpton weir at a capacity of approximately 1MW is the largest project by far. Together all of the known site of potential, in the study area, equate to a capacity of 2.8MW, with a production potential of approximately 14 GWh per year, or less than 0.0002% of (2006) regional energy consumption and less that 1% of the 2025 estimated renewable energy capacity.

6 Assessment of wind energy

6.1 Methodology

6.1.1 Identifying potential wind locations - GIS Mapping

A GIS[29] analysis has been undertaken to identify sites which are suitable for large scale wind. This analysis combines a host of wind resource, spatial and social constraints to identify zones which would be more technically viable for the siting of large scale wind turbines.

The 'layers' included in the GIS analysis are listed in Table 8. These have been overlaid to form composite maps of constrained and less constrained zones of potential. The sites identified could (technically) accommodate an single turbine, however, some of the larger sites would allow multiple turbines.

Table 8 shows a full list of layers the relevant buffer distances (where applicable) and degree of constraint that they impose on wind development. Some pose a high degree of constraint and, for the purposes of calculating renewable energy potential, are considered effectively to rule out wind farm development.

Table 8: GIS Layer Information

GIS Layers			
Category	**Name**	**Buffer**	**Type**
Wind speed			
	Average wind speed @ 45m above ground level < 5.9m/s		Constrained
International, national and local designations for heritage			
	World Heritage Sites		Constrained
	Heritage Parks & Gardens		Constrained
	Heritage Coast (not relevant for this study)		less constrained
International, national and local designations for landscape			
	Areas of Outstanding Natural Beauty		less constrained
	Greenbelt		less constrained
	National Parks		Constrained
	Sites of Importance for Nature Conservation		less constrained
	County Heritage Sites		less constrained
	Environmentally Sensitive Areas		less constrained
International, national and local designations for ecology			
	Sites of Special Scientific Interest		constrained
	Special Areas of Conservation		constrained
	Special Protection Areas		constrained
	Ramsar Sites		constrained

[29] *Geographic Information Systems*

GIS Layers			
Category	**Name**	**Buffer**	**Type**
	RSPB Reserves		less constrained
	Important Bird Areas		less constrained
	National Nature Reserves		less constrained
	Local Nature Reserves		less constrained
	Ancient Woodland		constrained
Designations for archaeology			
	Scheduled Ancient Monuments		constrained
Space requirements			
	Open water		constrained
	Woodland		constrained
	Dwellings	600m	constrained
	Commercial buildings	50m	constrained
	Motorways, A roads & B roads	150m	constrained
	Railways	150m	constrained
	Bridleways	250m	constrained
	Other Public Rights of Way	50m	constrained
Air safeguarding and radar constraints from MOD and civil aviation interests			
	Civil airports	30km	less constrained
	MoD airbases	30km	less constrained
	Small civil airfields	10km	less constrained
Electromagnetic interference to communications radar			
	Primary TV transmission masts	100m	constrained
	Secondary TV transmission masts	100m	constrained
	TV broadcast links	100m	constrained
	Radio transmission masts	100m	constrained
	Radio broadcast links	100m	constrained
	Weather radar stations	10km	less constrained
Other			
	Steep terrain > 20°		constrained
Cumulative impact			
	Existing or consented wind farms	5km	constrained

‘Air safeguarding’ zones around MOD and civil aviation interests are consultation zones, i.e. local planning authorities are required to consult the Civil Aviation Authority (CAA) upon any proposed developments with tall structures that would fall within safeguarding map-covered areas. This is an example of a ‘less constrained zone’ rather than an absolute constraint for wind development (i.e. one that would not necessarily prevent wind energy developments in the area, but which requires consultation with the respective stakeholders). The British Wind

Energy Association's 'Wind energy and aviation guide' points out that the aviation community has "procedures in place to assess the potential effects and identify mitigation measures". Furthermore, the guide states that while both wind energy and aviation are important to UK national interests, the 'overall national context' will be taken into account when assessing the potential impacts of a wind development upon aviation operations.

Therefore, the air safeguarding zones are only considered 'consultation zones' and were therefore excluded at this stage from the wind energy constraints analysis.

However, despite air safeguarding zones not being absolute constraints, they need to be addressed by developers early in the process of wind energy site development. It is, therefore, advised for developers to start a pre planning consultation process with the relevant aviation stakeholders early in the feasibility process. It is worth noting that there are developing technical solutions to potential radar interference, for example, 'stealth' treatments to the key elements of the wind turbine structure. Moreover, the fact that there are numerous examples of development in close proximity to airports, such as Prestwick in Scotland and Schipol in The Netherlands, suggests that wind turbines can be compatible with airport locations.

The GIS analysis presents a view of the potential sites for wind energy development, based upon the spatial constraints considered. It does not the directly account likelihood of being able to easily connect to the electrical distribution network (largely an economic issue), nor does it consider landscape / visual amenity constraints which, would need to be considered on a project-by-project basis. Additionally, telecommunications masts have been excluded from the analysis due to a lack of relevant GIS data for such a large area, and again this should be considered on a project-by-project basis.

We have identified the key absolute constraints which are likely to rule out wind turbine developments but there are a number of additional local issues and preferences that could constrain any specific wind turbine location. These include local landscape considerations, access issues, contamination, private airstrips, economic issues and political decisions concerning the desirability of a wind turbine at that specific site. The identified sites for potential wind turbine developments would also need to be considered against the local landscape character assessments to ascertain their potential impact on character areas. One issue which may cause a wind turbine development to prove uneconomic would be the proximity of the local power grid. Once wind developers have identified general sites, they analyse these further issues in greater detail before putting together an economic case and a subsequent planning application.

Cumulative landscape amenity impact of multiple turbines, is an important issue and one that is a critical concern for more rural districts, where they also have limited spatial constraints. In such locations the GIS analysis described above may suggest a large number of suitable locations for wind energy development. Consideration should be given to conducting a landscape capacity study for the study area, notably for South Derbyshire.

6.1.2 Potential energy supply from identified wind energy sites

This section provides a brief overview of the methodology to convert technically viable sites (from the GIS analysis) into an estimate of the number of wind turbines and extent of electricity delivered from these.

Based on guidance from the Danish Wind Energy Association[30], a maximum of five wind turbines per square kilometre could be installed for the larger sites. This allows for adequate

[30] *www.windpower.org*

spacing between turbine blades to prevent air stream interference to the operational determent of the turbines.

The size of the wind turbine is proportional to its energy output, and onshore wind developers will look to install the largest turbines viable for a given site. The current market for large scale wind turbines suggests that 2.5 MW turbines (approximately 120m to the tip of the blade at the top of its swept area) and this has been applied as a typical wind turbine for the study period, although it should be recognised that the wind turbines will be selected to suit each specific location. A simple method to quickly understand the likely electricity generated from a wind turbine is to apply a capacity factor (or load factor): actual annual generation as a percentage of a turbine's theoretical maximum output. The long term UK average annual capacity factor (for all wind energy projects) as reported by DECC in 2009 is 28%, however we have assumed a more conservative view of 25% to account for the low wind speeds within the study area. In addition to the capacity factor, it is assumed that any wind turbine will be taken off line for maintenance for 5% of the time. The calculation below sets out how these factors are combined to estimate the energy generation from a single 2.5 MW large scale wind turbine.

2.5 MW x 8,760 hrs/yr x 95% availability x 25% capacity factor = 5,201 MWh/yr

6.1.3 Discounting for development viability

The technical potential calculated through GIS mapping has then been discounted to reflect development viability. Standalone development has been deemed viable for all sites with the potential for at least two large turbines (~2.5MW capacity) where development costs and risks can be justified. An example of this would be small scale community wind projects such as that in the market town of Swaffham in Norfolk[31]. The proportion of this scale of project that goes forward to planning has been set in each of the modelled scenarios.

Smaller single-turbine projects are also deemed possible when developed on a 'merchant wind power' basis, for example when sited on industrial land, normally with power sold on site. An example of this kind of development would be that at Green Park, Reading[32]. The proportion of this scale of project that goes forward to planning has been set in each of the modelled scenarios.

6.1.4 Discounting for planning approval rates

For both scales of development, the potential number of turbines has been discounted further to reflect potential planning approval rates. The proportion of turbines that receive planning approval has been set in each of the modelled scenarios.

6.1.5 Avoiding double counting

The development of wind turbines fall into two principal groups: standalone decentralised energy generators and turbines to support new build sites. The methodology set out above identifies a realistic view of the wind resources available for decentralised energy generation, and includes a number of discounting factors which reduce the number of technically feasible sites. However, as discussed in section 8, wind turbines are also anticipated to be implemented within the existing built environment, i.e. not part of new-build development nor 'decentralised'. These are assumed to be in addition to the decentralised wind turbines. The justification for this is that wind site developers will look to cherry-pick the largest sites with the highest wind speeds. The priorities are different for wind turbines associated with a new development, which are likely to need fewer wind turbines (designed to achieve specific carbon savings) and will

[31] *www.ecotricity.co.uk/wind-parks/*
[32] *www.ecotricity.co.uk/wind-parks/*

seek sites with proximity to the development itself. It is hence assumed that the two 'groups' will prioritise differing sites and that double counting would not take place. From 2016 onwards (for housing) the zero carbon standard will allow off-site development of renewable energy to fulfil carbon reduction requirements and this is included the assessment of the decentralised renewable energy resources, rather than linked to 'new-build'.

Note that the number of wind turbines for new build developments fall easily within the technical capacity of the study area, and hence there are no issues of this analysis exceeding the technical capacity for large scale wind.

6.1.6 Scenarios

Modelling has been carried out for two scenarios representing a range of potential, called Base Case and Elevated Case:

Base Case

- This is considered to be broadly representative of the current situation taking into account development economics, existing market mechanisms, typical UK planning approval rates, etc.
- It is assumed that there is development interest for all sites with potential for three or more turbines and 10% of sites suitable for one turbine
- The planning approval rate for all sites of interest is taken to be 33%.

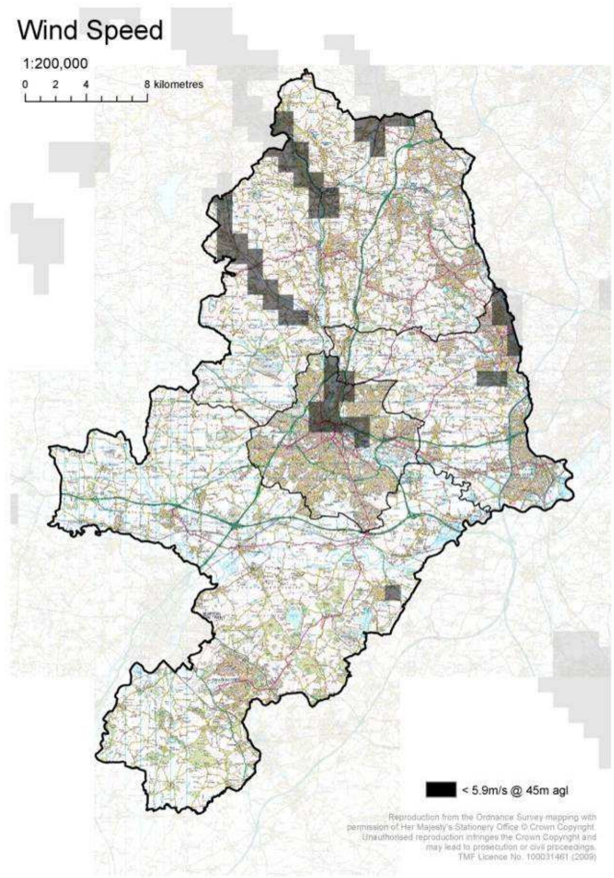
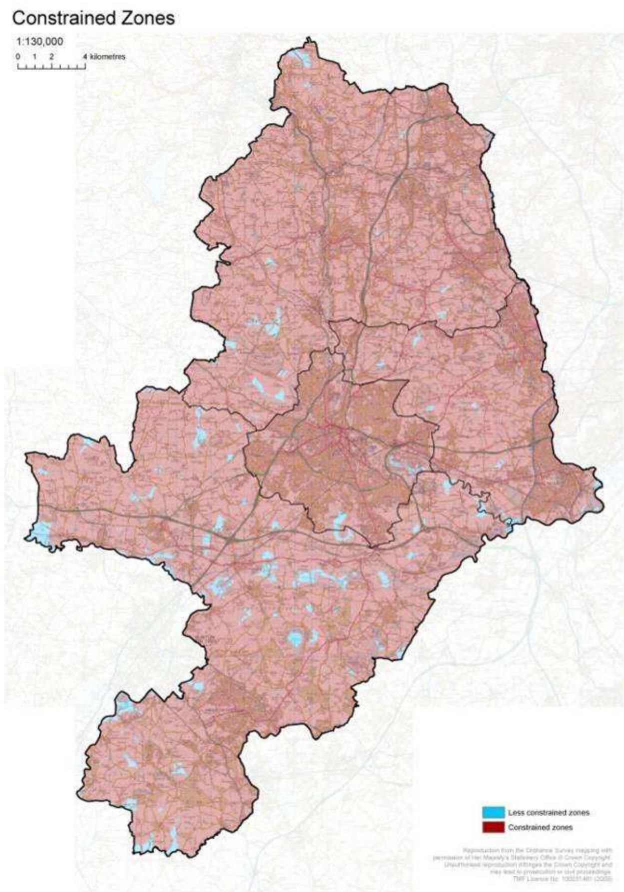
Elevated Case

- This is considered to be a reasonable scenario of elevated potential, primarily as a result of increased planning approval rates.
- It is assumed that there is development interest for all sites with potential for three or more turbines and 10% of sites suitable for one turbine
- The planning approval rate for all sites of interest is taken to be 66%, whether this is through local determination or approval following appeal. The increase could reflect increased acceptance at a local level, better understanding of the issues by officers and elected members or better constructed planning applications brought forward in line with industry best practice protocols.

6.1.7 GIS mapping of resource and constraints

Table 9 shows the primary GIS mapping results for the study area. Further GIS layers are included in Appendix V. It can be seen that the wind resource is generally reasonably good, with much of the study area experiencing average wind speeds in excess of 6 metres per second at a height of 45m above ground. This is a notional benchmark of viable wind speed but wind speeds will be much greater at a typical hub height in excess of 85m. It can be seen that the majority of less constrained sites lie in the south of the study area in South Derbyshire.

Table 9: GIS Mapping Results

GIS Mapping Results	
Wind Speed	
 	

6.2 Base Case Potential

The results of the Base Case analysis are shown below for each local authority area.

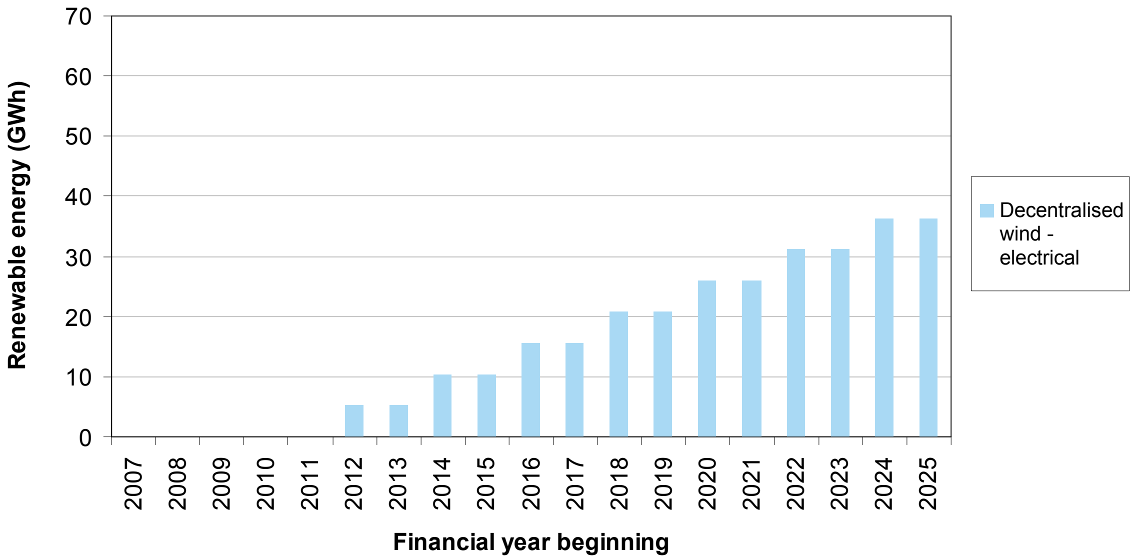
6.2.1 Amber Valley

Under Base Case conditions, around seven wind turbines could be developed by 2025, meeting 6% of Amber Valley's electrical needs.

Table 10: Renewable energy results - Amber Valley decentralised wind, base case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Electrical	10.4	26.0	36.4
Proportion of demand	Electrical	1.68%	4.25%	6.02%
No of 2.5 MW turbines		2	5	7

Figure 24: Renewable energy generated by decentralised wind – base case



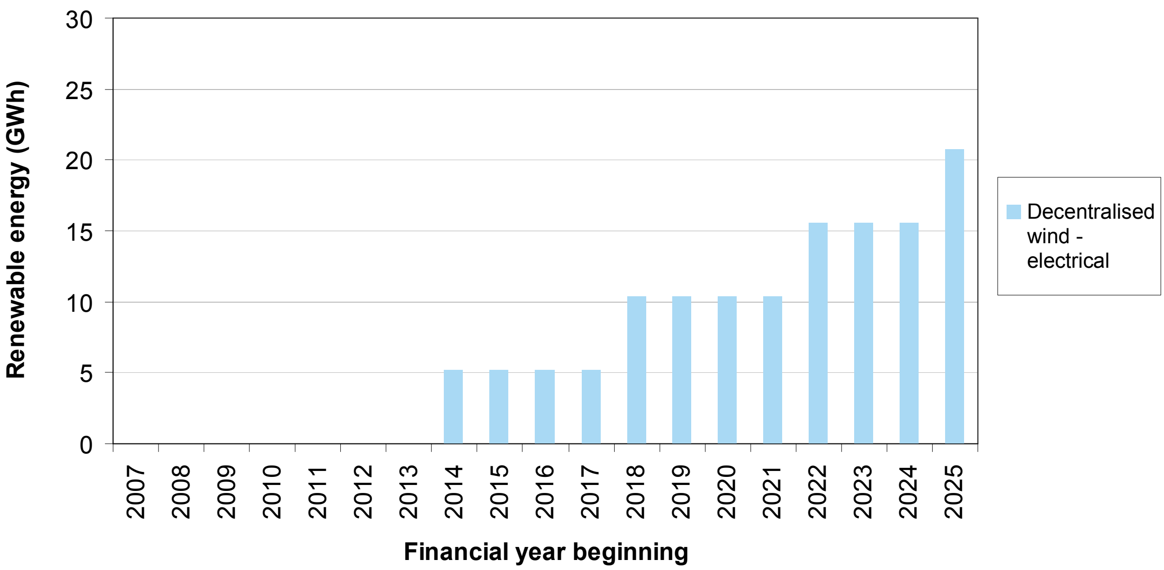
6.2.2 Derby

Under Base Case conditions, Derby also has the potential to see wind development around the edge of the city including up to around 4 wind turbines by 2025, meeting just less than 2% of the city's electrical needs by 2025/26. This is similar to the kind of development seen around other urban areas such as the two large turbines in Dagenham, East London, at the Ford car plant[33].

Table 11: Renewable energy results - Derby City decentralised wind, base case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Electrical	5.2	10.4	20.8
Proportion of demand	Electrical	0.44%	0.89%	1.79%
No of 2.5 MW turbines		1	2	4

Figure 25: Renewable energy generated by decentralised wind – base case



[33] *www.ecotricity.com*

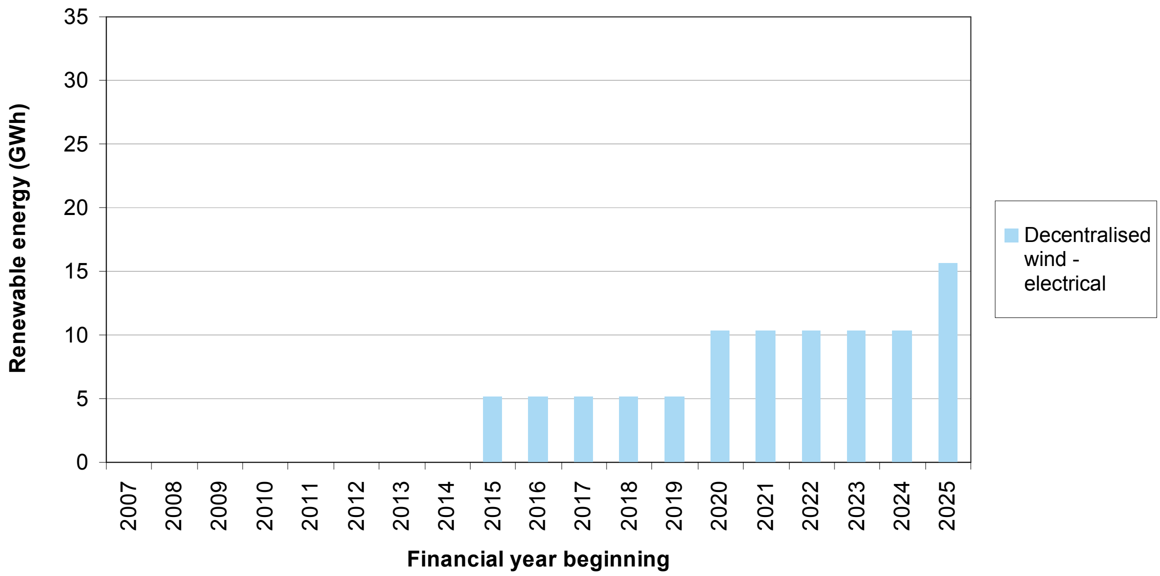
6.2.3 Erewash

Under Base Case conditions, Erewash has the potential for a similar number of wind turbines as Derby but due to its lower settlement density this could provide over 3% of the authority's 2025/26 electrical needs.

Figure 26: Renewable energy results - Erewash decentralised wind, base case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Electrical	5.2	10.4	15.6
Proportion of demand	Electrical	1.06%	2.14%	3.24%
No of 2.5 MW turbines		1	2	3

Figure 27: Renewable energy generated by decentralised wind – base case



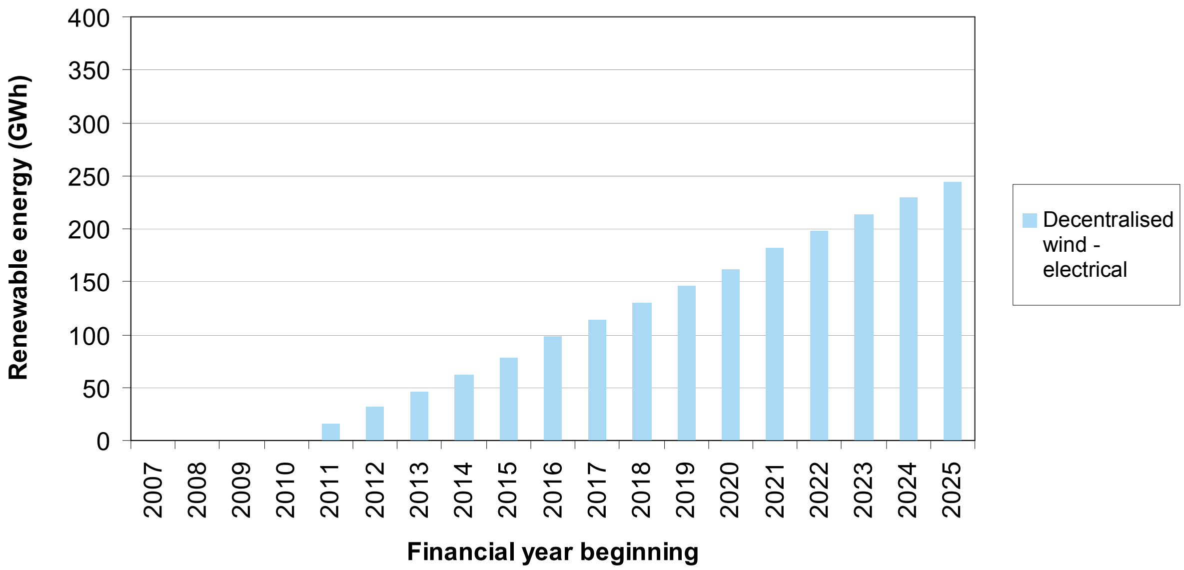
6.2.4 South Derbyshire

South Derbyshire has by far the greatest wind energy potential of all the authorities in the study area. This is due to its low settlement density, relatively high wind speeds and more sparsely distributed constraints (such as buildings, roads etc.). It is worth noting that our analysis does not include a qualitative assessment of 'Landscape Carrying Capacity' but does model a buffer zone around existing or planned wind farms and models a maximum development density for new sites. These numbers should therefore be viewed as a maximum number that we see potentially coming forward under Base Case conditions. The area has the potential to meet almost a third of its electrical demands in 2020/21 and nearly half by 2025/26.

Table 12: Renewable energy results - South Derbyshire decentralised wind, base case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Electrical	78.0	161.2	244.5
Proportion of demand	Electrical	19.60%	31.42%	47.72%
No of 2.5 MW turbines		15	31	47

Figure 28: Renewable energy generated by decentralised wind – base case



6.3 Elevated Case Potential

The results for the wind Elevated Case potential are set out below.

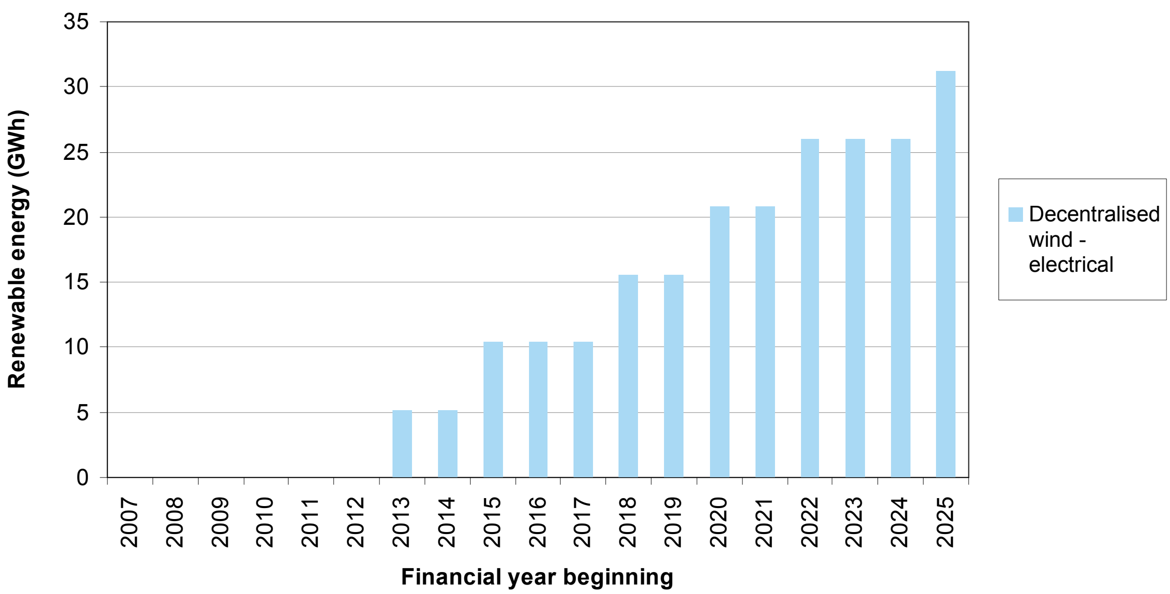
6.3.1 Amber Valley

With enhanced planning approval rates, wind energy could potentially supply over 10% of Amber Valley's electricity from around 12 turbines.

Table 13: Renewable energy results – Amber Valley decentralised wind, elevated case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Electrical	20.8	41.6	62.4
Proportion of demand	Electrical	3.63%	6.80%	10.32%
No of 2.5 MW turbines		4	8	12

Figure 29: Renewable energy generated by decentralised wind – Amber Valley elevated case



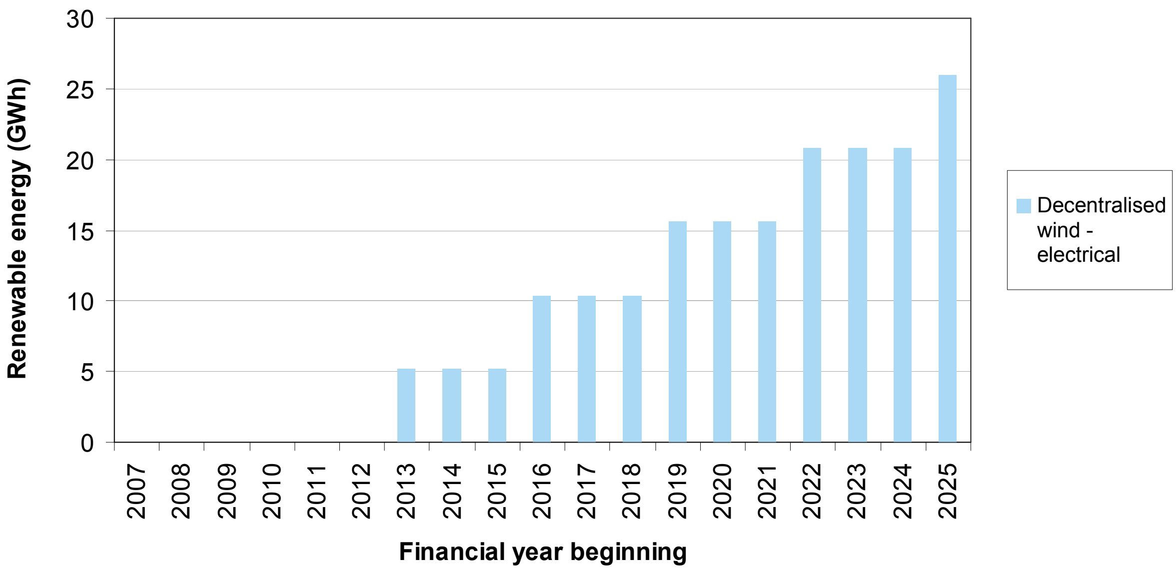
6.3.2 Derby

Derby fairs slightly better with higher planning approval rates but is still unlikely to see more than a handful of large turbines been accommodated within the authority's boundary.

Table 14: Renewable energy results – Derby City decentralised wind, elevated case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Electrical	5.2	15.6	26.0
Proportion of demand	Electrical	0.44%	1.33%	2.24%
No of 2.5 MW turbines		1	3	5

Figure 30: Renewable energy generated by decentralised wind – Derby, elevated case



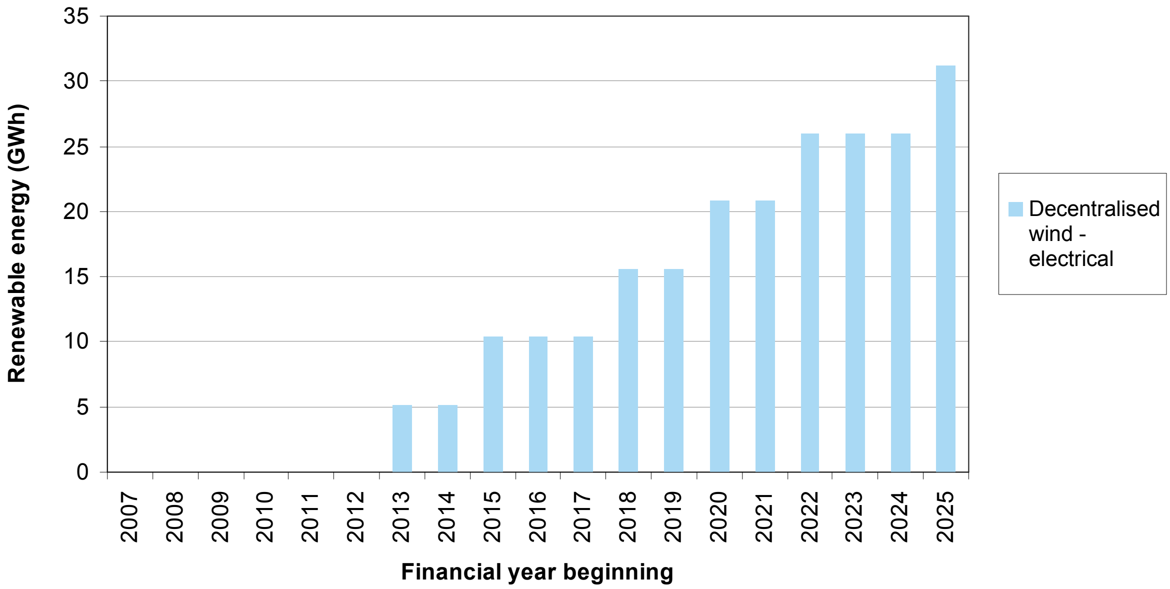
6.3.3 Erewash

Under the enhanced case conditions, around 6.5% of Erewash's electricity needs could be supplied from local wind projects by 2025/26, equivalent to around six large turbines.

