Report


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Executive Summary

INTRODUCTION

As part of the Climate Change Act 2008\(^1\), the Government has committed to legally binding targets of achieving reductions in CO\(_2\) emissions of at least 26% in 2020 and 80% in 2050, against a 1990 baseline, so that the UK can play its role in helping to stabilise climate change at an acceptable level. Local authorities are facing a growing number of climate change related duties, and have the responsibility of stimulating energy efficiency and renewable energy within their areas. The Climate Change Supplement to PPS 1 requires renewable energy and low carbon requirements within local planning policies to be based on a detailed understanding of the local available resource.

ESD has undertaken a study of the potential for renewable and low carbon energy sources (otherwise known as Low and Zero Carbon (LZC) sources) within Bolsover District to help inform policy development within the Council’s Local Development Framework (LDF).

The study had the following scope:

- To assess the District’s LZC resources available up to 2026. These have been quantified in terms of a theoretical maximum potential - the Resource Potential - and in terms of a Development Scenario, accounting for market and other development constraints;
- To suggest suitable low carbon response for different scales and type of development;
- To provide direction on the policy options required to realise the District’s LZC potential.

BUILDING DEVELOPMENT PROFILE AND RELATED REGULATIONS

Following requirement for new housing provision in the emerging RSS, an estimated 8,100 residential dwellings and 200 hectares of employment land will need to be developed between 2006 and 2026 within the District.

Government aspirations mean that for new buildings, LZC technologies shall be required to achieve high building regulations standards towards the goal of “zero carbon” (in 2016 for residential, and 2019 for non-residential). It is widely regarded that the cost for developers to achieve zero carbon is reduced as the scale of development increases. Within Bolsover, which may not expect large urban extensions to be part of the housing strategy, this is a crucial point. Smaller developments which will not be of a scale to benefit from communal energy systems (such as district heating, CHP or a directly connected large scale wind turbine) will instead rely on microgeneration technologies (photovoltaics, solar thermal panels, individual biomass boilers, etc.).

It is important to note that during the completion of this report, the Department for Communities and Local Government issued a consultation document on the definition of “zero carbon”\(^2\). The analysis behind the Bolsover study does not take into consideration the wide range of scenarios presented in the consultation. In particular, the consultation suggests that buildings should meet the zero carbon standard by achieving circa 35-50% of the total (regulated and unregulated) emission reduction on-site, with the rest achievable through off-site measures. The study conducted analysed achieving zero carbon with a 50%

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contribution from off-site generation. In consequence the report suggests solutions that may be more challenging, i.e. suggesting a greater focus on on-site measures than may be the case in the eventual national policy that will come forward.

BOLSOVER’S 2006 EMISSIONS BASELINE FOR THE BUILT ENVIRONMENT

The annual emissions from Bolsover’s built environment totalled almost 495,000 tCO₂/yr for 2006. This equates to 6.9 tCO₂/yr per capita within the District, compared to 6.2 tCO₂/yr/capita in the East Midlands and 8.9 tCO₂/yr/capita nationally³. Figure 1 on page 3 provides further detail on the breakdown of the respective emissions by fuel source.

DISTRICT LOW- AND ZERO-CARBON RESOURCES

The analysis conducted indicates that, theoretically, 418,149 tonnes of carbon dioxide per year (tCO₂/yr) could be abated through the installation of low- and zero-carbon technologies in Bolsover. This resource equates to 196% of the District’s electricity consumption, and 49% of heat consumption against 2006 data.

From these overall resource figures, Development Scenarios have been modelled, accounting for market and other constraints. This modelling has been completed for retrofit of existing buildings, new developments and stand-alone generation. The results suggest that in 2016, 13,494 tCO₂/yr could be abated as a result of renewable energy installations within Bolsover. At this point, 2.6% of the District’s energy demand is generated by renewables (in terms of CO₂).

By 2026, the model shows renewable energy installations abating 72,560 tCO₂/yr, representing 13.4% of the District’s energy demand (in terms of CO₂). Figure 12 (page 38) describes the extent of the renewables installed in tangible terms.

The graph below illustrates that for both the Resource Potential and the Development Scenario for both 2016 and 2026, renewable energy generation is dominated by large wind turbines.

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RESULTS AND CONCLUSIONS

Bolsover currently has limited renewable energy generation and the district has set local targets - adopted from regional targets - to increase the renewable energy contribution from 2% in 2006 to 6.4% by 2010, 23% by 2020 and 24% by 2025. These targets are expressed as a percentage of the electricity consumption only (not carbon emissions). In addition, the East Midlands Regional Assembly is in the process of revising these figures after they were questioned during the recent Examination in Public of the Regional Planning Guidance. It is understood that the targets will, in future be devolved down to Housing Market Areas.

Our analysis suggests that renewable technologies may generate approximately 30% of the District's estimated electricity demand in 2026\(^4\). Under this scenario, the current indicative regional target of 24% for 2025 would be achieved.

As set out in the Government’s Climate Change Act 2008, a national target for carbon emission reduction is 26% by 2020, against a 1990 baseline. In comparison, our analysis suggests that the district would achieve a CO\(_2\) emission reduction of 7.6% by 2026 through the forecast level of the LZC deployments estimated. This finding takes into account a) Bolsover’s built environment emissions until 2026, b) future building regulations, as well as c) the hypothetical case of the adoption of the entire suggested development scenario. The district’s 1990 emissions were estimated by scaling down national emissions data (excluding transport) by Bolsover’s population. Note that it would not be expected for Bolsover to achieve CO\(_2\) reductions comparable to this national 26% target. This is due to the significant savings resulting from de-carbonising power stations (of which Bolsover has little control), as well as activities such as transport which are beyond the scope of the 7.6% savings identified. Such a comparison, however, puts into context the contribution that renewable energy systems could make.

Achieving the deployment levels suggested in the Development Scenarios will be challenging and the council Local Development Framework needs to establish supportive conditions for the market to attempt to deliver. This could, for example, suggest encouraging large scale developments as opposed to infill (to achieve economies of scale) and facilitate close proximity between LZC resources and areas of development. This would make it easier to achieve carbon targets due to the correlation between development size, density of energy demand, access to resources and the viability of communal energy systems.

It is important to recognise that planning policy alone will not be able to deliver LZC aspirations for the district. Non-planning enabling mechanisms, such as a Bolsover district ESCO, a district carbon offset fund and other provisions for off-site mechanisms will be critical. Some of these mechanisms are highlighted in section 8 from page 60 onwards.

Finally, the recommendations drawn from our analysis are summarised below to provide easy reference.

RECOMMENDATIONS

Based on the analysis of the findings of this report, the following recommendations are made:

\(^4\) Note that Bolsover’s electricity demand for 2026 has been estimated using an annual growth factor of 1.1%, forecast by the National Grid [http://www.nationalgrid.com/uk/sys_07/print.asp?ch=2]
A A spatial correlation of key power resources -i.e. most importantly large scale wind sites-and existing heat sources and loads -which includes sources of industrial (waste) heat-against new developments is recommended to be conducted. This is crucial in determining whether larger developments in the district can achieve zero carbon status.

B Taking into account the analysis conducted, we recommend that Bolsover establishes policy that sets out the following requirements:

B.1 Achieve following carbon savings on all housing development against the Target Emission Rate required under Building Regulation (2006) standards:
- 25% (2010 to 2013);
- 44% (2013-2016);
- zero carbon\(^5\) (2016);

through the application of low and zero carbon technologies, building design (and specification) or a mixture of both.

B.2 All major developments\(^6\) achieve a minimum 10% reduction of regulated carbon emissions from the prevailing Building Regulations compliance standards through renewable energy. This would cover all buildings, not just residential. This standard is anticipated to be exceeded by the aforementioned housing standards and may well be exceeded by non-residential standards introduced into regulation in the future. This policy proposal is therefore designed to provide early yet minimal standard improvements by default as required by the Regional Plan Guidance (Policy 3).

B.3 Specific development sites (identified by location or criteria) within the district that are considered strategically important with regard to low and zero carbon development opportunities to conduct a detailed analysis and costs of the option to achieve a zero carbon standard.

B.4 Where applicants wish to submit proposal achieving lower standards they will need to submit detailed evidence for the argument that development would not be feasible or viable where the standards upheld.

C To support compliance and to encourage approaches that maximise the long term opportunities for deploying low and zero carbon energy options the following is recommended:

C.1 The LDF should indicate the carbon standards expected of developments of particular scales, density and mix, whilst indicating possible solutions (which may change over time) as defined in section 4, and encourage developers to install communal systems, where applicable.

C.2 Develop rules to ensure that ‘off site’ renewables are additional to any commercial renewable energy developments that would occur anyway within the district (and support the development of a delivery mechanism).

C.3 Encourage developers to work with wind turbine developers so as to establish contractual relationship with ‘off site’ wind turbines that are located within the district or county.

D To facilitate the development of shared infrastructure and renewable energy supply chains the following is recommended:

D.1 The LDF should encourage the adoption of CHP for large developments rather than building-integrated renewables.

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\(^5\) requiring a carbon reduction of all “regulated” and “unregulated” emissions as defined in the Code for Sustainable Homes (2008) AND achieving a Heat Loss Parameter less than 0.8 W/m\(^2\) and a minimum of 50% of the remaining carbon emission reduction being discharge through the use of ‘on-site’ or ‘near-site’ renewable energy

\(^6\) above 10 dwellings or 1,000m\(^2\) GFA for non-residential development
D.2 Undertake heat mapping in the most densely populated area of the district and appraise possible heat infrastructure projects linked to major new developments and the existing major heat loads and major heat waste opportunities.

D.3 Require the use of CHP and district heating in all significant new mixed-use developments above certain scale and density.

D.4 Ensure that the master plans for the key growth sites contain comprehensive zero carbon methodologies addressing buildings and low carbon infrastructure.

E  To manage ‘undue burden’ on developers in implementing tightened carbon standards we make the following recommendations:

E.1 Site specific targets in advance of national standards could be set for the large sites as it will be technically possible to achieve zero carbon status due to the potential for large wind turbines within the district. This should not be considered an undue burden as it is an affordable option and would have the benefit of stimulating renewable energy development within the district.

E.2 The LDF should outline that the low carbon energy supply market is developing all the time and that what constitutes an ‘undue burden’ is therefore reducing over time.

F  To facilitate the delivery of ‘off-site’ mechanism to support the achievement of the zero carbon standards, the Council could establish a ‘carbon offset fund’ in a similar way to Milton Keynes Council, which requires developers to pay to offset all the residual emissions from their developments. The ‘carbon offset fund’ which the Council would need to establish and into which these payments are deposited, would then distribute these payments to cost efficient carbon reduction measures within the district. It will be important to consider the cost (per tonne) of the offsets and establish clear rules to determine additionality.

G  To develop effective monitoring and compliance processes we make the following recommendations:

G.1 ESD recommends that Bolsover ensure that the new developments include provisions for energy monitoring in their Sustainable Energy Strategies that should accompany any planning application. The monitoring programmes should be able to provide Bolsover annual figures on CO₂ emissions for dwellings and non-residential buildings, and preferably non-residential buildings should split into office, retail and industrial. It would also be useful to obtain figures for the amount of energy generated by different renewable energy technologies to compare with the original Sustainable Energy Strategies in order that lessons can be learnt if any of the systems are under performing.

G.2 Bolsover could prepare CO₂ emissions trajectories of how they forecast emissions from now until 2026 to compare with the monitored data as it comes in. It would be necessary to have separate trajectories for dwellings and non-residential buildings to effectively compare against LDF carbon targets.

G.3 Monitoring is also important for the existing building stock in terms of CO₂ emissions for Bolsover as a whole; this should be captured in National Indicator 186. It would also be useful to monitor the number and type of renewable energy installations progressed throughout Bolsover to compare with overall CO₂ emissions.

H  Planning policy alone will not be able to deliver renewable energy targets for the district, and a range of policy measures covering economic development to council initiated energy projects will also be required ensuring that renewable energy development is facilitated and encouraged within the district. These non-planning delivery mechanisms include:

H.1 Coordinating the development of low carbon infrastructure
H.1.1 Managing and financing energy infrastructure for long term, phased development projects is extremely challenging. The Council therefore needs to encourage developers to engage with expert entities in order to most effectively progress energy infrastructure within their developments. This could include two steps: a) the set up of at least one Energy Services Company (ESCO) to ensure planning and delivery of low carbon infrastructure by an entity with long term interests in assets and b) the set up of Special Purpose Vehicles (SPV) to lead early client negotiation and risk mitigation before bringing proposals to market.

H.2 Financing low carbon infrastructure

H.2.1 Addressing investment challenge for communal infrastructure: such as district heating through the form of a council operated ring fenced ‘carbon investment fund’ which 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.

H.2.2 Managing contractual complexities and project uncertainties: By the means of a) close collaboration between the Council, developers and ESCOs and b) commitments to long term power and heat purchase contracts with ESCOs.

H.2.3 SPVs / ESCOs: the Council and its partners could establish ESCOs which would work to install sustainable energy systems within both the new developments and existing buildings, thereby addressing market and policy failures that affect local sustainable energy projects; SPVs could help in rolling out CHP and district heating to existing communities;

H.2.4 Council leading by example: By implementing renewable energy installations and decentralized energy generation projects on its own buildings and land. This can be realised by public sector buildings providing ‘anchor loads’ for district heating and low carbon infrastructure networks.
1 Introduction

1.1 Study overview

Bolsover District Council commissioned ESD to undertake a study of the potential for renewable and low-carbon energy sources within Bolsover District to help inform policy development within the Council’s Local Development Framework (LDF). This report presents the conclusions of this work.

More specifically, the project:

• assesses the resource potential for renewable energy generation within Bolsover District;
• provides guidelines for using this resource potential, suggested to set renewable energy targets within Bolsover District for 2026 in line with the LDF target dates;
• specifies suitable low carbon solutions and requirements for different development types, and related this to the planned new development within the district;
• outlines direction on the policy options that would be required to turn the district’s potential renewable energy resource into reality;

Further objectives of this work include:

• raising awareness of the issues surrounding climate change in Bolsover’s local development framework;
• increasing the understanding of the County and District Councils of the capacity of the plan area for accommodating a range of renewable energy and low carbon technologies;

1.2 The Bolsover Context

Bolsover District lies within Derbyshire and covers an area of 160.33 km² with a resident population of some 74,200 people. The District is mainly rural interspersed with a number of small towns and villages with Bolsover, Shirebrook, South Normanton and Clowne as the main centres of the district.

Bolsover is also characterised by landscape designations (Sites of Importance for Nature Conservation, Greenbelt), ecological designations (mostly ancient woodlands), and also heritage designations (Heritage Parks and Gardens). Although the District is more watershed than valley, there are four rivers running through the area are River Meden, River Erewash, River Doe Lea and part of Normanton Brook.

There are currently around 33,600 dwellings within Bolsover District, as well as 1,134,930 m² of non-residential ground floor area. Currently, Bolsover has the following development targets to be achieved between 2006 and 2026:

• 8,100 dwellings\(^7\), of which around 2,684 are already committed
• 200 hectares of employment land\(^8\)

\(^7\) East Midlands proposed RSS changes
\(^8\) Bolsover LDF Preferred Options Core Strategy, October 2006
Regarding existing district-wide energy-related policies and targets, the Bolsover Local Plan (adopted in 2001) addresses these issues by aiming -under the umbrella of ‘environmental sustainability’ (sustainability in turn is one of the main themes of the local plan)- for encouraging energy efficiency and influencing the location and design of development to reduce energy wastage. The main further energy-related aspects that are addressed as part of the Bolsover District Plan include:

- use of energy efficient means of transport
- requirement for all major new developments to make provision for access by public transport, cycling and walking
- encouragement of greater use of renewable energy sources and prevention of development of sites which may be suitable for renewable energy schemes

On a regional level, existing energy-related policies and targets use the following ‘energy hierarchy’ as their basis:

- Reduction of the need for energy
- More efficient usage of energy
- Usage of renewable energy
- For continued use of fossil fuels to be clean and efficient for heating and co-generation

The Regional Policy Plan has been informed by the Regional Energy Strategy\(^9\) in combination with two Regional Planning Body studies\(^10\). Their main outcomes emphasized the need for a) the importance of planning policies in reducing energy demand, b) an increase in Combined Heat and Power (CHP) uptake, c) regional targets for renewable energy generation for 2010 and 2020, in combination with an increased use of microgeneration technologies and d) planning policies to support the Government’s targets of zero carbon development from 2016 onwards.

