Staffordshire County-wide Renewable / Low Carbon Energy Study

climatechangesolutions

Presented to: The Councils of Cannock Chase, East Staffordshire, Lichfield District, Newcastle Borough, Stafford Borough, Staffordshire County, Staffordshire Moorlands, South Staffordshire and Tamworth

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1 Non-technical summary

The Staffordshire County-wide Renewable / Low Carbon Energy Study has been conducted by Camco on behalf of the authorities of Cannock Chase, East Staffordshire, Lichfield, Newcastle-under-Lyme, South Staffordshire, Stafford, Staffordshire Moorlands, Tamworth and Staffordshire County Council.

The aim of the study is to inform the partner authorities about the technical potential, the viability and the deliverability of various renewable and low carbon options through the preparation of a local evidence base. This evidence base has been developed with the project steering group and includes:

- Analysis of low carbon generation resource potential
- Investigation of suitable carbon standards for new development
- Recommendations for planning policy and associated non-planning measures to support effective planning policy.

The study also included a review of a number of major development sites within the study area to examine the viability and delivery implications for achieving higher carbon standards in practice, which is covered by a separate report[1]. During the course of the study, a consultation workshop was held[2] to review and test the principal recommendations with a range of stakeholders.

It is important to note that the primary analysis and reporting of this work was completed at the beginning of 2010. Since that time (and this final version of the report), a new government has come to power and a number of significant policy shifts have been announced, with some being enacted. Some of these have a bearing on the analyses included in the study and affect the certainty of the some of the assumptions used and the recommendations made. Commentary in this final version of the report has been added to highlight where policy changes may affect the base of evidence, which overall remains valid. Of particular note is the revocation of West Midlands Regional Spatial Strategy which has been used in the study to inform (along with other evidence) the recommended policy of carbon targets for new development. It should also be noted that the evidence base collated to support the preparation of the regional spatial strategy remains, and can be used by authorities to support local policy.

The intention of this work is for the authorities to draw upon the relevant evidence and recommendations in preparing their Local Development Frameworks in accordance with the requirements of Planning Policy Statements 1 and 22 and the West Midlands Regional Spatial Strategy, which has since been revoked. In addition, the report presents a series of non-planning recommendations that are included in recognition of the need to support the achievement of the principal goals of the increased uptake of low carbon energy and to enable the delivery of viable low carbon development.

The study considers the period up to 2026 in line with the West Midlands Regional Spatial Strategy period.

The key conclusions of the study are shown below, with summaries for each authority included in Appendix I.

[1] *Staffordshire development-specific sustainable energy strategies – worked examples, August 2010*
[2] *18th March 2010, Cannock*

1.1 Policy overview

The challenge of achieving climate change mitigation through delivering more carbon efficient development and implementing a significant increase in low carbon energy generation requires strong and effective local planning policy and enforcement.

The new government will doubtless seek to adjust the policy and regulatory frameworks in this area, particularly with respect to its stated strategic approach to devolved governance, i.e. 'localism', and also it addresses the current national macro economic problems and future uncertainties. This may see some of the policy mechanisms proposed by the previous government scrapped or modified. However, it is expected that climate change mitigation measures including renewable energy generation and lower carbon development will be maintained as high priority and therefore that the overall thrust of the policy recommendations included here will remain valid for the purposes of preparing Local Development Frameworks.

In tandem with new planning policies, non-planning strategies need to be implemented in key areas such as biomass market stimulation, identifying and supporting the implementation of district heating infrastructure and the provision (or facilitation) of financing mechanisms, e.g. a carbon investment fund, to address economic barriers to low carbon solutions.

The challenge to implement the proposed new planning policy and related non-planning measures is best met on a cooperative basis. This study has been directed by a steering group representing all the authorities involved and a key recommendation is for a similar steering group to be formed to manage coordinated implementation. The remit of this group would be to:

- Identify and develop shared resources for policy implementation and enforcement (particularly where specialist knowledge is required);and;
- Implement key non-planning measures that will benefit from up-scaling, for example, a carbon investment fund for Staffordshire (which will be a more efficient solution than a fund for each authority).

1.2 Carbon standards for new development

Local Authorities have the power to establish carbon targets ahead of national building standards. During the course of the study a range of carbon standards were considered in detail, across the range of expected domestic development. Where the standards exceed those proposed nationally, the resulting additional net costs for domestic development were reviewed (accounting for potential revenue from national financial incentives). The analysis concluded that for large development, or where developments have access to low cost solutions (e.g. directly connected wind energy or connection to existing district heating networks), then setting targets beyond national levels presents limited additional burden. Because there are significant benefits such as achieving greater carbon savings and early mobilisation of local supply chains, acceleration of low carbon standards, where it is viable, is considered warranted. It is important to note that burden is significantly limited where financial support is available as is currently proposed with the Feed-in-Tariff (now operational) and Renewable Heat Incentive (proposed for 2011). Furthermore, with the introduction of a mechanism to support offsite carbon reduction ("Allowable Solutions") the price of off site solutions can be capped. The latter measure would provide important contributions to a Carbon Investment Fund.

Non-domestic development has been more difficult to consider since the roadmap to national carbon standards are yet to be resolved in this area. National consultation was concluded on this in February 2010 but no response from government has been issued.

As a result of the analysis, a framework of carbon standards has been proposed, presenting a range of standards that authorities can require developers to achieve depending on the nature of the development proposed and period in which the development occurs. The framework is intended to be a flexible planning tool dealing with both economic uncertainty and the variability of the development and its economic viability, which will be a key determinant in establishing the targets for individual schemes. In essence, the framework provides a set of minimum and maximum carbon (and low carbon generation) targets encouraging higher standards where they are achievable.

Whilst framework itself has been demonstrated to present limited burden and is justified in terms of its intended consequences, it is necessary for authorities to conduct further viability tests to determine whether other development goals, e.g. affordable housing, development rates, S106 contributions are not adversely affected.

As part of the carbon framework the study recommends the establishment of specific low carbon renewable energy generation targets on new development (all housing and non-domestic development above 1,000m^2), i.e. Merton-rule policies. These also have a limited cost impact particularly where the previously mentioned financial incentives are available.

The following are a summary of the key recommendations made in support of delivering low carbon development:

- Accelerate local development carbon targets ahead of national policy, as set out in a flexible framework which will support the process of dealing with concerns over viability yet maintain a focus on driving up carbon standards
- Establish a multi-authority / county carbon investment fund to channel developer contributions towards carbon reduction projects with the local/county area and provide “allowable solutions” that will be required to deliver zero carbon standards on new buildings (2016 from homes and from 2019 for most other buildings)
- Establish a county-wide low carbon energy generation / low carbon development steering group (with representation from all authorities involved). The principal aims of this group will be to oversee and support:
    - the implementation of joint initiatives
    - the development of shared capabilities and resources
    - consistency of planning policy across the county
    - consistency development control practices of across the county
- Develop a shared technical support service, principally to review compliance to carbon standards in new development seeking planning permission

1.3 Potential for low carbon / renewable energy generation

There are significant low carbon energy generation resources within the study area which are estimated to be able to provide between 8% and 11% of energy consumption by 2021. This is arguably within the range required for the local areas to support the national target of 15% (with large centralised generation significantly contributing towards this and thereby displacing the need for additional local generation) by the same period. The estimate of resource potential for the study area excludes the contribution from co-firing of biomass (particularly relevant to Cannock Chase) and production of renewable fuels for transport. Stand-alone wind energy and biomass energy present significant opportunities as do district heating (in urban centres and on larger development sites) and microgeneration (on new development and within the existing built environment).

The resources available to each authority vary considerably, as is shown in Energy Opportunity Map below (Figure 1) and the authority summaries in Section 10. Resources are dependent on a range of technical factors (e.g. wind speed, access to biomass resources and quantum of existing and new development) and the technical, economic and practical constraints that exist.

Over the period considered (up to 2026) approximately 57,000 new dwellings are forecast to be built (as projected in the West Midlands Regional Spatial Strategy). Much of this development will be zero carbon (homes from 2016 and non residential properties from 2019), requiring the incorporation of high standards of energy efficiency, on-site low carbon generation and additional off-site carbon reduction. The relative contribution that development makes to the total low carbon energy generation potential for each authority is highly variable from 5% to 25% (of project consumption in 2021). The marked differences between authorities are largely due to the variation in quantum of development forecast.

Overall, some authorities have much more potential than others, with a number likely to fall well short of the benchmark range of the 7.5% to 10% of energy consumption in 2020 supplied from local renewable energy. This suggests that those authorities with greater resource need to exceed the benchmark range to enable the study area / county as a whole to achieve the benchmark range. However, each authority should seek to maximise the use of the low and zero carbon resource available to them and where they do not have access to specific resources such as wind energy or biomass then they should explicitly focus on those other solutions that are possible, such that they make a fair contribution.

The study highlights district heating / CHP as having a important contributory role to both maximising the level of low carbon generation and enabling low carbon development. The study draws together various sources of information to highlight zones/areas that may support district heating. It is recommended that detailed technical and market studies are conducted in these zones to determine whether schemes (which can be affected by a wide range of constraints) are viable or not.

Other areas of important work following this study are the development of implementation strategies to support the market development of biomass supply chains across the study area and to supplement the information included in report on hydro energy with the results from a more detailed study due to be completed in 2010 by Environment Agency.

The key policy recommendations concluded from the study are:

- Publish details of the resource study conducted (and reported here), within relevant spatial plans including an Energy Opportunities Map (as shown in Figure 1).
- Develop and implement criteria-based policies around key low carbon / renewable energy generation technologies. Planning policies need to be supportive of all energy generation technologies but particularly wind energy, biomass and microgeneration, as these have the greatest potential within the study area. A criteria-based approach will enable objective decision-making, in what can be a controversial area.
- Establish authority-wide targets for generation and establish effective monitoring to assess performance on an annual basis.