Table 15: Renewable energy results – Erewash decentralised wind, elevated case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Electrical	10.4	20.8	31.2
Proportion of demand	Electrical	2.13%	4.29%	6.48%
No of 2.5 MW turbines		2	4	6

Figure 31: Renewable energy generated by decentralised wind Erewash – elevated case



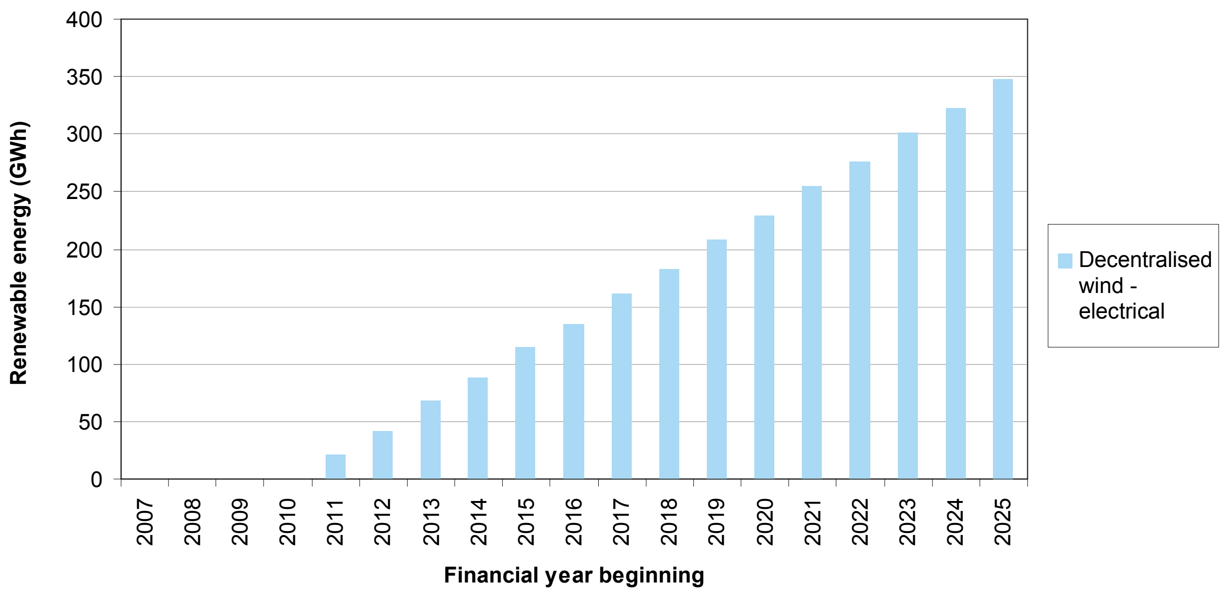
6.3.4 South Derbyshire

In the Elevated Case scenario, South Derbyshire could potentially meet almost 45% of its electricity needs from wind by 2020/21 and over two thirds by 2025/26. .As stated before, this should be viewed as a likely upper limit as in practice it would mean around ten wind farms of 5-7 turbines each. This has been considered further when recommending targets.

Table 16: Renewable energy results – South Derbyshire decentralised wind, elevated case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Electrical	114.4	228.9	348.5
Proportion of demand	Electrical	22.81%	44.60%	68.03%
No of 2.5 MW turbines		22	44	67

Figure 32: Renewable energy generated by decentralised wind – South Derbyshire elevated case



7 Assessment of biomass energy

7.1 Methodology

7.1.1 Overview of approach

The overall approach to assessing the biomass resource potential has been to quantify the total biomass available for energy generation from a wide range of existing streams within the study area and to then apply resource uptake curves to project potential achievable rollout of generation capacity over the study period. The assessment covers the following bio-energy feedstocks:

- Crop residues
- Animal manures
- Energy crops
- Residues from forestry operations
- Sawmill co-products
- Municipal Solid Waste components of biogenic origin (wood waste, food/kitchen waste, green waste, paper and card)
- Commercial & Industrial waste wood

The procedure followed for this assessment is outlined below:

1. Quantification of the resource available from each of the biomass streams considered. This is based on resource information provided by the local authorities and data specific to the study area collated from DEFRA and a range of other cited sources. The analysis follows through a number of stages in order to arrive at a reasonable estimate of the available potential resource:

   1.1. Estimate theoretical potential i.e. the total quantity of feedstock generated in the study area (see Appendix VII for results by authority).

   1.2. Estimate technical potential. This is the fraction of the theoretical potential that is not limited by absolute technical and environmental constraints, e.g. maximum quantity of straw that can be extracted from the field using technology currently available.

   1.3. Estimate available potential. This is the technical potential minus competing demands for the resource that is assumed need to be met before resources can be diverted for purpose of energy generation; specifically:

   - for sawmill co-products, the wood processing industry's needs are supplied first
   - for crop residues, feed and bedding needs are supplied first
   - for wastes, recycling is supplied first. Composting is not treated as competing demand.
   - for energy crops, arable land required for food production is excluded

2. Define uptake curves for each feedstock considered. The fraction of the available resource that can be realistically extracted now is estimated based on current capabilities and practices. This is then increased gradually over time up to the full available resource, taking into consideration the rate at which each sector could develop. The principles upon which the uptake curves have been defined are drawn

from a recent study commissioned by DECC[34], as well as previous experience in other EU countries. Resource uptake curves for each feedstock are then converted into primary energy curves using calorific values specific to each feedstock[35].

3. Primary energy curves for each bio-energy feedstock are grouped in accordance to the suitability for use within three broad categories of conversion technologies: 'clean biomass' combustion, energy from waste plants and anaerobic digestion plants.

4. Useful energy generation is estimated under a number of case scenarios that explore useful energy that could be delivered depending on the proportion of the resource dedicated to cogeneration, heat generation only or electricity generation only.

Specific assumptions regarding resource potential for particular fuel types are described in Appendix VII. A major waste-to-energy plant is proposed within Derby and this has been considered in the analysis and is described in this Appendix.

7.1.2 Avoiding double counting

Biomass resources can be diverted to three fundamental groups: decentralised energy generators (power generation and community heating); new build sites (new boilers, CHP and community heating); and the existing built environment (retrofit of boilers, CHP and community heating). The methodology set out above identifies a realistic view of the biomass resources available for energy generation. Uptake curves for the biomass required to meet the needs of new build were subtracted from the resource, leaving the remainder for decentralised energy generation. This leaves the biomass required for the existing built environment to be considered.

As outlined in section 9, renewable energy generation within the existing built environment is derived from a study at the regional and national level[36]. The scenario which was used to inform our analysis for uptake in the CGES study area included no microgeneration-scale biomass installations by 2020. Whilst Camco see this as a pessimistic view of the potential for retrofit biomass, it is considered that the uptake will not be significant due to technical difficulties such as space requirements for wood chip/pellet stores. Hence, it is viewed that although double counting may exist, it will be negligible.

This position can be substantiated by quickly looking at the scales of biomass required in a retro-fit installation compared to that diverted to decentralised energy generation. A single biomass boiler for a dwelling would produce approximately 0.002% of the decentralised thermal energy provided by biomass within the study area in 2025[37] therefore even if a thousand household systems were installed this would only deliver 2% of the total biomass resource within the study area.

[34] To inform the government's Renewable Energy strategy, the Department of Energy and Climate Change (DECC) [34] commissioned research to forecast the likely roll-out / uptake of generation capacity across the UK. E4tech, 2009, Biomass supply curves for the UK, available at http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/renewable/res/res.aspx
[35] It should be noted that for anaerobic digestion feedstocks, the energy content of the biogas yield expected has been used rather than the calorific value of the feedstock.
[36] Element Energy, 2008, The growth potential for microgeneration in England, Scotland and Wales
[37] Based upon 283,559 MWh/yr thermal energy from decentralised biomass in the study area in 2025, and the thermal demand of an existing dwelling being 6.6 MWh/yr.

7.2 Uptake Scenarios

The following scenarios have been defined for biomass.

Base Case

- Assume that all of the available local biomass resource is used according to the market uptake curves. It is assumed that this increase in use of biomass resources also reflects an increase in planning approval rates for biomass power and CHP projects, maturing of the supply chain and reduction / management of development and planning risk.
- No net import of biomass fuels from beyond the study area.

Elevated Case

- This is assumed to be the same as the base case, i.e. biomass project development is limited to using local resources only. In practice it is likely that some larger projects will source biomass from outside the study area. However, the purpose of the PPS1 evidence base is primarily to assess the potential from locally available resources in order to avoid double counting with neighbouring authorities, 'local' had been defined as the study area.

7.3 Base Case Potential

The results of the biomass analysis for the Base Case scenario are shown below.

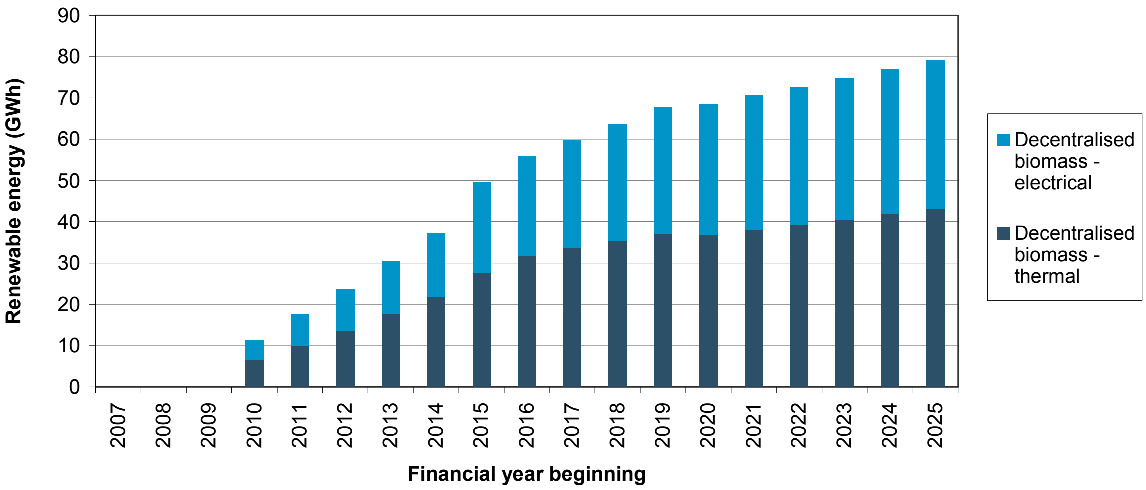
7.3.1 Amber Valley

There is good potential for biomass development in Amber Valley, with over 3% of energy needs potentially met by 2025/26. This is equivalent to around 5 MW_e of biomass power generation and 22 MW_{th} of heat generation from biomass boilers.

Table 17: Renewable energy results - Amber Valley decentralised biomass, base case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	27.5	36.9	43.0
	Electrical	22.0	31.7	36.0
	Total	49.5	68.6	79.0
Proportion of demand	Thermal	1.43%	1.98%	2.38%
	Electrical	3.54%	5.17%	5.96%
	Total	1.95%	2.77%	3.28%

Figure 33: Renewable energy generated by decentralised biomass – base case



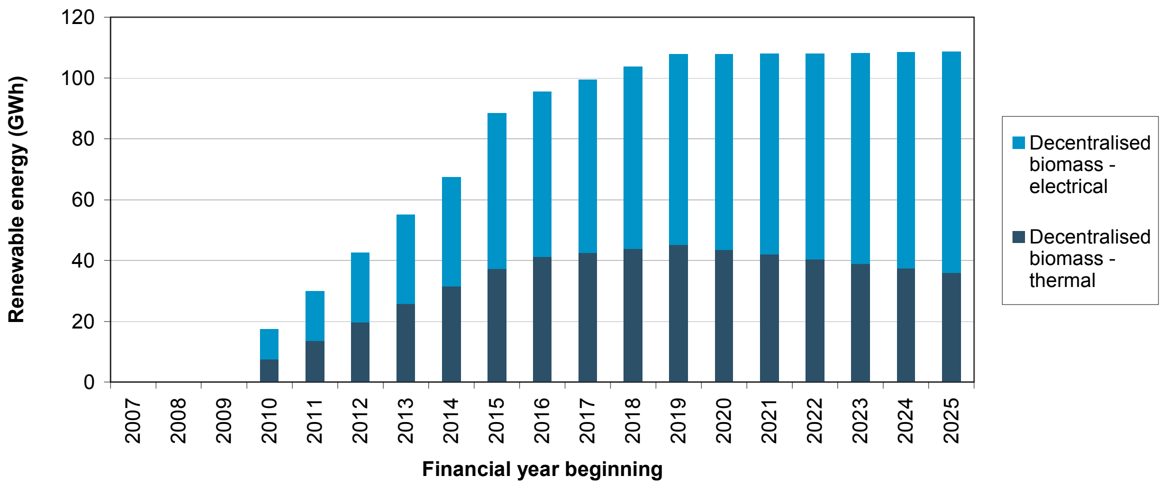
7.3.2 Derby

There is also good potential for biomass heat and power serving the city using feedstocks sourced within the study area. The 2025/26 capacity is equivalent to around 30 MW_e of biomass CHP with half the heat used within a district heating system.

Table 18: Renewable energy results - Derby City decentralised biomass, base case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	37.3	43.6	35.9
	Electrical	51.3	64.3	72.8
	Total	88.6	107.9	108.7
Proportion of demand	Thermal	1.36%	1.63%	1.39%
	Electrical	4.34%	5.48%	6.27%
	Total	2.26%	2.81%	2.90%

Figure 34: Renewable energy generated by decentralised biomass – base case



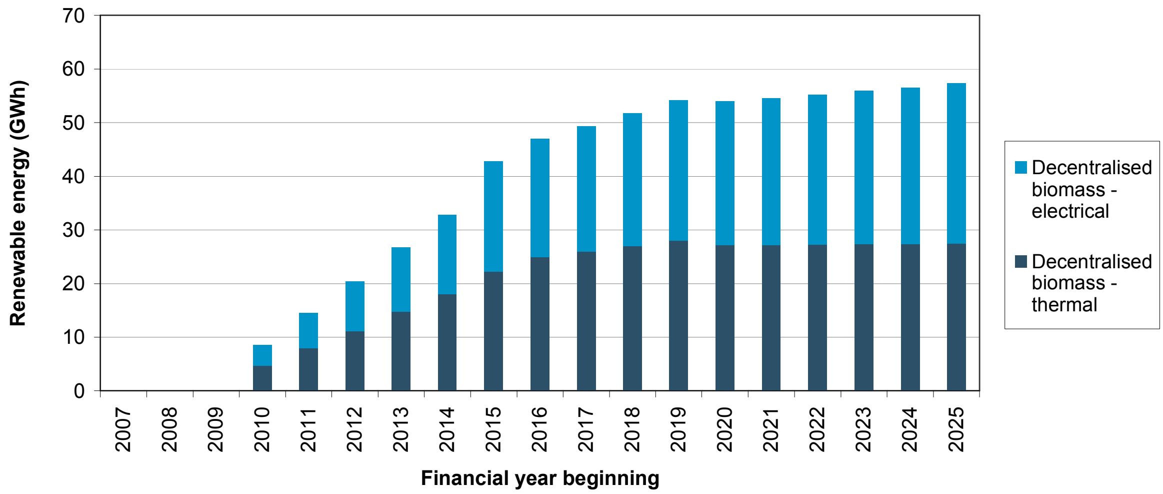
7.3.3 Erewash

Under Base Case conditions, Erewash could meet over 3% of its energy needs from biomass heat and power by the end of the study period.

Table 19: Renewable energy results - Erewash decentralised biomass, base case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	22.2	27.2	27.4
	Electrical	20.6	26.8	29.9
	Total	42.8	53.9	57.3
Proportion of demand	Thermal	1.71%	2.16%	2.25%
	Electrical	4.21%	5.51%	6.20%
	Total	2.40%	3.09%	3.36%

Figure 35: Renewable energy generated by decentralised biomass , Erewash, base case



7.3.4 South Derbyshire

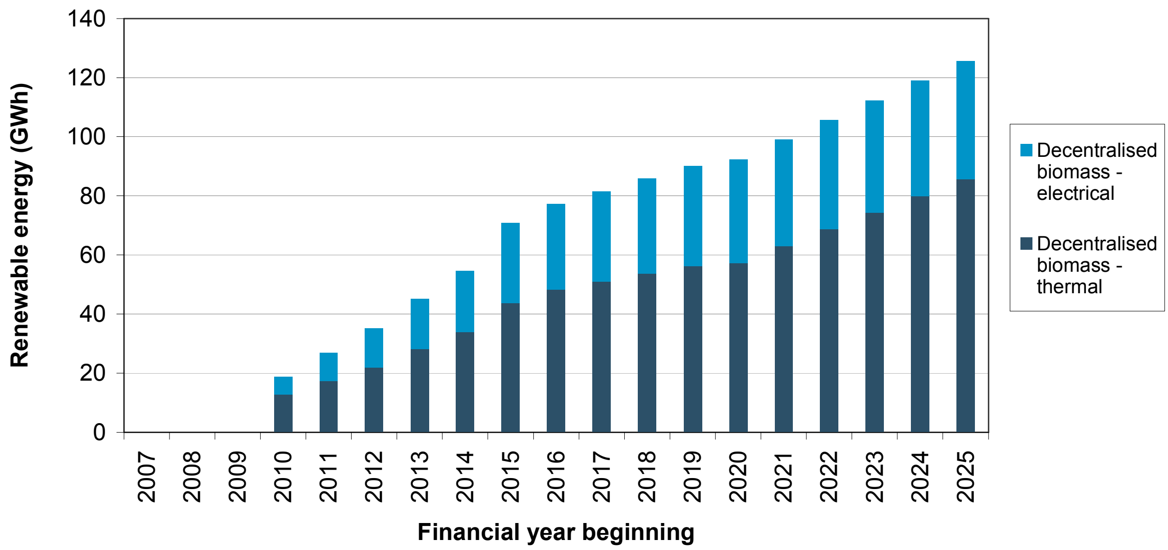
As is the case for the wind analysis, South Derbyshire has the greatest biomass potential of the four authorities. By 2020/21 biomass could meet 4% of its energy needs, rising to nearly 5.5% by 2025/26.

Although the National Forest is highly prevalent within the Authority's boundary, it is assumed that it will make a major contribution in absolute fuel volume terms. Any existing woodland will be defined as ancient, and would therefore be restricted in terms of its thinnings. New plantation as part of the National Forest will be broad leaved in species, and hence will not mature sufficiently to yield wood within the study period. However, the role of the National Forest to contribute to the stimulation of wood fuel markets is an important one, with the opportunity for the organisation to take a leadership role.

Table 20: Renewable energy results - South Derbyshire decentralised biomass, base case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	43.6	57.4	85.6
	Electrical	27.1	35.0	40.0
	Total	70.7	92.4	125.6
Proportion of demand	Thermal	2.40%	3.19%	4.86%
	Electrical	5.40%	6.82%	7.81%
	Total	3.05%	3.99%	5.52%

Figure 36: Renewable energy generated by decentralised biomass – base case



7.4 Delivering biomass energy

Developing biomass as a renewable energy resource is notoriously difficult because, unlike other technologies such as wind energy, it is necessary to resolve the twin problems of fuel supply and demand simultaneously. Without sufficient demand the supply market is not stimulated and vice versa. Hence, biomass is a prime area for public sector intervention to overcome the market discontinuities that exist. There are some good examples of this in Europe such as in Austria, but also emerging examples in the East of England, in Yorkshire and Humber and in the North West of England, with growing amounts of investment for infrastructure projects.

For the study area to support the development of the biomass sector and maximise uptake, the following are suggested actions:

- Develop a comprehensive medium term (say 5 year) strategy
- Raise awareness of bio-energy among key stakeholders, including the development industry, waste managers, e.g. municipal waste and land owners / farmers
- General education and advocacy on the opportunities presented by bio-energy to overcome any public concerns.
- Review funding opportunities, e.g. DEFRA Bio-energy Capital Grants Scheme, the Bio-energy Infrastructure Grants Scheme and the Regional Development Agency, and co-ordinate strategic applications, learning from actions/best practice elsewhere.
- Review specific opportunities around the estates of the partner authorities, e.g. anchor for community heating or fuel switching within council buildings.
- Take advantage of existing resources/expertise of UK-wide bodies and UK-wide schemes (e.g. the Carbon Trust's Biomass Heat Accelerator Scheme, the National Non Food Crop Centre and the Biomass Energy Centre).
- Consider access and costs issues for bio-energy power plants seeking to connect to the grid.
- Consider opportunities to increase the use of bio-energy through planning guidance and building regulations.
- Consider local air quality of emissions from bio-energy heat and power plants. To ensure that bio-energy plants meet air quality legislation.
- Develop funding scheme for pilot projects. Support a limited number of representative projects in each sector with good dissemination potential.
- Consider potential for the Anaerobic Digestion plant not just wood based projects.
- Develop an understanding of the market potential of the existing feedstocks and seek to quantify potential, as an initial step to developing the business case for strategic investment, and encourage prime movers.

8 New Build Development

8.1 Methodology

The assessment of renewable energy potential in new build development has taken on board a range of factors including policy trajectories for compliance with building regulations, technical potential in different development types, capital cost, whole life cost, carbon cost effectiveness and deliverability. This is explained in following sections.

8.1.1 Approaches to Low Carbon Development

Communal energy supply systems

Combined heat & power (CHP) systems, with a district heating network, typically enable the greatest carbon reductions in new developments. However, the viability and effectiveness of CHP is dependent on the scale, density and mix of development. In general, CHP requires large numbers of units at high density with a good mix of building types and a good spread of daily and seasonal energy demand. The guide 'Community Energy: Urban Planning for a Low Carbon Future' produced by the CHPA and TCPA[38] provides a useful overview of the types of development that suit CHP and district heating and the range of issues that need to be considered in the development of CHP and district heating networks. In fact, the practical achievement of very low to zero carbon developments through an on-site approach tends to require a communal energy system as the basis of the energy strategy.

Thresholds for density & scale:

Although density is vitally important in determining the practicality and viability of CHP and district heating, average density thresholds recommendations are indicative only, and other characteristics of specific schemes such as scale and building mix are equally important in determining whether CHP is a suitable option. Any specific development will have different densities across the site, and a communal system may be appropriate for various pockets within the development (for example in the central areas). In addition, the communal systems could link to existing high density development next to the site, and this will be encouraged under the proposed new definition of a zero carbon scheme.

The general criteria for a communal system are at a scale of at least 1,000 units and a density of 50 units per hectare – the number of units could be lower if non-domestic buildings are in the mix or if appropriate existing development is located nearby. Many of the planned Urban Expansion schemes or major regeneration proposed around the Derby Principal Urban Area, such as Rolls Royce and the Hospital redevelopments, could be well suited, but in practice any scheme of this scale could be suitable through the study area.

Communal heating is not entirely ruled out at lower development scales or lower density levels, but they may have a more restricted role, for example, focused around higher density central areas. Community heating may be viable in other circumstances such as

- Where connections with existing high density heat loads, e.g. commercial space heating or apartment blocks can be made
- Where low installation costs can be achieved, e.g. through technology development

[38] *Community Energy: Urban Planning for a Low Carbon Future, TCPA & CHPA 2008*

- Where low cost waste heat can be capture, e.g. from new power stations or waste-to-energy plant which are obliged to give detailed consideration to community heating. Development around the proposed construction of a power station at Drakelow is a good example of the former.
- Non-gas connected areas, in rural locations, which should greatly benefit from the future introduction of the Renewable Heat Incentive, the tariff for which is expected to be pegged against gas, rather than the more expensive coal, oil and electricity typically used in the such locations.

In our analysis of the potential technical solutions for achieving zero carbon standards in the proposed new developments, we have modelled communal CHP systems for the larger scale development sites – and these communal systems represent the lowest cost energy supply solution to delivering zero carbon development within the study area. Large scale wind turbines also represent a typically lower cost means of achieving a very low to zero carbon development, and will be a key ingredient of a lower cost zero carbon supply strategy. Large scale wind can be linked to larger development sites where the overall electricity demand can support a supply contract with a wind developer or co-development agreement depending on linking required under the emerging definition of zero carbon, whereas a smaller development will not have a large enough energy demand to support a large turbine.

Microgeneration energy supply systems

Individual building-integrated low carbon technologies such as photovoltaics, solar water heating, ground sourced heat pumps and improved energy efficiency standards can deliver substantial carbon reductions in new developments, but will struggle to achieve the very low carbon requirements of Code for Sustainable Homes Levels 4, 5 and 6. Individual systems can achieve the 44% carbon reduction under CSH Level 4, but it would constitute a very expensive approach, particularly if rolled out over a large number of units. Taking into account current proven technologies, an individual system approach would not achieve zero carbon status for new developments due to the space requirements and extensive renewable energy installations that would be needed on each and every building. The current definition of a zero carbon home is not yet set. The government position[39] appears to be moving towards requiring at least 70% of a zero carbon dwelling's 'regulated'[40] emissions to be abated on-site. Even if the remaining emissions were abated through investment in remote wind farms or local energy efficiency schemes for existing buildings, the reduced scale of on-site microgeneration would still not offer a financially nor technically viable solution to achieving zero carbon.

In our Elevated Case scenario below, we have modelled the microgeneration measures for each of the main developments but assume a limit of 20% renewable energy through these measures from 2010-2013.

8.1.2 Assessing the Growth Plans for Study Area

Planned or anticipated residential and non residential development numbers and characteristics have been supplied by the authorities within the study area. Housing numbers, residential development types and the area of forecasted economic land development are summarised in Table 21 and major developments are summarised in Table 22.

[39] *http://www.communities.gov.uk/publications/planningandbuilding/zerocarbondefinition*

[40] *Regulated emissions arise from fuel consumption for space heating and hot water, as well as electricity for lighting, fans and pumps. Electricity consumed by appliances are not included, and are known as 'unregulated' emissions sources*

Table 21: Forecasted Growth: Residential[41] and non-residential

	Amber Valley	Derby City	Erewash	South D'shire	TOTAL
No of Residential Units 2006-2026	**10,200**	**14,400**	**7,200**	**12,000**	**41,750**
Increase upon existing dwelling numbers[42]	*20%*	*15%*	*15%*	*36%*	-
Urban infill	*11%*	*83%*	*50%*	*10%*[43]	-
Rural infill	*85%*		*2%*	*10%*[43]	-
Settlement extension	*4%*		*12%*		-
Urban extension	*0%*	*17%*	*5%*	*80%*	-
Large urban extension / new settlement	*0%*		*31%*		-
Economic land development (Hectares)	**zero**	**86**	**20**	**17.6**	**125.6**

An anticipated build rate has been applied to the residential data sets to estimate the growth in each year to 2026 and the resulting housing growth projects, by year, are shown in Appendix II along with the Non-residential growth by year, by each authority.

The various Strategic Housing Land Allocation Assessments (SHLAA) sites identified by each authority have been mapped in Figure 37 (against sites that are less constrained for potential wind development, for interest). Whilst many of the SHLAA sites are some distance from potential wind development locations, it can be seen that several around the edge of Derby and in South Derbyshire are reasonably close and could therefore hold the potential for zero carbon development with local generation. It is notable that the opportunities for wind turbines in Erewash are limited. The sites to the East of the study area should therefore explore potential linkages with the energy systems developed in the Nottingham HMA area in order take maximum advantage of the opportunities for low carbon heat and power systems, for example associated with new generating capacity coming on stream in the near future.

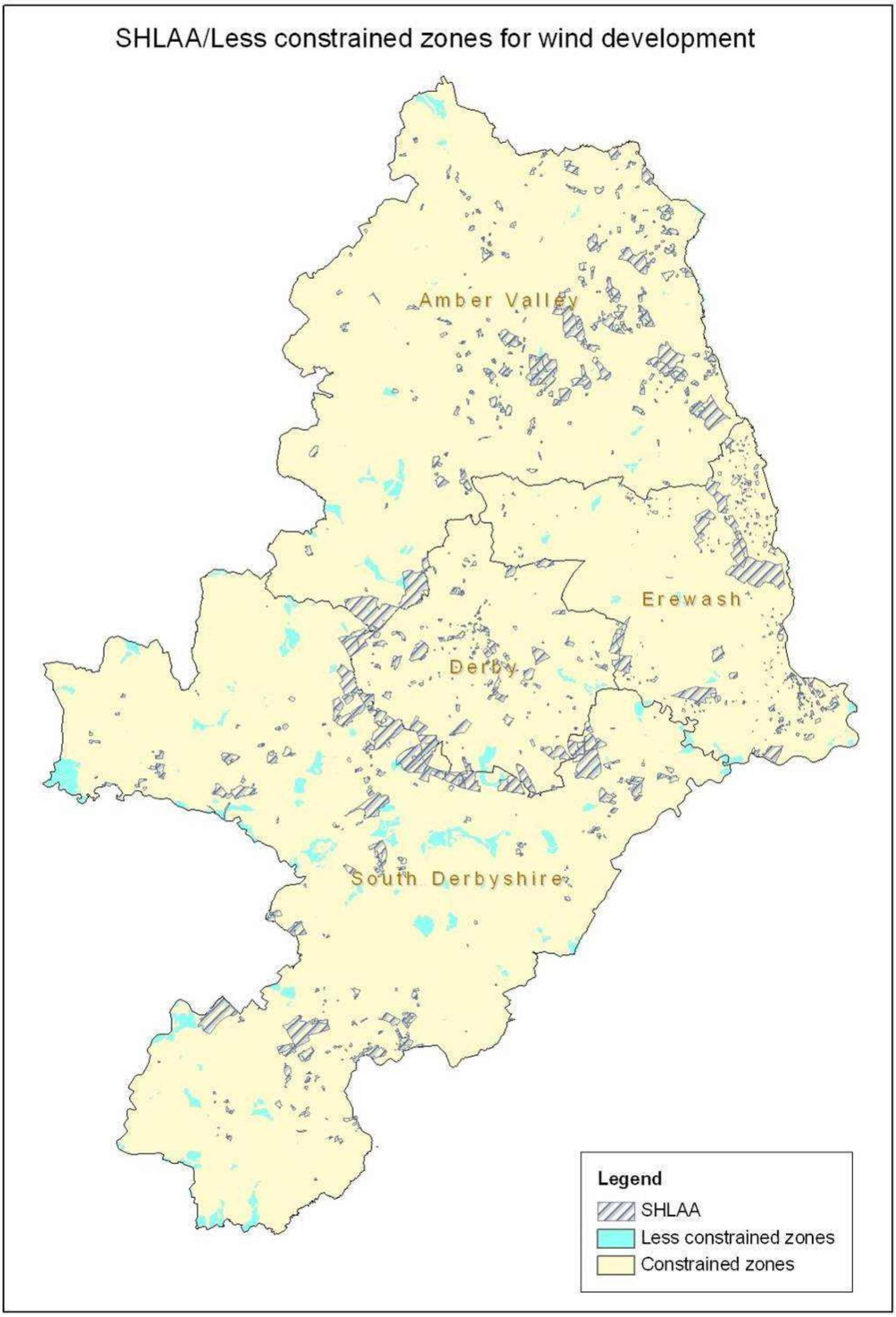
It is worth noting that there are a number of large greenfield SHLAA sites identified which additionally sit within 'Green Wedge' and 'Green Belt' allocations. These include Hackwood Farm (28ha) and Boulton Moor (2 overlapping sites 46ha & 79ha), which have cross boundary implications between Derby City and South Derbyshire. The councils have yet to fully appraise these sites and as such cannot attribute specific numbers of dwellings to each site at this stage.

[41] *Definitions of development type is set out in Table 23 on page 82.*
[42] *Existing dwelling numbers taken from National Statistics, dataset 'Accommodation Type – Household Spaces (UV56)', data from April 2001*
[43] *Camco assumption based on conversations with Kevin Exley, South Derbyshire planning officer*

Table 22: Summary of Major Developments

Site	Location (e.g. postcode, grid reference)	Development type	Residential		Non-residential		Expected competion period
			No. of dwellings	Residential type	Development area (m^2)	Planning class	
Amber Valley							
Cinderhill	Denby	Mixed	300	Settlement extension			2013 to 2016
Radbourne lane	Mackworth	Residential	600	Large urban extension / new settlement			After 2019
Derby City							
Castleward	435929, 335801	Mixed	up to 1200	Urban extension	1,000	A1 Shops - Shops, retail	After 2019
North Castleward	435730, 335989	Non-residential	n/a		48,000	B1 Business - Offices,	
Derby Royal Infirmary	435721, 335419	Mixed	up to 850	Urban extension			After 2019
North Riverside	435521, 336505	Mixed	390	Urban Infill			2016 to 2019
Friar Gate Station (current undetermined planning application)	434591, 336298	Residential	770	Urban Infill			2016 to 2019
Heatherton Phase II	431328, 332713	Residential	980	Urban extension			2013 to 2016
Manor Kingsway (current undetermined application)	432903, 335592	Residential	700	Urban Infill			2013 to 2016
Temporary Waste Transfer Site, Magferns Yard, Downing Road, West Meadows Industrial Estate (planning ref 04/09/00427)	437100, 336054	Non-residential	n/a		0.43ha	B2 General industrial	2010 to 2013
Proposed Waste to Energy Plan, Sinfin (planning ref 05/09/00571)	435240, 333037	Non-residential	n/a		3.4ha	B2 General industrial	2010 to 2013
Nightingale Road	436238, 333616	Residential	498	Urban Infill			After 2019
Russell Street	436050, 334140	Residential	360	Urban Infill			After 2019
Erewash							
Stanton Ironworks Regeneration Site	Easting: 446,703, Northing: 339,142	Mixed	4,000	Large urban extension / new settlement	330,000	B1 Business - Offices, research and	After 2019
South Derbyshire							
Drakelow Park (Planning Application)	4.24187E+11	Mixed	2,239	Large urban extension / new settlement	58,065	B1 Business - Offices, research and	After 2019
Burnaston Cross (planning Application)		Non-residential			118,000	B8 Storage or distribution - This class	2016 to 2019

Figure 37: Proximity of SHLAA areas to less constrained potential wind site



8.1.3 Characterising the main developments and modelling indicative energy supply strategies

The precise nature of the technical solution for a specific development will vary depending on the scale, density and mix of the development. However, in order to assess the potential carbon standards that could be appropriate for the proposed new development in the study area, it is necessary to identify the characteristics of the developments and their suitability for installing low to zero carbon technologies. To enable this analysis we have characterised each of the main development locations into one of five development types:

- Urban infill;
- Rural infill;
- Settlement extension;
- Urban extension;
- Large urban extension/ new settlement

The smaller developments that constitute urban and rural infill are typically not appropriate for communal systems and therefore the optimum energy strategy will consist of highly energy efficient buildings with individual building integrated technologies. The urban extensions are at the larger size and density necessary to support a communal system in some or all of their development areas, and are large enough to potentially establish a long term power purchase agreement with a wind turbine developer or justify the creation of a local community owned ESCO on behalf of the future development. It is deemed that projects over 1000 dwellings could have the potential for biomass CHP serving the highest density zones.