\(^9\) Available at www.emra.gov.uk
\(^10\) ‘Determining Baseline Energy Consumption Data’ and ‘Regional Targets and Scenarios for Renewable Energy’ (both available at www.emra.gov.uk)
2 Built Environment Emissions Baseline

It is essential to firstly understand Bolsover’s current and future emissions. Emissions are measured in terms of “tonnes of carbon dioxide emitted per year”, or tCO\(_2\)/yr. This study investigates the CO\(_2\) arising from the built environment only – emissions from transport are outside of the scope.

2.1 Bolsover District’s energy demand and CO\(_2\) emissions

2.1.1 2006 emissions baseline for the built environment

The annual emissions from Bolsover’s built environment totalled almost 495,000 tCO\(_2\)/yr for 2006. This equates to 6.9 tCO\(_2\)/yr per capita within the District, compared to 6.2 tCO\(_2\)/yr/capita in the East Midlands and 8.9 tCO\(_2\)/yr/capita nationally\(^\text{11}\). A break-down of these emissions by fuel source demonstrated in Figure 1.

Figure 1: Emissions arising from the built environment in Bolsover for 2006, [Source: BERR, Regional and local energy consumption statistics, 2006]

![Emissions Breakdown Diagram]

Table 1 helps put this emissions break-down into context against a national average. Bolsover’s dwelling emissions are proportionally similar to the UK average – indicating that the fuel mix in residential areas is typical of Great Britain. However, coal consumption within the commercial and industrial sector is proportionally ten times larger than the national average. It has been suggested that the high coal consumption is likely to be attributed to one or two large industrial users within the District.

Table 1: Comparison of Bolsover CO\(_2\) emissions sources against national figures

<table>
<thead>
<tr>
<th></th>
<th>Coal</th>
<th>Petroleum (Oil)</th>
<th>Gas</th>
<th>Electricity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial and industrial</td>
<td>Bullsover</td>
<td>42.3%</td>
<td>5.6%</td>
<td>12.1%</td>
</tr>
<tr>
<td></td>
<td>National</td>
<td>4.1%</td>
<td>22.2%</td>
<td>20.9%</td>
</tr>
<tr>
<td>Dwellings</td>
<td>Bullsover</td>
<td>1.3%</td>
<td>4.2%</td>
<td>55.6%</td>
</tr>
<tr>
<td></td>
<td>National</td>
<td>0.9%</td>
<td>4.7%</td>
<td>50.8%</td>
</tr>
</tbody>
</table>

2.1.2 Future emissions forecast

Projecting forward the future developments for 8,100 dwellings and 200 ha of industrial land, a forecast for the future emissions of Bolsover can be produced.

Two scenarios are compared for new construction: Firstly, all new build is assumed to conform to current building regulations, seeing the District’s emissions rise to over 540,000 tCO$_2$/yr in 2026.

The second scenario applies the current ‘road-map’ for building regulations. For residential dwellings, this is the Code for Sustainable Homes framework, which sets targets for the percentage reduction of a building’s emissions. A ‘Code 3’ dwelling will emit 25% less CO$_2$ from regulated emissions$^{12}$ compared to the 2006 Building Regulations standard. A Code 4 dwelling sees a 44% improvement, and Code 6 achieves true zero carbon$^{13}$. These standards are staged at three year intervals starting from 2010, and further details can be found in section 3.6. Future building regulations for non-residential buildings are not yet set, besides the intention to make all such buildings zero carbon as of 2019.

Figure 2 below forecasts the effect that these building regulations will have upon the future emissions of Bolsover. It is estimated that in 2026, Bolsover’s emissions will plateau at almost 517,000 tCO$_2$/yr, even with the tightening building regulations. This takes into consideration zero carbon development from 2016 for dwellings and 2019 for non-residential. And crucially, the building regulations scenario already includes the emissions abated by both energy efficiency and renewable energy sources which are installed to meet the standards.

As a gap-analysis, the area in yellow quantifies the savings made through energy efficiency and renewables – cumulatively totalling over 136,000 tCO$_2$ by 2026.

Figure 2: Forecast of Bolsover’s built environment emissions until 2026, based on the future development outlined in section 1.2
2.1.3 Spatial distribution of energy

To enable energy consumption to be reduced, there is a need to know where the most significant energy users exist. Figure 3 demonstrates the spatial distribution of gas consumption, and confirms that built-up areas of Bolsover District Council are the most energy intensive.

Figure 3: Spatial distribution of gas consumption within Bolsover (kWh/m$^2$ floor area)

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12 Regulated emissions are those which are covered by the SAP methodology – space heating, hot water, lighting, fans and pumps. This does not include ‘unregulated’ energy from appliances.

13 Both regulated and unregulated emissions are abated. The exact definition of zero carbon is currently under consultation.
2.2 Bolsover existing and planning Renewable Energy capacity

Regional targets have been set to increase the renewable energy contribution from 2% in 2006 to 6.4% by 2010, 23% by 2020 and 24% by 2025\textsuperscript{14}. These have been adopted as local targets.

Bolsover currently has limited renewable energy generation. Landfill/methane gas capacity in the district represents about 4% of the Council's local contribution, pro-rata to the population\textsuperscript{15}. There is currently no existing major renewable energy capacity within the district. The only noteworthy systems known to the Council are three small wind turbines adding up to 8.5 kW in capacity. It is assumed that there are a few dwellings with solar PV and/or solar thermal systems within Bolsover.

Regarding planned renewable schemes, there is one sizeable proposal to construct a wind farm within the district. Following an environmental impact assessment and a consultation exercise, Banks Developments proposes to submit a planning application for up to 5 wind turbines with a combined maximum capacity of up to 16.5 MW on land north of Glapwell. A public exhibition on this proposal was held in November 2008.

We also understand that there is some interest in a community wind energy development within the district.

\textsuperscript{14} \textit{East Midlands Regional Spatial Strategy Review 2006, p. 98}

\textsuperscript{15} \textit{Bolsover District Council Annual Monitoring Report 2006}
3 Renewable Energy Policies and Targets

3.1 Climate Change Bill

The UK has introduced a long term legally binding framework to reduce greenhouse gas emissions. The Bill was introduced into Parliament on 14 November 2007 and became law on 26th November 2008, putting into statute the UK’s targets to reduce carbon dioxide emissions through domestic and international action by at least 80 per cent by 2050 and at least 26 per cent by 2020, against a 1990 baseline. A new Committee on Climate Change has been established as a new independent, expert body to advise Government on carbon budgets and cost effective savings. A key part of the Climate Change Bill is the establishment of a carbon budgeting system capping emissions over five year periods. The first three carbon budgets – to be set by 1 June 2009 – will cover five year periods from 2008 until 2022. It will be a Government obligation to report to Parliament the policies envisaged to meet the budgets. This will happen as soon as practical after 1 June 2009.

3.2 Energy White Paper 2003

Achieving the commitments set within the 2003 ‘Energy White Paper’ will require at least 40% of electricity to be generated from renewable sources by 2050. In the shorter term the Government is committed to the achievement of 10% renewable electricity by 2010 and is aiming for 20% by 2020.

3.3 Renewable Energy Strategy

Having completed its consultation period on 26 September 2008, the Renewable Energy Strategy is likely to call for 15% of the UK’s electricity, heat and transport fuel to come from renewable sources by 2020. This is likely to comprise a 35% target for electricity and a 14% target for heat. The strategy is expected to be published in spring 2009.

3.4 Planning Policy Statement on Renewable Energy PPS22

Planning Policy Statement 22 (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:

8. 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.
3.5 Planning Policy Statement on Planning and Climate Change Supplement to PPS1

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”.

3.6 Building Regulations

The Government has set out its intentions 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.
4 Renewable and Low Carbon Energy Resources in Bolsover

4.1 Low and zero carbon responses

In responding to the need for reduced emissions in the built environment, the energy hierarchy has been applied to this analysis:

1. Reduce the need for energy
2. Use energy more efficiently
3. Supply energy from renewable sources
4. Any continuing use of fossil fuels to use clean, efficient technologies

The scope of this report covers parts 2 to 4 of the hierarchy. That is, energy efficiency, renewable technologies, and other low carbon technologies.

4.1.1 Energy efficiency

Making a building more energy efficient fits with the first step of the hierarchy, and should always be considered before looking to introduce renewable or low carbon energy sources. There comes a point, however, where energy efficiency becomes a more expensive option than renewables, particularly for more advanced low carbon construction. Figure 4 illustrates an example of a marginal abatement cost curve, which looks to establish the most cost effective method for achieving a 44% reduction in emissions (Code for Sustainable Homes level 4). This demonstrates that the lowest cost option is for 19% by energy efficiency, and hence the remaining 25% by renewable energy. The optimum balance between energy efficiency and renewable energy is specific to a single dwelling – there is no one-size-fits-all solution. This factor has been considered on a broad basis in the analyses presented within this report.

Figure 4: An example of finding a cost effective scenario for achieving emissions targets such as the Code for Sustainable Homes (illustrative purposes only)
4.1.2 Renewable energy technologies

A host of renewable energy technologies have been considered for suitability within the District. These are:

- Large scale wind
- Small scale wind
- Biomass
- Photovoltaics
- Solar thermal
- Ground source heat pumps
- Hydroelectricity

Further details about these technologies can be found in the appendices.

4.1.3 Other low carbon technologies

The renewable technologies listed above are by no means an exhaustive – there are a number of other systems which can provide carbon benefits for new developments. This section outlines some of the alternative options which may be appropriate for Bolsover, but which have not formed part of this analysis.

Gas fired combined heat and power (CHP)

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\textsuperscript{16} would essentially require biomass CHP, where is possible rather than gas-fired CHP.

Bolsover's largely rural nature means that large residential or non-residential developments are not commonplace. However, major residential and employment development at South Shirebrook is already committed, and as part of the LDF consideration is being given to the potential for large scale residential developments at Clowne and Bolsover. On any such large scale developments the potential for CHP or community heating should be evaluated as an option at an early stage in the planning process - it has not been possible to do this as part of this study.

**Coal Mine Methane**

Coal Mine Methane (CMM) deserves special mention in Bolsover because of the mining history of the district and potential methane gas resource trapped within disused mine working and the within the remaining coal seams. Alkane Energy, based in Edwinstowe, provided some insight into the potentially extractable resource within the district. In general, the resource from existing collieries is too small and too short-lived to justify the major investment required to be exploited and hence the development scenario resource for coal mine methane is essentially zero.

An alternative technology which is currently being trialed in the UK is Coal Bed Methane (CBM) which utilises gas drill techniques offers some promise as it means that large existing coal seams could be tapped for methane gas.

Prior to completing this report we had not received any evidence of the resource potential from CMM or CBM within the district

Finally, whilst coal derived gas is not considered a renewable fuel it does present carbon benefits compared against coal because of more efficient combustion of gas compared with solid fuel.

**4.2 Assessing the Resource Potential and Development Scenario for renewable energy**

In order to assess future renewable energy and low carbon opportunities and their expected uptake in the district, the following approach has been chosen:

- The RESOURCE POTENTIAL of each technology considered has been determined. This includes the amount of renewable and low carbon energy possible to exploit in the district – subject to certain constraints, such as physical resource available, technology constraints and limits of the existing environment in the district.

- Using the resource potential as a baseline, further constraints -such as market conditions or landscape and visual consideration- are applied to arrive at the DEVELOPMENT SCENARIO. The development scenario summarises the uptake of renewable energy technologies and is used to anticipate the most realistic contributions that renewable energy can make to generate carbon savings in the future within Bolsover. Assumptions -where applicable- that had to be made for each

\textsuperscript{16} Prior to publications of the government consultation of the definition of the ‘zero carbon’

5 May 2009
technology to arrive at the development scenario are provided in the respective sections. Our own views of all relevant issues have been supplemented by those of local stakeholders.

The difference between the resource potential, i.e. the exploitable amount of renewable energy (subject to certain constraints) available in the district, and the development scenario, i.e. a judgement of what is likely to be exploited using development assumptions- is crucial to understanding this section of the study.

4.2.1 Overview of Resource Potential

The Resource Potential for renewable energy within the district is the total resource that is technically available. The study has calculated the technical resource available which outlines the total renewable energy resource that could be exploited within the district if all opportunities were taken advantage of.

**Definition of Resource Potential**

For the purpose of this project, Resource Potential means the amount of renewable energy possible according to the constraints imposed by the:

- physical resource, that is, the wind, solar, hydro, biomass, waste resource actually available within Bolsover;
- limits of the technology and their current efficiencies at converting the renewable resource into energy;
- limits of the existing environment in Bolsover, that is, roof space and number of buildings for building integrated technologies (solar PV, solar thermal hot water and ground source heat pumps) and, for wind energy, distance from existing buildings and infrastructure, distance from radars and air fields, distance from telecommunications links, avoidance of important ecological and archaeological features, avoidance of steep topography etc.*

The Resource Potential does not consider the likely uptake of the technologies and how the market, economics and technology may change over time; potential scenarios for these are considered for deriving suggested targets. Neither does it look at the renewables required to meet the energy needs of future build (as outlined in section 2.1.2).

*Note that for wind energy the Resource Potential does not include the constraints imposed by what might be considered acceptable on landscape and visual grounds. This important criterion has been considered

The renewable energy and low carbon technologies assessed were:

- wind energy – large scale and smaller scale turbines;
- energy from biomass and waste - both combined heat and power (CHP) and heat only;
- hydro energy;
- solar photovoltaic electricity (PV) – roof top potential only, although PV on facades and PV fields may become more viable in future if prices drop;
- solar thermal hot water (STHW) – roof top potential;
- ground source heat pumps (GSHP) – can provide low carbon heating especially, but not only to housing off the gas network.
4.2.2 Summary of Resource Potential

The analysis has identified that the district has an approximate renewable energy resource capable of abating 418,149 tCO$_2$/yr. This amounts to 85% of the 2006 carbon emission baseline set out in section 2.1.1.

Renewable technologies generate 196% of electricity consumption, and 49% of heat consumption against 2006 data$^{17}$. The UK has a target to provide renewable sources for 15% of its total energy use by 2020. A suggested method to deliver this is by generating 32% of electricity demand and 14% heat demand via renewable sources$^{18}$. Hence, it is technically possible for Bolsover to achieve this target.

Figure 5 demonstrates that large wind dominates the resource potential, abating 41% of the emissions arising in 2006. Biomass makes up the second most considerable component, abating 30%. All of the remaining technologies can be defined as microgeneration systems. PV is the most significant of these at 5%, followed by small wind and ground source heat pumps offering 3% each, and solar thermal at 2% of the baseline emissions. Regarding hydroelectricity, all sources of flowing water within Bolsover District are small tributaries, and the few weirs that are present are only suitable for very small scale energy generation.

The quantified resource potential data, in terms of carbon and power generation, can be found in Table 2.