In addition, the following key non-planning measures are recommended to help support the delivery of new generation:

- Support the establishment of a Carbon Investment Fund (as discussed above). By combing planning obligation revenue with a range of the other financial resources, e.g. CESP, CERT, Pays As You Save (Green Deal) funds, public sector borrowing and commercial investment, this could deliver significant carbon reduction projects. These could include generation project alongside energy efficiency measures.
- Develop and implement strategies to support the emergence of solutions for reducing carbon emission within existing buildings
- Develop and implement strategies to support areas / communities that are not connected to the natural gas network to enable fuel switching from conventional energy sources to low carbon energy sources

- Secure public sector (notably Local Authority) commitment to lead by example and develop low carbon exemplar projects and support programmes

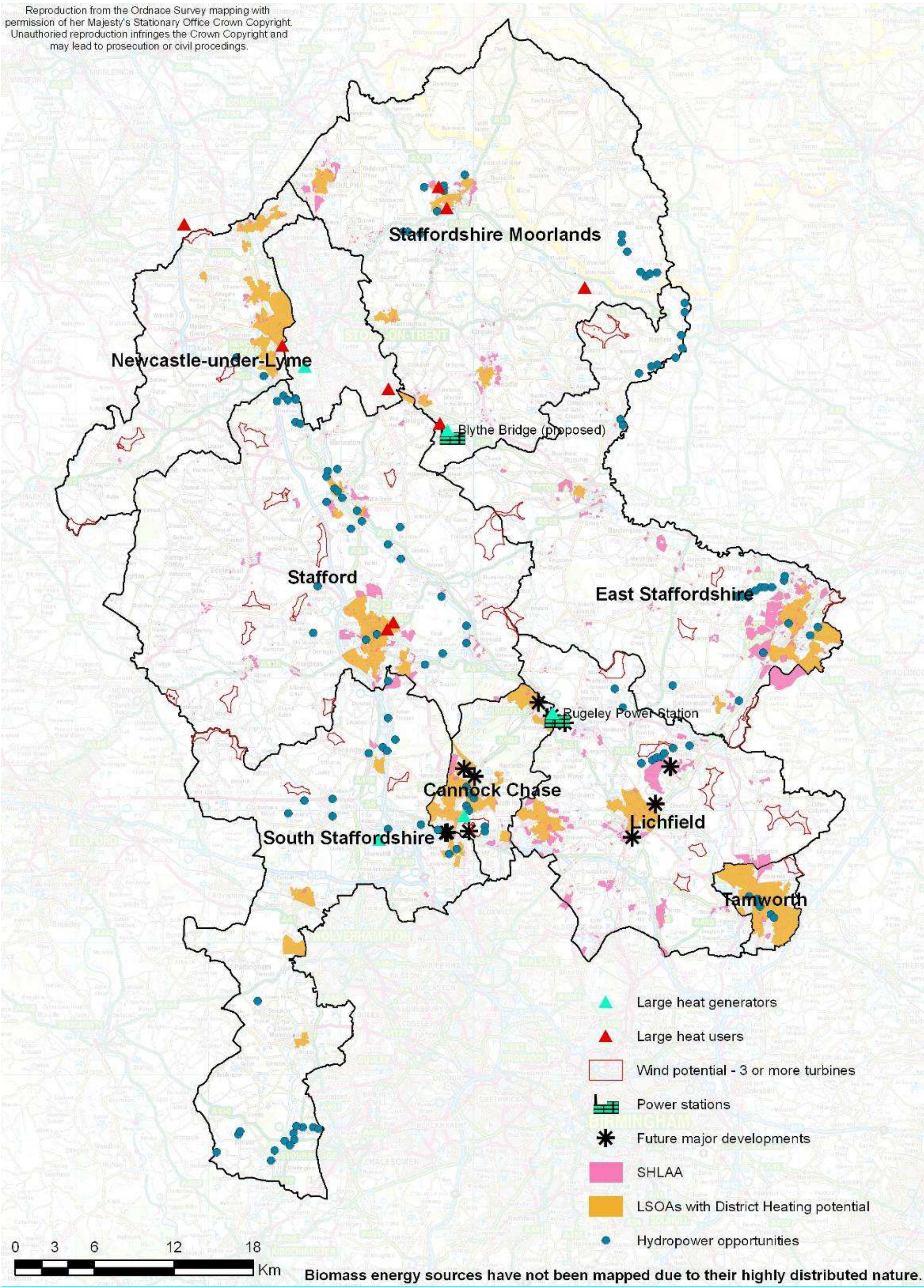

Figure 1 Energy Opportunities Map

2 Technical Summary

2.1 Introduction

This Staffordshire County-wide Renewable / Low Carbon Energy Study has been conducted by Camco on behalf of the authorities of Cannock Chase, East Staffordshire, Lichfield, Newcastle-under-Lyme, South Staffordshire, Stafford, Staffordshire Moorlands, Tamworth and Staffordshire County Council. The aim of the study is to inform the partner authorities about the technical potential, the viability and the deliverability of various renewable and low carbon options through the preparation of a local evidence base. This evidence base has been developed with the project steering group and included analysis of low carbon generation resource potential, investigation of suitable carbon standards for new development and the provision of recommendations for planning policy and delivery of related non-planning policy measures. The study also includes the detailed review of a number of major development sites within the study area to examine the viability and delivery implications for achieving higher carbon standards in practice. During the course of the study, a consultation workshop was held[3] to review and test the principal recommendations with a range of stakeholders.

The intention of this work is for the authorities to draw upon the relevant evidence and recommendations in preparing their Local Development Frameworks in accordance with the requirements of Planning Policy Statements 1 and 22 and the West Midlands Regional Spatial Strategy, which has since been revoked. In simple terms the national policy statements require authorities to develop planning policies to support the implementation low and zero carbon energy generation and for carbon standards in new development.

Urban development within the study area will have an influence on the delivery of low carbon technologies, not least because of increasing carbon standards set at a national level through Building Regulations. Within the study area there is anticipated to be general growth in housing and economic land development as well as numerous points of major development. This study has used development forecast data provided by the participating authorities which, in summary, expects provision of 57,000 dwellings between 2006 and 2026.

The previous Government announced in the policy statement Building a Greener Future[6] that all new homes in England and Wales must meet zero carbon standards by 2016, with interim reductions in CO_2 emissions of 25% below 2006 Building Regulations by 2010 and 44% by 2013. There are similar ambitions to achieve zero carbon standards for new non-domestic buildings by 2019, but the ‘road-map’ of how to get there is yet to be established. The government also identified that the planning system has a key role to play in supporting the delivery of this timetable for reducing carbon emissions from domestic and non-domestic buildings by providing evidence for, and helping to secure the delivery of, low or zero carbon development. Also at a national level, there is a strong policy drive to reduce carbon emissions (ultimately by 80% by 20250) and to rapidly increase renewable energy generation (to 15% of all energy, including that used for transport, by 2015)

At a West Midlands region level, the 2004 Energy Strategy[7] is somewhat out of step with national policy which has progressed rapidly in recent years. With the new government’s drive away from regional to local governance this is unlikely to be addressed. It is understood that a regional low and zero carbon generation study relating to is likely to be undertaken in the near future, but we presume this will focus on assessing resource capacity rather than setting policy direction.

The move away from regional governance has also seen the recent revocation of the West Midlands Regional Spatial Strategy (RSS). Whilst the RSS is no longer in force to provide

[3] *18th March 2010, Cannock*
[6] *http://www.communities.gov.uk/archived/publications/planningandbuilding/buildinggreener*
[7] *http://www.wmro.org/standardTemplate.aspx/Home/OurResearch/Regionalpolicyandstrategy/ EnergyStrategyMonitoringReport2006*

policy direction, the latest documents provide sound supporting evidence for local authority policy, particularly as it has passed through a rigorous assessment process including public consultation.

The last proposed amendments to the RSS where captured in the Phase 2 review report[8] and this included a clear move towards stronger policies around climate change, to support the West Midlands becoming a low carbon region, and to specifically support the aim of achieving a 30% carbon reduction by 2020. The report highlighted action required including implementation of decentralising energy supply, waste reduction and reuse and retrofit of the existing housing stock. It also included obligations on Local Authorities policy and proposals (in their plans, strategies and programmes) with respect to climate change to:

- Ensure development is more sustainable
- Encourage sustainable construction
- Accelerate local development carbon targets ahead of national policy where there is local justification
- Setting renewable energy requirements on new development at a level that can be locally justified, with a suggested interim minimum 10% (of residual energy) for all "significant" development"
- Requiring Design and Access Statements to fully consider sustainability

This report has been structured to provide a logical narrative of the analysis leading to proposed targets and policy recommendations. The key findings from each stage are as follows:

2.2 Current and Future Energy Consumption

The first step to determine future energy consumption was an assessment of current and projected energy consumption and carbon emissions across the study area, broken down by authority and illustrated spatially where appropriate.

This found that overall energy consumption within the study area is approximately 26,000GWh per annum, creating 7.7 million tonnes CO_2 per annum[9] (equivalent to 1.5% of UK emissions and 18% of emissions in the West Midlands).

Energy consumption is dominated by heat and transport, whereas CO_2 emissions show electricity and heat to be broadly equal. Figure 2 shows that South Staffordshire is the highest energy consumer on a per capita basis, with Cannock Chase and Tamworth being significantly lower energy consumers than the other authorities.

Baseline consumption is likely to increase in the absence of policy levers. However, the Low Carbon Transition Plan[11] sets a path for lower consumption as a result of a series of binding and non-binding policy levers leading to the deployment of energy efficiency. We have taken the conclusions of recent studies into account for the implementation of energy efficiency measures in both residential and non-residential buildings within the study area. This forms the projected baseline consumption against which our calculations of renewable energy potential are measured.