Table 23 below outlines the general principles regarding the most appropriate energy supply strategies for different development types, and relates these approaches to the key development sites proposed for the study area. These are general rule of thumb categorisations and there will often be overlap between these development types within the characteristics of any specific development site. The specific characteristics of the site will also determine the technical and financial suitability of CHP and district heating systems, and the unit numbers and densities in Table 23 are indicative only. Although high density developments are generally needed to reduce the costs of district heating systems, lower density developments can still install communal systems but at a higher cost per housing unit.

There are a number of developments within each Local Authority area which correspond to these development types and it may be appropriate for the Council's Local Development Framework to point towards such solutions for development types, whilst not being prescriptive over the technology choice. It would certainly be useful to ensure that large developments carefully consider communal systems rather than individual systems during the early development phases so that they do not jeopardise the ability of the development to achieve low to zero carbon status in the long term.

Table 23: Development types and typical low carbon energy strategies

Development types and typical low carbon energy strategies		
Category	**Description**	**Low carbon/ renewable energy supply options**
Urban Infill	Small numbers of dwellings (typically 10-100 units) integrated into existing urban environment/settlement framework. Few other building types. High density (50 dwellings/ha).	Micro-renewables, such as SWH, PV, GSHP. High levels of energy efficiency passive house design would compliment these technologies. **Difficult to achieve very low or zero carbon development.** Option for linking new buildings with existing buildings via a communal system, with potentially good mix of building types in town centre environment. Would need community ESCO to be established.
Rural infill	Small numbers of housing units situated within existing settlement framework - ranging from 1 to 100 Medium density (40 dwellings/ha).	Individual rather than communal systems – with building integrated micro-renewables, such as SWH, PV, GSHP and biomass / wood stove. These same technologies could equally be applied to existing homes, particularly those off the gas network, to deliver significant carbon savings. Ultra energy efficient passiv-haus design would compliment these technologies well. **Difficult to achieve very low or zero carbon development.**
Settlement extension	Up to 1,000 dwellings adjoined to existing town or village with limited mix of other building types. Medium density (40 dwellings/ha).	Currently more suited to communal biomass heating not biomass CHP technology due to scale and mix of uses, although biogas (from anaerobic digestion) CHP starts to become more suitable at the larger end of this development type. In future, biomass CHP is likely to become more feasible as technology matures. If outer area is less dense, individual systems may be favoured. Potential contribution from medium to large scale wind. **Potential to achieve low carbon development. Harder to achieve zero carbon unless a medium to large scale wind turbine is viable.**
Urban extension or Large scale Urban Regeneration	Over 1,000 housing units adjoined to existing town and mix of other building types. Medium density (40 dwellings/ha).	Meets indicative criteria for biomass/biogas CHP in terms of size and mix. Should have good enough mix and high enough density to support efficient communal systems with smaller CHP system based on gas or liquid biofuel, sourced from anaerobic digestion. Also potential contribution from medium to large scale wind and possibly a few small scale options for hydro. **Good potential to achieve very low carbon developments**
Large urban extension / new settlement	Large number of housing units adjoined to existing town - up to 4,000 dwellings - and good mix of other building types. High density (50 dwellings/ha).	Communal systems based on biomass / biogas CHP supported by high density & good building mix, with contributions from micro-renewables such as PV & small scale wind Also potential contribution from medium to large scale wind and possibly hydro. **Good potential to achieve very low or zero carbon developments.**

8.1.4 Viability

Meeting changing Building Regulations

The viability of meeting carbon standards needs to be considered in the context of changing building regulations that are intended to set increasingly stringent compliance standards during the plan period. For dwellings these have been accepted in the study as:

- 2010 – a 25% carbon reduction beyond current (2006) requirements;
- 2013 – a 44% carbon reduction beyond current (2006) requirements;
- 2016 – a 100% carbon reduction beyond current (2006) requirements

Non-domestic buildings have been assumed to follow a similar trajectory but lag behind by three years, reaching zero carbon in 2019.

It is assumed that ultimately the cost of meeting these carbon targets will be reflected in land values or supported through new market mechanisms such as the new Feed-in Tariff (FIT) and up-coming Renewable Heat Incentive (RHI). For the purposes of this study, therefore, they have been accepted as representing a Base Case that will be viable for the property developer.

Exceeding changing Building Regulations

Urban infill projects can potentially support 20% renewables given the right land values. For example, in London the Mayor's requirement for 10-20% on-site renewable energy has been widely accepted by developers as a cost of achieving planning consent. Before the economic downturn, this cost could potentially be accommodated within an overall development budget or taken off the land value. In a less favourable economic environment, this may not be the case.

However, 20% renewables can now potentially be justified through exploitation of the new Feed-in Tariff and up-coming Renewable Heat Incentive. These have in theory been set at a rate that will give an Internal Rate of Return of around 6-7% meaning that they are potentially viable for individual, community and public sector investors. Capitalising this revenue from FIT/RHI at the point of sale of a property will be important for reducing the burden on developers. Mechanisms such as delivery through an Energy Services Company or the establishment of low interest loans to consumers may allow this to happen. Financial arrangements such as Pay As You Save also offer the potential to support microgeneration in new build development.

The burden on developers must ultimately be assessed through S106 negotiations and a 'Three Dragons' type model that assesses construction costs, land values and developer margins in order to set a S106 tariff and attract housing grants. Nevertheless, 20% renewables provides a reasonable benchmark of what might be technically and financially achievable as an aspirational target. We recognise that authorities have competing aspirations from delivery of new housing, e.g. affordability of housing, and any acceleration of carbon targets should not be considered in isolation.

Experience on a range of development projects suggests that that biomass CHP is potentially viable in projects above 1000 units where at least half of the development is a suitable density (e.g. Northstowe, Bath Western Riverside). Delivery would be through an Energy Services Company responsible for some or all of finance, design, build, ownership and operation of district heating and CHP energy centres. Experience in the UK is extremely limited therefore development risk is high but there are several European projects to learn from as well as gas CHP systems within the UK. Gas CHP could well form the basis of such a project.

Wind energy development associated with new development is also viable for large turbines in windy locations. Projects of at least one turbine can potentially viable when supported by a developer contribution in lieu of Code targets. Examples of this include Green Park Reading.

8.1.5 Avoiding double counting

The analysis of renewable energy uptake within new-build development consider a range of the technologies including wind energy, biomass and microgeneration all of which are also considered within the Stand-alone and Existing Built Environment elements of this study. However, we avoid double counting between these because:

- the assumed implementation of biomass for new-build is simply extracted from the stand-alone biomass figures
- wind energy for new-build is assumed to be sufficiently different to developer-led wind farm development
- the microgeneration figures for the existing built environment are directly reduced to account for potential double counting

8.2 Scenarios

Modelling has been carried out against the project development growth for two scenarios representing a range of potential, called Base Case and Elevated Case:

Base Case

- Meeting changing building regulations including achieving zero carbon through on-site and off-site measures from 2016 for domestic measures and 2019 non-domestic measures.
- The current roadmap for residential new build will enforce the construction standards demonstrated in Table 24. We have applied our experience to estimate the proportion of CO2 which would be abated by the use of renewable technologies.
- Non-residential buildings have no such roadmap, except the target to be zero carbon by 2019. We have assumed that non-residential development will follow that set out for residential buildings, except with a three year lag. This is also set out in Table 24 below.
- Renewable energy technologies are applied based upon what is deemed suitable for the expected 'type' of development (referring to Table 23).
- Assumes that proposed Building Regulations will be met and not exceeded.

Table 24: Construction standards modelled for the new build Base Case (all values are for regulated emissions)

	Residential		Non-residential	
	Regulated CO_2 reduction	Proposed CO_2 reduction through renewables	Regulated CO_2 reduction	Proposed CO_2 reduction through renewables
2010-13	25%	10%	0%	0%
2013-16	44%	26%	25%	10%
2016-19	70%[45]	50%	44%	26%
Post 2019			70%[45]	50%

Elevated Case

- All development is assumed to have at least 20% of regulated emissions abated by renewables. In practice, this will only influence residential development prior to 2013 and non-residential development prior to 2016. Table 24 demonstrates that beyond these points, the Base Case construction standards will already exceed this minimum 20% figure.
- Large mixed use (or residential only) developments under the following designations:
    - urban extensions / large urban regeneration sites
    - new settlements
    - urban extensions

  are assumed to be zero carbon as of 2013. The modelling assumes that half of the dwellings are energised by large wind, the other half by biomass CHP plus large wind top-up. All non-residential development is abated by biomass CHP plus large wind top-up. An example of this development typology is Stanton in Erewash.

Table 25 summarises the elevated standards which have been modelled.

[45] *At 2016, all dwellings should be zero carbon. The definition of zero carbon has not been agreed at the time of writing, however the lead case within the government's consultation period was for 70% of regulated emissions to be abated on site.*

Table 25: Construction standards modelled for the new build Elevated case (all values are for regulated emissions)

<table>
<tr><th></th><th colspan="2">Residential</th><th colspan="2">Non-residential</th></tr>
<tr><td></td><td>Regulated CO_2 reduction</td><td>Proposed CO_2 reduction through renewables</td><td>Regulated CO_2 reduction</td><td>Proposed CO_2 reduction through renewables</td></tr>
<tr><td>2010-13</td><td>35%</td><td>20%</td><td>0%</td><td>10%</td></tr>
<tr><td>2013-16 (all sites with exception of large mixed use developments)</td><td>44%</td><td>26%</td><td>25%</td><td>10%</td></tr>
<tr><td>2013-16 (large mix use developments only</td><td>70%[45]</td><td>50%</td><td>70%[45]</td><td>50%</td></tr>
<tr><td>2016-19 (all sites with exception of large mixed use developments)</td><td>70%[45]</td><td>50%</td><td>44%</td><td>26%</td></tr>
<tr><td>2016-19 (large mix use developments only</td><td rowspan="2">70%[45]</td><td rowspan="2">50%</td><td rowspan="2">70%[45]</td><td rowspan="2">50%</td></tr>
<tr><td>Post 2019</td></tr>
</table>

8.3 Base Case Potential

The Base Case potential from renewable energy associated with new build development is as follows:

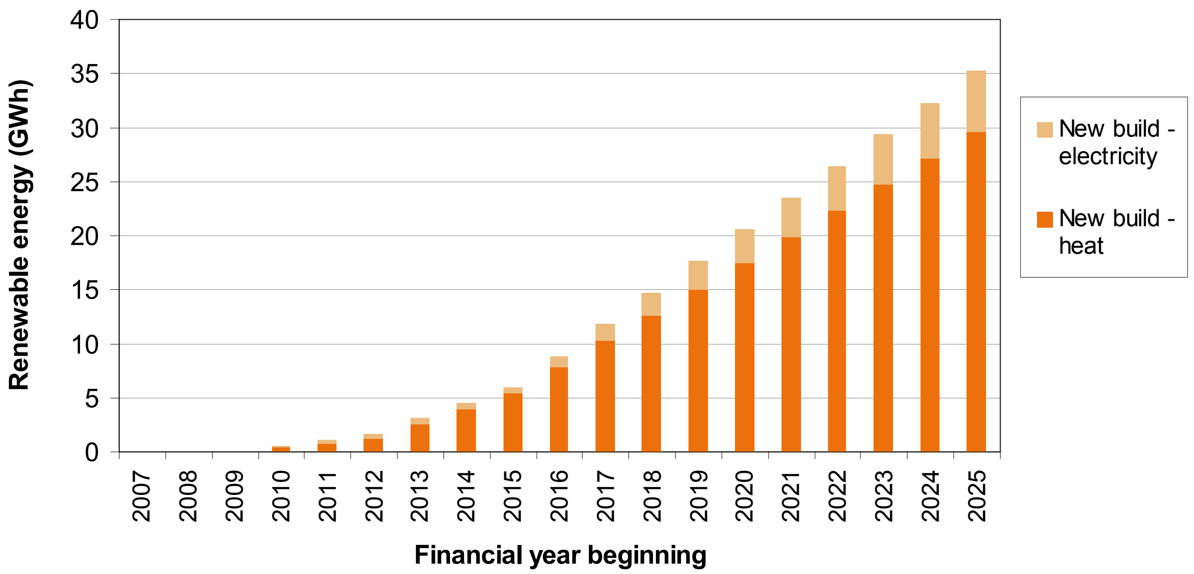
8.3.1 Amber Valley

In Amber Valley, the renewable energy potential associated with meeting the construction standards as set out in Table 26 is equivalent to meeting just under 1.5% of the district's energy needs by 2025.

Table 26: Renewable energy results - Amber Valley new build, base case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	5.4	17.5	29.7
	Electrical	0.6	3.1	5.5
	Total	5.9	20.6	35.2
Proportion of demand	Thermal	0.28%	0.94%	1.64%
	Electrical	0.09%	0.50%	0.92%
	Total	0.23%	0.83%	1.46%

Figure 38: Renewable energy generated within new build – base case



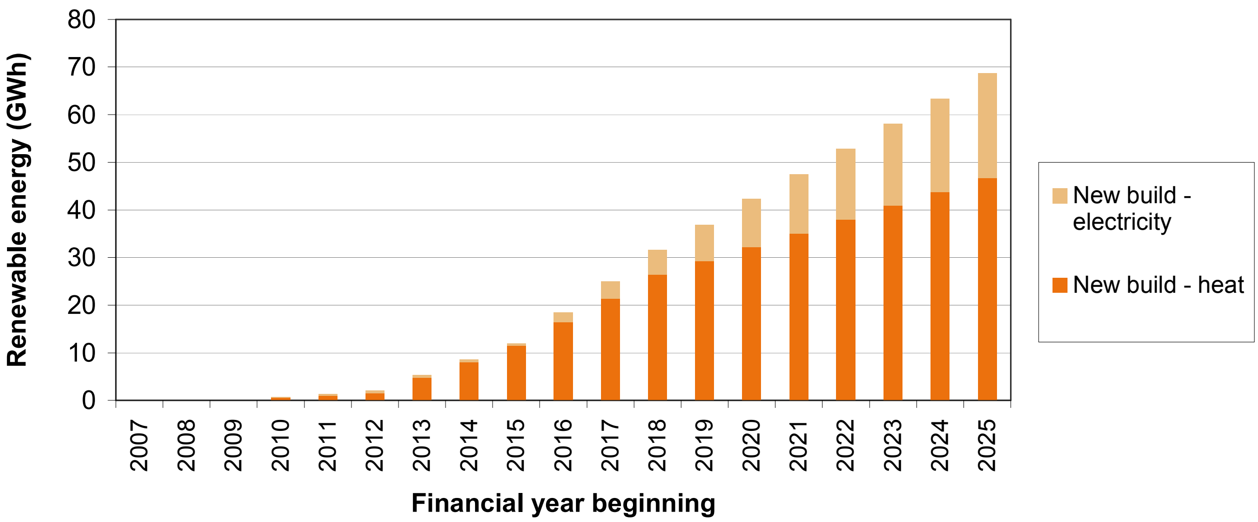
8.3.2 Derby

Whilst there is a large amount of development in Derby, the baseline energy consumption is the greatest of all the authorities. Therefore, whilst there is the potential for 69 GWh of renewable energy by 2025/26, this will provide only 1.8% of the city's energy needs at that time.

Table 27: Renewable energy results - Derby City new build, base case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	11.4	32.2	46.7
	Electrical	0.5	10.0	22.0
	Total	11.9	42.2	68.7
Proportion of demand	Thermal	0.42%	1.21%	1.81%
	Electrical	0.04%	0.85%	1.89%
	Total	0.30%	1.10%	1.83%

Figure 39: Renewable energy generated within new build – base case



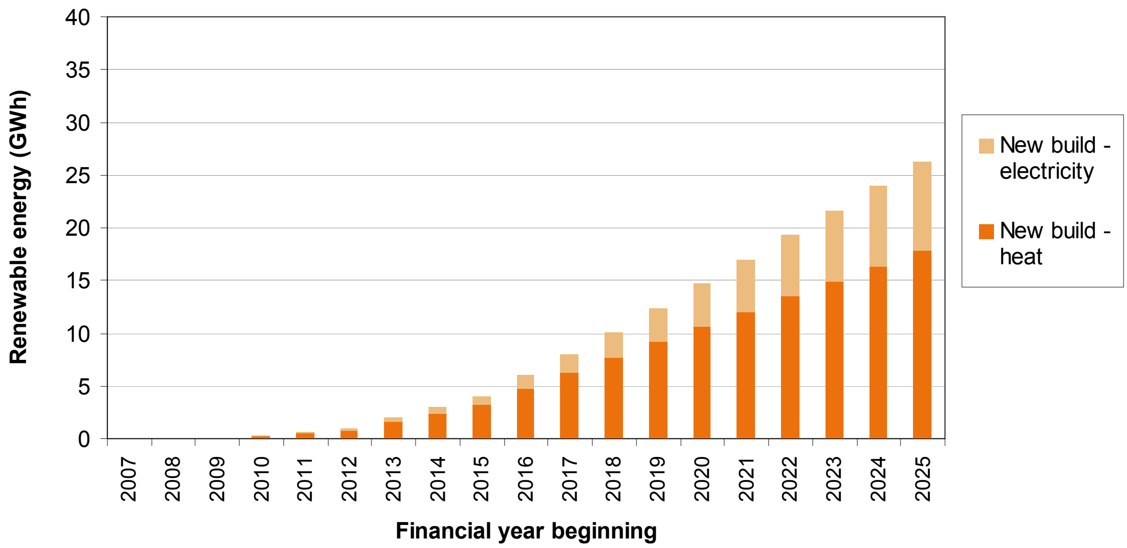
8.3.3 Erewash

A similar proportion of Erewash's energy needs could be met through renewables associated with low and zero carbon development. Around 26GWh of cumulative installed electrical capacity has been calculated as possible by 2025/26, equivalent to around 10MWp of PV. 17.8GWh renewable heat is equivalent to 9MWth of biomass boilers or 13,000 individual household solar thermal systems.

Table 28: Renewable energy results - Erewash new build, base case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	3.2	10.6	17.8
	Electrical	0.7	4.1	8.5
	Total	4.0	14.7	26.3
Proportion of demand	Thermal	0.25%	0.84%	1.46%
	Electrical	0.15%	0.85%	1.76%
	Total	0.22%	0.84%	1.54%

Figure 40: Renewable energy generated within new build – base case



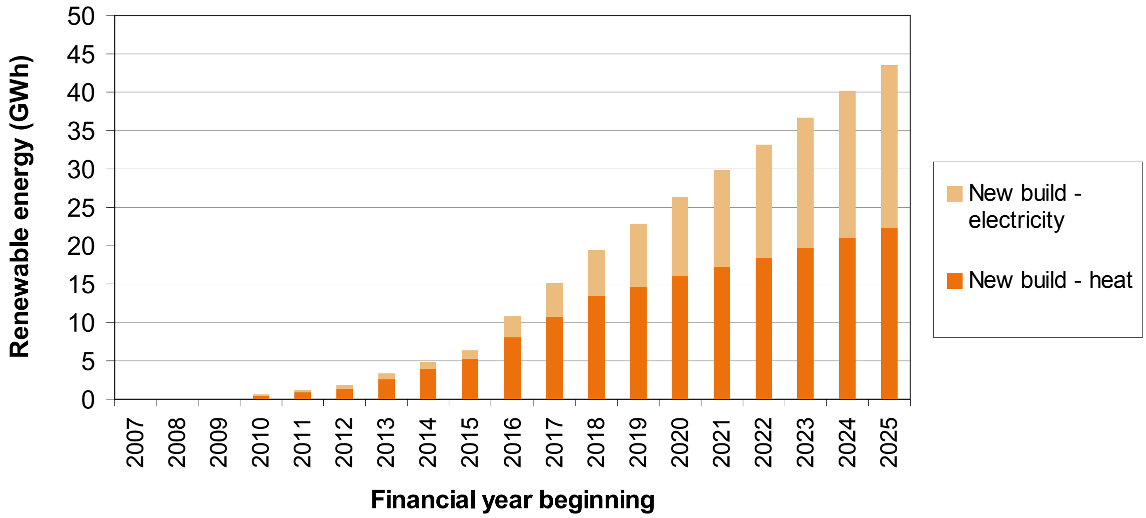
8.3.4 South Derbyshire

The Base Case potential for renewable energy associated with low and zero carbon development in South Derbyshire is relatively high due to good potential for wind and biomass.

Table 29: Renewable energy results - South Derbyshire new build, base case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	5.3	16.0	22.3
	Electrical	1.0	10.3	21.3
	Total	6.3	26.3	43.5
Proportion of demand	Thermal	0.29%	0.89%	1.27%
	Electrical	0.21%	2.02%	4.15%
	Total	0.27%	1.14%	1.91%

Figure 41: Renewable energy generated within new build – base case



8.4 Elevated Case Potential

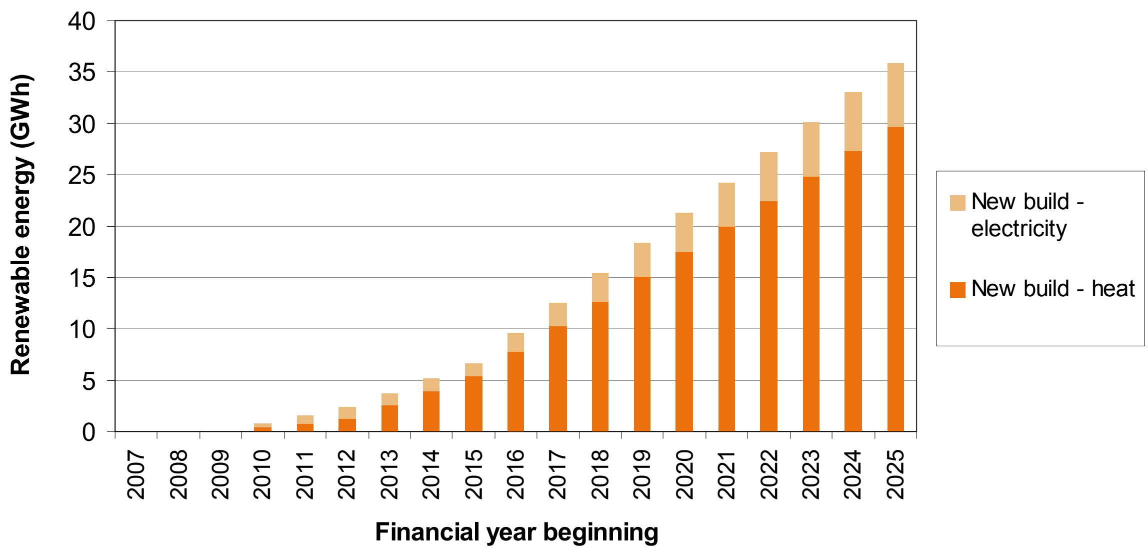
8.4.1 Amber Valley

In Amber Valley, there are no developments of sufficient scale that would be accelerated to zero carbon as defined in section 8.1.5. T herefore the Elevated Case only applies the 'minimum 20% regulated renewables' principle, which would see around 1,500 dwellings go beyond the 10% required for 2010 Building Regulations (Code for Sustainable Homes level 3) according to the growth projection provided by the Council.

Table 30: Renewable energy results - Amber Valley new build, elevated case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	5.4	17.5	29.7
	Electrical	1.3	3.7	6.2
	Total	6.6	21.3	35.9
Proportion of demand	Thermal	0.28%	0.94%	1.64%
	Electrical	0.20%	0.61%	1.03%
	Total	0.26%	0.86%	1.49%

Figure 42: Renewable energy generated within new build, elevated Case



8.4.2 Derby

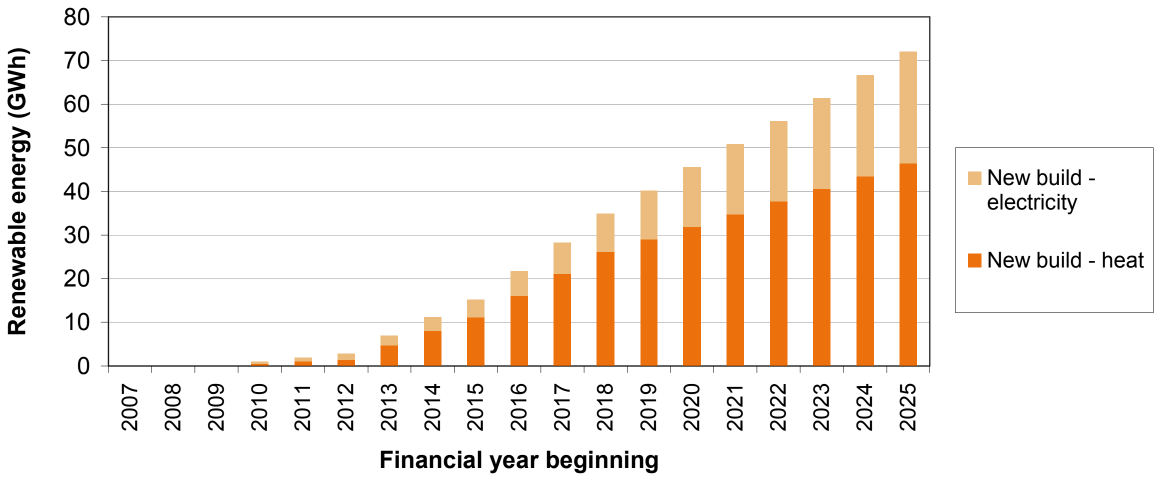
In Derby City, 2,160 dwellings built between 2010 and 2013 (Code for Sustainable Homes level 3) would benefit from enhanced renewables as part of the '20%' policy, as well as over 350,000 m^2 of non-residential floor area between 2010-16. Additionally, the model assumes that almost 1,600 dwellings within the Castleward and Derby Royal Infirmary urban extensions would be constructed in the period 2013-16, and hence would benefit from the advanced zero carbon standard set out in section 8.1.5.

It is noted that Derby City Council are currently investigating the feasibility of a city centre district heating scheme, served by biomass CHP. The density of inner-city development and the strong interest from the City Council makes this a distinct possibility but it has not been explicitly modelled here. If such as scheme were to proceed it is likely to take several years to come to fruition therefore its potential is largely covered by the zero carbon standards assumed for all new development from 2016/2019.

Table 31: Renewable energy results - Derby City new build, elevated case

Year		**2015/16**	**2020/21**	**2025/26**
Energy generated (GWh)	Thermal	11.1	31.8	46.4
	Electrical	4.1	13.6	25.6
	Total	15.2	45.5	72.0
Proportion of demand	Thermal	0.41%	1.19%	1.79%
	Electrical	0.34%	1.16%	2.20%
	Total	0.39%	1.18%	1.92%

Figure 43: Renewable energy generated within new build, elevated case



8.4.3 Erewash

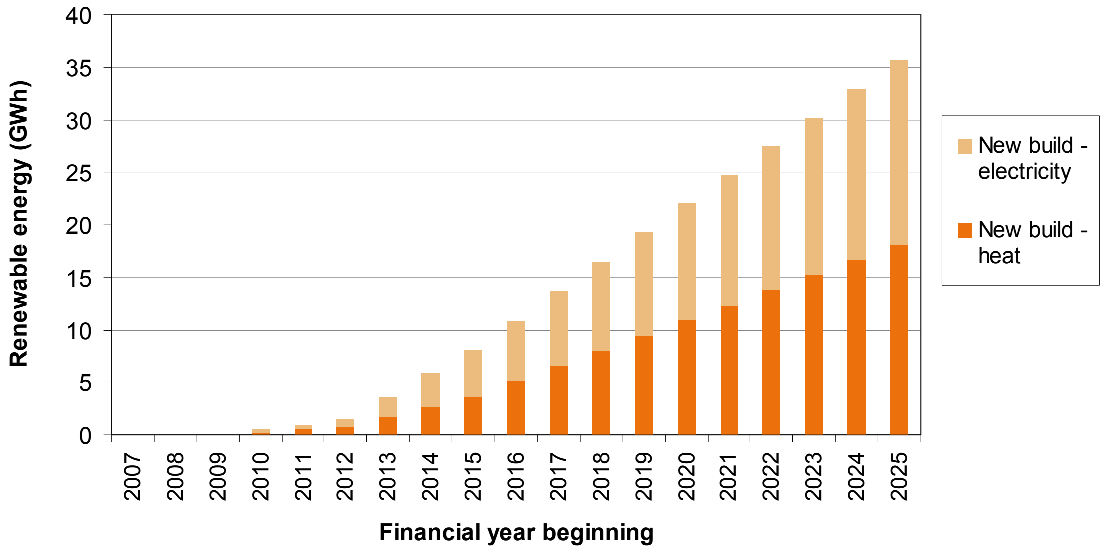
Stanton is Erewash's largest development site, comprising of approx 2,000 dwellings during the RSS period, with an additional 2,000 expected later. Both the scale of proposed development and its mixed use nature could offer an opportunity to bring forward zero carbon before 2016, while retaining viability. Current examples exist where such advanced carbon standards have been implemented or have been investigated in detail (e.g. Bath Western Riverside).

In the Elevated Case scenario, it has been assumed that all development at Stanton (residential & non-residential) will be zero carbon as of 2013 (1,450 dwellings and 72,000 m^2 of non-residential floor area). 6 MW of wind is forecast to be required for the above (typically equating to 3 large wind turbines).

Table 32: Renewable energy results - Erewash new build, elevated case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	3.6	10.9	18.1
	Electrical	4.4	11.1	17.6
	Total	8.0	22.0	35.7
Proportion of demand	Thermal	0.28%	0.86%	1.48%
	Electrical	0.90%	2.29%	3.65%
	Total	0.45%	1.26%	2.09%

Figure 44: Renewable energy generated within new build – elevated case



8.4.4 South Derbyshire

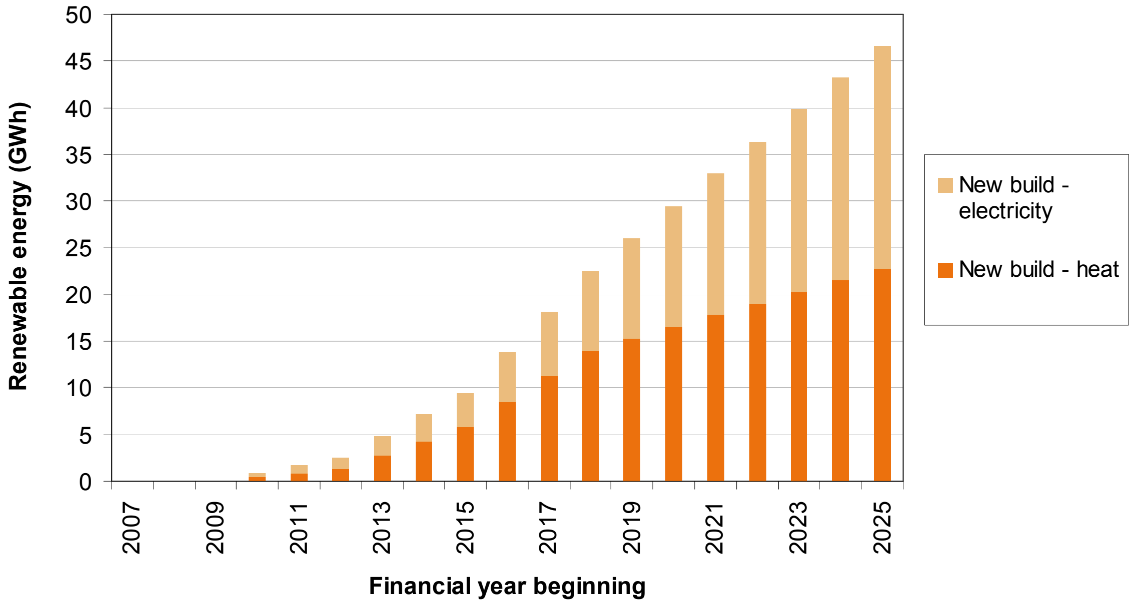
Within South Derbyshire, 1,800 dwellings were modelled as being constructed within the 2010-13 window (Code for Sustainable Homes level 3), which would hence have the elevated '20% regulated renewables' policy applied to them. No non-residential development was forecast within the 2010-16 period which would have been affected by this policy.

Significant urban extensions are planned within the Council's boundary – 80% of the expected completions during the RSS period, as outlined in Table 21 (page 78). An example of this type of development is Drakelow Park, which also has the potential opportunity of connecting to community heating, where it to be developed from the proposed re-establishment of power generation (on the nearby power station site). The large number of dwellings which are within sites technically viable for raised carbon standards results in 1,440 dwellings being advanced to zero carbon. These join the 5,280 which scheduled to meet the 2016 construction standard (Code for Sustainable Homes level 6).