$^{17}$ This assumes that gas, oil and coal consumption is converted to heat only

$^{18}$ BERR UK Energy Strategy Consultation June 2008, paragraph 17. This is in addition to supplying 10% of energy consumed in transport, which is outside of the scope of this report.
Table 2: Resource potential for renewable energy technologies in Bolsover

<table>
<thead>
<tr>
<th>Technology</th>
<th>Large Wind</th>
<th>Small Wind</th>
<th>Biomass</th>
<th>PV</th>
<th>Solar Thermal</th>
<th>Ground Source Heat Pump</th>
<th>Hydro</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Power (MWe)</td>
<td>227.5</td>
<td>23.6</td>
<td>24.4</td>
<td>57.0</td>
<td>0.0</td>
<td>-24.9</td>
<td>0.0</td>
<td>307.5</td>
</tr>
<tr>
<td>Thermal Power (MWth)</td>
<td>0.0</td>
<td>0.0</td>
<td>68.9</td>
<td>0.0</td>
<td>62.9</td>
<td>87.3</td>
<td>0.0</td>
<td>219.0</td>
</tr>
<tr>
<td>Emissions abated (tCO₂/yr)</td>
<td>203,525</td>
<td>16,890</td>
<td>146,598</td>
<td>23,732</td>
<td>11,241</td>
<td>16,088</td>
<td>75</td>
<td>418,149</td>
</tr>
<tr>
<td>Proportion of emissions from the built environment 2006</td>
<td>41%</td>
<td>3%</td>
<td>30%</td>
<td>5%</td>
<td>2%</td>
<td>3%</td>
<td>0%</td>
<td>85%</td>
</tr>
</tbody>
</table>

The methodology for calculating the Resource Potential for each of the above technologies is provided in sections 4.3 to 4.9.

4.2.3 Overview of Development Scenario

The resource potential provides a baseline from which to consider the opportunities available for low carbon technologies within the district. To provide a more useful indication of the anticipated exploitation of this resource we considered the resource, by technology and market pathway, to arrive at a ‘development scenario’ quantification of the resource.

**Definition of Development Scenario**

Development Scenario is the scenario of renewable energy exploitation for the district, once market conditions and other constraints (largely landscape and visual considerations) have been accounted for. Market conditions can be inferred from recent historical experience but the future will be influenced by a wide range of issues such as government policy, political delivery, underlying national and local economics, technological advancement and consumer behaviour; hence it is difficult to predict market uptake over time. Likewise, landscape and visual considerations are highly subjective and the views of stakeholders are variable (both spatially and over time).

The Development Scenario is quantified in line with the RSS’s target time frames, using assumptions based on ESD’s professional judgement and recent market update research available for renewable energy (where possible). We have also supplemented our own views of these issues with those of local stakeholders. The assumptions for each technology are provided in each of the respective sections below.

Turning the available resource (e.g. wind speed or solar irradiation in the district) into a Development Scenario involves a 3-step process.

1. The first step is based on the available resource in the district for each renewable energy technology- to determine the resource potential.
2. The second step involves applying constraints, such as market conditions or landscape and visual considerations to the Resource Potential in order to identify the Development Scenario of each renewable energy technology.
3. The final step makes use of the Development Scenario of each technology considered in this study to turn these into suggestions for practical recommendations for the district.
Figure 6 below illustrates a summary of the uptake of renewable energy technologies under the development scenario in Bolsover.

This shows that by 2016, 13,494 tCO$_2$/yr will be abated as a result of low and zero carbon technologies. This equates to less than one-thirtieth of the resource potential. Table 3 demonstrates the contribution for each technology, with large wind being the most significant contributor with 8,946 tCO$_2$/e/yr. This is followed by small scale heat-providing technologies, including biomass boilers, solar thermal, and ground source heat pumps.

By 2026, the contribution of these technologies has risen markedly to 72,560 tCO$_2$/yr, or one-sixth of the resource potential. By this time, biomass CHP and PV have been adopted on a much wider scale, and the further development of large scale wind continues to provide the mainstay of the abated emissions. Microgeneration technologies continue to be developed, but due to their scale they provide a much lesser impact than decentralised or communal systems.

<table>
<thead>
<tr>
<th>Technology</th>
<th>2016 Electrical Power (MWe)</th>
<th>2016 Thermal Power (MWth)</th>
<th>2016 Emissions abated (tCO$_2$/yr)</th>
<th>2026 Electrical Power (MWe)</th>
<th>2026 Thermal Power (MWth)</th>
<th>2026 Emissions abated (tCO$_2$/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydro</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Ground Source Heat Pump</td>
<td>0.4</td>
<td>0.4</td>
<td>0.5</td>
<td>0.4</td>
<td>0.4</td>
<td>0.5</td>
</tr>
<tr>
<td>Solar Thermal</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>PV</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Biomass</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Total</td>
<td>7.9</td>
<td>17.5</td>
<td>13,494</td>
<td>74.2</td>
<td>35.7</td>
<td>72,560</td>
</tr>
</tbody>
</table>
Table 4 demonstrates the impact that the development scenarios will have on Bolsover’s projected emissions. In 2016, the development scenarios would generate 2.6% of the district’s electricity and heat demand. By 2026, this will rise to 13.4%.

### Table 4: Impact of development scenarios upon Bolsover’s projected emissions

<table>
<thead>
<tr>
<th>Year</th>
<th>2006</th>
<th>2016</th>
<th>2026</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy demand (tCO₂e/yr)</td>
<td>494,680</td>
<td>515,442</td>
<td>541,413</td>
</tr>
<tr>
<td>Renewable energy (tCO₂e/yr)</td>
<td>0</td>
<td>13,494</td>
<td>72,560</td>
</tr>
<tr>
<td>Proportion of renewables</td>
<td>0.0%</td>
<td>2.6%</td>
<td>13.4%</td>
</tr>
</tbody>
</table>

To further understand what impact the development scenario would have on Bolsover’s future emissions, Figure 7 illustrates the effect that the renewable energy generation will have against the Building Regulations\(^\text{19}\). Interpreting this graph, the top of the yellow area indicates Bolsover’s emissions from the built environment if all buildings until 2026 are constructed to current building regulations. The yellow area represents the emissions saved due to the future Building Regulation ‘road-map’. The blue area in turn describes the emissions saved over and above those required for building regulations. The red area represents the remaining emissions which Bolsover produces.

Under the Climate Change Act 2008, the UK has legally binding targets to reduce total greenhouse gas emissions by 26% in 2020 and 80% in 2050, against a 1990 baseline\(^\text{20}\). Figure 7 plots these targets against estimated 1990 emissions of 507,000 tCO₂/yr for Bolsover. No data was available to directly reference Bolsover’s emissions in 1990. Therefore, the national emissions, excluding those from transport, were scaled down by population to approximate the district’s energy demand at this point in time.

Local authorities are not committed to achieve these targets since a significant proportion of the target is expected to be provided by grid-scale projects such as off-shore wind farms or nuclear energy plants. However, it is interesting to put the development scenario into context against the UK’s overriding requirements. In 2020, over 100,000 tCO₂/yr must be abated in addition to the development scenario to meet the 26% target.

\(^{19}\) Note that this graph is a revision upon Figure 2 which forecasts the district’s future emissions trend

Figure 7: Forecast of Bolsover’s built environment emissions until 2026, including the emissions abatement resulting from the development scenario. UK emissions reduction targets from the Climate Change Act 2008 are inserted for comparison.

- Abated emissions - building regulations
- Abated emissions - development scenario
- Remaining emissions

- - 26% by 2020 target
- - 80% by 2050 target
Sections 4.3 to 4.11 outline the major assumptions and sources which were compiled to create the development scenario data shown above. Further background information can also be found in the Appendices.

### 4.3 Large Wind

<table>
<thead>
<tr>
<th></th>
<th>Electricity (MWe)</th>
<th>Heat (MWth)</th>
<th>Electricity (MWh)</th>
<th>Heat (MWh)</th>
<th>Emissions abated (tCO₂/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resource</td>
<td>227.5</td>
<td>473,314</td>
<td></td>
<td></td>
<td>203,525</td>
</tr>
<tr>
<td>2016</td>
<td>10.0</td>
<td>20,805</td>
<td></td>
<td></td>
<td>8,946</td>
</tr>
<tr>
<td>2026</td>
<td>59.6</td>
<td>123,923</td>
<td></td>
<td></td>
<td>53,287</td>
</tr>
</tbody>
</table>

**Resource Potential**

A GIS analysis was undertaken which identified 137 sites (some of them very small) within the Council's boundaries which were not affected by the major constraints considered.

All of the larger sites were reviewed to assess for key barriers which were not possible to integrate within the GIS process. Examples include suitable access to the land, current land use, and likely proximity to a suitable substation. The latter of these is difficult to judge without a detailed site-by-site analysis in conjunction with distribution network operators (DNOs), however highly remote locations, where it was envisaged that no local substations would be present, were discounted due to the high cost of grid connection.

Applying the above experience in the feasibility of individual sites, a shortlist of 16 potential sites were identified as being probable for wind developers.

Wind turbines must be spaced appropriately so as not to affect their effectiveness. Taking into consideration the likely number of large scale wind turbines which could be fitted onto the unconstrained sites, it was estimated that 42 large scale wind turbines are technically feasible.

Each wind turbine would be 2.5 MW in size. This is currently the largest size of onshore wind turbine available, and is expected to be the status quo in future years.

**2016 Potential**

- All sites with 4 or more wind turbines will be financially viable: 5 sites with a total of 21 turbines

- Taking into consideration lead times for wind turbines, as well as planning issues which are regularly encountered, it is assumed that one site will gain planning permission for 4 wind turbines, each of 2.5 MW, totalling 10MW. This wind farm will be grid connected and not directly associated with any future developments.

**2026 Potential**

- As previously, all sites with 4 or more wind turbines will be financially viable: 5 sites with a total of 21 turbines
- It is assumed that by 2026, attitudes will have evolved towards large scale wind and hence planning will be more relaxed. Therefore, 100% of these 16 most viable sites will gain planning permission. This will equal 21 turbines of 2.5 MW, totalling 52.5 MW. These wind farms will be grid connected and not directly associated with any future developments.

- In addition to the ‘decentralised’ wind farms set out above, it is likely that individual developments will look to install on- or near-site wind turbines as a method for powering that site. At the time of writing, the exact definition of zero carbon is under review, and the outcome will have large implications for zero carbon homes. Currently, this definition does not permit off-site renewables which are not directly connected to the dwellings.

- In addition to the above 21 decentralised wind turbines, the technology may be utilised by new build developments aspiring to zero carbon. A recent report suggested that half of abated emissions from true zero carbon (Code 6) dwellings should be allowed to be off-site and not directly connected to the development. It is therefore assumed that 50% off-site generation is permitted.

- It is assumed that 50% of this off-site generation is by large wind.

- There is also a case for large wind turbines to be directly connected to future developments (i.e. on-site).

- This is best suited to large developments, such as urban extensions. It is assumed that a 1,000 dwelling development will have half its emissions abated by on-site or directly connected large wind. This will be provided by a further single large wind turbine, in addition to the 21 decentralised.

- The balance between heat and power demand in non-residential buildings is highly dependant upon the usage. There is currently limited information available as to the type of commercial/industrial buildings which will be constructed - retail, office, industrial, warehouse etc.

- 50% of emissions arising from zero carbon commercial buildings shall be provided by large wind. This will be provided by a further two large wind turbines, in addition to the 21 decentralised.

- In total, 24 wind large wind turbines, of around 2.5 MW each could be expected under the development scenario.

For large scale wind, the assessment is based on a spatial analysis undertaken in the form of a GIS constraints analysis. The GIS mapping considered 38 constraints relevant to large scale wind turbines. The key constraints include:

- Wind speeds which are greater than 5 metres per second at 45m above ground level
- International, national and local designations for heritage
- International, national and local designations for landscape
- International, national and local designations for ecology
- Designations for archaeology
- Space requirements, including proximity to buildings (for noise and visual reasons) and other turbines (to avoid wind turbulence)
- Air safeguarding and radar constraints from MOD and civil aviation interests
- Electromagnetic interference to communications radar (TV, radio, weather, mobile phone, etc.)
- Distribution network and landscape and visual constraints were not part of the GIS constraints mapping (refer to Appendix 1 for further details)

Combining all absolute constraints resulted in potential sites identified for 42 large wind turbines in the district. These 42 wind turbines represent the Resource Potential for large-scale wind in the district, as graphically illustrated in Figure 8. Overall, the areas in blue in this map (the ‘less constrained zones’) represent those areas that are suitable for large-scale wind turbines in the district, whereas the areas in red represent those areas that are unsuitable for the development of large-scale wind turbines in the district. The blue areas therefore, should not be immediately regarded as suitable areas for large wind turbines, but as areas of search within which suitable sites may exist.
Figure 8: GIS constraints analysis – constrained and less constrained zones for large-scale wind in the district
## 4.4 Small Wind

### Small Wind

<table>
<thead>
<tr>
<th></th>
<th>Electricity (MWe)</th>
<th>Heat (MWth)</th>
<th>Electricity (MWh)</th>
<th>Heat (MWh)</th>
<th>Emissions abated (tCO₂/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resource</td>
<td>24</td>
<td>39,280</td>
<td></td>
<td></td>
<td>16,890</td>
</tr>
<tr>
<td>2016</td>
<td>0.4</td>
<td>662</td>
<td></td>
<td></td>
<td>284</td>
</tr>
<tr>
<td>2026</td>
<td>0.7</td>
<td>1,180</td>
<td></td>
<td></td>
<td>507</td>
</tr>
</tbody>
</table>

### Resource Potential

- All farms larger than 5 ha and out-of-town retail/industrial parks are potentially suitable for a 100 kW wind turbine (156 sites).
- All farms smaller than 5 ha and all school/college/sites are potentially suitable for a 50 kW wind turbine (160 sites).

#### 2016 Potential

- 1% uptake for retail and industrial parks, as well as farms. This small uptake can mainly be attributed to a lack of will to invest in a project which takes longer than 3 years to pay back
- 10% uptake for schools due to public sector ownership.

#### 2026 Potential

- 2.5% uptake for retail and industrial parks, as well as farms. This small uptake can mainly be attributed to a lack of will to invest in a project which takes longer than 3 years to pay back
- 10% uptake for schools due to public sector ownership.
4.5 Biomass

<table>
<thead>
<tr>
<th>Resource</th>
<th>Electricity (MWe)</th>
<th>Heat (MWth)</th>
<th>Electricity (MWh)</th>
<th>Heat (MWh)</th>
<th>Emissions abated (tCO₂/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resource</td>
<td>24</td>
<td>69</td>
<td>194,896</td>
<td>388,313</td>
<td>146,598</td>
</tr>
<tr>
<td>2016</td>
<td>0</td>
<td>3.45</td>
<td>-</td>
<td>-</td>
<td>1,533</td>
</tr>
<tr>
<td>2026</td>
<td>0.18</td>
<td>14.82</td>
<td>-</td>
<td>-</td>
<td>7,499</td>
</tr>
</tbody>
</table>

**Resource Potential**

- Investigation into potential biomass sources arising from farmland and waste segregation.

- The resource was divided into marginal markets. Two for heat: pellet and dry chip, and five for combined heat and power: wet chip, off-cuts, straw, anaerobic digestion (AD) and municipal solid waste (MSW).

- It is assumed that every oven dried tonne of biomass is equivalent to 5 MWh of energy.

**2016 Potential**

- A recent BERR study\(^{21}\) identified the potential uptake of micro-generation for the UK up to 2050. From this data, it has been derived that 1.5% of existing dwellings in the East Midlands will install micro-generation technologies by 2016. It is estimated that one quarter of these dwellings will choose a biomass boiler.

- 11 kW biomass boiler is installed per existing dwelling.

- For new build, the following will be installed. These are smaller than those recommended above for existing dwellings. This is due to enhanced thermal performance of future new buildings which therefore require a smaller heat input.

<table>
<thead>
<tr>
<th>Period</th>
<th>Building Regulations</th>
<th>Total number of new dwellings</th>
<th>No. of dwellings to include individual biomass boilers</th>
<th>Biomass boiler size per dwelling (kW)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006-2010</td>
<td>2006 Part L</td>
<td>960</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2010-2013</td>
<td>CSH 3</td>
<td>1,020</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2013-2016</td>
<td>CSH 4</td>
<td>1,140</td>
<td>380</td>
<td>5.5</td>
<td></td>
</tr>
</tbody>
</table>

2026 Potential

- A recent BERR study\textsuperscript{21} identified the potential uptake of micro-generation for the UK up to 2050. From this data, it has been derived that 10\% of existing dwellings in the East Midlands will install micro-generation technologies by 2026. It is estimated that one quarter of these dwellings will choose a biomass boiler.

- 11 kW biomass boiler is installed per existing dwelling.