[8] *West Midlands Regional Spatial Strategy Phase Two Revision of the Panel: September 2009, R2.1 and R2.7*
[9] *DECC NI186 CO_2 data for 2007*
[11] *The UK Low Carbon Transition Plan - National strategy for climate and energy, DECC, July 2009*

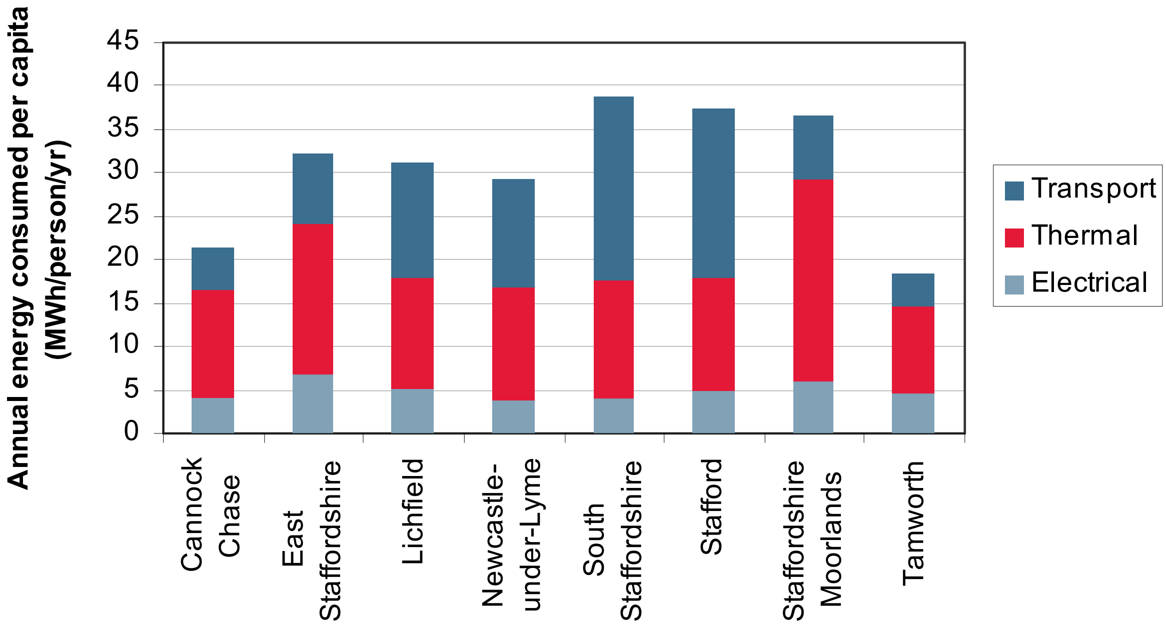

Figure 2 Annual per capita energy consumption in each of the authorities

2.3 Existing and Proposed Renewable Energy Capacity

Existing renewable energy capacity is described on the basis of evidence assembled for this study. It was found that the availability of information about existing or planned installations is patchy; however, the available information has been collated and assessed to provide reasonable estimates. Estimated installed capacity within the study area is around 88 mega-watts (MW), with an energy production equivalent of 400 Gigawatt hours (GWh), equating to 2.5% of energy demand across the study area (excluding transport).

A further 132 MW of capacity has also be identified as proposed, i.e. specific projects that have been indentified and are at some stage of the implementation process. This captures projects that will be at various stages of completion from those that are not fully formed proposals through to those that are constructed but not yet commissioned and operational. Biomass co-firing at Rugeley Power Station represents 72% of the current installed renewable energy capacity of the study area. Excluding Rugeley, existing installed renewable technologies provide 1.1% of the study area's energy (excluding transport). The remainder is primarily made up from landfill gas within five of the eight authorities, with significant contributions from biomass combined heat and power (CHP) and biomass heating systems. It is important to note that the contribution that landfill gas can make will diminish over time as methane extraction from existing sites will reduce naturally, whilst new organic wastes are actively being diverted from landfill disposal. Investigations have shown that for planned projects, large wind (65 MW) and energy from waste facilities in South Staffordshire (29 MW) and Stafford (20 MW) represent the largest proposed schemes for the future. Wind energy and Energy from Waste dominate the 'planned' developments, accounting for 88% of the proposed new generation capacity.

2.4 Low carbon policies and targets

The study goes on to explore the relevant low carbon policies and targets at national, regional and local levels. These include both those related to renewable energy generally and low carbon development more specifically. Of particular relevance are the previous government's

Low Carbon Transition Plan, the UK Renewable Energy Strategy, the proposed changes to building regulations setting out a path to zero carbon development, and local low carbon policies in place to date. Clearly, government policy will need to be kept under review to take account of the new administration's priorities.

The Low Carbon Transition Plan and the Renewable Energy Strategy[12] present significant policy intentions relevant to this study. However, there are a number of issues that remain unresolved or are likely to change in the near future, for example, the definition of zero carbon homes and the roadmap for zero carbon non-residential buildings.

A range of policy and market mechanisms are designed to provide much greater support for building integrated and other decentralised energy projects. These reduce the burden on developers of delivering low and zero carbon buildings as well as support stand-alone wind and biomass projects. These include new market mechanisms for renewable energy generation: the Feed-in Tariffs (FITs) for small scale renewable electricity generation (available from April 2010) and potentially the Renewable Heat Initiative (RHI) intended to commence April 2011. The Renewable Energy Strategy announced the establishment of the Office for Renewable Energy Deployment (ORED) which will drive delivery of the UK's targets.

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

The approach to developing planning policy for renewable energy generation and low carbon development standards is going to continue to change. The new government has suggested it wishes to introduce significant change to the planning system with strong drive to towards locally developed policy. Regional Spatial Strategies have been revoked, removing the regional link to directing policy at a local level, which in most instances was simply reinforcing national requirements. Following earlier consultation Government is also considering options to creating a new single Climate Change Planning Policy Statement, intended to bring together Planning Policy Statements 1 and 22 (Climate Change and Renewable Energy). The published consultation document proposes moving away from locally specific carbon standards in recognition that these become obsolete as significantly higher standards post-2013 become enshrined in the Building Regulations. It also places a greater focus on developing local authority policy (supported by suitable evidence) that seeks to support the delivery of low carbon development solutions (and stand-alone low carbon energy generation), with spatial mapping having an important role, where it is relevant. The Planning Advisory Service intends to develop guidance to support implementation of the final planning statement, for which there is not yet a published timetable.

2.5 Zero Carbon definition

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

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

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

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

- 2016 – zero carbon.

In the March 2008 budget the Government also announced its intention for all non-domestic buildings to be zero carbon by 2019.

The aspiration for zero carbon development by 2016 (or 2019) is very challenging. It will require innovative approaches from all quarters of development industry and the public sector. The latter will have an important role in establishing and delivering effective policy and providing the conditions and infrastructure to enable the standards to be delivered.

The government is proposing to introduce a more flexible definition of 'zero carbon' to guide building policy, but this has yet to be fully agreed. On going consultation on remaining elements of the definition are due to be resolved in 2010. In simple terms it will require the mitigation of all carbon (regulated and unregulated[13]) from a mixture of 'on-site' energy efficiency and renewable energy measures, together with a number of 'allowable solutions' which could include large scale 'off-site' renewable energy infrastructure, investment in energy efficiency measures for existing building stock, energy efficient white goods, building controls, and 'CO_2 offset' tariffs, e.g. towards a carbon investment fund. The latest policy developments suggest limiting the burden of 'on-site' measures, i.e. energy efficiency and directly connected low carbon energy supply, to 70% of the regulated carbon emissions whilst establishing a price cap for measures to address the remaining estimated carbon emissions.

Whilst it seems likely that the costs of achieving higher standards will ultimately be reflected in land values and sale prices, in the short term, the cost of delivering zero carbon could still place significant burden on developers. The study considers this further in terms of the assessment of additional costs of achieving carbon standards beyond the national zero carbon roadmap.

2.6 Renewable energy assessment

Within the study, an assessment of the potential for local renewable energy up to 2026 has been undertaken, looking at decentralised generation together with opportunities within future new development and retrofit within existing buildings. The methodology used is set out, including key assumptions and reference sources. The results of the analysis are presented for two future uptake scenarios: a Base Case and an Elevated Case. The work is presented for each Local Authority and in total for the study area, expressed in a range of ways including energy generated, percentage of heat and power needs that could be met from renewable sources and associated carbon reduction. Where possible the energy resources available within the study area are shown on an Energy Opportunities Map shown in Figure 1.

2.6.1 Wind Energy resources / potential

Wind energy resources and constraints have been mapped using GIS[14]. These have been overlaid to form composite maps of 'constrained' and 'less constrained' areas of possible development, which have then been used to calculate the technical potential for wind energy development. The geographic extent of this technical potential has been discounted to reflect development viability, as follows. Decentralised generation has been deemed viable for all sites with the potential for at least three large turbines where development costs and risks can

[13] Regulated emissions are those covered by Building Regulations, namely space heating, how water, lighting and ventilation; unregulated emissions are those not covered by Building Regulations, such as appliances and small power loads.
[14] Geographical Information Systems[15] The term Merchant wind power refers to the development of wind turbine(s) to power a dedicated on-site energy demand. Examples include Ecotricity's wind park at Ford, Dagenham.

potentially be justified. Smaller areas are deemed possible when developed on a 'merchant wind power'[15] or community basis, but only 10% of these sites are assumed to developable.

The technically viable sites are then cross-referenced with the average annual wind speed (since this is a critical factor for the viability of any wind farm site) to identify individual sites in the study which are perceived as optimal from a wind development perspective. The GIS mapping shows that the wind resource is generally reasonably good, with much of the study area experiencing average wind speeds[16] in excess of 6 ms^{-1} (metres per second) at a height of 45m above ground. This has been taken as a threshold of project viability. The best wind speeds are found largely in Staffordshire Moorlands, with other zones in Newcastle-under-Lyme, Stafford and Cannock Chase. However, many of the zones of high wind speed suffered from other physical or land designation constraints, thus largely presenting a mismatch between the critical factors of optimal wind speed and technically suitable land availability. Stafford and East Staffordshire appear to have the greatest wealth of technically viable land for large scale wind.

The analysis does not take into consideration the issues associated with cumulative landscape impact of multiple wind turbines. This is in agreement with DECC's recently published methodology[17] for estimating renewable energy targets at a regional level. It is impossible to understand the extent to which cumulative visual impact will affect an area without undertaking a specialist analysis. However, applying a rule of thumb buffer zone of 18 km[18] as a minimum spacing between wind farms would see the number of wind sites reduce to only four sites (23 wind turbines) within the entire study area.

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

2.6.2 Biomass resources / potential

To evaluate biomass resource potential, an assessment of resources provided by the Local Authorities, Department for Environment Food and Rural Affairs (Defra) and other cited sources was carried out. Resource uptake curves produced for the Department of Energy and Climate Change (DECC) were then applied to define the likely roll-out of generation capacity across the study area. The assessment covers a range of feed stocks available for bio-energy in the region including: Crop residues, Animal manures, Energy crops, Residues from forestry operations, Sawmill co-products, Waste components of biogenic origin (wood waste, food/kitchen waste, green waste, paper and card).