Table 33: Renewable energy results – South Derbyshire new build, elevated case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	5.8	16.5	22.8
	Electrical	3.7	13.0	23.9
	Total	9.4	29.5	46.7
Proportion of demand	Thermal	0.32%	0.92%	1.29%
	Electrical	0.73%	2.53%	4.66%
	Total	0.41%	1.27%	2.05%

Figure 45: Renewable energy generated within new build, elevated case



9 Existing Buildings

9.1 Methodology

Prior to reviewing the approach taken to assess the potential role for low and zero carbon technologies in the existing built environment, it is worth reflecting on the fact that local planning policy can not significantly influence the uptake in this area, except where major refurbishment or extensions are involved. In the majority of cases planning permission is not required. Most domestic microgeneration, for example, is classed as Permitted Development, with even micro-scale wind energy being considered for re-classification as such in the future. Non-planning measures are discussed in the 14 and a number of recommendations are made around the existing built environment.

A recent study commissioned by a range of regional and central government bodies investigated the uptake of microgeneration in the East Midlands[47], and hence we have utilised this as the basis for the estimated future uptake within the study area. This study presents a range of uptake scenarios and we contend that the scenario that best fits current policy for renewable energy generation is that which considered the implementation of the renewable power and heat tariffs, which have subsequently be announced as government policy. The scenario models uptake of microgeneration based upon the availability of 2p/kWh for heat and 40p/kWh for electricity. Support is assumed to run for 10 years at a 3.5% discount rate, with the level of support for future installations being degressed[48].

The study provides overall energy generation for the East Midlands region and so the resulting uptakes have been simply scaled down for the each authority using the number of dwellings as a scaling factor, as shown in Table 34.

Table 34: Scaling factors used to disaggregate regional data for microgeneration uptake

Scaling factors by no. of dwelllings		
	No. of dwellings[49]	Proportion of region
East Midlands region	1,798,879	100%
Amber Valley	51,022	2.8%
Derby City	98,588	5.5%
Erewash	47,496	2.6%
South Derbyshire	33,766	1.9%

The regional study's results include new build uptake of microgeneration technologies. It is not possible to disaggregate the existing build component from the results, hence an assumption has been made that 2/3[rds] of the delivered energy is generated on/in existing buildings. The remaining 1/3[rd] is ignored to avoid double counting with the new build analysis.

The study's results also include biomass boilers. It is assumed that the aforementioned scaling also removes a biomass fraction which would otherwise double count with the decentralised biomass analysis.

[47] *Element Energy, 2008, The growth potential for microgeneration in England, Scotland and Wales*
[48] *The annual payment is set for 20 years but the value reduces depending on the year of commencement of the project*
[49] *National Statistics, 2009, Neighbourhood statistics – household spaces (UV56), data from 2001*

9.2 Scenarios

The analysis uses the following scenarios:

Base case

- The Base Case is the deployment two-thirds of the technologies as set out in the East Midlands study and scaled down for the Study Area and each district.

Elevated case potential

- The advanced case is a 30% increase on the Base Case to reflect additional local and regional support programmes that could potentially be provided.

9.3 Base Case Potential

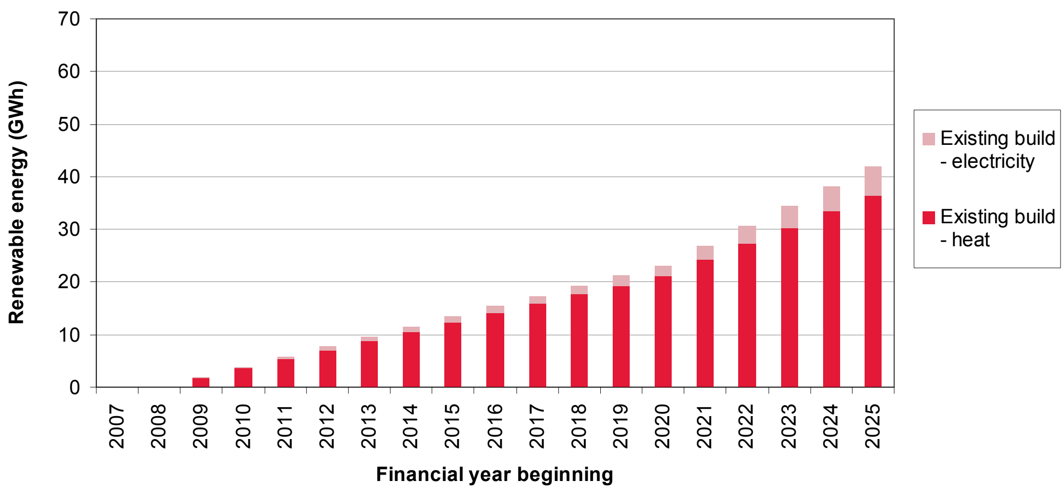
9.3.1 Amber Valley

The Base Case renewable energy potential in existing buildings is 1-2% over the study period, equivalent to 6.5MW PV, 1000 x 9kW biomass boiler systems and 13,000 solar water heating systems. In practice, the technology mix could vary.

Table 35: Renewable energy results - Amber Valley existing build, base case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	12.3	21.1	36.4
	Electrical	1.2	2.0	5.5
	Total	13.5	23.1	41.9
Proportion of demand	Thermal	0.64%	1.13%	2.01%
	Electrical	0.19%	0.33%	0.91%
	Total	0.53%	0.93%	1.74%

Figure 46: Renewable energy generated within existing build – base case



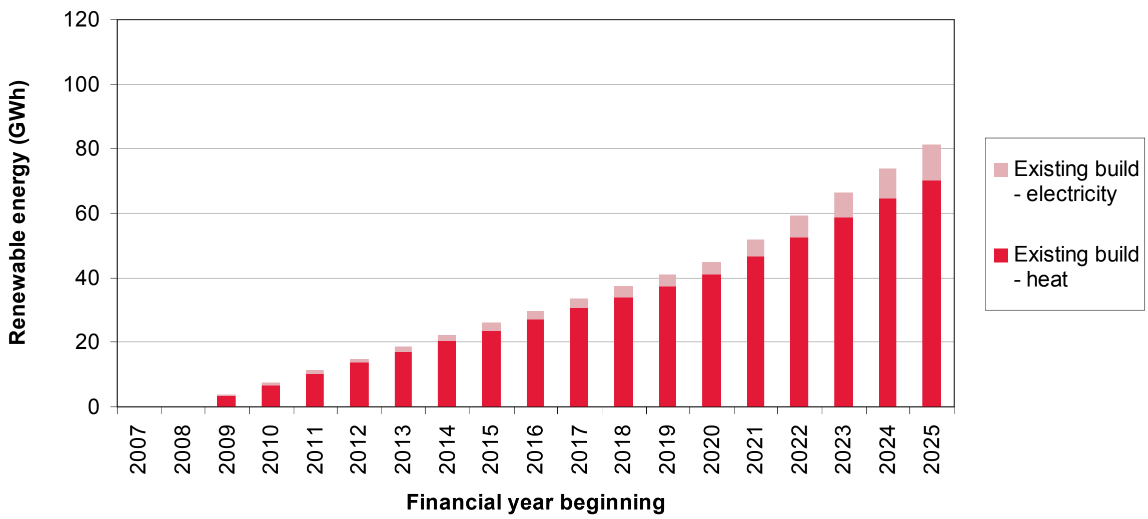
9.3.2 Derby

The Base Case micro-generation renewable energy potential in existing buildings in Derby is over 2% by 2025/26, equivalent to 10MWp PV and 35MW biomass boilers.

Table 36: Renewable energy results - Derby City existing build, base case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	23.8	40.8	70.3
	Electrical	2.3	3.9	10.7
	Total	26.1	44.7	81.0
Proportion of demand	Thermal	0.87%	1.53%	2.72%
	Electrical	0.19%	0.33%	0.92%
	Total	0.67%	1.16%	2.16%

Figure 47: Renewable energy generated within existing build – base case



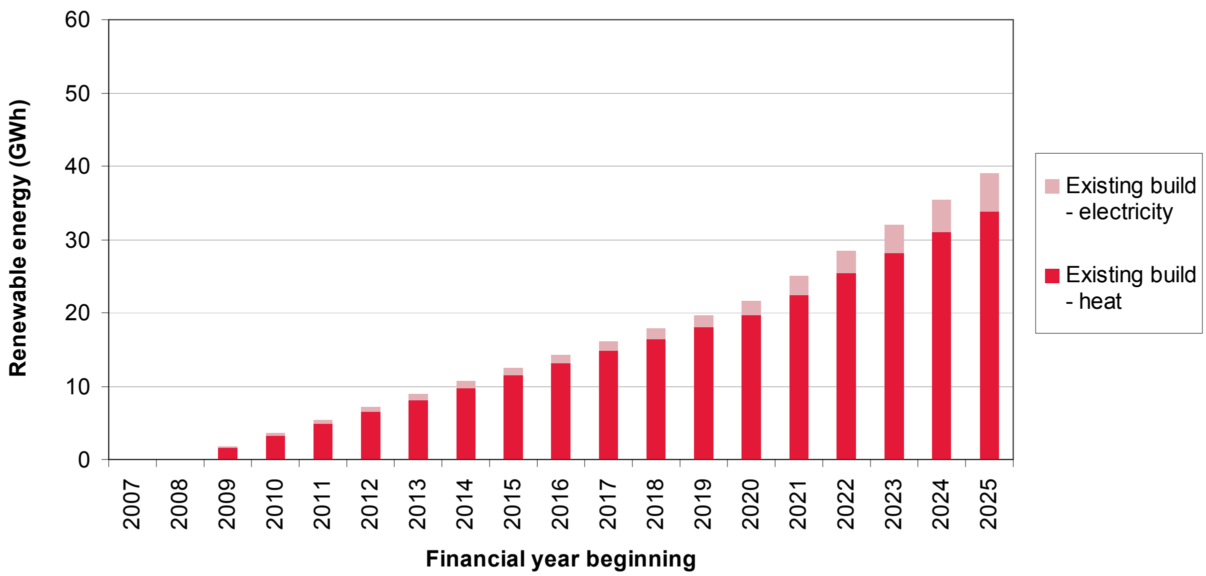
9.3.3 Erewash

Erewash has the potential to deliver over 2% of its needs from microgeneration in the base case.

Table 37: Renewable energy results - Erewash existing build, base case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	11.5	19.7	33.9
	Electrical	1.1	1.9	5.1
	Total	12.6	21.5	39.0
Proportion of demand	Thermal	0.88%	1.56%	2.77%
	Electrical	0.22%	0.39%	1.07%
	Total	0.70%	1.23%	2.29%

Figure 48: Renewable energy generated within existing build base case



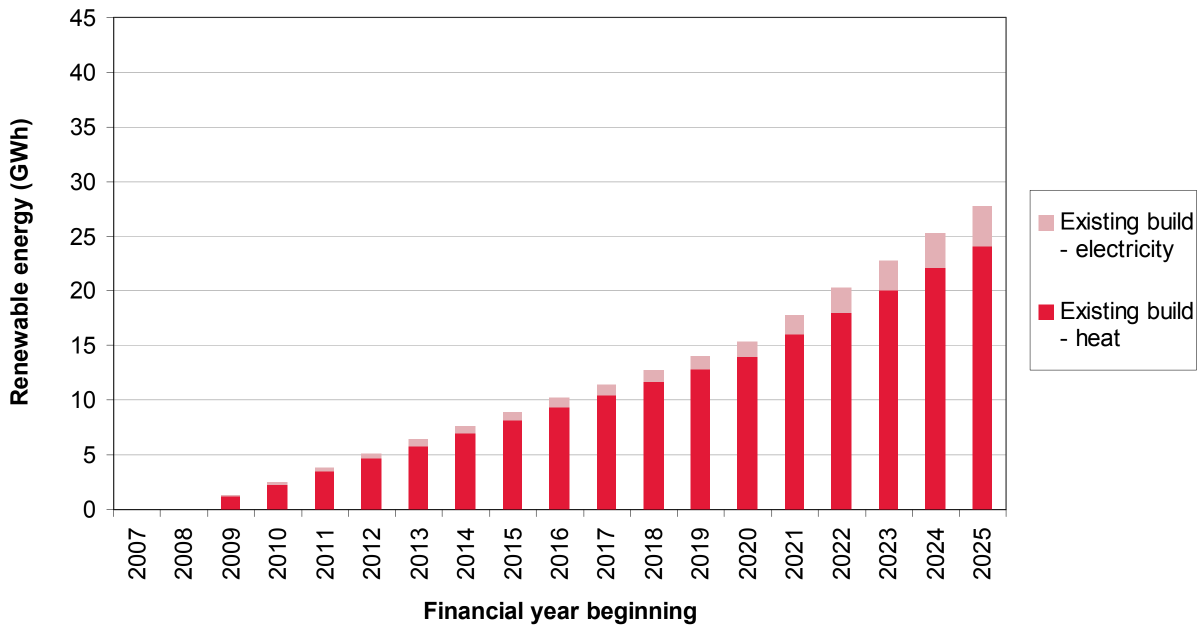
9.3.4 South Derbyshire

The microgeneration potential in existing buildings under the Base Case is up to 1.2%.

Table 38: Renewable energy results - South Derbyshire existing build, base case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	8.2	14.0	24.1
	Electrical	0.8	1.3	3.7
	Total	8.9	15.3	27.7
Proportion of demand	Thermal	0.45%	0.78%	1.37%
	Electrical	0.16%	0.26%	0.71%
	Total	0.38%	0.66%	1.22%

Figure 49: Renewable energy generated within existing build – base case



9.4 Elevated Case Potential

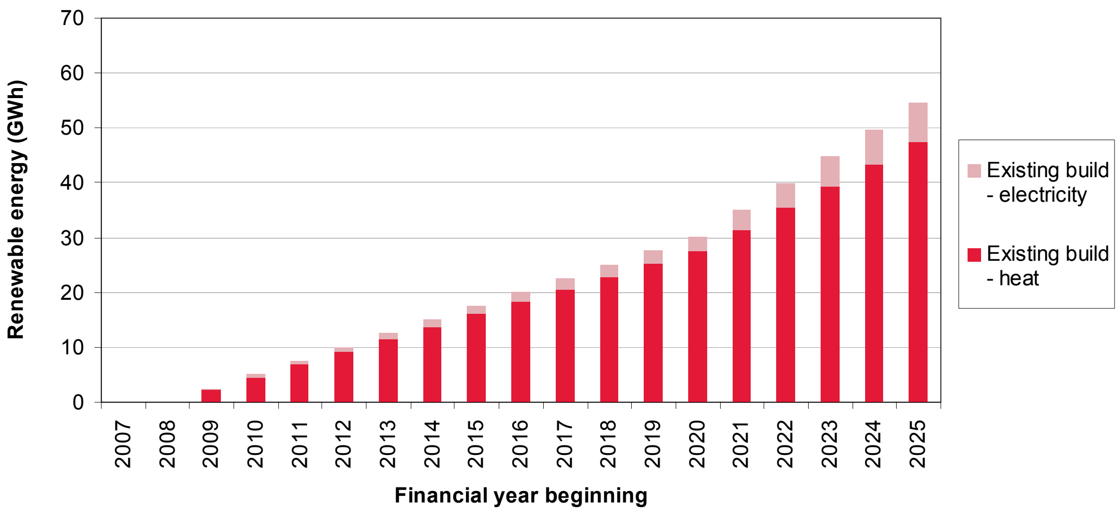
9.4.1 Amber Valley

In the Elevated Case scenario, the renewable energy potential in Amber Valley rises to 55GWh capacity by 2025, nearly 2.3%.

Table 39: Renewable energy results - Amber Valley existing build, scenario 2

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	16.0	27.5	47.3
	Electrical	1.5	2.6	7.2
	Total	17.6	30.1	54.5
Proportion of demand	Thermal	0.83%	1.47%	2.62%
	Electrical	0.25%	0.43%	1.19%
	Total	0.69%	1.21%	2.26%

Figure 50: Renewable energy generated within existing build – base case



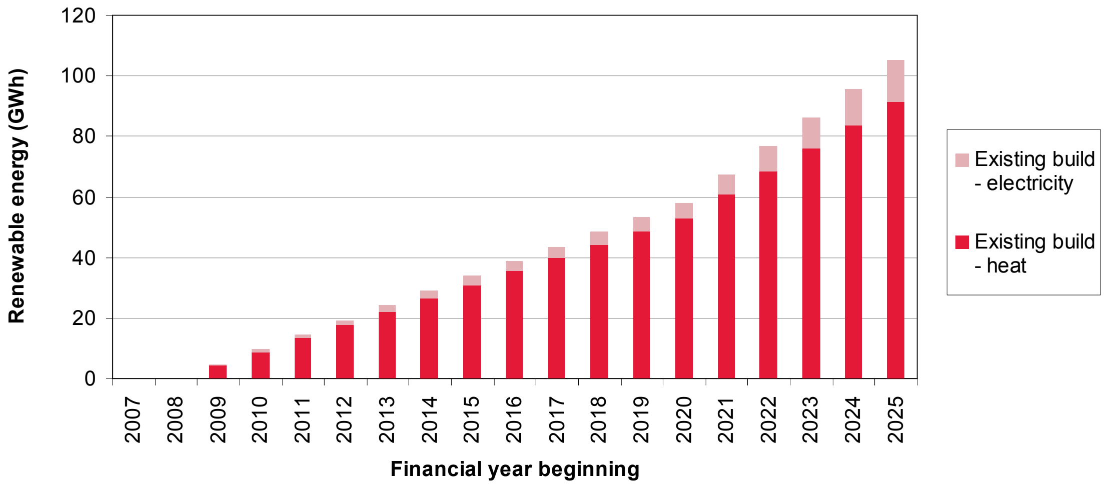
9.4.2 Derby

In the Elevated Case scenario, the renewable energy potential in Derby rises to 105GWh capacity by 2025, just under 3% of energy needs.

Table 40: Renewable energy results - Derby City existing build, elevated case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	30.9	53.1	91.4
	Electrical	3.0	5.1	13.9
	Total	33.9	58.1	105.3
Proportion of demand	Thermal	1.13%	1.99%	3.54%
	Electrical	0.25%	0.43%	1.19%
	Total	0.87%	1.51%	2.81%

Figure 51: Renewable energy generated within existing build – base case



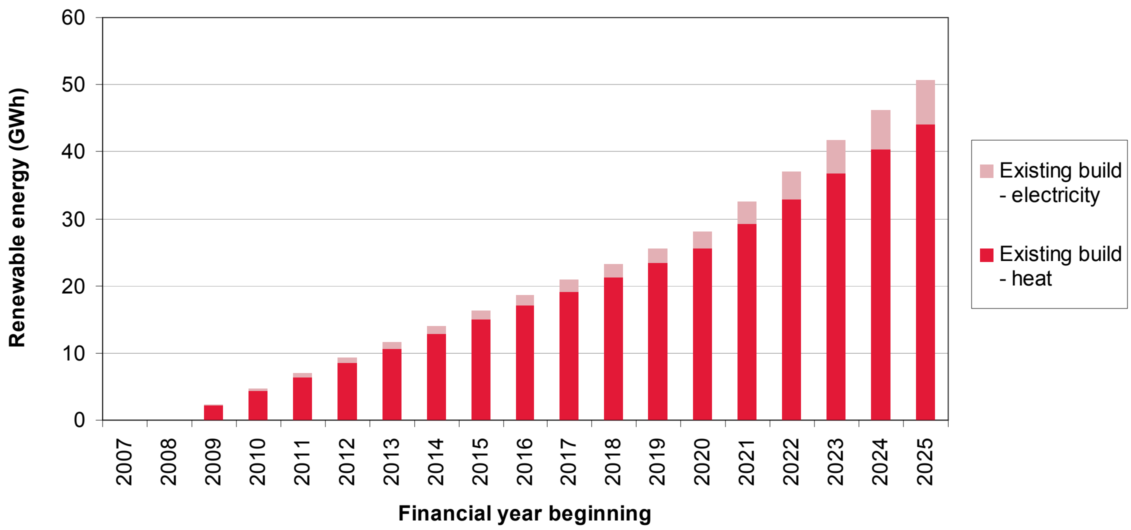
9.4.3 Erewash

In the Elevated Case scenario, the renewable energy potential in Erewash rises to 50GWh capacity by 2025, just under 3% of energy needs.

Table 41: Renewable energy results – Erewash, existing build, elevated case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	14.9	25.6	44.0
	Electrical	1.4	2.4	6.7
	Total	16.3	28.0	50.7
Proportion of demand	Thermal	1.15%	2.03%	3.61%
	Electrical	0.29%	0.50%	1.39%
	Total	0.91%	1.60%	2.98%

Figure 52: Renewable energy generated, Erewash, existing build, elevated case



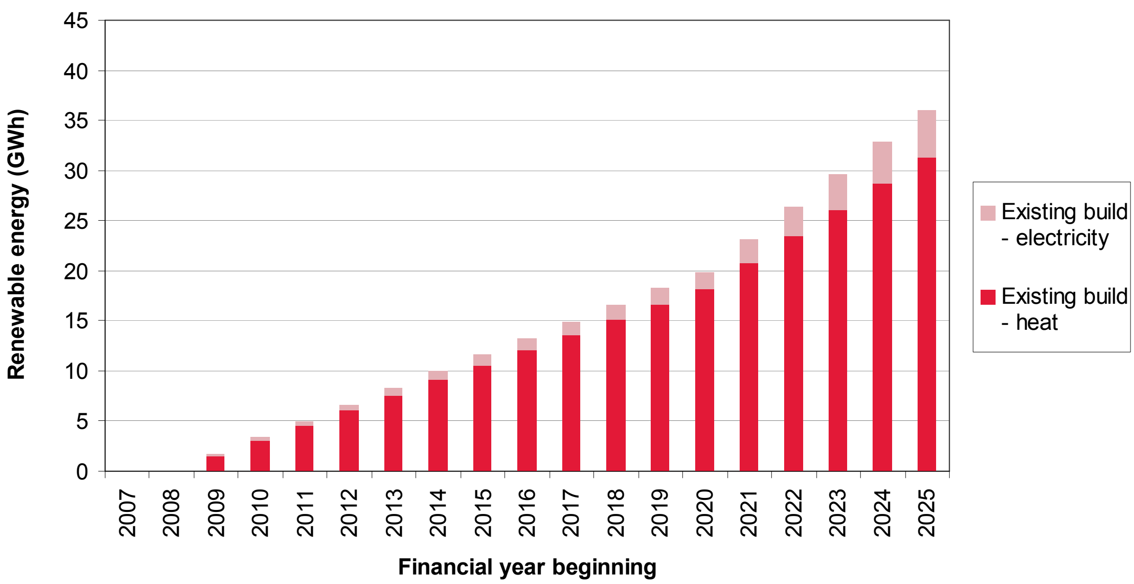
9.4.4 South Derbyshire

In the Elevated Case scenario, the renewable energy potential in Derby rises to 36GWh capacity by 2025, around 1.6% of energy needs.

Table 42: Renewable energy results - South Derbyshire existing build, scenario 2

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	10.6	18.2	31.3
	Electrical	1.0	1.7	4.8
	Total	11.6	19.9	36.1
Proportion of demand	Thermal	0.58%	1.01%	1.78%
	Electrical	0.20%	0.34%	0.93%
	Total	0.50%	0.86%	1.59%

Figure 53: Renewable energy generated within existing build – base case



10 Bringing it all together

This section brings together the various streams of the Low and Zero Carbon supply potential identified for existing capacity, new decentralised generation, new-build development and the new uptake in the existing built environment. Care has been taken to avoid double counting between the various assessments, for example, a potential equivalent to the biomass assumed to be delivered through new buildings has been removed from the decentralised biomass resource assessment. We anticipate that there is some double counting between the decentralised biomass estimate and the biomass element of the existing built environment uptake, but we anticipated that this will be small.

10.1 Base Case

Table 43 summarises the aggregated Base Case results of forecasted renewable energy generation, by authority, set in the context of predicted energy consumption (from section 2.4). It can be seen that by 2021, 4% of thermal energy demand could come from renewable source whilst 14% of electricity could be renewable, largely as a result of the good wind resource in South Derbyshire. Overall, the study suggests 7% of heat and electricity needs could be met from renewables.

The resulting estimate of the potential at the study area level is significantly in excess of the 4% baseline scenario for 2021, consulted on as part of the recent RSS partial Review options consultation. However, the figures for each authority, other than South Derbyshire are between 5% and 6%. South Derbyshire's sit at almost 13% of the total energy demand.

This 2021 date has been chosen as it is approximately coincides with the national 2020 target of 15% renewable energy (including transport) so further comparison can reasonably be drawn.

In addition to the figures outlined on this page, existing and currently planned renewables (set out in section 3) is estimated to supply 0.2% and 0.1% of 2021 energy demand respectively.

Table 43: Base Case forecast of total renewable energy generation

	Renewable Energy Generation in 2021 (GWh)					2021 consumption	2021 renewable energy contribution (%)
	Amber Valley	Derby City	Erewash	South Derbyshire	Study Area Total		
Thermal	76	117	57	87	337	7,593	4%
Electrical	63	89	43	208	402	2,786	14%
Total	**138**	**205**	**101**	**295**	**739**	**10,379**	**7%**
% RE potential by authority (2021)	**5.6%**	**5.3%**	**5.8%**	**12.8%**			

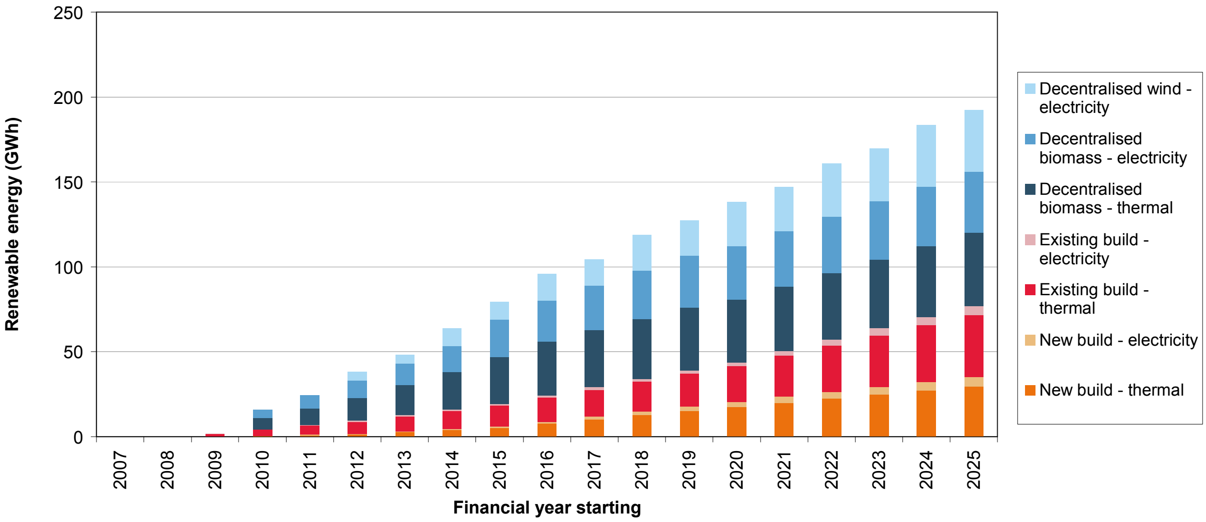
10.1.1 Amber Valley

Overall, over 138 GWh of renewable energy could be produced in Amber Valley by 2021 and 193 GWh by 2025. This is equivalent to 5.6% energy needs in 2021, abating approximately 43,000 tonnes CO_2 in that year.

Table 44: Collated renewable energy results, base case, Amber Valley

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	45.2	75.5	109.0
	Electrical	34.1	62.7	83.5
	Total	79.3	138.3	192.5
Proportion of demand	Thermal	2.35%	4.05%	6.03%
	Electrical	5.51%	10.25%	13.81%
	Total	3.12%	5.58%	7.98%
CO_2 abated (k tonnes)	Thermal	9.7	16.2	23.5
	Electrical	14.7	27.0	35.9
	Total	24.4	43.2	59.4

Figure 54: Collated renewable energy results, base case, Amber Valley



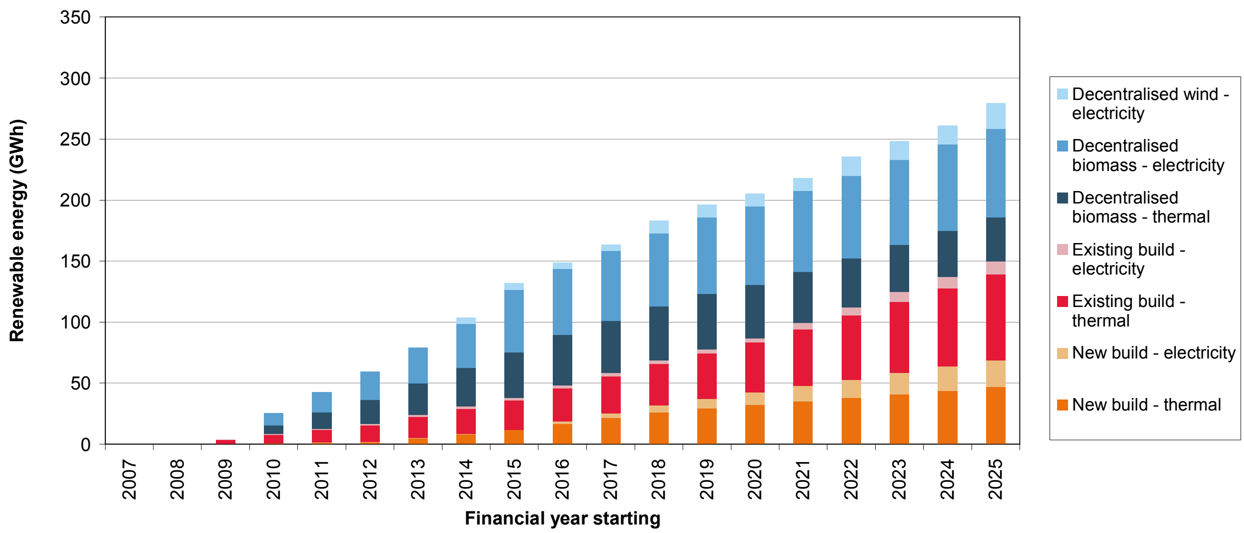
10.1.2 Derby

In the base case, the overall renewable energy potential for Derby is over 200 GWh of renewable energy equivalent to 5.3% of energy needs in 2020/21, and abating 63,000 tonnes CO_2 in that year.

Table 45: Collated renewable energy results, base case, Derby

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	72.6	116.5	152.9
	Electrical	59.2	88.7	126.3
	Total	131.8	205.2	279.2
Proportion of demand	Thermal	2.7%	4.4%	5.9%
	Electrical	5.0%	7.5%	10.9%
	Total	3.4%	5.3%	7.5%
CO_2 abated (k tonnes)	Thermal	15.6	25.1	32.9
	Electrical	25.5	38.1	54.3
	Total	41.1	63.2	87.2

Figure 55: Collated renewable energy results, base case, Derby



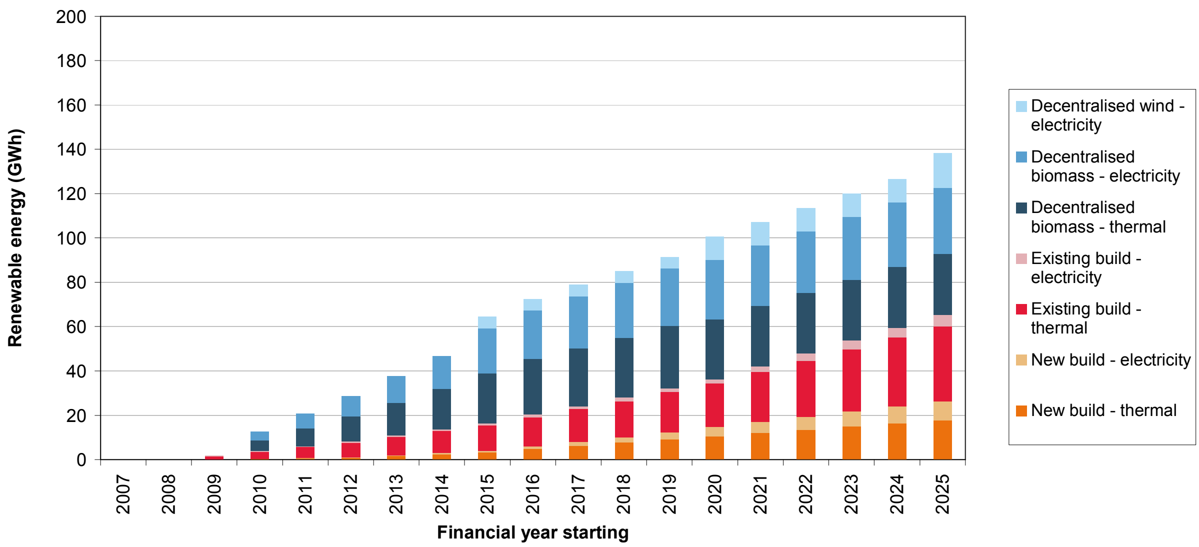
10.1.3 Erewash

In the base case, the overall renewable energy potential for Erewash is over 100 GWh of renewable energy in 2020/21 equivalent to 5.8% of energy needs, abating over 30,000 tonnes CO_2 in that year.