- One of the 1000 unit urban extensions is to have 50\% of its emissions abated on-site via a biomass CHP unit, which will provide 1.44 GWh electricity and 2.1GWh of heat.

- For new build, the following will be installed:

<table>
<thead>
<tr>
<th>Period</th>
<th>Building Regulations</th>
<th>Total number of new dwellings</th>
<th>No. of dwellings to include individual biomass boilers</th>
<th>Biomass boiler size per dwelling (kW)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016-2026</td>
<td>CSH 6</td>
<td>4,980</td>
<td>1,490</td>
<td>3.85</td>
<td></td>
</tr>
</tbody>
</table>

Resource potential

Biomass energy can be derived from a diverse set of sources, but can be defined as plant materials and animal waste which are used as a fuel source. This resource assessment looks at the potential biomass resource from a number of different sources within Bolsover, including farm, waste and industrial segregation. This produced the biomass sources outlined in Figure 9.
Figure 9: Biomass resources identified within Bolsover

<table>
<thead>
<tr>
<th>Biomass / Waste source</th>
<th>Annual resource</th>
<th>Marginal market</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crops &amp; bare fallow used for energy crops</td>
<td>6,045 Hectares of land</td>
<td>Dry Chip 10kW+</td>
</tr>
<tr>
<td>Set-aside used for energy crops</td>
<td>496 Hectares of land</td>
<td>Dry Chip 10kW+</td>
</tr>
<tr>
<td>Straw from cereals</td>
<td>4,256 Hectares of land</td>
<td>Straw 2MWe+</td>
</tr>
<tr>
<td>Silage from cattle</td>
<td>4,877 Number of cattle</td>
<td>AD Plant 500kWe+</td>
</tr>
<tr>
<td>Poultry waste</td>
<td>183,161 Number of poultry</td>
<td>AD Plant 500kWe+</td>
</tr>
<tr>
<td>Landfill - garden and food waste</td>
<td>5,126 tonnes</td>
<td>MSW plant 5MWe+</td>
</tr>
<tr>
<td>Landfill - paper and card</td>
<td>0 tonnes</td>
<td>Wet Chip 500kWe</td>
</tr>
<tr>
<td>Council Parks - green waste</td>
<td>0 Number of parks</td>
<td>AD Plant 500kWe+</td>
</tr>
<tr>
<td>Council forest/woodland residues/thinnings</td>
<td>0 Oven dry tonne</td>
<td>Wet Chip 500kWe</td>
</tr>
<tr>
<td>Forestry</td>
<td>1,835 Hectares of non-ancient</td>
<td>Dry Chip 10kW+</td>
</tr>
<tr>
<td>Joinery/Sawmills - sawdust</td>
<td>4 Number of Sawmills</td>
<td>Pellet 2kW+</td>
</tr>
<tr>
<td>Joinery/Sawmills - chip</td>
<td>4 Number of Sawmills</td>
<td>Dry Chip 10kW+</td>
</tr>
<tr>
<td>Joinery/Sawmills - offcuts</td>
<td>4 Number of Sawmills</td>
<td>Offcuts 100kWe+</td>
</tr>
<tr>
<td>Recycling centres - currently landfilled waste</td>
<td>25,993 tonnes</td>
<td>MSW plant 5MWe+</td>
</tr>
<tr>
<td>Category 1 industrial waste</td>
<td>0 tonnes</td>
<td>MSW plant 5MWe+</td>
</tr>
<tr>
<td>Private tree surgery wastes</td>
<td>3 number of tree surgery businesses</td>
<td>Wet Chip 500kWe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Marginal market</th>
<th>Primary energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood pellet</td>
<td>50,000</td>
</tr>
<tr>
<td>Wood chip - dry</td>
<td>576,225</td>
</tr>
<tr>
<td>Wood chip - wet</td>
<td>1,500</td>
</tr>
<tr>
<td>Off-cuts</td>
<td>54,330</td>
</tr>
<tr>
<td>Straw</td>
<td>42,560</td>
</tr>
<tr>
<td>Anaerobic digestion feed</td>
<td>39,313</td>
</tr>
<tr>
<td>Energy from waste feed</td>
<td>65,655</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Technology</th>
<th>Electrical energy (MWh/yr)</th>
<th>Thermal energy (MWh/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomass heating</td>
<td>0</td>
<td>37,500</td>
</tr>
<tr>
<td>Biomass heating/CHP</td>
<td>168,654</td>
<td>303,577</td>
</tr>
<tr>
<td>Anaerobic digestion</td>
<td>9,828</td>
<td>17,691</td>
</tr>
<tr>
<td>Energy from waste</td>
<td>16,414</td>
<td>29,545</td>
</tr>
</tbody>
</table>
The following summarises the existing sources of biomass, as well as the related future plans and potential opportunities within Bolsover:

### Waste and biomass

#### Current situation, future plans and potential opportunities in the district

<table>
<thead>
<tr>
<th>Current situation</th>
<th>Future plans</th>
<th>Potential for improving biomass- and waste-related energy generation opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Waste streams overall</strong></td>
<td>The current waste collection streams in the district are from households, at the Bolsover recycling centre located in Duckmanton and by the Council’s tree team that collects waste wood from trees and hedges in council gardens and public spaces. Data for commercial / industrial waste and supermarket food waste is unavailable, but due to the rural nature of the district, the related resource potential is estimated to be small.</td>
<td></td>
</tr>
<tr>
<td><strong>Green waste</strong></td>
<td>Green waste, i.e. general garden waste from households, is currently collected and taken to two composters outside of the district.</td>
<td>Green waste, all of which will be used for the new composting plant(s).</td>
</tr>
<tr>
<td><strong>Waste wood and chipboard</strong></td>
<td>Waste wood and chipboard is transported to recycling and composting contractors outside of the district (e.g. in Leicestershire and Sheffield).</td>
<td></td>
</tr>
<tr>
<td><strong>Conclusion current situation</strong></td>
<td>Apart from kitchen waste and household waste wood, every other waste stream that could be put to use -either to create soil improver or for energy generation- is currently already being collected in the district. However, all of the collected waste streams are currently being transported to outside of the district.</td>
<td>Wood waste could be collected from private and commercial sources within the district.</td>
</tr>
<tr>
<td><strong>New in-vessel composter to be set up by 2010</strong></td>
<td>Under the lead of Derbyshire County Council (DCC), one in-vessel composter is to be set up in 2010 in North-East Derbyshire. BDC’s Waste Services Department confirmed that there are even plans to put in another bid -again in partnership with DCC- for a second composter in the area.</td>
<td>The rural nature of the district offers a high potential to grow energy crops. Energy crops are crops grown specifically to be harvested and burnt to generate electricity and/or heat. Biomass energy crops can be divided into short rotation energy crops -harvested on a cycle of anything from 2 to 20 years, depending on the crop and the system- and herbaceous energy crops, which are harvested annually. Short rotation energy crops can be divided into two types. Firstly, short rotation coppices (SRC) include willow or poplar which are typically harvested every three years and secondly, short rotation forestry (SRF) which is closer to conventional forestry, but on a shorter timescale (8-20 years). Herbaceous energy crops are grass and non-woody energy crops with a typical harvest cycle of 2 - 5 years. However, there are also grasses and other plants offering annual yields, such as miscanthus. Miscanthus, for example, can be used on both large- and small-scale, even down</td>
</tr>
<tr>
<td><strong>Green waste</strong></td>
<td>All of Bolsover district’s green waste will be used for the new composting plant(s).</td>
<td></td>
</tr>
</tbody>
</table>

| Energy crops yield maps | DEFRA has published yield maps for energy crops for every region in the UK. The East Midlands' yield map for **SRC** reveals a medium potential yield for the district of Bolsover:

![Map](image1.png)

The East Midlands' yield map for **miscanthus**\(^{22}\) also reveals a medium potential yield for the district of Bolsover:

![Map](image2.png)

DEFRA's medium yield estimates for miscanthus would yield between 8 and 12 oven dried tons per hectare per year.

According to DEFRA's existing energy crop locations map\(^{23}\), there is one existing miscanthus energy crop scheme in the district (close to Langwith).
4.6 Photovoltaics (PV)

<table>
<thead>
<tr>
<th>PV</th>
<th>Electricity (MWe)</th>
<th>Heat (MWth)</th>
<th>Electricity (MWh)</th>
<th>Heat (MWh)</th>
<th>Emissions tCO₂/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resource</td>
<td>57</td>
<td>55,190</td>
<td>23,732</td>
<td>2016</td>
<td>0.48</td>
</tr>
<tr>
<td>2026</td>
<td>17.72</td>
<td>17,168</td>
<td>7,382</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Resource Potential

- There are 30,267 dwellings which have available roof space for PV. This excludes any residential buildings which are listed, and assumes that flat blocks have sufficient roof space for PV to supply 1 in 4 flats.

- 19% of roof space is suitable, taking into consideration orientation, architectural unsuitability, and overshading. Also 3 sqm per dwelling is set aside for solar thermal. This leaves 234,228 sqm for PV on residential buildings.

- It is assumed that the 1,134,930 sqm of non-residential floor space within the council’s boundary is, on average, spread over 2 storeys. The same proportion of available roof space is assumed as for residential, above.

2016 Potential

- A recent BERR study²¹ identified the potential uptake of micro-generation for the UK up to 2050. From this data, it has been derived that 1.5% of existing dwellings in the East Midlands will install micro-generation technologies by 2016. It is estimated that one quarter of these dwellings will choose a PV array.

- 1 kWp is installed per existing dwelling.

- For new build, the following will be installed:

<table>
<thead>
<tr>
<th>Period</th>
<th>Building Regulations</th>
<th>Total number of new dwellings</th>
<th>No. of dwellings to include PV</th>
<th>PV size per dwelling (kWp)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006-2010</td>
<td>2006 Part L</td>
<td>960</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2010-2013</td>
<td>CSH 3</td>
<td>1,020</td>
<td>255</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>2013-2016</td>
<td>CSH 4</td>
<td>1,140</td>
<td>380</td>
<td>0.6</td>
<td>With 4 sqm of solar thermal panels</td>
</tr>
</tbody>
</table>

2026 Potential

- A recent BERR study²¹ identified the potential uptake of micro-generation for the UK up to 2050.
From this data, it has been derived that 10% of existing dwellings in the East Midlands will install micro-generation technologies by 2026. It is estimated that one quarter of these dwellings will choose a PV array.

- 1 kWp is installed per existing dwelling.

- For new build, the following will be installed:

<table>
<thead>
<tr>
<th>Period</th>
<th>Building Regulations</th>
<th>Total number of new dwellings</th>
<th>No. of dwellings to include PV</th>
<th>PV size per dwelling (kWp)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016-2026</td>
<td>CSH 6</td>
<td>4,980</td>
<td>2,980</td>
<td>2.55</td>
<td>With 2 sqm of solar thermal panels. This assumes that 50% of emissions are abated by on-site renewables, with the remainder generated off-site.</td>
</tr>
</tbody>
</table>
4.7 Solar thermal

<table>
<thead>
<tr>
<th>Solar thermal</th>
<th>Electricity (MWe)</th>
<th>Heat (MWth)</th>
<th>Electricity (MWh)</th>
<th>Heat (MWh)</th>
<th>Emissions tCO₂/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resource</td>
<td>63</td>
<td>52,284</td>
<td>11,241</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td>3.5</td>
<td>2,880</td>
<td>533</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2026</td>
<td>6.9</td>
<td>5769</td>
<td>1,240</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Resource Potential

There are 29,945 dwellings which have available roof space for solar thermal collectors. This excludes any residential buildings which are listed, and assumes that flat blocks have sufficient roof space for solar thermal collectors to supply 1 in 4 flats.

Assuming flat plate collectors continue to be the most prevalent solar thermal technology, it would be typical to install 3 sqm of collector area per suitable dwelling. This would enable a total collector area of 89835 sqm to be installed upon residential dwellings.

With an average annual heat output of 582 kWh per sqm, the total potential energy generation can be estimated as 52,284 MWh per year.

2016 Potential

- A recent BERR study identified the potential uptake of micro-generation for the UK up to 2050. From this data, it has been derived that 1.5% of existing dwellings in the East Midlands will install micro-generation technologies by 2016. It is estimated that one quarter of these dwellings will choose a solar thermal array.

- 3 sqm of collector area installed per existing dwelling.

- For new build, the following will be installed:

<table>
<thead>
<tr>
<th>Period</th>
<th>Building Regulations</th>
<th>Total number of new dwellings</th>
<th>No. of dwellings to include SHW</th>
<th>SHW size per dwelling (m²)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006-2010</td>
<td>2006 Part L</td>
<td>960</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2010-2013</td>
<td>CSH 3</td>
<td>1,020</td>
<td>765</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>2013-2016</td>
<td>CSH 4</td>
<td>1,140</td>
<td>380</td>
<td>4</td>
<td>With 0.6 kWp of PV</td>
</tr>
</tbody>
</table>

2026 Potential

- A recent BERR study identified the potential uptake of micro-generation for the UK up to 2050. From this data, it has been derived that 10% of existing dwellings in the East Midlands will install micro-generation technologies by 2026. It is estimated that one quarter of these dwellings will choose
a solar thermal array.

- 3 sqm of collector area installed per existing dwelling.

- For new build, the following will be installed. The panel size below is smaller than set out above for CSH 4 due to the emissions savings generated by the sizable PV array.

<table>
<thead>
<tr>
<th>Period</th>
<th>Building Regulations</th>
<th>Total number of new dwellings</th>
<th>No. of dwellings to include SHW</th>
<th>SHW size per dwelling (m²)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016-2026</td>
<td>CSH 6</td>
<td>4,980</td>
<td>1,490</td>
<td>2</td>
<td>With 2.55 kWp of PV. This assumes that 50% of emissions are abated by on-site renewables, with the remainder generated off-site.</td>
</tr>
</tbody>
</table>
4.8 Ground source heat pump

<table>
<thead>
<tr>
<th>Ground source heat pump</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Resource</td>
</tr>
<tr>
<td>2016</td>
</tr>
<tr>
<td>2026</td>
</tr>
</tbody>
</table>

Resource Potential

| | Resource | 2016 | 2026 |
|-------------------------|
| There are 33,600 dwellings within the Local Authority's boundary. |
| There are two common types of ground source heat pumps (GSHP): For houses/bungalows with gardens, a shallow network of piping can be laid. Where there is little/no garden space, a deeper borehole can be drilled. |
| Access to drill boreholes or dig trenches is an inhibiting factor, and typically only 45% of dwellings provide sufficient access. |
| A typical residential GSHP system is sized at approximately 5 kWth. |
| Due to the minimal visual impact of the technology, it is not necessary to exclude listed buildings from the technical potential. |
| GSHPs are also technically feasible for the 1,134,930 sqm of non-residential floor space. |
| A 5 kWth GSHP could typically provide the space heating demand for 150 sqm of floor space. |
| Note that GSHPs require an electrical input, therefore the heat benefits are partially counteracted by the elevated electrical demand (shown as negative). For the sake of this analysis, it is assumed that grid electricity is used to power the heat pump, and thus the CO\textsubscript{2} reductions take this into consideration. |

2016 Potential

- A recent BERR study\textsuperscript{21} identified the potential uptake of micro-generation for the UK up to 2050. From this data, it has been derived that 1.5% of existing dwellings in the East Midlands will install micro-generation technologies by 2016. It is estimated that one quarter of these dwellings will choose a GSHP.
- In addition to the standard market uptake, the council has 3608 dwellings fuelled by either oil or solid fuel. It is assumed that GSHP will provide an elevated cost benefit to all of these properties. However, access for installing a GSHP allows only 45% to uptake this technology.
- 5 kWth system installed per existing dwelling.
- For new build, the following will be installed:
### Period Building Regulations Total number of new dwellings No. of dwellings to include GSHP GSHP size per dwelling (kWth) Notes

<table>
<thead>
<tr>
<th>Period</th>
<th>Building Regulations</th>
<th>Total number of new dwellings</th>
<th>No. of dwellings to include GSHP</th>
<th>GSHP size per dwelling (kWth)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006-2010</td>
<td>2006 Part L</td>
<td>960</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2010-2013</td>
<td>CSH 3</td>
<td>1,020</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2013-2016</td>
<td>CSH 4</td>
<td>1,140</td>
<td>380</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td><strong>2026 Potential</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>- A recent BERR study</strong>(^{21}) identified the potential uptake of micro-generation for the UK up to 2050. From this data, it has been derived that 10% of existing dwellings in the East Midlands will install micro-generation technologies by 2026. It is estimated that one quarter of these dwellings will choose a GSHP.**</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>- 5 kWth system installed per existing dwelling.</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>- For new build, no GSHPs have been modelled beyond 2016. GSHPs tend to present a more expensive option to achieve zero carbon compared to other renewable technologies. This is due to the electrical input which is required to operate the GSHP. Generating this electricity via renewables in addition to the GSHP tends to be costly.</strong></td>
</tr>
<tr>
<td>2016-2026</td>
<td>CSH 6</td>
<td>4,980</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>
4.9 Hydroelectricity

<table>
<thead>
<tr>
<th>Hydroelectricity</th>
<th>Electricity (MWe)</th>
<th>Heat (MWth)</th>
<th>Electricity (MWh)</th>
<th>Heat (MWh)</th>
<th>Emissions tCO₂/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resource</td>
<td>0.080</td>
<td>350</td>
<td></td>
<td></td>
<td>151</td>
</tr>
<tr>
<td>2016</td>
<td>0.020</td>
<td>88</td>
<td></td>
<td></td>
<td>38</td>
</tr>
<tr>
<td>2026</td>
<td>0.080</td>
<td>350</td>
<td></td>
<td></td>
<td>151</td>
</tr>
</tbody>
</table>

Resource Potential

The Environment Agency and British Waterways hold information regarding weirs which are of interest to them for environmental and navigation purposes respectively. The Environment Agency identified three weirs which they held data for – Buttermilk Bridge (Doe Lea river, Staveley (Doe Lea river) and Whittington (River Rother). British Waterways identified no weirs which they held data for. Communication with Bolsover council has identified that only Buttermilk Bridge is within the council’s boundary.