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

[15] *The term Merchant wind power refers to the development of wind turbine(s) to power a dedicated on-site energy demand. Examples include Ecotricity's wind park at Ford, Dagenham.*
[16] *Annual Mean Wind Speed (using data from the national Windspeed Database, available at http://www.decc.gov.uk/en/windspeed/default.aspx/)*
[17] *Renewable and Low-carbon Energy Capacity Methodology - Methodology for the English Regions, DECC, January 2010*
[18] *Based upon the Sinclair-Thomas matrices (available at http://www.cprw.org.uk/wind/Hlords/hlapp1.htm), where visual impact is low/medium*

there will be free transit into and out of the each authority and the study area as a whole but limiting the analysis to the study area boundary ensures the resource potential between neighbouring authorities is not double counted.

The conclusion from this work is that there is moderately good biomass resource in Lichfield, South Staffordshire and Stafford, which could potentially deliver an equivalent of approximately 6.3%, 4.6% and 4.4% of each district's energy needs by 2025/26. The estimated potential for East Staffordshire, Staffordshire Moorlands, Tamworth, Newcastle and Cannock Chase could deliver around 3.21%, 1.85%, 1.37%, 1.36% and 0.96% of their respective total energy demand by 2025/26.

2.6.3 Hydro power resources / potential

Overall the analysis has identified a limited potential from hydropower, from 17 sites across the study area resulting in an estimated potential of 1.5MW. The analysis has been restricted by the data available regarding the technical suitability of potential sites (largely existing weirs). However, the Environment Agency are currently conducting UK-wide study of hydropower resource potential, updating the previous reported work which should provide useful information which should be cross-referenced with the analysis conducted here. Presently the Agency can only confirm the existence of potential development sites (which are far more numerous than identified from other sources). These sites have been mapped in the Energy Opportunity Map for the study area and the recommendation is made for further site specific data to be sought from the Agency once their study is complete (no date was provided by the Agency).

2.6.4 New build development – low and zero carbon energy potential

The precise nature of the technical solutions for a specific new build development will vary depending on the scale, density and mix of the development. However, in order to assess the potential carbon standards that could be appropriate for the proposed new development in the study area, it is necessary to identify the characteristics of the developments and their suitability for installing low to zero carbon technologies. To enable this analysis each of the main development locations identified have been characterised into one of five development types: Urban infill; Rural infill; Settlement extension; Urban extension and Large urban extension/ New settlement. These are defined in section 8.

The smaller developments that constitute urban infill, rural infill and settlement extension are typically less appropriate for communal systems and therefore the optimum energy strategy will consist of highly energy efficient buildings with individual building integrated technologies (microgeneration). Urban extensions are at the larger size and density necessary to support a communal system in some or all of their development areas, and are large enough potentially to establish a long term power purchase or co-development agreement with a wind turbine developer or justify the creation of a local community owned Energy Services Company (ESCO) on behalf of the future development. It is deemed that projects over 1,000 dwellings could have the potential for communal heating and CHP serving the highest density zones. These are general rule of thumb categorisations used to support the analysis of the overall potential within future development.

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

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

- The Elevated Case assumes that larger developments have 20% renewables in the period 2010-2013. After this date, Code Level 4 (44% regulated carbon reduction) is assumed to be required under revised Building Regulations for residential schemes which will supersede the Elevated Case target. Large urban extensions / new settlements (residential & non-residential) are assumed to be able to achieve zero carbon as of 2013. The viability of meeting these advanced standards has been examined later in the study.

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

2.6.5 Worked examples site energy strategies

Site energy strategies were applied to four development sites in the study area, to provide worked examples of a range of schemes which would achieve the range of carbon standards proposed in the target framework.

In summary the findings of this study were as follows:

- The larger developments present a greater range of options, whereas smaller developments are limited to using microgeneration technologies and particularly solar PV at the higher carbon standards
- The Feed-in Tariff (FIT) and potentially the Renewable Heat Incentive (RHI) can provide long term revenue for renewable energy installations and this can significantly influences capital costs, assuming the revenue can be capitalised[19]. In most cases, in fact, energy efficiency improvements cost more than renewable energy solutions, where they access capitalised tariffs. It is therefore important to include minimum energy efficiency standards within the local authority targets in order to secure the associated long term carbon reduction benefits from energy efficiency measures.
- For non-domestic developments, options for energy efficiency and renewable energy will vary greatly depending on the design and site constraints. Our analysis of Tipping St has shown biomass heating to be the most suitable option. However, this assumes biomass will be available and that the building is designed for a water based heating system (rather than air-conditioning or direct radiant heating).
- It is important for developers to consider energy efficiency and renewable energy targets from the earliest stage of development, to ensure designs can accommodate the most suitable sustainable energy solution.

Full details of the study are available in the Camco Report entitled "Staffordshire development-specific sustainable energy strategies – worked examples" from August 2010.

2.6.6 Existing built environment - resources / potential for low carbon generation

To assess the potential within the existing built environment, i.e. retrofit into existing buildings/land, within the study area, our assessment is informed by a recent study[20] commissioned by regional and central government, which considered the potential for microgeneration uptake in a number of regions. Our analysis takes, as our Base Case scenario, assessment of uptake based on the policy scenario of implementing both power and heat tariffs at a national level, which is currently in progress. These tariffs are likely to be the

[19] In principle this is possible as rights to future revenue can be re-assigned (away from the building owner) and evidence is already appearing of equipment suppliers offering capital cost reduction in lieu of rights to future revenue from the Feed-in Tariff
[20] The growth potential for Microgeneration in England, Wales and Scotland, Element Energy, June 2008

key drivers in this market sector. The Elevated Case is a 30% increase on the Base Case to reflect additional local and regional support programmes that could potentially be provided.

The analysis shows that by 2025, microgeneration can typically meet 2.1% to 3.9% of the authorities' heat and power energy in the base case, rising to 2.9% to 5.1% of energy in the Elevated Case scenario.

2.6.7 Bringing it all together: impact of development standards and decentralised generation and local targets

The overall results have then been benchmarked against a 'localised national target range' for 2020/21. This is explained in section 10, but in simple terms it is an attempt to isolate those parts of the national 15% delivery scenario (for 2020) which it would be reasonable to assume can be delivered within the study area and individual districts, for example, by excluding off-shore wind energy, renewable transport fuels and co-firing of renewable fuels. It is important to note that excluding co-firing of renewable fuels removes the impact of biomass co-firing at Rugeley Power Station; whilst this is clearly happening at a local level it would significantly distort the analysis for the Cannock Chase and the entire study area and so was excluded on this base.

The results, summarised in Figure 3, show that for the study area, under the Base Case scenario, i.e. the most conservative view of potential from the various energy supply options, around 8% of energy needs could be met from low carbon sources. This significantly exceeding the (2004) 4% target in current regional energy strategy, and falls between the lower and upper margins on the 'localised national target range' for 2020. The 8% figure is made up of a 5% contribution towards heating energy and 14% towards electricity consumption.

The results suggest that across the study area it will be necessary to establish policy that aims to deliver uptake rates similar to the Elevated Case scenario. Some authorities have a far greater potential available to them (relative to their energy demand) and this particularly relates to those that are less populated and more rural. Hence, it is important to consider district benchmarks and targets in the context of the county, with the expectation that some authorities should achieve targets (relative to district energy demand) greater than others. In other words, authority level targets (and subsequent policy) should be guided by the strategy to maximise the use of low carbon energy resources. Moreover, it is contended that those authorities with apparently limited potential should establish ambitious targets (relative to potential) to ensure they are making a effective contribution to the overall target.

With respect to individual authorities the analysis results suggest that East Staffordshire, Lichfield and Stafford have the potential to exceed the upper level of the 'localised national target' target of 10%, when considering the Elevated Case scenarios. South Staffordshire can be added to this group to achieve the lower range of the 'localised national target' of 7.5% based upon the Base Case scenario, but all other authorities would fail to do so. It should be noted that the results for most authorities are significantly influenced by the wind energy potential and the assumptions made within this part of the analysis.

The potential for Stafford far exceeds the other authorities and this is due to the concentration of both biomass and wind energy resources available. Wind energy, for example, makes up approximately 45% of the estimated resource for 2020.

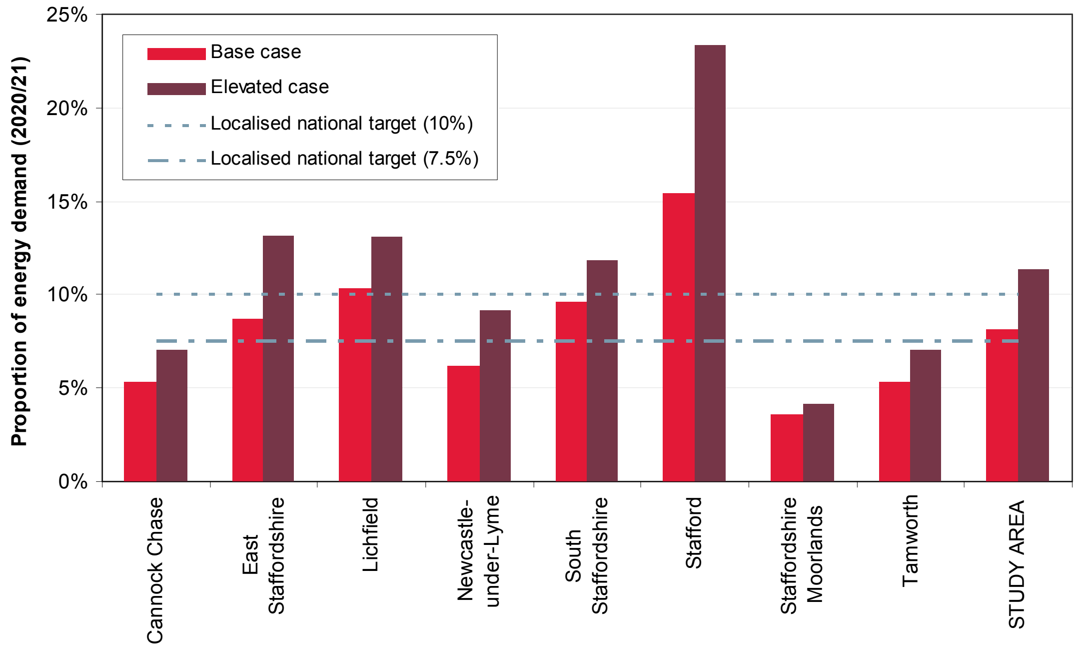

Figure 3 Benchmarking of supply potential for renewable energy

It is recommended that each authority establishes renewable energy targets with reference to the analysis of potential completed. In order for Staffordshire Moorlands, Tamworth, Newcastle, and Cannock to attempt to hit the localised national benchmarks it is necessary for each to establish targets, policies and support measures aimed at delivering the Elevated Case scenarios. For the other authorities, achieving targets at some level between the Base Case and Elevated scenarios, achieving the 7.5% targets as a minimum, would be reasonable. Achieving the Base Case potential in each district would enable the lower level benchmark to be achieved at the county level, but only by a small margin. It is important therefore that district targets are established in the context of the results achieved at a county level with some authorities going beyond Base Case potential to provide headroom above the lower benchmark at county level and to aspire towards the upper benchmark.