Table 46: Collated renewable energy results, base case, Erewash

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	36.9	57.4	79.1
	Electrical	27.6	43.1	59.1
	Total	64.6	100.6	138.2
Proportion of demand	Thermal	2.84%	4.56%	6.48%
	Electrical	5.65%	8.89%	12.27%
	Total	3.61%	5.76%	8.12%
CO_2 abated (k tonnes)	Thermal	7.9	12.4	17.0
	Electrical	11.9	18.6	25.4
	Total	19.8	30.9	42.4

Figure 56: Collated renewable energy results, base case, Erewash



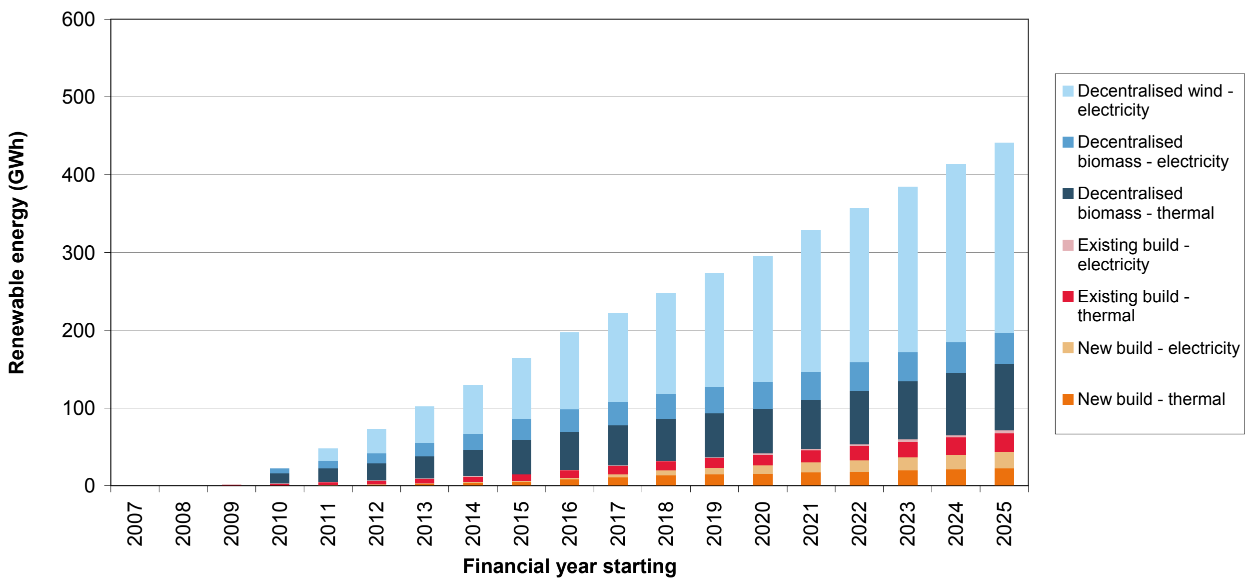
10.1.4 South Derbyshire

In the base case, the overall renewable energy potential for South Derbyshire is 295 GWh of renewable energy in 2020/21 equivalent to 13% of energy needs, abating over 108,000 tonnes CO_2 in that year.

Table 47: Collated renewable energy results, base case, South Derbyshire

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	57.1	87.3	132.0
	Electrical	106.9	207.9	309.4
	Total	164.0	295.3	441.4
Proportion of demand	Thermal	3.14%	4.85%	7.49%
	Electrical	21.31%	40.52%	60.40%
	Total	7.06%	12.76%	19.41%
CO_2 abated (k tonnes)	Thermal	12.3	18.8	28.4
	Electrical	46.0	89.4	133.0
	Total	58.2	108.2	161.4

Figure 57: Collated renewable energy results, base case, South Derbyshire



10.2 Elevated Case

Table 48 summarises the aggregated Elevated Case results of forecasted renewable energy generation, by authority, set in the context of predicted energy consumption (from section 2.4). The study suggests that in the elevated scenario around 5% of thermal energy demand could be delivered by renewable sources by 2021 (no significant increase against the base case), whilst 19% of electricity could be renewable (an increase of 5% against the base case). Overall, 9% of heat and electricity needs could be met from renewables, which meets the 9% target in the draft regional 'energy efficiency and high renewables' scenario by 2021.

For the authorities individually we see limited increases from between 5 and 6% in the base case to between 5.9% and 7,2%. South Derbyshire is the exception as the elevated case sses it jumps from 13% to 16%.

The existing and planned renewables (discussed in section 3) accounts for a small proportion of 2021 potential at 0.2% and 0.1% of thermal and electrical demand respectively.

Table 48: Elevated Case forecast of total renewable energy generation

	Renewable Energy Generation in 2021 (GWh)					2021 consumption	2021 renewable energy contribution (%)
	Amber Valley	Derby City	Erewash	South Derbyshire	Study Area Total		
Thermal	82	129	64	92	366	7,593	5%
Electrical	80	99	61	279	518	2,786	19%
Total	162	227	125	371	884	10,379	9%
% RE potential by authority (2021)	**6.5%**	**5.9%**	**7.2%**	**16%**			

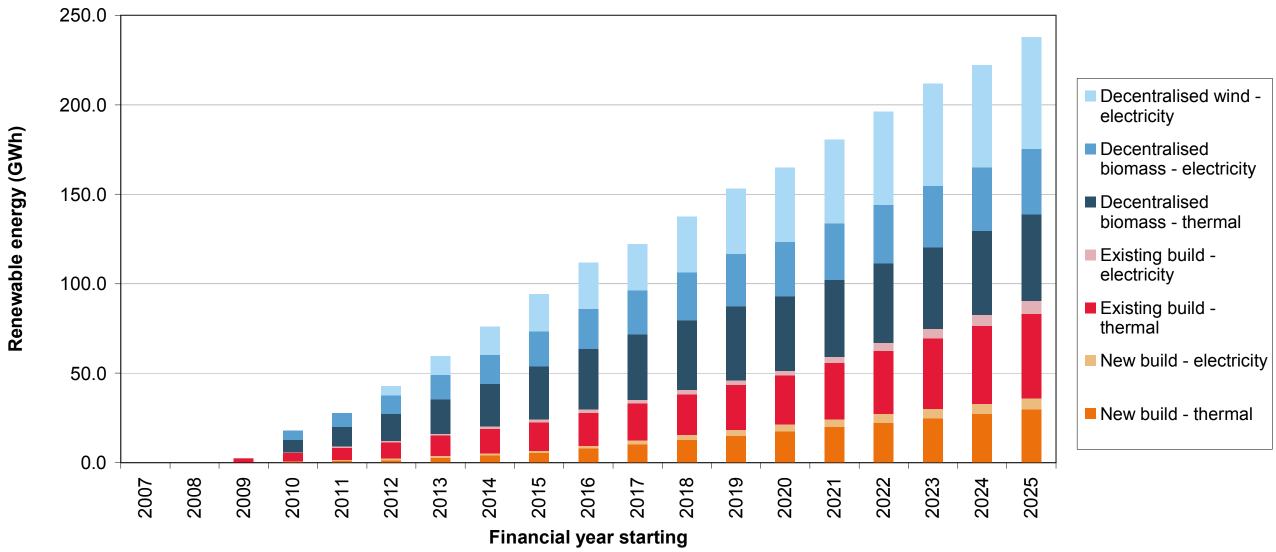
10.2.1 Amber Valley

In the elevated case, the overall renewable energy potential for Amber Valley is 161 GWh of renewable energy in 2021 equivalent to 6.5% of energy needs, abating nearly 52,000 tonnes CO_2 in that year.

Table 49: Collated renewable energy results, elevated case, Amber Valley

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	48.9	81.9	120.0
	Electrical	45.6	79.6	111.9
	Total	94.5	161.5	231.8
Proportion of demand	Thermal	2.54%	4.39%	6.64%
	Electrical	7.35%	13.01%	18.50%
	Total	3.72%	6.52%	9.61%
CO_2 abated (k tonnes)	Thermal	10.5	17.6	25.8
	Electrical	19.6	34.2	48.1
	Total	30.1	51.9	73.9

Figure 58: Collated renewable energy results, elevated case, Amber Valley



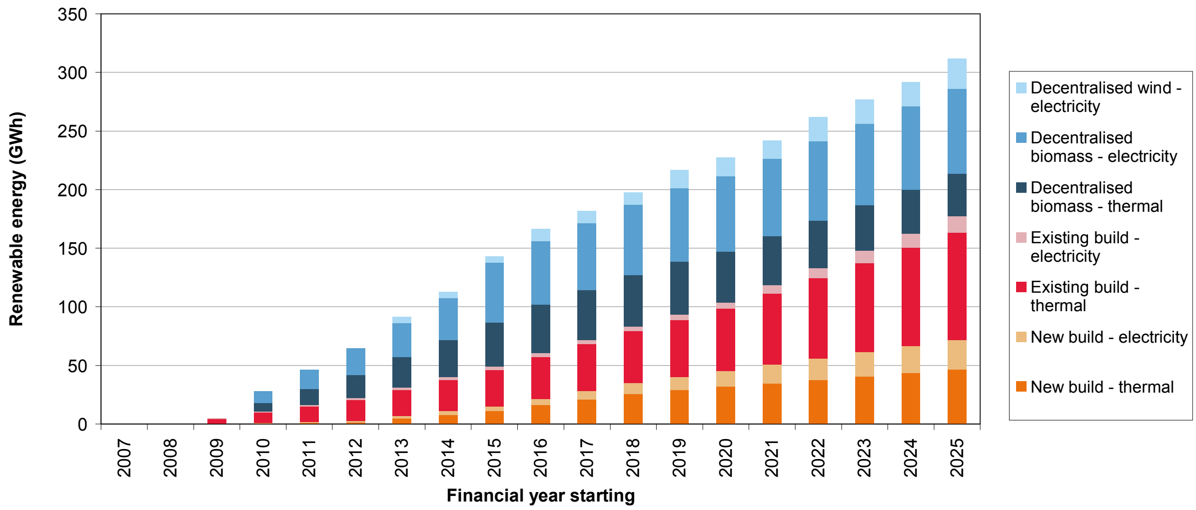
10.2.2 Derby

In the elevated case, the overall renewable energy potential for Derby is 227 GWh of renewable energy in 2021 equivalent to 5.9% of energy needs, abating 70,000 tonnes CO_2 in that year.

Table 50: Collated renewable energy results, elevated case, Derby

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	79.4	128.5	173.7
	Electrical	63.5	98.7	138.3
	Total	142.9	227.1	312.0
Proportion of demand	Thermal	2.9%	4.8%	6.7%
	Electrical	5.4%	8.4%	11.9%
	Total	3.6%	5.9%	8.3%
CO_2 abated (k tonnes)	Thermal	17.1	27.6	37.4
	Electrical	27.3	42.4	59.5
	Total	44.4	70.1	96.8

Figure 59: Collated renewable energy results, elevated case, Derby



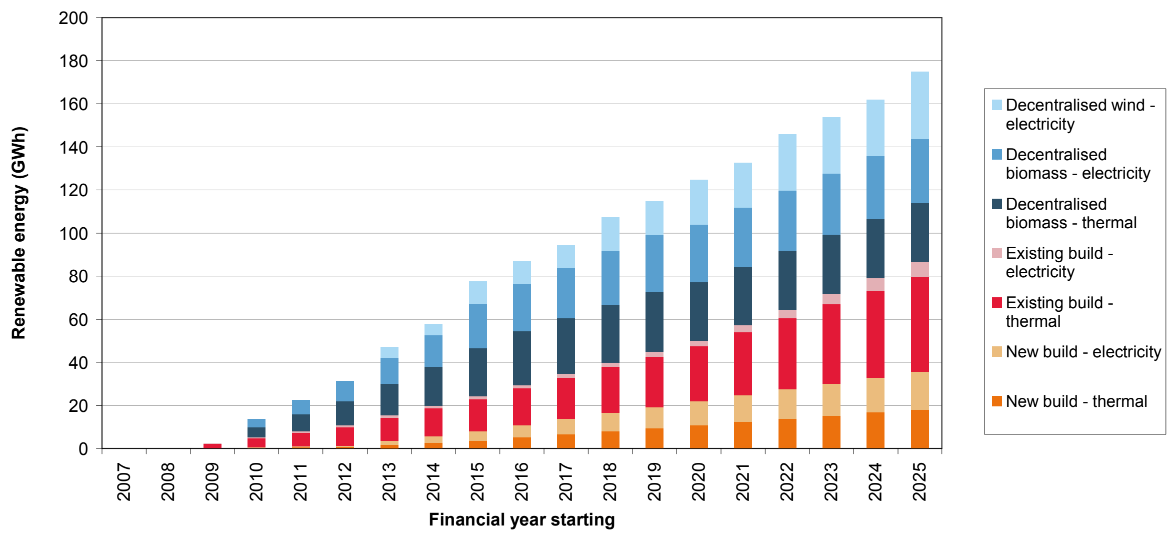
10.2.3 Erewash

In the elevated case, the overall renewable energy potential for Erewash is 125 GWh of renewable energy in 2021 equivalent to over 7% of energy needs, abating 40,000 tonnes CO_2 per annum.

Table 51: Collated renewable energy results, elevated case, Erewash

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	40.8	63.6	89.6
	Electrical	36.8	61.1	85.4
	Total	77.6	124.7	174.9
Proportion of demand	Thermal	3.14%	5.05%	7.33%
	Electrical	7.53%	12.60%	17.71%
	Total	4.34%	7.15%	10.27%
CO_2 abated (k tonnes)	Thermal	8.8	13.7	19.3
	Electrical	15.8	26.3	36.7
	Total	24.6	40.0	56.0

Figure 60: Collated renewable energy results, elevated case, Erewash



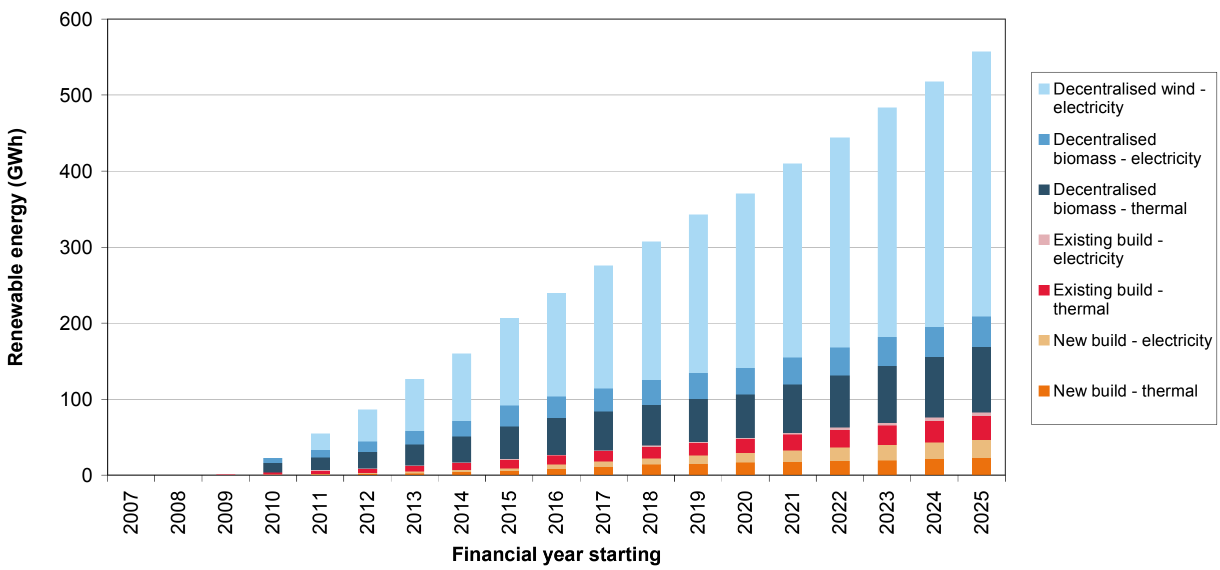
10.2.4 South Derbyshire

In the elevated case, the overall renewable energy potential for South Derbyshire is 371 GWh of renewable energy in 2021 equivalent to over 16% of energy needs, abating 140,000 tonnes CO_2 per annum.

Table 52: Collated renewable energy results, elevated case, South Derbyshire

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	60.0	92.0	139.7
	Electrical	146.2	278.6	417.1
	Total	206.2	370.6	556.8
Proportion of demand	Thermal	3.30%	5.11%	7.93%
	Electrical	29.14%	54.29%	81.43%
	Total	8.88%	16.02%	24.49%
CO_2 abated (k tonnes)	Thermal	12.9	19.8	30.1
	Electrical	62.9	119.8	179.4
	Total	75.8	139.6	209.4

Figure 61: Collated renewable energy results, elevated case, South Derbyshire



10.3 Comparison of Base Case and Elevated Case

Table 53 compares the study area renewable energy generation potential for both the Base Case and Elevated Case scenarios. It also summarises the potential CO_2 abatement from renewables by 2021. The Elevated Case represents a 20% increase in renewable energy upon the Base Case, leading to around 9% of heat and power needs being met from renewables. On average for the two scenarios, 274,000 tonnes of CO_2 per annum could be saved in 2021. Comparing this to current figures, this is just over 6% of the study area's 2007 emissions (as set out in Figure 2 (page 25)).

Overall, the analysis demonstrates that the wind and biomass resources in the study area are sufficient for delivering the zero carbon requirements, provided that "allowable solutions" can be off-site. In high density city centre sites, 70% on-site carbon compliance will be challenging for logistical reasons (lack of roof space, site constraints, managing air quality, etc.), highlighting the benefits and potentially the necessity of developing zero carbon district heating schemes in order to meet the current definition of Zero Carbon.

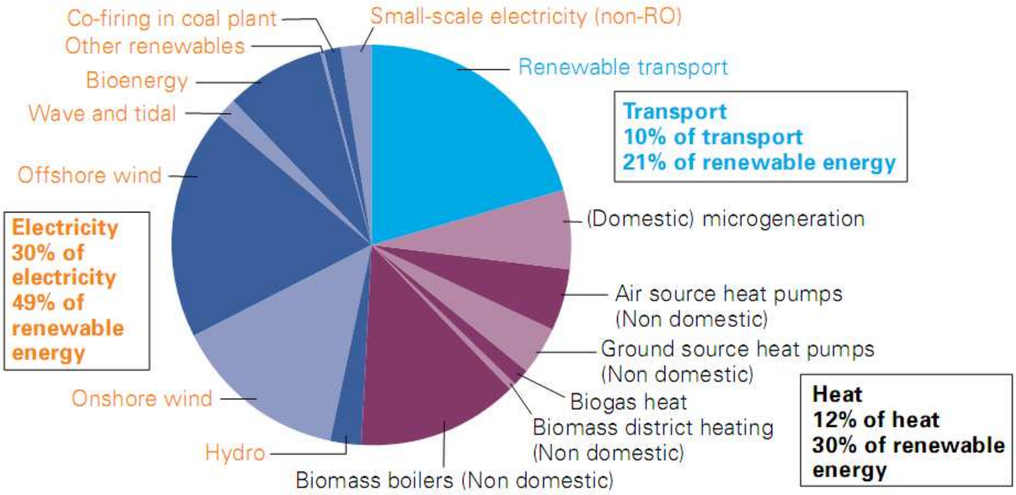
Table 53: Comparison of Base Case and Elevated Case potential – study area totals

	Renewable Energy (GWh)	Renewable heat (%)	Renewable electricity (%)	Renewable heat and electricity (%)	Carbon reduction (kTonnes CO_2)	Carbon reduction on 2007 baseline (%)
Base Case	739	4%	14%	7%	246	5%
Elevated Case	884	5%	19%	9%	302	7%

11 Benchmarking against national and regional targets

The UK has established a national target to supply 15% of total energy demand through renewable sources[50]. This target is applicable to electricity, heat and transport energy sources. The 'lead scenario' for delivering this national target is illustrated in Figure 62.

Figure 62: Lead Scenario for meeting 2020 UK renewable energy target



When regionalising national target we can extract components by saying what is defined as "regional" by PPS 22: This includes:

- Onshore wind (large scale)
- Hydro electric
- Anaerobic digestion (from organic waste feedstock)
- Farm slurry anaerobic digestion
- Sewage gas
- Landfill gas
- Poultry litter combustion
- Microgeneration (all types)
- Small scale biomass combustion

Table 54 further explains which components of the lead scenario can be influenced at a local level. When those components that are defined as 'non locally influenced' are excluded from the government's lead scenario, and then compared to the pie chart above, it can be concluded that half of the national target can be delivered 'locally' (7.5%) and the other half 'nationally' (7.5%). This provides a useful benchmark of the overall renewable energy target for heat and power of relevance to the study area.

[50] *The UK Renewable Energy Strategy, DECC, July 2009*

Table 54: Summary of local relevance of the components of the UK Renewable Energy Strategy

Component of the anticipated 2020 energy mix (UK)		Locally influenced	Non locally influenced	
Transport				While there is the ability to grow fuel crops within agricultural areas, converting these crops to biofuel requires refining, the capacity for which lies outside of the study area and is significantly driven by national decisions.
Heat (all sources)				Heat cannot be transported over long distances, hence utilisation should be at a local level.
Electricity	Small scale electricity			Microgeneration takes place on or next to buildings, to supply energy directly to that building.
	Co-firing in coal plant			While co-fired fuels can be grown locally, the ability to address this opportunity stands mostly at a national level for larger coal fired power stations. So even though there is coal generation within the study area we have opted to exclude it form the consideration of local targets
	Other renewables			Although the definition of 'other renewables' is not clear, it is assumed that this can be influenced locally. It makes a small contribution to the national mix so will have little impact on this analysis
	Bio-energy			Developing decentralised power stations which are fuelled exclusively by biomass sources are likely. The scale of project envisaged is likely to be dealt with by the local planning authority
	Wave & tidal			Not geographically relevant to this study.
	Offshore wind			Not geographically relevant to this study.
	Onshore wind			Interest in developing suitable sites, as well as planning decisions, are highly likely to happen at a local level.
	Hydro			Interest in developing suitable sites, as well as planning decisions, are highly likely to happen at a local level.

Table 55 goes on to summarise the analysis results by district and study area level, with Figure 63 showing the renewable energy totals graphically. The graph clearly demonstrates that (relative to the 'localised national target') capacity in Amber Valley, Derby and the Erewash are much lower than those in South Derbyshire.

One advantage of conducting a joint study is to be able to compare authorities. When large differences between authorities is identified, particularly where one or more of those authorities have capacity in excess of what might be considered national or regional aspirations, it begs the question as to whether the a joint approach to delivering against these aspirations could be considered. Essentially, renewable energy targets (if authorities wish to adopt them) could be expressed on a study area basis with the authorities then exploring pathways to deliver renewable energy across the study area, rather than just within their own boundaries. For example, a study area wide investment fund could be established which could then absorb developer contributions (from new development) to support generation projects across the study area. Perhaps there is an opportunity here for the districts to demonstrate leadership in driving forward renewable energy development together to exploit and reap the carbon benefits of the resources, irrespective of planning boundaries.

Overall Table 55 shows that the Elevated Case scenario which delivers 9% renewable heat and power by 2021 is comparable with the 9% high regional target and the 10% 'localised' national target**.**

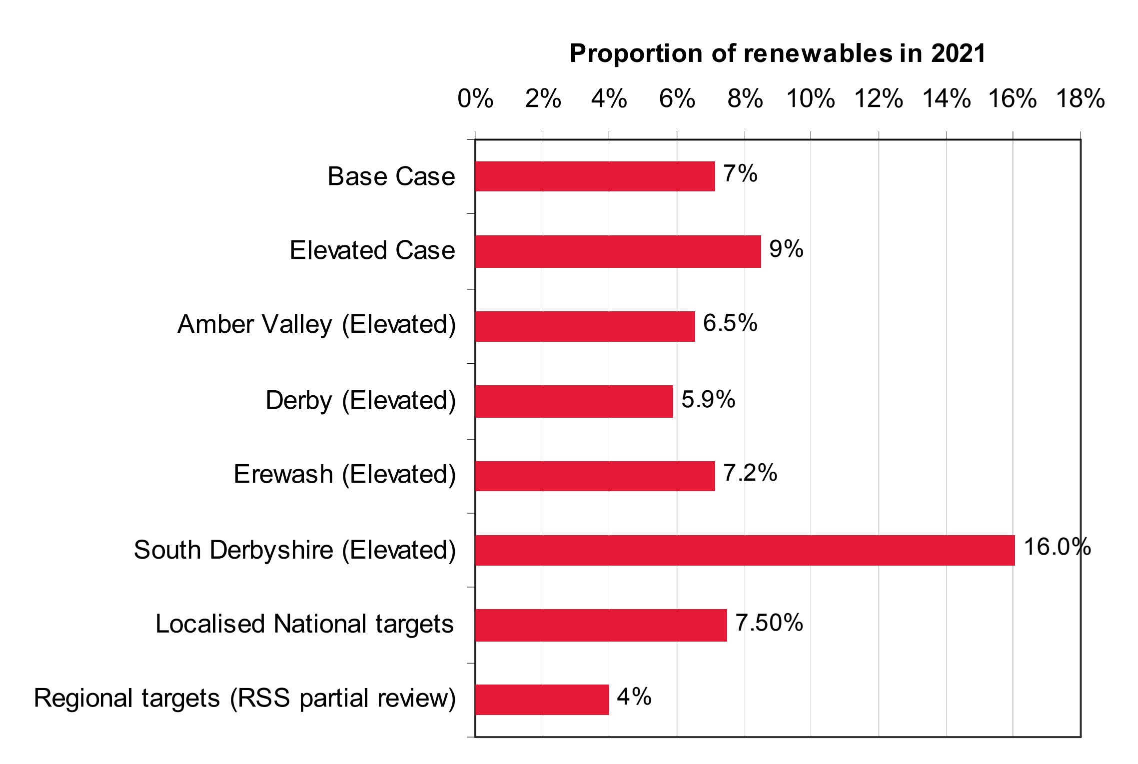
The 'localised national targets' are shown as a range since the government's lead scenario is open to interpretation as to which components can be influence at a regional level. If non-locally influenced energy sources (as set out in Table 54) are ignored, then a local target of 7.5% renewable energy can be derived. As a high scenario, if all 'non-local' sources are included, aside from transport and offshore wind, then the local target could instead be derived as 10% of the energy demand in 2020/21. Hence, a range of 7.5 – 10% has been referenced in the table below.

Regional renewable energy targets exist following a recent review, and give a base case target of 4%, with an elevated scenario of 9%.

Table 55: Comparison of local potential with national and regional targets

Comparison of local potential (2021) with national and regional targets				
	Renewable energy generation (GWh)	**% renewable heat**	**% renewable electricity**	**% renewable energy (heat + power)**
Study Area				
Base Case	739	4%	14%	**7%**
Elevated Case	884	5%	19%	**9%**
Individual Authorities				
Amber Valley (Base - Elevated)	138 - 162	4% - 4.4%	10.3% - 13.0%	**5.6% - 6.5%**
Derby (Base -Elevated)	205 - 227	4.4% - 4.8%	7.5% - 8.4%	**5.3% - 5.9%**
Erewash (Base -Elevated)	100 - 125	4.6% - 5.1%	8.9% - 12.6%	**5.8% - 7.2%**
South Derbyshire (Base -Elevated)	295 - 371	4.9% - 5.1%	40.5% - 54.3%	**12.8% - 16.0%**
National / Regional target benchmarks				
'Localised' National targets (excluding offshore wind and other not locally influenced technologies)	-	12%	20%	**7.5 - 10%**
Regional targets (RSS partial review: base case and elevated)	-	-	-	**4 - 9%**

Figure 63: Comparison of local, study area, regional and national potential



11.1 Process for setting targets

In accordance with PPS1, we have followed the process set out in Figure 64 in order to arrive at a series of proposed targets. Through a combination of GIS mapping and biomass resource analysis we have reviewed the each authority's potential for decentralised energy and cross referenced against national, regional and local policies and plans for low carbon development and renewable energy. This has confirmed that in Amber Valley, Derby and Erewash there is the potential to meet 4-5% of each authority's energy needs from renewable energy in 2021. In South Derbyshire the potential is much greater, principally because it has the majority of less constrained sites for potential wind development.

We have also concluded that there is sufficient wind and biomass potential for helping new property development to reach the government's proposed zero carbon standards from 2016 (housing) and 2019 (non-domestic). However, we have acknowledged the practical difficulties in reducing regulated emissions by 70% from city centre sites and understand that some sites will struggle to link into district heating systems due to low development density and will not be sufficiently close to wind development sites so as to be able to develop wind energy connected to the scheme.

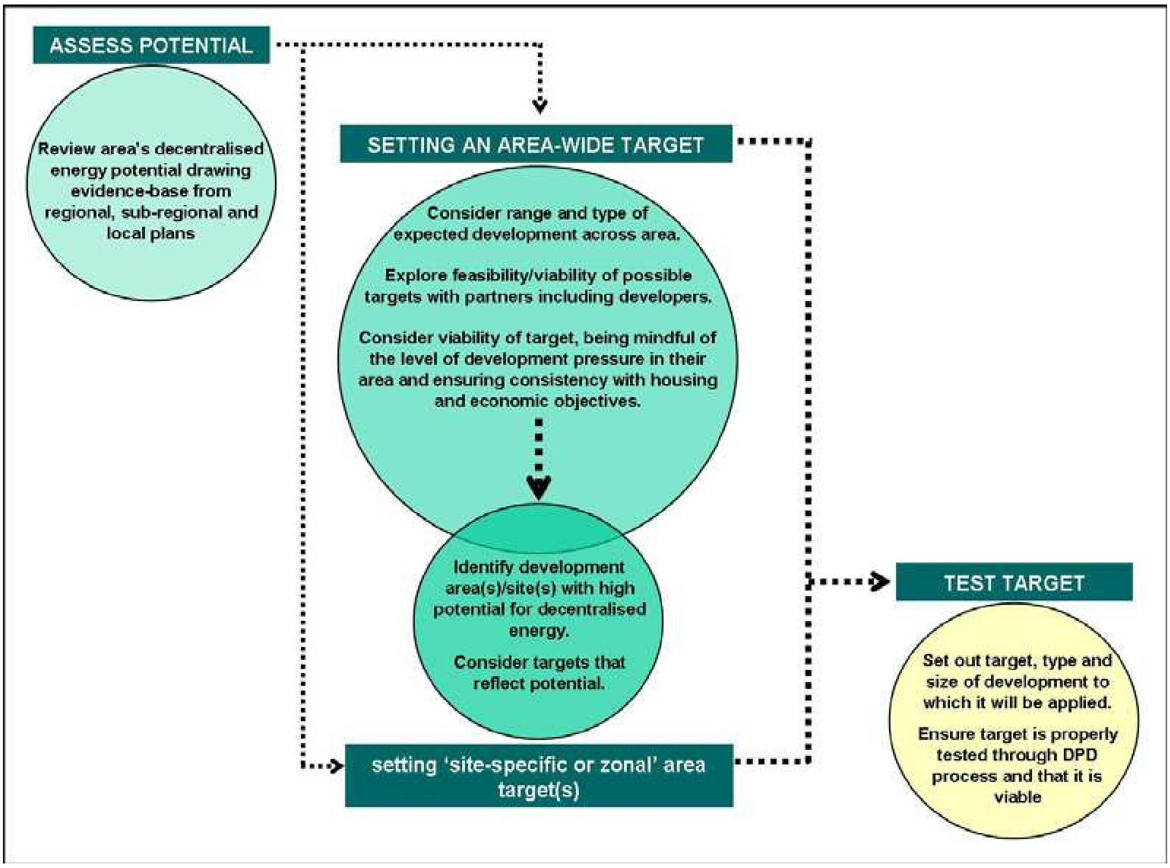
These are issues which must be resolved nationally, however, it seems clear that zero carbon targets will ultimately be met through a combination of on-site and off-site mechanisms. Until these issues are resolved, it is our recommendation that the area-wide target be set at a level which is more likely to be technically and financially possible given the current mechanisms in place. For most sites it will be technically possible to achieve a 20% reduction in CO_2 emissions from regulated and unregulated emissions using on-site renewable technologies such as PV, solar water heating and biomass boilers. On high density sites it will be more difficult but there are many examples in London where planning has been granted on the basis of achieving this target.

Furthermore, the new Feed-In Tariff and upcoming Renewable Heat Incentive offer the potential for these technologies to be cost-effective investments giving a modest rate of return that may be acceptable to householders, communities and the public sector. Capitalising this revenue at the point of sale of the property will be important for developers to be satisfied that meeting the targets will not place undue burden on them. However, given the large amount of activity in the industry seeking to develop mechanisms to realise this value (such as PAYS, leasing schemes and low interest finance facilities) it seems justifiable to set a target on this basis.

For developments over 1,000 units in size, we are proposing that these be set a target of meeting zero carbon standards ahead of 2013, given that the FIT and RHI can now support these schemes and help to deliver Code for Sustainable Homes credits in a viable way. At this scale it is considered that infrastructure could in many cases be delivered through an ESCO, although detailed evaluation will be required on a case-by-case basis.

Since early phases of these schemes would be developed in advance of mandatory zero carbon requirements, greater flexibility could be built in to the policies such as relaxing the on-site carbon compliance figure if it was deemed unviable to meet it on a particular project. In such circumstances, it is recommended that a "buy out" price is set for investment into local off-site solutions.

Figure 64: Process for setting targets



11.2 Carbon targets for new developments

Given that the Elevated Case is considered technically feasible and financially viable, in the majority of cases, as described in the scenario definitions, it is proposed that these are set as aspirational targets. Whilst this includes carbon standards, which in some areas are ahead of the stated 'road map' for zero carbon, they reach the same zero carbon milestones (for 2016 and 2019) and so merely serve to accelerate progress, where it is deemed possible. This has proved elsewhere as an important measure to encourage preparedness in the development market place and within Planning Authorities. The recommended targets are also designed to encourage the adoption of Low and Zero Carbon technologies (rather than simply energy efficiency) since this will facilitate the development of local supply chains and the hence more rapidly deliver cost reductions, reducing the financial burden on future development.

Government has not set out is aspirations for the improvements of carbon standards in non-residential buildings, other than a "zero carbon" milestone in 2009. We have assumed that non-residential development will follow a similar carbon road map to residential development and therefore recommend carbon targets based upon residential targets, but with a three year time lag, with the exception of large mixed use developments.