In addition to the above, it is known that there is interest in developing a hydro scheme at a further weir in Pleasley Vale.

In total, two weirs have been identified. The weir size (1 to 2 m head) and river flow data available suggest that these weirs are only capable of ‘microhydro’ systems. It is estimated that each of the sites are capable of supporting a 20 kW hydrodynamic generation plant.

Consultation with the Environment Agency has suggested that such hydro systems are unlikely to have a significant environmental impact upon the rivers. There are no applicable restrictions upon these rivers within local Catchment Area Management Systems (CAMS). It is therefore assumed that no planning issues would be faced in installing such systems.

2016 Potential

It is assumed that only the Pleasley Vale site is developed for a 20 kW hydrodynamic system.

2026 Potential

It is assumed that both sites are fully developed for hydro generation.
5 New Developments

5.1 Categorising development types

As outlined in section 1.2, Bolsover has targets to achieve 8,100 new dwellings and 200 hectares of commercial/industrial land in the period 2006 - 2026. Residential development can be divided into five categories, bulleted below. The major differentiators between these categories are size, location and density.

- Urban infill
- Rural infill
- Small urban extension
- Medium urban extension
- Large urban extension / new settlement

For each of these categories, a selection of opportunities and constraints exist which inform the most apt approach to achieve low carbon targets. Figure 10 identifies which of these categories are most representative of Bolsover's future residential development, and discusses the renewable and low carbon energy options for each.

5.2 Allocating different low carbon approaches to different development categories

5.2.1 Microgeneration

Microgeneration can be defined as renewable energy systems which are appropriate to be placed onto, or within the grounds of an individual building. Improved energy efficiency standards plus microgeneration technologies (such as photovoltaics, solar water heating, and ground sourced heat pumps) can deliver substantial carbon reductions in new developments.

Microgeneration is suitable for all scales of development, from small rural sites to large urban extensions. However, section 5.2.2 goes on to explain that for large scale development, communal energy generation tends to offer the most cost effective solutions. Hence, this analysis applies microgeneration as follows:

- Where development is too small scale to be supported by communal generation
- Where larger developments require a 'top-up' of renewable energy in addition to the communal system (mostly applicable to zero carbon developments)

5.2.2 Communal systems

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. The requirements of a communal energy system are discussed in section 4.1.3.
Therefore, on the basis of cost, the practical achievement of very low to zero carbon developments requires a communal energy system. This assumes that the total carbon reduction is required to be achieved ‘on-site’.
### Figure 10: Development types for Bolsover and typical low carbon energy strategies for each

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Proportion of future dwellings</th>
<th>Scenario for renewables testing</th>
<th>Options for low carbon/ renewable energy supply and carbon reduction potential</th>
</tr>
</thead>
</table>
| 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). | 25%                           | 2,049 dwellings, the majority of which are set in towns, with a small number in main villages. | • Individual rather than communal systems – with building integrated micro-renewables, such as SWH, PV, GSHP. Ultra energy efficient 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).                    | 8%                            | 626 dwellings, set in main villages and smaller villages. | • 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 passive house 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).            | 43%                           | 3,500 dwellings, with over half being extensions to towns. A single 500 unit development is assumed within this number, with the remainder being a few hundred units per development. | • Currently more suited to communal biomass heating rather than current 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 the future biomass CHP is likely to become more feasible as the technology matures.  
• If outer area is less dense, individual systems may become favoured for the less dense buildings.  
• Potential contribution from medium to large scale wind.  
• Potential to achieve low carbon development. Harder to achieve |
<table>
<thead>
<tr>
<th><strong>Urban extension</strong></th>
<th>Over 1,000 housing units adjoined to existing town and mix of other building types. Medium density (40 dwellings/ha).</th>
<th>24%</th>
<th>2,000 dwellings, all extending the district’s towns. Two developments of 1,000 units are assumed.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Meets indicative criteria for biomass/biogas CHP in terms of size and mix.</td>
<td></td>
<td>- 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.</td>
</tr>
<tr>
<td></td>
<td>- Also potential contribution from medium to large scale wind and possibly a few small scale options for hydro.</td>
<td></td>
<td>- Good potential to achieve very low carbon developments</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Large urban extension / new settlement</strong></th>
<th>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).</th>
<th>0%</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Communal systems based on biomass / biogas CHP supported by high density &amp; good building mix, with contributions from micro-renewables such as PV &amp; small scale wind</td>
<td></td>
<td>- Also potential contribution from medium to large scale wind and possibly hydro.</td>
</tr>
<tr>
<td></td>
<td>- Good potential to achieve very low or zero carbon developments.</td>
<td></td>
<td>- Good potential to achieve very low or zero carbon developments.</td>
</tr>
</tbody>
</table>
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 Figure 10 are indicative only.

There are a number of developments within Bolsover 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 opt for 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.

5.3 LZC responses

5.3.1 On-site / near-site / off-site

These three terms have recently come into the sustainable energy lexicon from their initial use in the Ecohomes methodology. Ecohomes, and its successor, the Code for Sustainable Homes required the delivery of the renewable energy to come from ‘on-site’ sources at the lower levels of the standard. At the upper end of the standards an array of options within successive issues of the Code for Sustainable Homes has opened the possibility of incorporating ‘near-site’, where a physical connection is still required, and under certain circumstances, ‘off-site’, under onerous conditions.

However, the development sector has called for exclusion of unconstrained ‘off-site’ generation, which for various technical reasons is typically far more cost effective than ‘on-site’ renewables. At present there is no accepted mechanism, nor procedure, to formally link ‘off-site’ generation (or other carbon reduction mechanisms) to a new development, hence, the reluctance to enable it as an option in the Code for Sustainable Homes.

We anticipate the release of the government consultation on the definition of zero carbon by the end of 2008 and we anticipate this will seek to establish rules of the use of ‘off-site’ renewables in the compliance of carbon reduction targets in the future.
6  Overall summary of Development Scenario

The results of Figure 6 in section 4 suggest that in 2016, 13,494 tCO$_2$/yr could be abated as a result of renewable energy installations within Bolsover. At this point, 2.6% of the District's energy demand is generated by renewables (in terms of CO$_2$). By 2026, the model shows renewable energy installations abating 72,560 tCO$_2$/yr, representing 13.4% of the District's energy demand (in terms of CO$_2$). These figures are tabulated in Figure 11.

**Figure 11: Summary of emissions abated by renewable technologies in the development scenario**

<table>
<thead>
<tr>
<th>Year</th>
<th>2006</th>
<th>2016</th>
<th>2026</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emissions from energy demand (tCO$_2$/yr)</td>
<td>494,680</td>
<td>515,442</td>
<td>541,413</td>
</tr>
<tr>
<td>Cumulative emissions abated due to renewable technologies (tCO$_2$/yr)</td>
<td>0</td>
<td>13,494</td>
<td>72,560</td>
</tr>
<tr>
<td>Proportion of renewables</td>
<td>0%</td>
<td>2.6%</td>
<td>13.4%</td>
</tr>
</tbody>
</table>

Figure 12 summarises the actual number of renewable energy installations required to achieve the 2026 development scenario. This enables a more tangible representation of the District's renewable portfolio if the development scenario was adopted.

As illustrated in Figure 6 on page 15, the installations below abate 72,560 tCO$_2$/yr, equating to 9.3% of the 2006 baseline.

**Figure 12: Summary of the renewable energy installations required to achieve the 2026 development scenario**

<table>
<thead>
<tr>
<th>Technology</th>
<th>2026 development scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind turbines – large scale</td>
<td>24 large turbines (circa. 2.5 MW) with a combined capacity of 60 MW. 21 of these will be installed by private developers, who will look to install at least four turbines on each of 5 sites. These sites do not have to be within proximity to an end user of the electricity generated. The remaining three wind turbines will be of similar size and installed in proximity to large new residential and commercial developments to enable a direct link with the end users of the energy generated.</td>
</tr>
<tr>
<td>Wind turbines – small scale</td>
<td>11 small turbines, roughly evenly split between turbines with a capacity of either 50kW (farms over 5ha and out-of-town retail/industrial parks) or 25kW (for farms under 5ha and school/college/university sites).</td>
</tr>
<tr>
<td>Technology</td>
<td>2026 development scenario</td>
</tr>
<tr>
<td>----------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Photovoltaics (PV)</td>
<td>784 existing buildings to install a 1 kWp PV array.</td>
</tr>
<tr>
<td></td>
<td>255 new build Code 3 dwellings to install a 0.5 kWp PV array.</td>
</tr>
<tr>
<td></td>
<td>380 new build Code 4 dwellings to install a 0.6 kWp PV array.</td>
</tr>
<tr>
<td></td>
<td>2,980 new build Code 6 dwellings to install a 2.5 kWp PV array.</td>
</tr>
<tr>
<td></td>
<td>9 MWp installed onto zero carbon commercial buildings.</td>
</tr>
<tr>
<td>Solar thermal hot water</td>
<td>784 existing buildings to install a 3 sqm STHW collector.</td>
</tr>
<tr>
<td></td>
<td>765 new build Code 3 dwellings to install a 4 sqm STHW collector.</td>
</tr>
<tr>
<td></td>
<td>380 new build Code 4 dwellings to install a 4 sqm STHW collector.</td>
</tr>
<tr>
<td></td>
<td>1,490 new build Code 6 dwellings to install a 4 sqm STHW collector.</td>
</tr>
<tr>
<td>Ground source heat pumps</td>
<td>784 gas-heated existing buildings to install a 5 kWth GSHP.</td>
</tr>
<tr>
<td></td>
<td>1,624 solid fuel-heated existing buildings to install a 5 kWth GSHP.</td>
</tr>
<tr>
<td></td>
<td>380 new build Code 4 dwellings to install a 5 kWth GSHP.</td>
</tr>
<tr>
<td>Hydroelectricity</td>
<td>Two small hydrodynamic systems of 20 kW each.</td>
</tr>
</tbody>
</table>
7 Recommendations for Local Development Framework Policies

7.1 Obtaining the views of key stakeholders

7.1.1 Dialogue with stakeholders

In undertaking the renewable energy resource assessment we had discussions with a number of key individuals:

- Ian Collis, Head of Planning Policy, Bolsover District Council
- Ruth Hayes, Planning Assistant (Policy), Bolsover District Council
- John Dengate, Senior Planning Technician (Policy), Bolsover District Council
- Ian Usher, GIS Officer (LLPG Custodian), Bolsover District Council
- Catherine Hedley, Waste Services Manager, Bolsover District Council
- Adie Lowery, Street Services Manager, Bolsover District Council
- Maggie Bishop, Derbyshire County Council
- Helen Chadwick Regional Energy co-ordinator
- Paul Tame, Environment & Land Use Advisor (East Midlands), National Farmers Union
- Environment Agency (East Midlands)
- Tony Trafford, Bolsover Energy Partnership
- Welbeck Estates
- Helen McLoughlin, Waystones developments
- Banks Development’s Wind Farm Team
- David Oldham, Alkane Energy
- Barbara Hilton, Coppice Resources

7.1.2 Stakeholder workshop

Interim findings for this study were tested with a multi stakeholder workshop held at Markham Vale Environment Centre on 14 November 2008. Its aims were to obtain the opinions of key stakeholders regarding obstacles and opportunities for realising the renewable energy resource within the district and the types of planning policies that will be needed in order to facilitate the development of renewable energy.

The first session considered the potential renewable energy resource within the district. Following a presentation on the resource potential within the district of a range of renewable energy technologies, breakout groups discussed the most suitable technologies, and potential quantities and locations for renewable energy in the district.

Key discussion topics included:

- New developments / existing resources that may not have been considered
- Key barriers to renewable energy development within the district;
- Main opportunities for renewable energy development within the district;
• Appropriate types and locations for renewable energy in the district;

The second session considered the planning requirements for new developments in order to ensure that housing growth within the district is low carbon.

Key discussion topics included:

• Aspirations within the council and the district for sustainable low carbon development;
• Specific planning measure responses in Bolsover
• Specific non-planning measures to ensure planning targets / policy are successful
• Consideration of burden on developers in the district.

The workshop was organised as an interactive event to maximise the opportunity for comment and feedback and the following is a summary of the key issues raised at the workshop. The views expressed in the workshop fed into the consideration of policy mechanisms outlined below.

7.1.3 Summary of workshop outcomes

Renewable energy potential in the district

The general view of allowing development of wind energy, whilst being “sensitive” to the heritage and cherished parts of the landscape, was widely held. It was recognised that the wind development market together with the planning process would judge where and if a turbine or turbines were to actually go ahead. Some participants felt that the scope for multiple smaller turbines could be further investigated – however, they recognised that the smaller turbines have a substantially smaller energy output than the large turbines.

Participants felt that a national ‘feed-in tariff’ policy measure, similar to the one in Germany, would be an appropriate means to incentivise householders and building owners of existing buildings to install solar photovoltaics and solar water heating technologies.

Regarding demonstrating the benefits of microgeneration technologies (including Ground Source and Air Source Heat Pumps) to the local community, contributions can come from both, the planned new developments within the district as well as from the existing stock, e.g. refurbishment of the council housing stock.

Participants felt that biomass and waste are resources that should be further exploited, mainly by

• diverting waste from landfill to feed energy-from-waste plants;
• making use of the significant farmland within the district to develop short rotation coppice (SRC) and/or woodland management schemes (e.g. growing SRC on colliery spoil heaps) or to develop organic oils / biodiesel schemes;
• considering anaerobic digestion (AD) schemes, whereby waste can produce methane (to burn) and a mineral rich digestate.
As for coal mine methane (CMM), it was felt that there are two main challenges, i.e. resource estimation and risk appraisal. This in turn has an impact on the economic feasibility of such schemes, as the cost of drilling to tap methane is only justified if there are large reserves of the gas to extract.