2.7 New build development –carbon standards

Within the study, options for setting development carbon standards have been considered. In particular the study looked at options for exceeding the nationally proposed zero carbon buildings roadmap, reviewing associated benefits including:

- achieving increased carbon reduction;
- supporting early action within the local development market; and;
- ensuring current opportunities for delivering lower carbon development are not lost particularly for major development sites
- developing locally developed delivery mechanisms, for example, a locally administered carbon investement fund, providing wider local carbon reduction benefits.

In summary, the areas of acceleration considered were:

- requiring 10% reduction in regulated and unregulated emissions through low or zero carbon energy measures in all development from 2010

- requiring 20% reduction in regulated and unregulated emissions through low or zero carbon energy supply in all development from 2013 and from 2010 where lower cost solutions are available
- requiring 44% reduction in regulated emissions from 2010 where lower cost solutions are available
- requiring the zero carbon standard to apply from 2013 where lower cost solutions are available

Based upon these points of acceleration (compared with the national zero carbon roadmap) a target framework has been established as shown in Table 1. The framework only relates to domestic development since the equivalent roadmap for for non-domestic development is still to be resolved. We do however recommend Low and Zero Carbon energy generation targets to be set for non-domestic targets and these are discussed later in this section.

Table 1. Proposed carbon standard framework

<table>
<tr><th rowspan="2">Period</th><th colspan="3">Domestic Reductions</th><th rowspan="2">Resulting range in carbon reduction (Regulated emission equivalent)</th></tr>
<tr><th>Regulated (vs Part L 2006)</th><th>Minimum Proportion of Low and Zero Carbon energy generation* (against total carbon**)</th><th>Un-regulated</th></tr>
<tr><td>2010-13</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Minimum***</td><td>25%</td><td>10%</td><td>0%</td><td>25 - 42%</td></tr>
<tr><td>Maximum[χ]</td><td>44%</td><td>20%</td><td>0%</td><td>44 -78%[χχ]</td></tr>
<tr><td>2013-16</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Minimum***</td><td>44%</td><td>20%</td><td>0%</td><td>44 -78%[χχ]</td></tr>
<tr><td>Maximum[χ]</td><td rowspan="5">100%
(min. 70% Carbon compliance / 30% AS[χχχ])</td><td rowspan="5">Obsolete at this carbon standard

Zero Carbon</td><td rowspan="5">100%
(Carbon compliance or AS)</td><td rowspan="5">100 – 150%</td></tr>
<tr><td>2016-19</td></tr>
<tr><td>Minimum***</td></tr>
<tr><td>Maximum[χ]</td></tr>
<tr><td>Post 2019</td></tr>
</table>

*Depending on the technical solutions this may not result in additional carbon savings.

** total carbon = 100% regulated plus 100% unregulated emissions

***To be applied to all housing development including those of less than 10 dwellings to ensure consistency with Code for Sustainable Homes

[χ] where lower cost solutions are available because of technical opportunities, e.g. community heating, biomass heating / CHP, large wind energy, surplus heat or scale of the development

[χχ] unlikely to result in this maximum level of savings since the 44% regulated emissions reduction target will typically require a significant element of renewable energy.

[χχχ] AS = Allowable Solutions

The framework establishes standards in terms of carbon reduction and as such does not set specific standards for energy efficiency. This then leaves developers to decide on the appropriate mix of energy efficiency and low carbon energy supply (and allowable solutions when the target is zero carbon). Energy efficiency is typically the 'least cost' approach and will therefore form the cornerstone of most low carbon solutions. However, financial incentives such as the Feed-in Tariff and potential Renewable Heat Incentive may in future present a disincentive for energy efficiency. We recommend that compliance against the framework is monitored over time, specifically to enable Authorities to review whether minimum energy efficiency standards are required.

Within the framework, targets are set out on a minimum and maximum basis to provide a clear starting point for the developer and for the Planning Authority to review what the appropriate target should be in the case of each development that comes forward. The expectation would be that the planning policy for carbon targets would be framed such that the onus would be placed upon the developer to prove that the maximum targets were not viable, in the context of the specific carbon reduction solutions available. Thereafter the developer would be required to justify what target could be achieved between the minimum and maximum standards, with a backstop requirement of the minimum target[21]. In general the maximum target would apply

[21] *Applicants, as with other policy requirements, could challenge this but they would need to demonstrate clear evidence that the minimum requirement makes the specific development they propose unviable.*

only to those development sites that can viably incorporate lower cost solutions (which the Planning Authority would need to test), i.e.:

- Connecting to existing communal heating network near the development site or connect to appropriate source of surplus heat
- Developing communal heating and / or CHP on site, particularly where biomass can be the principal fuel
- Developing wind energy on or near to the development site, with a physical connection to the development site

This will tend to mean that the maximum targets are applied to larger, higher density developments, or where low cost generation opportunities exist.

For most development sites it will be technically possible to achieve a 20% reduction in total carbon (regulated and unregulated emissions) using on-site renewable technologies such as PV, solar water heating and biomass boilers.

For larger development (generally over 1,000 units) or where lower cost solutions are available, we are proposing that a target of meeting zero carbon standards ahead of 2016 is set, given that the Feed-in Tariff (FIT) and potentially the Renewable Heat Incentive (RHI) will support these schemes. At this scale it is considered that infrastructure could in many cases be supported through an Energy Services Company (ESCO).

To provide additional support for the achievement of the zero carbon standards, the development of local 'allowable solutions (AS)' strategies (and delivery vehicles) ahead of the 2016 milestone, should be considered. This will enable authorities to present the lowest cost options to the development sector at an early stage and also ensure that investment for local carbon reduction priorities, e.g. communal heating infrastructure or civic renewable energy projects, is captured at an early stage.

The development target framework only considers residential development. Since a zero carbon roadmap for non-domestic buildings does not exist, it is impossible to review opportunities for acceleration. Ahead of the conclusion of the on-going consultations in this area, it is recommended that 10% and 20% renewable / low carbon energy supply targets are established from 2010 and 2013 respectively, to be applied to regulated and unregulated emissions. We propose that unregulated emissions are calculated as fixed 20% of regulated emissions for all development types over 1,000m^2, for the reasons of simplicity in applying the policy.

Viability of the higher carbon standards needs to be considered on a local authority basis to ensure targets are generally deliverable in the local area without conflicting with other key objectives, such as the provision of housing, appropriate proportions of affordable housing and bringing forward economic development sites.

Each of the Planning Authorities needs to satisfy itself that the targets as they are framed are generally financially viable within the current development markets (and take account of possible future conditions). Carbon reduction targets cannot be considered in isolation and viability needs to be considered alongside viability of the development generally against prevailing market conditions, whilst considering additional costs such as including affordable homes, providing Section 106 contributions and delivering against other sustainability standards such as Lifetime Homes and the Code for Sustainable Homes / BREEAM.

Financial viability studies should consider both costs and potential incomes associated with low carbon development:

- Additional costs of energy efficiency measures
- Additional costs of renewable / low carbon supply technologies
- Additional maximum costs of Allowable Solutions

- Potential capitalised revenue from renewable energy tariffs
- Potential capital contribution for an Energy Services Company
- Potential additional sales / rental value.

All but the last item is analysed within the study and data is presented that could be used within viability studies. The results are not straightforward to interpret because of the wide range of technical solutions and the development types that need to be considered. However, overall the conclusions of the cost modelling suggest that when capitalisation of future revenues (ESCO arrangements and accessing renewable energy tariffs) are accounted for, the net additional costs for each point of acceleration are relatively small. The early provision of ‘allowable solutions’ will also significantly aid the introduction of a zero carbon standard.

2.8 Policy Recommendations

In summary our recommendations from the study are as follows:

Supporting low carbon new development

Recommendation 1: Require developers to achieve carbon reduction targets for new residential development as set out in the carbon targets framework. Require developers to achieve 10% and 20% renewable / low carbon energy supply targets from 2010 and 2013 respectively for all non-residential development types over 1,000m^2. Require developers to specifically consider the viability (technical and otherwise) of community heating, biomass heating, CHP and utilising surplus heat

Recommendation 2: Conduct development viability assessment(s) to collectively consider the full range of planning obligations, e.g. affordable homes, S106, alongside the estimated additional costs and potential incomes associated with achieving lower carbon development from ESCOs, capitalisation of the renewable energy tariffs and ‘allowable solutions’.

Recommendation 3: Establish a Carbon Investment Fund mechanism, either unilaterally, or as a group, to support implementation of the ‘allowable solutions’, particularly aimed at supporting the proposed acceleration to the zero carbon standard to 2013 for major development.

Recommendation 4: Conduct high resolution heat mapping and feasibility analysis (including market assessment) of district heating and CHP around locations identified as having potential, i.e. where major development and/or surplus heat occur alongside existing high energy consumption intensity

Recommendation 5: Include infrastructure requirements for the low carbon energy technologies, particularly for district heating, where they are known within local infrastructure plans.