The recommended carbon targets are set out in Table 56, which also illustrates the proportion we recommend to be delivered by renewable energy to support acceleration of the renewable energy deployment against the national 15% target (by 2020). From this, the energy efficiency component of the carbon target can be inferred. Clearly where renewable energy targets are not deemed achieve-able then energy efficiency would be needed to cover the gap and a reasonable negotiation with planning applicants is anticipated in most cases. Table 56 also illustrates the equivalent Code for Sustainable Homes level that would be achieved for the energy component, for residential development.

The targets vary in a number of ways against the UK zero carbon 'road map' as follows:

- Requirement for a 35% carbon reduction for residential development between 2010 and 2013 (10% ahead of the 'road map') with 20% renewables from 2010 (for residential development)
- The targets for non-residential development (where its not part of a large mixed use scheme) are not proposed to be accelerated ahead of Building Regulations other than the 10% renewable requirements which is an obligation set by the Regional Spatial Strategy
- From 2013 onwards the development standards remain consistent with the 'road map' for smaller development types (rural and urban infill and smaller settlement extension)
- For the period 2013-2016 the development standards for larger development (urban extension, major urban regeneration and large urban extension / new settlement), both residential and mixed use, are accelerated ahead of the 'road map'
- The targets for residential development from 2016 is consistent with the roadmap.
- For the period 2016-2019 large non-residential schemes (whether solely non-residential of mixed use) are accelerate to the zero carbon standard.

Table 56: Proposed Carbon Targets for New Developments (improvement above Building Regulation Part L 2006)

	Residential			Non-residential		
	Regulated emission reduction against Part L 2006 *(CSH equivalent[52])*	*Un-regulated*	Proposed % reduction by LZC	Regulated emission reduction against Part L 2006	*Un-regulated*	Proposed % reduction by LZC
2010-13						
	35% *(Code 3-4)*	*0%*	20%	0%	*0%*	10%
2013-16						
Smaller development types	44% *(Code 4)*	*0%*	26%	25%	*0%*	10%
Large developments types including mixed use	100%[53] *(Code 4-5)*	*100%*	50%	44%	*0%*	*26%*
2016-19						
Smaller development types	100%[53] *(Code 4-5)*	*100%*	50%	44%	*0%*	*26%*
Large developments types	100%[53] *(Code 4-5*	*100%*	50%	100%[53]	*100%*	50%

It is worth noting that there is an inconsistency in the Code 5 and Code 6 definitions and the anticipated zero carbon home re-definition, following recent national consultation. The current Code for Sustainable Homes technical guidance requires 100% improvement in regulated carbon for Code 5 and 6 but provides no basis on which "allowable solutions" (including "off-site" measures) can be considered. By contrast the Zero Carbon Home definition will set a minimum "on-site" threshold of 70% of regulated emission with the rest of the carbon saving, including unregulated emissions (for Code 6) being possible to achieve through "off-site " measures. It is assumed this will be addressed by future revisions to the Code for Sustainable Homes.

It is proposed that these targets be set as aspirational performance-based targets to be accompanied by a viability test that is applied when reviewing planning applications. Section 12 recommends policy approaches that could be included with the emerging LDFs within the Study Area. Within Table 57 we describe the principal generic solutions to achieving the recommended targets and the nature of viability tests required.

[52] *Code for Sustainable Homes - for energy credits only*
[53] *This assumes 70% of the carbon reduction is achieved "on-site" as per recent government announcements.*

Finally, the targets are proposed to apply to projects at the point of completion, rather than planning determination. In this way targets are being applied as they are through the application of building regulations. This has a two key consequences, firstly, on many schemes a range of standards could apply to different elements of the development and, secondly, their will be a strong onus on Development Control to ensure standard are met in practice. The first point should be resolved through providing clarity around the policy, negotiating reasonable conditions linked to the changing targets. The second issue will require development of the in-house capabilities and would suggest the need for additional monitoring and assessment practices. Ultimately, this will require dedicated staff resources or establishment of discrete budgets to outsource this support.

Table 57: Summary of generic solutions (for 2013 onwards) and viability tests

Category	Potentially viable opportunity	Recommended Carbon target	Viability test
Urban Infill	Biomass boilers or microgeneratio n	44% CO_2 reduction 26% reduction of regulated carbon emissions from on-site renewables	System is technically feasible Payback within system lifetime taking into account market mechanisms such as FIT/RHI S106 contribution to off-site measures if 20% cannot be achieved on-site “buyout price” to be set at price equivalent to off-site solution that can be delivered by LA or RSL partner
Rural infill	As above	As above	As above
Settlement extension	As above	As above	As above
Urban extension / large urban regeneration project	Biomass CHP in high density areas Wind on adjoining land	Zero carbon from 2013 in line with national definition of “zero carbon” as set by CLG	System is technically feasible Internal Rate of Return (IRR) of project is above hurdle rate of potential investor (at least 10%) S106 contribution to off-site solution if not possible on site OR Contribution to off-site solutions using nationally defined mechanisms to be confirmed
Large urban extension / new settlement	Biomass CHP in high density areas Wind on adjoining land	Zero carbon from 2013 in line with national definition of “zero carbon” as set by CLG	System is technically feasible Internal Rate of Return (IRR) of project is above hurdle rate of potential investor (at least 10%) S106 contribution to off-site solution if not possible on site OR Contribution to off-site solutions using nationally defined mechanisms to be confirmed

12 Recommendations for Local Development Framework Policies

12.1 Planning policies

For new build development, it is proposed that the authorities set out the trajectory to zero carbon as baseline expectation to be considered alongside the intended phasing of the development. Each should seek evidence from developers as to how they intend to meet these increasingly stringent baseline targets, including:

- Proportion of the target to be met from on-site measures
- Infrastructure to be provided in support of on-site measures (e.g. district heating)
- Exploration of opportunities to exceed the target
- Strategy for safeguarding opportunities to exceed the target
- Strategy for anticipating policy and technology changes over the development plan period
- Exploration of opportunities for off-site measures to be developed in the district and wider study area
- Exploration of opportunities to support the development of low and zero carbon infrastructure serving existing development

Beyond this, we recommend that the authorities should set Elevated Case targets as aspirational performance-based targets.

Recommendation 1: To require developers to achieve carbon reduction targets for new development as set out in Table 56, and to consider the development of community heating and CHP.

Authorities should require evidence of viability assessment to accompany planning applications, with assessment by the developer (or in conjunction with the authority) to include:

- Technical feasibility – including space availability, integration with building energy systems, impact on townscape, running hours of plant
- Financial viability – including capital cost and whole life cost over plant lifetime taking into account market mechanisms such as feed in tariffs. Measures using indices such as Internal Rate of Return for benchmarking against typical investment hurdle rates for delivery by ESCOs.
- Deliverability – including opportunities and requirements for delivery of infrastructure through Energy Services Companies
- Impact on overall viability of the development using an assessment method such as the Three Dragons model that will examine factors such as land value, sale value, construction costs and other S106 contributions

Recommendation 2: Establish a regime of target and viability assessment suitable to support compliance to elevated targets

It is proposed that performance targets be expressed in terms of CO_2 reduction to be consistent with the Code for Sustainable Homes. If the achievement of advanced targets is deemed viable then set these targets as planning conditions and agree these as part of the planning approval process. If the achievement of these targets through on-site measures alone is not possible then the authorities should test the viability of the development with a “buy out” price for off-site solutions. They should set a formula for updating this "buy out" price periodically in line with emerging government policy.

In the absence of fixed "buy out" price set at a minimum of £100/tonne CO_2 and a 30 years project life in line with current thinking in the industry[54]. Furthermore, in the absence of a standard national mechanism for securing off-site solutions, the authorities should support the identification of potential off-site solutions for direct investment by the developer.

We recommend that the authorities consider the establishment of a local-authority controlled Carbon Investment Fund to channel S106 contributions for off-site solutions into local low carbon projects. If such a mechanism were to be used then it will be important to choose projects that are demonstrably "additional" to current activity, i.e. projects that wouldn't have gone ahead without the investment. This might include wind energy projects on marginal sites or advanced energy efficiency measures in existing buildings that are not already subsidised through CERT. Examples of this approach exist in other authorities such as Milton Keynes.

Further detail is included in section 14.

Recommendation 3: The authorities to consider the establishment of a Carbon Investment Fund, either unilaterally, or as a group, to support delivery of local carbon reduction measures.

This study illustrates simplistic heat mapping of the study area. We recommend that further high resolution spatial analysis is conducted into current and the future heat loads particularly in areas anticipated to experience major growth. This should be designed to inform the authorities of key opportunities for community heating / CHP, where new development can supply the development of heat infrastructure to also supply the existing built environment, such as high density housing. In addition, this study provides data on off-gas grid properties, some of which may be within suitably large clusters to justify the development of the renewable energy fuel switching projects, e.g. biomass community heating, as well as target energy efficiency programmes. We recommend this is considered further.

Recommendation 4: Conduct high resolution heat mapping to consider potential for the community heating, particularly around areas of major growth

Recommendation 5: Conduct analysis of the potential for fuel switching in off-gas grid locations.

For micro generation in existing buildings, it is recommended that the LDFs be updated to acknowledge the Permitted Development status now being granted for small scale technologies. Simple protocols should set out the planning information required in support of biomass boiler installations and other non-Permitted Development. The development of micro generation technologies in existing buildings could potentially be supported further through channelling S106 contributions for off-site allowable solutions.

Recommendation 6: Set out Permitted Development rights through Local Development Orders as part of the LDF for renewable energy and provide specific and clear planning protocols for those small-scale technologies not classed as Permitted Development

For standalone generation this study provides a good representation of the most relevant technologies, notably wind energy bio-energy (in its many forms). We recommend that the authorities further develop their existing planning guidance on these (and other relevant) technologies, providing clear criteria-based planning policies to simplify determination. In the

[54] *www.zerocarbonhub.org.uk*

case of wind energy we recommend that each authority provides indicative areas of potential within their boundary.

Recommendation 7: The authorities develop clear criteria-based planning policy for the key standalone generation technologies, notably wind energy and bio-energy projects

Recommendation 8: The authorities provide maps showing indicative areas of potential for wind energy development

Overall this study has assessed the potential for the renewable energy generation within each of the authorities. We do not recommend that absolute targets? are established because it is hard to see how they would be enforced, since the planning system only influences certain elements of the uptake of the potential resources. However, we recommend that the Local Development Frameworks of each authority include description of the estimated resources, the relative contribution from key technologies and the overall potential in comparison to future energy consumption and how this compares with national and regional benchmarks. We also recommended that this is monitored on an annual basis (see section below for further detail).

Recommendation 9: Publish, within each authority's LDF documents, summaries of the renewables energy resource potential and its potential long terms contribution in comparison to national and regional benchmarks

Recommendation 10: Conduct detailed annual monitoring of renewable energy uptake in each authority.

12.2 Recommendations for monitoring and enforcing targets

This study concludes targets for both authority-wide renewable energy implementation and the carbon standards for new development. Clearly each authority should have the necessary capability and resource to enforce and monitor performance against these targets. Planning Authorities are required, through AMR, the development of renewable energy on an annual basis and government is presently considering the inclusion of a National Indicator for renewable energy, which will firm up and extend the requirements placed upon the authority to report in the future.

12.2.1 Stand-alone generation and the existing buildings

With respect to the stand-alone generation or existing buildings each authority is not in a position to enforce targets. For existing building, other than for major refurbishment planning permission will not be required. For stand-alone generation, the Planning Authority can establish the planning framework, with ambitious targets, clear criteria based policies and the some degree of spatial identification of areas of suitability, where relevant, which can encourage delivery of stand-alone generation projects. However, the many commercial factors affecting the individual projects are also key determinants of whether schemes will come forward.

Planning authorities will, potentially, have greater influence over the implementation of stand-alone and existing building schemes, where they opt to establish direct links between new-build and so-called Allowable Solutions, by restricting their implementation within the same Authority. As demonstrated in this study, where we see a high degree of co-operation between neighbouring authorities, it may be appropriate to restrict implementation to a number of jurisdictions. The contribution of Allowable Solutions to the overall authority-wide uptake of the renewable energy is likely to be small since this is limited by the scale carbon offset required from new development, which in the context of the overall carbon emissions is small.

The Local Authority, rather than the Planning Authority, may also see it reasonable to take a leading role in the development of renewable energy initiatives, which will support delivery against the authority-wide targets

Monitoring of stand-alone generation should be straight forward since they require formal consent, e.g. planning and power connection, and they are therefore highly traceable. There are likely to only be a small number in any given year and so good information should easily be collated on an annual basis.

Monitoring of uptake in the existing built environment is the most difficult area. To give the slightly fuller definition, by the existing built environment, we mean the development of low or zero carbon energy generation projects in or around existing buildings and associated land, and not associated with new development on that land. So it covers a solar thermal panel on a house, a wind turbine in a school grounds through to an anaerobic digestion plant on a farm. Most installations do not require planning permission, although for some exceptions, e.g. for small wind turbines and biomass boilers (with certain height flues), this is a useful source of monitoring data. For electrical installations, data from electricity network companies (Distribution Network Operators) is useful since all such systems need to obtain a formal licence for connecting to the network. Thereafter, for thermal-based energy systems rely upon existing market data, expert opinion from stakeholders, e.g. Natural England for biomass systems, and suppliers.

12.2.2 New-build development

Enforcing of carbon standards on new-build development is crucial and difficult. The actual energy consumption within buildings is notoriously difficult to assess, because of the many dynamic components of buildings. Standardised tools such SAP and SBEM have been developed to support more consistent assessment of the energy consumption, but it remains complex. In addition, the analysis of the energy supply from Low and Zero Carbon technologies can be hard to assess; some technologies are greatly influenced by local specific circumstances, whilst for others, long term performance has tended to have been overstated, e.g. micro-wind and Air Sourced Heat Pumps. It has therefore proved problematic for developers to clearly represent how they will meet set standards, and in turn it is difficult for Development Control officers to interpret these standards.

Clarity with planning policy and guidance is critical. The key operational terms need to be well defined and described in sufficient detail. Also planning policy needs to call for standardised data, in a format that the Planning Authority can readily interpret to judge compliance, to ensure simple monitoring and reporting. Development Control officers should rely on on-site built information, and not just design information, ensuring that site inspection staff are adequately including this. Clearly the authority needs to be prepared to call-in poor performance and to take appropriate action to ensure the local development market understands that these standards are a key feature of building compliance. In addition, we recommend that authorities require the installation of on-site monitoring equipment capable of capture sufficient data to assess long-term building (carbon) performance against the stated claims during the development phase. This will help to inform future changes to compliance and assessment and future evolution of planning policy, e.g. through Supplementary Planning Guidance. The requirement to provide on-going monitoring could also be coupled with a financial bond requirement, which would be returned if the development achieves the long term performance standards proposed.

Recommendation 11: The authorities should consider the establishment of an expert enforcement assessments service, ideally servicing all authorities in the Derby HMA or similar collection of authorities. This would require dedicated staff resource or discrete budget if support were to be outsourced.

Recommendation 12: The authorities should provide training for Development Control officers to conduct sustainable energy assessments (unless authorities are relying on an external assessment service), and support information sharing with developers

Recommendation 13: Require suitable on-site carbon monitoring to be installed in major new development to enable assessment of long-term (carbon) performance compliance

Recommendation 14: Alongside **Recommendation 13** the authorities, should consider establishing a requirement for a financial bond returnable on achievement of long term (carbon) performance compliance

12.2.3 Key features effective monitoring and compliance

Table 58 and Table 59 summarise key elements of the discussion of monitoring and compliance above.

Table 58: Key features of effective enforcement

Enforcement		
New-build	***Existing build (and associated land)***	***Stand-alone***
• Very clear planning policy & guidance • Require standardised data for compliance • DC officers should rely on on-site built information, and not just design information. • Ensure building inspectors adequately include LZC investigation • Ensure DC staff are adequately trained or provide external expert service • Authority being willing to call-in poor performance (avoiding local perception that this aspect of compliance is less important. • Require long-term performance monitoring (perhaps with financial bond arrangement)	• Establish strong planning framework (ambitious targets, clear criteria based policies and some degree of spatial identification of areas of suitability) • Consider restricting Allowable Solutions within the Authority (or with neighbouring authority, where co-operation can play a role). • The Local Authority (rather than the Planning Authority) may be able to take a leading role in the development of renewable energy initiatives	

Table 59: Key features of effective monitoring

Monitoring		
New-build	***Existing build (and associated land)***	***Stand-alone***
• Use standard compliance data, from planning permission & Building Control processes • Require on-site monitoring, particularly for major development	• Monitoring of existing buildings is the most difficult area. • Collate data associated to those project requiring planning permission, e.g. for small wind turbines and biomass boilers (with certain height flues) • Collate data for electrical installation which require power connection agreements (from DNOs) • For remaining thermal-based energy systems collate market data from stakeholders, e.g. Natural England for biomass systems, and suppliers.	• Collate planning application information • Could be supplemented power network connection agreement data from Distribution Network Operators • Easy to collate on an annual basis and to then account for large proportion of the overall implementation
• *Conduct a detailed survey of renewable energy uptake, collating the information from planning applications (stand-alone generation, new build development and those small-scale projects in the existing built environment that are not classed as Permitted Development* • *Data can be collated from a number of key data sources: regional studies, RESTATS, ROC register, databases operated by renewable energy agencies such as the British Wind Energy Association and the Renewable Energy Association* • *It is anticipated that information covering small-scale projects, in particular, will be difficult to collate directly and hence it is recommend that an annual external survey is conducted, asking local active stakeholders to provide information on existing or planned systems. This in particular should seek to gain insight on the areas for which is it hard to gain information with any degree of confidence, e.g. thermal installations in existing build applications and installations on new developments where insufficient data has been provided by the developer or reported by Development Control. As this will be a survey (of a sample) the results will need to be statistically interpreted to provide results for the entire authority. In future the introduction of the Feed-in-tariff and the Renewable Heat Incentive may make data collection easier for smaller scale projects.*		

13 Erewash Borough and existing Nottinghamshire planning guidance

Erewash Borough is within Derbyshire but falls under the auspices on the Nottingham Core Housing Market Area (HMA). An earlier study[55] principally focused on carbon standards for new development was produced for the Nottinghamshire Energy Partnership (NEP), covering Erewash Borough.

There is some variance between the conclusions from the NEP study and the recommendations reported here.

From 2010-2013, both studies recommend similar carbon reduction from low and zero carbon energy sources: 20% (Camco) and 23.5% (NEP), however, the NEP targets relate to regulated and the unregulated emissions, consequently requiring a 50% increment on the Camco target overall. Both reports also recommend 10% for non-residential developments for the same period, but again the NEP standard is against regulated and unregulated emission. After this the recommendations vary in the number of area and the key differences as follows:

- Camco distinguishes between scales of development (applying stricter targets on major development, e.g. urban extensions, essentially bringing forward the zero carbon standard) and the NEP study does not
- Camco qualifies the zero carbon standard as 50% renewables, a total regulated carbon reduction of 70% and the offsetting via “allowable” solutions of the unregulated emissions, and the NEP study does not. NB. parts of the national policy guidance has evolved since the publication of the NEP report.
- Camco proposes to accelerate non-residential development, particular where it is of large scale and where it is part of a mixed use with a higher proportion of the residential development, and the NEP study does not, however, as a stated earlier the NEP target starts from a higher base point since it is set against the combination of the regulated and unregulated emissions.

It is also worth noting that the NEP report (and the underlying modelling) does not take account of new national policy, including the implementation of heat and power tariffs, because it pre-dates this. The financial benefits gained from these measures underpins the Camco case for accelerated targets. In other respects the NEP study appears to be comprehensive.

Clearly there is potential for some discontinuity between Erewash and neighbouring authorities, which ever set of target is chooses to adopt.

14 Non-Planning Delivery Mechanisms

14.1 Introduction

The section should also be read in conjunction with second report from the Cleaner, Greener Energy Study: Report 2 - Preparing for NI186 & Options for Local Authority power generation.

Planning policy alone will not be able to deliver renewable energy targets for the district, and a range of policy measures from supporting economic development to developing council-led energy projects will also be required.

[55] *Towards a countywide sustainable energy policy for Nottinghamshire: Consultation Draft, 2009*

It is proposed that a series of non-planning delivery support mechanisms also be put in place to encourage renewable energy development. The authorities are in a prime position to see the "big picture" of development in their area and would be well placed to coordinate the development of low carbon infrastructure between developments. This could be a brokering role or something more substantial. Given the challenges of meeting the likely target of 70% on site carbon compliance from 2016, the local authorities should continue to evaluate the potential for development of a low carbon community energy system with strong local authority involvement. This is particularly important for dense city centre schemes that may struggle establish biomass energy centres within the 'redline' of their planning application.

The authorities could go further in seeking to secure structural funds to enable the delivery of low carbon infrastructure and both capital funds and development funds to mitigate early stage development risk. Examples of this include European Regional Development Funds (that have been used to support the development of biomass CHP in the East of England), European Investment Bank investment (such as being sought for low carbon refurbishment of existing buildings in the South East) and Housing Growth Funds from CLG that may be able to support the development of low carbon infrastructure projects in support of growth.

Finally, the authorities should continue to demonstrate leadership by developing low carbon projects on council land and buildings and providing public buildings to be anchor projects for low carbon district heating schemes.

14.2 Coordinating the development of low carbon infrastructure

Managing and financing energy infrastructure for long term, phased development projects is extremely challenging. Large combined heat and power systems are a very cost effective low carbon strategy but they are difficult to establish in phased development. The Council needs to encourage developers to engage with expert entities in order to most effectively progress energy infrastructure within their developments. Key steps include:

- Planning & delivery of low carbon infrastructure should be carried out by an entity with long term interest in assets, such as an Energy Services Company (ESCO);
- Developers should be encouraged to engage early with ESCOs to facilitate a more effective approach to rolling out low carbon infrastructure;
- A Special Purpose Vehicle could be established to lead early client negotiation and mitigate risk before bringing proposals to market.

14.3 Financing low carbon infrastructure

14.3.1 Addressing investment challenge for communal infrastructure

A 'carbon investment fund' could help overcome the high upfront costs of energy infrastructure with the public sector providing the initial lump sum which is then repaid through developer's energy contributions. It would also provide a proactive response to the government's aspiration to support future carbon reductions through a variety of 'off-site' means, and ensure greater local control of delivery. A council (or joint council) operated ring fenced carbon investment fund could provide the upfront capital needed for financing large scale low carbon infrastructure such as CHP and district heating networks that can supply phased developments. The carbon investment fund would bring forward the value of staged developer contributions to early stage investment and would be reimbursed through payments from private sector developers as their developments are rolled out.

Key actions to overcome potential investment shortages include:

- A ring fenced carbon investment fund may be needed to bring forward value of staged developer contribution to early stage investment (initially financed by the public sector, but reimbursed through payments from private sector developers);
- Contractual complexities & residual uncertainties need to be managed through secured rights to sell energy & carbon benefits to customers into the future (ESCOs need to know the size of market for heat & power, timing of development, & price of future energy);
- Housing developer investment needs to be channelled towards shared off-site renewable developments and carbon investment fund could manage this role.
- Additional measures needed to mitigate early stage infrastructure development risk;
- Increased support for renewable energy development with mechanisms to contractually link off-site renewable energy infrastructure to new developments.

There are numerous contractual complexities which authorities could seek to mitigate through:

- working with developers and ESCOs to help secure rights to sell energy & carbon benefits to customers into the future
- ensuring that developers commit their buildings to the energy network with long term energy power & heat purchase contracts
- committing to long term power and heat purchase contracts with ESCOs for their own buildings so as to help establish low carbon networks

14.3.2 Special purpose vehicles / ESCOs

Each authority of group of authorities could also seek to establish an ESCO which works to install sustainable energy systems within both the new development and existing buildings. A special purpose vehicle could particularly help in rolling out CHP and district heating to existing communities, and thereby help realize the substantial carbon reductions that CHP can deliver to existing buildings.

The term 'Energy Services Company' or ESCO is applied to many different types of initiatives and delivery vehicles that seek to implement energy efficiency measures or local energy generation projects. ESCOs are established in order to take forward projects that the general energy market place is failing to deliver – and in this way ESCOs are designed to overcome the market and policy failures that affect local sustainable energy projects. There are a number of commercial ESCOs in existence which can support developers in designing, installing and operating a communal energy system for a new development. These ESCOs may either operate the energy system entirely themselves or enter into an arrangement with the developer and other entities in order to establish a new ESCO specifically designed to operate the energy infrastructure of the new development. These development-specific ESCOs tend to be arranged so that they are part, or wholly, owned by the residents of the development, and are therefore often referred to as 'community ESCOs'.

An ESCO can take many forms and be designed to progress small energy projects or large projects. Different ESCO applications include:

- Low carbon energy supply for a new development
- District heating or CHP scheme for social housing and / or other community and private sector customers
- Community renewables projects
- Retrofitting energy efficiency measures into buildings or energy management in buildings
- Pre-commercial energy development / projects and small bespoke projects.

Local authority ESCO activity would be controlled by the rules governing local authority borrowing, trading and charging for services and public procurement legislation. Key relevant legislation concerns the supply of utilities, and particularly electricity which is heavily regulated with complex licensing arrangements. Although a local authority-led ESCO might be entirely public sector owned and operate as a public body or quasi-public body, it may deliver its services through contracting private sector companies.

An ESCO or special purpose vehicle led by a public sector organisation may be needed if a low carbon project is not being taken forward by the market place due to financial or technological risks. An ESCO can be designed so as to manage these risks and enable a project to proceed. Nonetheless, a local authority or community group will only want to go down the path of establishing an ESCO if the energy project they wish to pursue is of no interest to an existing ESCO or if certain market risks cannot be reduced through other actions by the public sector, such as guaranteeing revenue streams for the heat or electricity generated by a renewable energy installation. Establishing an ESCO is not a simple short term task and the there are risks involved so it is important the need for an ESCO is fully established at the outset.

When developing the plans for a low carbon project, it is sensible to test the business case with energy experts and existing commercial ESCOs that have implemented similar projects. Nonetheless, the local community or local authority might want to maintain a significant degree of control over the project to ensure that it delivers certain social and environmental objectives, and therefore might wish to establish its own ESCO in partnership with an existing private sector ESCO which could undertake the technical implementation.

14.3.3 Council leading by example

Each authority or group of authorities has a great opportunity to directly progress renewable energy installations and decentralized energy generation by taking forward projects on its own buildings and land. As outlined earlier, the council could establish a local ESCO to help implement these low carbon energy projects.

The council has opportunities in terms of using its public buildings as an anchor heat load around which to establish CHP and a district heating network, establishing renewable energy installations on its buildings, such as PV and solar water heating, and even a power supply agreement with a wind turbine located within the district. Key actions include:

- Public sector buildings to provide ‘anchor loads’ for district heating and low carbon infrastructure networks so as to lead the way in installing CHP and developing heat networks;
- Renewable energy installations on council buildings, including PV, solar water heating and small to medium wind turbines;
- Identify a number of public sector demonstration projects across the district;
- Develop an action plan for implementing these demonstration projects

Appendix I: Glossary

AD	Anaerobic Digestion
AMR	Annual Monitoring Return
BERR	UK Department for Business, Enterprise & Regulatory Reform
CHP	Combined Heat and Power; also known as cogeneration
CHPA	Combined Heat and Power Association
CSH	Code for Sustainable Homes; also referred to as 'Code'
DECC	Department for Energy and Climate Change
ESCO	Energy Service Company; an ESCO ensures planning and delivery of low carbon infrastructure by an entity with long term interests in assets
FIT	Feed-in-Tariff
CGES	Cleaner, Greener Energy Study
GHG	Greenhouse Gas
GIS analysis	Geographic Information System analysis; includes data that is referenced by spatial or geographic coordinates
GSHP	Ground Source Heat Pump
kW	Kilowatt – unit of power. Can be expressed as thermal power (kW_{th}) and electrical power (kW_e)
kWh	kilowatt hour – unit of energy. Can be expressed as thermal energy (kWh_{th}) and electrical energy (kWh_e)
kWp	kilowatt peak – maximum power output of a photovoltaic cell, occurring with intense sunlight.
LDF	Local Development Framework
LZC	Low and Zero Carbon
MLSOA	Middle Layer Super Output Area;
MOD	Ministry of Defence
MSW	Municipal Solid Waste
$MTCO_2e$	Million Tonnes of Carbon Dioxide Equivalent
MW_e	Megawatts of electrical capacity
MW_{th}	Megawatts of thermal capacity
MWh	Megawatt-hour
ODT	oven dried ton; an amount of wood that weighs 2,000 pounds at zero percent moisture content[56]; common conversion unit for solid biomass fuel
PPS	Planning Policy Statement
PV	Photovoltaic (solar energy technology, producing electricity)
RHI	Renewable Heat Incentive
SHLAA	Strategic Housing Land Allocation Assessment
SHW / STHW	Solar Hot Water; also known as Solar Thermal Hot Water

[56] *http://www.encyclo.co.uk/define/oven%20dry%20ton*

Solar PV	Solar Photovoltaic
SPV	Special Purpose Vehicle; a legal entity set up for a specific ; purpose: to isolate financial risk from a lead organisation.
tCO_2/yr	tons of CO_2 per year
TCPA	Town and Country Planning Association
TWh	Terra Watt Hours ($1x10^{12}$ Watt Hours or $1x10^{9}$ Kilowatt Hours)

Appendix II: Growth projections – new development

Modelled build programme for residential developments (no. of dwellings)

Year (financial, beginning)	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
Amber Valley	510	510	510	510	510	510	510	510	510	510	510	510	510	510	510	510	510	510	510	510	**10,200**
Derby City	1,052	1,104	478	244	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	720	**14,398**
Erewash	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	**7,200**
South Derbyshire	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	**12,000**

Modelled build programme for non-residential developments (m^2 floor area)

Year (financial, beginning)	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
Amber Valley	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Derby City	59,458	59,458	59,458	59,458	59,458	59,458	59,458	59,458	59,458	59,458	59,458	59,458	18,406	18,406	18,406	18,406	18,406	18,406	18,406	18,406	**860,744**
Erewash	0	0	0	0	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	**200,000**
South Derbyshire	0	0	0	0	0	0	0	0	0	0	39,333	39,333	39,333	29,033	29,033	0	0	0	0	0	**176,065**

Appendix III: CO_2 emissions for the study area

The tables below illustrate CO_2 emissions sources for the study area, taken from DECC's NI186 data. The colour coding illustrates the categories which were assumed to relate to electricity, thermal, transport, and other energy sources.