Planning policy in new development

All participants felt that the Bolsover District Local Development Framework must assist and encourage developers to build excellent low carbon developments. However, we identified a genuine divergence of opinion from stakeholders which was played out during the workshop through a lively debate. Some individuals felt that the national policy for improving carbon standards over the next decade, with all development from 2016 being zero carbon, is strict enough – and that the Bolsover LDF should concentrate on helping developers to achieve these challenging standards. Other individuals strongly felt that Bolsover should have higher aspirations than the national targets, with zero carbon requirements potentially coming earlier than 2016. It was felt that all renewable energy technologies have a role to play and should be encouraged in the district. It was also felt that the existing building stock should be the key focus for improving energy performance and installing renewable energy technologies – and that the council should seek to influence this both through the planning and outside it.

Undue burden on developers

Although participants recognised the challenges for developers in the current economic climate, they felt that strict sustainability requirements should now be accepted as a standard component of development costs. However, they felt that the public sector would need to assist developers wherever possible in achieving these standards, and that a partnership approach should be adopted in seeking to follow the low carbon development trajectory set out.

In order to support developers in achieving low carbon developments, it was felt that the public sector should increase grants to assist developers to meet energy standards for new buildings and supply affordable homes. Knowledge transfer between key stakeholders within the district was also mentioned as a useful means to address this issue.

Planning measures required to ensure successful planning targets / policy

Regarding specific planning measures, participants felt that policies should be specific to individual renewables. However, in order to achieve these, Planning Control would require a higher level of expertise to help make informed decisions. Furthermore, it was addressed that other planning restrictions would need to be relaxed, if CO\textsubscript{2} emission reductions were ‘above and beyond’.

Non-planning measures required to ensure successful planning targets / policy

The two main arguments related to the role of specific non-planning measures were

- financial feasibility of renewables: this can be increased through large-scale generation or bulk buying of microgeneration technologies
- removal of inhibiting regulatory restrictions
7.2 Planning policy for new development

7.2.1 Building Regulations driving low and zero carbon development

As outlined above, the phased housing growth in the district over the next 15 years will be shaped by a changing set of carbon performance standards in the Building Regulations. The Government has set out its intentions 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 requirements;
- 2013 – a 44% carbon reduction beyond current requirements; and,
- 2016 – zero carbon.

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 residential development after 2016 is likely to need to be zero carbon. Whilst a final definition of zero carbon has yet to be established it will be very challenging and will require innovative approaches from both the public sector as well as the development industry. For the purposes of this project we have assumed a definition of a zero carbon home as a highly efficient home with a Heat Loss Parameter of 0.8 W/m² and with all space heating, electricity and cooking energy consumed within the home to be offset with new renewable energy, with a minimum of 50% of this being generated “on-site” or “near-site” and the remainder being delivered “off-site” but formally linked to the development. The government published its consultation on the definition of the ‘zero carbon’ in December 2008, but it has not been possible to consider the options presented for achieving ‘zero carbon’ within this report.

7.2.2 Setting renewable energy and carbon reduction policy within the LDF

The tightening carbon requirements in the Building Regulations will nonetheless allow developers flexibility in terms of their choice of technology and approach to meeting carbon targets. Bolsover needs to determine how to embed these carbon requirements within its LDF and to shape the interpretation of the Building Regulation requirements within the district.

The two key variables in terms of crafting LDF policies for new developments are the level of carbon reductions required and the flexibility allowed in meeting these requirements. Although it represents an example of regional planning policy, the London Plan is a good example of highly prescriptive planning policies that even sets out the balance of technologies required depending on the nature of the development. If planning policy is only prescriptive over carbon targets and is not able to exercise some degree of control over the choice of technology, then developments may opt for technologies that may be inappropriate for the particular location or ‘sterilise’ the ability of the development to achieve very low to zero carbon status in the long term. As outlined in chapter 5, the type of development and the scale of the development all determine the most appropriate technical approach and the level of carbon reductions that are achievable. In general, larger developments are able to achieve significant carbon reductions more cost effectively than small developments.

When considering carbon requirements within the Bolsover District Development Framework, the key question is whether the proposed Building Regulation improvements are adequate or
whether Bolsover would like to set stricter requirements. Tighter requirements could be set for all new development in the district or site specific policy could be set for specific developments. The site specific policies would need to be evidence based policies that are underpinned by analysis of what is possible for the development considering its size, density and mix, and the renewable resource at that locality.

The figure below outlines the approach of using the evidence base of the low carbon and renewable energy potential resource within the district to set carbon standards for new developments. The carbon targets for specific developments would not only be based on the potential renewable resource around the district, but also, perhaps more importantly, the specific characteristics of the developments themselves and the specific characteristics of the development sites.

Figure 13: Approach to setting low carbon targets for new developments

7.2.3 Evolving Regional & National Policy Guidance

The East Midlands Regional Plan is currently in draft form after completing Examination in Public in 2007. The outcomes of this process included a number of recommended changes relevant to the issues covered in this report. These proposed changes were due to the redefinition of key terms such as “carbon neutral” (becoming “zero carbon”) and responding to national planning guidance, particularly PPS1 Supplement (Climate Change). The following identifies the key issues:

“Policy 3 (was Policy 2): Promoting Better Design

The layout, design and construction of new development should be constantly improved by………design and construction that minimises energy use, uses sensitive
lighting, improves water efficiency, reduces waste and pollution, incorporates renewable energy technologies and sustainably sourced materials wherever possible, and considers building orientation at the start of the design process……….”

Clearly this provides a mandate for greener buildings but it does not specifically establish standards to be met.

The Regional Plan review recommended updating the context for Policy 3 as follows:

“In securing a proportion of energy from decentralised and renewable or low-carbon sources…..development plan documents [should] include policies which expect a proportion of the energy supply of new development to be secured from decentralised and renewable or low-carbon sources. In the interim period, before DPDs are in place, all new developments of more than 10 dwellings, or for others uses exceeding 1,000m² floorspace, should secure at least 10% of their energy from decentralised and renewable or low-carbon sources unless it can be demonstrated by the applicant, having regard to the type of development involved and its design, that this is not feasible or viable;” and;

“…..there will be situations where it could be appropriate for local planning authorities to anticipate levels of building sustainability, for identified development areas or site-specific opportunities, in advance of those set out nationally.

……..local planning authorities must be able to demonstrate the local circumstances that warrant and allow this and that any local requirement must be set out in a development plan document to ensure it is properly tested. It also makes clear that local requirements should be specified in terms of achievement of nationally described sustainable buildings standards (the Code for Sustainable Homes in the case of housing).”

Consequently as a minimum Bolsover should set a 10% policy for new “major” development and give consideration to specific opportunities to go beyond existing and proposed future standards.

“Policy 38: Regional Priorities for Energy Reduction and Efficiency
Local Authorities, energy generators and other relevant public bodies should:
• promote a reduction of energy usage in line with the ‘energy hierarchy’;
• develop policies and proposals to secure a reduction in the need for energy through the location of development, site layout and building design;
• develop policies and proposals that contribute to a reduction in energy demand in new development and promotes operational ‘carbon neutrality’ wherever practical.

Supplementary Planning Documents should be prepared where appropriate to explain how such policies will be implemented.”

The Regional Plan review recommended clarification of Policy 38 as follows
"...the Planning and Climate Change PPS (PPS1 supplement) expects development plan documents (DPDs) to include policies which promote and encourage a proportion of the energy supply of new development to be secured from decentralised and renewable or low-carbon sources. The East Midlands will have significant growth in development over the Regional Plan period and new development will need to secure the highest viable resource and energy efficiency in order to ensure that the Region can also make its contribution to the national carbon emissions reduction targets and longer term goals. To achieve this, substantial areas of new development need to be located where there is good accessibility by means other than the private car and where energy can be gained from decentralised energy supply systems, or where there is clear potential for this to be realised..."

In practice, the larger developments in the district could aim for tighter carbon standards than the national requirements require in the period before 2016. All developments that are large and dense enough to support CHP systems are theoretically able to achieve zero carbon performance through “on-site” biomass CHP and PV or a large wind turbine. Moreover, if the eventual definition of ‘zero carbon’ allows for “off-site” energy generation then this would mean zero carbon would be achievable on most sites. However, a detailed study of each specific development site will highlight whether or not the conditions are appropriate for a biomass CHP system and a wind turbine, and/or whether there is an accepted mechanism for an “off-site” contribution. The last and not-insignificant hurdle is whether the zero carbon status can be achieved at a cost that can be borne by the market.

“Policy 39: Regional Priorities for Low Carbon Energy Generation
Local Authorities, energy generators and other relevant public bodies should promote:
• the development of Combined Heat and Power (CHP) and district heating infrastructure necessary to achieve the regional target of 511 MWe by 2010 and 1120 MWe by 2020; and;
• the development of a distributed energy network using local low carbon and renewable resources. .....“and;

“Low carbon energy proposals in locations where environmental, economic and social impacts can be addressed satisfactorily should be supported. As a result, Local Planning Authorities should:
• safeguard sites for access to significant reserves of coal mine methane;
• identify suitable sites for CHP plants well related to existing or proposed development and encourage their provision in large scale schemes;
• consider safeguarding former power station and colliery sites for low carbon energy generation;
• support the development of distributed local energy generation networks; and;
• develop policies and proposals to achieve the indicative regional targets for renewable energy set out in Appendix 5

The Regional Plan review did not suggest major changes to Policy 39. It therefore currently recognises the importance of CHP, district heating in terms of enabling larger development to attain high carbon standards, and the need to safeguard locations of value for renewable energy generation.
7.2.4 Timescales of Bolsover District housing growth and the changing Building Regulation standards

The various phases of housing growth in the district up to 2026 will be captured by these differing Building Regulation standards. When determining whether there is a need for carbon reduction policies in the LDF that are in advance of national requirements, it is a useful exercise to assess the projected timescales of the housing growth and identify the numbers of units which will precede 2013 and 2016. If most of the development will come after 2016 then the benefits of prescribing and justifying tighter requirements in advance of this date will be minimal.

If Bolsover was keen to encourage zero carbon developments before 2016, then it will need to provide an evidence base that demonstrates the local circumstances that enable zero carbon status to be achieved at the particular location. As outlined above, zero carbon developments are theoretically possible at any location if the size, density and mix of uses suit biomass CHP – as the biomass fuel can be brought from outside the district. Solar PV or a large wind turbine, contractually linked to the development are also likely to be needed and/or the existence of an accepted “off-site” mechanism (if this were allowed under the future zero carbon definition).

If the phased build-out rate of new housing within Bolsover follows the projection figures provided by BDC, then approximately 3,120 housing units will be constructed before 2016 and approximately 4,980 units will be built after 2016. Therefore, approximately 60% of the development would be captured by the 2016 zero carbon requirement. Bolsover Council needs to assess the likelihood of these build-out rates being achieved, and also the specific developments that are likely to come forward prior to step-changes in carbon standard at 2010, 2013, 2016 and 2019. If the first phases of the larger scale developments are coming forward in the earlier years, and these first phases are planning energy solutions that are only achieving relatively small carbon savings, then they might miss the opportunity for putting in place zero carbon infrastructure across the whole of the large scale development. Under the current economic conditions, the pace of housing development within the UK has slowed right down, and therefore it is very likely that the housing projection figures will fall back a few years. In which case, the number of housing units which will be built after 2016 will be larger than 4,980 units and the effect of tighter carbon requirements, and carbon standards that are in advance of national policy, will have a smaller corresponding impact on carbon emissions.

It has not been possible during the course of this analysis to identify and assess a temporal-spatial growth pattern across the district and doing this for the major urban extensions proposed within the district will be important to ensure key opportunities are captured.

7.2.5 Potential requirements for large new developments

It is technically feasible for all the developments, apart from the small scale urban infill, to achieve zero carbon status, i.e. reduce the net CO₂ emissions over the course of the year, resulting from all energy consumption within the buildings, to zero by using renewable energy on or near the site.
As outlined in section 5 above, it is very difficult with current technology for the average small scale urban infill, often consisting of high density flats, to achieve very substantial carbon reductions unless the development can share energy systems with existing neighbours. This is mainly due to the fact that solar PV will be relied on to generate electricity and with limited space to integrate PV in dense urban infill it may not be technically feasible. However, for larger urban extension developments, the chances of achieving zero carbon status are greater if biomass or gas CHP can be used to generate renewable electricity. The large developments, such as urban extensions, are more easily able to achieve zero carbon status using a range of renewable technologies and communal heat networks, with the majority of electricity provided by wind energy, biomass/gas CHP and PV.

The key issue regarding whether the larger developments in Bolsover District can achieve zero carbon status, is whether they can be built in conjunction with large wind turbines that can provide large amounts of zero carbon electricity. The available wind resource for the district has been shown to reside across the district, although because it has not been possible to correlate these sites with spatial mapping of new development it is difficult to suggest linkages. This is also the case for possible linkages with sources of industrial (waste) heat and possible linkages to existing heat loads could be partly met from oversized generation / community heating incorporated into new development. It is recommended that a spatial correlation of key power resources and existing heat sources and loads against new development is conducted [RECOMMENDATION]

Even if physical linkages are not possible, this does not necessarily mean that the district’s wind resource is incompatible with the energy demands of the new development, and in fact the new developments could possibly establish contractual relationships with “off-site” power and heat generation. The conclusions of the government consultation over the definition of the ‘zero carbon’ will significantly influence this. Bolsover Council and other stakeholders such as the Bolsover Energy Partnership could play a role in stimulating and sanctioning such relationships between housing developers and commercial wind developers.

Presently, the Code for Sustainable Homes requirement for all energy to be generated ‘on site’ presents a challenge to the inclusion of renewable energy supply that is located elsewhere within the district. However, the Department of Communities and Local Government is aware of the difficulty of all renewable energy generation having to be located within the boundaries of the site, and is considering the potential of local renewable energy generation that is physically off site but contractually linked to development sites.

7.2.6 Planning policy to support developers in achieving low carbon standards

Even if Bolsover decides that the carbon requirements within the phased Building Regulation improvements are strict enough, there are still a number of measures and policies that need to be implemented within the LDF to help ensure that developers meet these standards. A key issue is ensuring that developers install the correct energy supply systems so as to enable continued carbon reductions into the longer term. It is important that developers do not opt for cheaper strategies in the earlier phases which jeopardise the ability of the development to achieve significant carbon savings in the longer term (post 2013/16). In particular, developers need to plan for a communal system from the outset so as to ensure that greater carbon reductions are achievable. If developers concentrate on individual building systems for the earlier phases in the period pre-2016, then it will be difficult to introduce successful communal systems in the later periods.

The technical energy solutions for different development types outlined in chapter 5 provide a useful guide to the energy strategies that developers will need to install in order to achieve very high carbon standards. A detailed understanding of the technical requirements for
different development types will also enable the planning authority to outline in detail what they expect from developers, which will aid planning negotiations. It will also help ensure that energy strategies for phased developments are future-proofed so that they do not opt for individual building solutions in the early phases which jeopardise the viability of a development-wide CHP and district heating scheme.

The inclusion of a large wind turbine can be an important element of a low carbon strategy, and yet in order to progress this option the developer will need to arrange a contract with a wind turbine developer and a land-owner. This presents additional challenges for the developer and the Council may need to assist the developer in forming relationships with adjacent land-owners and in encouraging land-owners to opt for installing turbines on their land. A large wind turbine can not be located on the actual development site as it would be too close to housing, and it will therefore need to be located on land close to the site. This will require the LDF to specifically allow for ‘off-site’ renewable energy in supplying energy to new developments, so that developers can use a wind turbine located on land nearby to provide power for the development.

7.2.7 Supporting CHP and district heating infrastructure

Characteristics of communal infrastructure

As outlined in chapter 4, shared low carbon infrastructure has an essential role to play in enabling carbon reductions in the built environment and in facilitating the exploitation of renewable energy. District heating networks are particularly important in terms of enabling the efficient use of biomass fuel through combined heat and power (CHP) systems or enabling advanced technology energy-from-waste CHP plants to provide heat and power to communities. Planning policy needs to be proactive in encouraging these networks and in encouraging buildings to connect to these networks – and the approach can vary from prescriptive requirements to more general policies of encouragement.