Low and zero carbon technology in decentralised and existing built environment applications

Recommendation 6: Provide specific planning protocols for those small-scale technologies not classed as Permitted Development.

Recommendation 7: Develop delivery and funding strategies to maximise the uptake of energy efficiency and low carbon energy supply in the existing built environment, notably around public sector buildings, managed housing and private sector housing. Where Carbon Investment Funds are developed these could support investment in this area.

Recommendation 8: Conduct analysis of the potential for fuel switching in off-gas grid locations, since this provides discrete opportunities for the switching to lower carbon fuels, particularly with the introduction of the Renewable Heat Incentive in 2011.

Decentralised generation

Recommendation 9: Develop clear criteria-based planning policy for the key stand-alone generation technologies, notably wind energy and bio-energy projects

Recommendation 10: Publish maps showing indicative areas of potential for wind energy development and spatial distribution of other resources and consider establishing appropriate targets at local authority level and/or study area/county level.

Recommendation 11: Conduct a review of the landscape impact from wind energy and biomass in sensitive parts of the study area

Recommendation 12: Review hydropower potential across the study area as and when site specific energy data is made available from the on-going Environment Agency UK-wide resource study

Other recommendations including compliance enforcement and monitoring

Recommendation 13: Publish, within each authority's LDF documents, summaries of the Low and Zero Carbon (LZC) energy resource potential and its potential long term contribution when benchmarking against national targets (and regional targets as and when they are updated to reflect national targets)

Recommendation 14: Establish a low carbon / renewable energy planning steering group with a remit covering the strategic issues raised within this study, and with representation from all authorities within the county (including the county council)

Recommendation 15: Establish a monitoring mechanism and conduct detailed annual monitoring of Low and Zero Carbon (LZC) energy uptake in each authority. LZC that is not subject to local planning approval will need a different approach from that development passing through local planning.

Recommendation 16: Establish expert low carbon planning assessment services, either on an individual Authority basis, or more cost effectively through shared-working across a number of authorities or across the county. Assessment services would need to adequately deal with the technical and financial aspects of low carbon standards, and enable critical negotiation around development as it comes forward.

Recommendation 17: Provide training for Development Control officers to assess energy and carbon reduction strategies. Implementation of this recommendation will need to be consistent with the recommendation to establish expert low carbon planning assessments services, which if conducted on a shared working basis, would externalise the approach to assessment.

Recommendation 18: Require suitable on-site carbon monitoring to be installed in major new development to enable assessment of long-term (carbon) performance compliance.

Recommendation 19: In supporting **Recommendation 18** conduct a study to establish a financial penalty scheme based upon a financial bond returnable on achievement of long term (carbon) performance compliance

Recommendation 20: Develop a county-wide biomass supply chain infrastructure strategy

2.9 Non-Planning Delivery Mechanisms

Planning policy is a core plank of local strategies for delivering decentralised energy generation and low carbon development. However, to maximise the chances of success it has to be married with a range of non-planning measures that should attempt to create local delivery leadership, promote demand for low carbon solutions and the supply of services required to deliver and facilitate the delivery of the key solutions, particularly:

- Low carbon infrastructure (communal heating networks), to enable connections between new development, the existing built environment, sources of surplus heat and waste-to-energy opportunities (incineration and anaerobic digestion of municipal waste)
- Develop a county-wide strategy for the development of the biomass fuel markets for heat and power generation:
  - Identifying the gaps in the existing supply chain and major opportunities for project development (district heating, new low carbon development, off-gas fuel switching)
  - Identifying funding opportunities
  - Implementing strategic market development interventions
- Provide or facilitate financing mechanisms that support delivery of local Allowable Solutions that enable zero carbon development to be achieved, whilst supporting priority carbon measures, e.g. communal heating infrastructure, civic renewable energy projects and carbon reduction measures in the existing built environment
- Provide or facilitate financing measures that facilitate access to capitalisation of the future revenues from energy generation or energy saving, e.g. Energy Services Company solutions, Renewable Tariff capitalisation and low interest loans, to minimise direct cost for land development
- Capture external grants such as innovation funding and structural funds. Examples of this include European Regional Development Funds, European Investment Bank investment development and planning funding for Ecotowns, and Housing Growth Funds from CLG that may be able to support the development of low carbon infrastructure projects in support of growth.

These issues are reviewed within the report.

3 Introduction

This study's aim is to inform the Partner Authorities about the potential, viability and deliverability of various renewable and low carbon options. The findings of this study provide an evidence base for the Partner Authorities' Local Development Frameworks in accordance with the requirements of Planning Policy Statement 1 (Planning and Climate Change) and PPS22 (Renewable Energy).

With support from Staffordshire County Council, the study has been jointly commissioned by the following authorities, whose boundaries collectively form the study area:

- Cannock Chase District Council
- Lichfield District Council
- South Staffordshire Council
- Staffordshire Moorlands District Council
- East Staffordshire Borough Council
- Newcastle-under-Lyme Borough Council
- Stafford Borough Council
- Tamworth Borough Council

3.1 Study Area Context

The study area, shown in Figure 4, covers the eight councils within the administrative county of Staffordshire. Stoke-on-Trent is excluded from the study because it had previously commissioned a similar study. Detail about the partner authorities are set out in the following sub sections.

3.1.1 Cannock Chase District Council

Introduction

Cannock Chase District covers an area of 79 km^2 and lies within southern Staffordshire on the northern edge of the Black Country Major Urban Area. At the heart of the District lies the nationally significant Cannock Chase Area of Outstanding Natural Beauty and around 60% of the District is designated Green Belt, testament to its strategic role as part of the West Midlands rural-urban fringe. The District is characterised by a mixture of medium-small scale urban areas and rural settlements and has a resident population of 92,126 (2001 Census), most of which resides in the urban areas. There are two main towns (Cannock and Rugeley) alongside a series of other key centres serving local needs e.g. Hednesford Town and Norton Canes local centre. The District has been heavily influenced by the growth and decline of the coal mining industry in recent history but despite this common influence there are areas of distinct character, environmental and socio-economic profiles associated with each of the principal urban areas and rural settlements. Most importantly the urban areas, principally the town centres, are in need of regeneration and the rural communities require support in terms of their economies and provision of services.

Housing and Employment Growth

The West Midlands Regional Spatial Strategy Phase Two Revision requires that 290 homes be built within the District each year up to 2026 (5,800 between 2006-2026). There is also a need to provide for at least 84ha of employment land (between 2006-2026). Housing growth and regeneration aims will have to be balanced against the need to protect the sensitive natural and historic environment of the District.

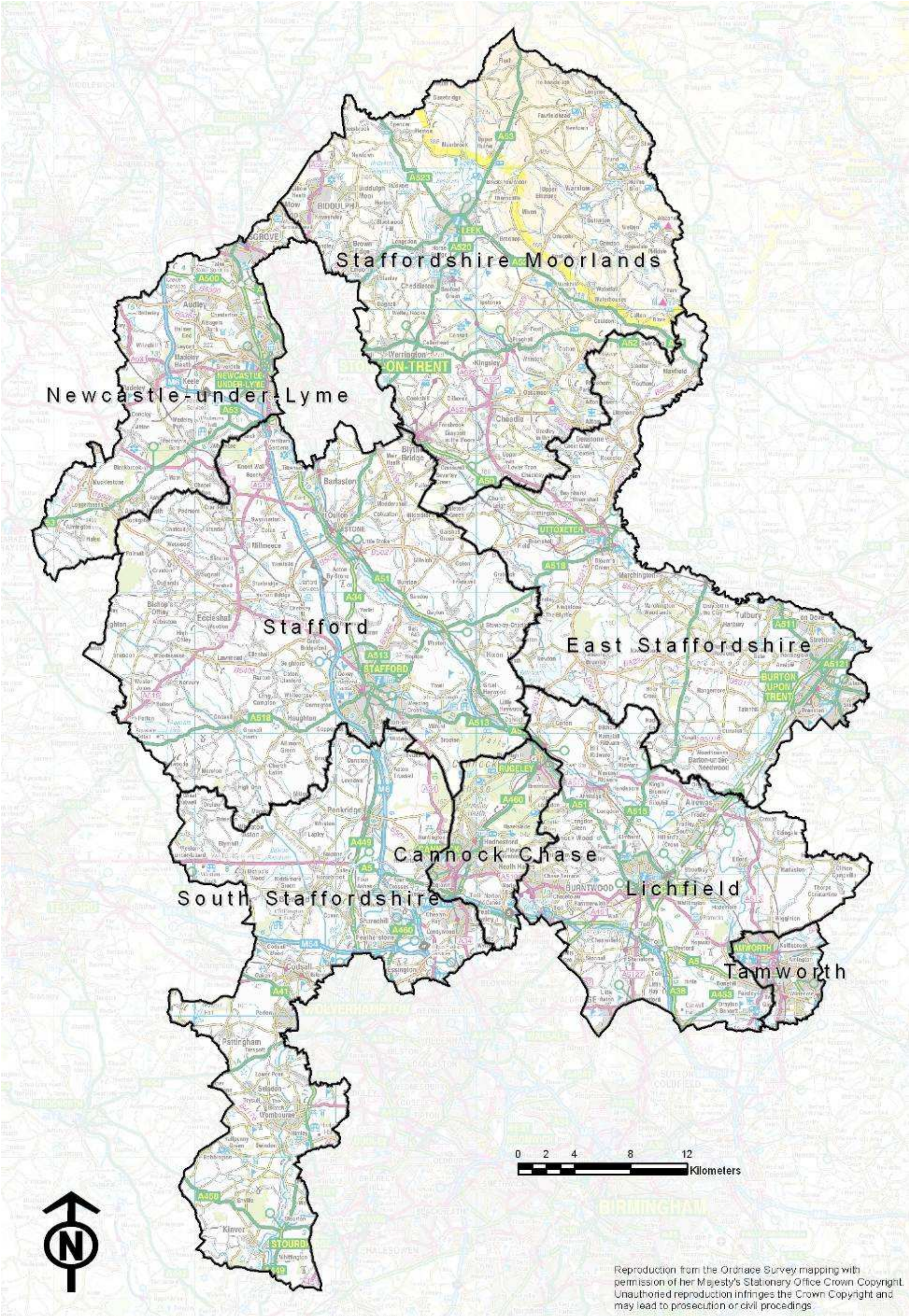

Figure 4: Image of study area

Other Issues

Parts of the District's built and natural environment have been accorded international, national and locally protected status, the most significant of which are the Cannock Chase and Cannock Chase Extension Canal Special Areas of Conservation (SAC) and the Cannock Chase Area of Outstanding Natural Beauty (AONB). The AONB represents a nationally important landscape and it is therefore a very sensitive area within the District and a potential key constraint to any major renewable energy and low energy development. Similarly, Green Belt makes up approximately 60% of the total area and 8 designated Conservation Areas are dotted across the District, principally focused around Rugeley; these characteristics could also potentially influence the nature of renewable energy technologies employed.