Dataset name	Full Local CO_2 emission estimates, sector and fuel details
Year	2007
Release date	17/09/2009
Units	e stated

LARegionName	Year	A. Industry and Commercial Electricity	B. Industry and Commercial Gas	C. Industry and Commercial Large Gas Users	D. Industry and Commercial Oil	F. Industry and Commercial Solid fuel	G. Industry and Commercial Process gases	H. Industry and Commercial Wastes and biofuels	I. Industry and Commercial Non fuel	J. Industry Offroad	K. Diesel Railways	L. Agriculture Oil	M. Agriculture Solid fuel	N. Agriculture Non fuel	O. Domestic Electricity	P. Domestic Gas	Q. Domestic Oil	R. Domestic Solid fuel	S. Domestic House and Garden Oil	T. Domestic Products	U. A-Roads Petrol	V. A-Roads Diesel	W. Motorways Petrol	X. Motorways Diesel	Y. Minor Petrol	Z. Minor Diesel	ZA. Road Transport Other	ZB. LULUCF Emissions Soils & Deforestation	ZC. LULUCF Emissions Other	ZD. LULUCF Removals	**Grand Total**	**Population ('000s, mid-year estimate)**	**Per Capita Emissions (t)**	**Domestic emissions fom energy**	**Domestic per capita emissions (t)**
Amber Valley	2007	211	79	0	82	23	3	0	2	45	13	7	0	0	128	158	5	2	1	3	58	81	0	0	48	37	1	1	19	-16	**990**	**120.4**	**8.2**	**293**	**2.43**
Derby	2007	399	168	117	15	1	6	2	0	75	9	1	0	0	233	277	1	3	1	6	81	73	0	0	138	94	2	0	6	-4	**1,704**	**237.9**	**7.2**	**514**	**2.16**
Erewash	2007	155	53	0	26	22	0	0	0	30	7	2	0	0	110	140	2	1	1	3	39	43	34	96	36	25	1	0	8	-6	**829**	**110.7**	**7.5**	**253**	**2.28**
South Derbyshire	2007	177	80	0	114	50	5	0	2	26	10	8	0	0	93	101	8	3	1	2	92	153	0	0	27	24	1	2	28	-22	**985**	**91.2**	**10.8**	**205**	**2.25**

LARegionName	Year	Electrical	Thermal	Transport	LULUCF	Other	**TOTAL**
Amber Valley	2007	339	359	282	4	6	**990**
Derby	2007	632	591	472	2	7	**1,704**
Erewash	2007	265	247	311	2	4	**829**
South Derbyshire	2007	270	368	334	7	5	**985**

Key
- Electricity emissions source
- Thermal emissions source*
- Transport emissions source
- Other emissions source

* Assumptions have been made as to which categores constitute a thermal energy

Appendix IV: Energy projections

Amber Valley

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Existing residential - thermal (GWh)	948	938	927	917	907	897	886	876	866	856	846	835	825	815	805	794	784	774	764
Existing residential - electrical (GWh)	238	236	234	233	231	229	227	225	223	222	220	218	216	214	212	211	209	207	205
Existing non-residential - thermal (GWh)	1,068	1,062	1,057	1,053	1,049	1,044	1,040	1,035	1,031	1,026	1,022	1,017	1,013	1,009	1,004	1,000	995	991	986
Existing non-residential - electrical (GWh)	394	392	391	389	387	386	384	382	381	379	378	376	374	373	371	369	368	366	364
New build residential - thermal (GWh)	0.0	3.2	6.4	9.6	12.8	16.1	19.3	22.5	25.7	28.9	32.1	35.3	38.5	41.7	44.9	48.2	51.4	54.6	57.8
New build residential - electricity (GWh)	0.0	2.0	3.9	5.9	7.8	9.8	11.7	13.7	15.7	17.6	19.6	21.5	23.5	25.4	27.4	29.4	31.3	33.3	35.2
New build non-residential - thermal (GWh)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
New build non-residential - electricity (GWh)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Thermal energy (GWh/yr)	2,016	2,003	1,991	1,980	1,968	1,957	1,945	1,934	1,922	1,911	1,900	1,888	1,877	1,865	1,854	1,842	1,831	1,819	1,808
Electrical energy (GWh/yr)	632	631	629	628	626	624	623	621	620	618	617	615	614	612	611	609	608	606	605
Total (GWh/yr)	2,648	2,633	2,620	2,607	2,594	2,581	2,568	2,555	2,542	2,529	2,516	2,503	2,490	2,477	2,464	2,451	2,438	2,425	2,412

Derby City

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Existing residential - thermal (GWh)	1,625	1,607	1,590	1,572	1,555	1,537	1,520	1,502	1,484	1,467	1,449	1,432	1,414	1,397	1,379	1,362	1,344	1,327	1,309
Existing residential - electrical (GWh)	435	432	428	425	422	418	415	412	408	405	401	398	395	391	388	385	381	378	375
Existing non-residential - thermal (GWh)	1,208	1,201	1,196	1,191	1,186	1,181	1,176	1,171	1,166	1,161	1,156	1,151	1,146	1,141	1,135	1,130	1,125	1,120	1,115
Existing non-residential - electrical (GWh)	743	740	736	733	730	727	724	721	718	715	712	709	705	702	699	696	693	690	687
New build residential - thermal (GWh)	0.0	2.6	4.7	8.9	15.8	22.7	29.0	33.3	37.4	41.3	43.4	44.8	46.1	47.0	47.9	48.7	49.6	50.4	51.3
New build residential - electricity (GWh)	0.0	1.6	2.9	5.6	9.9	14.2	18.2	20.9	23.5	25.9	27.2	28.1	28.9	29.5	30.1	30.6	31.1	31.7	32.2
New build non-residential - thermal (GWh)	6.7	13.3	20.0	26.6	33.3	40.0	46.6	53.3	59.9	66.6	73.3	79.9	82.0	84.0	86.1	88.2	90.2	92.3	94.3
New build non-residential - electricity (GWh)	4.2	8.3	12.5	16.6	20.8	25.0	29.1	33.3	37.5	41.6	45.8	49.9	51.2	52.5	53.8	55.1	56.4	57.7	59.0
Thermal energy (GWh/yr)	2,840	2,824	2,810	2,799	2,790	2,781	2,771	2,759	2,747	2,736	2,722	2,707	2,688	2,668	2,649	2,629	2,609	2,590	2,570
Electrical energy (GWh/yr)	1,182	1,181	1,180	1,181	1,183	1,185	1,186	1,187	1,187	1,187	1,186	1,185	1,180	1,176	1,171	1,167	1,162	1,157	1,153
Total (GWh/yr)	4,021	4,005	3,991	3,979	3,972	3,965	3,957	3,946	3,934	3,923	3,908	3,892	3,868	3,844	3,820	3,796	3,771	3,747	3,723

Erewash

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Existing residential - thermal (GWh)	830	821	812	803	794	785	776	767	758	749	740	731	722	713	704	695	686	677	668
Existing residential - electrical (GWh)	205	204	202	201	199	197	196	194	193	191	189	188	186	185	183	181	180	178	177
Existing non-residential - thermal (GWh)	534	531	528	526	524	522	520	517	515	513	511	508	506	504	502	500	497	495	493
Existing non-residential - electrical (GWh)	289	288	287	286	285	283	282	281	280	279	277	276	275	274	273	271	270	269	268
New build residential - thermal (GWh)	0.0	3.2	5.2	7.3	9.3	11.3	13.4	15.4	17.4	19.4	21.5	23.5	25.5	27.6	29.6	31.6	33.7	35.7	37.7
New build residential - electricity (GWh)	0.0	2.0	3.3	4.5	5.8	7.1	8.3	9.6	10.8	12.1	13.4	14.6	15.9	17.2	18.4	19.7	21.0	22.2	23.5
New build non-residential - thermal (GWh)	0.0	0.0	0.0	1.4	2.8	4.2	5.6	7.0	8.4	9.8	11.2	12.6	14.0	15.4	16.8	18.2	19.6	21.0	22.4
New build non-residential - electricity (GWh)	0.0	0.0	0.0	0.9	1.8	2.6	3.5	4.4	5.3	6.1	7.0	7.9	8.8	9.6	10.5	11.4	12.3	13.1	14.0
Thermal energy (GWh/yr)	1,363	1,355	1,345	1,338	1,330	1,322	1,314	1,307	1,299	1,291	1,283	1,276	1,268	1,260	1,252	1,245	1,237	1,229	1,221
Electrical energy (GWh/yr)	495	494	492	492	491	490	490	489	488	488	487	486	486	485	485	484	483	483	482
Total (GWh/yr)	1,858	1,848	1,838	1,829	1,821	1,813	1,804	1,796	1,787	1,779	1,771	1,762	1,754	1,745	1,737	1,728	1,720	1,712	1,703

South Derbyshire

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Existing residential - thermal (GWh)	634	627	621	614	607	600	593	586	579	573	566	559	552	545	538	532	525	518	511
Existing residential - electrical (GWh)	173	172	171	169	168	167	165	164	163	161	160	159	157	156	155	153	152	151	149
Existing non-residential - thermal (GWh)	1,250	1,242	1,237	1,232	1,227	1,222	1,216	1,211	1,206	1,201	1,196	1,190	1,185	1,180	1,175	1,169	1,164	1,159	1,154
Existing non-residential - electrical (GWh)	330	328	327	326	324	323	322	320	319	317	316	315	313	312	311	309	308	306	305
New build residential - thermal (GWh)	0.0	4.3	8.6	12.9	17.2	21.5	25.8	30.1	34.4	38.6	42.9	47.2	51.5	55.8	60.1	64.4	68.7	73.0	77.3
New build residential - electricity (GWh)	0.0	2.5	5.1	7.6	10.1	12.7	15.2	17.7	20.3	22.8	25.4	27.9	30.4	33.0	35.5	38.0	40.6	43.1	45.6
New build non-residential - thermal (GWh)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.4	8.8	13.2	16.5	19.7	19.7	19.7	19.7	19.7	19.7
New build non-residential - electricity (GWh)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8	5.5	8.3	10.3	12.3	12.3	12.3	12.3	12.3	12.3
Thermal energy (GWh/yr)	1,884	1,874	1,866	1,859	1,851	1,843	1,835	1,828	1,820	1,816	1,813	1,810	1,805	1,801	1,793	1,785	1,777	1,770	1,762
Electrical energy (GWh/yr)	503	503	503	503	502	502	502	502	502	504	507	509	511	513	513	513	513	512	512
Total (GWh/yr)	2,387	2,377	2,369	2,361	2,353	2,345	2,337	2,329	2,321	2,321	2,320	2,319	2,316	2,314	2,306	2,298	2,290	2,282	2,274

Appendix V: Large wind

Based on the GIS constraints analysis, the district was subdivided into constrained zones, i.e. absolute constraints which would definitely prevent wind energy developments (illustrated in red in the map below) and less constrained zones, i.e. constraints which would not necessarily prevent wind energy developments, but which would rather result in consultations with the respective stakeholders (illustrated in map below).

One example of an absolute constraint would be those areas in the district covered by woodland as illustrated in the GIS map below.

An example for a less constrained zone (i.e. one that would not necessarily prevent wind energy developments in the district, but which would rather result in consultations with the respective stakeholders) is illustrated in the GIS map below which shows those areas in the study possibly affected by radar issues.

Air safeguarding zones are 'consultation zones', i.e. local planning authorities are required to consult the Civil Aviation Authority (CAA) upon any proposed developments with tall structures that would fall within safeguarding map-covered areas. Regarding this issue, the British Wind Energy Association's (BWEA) 'Wind energy and aviation guide' points out that the aviation community has "procedures in place to assess the potential effects … and identify mitigation measures". Furthermore, the guide states that while both wind energy and aviation are important to UK national interests, the 'overall national context' will be taken into account when assessing the potential impacts of a wind development upon aviation operations.

Therefore, the air safeguarding zones are only considered 'consultation zones' and were therefore excluded at this stage from the wind energy constraints analysis. Figure 66 illustrates these consultations zones which cover the majority of the study area.

However, despite air safeguarding zones not being constraints per se, they need to be addressed by developers early in the process of wind energy site development. It is, therefore, advised for developers to start a pre planning consultation process with the relevant aviation stakeholders early in the feasibility process.

Figure 65: Absolute constraint: Woodland areas in the district

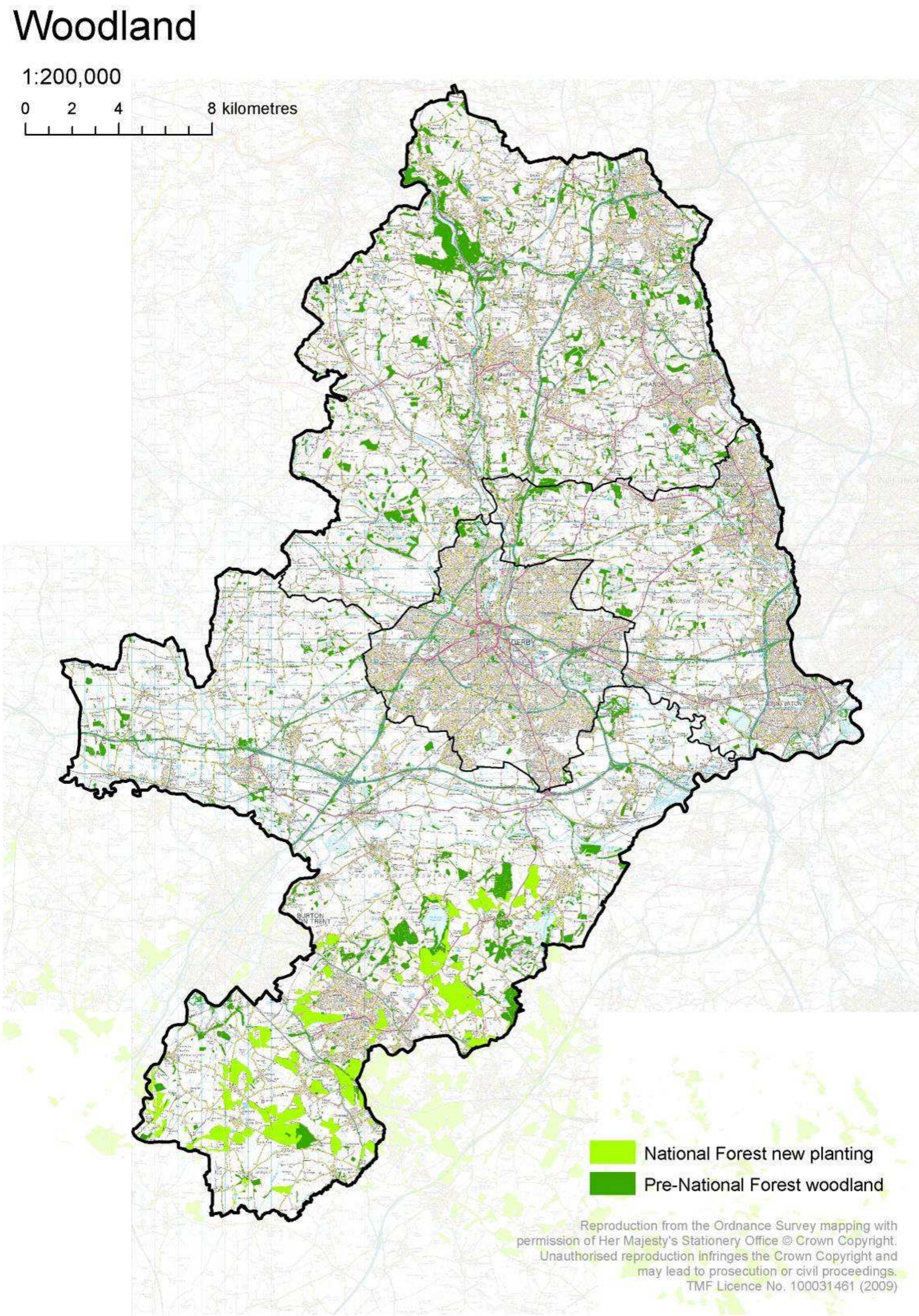
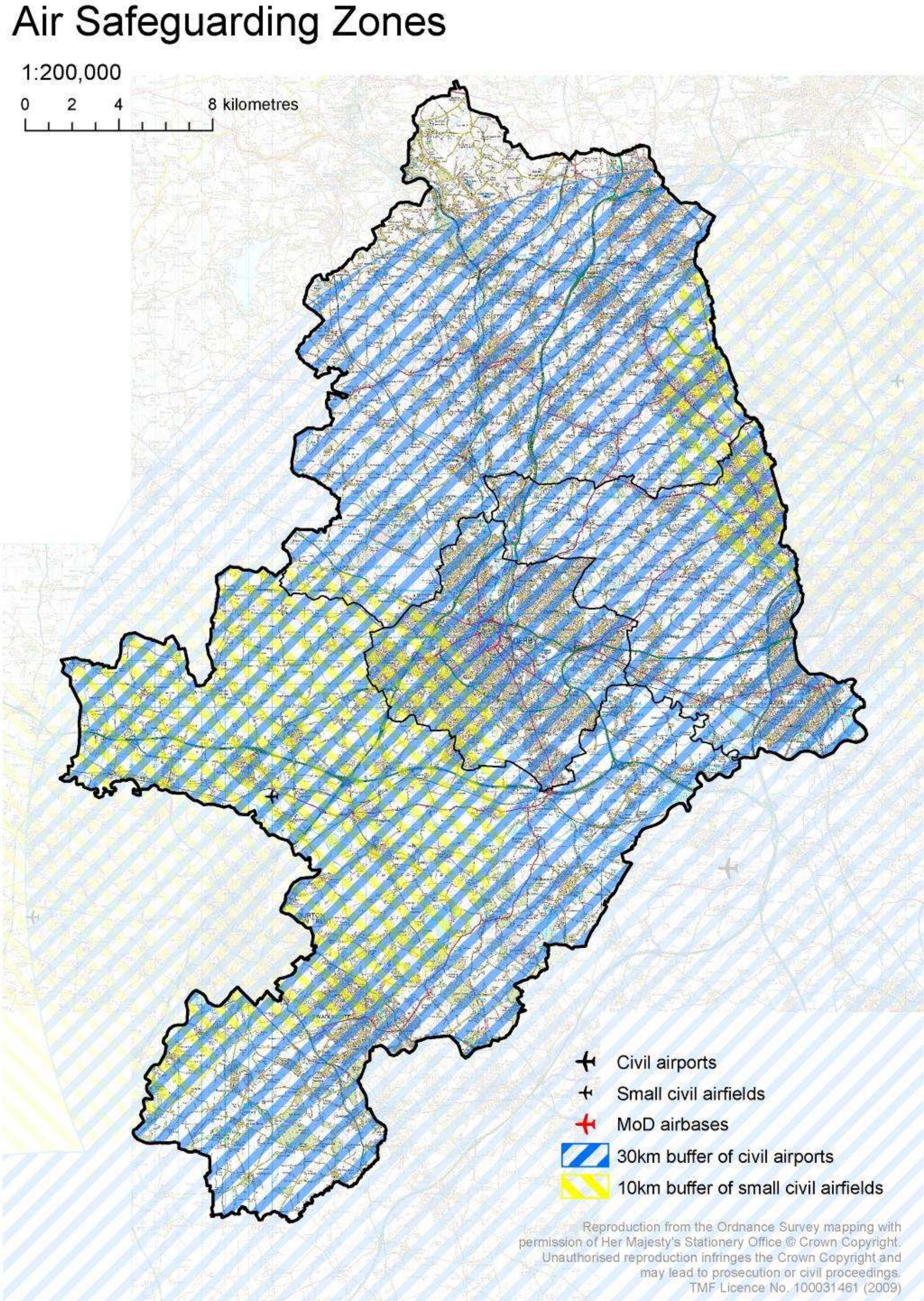


Figure 66: Consultative zones: Air Safeguarding Zones in the district



Distribution network within the district

When evaluating the feasibility of large renewable energy power generation, the distance from potential generation location sites to sections of the electricity network of suitable voltage is important. This does not account for capacity (thermal and load flow) characteristics of any particular connection point, which would need to be considered at the project level. Proximity to the electricity network (usually at the 11kV and 33kV level network) is a significant constraint to the viability of individual development sites.

The map below obtained from the Distribution Network Operator (DNO) shows the distribution network within the boundaries of the study area.

Whilst in general the distance to the next grid connection point is necessary for the assessment of potential opportunities from all types of renewable energy developments that feed into the grid, such a distribution network map does not give an indication about the possible availability of connection capacity. This issue would normally only be addressed on an individual scheme basis. Therefore, the map below is provided to illustrate the existing distribution network in the district, however, it has not been taken into account for the wind GIS constraints analysis undertaken as part of this study.

Other aspects important with respect to grid connection for renewable energy projects include:

- Local loads
    - The more similar the generator capacity is to the magnitude of local loads, the more cost effective the grid connection; this is due to the network usually being designed and sized for the local load in a certain area.
    - The annual charges that the generator incurs when using the distribution system can be saved if the generation can be connected into an existing customer network.
    - Using energy on-site can triple its value as this is the equivalent higher factor that suppliers charge for selling energy in comparison to purchasing energy.

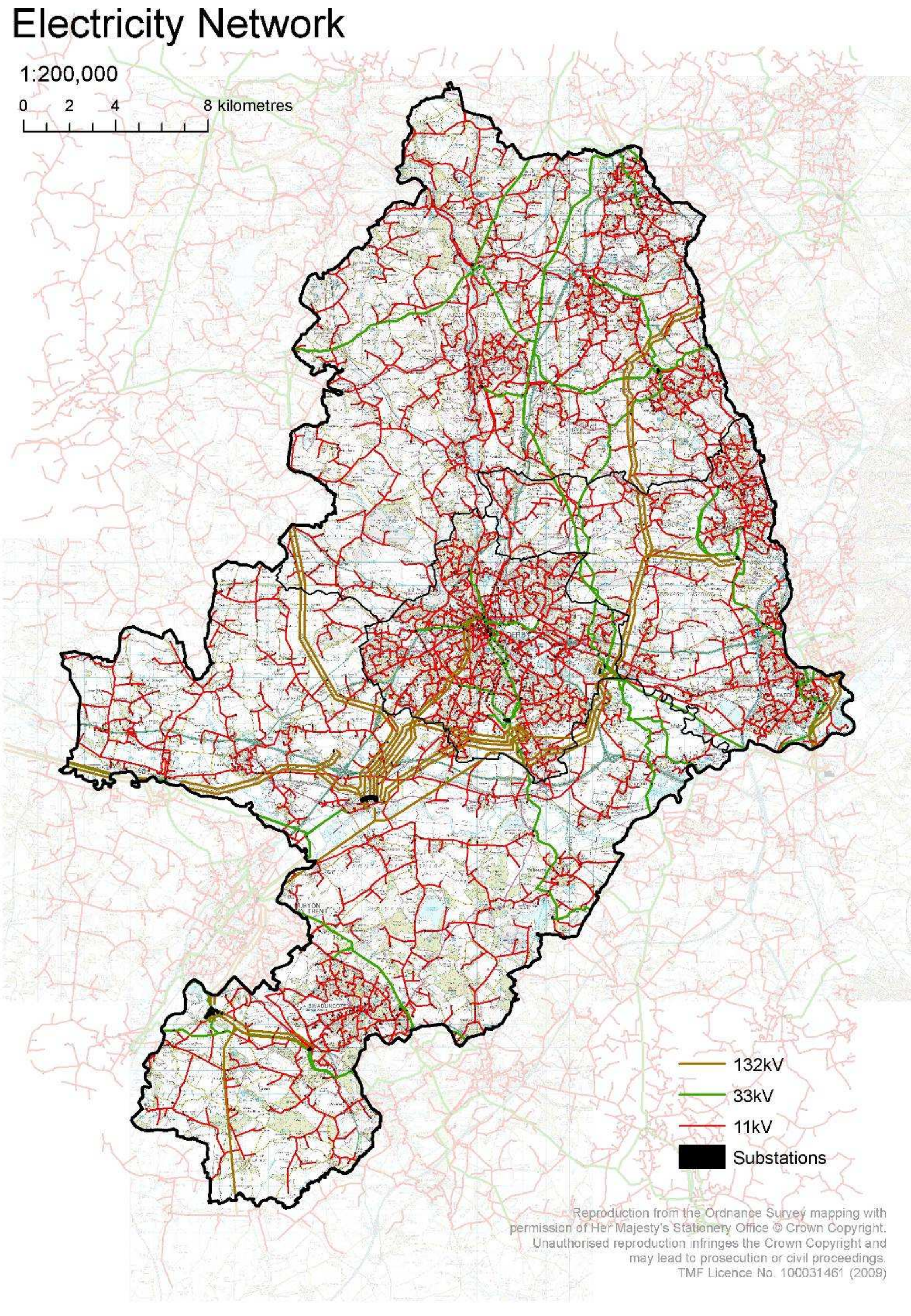
- Voltage
    - If the generating voltage differs from network voltages, transformers might be required which in turn, however, can increase connection costs significantly.
    - Purchasing additional equipment is generally only worth it if losses on the cables are significant; if that's not the case, connection should happen at the generator voltage.
    - Determining the most suitable connection voltage for various generator capacities can be done by applying the following rule of thumb:
        - Less than 3.6kW – 240V (1-phase)
        - Less than 400kW – 400V (3-phase)
        - Between 400kW and 8MW – 11kV
        - Over 8MW – EHV connection (33kV or higher)

- Switchgear and ratings
    - Extending an existing switchboard (used for isolation of electrical equipment) might be less cost effective than connecting into a cable with a ring main unit – depending on required civil works and distance from generation.

- Regulatory requirements
    - When connecting renewable generation to the distribution network, there are two Electricity Networks Association guidelines, i.e. G83 and G59.
    - G83 is for very small embedded generators (up to 16A per phase), whereas G59 is for medium-sized embedded generators, i.e. up to 5MW, connection up to 20kV.

- Connection applications
    - Generators installed under the G59 guidelines -or multiple smaller generators-, require the submission of a generator connection application to the local distribution network operator (DNO). Within a maximum of 90 days upon receipt of the application, the DNO will assess the effect of the proposed generation on the remaining network.
    - Upon successful detailed assessments, a connection offer will be made by the DNO indicating the non-contestable work and costs (to be undertaken by the DNO) and contestable work (to be undertaken by either the DNO or an accredited third party) and their respective timeframes.

Figure 67: Distribution network in the study area



Appendix VI: Small wind – background notes

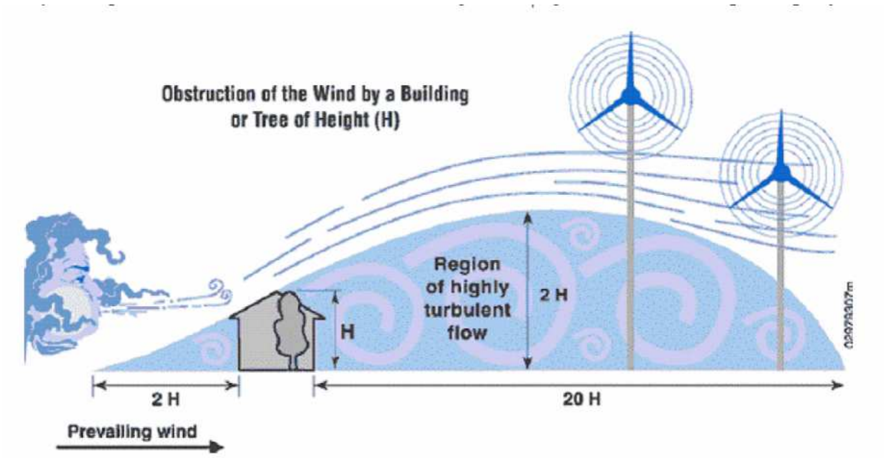
The assessment of the energy potential for small scale wind is based on the most likely application for such turbines:

- The windiest locations are likely to be farms, which have little built environment surrounding them.
- It is assumed that the public sector will attempt to accelerate the uptake of renewables, therefore schools are publicly owned buildings which are most likely to have sufficient space to install a wind turbine.
- Industrial parks and retail parks are more likely to be on the edge of towns, and will not generally be adjoining residential areas. They may also have both the space and energy demand to make a small scale wind turbine a reasonable option.

When considering small wind energy schemes - which can also include building-mounted wind turbines, the following aspects need to be taken into consideration:

- Surrounding obstacles create turbulence which a) decreases a wind turbine's output and b) increases both the load and vibration effects on the building / site. These turbulences are obviously mostly prevailing in urban areas, making these potential sites often less suitable for small wind turbines than areas in rural regions, such as farm houses, small rurally located hamlets or villages or locations on the edge of larger settlements. The figure below illustrates the turbulences that obstacles, such as buildings or trees create which can result in much lower wind speeds for small-scale wind turbines.

Figure 68: Effects of wind shadowing (Source: www.awea.com)



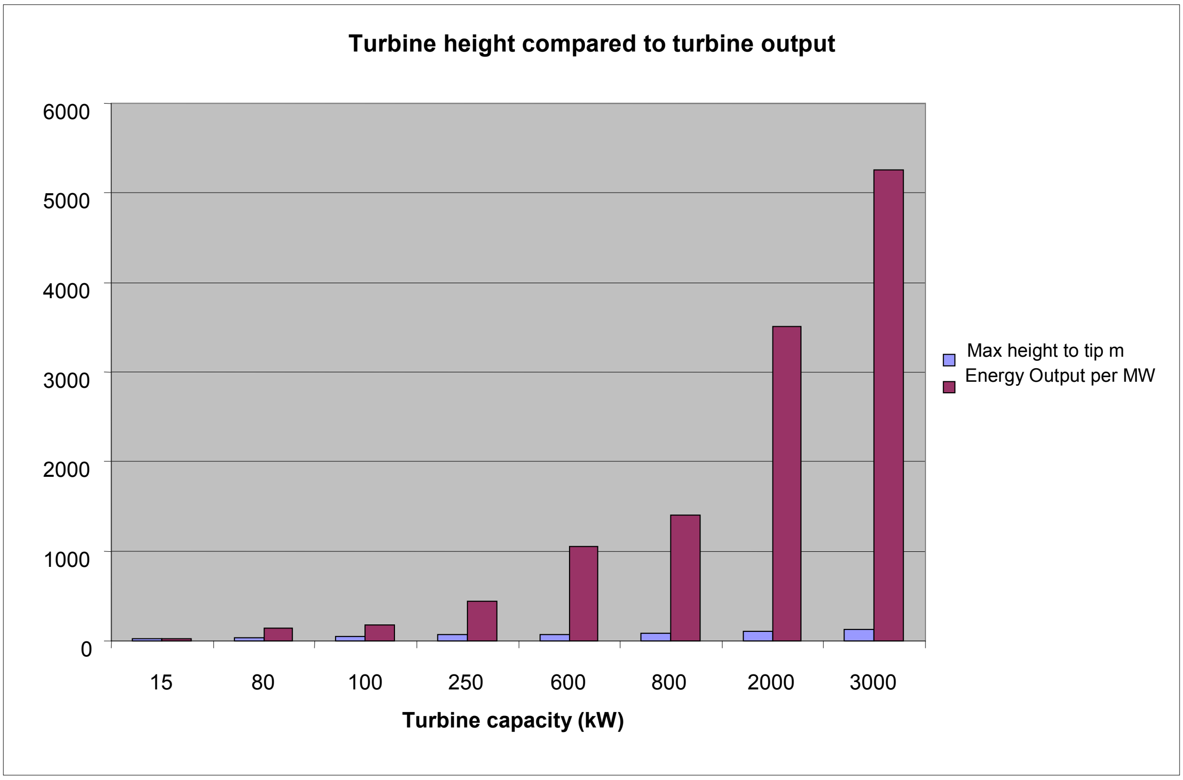
- Wind imposes considerable dynamic loads on a roof-mounted wind turbine and conventional buildings are not designed to deal with these, so care must be taking when planning installations.
- It is much easier to install a wind turbine on a new building instead of retrofitting it to an existing building (structural engineers must be consulted in both cases).
- Access for inspection and maintenance is important for building-mounted wind turbines.
- The electricity for small scale turbines can either link to the grid or charge batteries, the former being more cost effective.
- The availability of grants (such as through the Low Carbon Buildings Programme[57]) for the installation of microgeneration technologies, can increase the affordability of the development of small wind

[57] *http://www.lowcarbonbuildings.org.uk/home/*

schemes for potential target groups, such as community groups, schools, supermarkets, council buildings, industrial estates or other large commercial customers.

- At present national planning legislation requires that planning permission is obtained for domestic wind turbines and similar small wind energy installations, which do not benefit from Permitted Development Rights: different conditions and limitations apply depending on whether a small-scale turbine is fixed to a house, on a wall, to the roof or whether it is a free standing turbine. The main criteria that local authorities would take into consideration include turbine height; location, age and impact on the host building; shadow flicker; noise; interference with electromagnetic interference; highway safety; visual impact; environmental considerations and site access[58].
- With respect to potential sites for small-scale wind, the technology is particularly suitable for farms, but also for municipal buildings such as community centres or schools (above all in rural areas where the effects of wind shadowing would be smaller than in urban areas and where schools usually have more land to place the turbine on). An additional advantage of these “community” sites would support education. However, for the purpose of this study, only farms under 5ha and over 5ha have been considered.
- There is a significant difference in terms of electricity output based on the height and capacity of a turbine. The figure below illustrates that the energy output per MW installed grows exponentially with increasing turbine height.

Figure 69: Turbine height compared to turbine output



Technical and Development Scenario for small-scale wind

The following aspects have been applied to determine the Resource Potential of small-scale wind in the district:

- An industry-wide average capacity factor of 20% has been assumed for each small-scale turbine

[58] *http://www2.valeroyal.gov.uk/internet/vr.nsf/AllByUniqueIdentifier/DOCC3B2E8B8DEF3AD2380257260005AB960*

- Building integrated wind turbines has not been considered in this study, as they are currently not well suited to built up areas, as low output, noise and vibration issues still need to be resolved.

Developing wind

In turning the technical resource of wind energy into a practical target, the important issues to consider are:

- Developing a business strategy in order to incentivise wind developers to operate within the district
- Bringing together landowners and wind developers - when approaching landowners to incentivise them to have large scale turbines on their land, developers will need to offer return in the form of an annual rent
- Bringing together housing developers and wind developers
- Considering the following key elements within the implementation plan:
    - In view of high fixed cost related to wind farm development in general, the greater the number of turbines at one site the more interesting for wind developers
    - When choosing specific sites, financial viability can be increased through proximity of the wind farm to new developments or to high constant electricity demand (industrial).