Combined heat and power and biomass heating are vitally important low carbon technologies, and yet their use is generally dependent upon district heating networks in order to distribute the heating to housing and other buildings. CHP and district heating suffer a general lack of support policy and are not favoured by the UK’s energy market place. The challenge of realising the carbon savings from CHP and biomass heating within the existing built environment is generally wrapped up within the challenge of developing district heating networks which require high capital investment and long payback periods. CHP and district heating require support from both planning policy and financing mechanisms. The public sector can further assist heat network development by using their buildings as ‘anchor heat loads’ to form the basis of heat network development. Large buildings with fairly constant heat demand such as leisure centres, hospitals, prisons and hotels are all effective anchor loads.

Heat mapping

It is possible to quantify the potential for district heating, and the associated carbon savings of connecting existing buildings to a heat network, through producing a ‘heat map’ for the Bolsover District. The heat map would quantify the areas of greatest heat demand within the district and thereby highlight where CHP and district heating networks would be most effective. We have conducted this in a simple way during the project through the mapping of gas consumption data at Middle Layer Super Output Area (MLSOA) level, however, in practice a higher resolution analysis and combined with the collation of data regarding building types and floor areas would be necessary. This helps to build up an existing heat,
cooling and power density map which identifies where CHP can provide an excellent carbon reduction solution within the district. In Bolsover it is considered that the opportunities for CHP and Community Heat will be limited to the urban extension development, large mixed used development and connection of industrial waste heat sources and since there will be a limited number of these opportunities heat mapping the district would probably not present great value.

**Overcoming project risk and enabling commercial delivery**

Where linking heat infrastructure for the community heating is identified as an opportunity it will be important to give due consideration to the investment requirement which will be considerable, requires considerable financial investment, and yet revenue risks will be high. For this reason a support mechanism may be required to provide infrastructure funding for combined heat and power and district heating systems under current market conditions.

The government has established the Community Infrastructure Levy (CIL) to provide funding for long term infrastructure. However, the CIL is currently focusing on other types of infrastructure, such as transport and social infrastructure, and is unlikely to provide any finance for energy infrastructure. Nonetheless, the structure and management of the levy is a useful example of how local or sub regional funds could be established to support the development of low carbon infrastructure.

Infrastructure funding could be partly achieved through capturing the increase in land value that occurs when development is permitted, which means that developer contributions can be harnessed without stifling development incentives. However, general funds raised in this way will have many demands placed on them and therefore a separate fund for energy infrastructure is likely to be needed with the public sector providing the initial lump sum which is then repaid through developer’s energy contributions (see Non-Planning Policy section below).

A 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.

**7.2.8 Consideration of low carbon development through on site and off site renewable energy**

As outlined already in this report, it can be difficult to achieve very low or zero carbon developments through generating all energy needs within the boundaries of the development site – known as on-site renewable energy. To deliver low to zero carbon developments through on-site renewable energy for over 8,000 housing units and associated infrastructure in the district is likely to be very expensive and require large numbers of micro-renewable energy installations in new developments with consequences for the appearance of the new developments and the urban landscape of the district.

A balanced approach to energy supply with contributions from both on-site and off-site low carbon energy could help achieve the optimum technical and financial solution. Allowing off-site renewable energy generation for new developments could improve the technical potential of achieving low to zero carbon development and also substantially reduce the cost.
of doing so. However, it would raise a number of questions such as how to link the off-site renewable energy to the specific development (would it need to be a physical link or only a contractual link?) and whether financing mechanisms would need to be established in order to enable developers to invest in renewable energy projects within the district.

The policy considerations for enabling on-site and off-site energy generation for low to zero carbon developments are outlined in the tables below. The key issues for off-site generation include the problem of Code for Sustainable Home rules requiring the generation to be on-site, the challenge of connecting distant renewable energy installations to specific development sites, and the impending re-definition of zero carbon.

**Figure 14: Policy considerations for enabling greater on-site renewable energy generation**

<table>
<thead>
<tr>
<th>PLANNING</th>
<th>INFRASTRUCTURE</th>
<th>FINANCE</th>
<th>DEVELOPMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large quantity of micro-renewables installed on buildings</td>
<td>Displaced finance from other infrastructure needs, e.g. education/affordable housing</td>
<td>Very expensive approach</td>
<td>Development risk mitigation</td>
</tr>
<tr>
<td>Redirect S106 from other areas to renewables</td>
<td>Local district heating</td>
<td>Challenge for embedding CHP &amp; DH within phased construction</td>
<td></td>
</tr>
<tr>
<td>Need to allow innovative, new housing design</td>
<td>Grid connections</td>
<td>Cash flow</td>
<td></td>
</tr>
<tr>
<td>Requiring district heating in all large new developments</td>
<td></td>
<td>Heat/ power/carbon contract uncertainty</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 15: Policy considerations for delivering greater off-site renewable energy generation (within the district)**

<table>
<thead>
<tr>
<th>PLANNING</th>
<th>INFRASTRUCTURE</th>
<th>FINANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Need to agree planning mechanism for ‘connecting’ off-site renewables to specific developments</td>
<td>District heating network for connecting off-site CHP plant to development, and linking into other existing development</td>
<td>Need financing mechanism for developers to subsidise off-site renewables – wind, biomass, energy-from-waste</td>
</tr>
<tr>
<td>Revised criteria for wind development targets/ allowances in LDF</td>
<td></td>
<td>Carbon purchase/additionality arrangements</td>
</tr>
</tbody>
</table>
In order to allow a contribution from off-site renewable energy, the Council may need to draft rules to ensure that off-site installations are additional to any commercial renewable energy developments that may have occurred anyway within the district. This could involve the establishment of a centrally held registry of off-site schemes in the district so as to monitor the developments that are benefiting from more distant installations.

7.2.9 Impact on Developers of renewable energy requirements - consideration of ‘undue burden’

Consideration of undue burden is a key element of assessing what carbon requirements are acceptable for the district, or for specific developments within the district. The average estimated costs of achieving the carbon reduction standards within CSH Level 4, 5 & 6 are:

- CSH 4 - £8,000;
- CSH 5 - £11,500;
- CSH 6 - £30,000.

The additional cost on developments consists of the capital costs of enhanced energy efficiency measures, building integrated technologies (PV, STHW, GSHP) and communal infrastructure (heat networks, additional cabling). These costs illustrate that the marginal cost of delivering further carbon reductions in new developments gets higher as you progress towards CSH 6 and achieving a zero carbon development. The cost of achieving the carbon standards under CSH 5 & 6 assumes that a communal system approach is adopted, and the costs of achieving zero carbon status through individual building systems would be significantly higher. An assessment of the cost implications of achieving CSH levels 4-6 would need to be undertaken for each specific development and the issue of undue burden would therefore also vary from site to site. Developers can work in partnership with an Energy Services Company (ESCO) to finance, maintain and operate the energy system for a new development and therefore reduce the costs and the level of burden that they face.

The onus should be on the developer to prove if and why they cannot meet certain carbon targets. In evaluating the impact of the carbon costs on the viability of the development, the developer would need to consider the current state of play of all other development costs as well the market sales prices and land value at that time. Interpretation of the results also requires a judgement being made as to whether the additional costs will be borne by the end consumer (the buyers of the homes and buildings), the landowner (who could take a drop in sales price) or the developer. This requires analysis on a case by case basis depending on what is likely to be born by the market at time of selling and if the developer either already owns the land or has an option on it.

The impact on developers isn’t only that of cost, and there is also the challenge for developers of installing energy infrastructure, understanding the energy supply business and working with ESCOs. Many developers have considered the recent focus on low carbon developments to be a huge burden due to their lack of understanding of the issues.
Nonetheless, the knowledge of the development industry is advancing all the time and as a result the knowledge barrier is decreasing all the time. Even though the carbon standards in the Building Regulations will continue to get tighter, the skills and knowledge burden on developers is unlikely to increase because their understanding is constantly increasing.

The sections below on ESCOs and special purpose vehicles outline the approach that developers need to take in order to reduce the costs of delivering low carbon developments – and thereby manage the degree of burden that is caused by low and zero carbon building requirements.

### 7.2.10 Diverting finance to more cost effective carbon reduction measures within the district

The LDF could require developers to pay to offset all the residual emissions from their developments following the approach taken by Milton Keynes Council. The Council would need to establish a ‘carbon offset fund’ into which these payments are deposited, and then distributed to insulation schemes within the district. Milton Keynes Council has set a cost per tonne of carbon that it requires developers to pay which is based on the cost of delivering carbon savings through loft and cavity wall insulation in existing homes. If this money is invested in loft and cavity wall insulation then it will exactly offset the carbon emissions from the new build, which could then be viewed as a ‘carbon neutral’ development.

However, in order to claim that the new developments are carbon neutral, it is essential that these carbon reductions in existing housing are ‘additional’ savings – i.e. that they wouldn’t have happened unless they were financed by the carbon offset fund. It is difficult to judge whether these improvements would have happened even without the financing from the carbon offset fund, but there are a number of national home insulation schemes that are already operating, and that also seek to finance the lower cost measures of loft and cavity wall insulation. Further to this, as the policy focus on climate change continues to increase, the number of measures and funding targeted at existing housing is also likely to continue to increase so that the lower cost measures are further targeted.

The carbon offset fund could nonetheless be a very effective mechanism in the years up to 2016 if a planning authority feels that it is too expensive a demand to expect developers to deliver zero carbon developments. They could require the developers to provide carbon neutral developments by covering the costs of their residual carbon emissions based on an agreed market price per tonne of carbon.

### 7.3 Potential policy for the Bolsover LDF

#### 7.3.1 Low carbon requirements for new development

Key policy options consist of:

- Follow Government’s projected improvements in Building Regulations
- Prescribe stricter carbon requirements for all development in the district
- Prescribe renewable energy targets on developments with 10% as the a minimum starting point
- Allocate site specific targets (e.g. bringing in zero carbon requirement before 2016)
Issues to consider when drafting the LDF policies include:

- Decision depends on the aspirations within the council and the district for sustainable low carbon development
- Planned Building Regulation improvements are challenging for developers – and they are likely to argue against even tighter targets
- Would the tighter standards deliver significant carbon savings? The housing projections demonstrate that approximately 3,100 units will be built before 2016, and therefore the carbon savings of requiring that these dwellings are built to zero carbon standards rather than 2006 Building Regulation standards could amount to approximately 5,000 tCO$_2$ pa (1% of Bolsover’s annual emissions from the built environment)
- Site specific targets can be informed by energy studies for those specific sites – and these studies can prove what carbon reduction target is practical for the specific site. For this reason, a site specific target that is stricter than national requirements could be feasible whereas a stricter requirement for the whole district would be very difficult to justify.

[RECOMMENDATION] Taking into account the analysis conducted, we recommend that Bolsover establishes policy that sets out the following requirements:

- Achieve following carbon savings on all housing development against the Target Emission Rate required under Building Regulation (2006) standards:
  - 25% (2010 to 2013)
  - 44% (2013-2016)
  - zero carbon** (2016)
  through the application of low and zero carbon technologies, building design (and specification) or a mixture of both.
- All major development* achieve a minimum 10% reduction of regulated carbon emissions from the prevailing Building Regulations compliance standards through renewable energy. This would cover all buildings, not just residential. This standard is anticipated to be exceeded by the aforementioned housing standards and may well be exceeded by non-residential standards introduced into regulation in future. This policy proposal is therefore designed to provide early yet minimal standard improvements by default as required by the Regional Plan Guidance (Policy 3).
- Specific development sites (identified by location or criteria) within the district that are considered strategically important with regard to low and zero carbon development opportunities conduct a detailed analysis and costs of the option to achieve a zero carbon standard
- Where applicants wish to submit proposal achieving lower standards they will need to submit detailed evidence for the argument that development would not be feasible or viable where the standards upheld

  * above 10 dwellings or 1,000m$^2$ GFA for non-residential development

  ** requiring a carbon reduction of all “regulated” and “unregulated” emissions as defined in the Code for Sustainable Homes (2008) AND achieving a Heat Loss Parameter less than 0.8 W/m$^2$ and a minimum of 50% of the remaining carbon emission reduction being discharge through the use of ‘on-site’ or ‘near-site’ renewable energy.
7.3.2 Supporting compliance and future-proofing for low to zero carbon developments

[RECOMMENDATION] To support compliance and encourage approaches that maximise the long term opportunities for deploying low and zero carbon energy options the following is recommended:

- The LDF should indicate the carbon standards expected of developments of particular scales, density and mix, whilst indicating possible solutions (which may change over time) as defined in section 4, and encourage developers to install communal systems, where applicable.
- Develop rules to ensure that ‘off site’ renewables are additional to any commercial renewable energy developments that would occur anyway within the district (and support the development of a delivery mechanism)
- Encourage developers to work with wind turbine developers so as to establish contractual relationship with ‘off site’ wind turbines that are located within the district or county

Issues to consider when developing these policies include:

- The assistance it will provide to planning negotiations, as the LDF will outline in detail what is expected from developers
- It will also help future-proof energy strategies for phased developments – so that developers do not opt for cheaper strategies in the earlier phases which jeopardise the ability of the development to achieve significant carbon savings in the longer term (post 2013/16)
- Developers may have concerns that the LDF prescribes the type of energy supply strategy that they should follow for their development – and they may argue that they should be allowed flexibility in how they meet carbon reduction targets
- Allowing ‘off site’ generation that is linked to the development either through a physical connection or contractual arrangements will make it financially & technically easier for a zero carbon development to be achieved, and thereby help reduce carbon emissions from new development in the district
- ‘Off site’ generation is currently not allowed under CSH rules and so this will need to change in order to enable planning authorities to establish the off-site mechanism
- Would require careful development of arrangements that link the renewables to the new development and ensure additionality
- Would the ‘off site’ infrastructure need to be within the district to count as local renewable energy generation, or would the wider sub region or county also be acceptable?

7.3.3 Facilitating the development of shared infrastructure and renewables

[RECOMMENDATION] To facilitate the development of shared infrastructure and renewable energy supply chains the following is recommended:

- The LDF should encourage the adoption of CHP for large developments rather than building-integrated renewables
- Undertake heat mapping in the most densely populated area of the district and appraise possible heat infrastructure projects linked to major new developing and the existing major heat loads and major heat waste opportunities.
- Require the use of CHP and district heating in all significant new mixed-use developments above certain scale and density
• Ensure that the master plans for the key growth sites contain comprehensive zero carbon methodologies addressing buildings and low carbon infrastructure.

Issues to consider when drafting these planning policies include:

• In terms of achieving CSH levels 3 & 4 carbon standards, the Council could outline that developers should focus on communal energy infrastructure rather than just opting for the smaller building integrated renewables. Developers may not like being constrained by these technology requirements and may try to argue against them.

• Heat mapping will highlight where heat networks could be feasible, and this could form the basis for encouraging ESCOs to establish networks within the district. The Council will still need to provide policy support that enables ESCOs to develop networks, and in particular provide support in creating a local heat demand – through using public sector buildings as an anchor load and encouraging other building owners to join the network.

7.3.4 Managing ‘undue burden’ on developers

[RECOMMENDATION] To manage ‘undue burden’ we make the following recommendations:

• Site specific targets in advance of national standards could be set for the large sites as it will be technically possible to achieve zero carbon status due to the potential for large wind turbines within the north of the district. This should not be considered an undue burden as it is an affordable option and would have the benefit of stimulating renewable energy development within the district.

• The LDF should outline that the low carbon energy supply market is developing all the time and that what constitutes an ‘undue burden’ is therefore reducing over time.

Issues to consider when drafting the policies include:

• Incorporating Government requirements for Building Regulations and the proportion of renewable energy supply improvements within the LDF should not be considered an undue burden on developers in Bolsover.

• Developers might argue that the low carbon requirements are an undue burden and that the requirements jeopardise housing growth targets for the district.

• The long term Building Regulation upgrades provide a clear message of development requirements and any additional costs that this leads to should be fed through into land value. Conversely, if the LDF demands stricter requirements in the short term then there won’t be time for any potential additional costs to feed through into land values.