3.1.2 East Staffordshire Borough Council

Introduction

East Staffordshire Borough covers an area of 38,880 ha and possesses significant historic heritage, together with an extremely attractive natural environment. East Staffordshire is situated on the eastern boundary of the West Midlands where it borders the East Midlands and enjoys close links with South Derbyshire District. A mix of urban and rural areas create a diverse place to live and work with the two major settlements - Burton upon Trent and Uttoxeter - providing two town centres for the Borough. The 2001 Census indicated that 103,770 people were living in East Staffordshire. Over half the population is concentrated in Burton upon Trent and a further 12,000 live in Uttoxeter. The largest villages within the rural areas are Barton under Needwood, Tutbury and Mayfield.

Housing and Employment Growth

Burton upon Trent is a designated Growth Point, which aims to deliver high levels of additional housing, including an uplift in premium homes, and at the same time support the regeneration of existing housing stock. The The West Midlands Regional Spatial Strategy Phase Two Revision proposes 12,900 new homes but that figure was lifted to 13,000 in the panel report. The requirement has been split so that 11,000 dwellings are to be located in and around Burton upon Trent and 2,000 are to be located elsewhere in the Borough.

Historically East Staffordshire has thrived upon its brewing and manufacturing industries. However the last 10 to 15 years has seen an increase in office, warehousing and logistic uses with a significant amount being concentrated within Burton upon Trent. Rapid development and occupation of employment land particularly within Centrum 100 has resulted in a reduction of high quality, readily available employment land. Measures to address this by way of stimulating regeneration and economic growth are underway in order to maintain East Staffordshire's prosperous economy.

Other Issues

Burton upon Trent is the largest community in the National Forest, which covers 200 square miles of parts of Derbyshire, Leicestershire and Staffordshire. The conurbation could benefit from the host of environmental initiatives intended for the designated area. The Council would like to see Burton upon Trent recognised as the "capital" of the National Forest with a high quality, diverse green infrastructure incorporating key assets such as the canal network, other watercourses and parks which help link the urban area with the wider landscape.

The Borough has valued natural assets that distinguish it from other areas and which need to be protected and enhanced but equally provide opportunities through green infrastructure to improve the attractiveness to residents, employees, tourists, visitors, and investors. New development and Green Infrastructure must be fully integrated if the Borough is to realise the quality of development it expects in the future.

3.1.3 Lichfield District Council

Introduction

Located in the south-east of the study area, close to the northern part of the West Midlands conurbation. Lichfield District extends to some 33,151 ha with a population of 97,900 (2008 mid-year projection). Around half of the District is covered by Green Belt designation and the District has two main settlements; the historic cathedral city of Lichfield and the town of Burntwood – both with similar population levels of around 30,000 – as well as many villages within a varied rural area. Fradley, although a rural settlement lying to the north of Lichfield, has been a focus for employment growth in recent years, mainly on and around the former airfield. Some of the other rural settlements are physically connected to urban areas that lie within the administrative boundaries of other Local Authority areas, including Little Aston which adjoins Sutton Coldfield and Streetly, and Fazeley which adjoins Tamworth. The town of Rugeley, which lies within Cannock Chase District, sits on the north-western boundary of Lichfield District. This geographic location, coupled with good road and rail communications has lead to high levels of out-commuting for jobs and services, particularly by car.

Housing and Employment Growth

The West Midlands Regional Spatial Strategy Phase Two Revision requires that a minimum of 400 homes be built within Lichfield District each year up to 2026 (8,000 between 2006-2026), of which around 3,700 have already been built, are under construction, or have planning permission, or could be brought forward on brownfield sites within existing settlement boundaries. However, if housing growth is focused on the most sustainable settlements in the District, it is very likely that Green Belt releases will be necessary to meet the RSS requirement. There is also a need to provide approximately 99ha general employment land (between 2006-2026). However, no new land will need to be allocated for employment uses, as existing allocations of new land and redevelopment of existing sites are sufficient to absorb the proposed growth to 2026.

Other Issues

The District is characterised by several areas of high landscape quality. Of greatest importance are the River Mease Special Area of Conservation (SAC) and the eastern fringes of the Cannock Chase Area of Outstanding Natural Beauty (AONB). The District's rich biodiversity resource is demonstrated by the fact that there are 6 designated Sites of Special Scientific Interest (SSSIs), several of these lying within Chasewater County Park, which acts as a focus for biodiversity enhancement, as well as providing recreation, leisure and educational opportunities. Other areas identified for habitat creation include the Central Rivers Initiative and regional policy has also identified a Biodiversity Enhancement Area that extends from Cannock Chase to Sutton Park, within the Major Urban Area (MUA), aimed at promoting lowland heath management. In the west of the District the Forest of Mercia, and part of the National Forest in the north of the District, are both landscape orientated initiatives that seek to redress the loss of woodland in these areas. All of these characteristics and initiatives could potentially influence the nature of renewable energy technologies employed within the District.

3.1.4 Newcastle-under-Lyme Borough Council

The Borough of Newcastle-under-Lyme covers an area of 21,000 hectares in the north-western corner of Staffordshire. Newcastle town, which adjoins the western edge of the City of Stoke on Trent, is the Borough's largest settlement, with a population of 73,944 (2001 Census). The town of Kidsgrove in the north-eastern corner of the Borough is the second largest settlement, with a population of 22,145. Almost 80% of the population lives within the urban areas of Newcastle and Kidsgrove. The remainder resides in the numerous villages to the west and south of the conurbation, which is dominated by greenbelt.

There has been a dramatic transformation of the Borough's employment structure in recent years, with significant losses in manufacturing accompanied by growth in transport/communications/logistics industries far in excess of regional and national averages. In this time there has also been significant growth in the banking, financial and insurance services sector.

Whilst rural parts of the Borough are largely attractive and relatively affluent, some urban neighbourhoods within Newcastle have suffered from severe housing market failure, low demand, and an imbalance of housing types and tenures. This has attracted Government intervention in the form of the Housing Market Renewal Initiative, which has been in place since 2003.

The adopted Newcastle-under-Lyme and Stoke-on-Trent Core Spatial Strategy requires that 5,700[22] dwellings be built in the Borough from the period 2006-2026. In recognition of the regeneration needs of the area, this will largely be directed towards Government intervention areas. A maximum of only 900 dwelling are to be provided outside the urban area to help sustain existing rural services.

In terms of commercial development, the adopted Core Spatial Strategy sets out a requirement for:

- 112 ha of employment land within the Borough
- 60,000m^2 of office development within or on the edge of Newcastle Town Centre
- 35,000m^2 of comparison retail floorspace within Newcastle Town Centre.

3.1.5 South Staffordshire District Council

South Staffordshire is the southernmost of the eight authorities, adjoining the north western edge of the West Midlands Conurbation. The District is rural in character, with 80% (32,310 ha) of South Staffordshire lying within the West Midlands Green Belt, and the remainder to the north of the Green Belt boundary is defined as 'Open Countryside'. It has an area of 101,000 acres (40,400 ha) and has a population of just over 106,000, which results in a relatively low population density of 2.61 per hectare. South Staffordshire has a rich legacy of historic landscapes and buildings, historic parklands and gardens, Local Nature Reserves and open spaces including Baggeridge Country Park, and Kinver Edge. The western fringe of the Cannock Chase Area of Outstanding Natural Beauty lies within the District. South Staffordshire has over 850 listed buildings and structures, and 19 Conservation areas.

South Staffordshire is made up of 27 parishes with a dispersed and diverse settlement pattern of villages ranging from small hamlets to large villages, each with their own distinctive character set in attractive countryside. There is no single dominant settlement and South Staffordshire can be described as a 'community of communities'. The villages of Brewood, Codsall, Bilbrook, Cheslyn Hay, Great Wyrley, Kinver, Penkridge, Perton and Wombourne are the largest villages in the District and act as service centres for smaller villages in the surrounding rural areas and contain a range of facilities and services.

South Staffordshire's villages have expanded in the last 30 years as they have proved attractive to people prepared to travel to work in nearby urban areas. The District also benefits from good road and rail links with the West Midlands and other parts of the country. The West Coast main railway line runs through the District and local services are provided on the Shrewsbury to Wolverhampton, and Walsall to Rugeley lines linking with towns and cities in the Region. The M6, M6 Toll and the M54 run through the District giving access to the Midlands motorway network and beyond. The good accessibility is attractive to commercial interests and has resulted in certain parts of the district being under pressure for large scale development. However, despite the pressure for additional housing from out-migration from urban areas and large commercial development, maintaining the rural nature and the Green Belt whilst meeting South Staffordshire's local needs remains one of the Council's key priorities.

Growth Requirements for South Staffordshire

The West Midlands Regional Spatial Strategy (RSS) provides a clear strategy for the region that is based on the key objectives of urban and rural renaissance. The RSS recognises that South Staffordshire has a vital role to play in the rural renaissance objectives of the RSS by providing for local needs and not the out-migration from the Major Urban Areas, which should in turn increasingly meet more of their own housing needs, with less migration into the

[22] *Net figure which takes into consideration demolitions*

surrounding Shire areas. As such, the RSS housing and employment requirements for South Staffordshire for 2006-2026 are for 3,500 dwellings, and a rolling 5 year reservoir of 8ha of employment land giving a longer term requirement of 32 ha over the plan period. South Staffordshire Council will be seeking to meet the RSS requirement through the geographic spread of development on the basis of a clearly defined settlement hierarchy.