Appendix VII: Biomass – theoretical resource & analysis assumptions

TECHNICAL RESOURE AT PRESENT – PRIMARY ENERGY

Local Authority	PRIMARY ENERGY (MWh)								
	MSW		Agriculture						
	Paper&card +wood waste	Green waste + Food/kitchen waste	Animal manure - wet	Animal manure -dry	Straw	Energy crops	Sawmill residues	Forestry residues	C&D + C&I wood waste
Amber Valley	27,787	37,034	15,238	2,407	19,777	27,611	0	2,247	69,588
Erewash	22,575	44,156	2,670	25	11,317	13,155	0	439	59,274
South Derbyshire	16,694	42,530	15,578	11,153	59,651	71,553	19,107	1,761	49,975
Derby	67,625	128,711	0	0	0	0	0	0	94,629
Total	**134,681**	**252,431**	**33,487**	**13,585**	**90,745**	**112,319**	**19,107**	**4,447**	**273,466**

TARGET POTENTIAL - PRIMARY ENERGY

PRIMARY ENERGY (MWh) - Total study area										
Year	MSW		Agriculture			Energy crops	Sawmill residues	Forestry residues	C&D + C&I wood waste	Total
	Paper&card+ wood waste	Green waste + Food/kitchen waste	Animal manure - wet	Animal manure - dry	Straw					
2010	7,482	43,195	3,349	6,793	15,244	0	2,293	222	15,193	93,770
2011	11,429	67,361	6,362	8,151	17,362	0	2,614	534	37,137	150,951
2012	15,478	91,662	9,376	9,510	19,481	0	2,935	845	59,082	208,369
2013	19,629	116,098	12,390	10,868	21,600	3,370	3,256	1,156	81,027	269,394
2014	23,882	140,670	15,404	12,227	23,719	6,739	3,577	1,468	102,972	330,657
2015	98,986	165,376	18,418	13,585	33,035	11,232	3,898	1,779	124,917	471,225
2016	98,406	175,386	21,431	13,585	33,884	15,725	4,219	2,313	146,862	511,811
2017	97,826	185,532	24,445	13,585	34,733	20,217	4,540	2,846	168,806	552,531
2018	97,246	195,813	27,459	13,585	35,582	24,710	4,861	3,380	190,751	593,387
2019	96,666	206,229	30,473	13,585	36,431	29,203	5,182	3,914	212,696	634,378
2020	96,086	216,779	33,487	13,585	37,281	33,696	5,503	4,447	212,696	653,560
2021	95,415	227,465	33,487	13,585	37,281	49,420	5,819	4,447	212,696	679,616
2022	94,745	238,286	33,487	13,585	37,281	65,145	6,136	4,447	212,696	705,808
2023	94,074	249,243	33,487	13,585	37,281	80,870	6,452	4,447	212,696	732,134
2024	93,404	260,334	33,487	13,585	37,281	96,594	6,768	4,447	212,696	758,596
2025	92,733	271,560	33,487	13,585	37,281	112,319	7,085	4,447	212,696	785,193

PRIMARY ENERGY (MWh) - AMBER VALLEY										
Year	MSW		Agriculture			Energy crops	Sawmill residues	Forestry residues	C&D + C&I wood waste	Total
	Paper&card+ wood waste	Green waste + Food/kitchen waste	Animal manure - wet	Animal manure - dry	Straw					
2010	1,544	7,407	1,524	1,204	3,377	0	0	112	3,866	19,034
2011	2,358	9,685	2,895	1,444	3,793	0	0	270	9,450	29,895
2012	3,193	11,990	4,267	1,685	4,209	0	0	427	15,035	40,806
2013	4,050	14,323	5,638	1,926	4,625	828	0	584	20,619	52,594
2014	4,927	16,684	7,009	2,166	5,042	1,657	0	742	26,203	64,430
2015	20,423	19,073	8,381	2,407	7,090	2,761	0	899	31,787	92,821
2016	20,303	21,138	9,752	2,407	7,202	3,866	0	1,169	37,371	103,209
2017	20,183	23,232	11,124	2,407	7,314	4,970	0	1,438	42,956	113,624
2018	20,064	25,353	12,495	2,407	7,426	6,074	0	1,708	48,540	124,067
2019	19,944	27,502	13,867	2,407	7,539	7,179	0	1,978	54,124	134,539
2020	19,824	29,679	15,238	2,407	7,651	8,283	0	2,247	54,124	139,453
2021	19,686	31,883	15,238	2,407	7,651	12,149	0	2,247	54,124	145,385
2022	19,548	34,116	15,238	2,407	7,651	16,014	0	2,247	54,124	151,345
2023	19,409	36,376	15,238	2,407	7,651	19,880	0	2,247	54,124	157,333
2024	19,271	38,665	15,238	2,407	7,651	23,745	0	2,247	54,124	163,348
2025	19,133	40,981	15,238	2,407	7,651	27,611	0	2,247	54,124	169,392

PRIMARY ENERGY (MWh) - EREWASH										
	MSW		Agriculture							
Year	Paper&card+ wood waste	Green waste + Food/kitchen waste	Animal manure - wet	Animal manure - dry	Straw	Energy crops	Sawmill residues	Forestry residues	C&D + C&I wood waste	Total
2010	1,254	7,425	267	12	1,908	0	0	22	3,293	14,181
2011	1,916	11,807	507	15	2,166	0	0	53	8,049	24,514
2012	2,594	16,213	748	17	2,425	0	0	83	12,806	34,887
2013	3,290	20,641	988	20	2,684	395	0	114	17,563	45,694
2014	4,003	25,091	1,228	22	2,942	789	0	145	22,319	56,541
2015	16,592	29,564	1,469	25	4,106	1,315	0	176	27,076	80,323
2016	16,495	31,242	1,709	25	4,203	1,842	0	229	31,832	87,576
2017	16,397	32,943	1,949	25	4,300	2,368	0	281	36,589	94,853
2018	16,300	34,666	2,190	25	4,397	2,894	0	334	41,345	102,151
2019	16,203	36,412	2,430	25	4,494	3,420	0	387	46,102	109,473
2020	16,106	38,180	2,670	25	4,591	3,946	0	439	46,102	112,060
2021	15,993	39,972	2,670	25	4,591	5,788	0	439	46,102	115,581
2022	15,881	41,785	2,670	25	4,591	7,630	0	439	46,102	119,124
2023	15,769	43,622	2,670	25	4,591	9,471	0	439	46,102	122,690
2024	15,656	45,481	2,670	25	4,591	11,313	0	439	46,102	126,278
2025	15,544	47,363	2,670	25	4,591	13,155	0	439	46,102	129,889

PRIMARY ENERGY (MWh) - SOUTH DERBYSHIRE										
	MSW		Agriculture							
Year	Paper&card+ wood waste	Green waste + Food/kitchen waste	Animal manure - wet	Animal manure - dry	Straw	Energy crops	Sawmill residues	Forestry residues	C&D + C&I wood waste	Total
2010	927	6,478	1,558	5,577	9,959	0	2,293	88	2,776	29,656
2011	1,417	11,497	2,960	6,692	11,403	0	2,614	211	6,787	43,580
2012	1,919	16,532	4,362	7,807	12,847	0	2,935	334	10,797	57,533
2013	2,433	21,584	5,764	8,923	14,291	2,147	3,256	458	14,807	73,662
2014	2,960	26,653	7,166	10,038	15,735	4,293	3,577	581	18,818	89,821
2015	12,270	31,739	8,568	11,153	21,838	7,155	3,898	704	22,828	120,153
2016	12,198	32,980	9,970	11,153	22,478	10,017	4,219	915	26,839	130,769
2017	12,126	34,237	11,372	11,153	23,118	12,880	4,540	1,127	30,849	141,402
2018	12,054	35,512	12,774	11,153	23,758	15,742	4,861	1,338	34,859	152,051
2019	11,982	36,803	14,176	11,153	24,398	18,604	5,182	1,549	38,870	162,717
2020	11,910	38,111	15,578	11,153	25,039	21,466	5,503	1,761	38,870	169,390
2021	11,827	39,435	15,578	11,153	25,039	31,483	5,819	1,761	38,870	180,965
2022	11,744	40,776	15,578	11,153	25,039	41,501	6,136	1,761	38,870	192,557
2023	11,661	42,134	15,578	11,153	25,039	51,518	6,452	1,761	38,870	204,166
2024	11,578	43,509	15,578	11,153	25,039	61,536	6,768	1,761	38,870	215,791
2025	11,494	44,901	15,578	11,153	25,039	71,553	7,085	1,761	38,870	227,434

PRIMARY ENERGY (MWh) - DERBY										
	MSW		Agriculture							
Year	Paper&card+ wood waste	Green waste + Food/kitchen waste	Animal manure - wet	Animal manure - dry	Straw	Energy crops	Sawmill residues	Forestry residues	C&D + C&I wood waste	Total
2010	3,757	21,885	0	0	0	0	0	0	5,257	30,899
2011	5,739	34,372	0	0	0	0	0	0	12,851	52,962
2012	7,772	46,927	0	0	0	0	0	0	20,445	75,144
2013	9,856	59,550	0	0	0	0	0	0	28,038	97,445
2014	11,992	72,241	0	0	0	0	0	0	35,632	119,865
2015	49,702	85,000	0	0	0	0	0	0	43,226	177,928
2016	49,411	90,026	0	0	0	0	0	0	50,819	190,256
2017	49,120	95,120	0	0	0	0	0	0	58,413	202,653
2018	48,828	100,282	0	0	0	0	0	0	66,007	215,118
2019	48,537	105,512	0	0	0	0	0	0	73,601	227,650
2020	48,246	110,810	0	0	0	0	0	0	73,601	232,656
2021	47,909	116,175	0	0	0	0	0	0	73,601	237,685
2022	47,573	121,609	0	0	0	0	0	0	73,601	242,782
2023	47,236	127,110	0	0	0	0	0	0	73,601	247,946
2024	46,899	132,679	0	0	0	0	0	0	73,601	253,179
2025	46,563	138,316	0	0	0	0	0	0	73,601	258,479

BIOMASS ANALYSIS ASSUMPTIONS

Forestry residues

- A GIS screening process has been used to identify the areas of woodland commercially managed or that have the potential to be under commercial management, the procedure followed is outlined below:

  1. Extract all woodland areas from OS Mastermap.

  2. Exclude all Ancient Woodland (AW) and Ancient Semi-natural Woodland (ASNW). No or minimal intervention will be the usual treatment for these woodlands, normally limited to pest and disease control and to favour selected trees. None of these treatments will generate residues in quantities that make extraction economically viable.

  3. Exclude all National Forest woodlands. The majority of the existing mature woods within the National Forest are AW or ASNW and therefore ruled out in the previous step. New planting over the past 10 years has focused on broadleaves. Low growth rates of broadleaves in early stages, wider initial spacing typically chosen when afforesting with broadleaves and response to light of most broadleaved species, make very unlikely that any thinnings yielding significant amount of residues will be carried out over the study period.

  4. Exclude all woods under 2 hectares. It’s very unlikely these are managed commercially and even if they were, the low concentration of residues would not make extraction practical.

- It is assumed that yield and ratio of residues to volume of merchantable timber for Scots pine YC10 are representative of all conifers in the region. Similar assumptions are made that Birch YC6 are representative of all broadleaves in the region. Volume of residues generated per hectare have been derived using parameters from Cannel and Dewar (1996) and Forestry Commissions Yield Tables (1981), assuming rotations of 70 for Scots pine and 60 for Birch. Total volume of residues generated from thinnings over rotation and final harvest is divided by rotation to derive annual oven-dried tonnes (ODT/year). Therefore, it is assumed that all forestry age classes are represented equally.
- Slow initial uptake is assumed, to account for machinery and labour required and incorporation of residues extraction in forest management plans: 5% by 2010; 40% by 2015; and 100% by 2020.

Energy Crops

- The E4tech report models 4 case scenarios based on data from the Refuel project, all 4 scenarios consider that land available for energy crops will increase: area of arable land available for energy crops increasing from 605 kha in 2008 to 963-1334 kha in 2030, and pasture area from 290 kha in 2008 to 1200 kha in 2030. However, for this study it has been considered appropriate to assume that land available for energy crops will remain constant over time and it is only equivalent to arable land currently out of production (i.e. no proportion in pasture land considered available), since:
  - The area of arable land not in production (the equivalent of bare fallow and un-cropped set-aside land in 2007) has fallen steeply, by over 62% between 2007 and 2008, (Defra Agricultural survey, 2008)
  - Defra abolished set aside land in 2008.
  - Current trends of expansion of organic agriculture and farming, which will require wider areas to obtain the same production volumes.
  - There are many environmental restrictions that make very unlikely the conversion of most pastures to energy crops (potentially significant loss of soil carbon, run-off and biodiversity to name a few)
- Very slow initial uptake is assumed, to account for required specialised machinery and labour, subsidy schemes, and delay of fist harvest (3 years for willow and 5 years for poplar): 10% by 2015, 30% by 2020 and 100% by 2025.

Sawmill residues

- The competing uses are the panel board industry, paper and pulp, exports and fencing. Currently, 12% of co-products are sold for bio-energy (Forestry Commission statistics 2009[59]). It is assumed that availability for bio-energy will increase up to 30% of current total resource by 2020, on the basis that:
    - Softwood availability in the United Kingdom continues to increase over the next 15 years from 12 million m^3 in the period 2007-2011, peaking in the period 2017-2021 at just over 14 million m^3 (Forestry Commission 2006[60]).
    - Increasing recycling rates of waste wood from the construction and other industries will supply part of panel board industry and therefore release part of the sawmill resource
- Immediate uptake achievable as soon as the resource is made available
- Output of the sawmills in the study area remain constant.

Crop residues - Straw

- The availability factor of 35% for cereal straw (Wheat and Barley account for over 95% of land dedicated to cereals in the UK) is derived from the UK Biomass Strategy: "The UK cereal straw (Wheat and Barley) resource is significant (9-10 mt per annum) but much of this is recycled to livestock and much of the rest is ploughed into soil (it has a resource value as a fertiliser and organic matter supplement). It is estimated, that up to 3m tonnes could be made available in the long term without disrupting livestock use/buying costs". Supported by Biomass Energy Centre: "Most Barley straw is used for animal bedding and feed, and figures for Winter wheat straw suggest that in the UK around 40% is chopped and returned to the soil, 30% used on the farm (for animal bedding and feed), and 30% is sold". Wheat accounts for 70% of all land dedicated to cereals.
- It is assumed that up 60% of the straw available for bio-energy can be recovered from the filed. To account for technology limitations.
- Uptake assumption for cereal straw: 50% by 2010, 100% by 2015
- Uptake assumptions from DECC/E4tech for oil seed rape: 10% of this can be collected now, 20% in 2010, 50% in 2015, and 100% from 2020 in all scenarios. The uptake rate is relatively slow, as oilseed rape straw is not currently extracted in large quantities and is more difficult to handle than wheat and barley straw.
- Wheat parameters (yield, moisture and NCV) have been used for cereal straw since practically all cereal straw will come from wheat. Wheat accounts for 70% of all land dedicated to cereals.
- Area of land dedicated to cereal and rape seed oil assumed to remain constant over time.

Agricultural animal waste

- 15% of theoretical resource is excluded to represent technical limitations of manure collection and handling losses.
- Extraction rates were considered to be (E4tech):

  For dry poultry litter 18% now, 50% in 2010 and 100% in 2015.

  For wet manures, the rate was assumed to be lower, at 1% now, 10% in 2010, 50% in 2015 and 100% in 2020

  High uptake rates proposed by E4tech (especially for dry poultry litter) and no competing demands can be backed by the following facts:

[59] *Forestry Commission statistics. 2009. http://www.forestry.gov.uk/website/forstats2009.nsf/TopContents?Open&ctx=92B74B2CCD24A56C8025731B0053FB26*
[60] *New forecast of softwood availability (Forestry Commission 2006). http://www.forestry.gov.uk/website/ForestStats2006.nsf/byunique/ukgrown.html*

- Since digestate from AD has a higher nutrient value than manure, farmers are likely to provide manure at zero cost in exchange for returned digestate – which needs to be spread to land (E4tech).
- Although much poultry litter has been spread on the land as a fertilizer, there has been evidence that when spread on land for cattle grazing or for hay or silage, this can cause botulism in cattle and the practice has been urged against by Defra. Defra advises either incineration or deep ploughing or burial.
- Animal slurry is widely used as a fertilizer and there are a number of methods to spread it on land, though recent concerns about loss of ammonia to the air means that Defra now advises against broadcast spreading[61]

- As implied by uptake assumptions above, use of manure as fertiliser has not been considered has a competing demand.
- Number of livestock to remain constant over time.

Waste currently land-filled

- For this study, slow growth of waste arisings (0.75% annually over current levels) has been assumed. It is acknowledged by a number of sources (Waste Strategy for England 2007[62], ERM[63] and E4Tech reports) that there is great uncertainty regarding future arisings. E4tech assumes static, waste strategy suggests four scenarios (one of them no growth, 3 of them little growth with maximum of 2% a year).
- For paper and card recycling is supplied first. Overall recycling targets in the waste strategy for household waste assumed to be applicable to individual waste components. This is supported by EU directive that sets specific recycling targets for 2020 of 50% for glass, plastic, paper and metals.
- Maximum recovery levels are set based on best performance across Europe, under the basis that if it has been achieved elsewhere in Europe, it can theoretically be achieved in the study area. These are taken from Table B1.2 of the ERM report.
- Separability of waste will increase linearly to reach maximum recovery levels in 2025/26.
- Initial recovery potential = 5% over recycling rate.
- Alternative disposal routes for kitchen waste and green waste e.g. composting are not considered as competing demand.
- The Waste Strategy for England 2007 sets actions to stimulate energy recovery of wood waste rather than recycling. Therefore, all collectable wood waste over current recycling rates assumed to be available for energy. From the waste strategy it is clear that wood has relatively low embodied energy (energy consumed in extraction) but high calorific value. Though for some kinds of wood waste re-use or recycling are better options, use as a fuel generally conveys a greater greenhouse gas benefit than recovering the material as a resource (and avoiding primary production).

Green waste currently diverted

- Composting is not considered a competing demand. However, an uptake period of 5 years is assumed.

[61] •Biomass energy centre http://www.biomassenergycentre.org.uk/portal/page?_pageid=75,17976&_dad=portal&_schema=PORTAL
[62] Waste strategy for England 2007. http://www.defra.gov.uk/environment/waste/strategy/strategy07/index.htm
[63] Carbon Balances and Energy Impacts of the Management of UK Wastes (ERM 2006). http://randd.defra.gov.uk/Document.aspx?Document=WR0602_4746_FRA.pdf

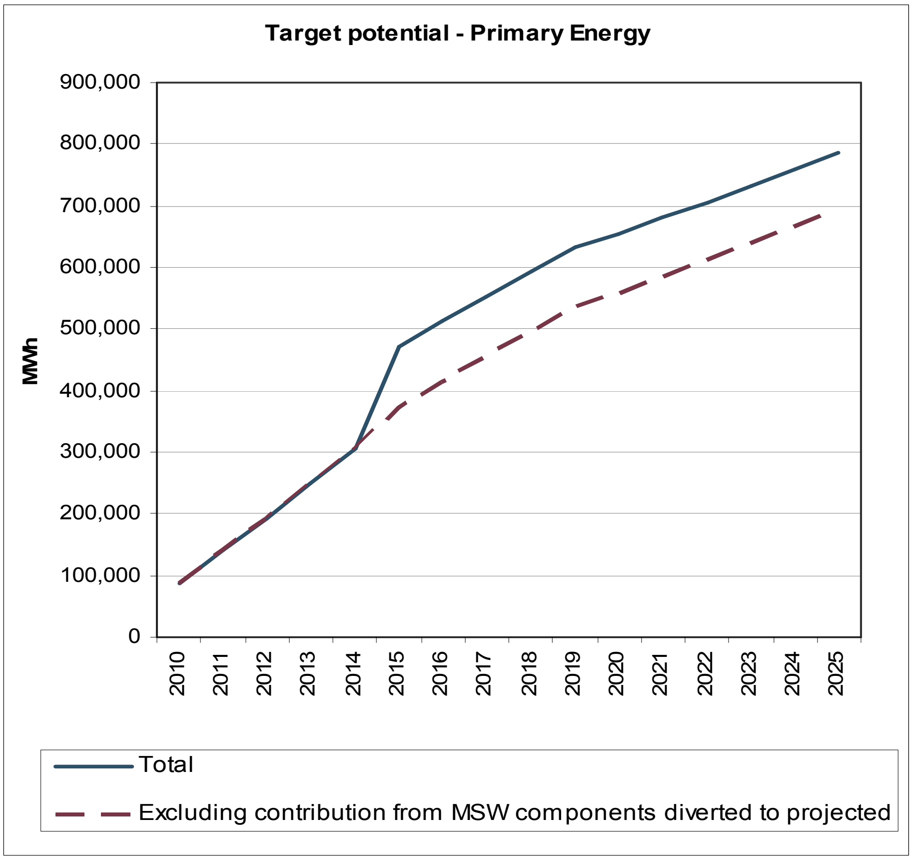
PROJECTED ENERGY FROM WASTE PLANT AND BIOMASS POTENTIAL

The proposed 8MW Energy from Waste (EfW) plant will be part of an integrated waste treatment facility receiving Derbyshire County Council and Derby City's residual waste.

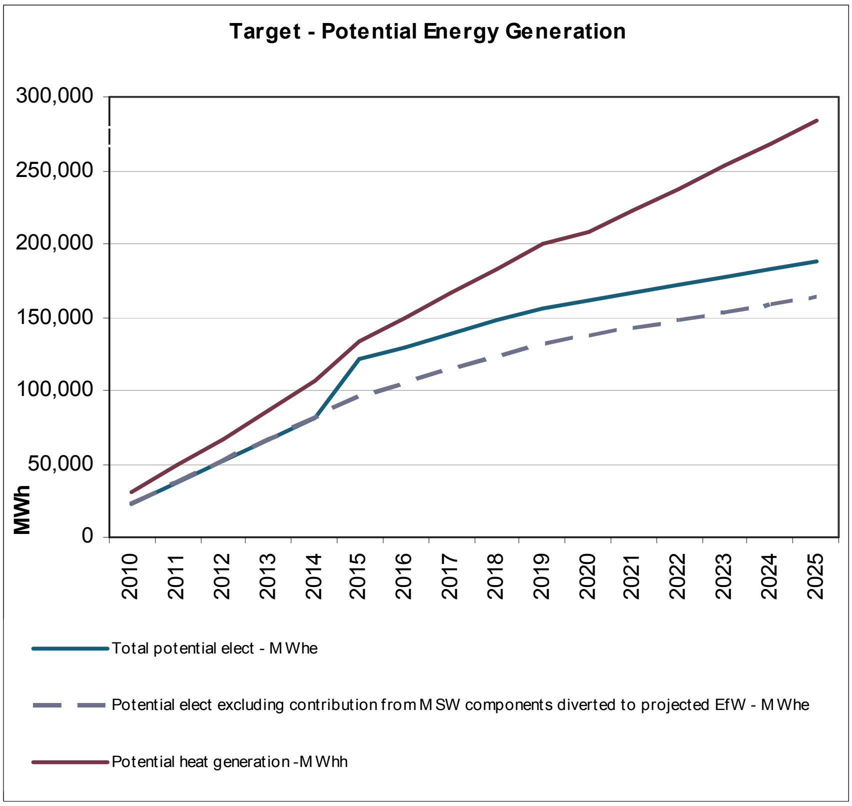
It is assumed that paper/card and wood waste will be gasified and combusted in the proposed EfW plant, and that green waste and kitchen waste will still be available for anaerobic digestion.

The graphs below shows the total bio-energy target potential and the bio-energy target potential excluding the contribution from MSW components that will be converted in the proposed EfW plant (i.e. paper/card and wood).

Year	Target potential - primary energy (MWh)	
	Total	Excluding contribution from MSW components diverted to projected EfW plant
2010	86,288	86,288
2011	139,522	139,522
2012	192,891	192,891
2013	249,765	249,765
2014	306,774	306,774
2015	471,225	372,239
2016	511,811	413,405
2017	552,531	454,705
2018	593,387	496,141
2019	634,378	537,712
2020	653,560	557,474
2021	679,616	584,201
2022	705,808	611,063
2023	732,134	638,060
2024	758,596	665,192
2025	785,193	692,460



Year	Potential energy generation - Total		Potential energy generation - excluding contribution from MSW components diverted to projected EfW - Mwhe	
Year	MWh_e	MWh_h	MWh_e	MWh_h
2010	22,953	31,286	22,953	31,286
2011	37,257	48,717	37,257	48,717
2012	51,612	66,181	51,612	66,181
2013	66,271	86,291	66,271	86,291
2014	80,980	106,434	80,980	106,434
2015	121,110	133,060	96,364	133,060
2016	129,880	149,622	105,279	149,622
2017	138,701	166,218	114,244	166,218
2018	147,572	182,847	123,260	182,847
2019	156,494	199,511	132,327	199,511
2020	161,900	207,704	137,879	207,704
2021	166,943	222,808	143,089	222,808
2022	172,036	237,945	148,350	237,945
2023	177,180	253,115	153,662	253,115
2024	182,375	268,320	159,024	268,320
2025	187,620	283,559	164,437	283,559



Appendix VIII: Solar photovoltaics

Solar photovoltaic (PV) panels are semi-conductor panels that convert light directly into electricity. This DC power is normally passed through an inverter which converts it into AC power which can be used to power the normal range of domestic appliances or be exported to the local electricity network. The amount of power that a PV panel will deliver is proportional to the amount of sunlight that falls upon it.

Solar energy can be exploited through three different means: solar photovoltaics (solar PV), active solar heating (solar thermal) and passive solar design. The least widespread of these is passive solar design: only a few thousand buildings in the UK have been designed to deliberately exploit solar energy - resulting in an estimated saving of around 10 GWh / year[64].

The key advantages of photovoltaics are:

- they can be integrated into buildings so that no extra land area is required,
- they can be used in a variety of ways architecturally, ranging from the visually unobtrusive to clear expressions of the solar nature of the building,
- they are modular in nature so that any size of system can be installed and
- there are fewer transmission losses since the electricity is used 'on site'.

Other important characteristics of photovoltaics:

- Compared to retrofitting existing buildings, it is significantly easier to integrate solar energy technologies into new buildings
- Building-integrated PVs offset some of the costs of the roof construction and save space. Some of the most promising applications include:
  - New, high profile commercial office buildings
  - New housing developments (preferably incorporating low energy design features)
  - Schools and other educational buildings
  - Other large high profile developments (such as sports stadiums)
- PV can be utilised in two ways:
  - Stand-alone PV – for remote uses such as monitoring and telemetry systems, where mains electricity is too difficult or expensive to supply.
  - Grid-connected PV – where the PV system is connected to and generates into the mains electricity system.

[64] *BERR, Digest of UK Energy Statistics 2007: http://stats.berr.gov.uk/energystats/dukes07_c5.pdf*

Appendix IX: Solar thermal – background notes

Solar thermal hot water (STHW) systems (sometimes referred to as solar collectors, or active solar systems) convert solar radiation into thermal energy (heat) which can be used directly for a range of applications, such as hot water provision and low temperature heat for swimming pools.

The key advantages of solar thermal systems are:

- they can be integrated into buildings so that no extra land area is required,
- they can be used in a variety of ways architecturally, ranging from the visually unobtrusive to clear expressions of the solar nature of the building,
- they are modular in nature so that any size of system can be installed and
- there are fewer transmission losses since the hot water is used ‘on site’.

Appendix X: Ground source heat pumps – background notes

According to the Energy Saving Trust[65], ground source heat pumps (GSHP) make use of the constant temperature that the earth in the UK keeps throughout the year (around 11-12 degrees a few metres below the surface). These constant temperatures are the result of the ground's high thermal mass which stores heat during the summer. This heat is transferred by (electrically powered) ground source heat pumps from the ground to a building to provide space heating and in some cases, to pre-heat domestic hot water. A typical efficiency of GSHP is around 3-4 units of heat produced for every unit of electricity used to pump the heat.

Characteristics of GSHP include:

- Sizing of the heat pump and the ground loop depends on the heating requirements.
- GSHP can meet all of the space heating requirements of a house, but domestic hot water will usually only be pre-heated.
- GSHP can work with radiators, however, underfloor heating works at lower temperatures (30-35 degrees) and is therefore better for GSHP.

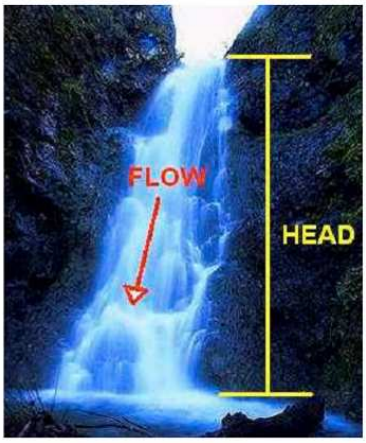
[65] *http://www.energysavingtrust.org.uk/uploads/documents/myhome/Groundsource%20Factsheet%205%20final.pdf*

Appendix XI: Hydroelectricity – background notes

Power has been generated from water for centuries, and there is theoretical potential for energy generation wherever there is water movement or difference in height between two bodies of water. The resource available depends upon the available head, i.e. the height through which the water falls (in metres) and flow rates, i.e. the volume of water passing per second (in m^3/sec).

The figure below illustrates the concepts of head and flow graphically.

Figure 70: Hydropower – Head and Flow (Source: British Hydropower Association – UK Mini Hydro Guide)



Power can be extracted by the conversion of water pressure into mechanical shaft power which, in turn, can drive a turbine to generate electricity. Power can also be extracted by allowing water to escape, for example, from a storage reservoir or dam through a pipe containing a turbine. The power available is in all cases proportional to the product of flow rate, head and the mechanical power produced by the turbine.

As for the efficiencies of hydro power schemes, these are generally in the range of 70 to over 90%. However, hydraulic efficiencies reduce with scheme size. Furthermore, schemes with a capacity of less than 100kW (micro-hydro) are generally 60 to 80% efficient.

There is a variation of different hydro energy site layout possibilities (e.g. canal and penstock; penstock only; mill leat; barrage), but, as illustrated by the figure below, a hydro energy scheme typically consists of the components shown in Figure 71

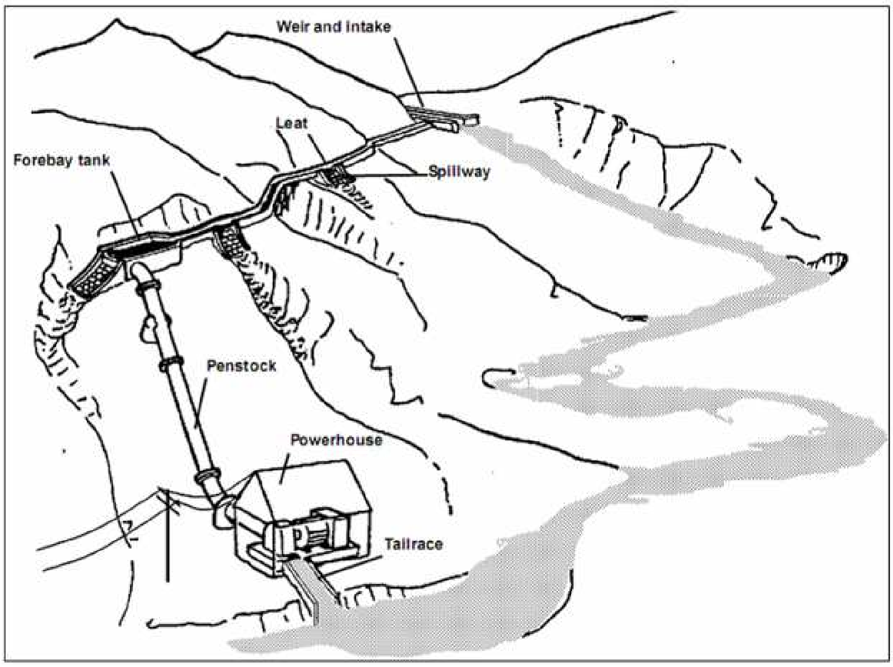
The technology for realising the potential from hydro is well established in the UK. Most of the UK's hydropower comes from large hydro projects; these are defined as those greater than 10 MW. These days large hydro is generally discounted from consideration for new construction due to the high environmental impact associated with constructing large dams and flooding valleys.

There are a number of benefits of hydro schemes (adapted from British Hydro Power Association (BHPA)), including:

- No direct CO_2 emissions
- Small hydro schemes have a minimum visual impact on surrounding environment
- One of the most inexpensive ways to generate power
- Bigger hydro schemes can include a possibility to store energy (reservoir storage, pumped storage)
- Hydro schemes can have a useful life of over 50 years
- Hydro is the most efficient way of generating electricity, as between 70 and 90% of the energy available in the water can be converted
- Hydro schemes usually have a high capacity factor (typically > 50%)
- A high level of predictability (however, varying with annual rainfall patterns)

- Demand and output patterns correlate well, i.e. highest output is in winter

Figure 71: Components of a hydro scheme (Source: British Hydropower Association – Guide to UK Mini-Hydro Developments)



Technologies for sites with medium and high heads and flows are well established, however with some of the sites only having a low head, finding suitable technology entails having to rely on less established technologies, such as Archimedes Screw turbines or VHL turbine (which is a very low head Kaplan turbine). Generally, impulse turbines are used for high head schemes whereas reaction turbines are used for low head schemes.

In turning the technical resource of hydro energy into a practical target, the important issues to consider are:

- Getting support from the Environment Agency (EA) will be crucial to the development for hydro energy schemes in the district; the EA is responsible for aspects such as licensing e.g. the water abstraction or for ensuring that each site has a fish passage
- Securing the necessary funds (possibly through a community-owned fund) will be important for project developers
- Economics of hydro energy schemes are absolutely site-specific, critically depending on the topography, geology, and hydrology of each site, which in turn requires feasibility studies for each potential site; this is especially important since civil works can be significantly more expensive for low head hydro developments
- Possible local resistance needs to be addressed accordingly
- For mill conversions it is important to ensure that all required hydro energy equipment and potential civil works could be integrated into the existing mill structure.
- Land ownership and water rights can be complex and time-consuming issues to be resolved
- In view of the complexity of developing hydro schemes, long lead times are required, most of all for hydrological studies, environmental impact assessments and getting the required permissions (flood prevention, fishery rights)

Appendix XII: Gas-fired CHP – background notes

Gas fired combined heat and power (CHP) is a technology which uses natural gas to generate electricity in the same way that many of our power stations do, albeit on a much smaller scale. These 'micro power stations' do, however, offer a significant advantage in that the heat that is generated can be used by nearby consumers. By utilising the heat benefits, as well as the electricity generated, this technology offers significant carbon benefits.

CHP systems with a community heating network enable sizable carbon reductions in new developments. However, the viability and effectiveness of CHP is dependent on how much of the heat and electricity can be utilised. This tends to hinge on three factors:

1. Scale of development. As a rule of thumb, community heating systems require a development of at least 300 dwellings, with improving economics as the scale of development increases.

2. Density of development. The suitability of community heating increases with the number of dwellings per hectare.

3. Mix of development. A good mix of residential, commercial and industrial building types is beneficial. Residential peak energy demand is early morning and evening. Commercial peaks tend to be during daytime hours. Adding the building uses together helps to provide a more even energy demand, which suits CHP.

The recent guide 'Community Energy: Urban Planning for a Low Carbon Future' produced by the Combined Heat and Power Association (CHPA) and Town and Country Planning Association (TCPA) provides a useful overview of the types of development that suit CHP and district heating and the range of issues that need to be considered in the development of CHP and district heating networks.

Biomass CHP is applied in this analysis in preference to gas CHP. This is due to the larger carbon savings available for the biomass option and that the current definition for the zero carbon homes[66] would essentially require biomass CHP, where is possible rather than gas-fired CHP.

[66] Prior to publications of the government consultation of the definition of the 'zero carbon'

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