7.3.5 Enabling carbon neutral developments through a Carbon Offset Fund

[RECOMMENDATION] To facilitate the delivery of ‘off-site’ mechanism to support the achievement of the zero carbon standards, the Council should establish a ‘carbon offset fund’ in a similar way to Milton Keynes Council which requires developers to pay to offset all the residual emissions from their developments. The Council would need to establish a ‘carbon offset fund’ into which these payments are deposited, and then distributed to insulation or renewable energy project within the district. The
issues to consider include the decision concerning the cost per tonne of the offsets and the challenge of ensuring the carbon savings are additional to what would have happened anyway.

7.4 Monitoring and Compliance

[RECOMMENDATION] To develop effective monitoring and compliance processes we make the following recommendations:

- ESD recommends that Bolsover ensure that the new developments include provisions for energy monitoring in their Sustainable Energy Strategies that should accompany any planning application. The monitoring programmes should be able to provide Bolsover annual figures on CO$_2$ emissions for dwellings and non-residential buildings, and preferably non-residential buildings should split into office, retail and industrial. It would also be useful to obtain figures for the amount of energy generated by different renewable energy technologies to compare with the original Sustainable Energy Strategies in order that lessons can be learnt if any of the systems are under performing.

- Bolsover could prepare CO$_2$ emissions trajectories of how they forecast emissions from now until 2026 to compare with the monitored data as it comes in. It would be necessary to have separate trajectories for dwellings and non-residential buildings to effectively compare against LDF carbon targets.

- Monitoring is also important for the existing building stock in terms of CO$_2$ emissions for Bolsover as a whole; this should be captured in National Indicator 186$^{28}$. It would also be useful to monitor the number and type of renewable energy installations progressed throughout Bolsover to compare with overall CO$_2$ emissions.
8 Non-Planning Delivery Mechanisms

8.1 Introduction

Planning policy alone will not be able to deliver renewable energy targets for the district, and a range of policy measures covering economic development to council initiated energy projects will also be required ensuring that renewable energy development is facilitated and encouraged within the district.

8.2 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.

8.3 Financing low carbon infrastructure

8.3.1 Addressing investment challenge for communal infrastructure such as district heating

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. This 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.

8.3.2 Managing contractual complexities & project uncertainties

Key actions to mitigate risk include:

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

8.3.3 Special purpose vehicles / ESCOs

The Council and its partners could also seek to establish an ESCO for the district which works to install sustainable energy systems within both the new development and existing buildings. A special purpose vehicle for Bolsover 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. This ESCO could be established at the district level.

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.

There is no standard definition of an ESCO in the UK, but existing ESCOs can be categorised in a number of ways. Perhaps one of the most informative approaches to
categorisation is to consider the balance of private and public sector involvement and ownership. An ESCO can be entirely owned by the public sector or be an entirely private entity.

There are essentially three different types of ESCO:

- Public sector driven
- Private sector driven
- Community driven

For an ESCO established to progress an energy system within a new development, it will generally be given a long lease for the energy centre building and plant and the distribution systems with the responsibility to operate, maintain, and replace as necessary. A key benefit of a community ESCO being wholly owned by a residents' management organisation is that a commercial ESCO’s assets could be sold off in the event of bankruptcy. Implementing a full ESCO project is a long and complex process which relies upon expert business, procurement, legal and technical advice. Contracts bring together the procurement, finance and management arrangements for an ESCO. The particular procurement strategy that is followed for an ESCO will differ from case to case, but will follow the basic contract structure of a relationship between a technical energy expert company and the entity that requires their services. Contract Management will be an important element of the long term monitoring of the successful delivery of the output specification and the successful relationship with the expert energy services partner. Good partnership working is essential to the viable and successful operation of a CHP and decentralised generation scheme.

Public sector-led ESCOs

Public authorities can lead the establishment of ESCOs generally with the desire to bring-on the market for energy services, particularly with respect to low carbon, decentralised energy supply, where they identify gaps in the commercial market. Local authorities are the principal candidates for this but other public agencies including regeneration organisations, NHS Trusts, Regional Development Agencies and the sub-regional partnerships can drive them forward. Local authority led ESCOs are typically established to progress energy efficiency refurbishment and CHP in social housing or council buildings, or to deliver renewable energy projects for council buildings or the local community. There are a number of local authority ESCO facilitated projects which have overseen the roll-out of CHP services to include private sector customers, such as in Woking and Sheffield town centres. More recently local authorities have begun to set-up ESCOs to install sustainable energy infrastructure as a component of large regeneration projects.

Typical features include:

- Led by Local authority, RDA or other public organisations such as NHS Trusts and sub-regional partnerships
- Private sector partners often also involved
- Umbrella approach – where a series of projects being brought forward over time
- Focus on initial delivery to own stock / estate
- Roll out of services to town or new growth areas
- Long term view of payback
• Public sector discount rates

A local authority is able to set-up an ESCO by using the following powers and duties:

• Well being power permitting local authorities to do anything which they reasonably consider will improve the well-being of their area
• The duty of a local authority to secure best value in the performance of its functions

Local authority ESCO activity is 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.

8.3.4 Council leading by example

The Council 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 1: GLOSSARY

Below is a table explaining the main technical terms used within the document.

<table>
<thead>
<tr>
<th>GLOSSARY</th>
<th>Definition</th>
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</thead>
<tbody>
<tr>
<td>AD</td>
<td>Anaerobic Digestion; process in which organic materials are broken down in the absence of oxygen producing biogas which can be burnt to produce electricity and/or heat</td>
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<tr>
<td>BERR</td>
<td>UK Department for Business, Enterprise &amp; Regulatory Reform</td>
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<tr>
<td>CHP</td>
<td>Combined Heat and Power; also known as cogeneration generation of both heat and power from a single heat source by recovering waste heat from electricity generation</td>
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<td>CHPA</td>
<td>Combined Heat and Power Association</td>
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<td>CMM</td>
<td>Coal Mine Methane</td>
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<td>CBM</td>
<td>Coal Bed Methane</td>
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<td>CSH</td>
<td>Code for Sustainable Homes; also referred to as ‘Code’</td>
</tr>
<tr>
<td>ESCO</td>
<td>Energy Service Company; an ESCO ensures planning and delivery of low carbon infrastructure by an entity with long term interests in assets</td>
</tr>
<tr>
<td>Feed-in-tariff</td>
<td>A feed-in-tariff is an incentive structure based on government legislation obliging electricity utilities to buy electricity generated from renewable sources at above market rates. The level of the electricity premium price -set by the government and guaranteed in the long term- usually varies for each renewable energy technology depending on their market status and constitutes a predictable source of income for renewable electricity generators mostly at small, i.e. household scale. In October 2008, the UK Secretary of State for Energy and Climate Change announced that the UK would implement a feed-in-tariff by 2010</td>
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<tr>
<td>GHG</td>
<td>Greenhouse Gas</td>
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<tr>
<td>GIS analysis</td>
<td>Geographic Information System analysis; includes data that is referenced by spatial or geographic coordinates</td>
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<tr>
<td>GSHP</td>
<td>Ground Source Heat Pump</td>
</tr>
<tr>
<td>kW</td>
<td>Kilowatt – unit of power. Can be expressed as thermal power (kW_th) and electrical power (kW_e)</td>
</tr>
<tr>
<td>kWh</td>
<td>Kilowatt hour – unit of energy. Can be expressed as thermal energy (kWh_th) and electrical energy (kWh_e)</td>
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<tr>
<td>kWp</td>
<td>Kilowatt peak – maximum power output of a photovoltaic cell, occurring with intense sunlight.</td>
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<tr>
<td>LDF</td>
<td>Local Development Framework</td>
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<tr>
<td>LZC</td>
<td>Low and Zero Carbon</td>
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<tr>
<td>MLSOA</td>
<td>Middle Layer Super Output Area; SOAs are a unit of geography used in the UK for statistical analysis. They are developed and released by Neighbourhood Statistics. SOAs were created with the intention that they would not be subject to frequent boundary change. This makes SOAs more suitable than other geography units (such as wards) because they are less likely to change over time. There are three</td>
</tr>
</tbody>
</table>
layers of SOAs (i.e. three different but related geography boundaries). These are:
- Lower Layer (minimum population 1000, mean population 1500)
- Middle Layer (minimum population 5000, mean population 7200)
- Upper Layer

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>MOD</td>
<td>Ministry of Defence</td>
</tr>
<tr>
<td>MSW</td>
<td>Municipal Solid Waste</td>
</tr>
<tr>
<td>MW_e</td>
<td>Megawatts of electrical capacity</td>
</tr>
<tr>
<td>MW_t</td>
<td>Megawatts of thermal capacity</td>
</tr>
<tr>
<td>MWh</td>
<td>Megawatt-hour</td>
</tr>
<tr>
<td>ODT</td>
<td>oven dried ton; an amount of wood that weighs 2,000 pounds at zero percent moisture content, common conversion unit for solid biomass fuel</td>
</tr>
<tr>
<td>PPS</td>
<td>Planning Policy Statement</td>
</tr>
<tr>
<td>SHW / STHW</td>
<td>Solar Hot Water; also known as Solar Thermal Hot Water</td>
</tr>
<tr>
<td>Solar PV</td>
<td>Solar Photovoltaic</td>
</tr>
<tr>
<td>SPV</td>
<td>Special Purpose Vehicle; a legal entity set up for a specific purpose: to isolate financial risk from a</td>
</tr>
<tr>
<td>tCO_2/yr</td>
<td>tons of CO_2 per year</td>
</tr>
<tr>
<td>TCPA</td>
<td>Town and Country Planning Association</td>
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</tbody>
</table>
APPENDIX 2: 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 blue in the map below).

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

Figure 16: Absolute constraint: Woodland areas in the district

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 district possibly affected by radar issues.

Figure 17: Consultative zones: Air Safeguarding Zones in the district
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.

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.

A Resource Potential of 42 large-scale wind turbines was identified within the District. This can be expressed in terms of installed capacity and generated output, as outlined in the below approach.

- 42 large wind turbines using 2.5MW turbines = 105MW
- Based on an industry-wide used average capacity factor\textsuperscript{30} for onshore large-scale wind turbines in the UK of 25%, the potential energy generation from these 42 large wind turbines in the district would be 229,950MWh.

However, this many turbines is not likely to be acceptable on landscape and visual grounds (hub heights of large-scale wind turbines are usually around 60 to 80m with their maximum height to the blade tip ranging from 100 to 125m). Factors such as visual impact, but also public accessibility and topography will therefore reduce the technical potential.

Obviously, undertaking detailed site visits is beyond the scope of this study, so based on a detailed landscape, visual and cumulative impact assessment that could be undertaken for the potential sites following this study, it will eventually be the political will that will determine how many of the 42 large-scale wind turbines will be realised in the district.

For the purposes of setting a target for 2026, we have taken into account site viability criteria for wind energy developers. Considering that a significant part of developing a wind energy site is incurred irrespective of the number of turbines per site, there is a general consensus that sites with up to and including 3 turbines would struggle for financial viability. A practical scenario has, therefore, been assumed taking into account those potential sites within the district where more than 3 turbines could be accommodated. This resulted in one site of 5 turbines (west of Palterton) and four sites of four turbines (hill west of Shuttlewood; area surrounding Roseland Wood; south-east of Rowthorne and south-east of Astwith). The total large-scale wind Development Scenario is therefore 21 turbines with a capacity of 52.5MW.

Undertaking detailed site visits was beyond the scope of this study, but Bolsover District Council could undertake a detailed landscape, visual and cumulative impact assessment in addition to a consultation of local and political opinions if it wanted to set a fully informed wind target. This assessment does not assume that Bolsover District Council would necessarily endorse this 21 turbine scenario, and environmental assessments and planning applications would be required before the development of any wind turbines would occur.
Following on from this, the technical and Development Scenarios (based on the scenario outlined above) for large-scale wind in the district are summarised in the table below.

**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 -initially obtained from Scottish and Southern, the Distribution Network Operator (DNO) owning and operating the distribution networks within the district and subsequently GIS-adapted - shows the distribution network within the boundaries of Bolsover.

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
  o 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.
  o 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.
  o 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
  o If the generating voltage differs from network voltages, transformers might be required which in turn, however, can increase connection costs significantly.
  o Purchasing additional equipment is generally only worth if losses on the cables are significant; if that’s not the case, connection should happen at the generator voltage.
  o 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
  o 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
  o When connecting renewable generation to the distribution network, there are two Electricity Networks Association guidelines, i.e. G83 and G59.
  o 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
  o 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.
  o 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.
APPENDIX 3: SMALL WIND

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, in the Bolsover District, 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 19: 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\textsuperscript{31}) for the installation of microgeneration technologies, can increase the affordability of the development of small wind 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\textsuperscript{32}.

• With respect to potential sites for small-scale wind in Bolsover District, small-scale wind 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.

\textbf{Figure 20:} Turbine height compared to turbine output

![Turbine height compared to turbine output](image)
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
- Building integrated wind turbines have not been considered in this study, as they are currently not well suited to build 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:

- Develop a business strategy in order to incentivise wind developers to operate within the district
- Bring 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
- Bring together housing developers and wind developers
- Consider 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 4: BIOMASS

For the purposes of measuring resource, the following assumptions are made:

- Biomass and waste within Bolsover District boundary were counted as the resource.
- Dry biomass – woodchip (from managed woodland, saw mill wastes and energy crops), straw, municipal waste.
- Wet biomass – silage from cattle, poultry litter, garden wastes, supermarket food wastes.
- Desk based assessment using maps, statistics and assumptions as appropriate.
- Resource divided into marginal markets. Two for heat: pellet and dry chip, and five for combined heat and power: wet chip, off-cuts, straw, anaerobic digestion (AD) and municipal solid waste (MSW).

In turning the technical resource of biomass energy and energy from waste into a practical target, the list below outlines important issues to consider are:

- Incentivisation schemes for farmers to provide farm wastes.
- Incentivisation schemes to encourage woods and forests to become managed for woodchip supply - could make more former set-aside, crop and bare fallow land available for energy crop production. This could possibly be done by using an integrated agro-forestry system so that forestry and livestock or crops could be grown on the same piece of land. Such systems are commonly used in for example the permaculture type systems used by many small scale farming cooperatives where enhanced management practices enable higher yields to be obtained from the land. A yield of 10 ODT/Ha may be difficult to achieve within an agro-forestry situation, but 5 ODT/Ha should be achievable.
- Bring more woodland into management and manage as commercial forestry for woodchip production. If for instance all of the non-ancient woodland was managed as commercial forestry for the express purpose of woodfuel creation then a significant amount of woodfuel could be produced per year. This would require major investment in the woodland resource and increase in the number of foresters working in the area.

Establish a biomass fuel group to help set-up a wood-fuel supply chain for the district and the promotion of agro-forestry systems which allow for food and wood production on the same land.
APPENDIX 5: PHOTOVOLTAICS (PV)

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\textsuperscript{33}.

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.
APPENDIX 6: SOLAR THERMAL HOT WATER

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 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 7: GROUND SOURCE HEAT PUMPS

According to the Energy Saving Trust\textsuperscript{34}, 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.
APPENDIX 8: HYDROELECTRICITY

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 m³/sec).

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

Figure 21: 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 following components:

Figure 22: Components of a hydro scheme (Source: British Hydropower Association – Guide to UK Mini-Hydro Developments)
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 CO₂ 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

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.

The methodology for determining the Resource Potential of hydro energy in the district is based on the following approach:

- Determine suitable locations from map e.g. weirs and local knowledge from e.g. Environment Agency and Alex Templeton
- Depending on data availability, determine head
- Get flow rate from National River Flow Archive website (http://www.nwl.ac.uk/ih/nrfa/station_summaries/map.html)
- Determine how much flow can be utilized (flow factor) as some may be needed for navigation or flood defence (use 0.5 as default)
- Determine combined turbine and generator efficiency (use 0.7 as default for low head rivers)
- Apply formula Power = gravity x head x density of water x flow rate x flow factor x efficiency

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)
Creating a sustainable low carbon society