3.1.6 Staffordshire Moorlands District Council

Staffordshire Moorlands is in north-east Staffordshire, bordered by Cheshire to the north-west, Derbyshire to the east and Stoke-on-Trent to the south-west. It covers an area of 57,624 ha (222 square miles), and has a population of 95,400 (2007 estimate). Around 53% of the population is based in the three towns of Leek, Biddulph and Cheadle; around 22% of the remainder live in the four largest villages, all located in the west of the district.

A third of the district lies inside the Peak Park – under the auspices of the Peak District National Park Authority. Of the remainder of the Moorlands, around 30 per cent is designated as Green Belt. The district has close links to parts of Cheshire, as well as to the city of Stoke-on-Trent, which exerts a strong influence on the west of the district in particular, providing significant employment opportunities and retail services. Nearly 50% of the working population of Staffordshire Moorlands works outside the district, particularly in Cheadle and Biddulph where levels of out-commuting exceed 60% and 70% respectively. Car ownership rates are higher than average, commuting/shopping trips exhibit high car use and low public transport use.

In terms of housing markets, its towns are part of a market that draws in population from Stoke-on-Trent, Newcastle-under-Lyme and the towns of Congleton and Macclesfield; whereas the National Park part is a non-centred rural area operating independently from the rest of the District in housing market terms. The “need” for new affordable housing units has grown significantly over the past 5 years, reflecting both wage:price differentials, new household formation, and slight in-migration – these trends are expected to continue.

The landscape and historic environment of the District is highly valued and contains a large and particularly rich stock of protected assets, reflected in the number of formal designations. There are extensive protected environments (SSSIs and Special Conservation Areas) distributed across the District and particularly within the Peak District National Park boundary. The District (outside the Peak District) also includes 14 Conservation Areas; and well over 90% of the District outside settlements has a ‘special landscape’ designation.

Future Growth

The future growth of the District’s settlements will be based on their ‘organic’ needs, reflecting their hierarchical position with the RSS, but in a way which balances this with the need to conserve the District’s special urban and rural assets. The West Midlands Regional Spatial Strategy Phase Two Revision requires that 300 homes be built within the District each year up to 2026 (6,000 in total). There is also a need to provide for around 24ha of employment land (between 2006-2026).

3.1.7 Stafford Borough Council

Introduction

Stafford Borough covers an area of over 56,500 hectares and is centrally placed within Staffordshire County. The Stafford Borough area is locally distinctive in terms of character and landscape and is home to over 120,000 people. Over 60% of the population live in Stafford and Stone whilst the remainder live in the rural area where there are a number of larger villages such as Eccleshall, Gnosall, Hixon, Barlaston, Great Haywood and Little Haywood as well as smaller villages and hamlets. Stafford Borough has a relatively low level of deprivation although there are several wards, mainly in Stafford town, where deprivation is an issue of concern. In recent years, the scaling back of major employers in the Borough has led to a degree of de-industrialisation, particularly at Stafford Town, which has resulted in the local economy restructuring from predominantly manufacturing to more service based industries.

Expected Growth

For the period 2006-2026 11,000 new houses need to be built in the area, 8,000 of which are to be in Stafford Town. There is also a need to provide for at least 160ha of employment land, 30,000 square metres of new retail space by 2021 and 45,000 square metres of offices. There is already investment in key sites, spread over Stafford town centre which will bring new shops, restaurants, car parking, leisure and entertainment facilities, offices, riverside apartments and hotels.

Other issues

The Borough has a rich and varied natural and built environment that is composed of a diverse range of conservation, nature and historic environment designations including seventeen Sites of Special Scientific Interest (SSSI), three Ramsar sites, four Special Areas of Conservation (SAC), three national nature reserves and 30 Conservation Areas. In addition, there is also the Cannock Chase Outstanding Area of Natural Beauty (AONB) and two areas of Green Belt. These are potential key constraints to any major renewable energy and low energy developments and could influence the nature of renewable energy technologies employed.

3.1.8 Tamworth

Tamworth Borough is located in the south eastern corner of Staffordshire, where it lies on the edge of the West Midlands Green Belt. Covering a land area of 3,100 hectares, it is one of the smallest authorities in England. The resident population at the 2001 Census was 74,531. This had grown to approximately 75,800 by 2008 (mid year estimate) and is predicted to grow by a further 6,700 by 2026, with most growth in the elderly population. The Borough is characterised by a densely populated predominantly urban area and although it is surrounded by open countryside, the tight administrative boundary means that only small rural areas the north east and south actually lie within the Borough.

The character of the single settlement, Tamworth, owes much of its recent history to being a post war overspill town, which saw the town's population triple and historic hamlets absorbed into the urban area. At its centre is a historic core surrounded by late 20th century development, which forms a series of recognisable neighbourhoods, some of which are disadvantaged and in need of regeneration. The town serves local needs but its influence also extends beyond its boundary, with its services and facilities drawing in population from the rural areas of Lichfield and North Warwickshire. A network of green space, canals and rivers run through the built up areas, providing opportunities for recreation and contact with biodiversity.

The economic base was in manufacturing, although re-structuring since the late 1990's has been marked by a shift towards the service industry. Town centre regeneration is a priority to deliver a more attractive and competitive shopping and working environment.

Housing, employment, retail and office growth

The West Midlands Regional Spatial Strategy Phase Two Revision requires 2900 dwellings to be built in the period to 2026. The delivery of a strategic allocation in the form of the Anker Valley sustainable urban extension is critical to achieving this requirement. There is a need to provide 42 ha of employment land over the long term, with a rolling 5 year supply of 14 ha, which will be met by a combination of redevelopment and greenfield new build. The town centre is designated as a strategic town centre in the RSS and has to accommodate 25,000 square metres of retail floorspace between 2006 to 2021 and 10,000 square metres 2021 to 2026. Office provision of 30,000 square metres is also proposed within the town centre.

Challenges for the Local Development Framework

The main challenges for the Local Development Framework are linked to the tight administrative boundary and a limited supply of land, for which there are competing land uses. There are constraints to development in the form of seven Conservation Areas, most of which are within the urban area although the Amington Hall Estate Conservation Area which will influence the form and extent of development in the Anker Valley. There is one SSSI to the east of the Borough, local biodiversity and geomorphological designations, a widespread greenspace network and flood zones relating to the Rivers Anker and Tame. Green Belt designations are widespread outside the urban area in the south of the Borough.

3.2 Aims and objectives of this report

This study is intended to provide an evidence base to meet the requirements of Planning Policy Statement 1 – Planning and Climate Change and Planning Policy Statement 22 – Renewable Energy. PPS1 sets out the Government's overarching planning policies on the delivery of sustainable development through the planning system. Local authorities must take PPS1 into consideration when preparing relevant polices under their Local Development Frameworks (LDFs). The partner authorities' specific objectives are summarised as follows:

- To assess the viability and applicability of all renewable and low carbon energy sources.
- To identify locations (general areas and, where feasible, specific sites) within the county that may be favoured for renewable energy generation.
- To assess the contribution that proposed developments in Staffordshire could make towards generating renewable and low carbon energy.
- To provide an estimate of the total quantity of energy that could be generated via viable renewable energy sources.
- To identify potential for CHP deployment for sites with high heat demand.
- To identify realistic targets for onsite energy production from renewable and low carbon energy sources that can be required on suitable new developments.
- To establish a size threshold for new developments in which the incorporation of renewable energy technologies is feasible (for example number of dwellings, level of commercial floor space etc), and to establish if the effectiveness of renewable energy technologies varies depending on the scale of the development.
- To identify the barriers to the success of future policies, including perceived financial impact.
- To clarify the relationship between renewable/decentralised energy targets with carbon requirements set out in Building Regulations Part L and the Code for Sustainable Homes.
- To suggest any other LDF policy measures or targets that might contribute towards energy generation.

3.3 Structure of report

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

The study then explores the relevant low carbon policies and targets at national, regional and local levels. These include both those related to renewable energy generally and low carbon development more specifically. Of particular relevance are the previous Government's Low Carbon Transition Plan, the proposed changes to building regulations setting out a path to zero carbon development, and existing regional and local low carbon policies and energy/climate change strategy.

An assessment of the local renewable energy potential then follows. This is the heart of the evidence base, looking in particular at the major opportunities surrounding:

- stand-alone decentralised energy (hydro, wind and biomass);
- opportunities in new build property; and
- technologies within existing buildings.

For each, a methodology is set out, including key assumptions and reference sources, the analysis results and the overall potential for two scenarios – a base case and an elevated case

– representing a range of opportunity that is defensible and reflects current and future policy options. The study is presented for each Local Authority and in total for the study area, expressed in a range of ways including energy generated, percentage of heat and power needs that could be met from renewable sources and the Tonnes of CO_2 (tCO_2) that could be abated.

The report also reviews possible future carbon standards for new development, including acceleration beyond the UK carbon reduction roadmap for zero carbon buildings.

Conclusions are drawn on the costs and technical viability (with the recommendation that further locally specific development viability analysis is undertaken) and in planning terms particular development carbon targets (which have been benchmarked against pro-rata national targets) and related recommendations are made. High level 2020/21 renewable energy targets by authority are also discussed.

This is followed by a series of recommendations for policy formation in support of these targets. These include recommendations on the structure of performance-based targets, the evidence to be sought from developers in demonstrating a thorough exploration of the opportunities and constraints of each site, tests for viability and proposals for how the Local Authorities should respond depending on the results of these viability tests. We also propose some best practice approaches to monitoring the effectiveness of the policies. Finally we propose some non-planning delivery support mechanisms for consideration by the Local Authorities as accompanying actions to complement effective planning policies.

Stakeholder testing of the study conclusions and recommendations has been conducted through a stakeholder workshop, the notes for which are included in Appendix II.

A glossary of technical terms is included in Appendix III.

4 Energy Consumption and Carbon Emissions

It is essential to firstly understand current and future energy consumption and carbon emissions of each of the local authorities within the study area. Emissions are measured in terms of "kilo tonnes of carbon dioxide emitted per year", or $ktCO_2$/yr. Energy consumption is shown in Gigawatt hours (GWh). This study concentrates its analysis on the built environment; however transport carbon emissions are shown below for comparison of total energy consumption against renewable energy generation, which is how the UK target is presently expressed[23]. Consideration of carbon reduction solutions for transport is outside of the scope of this study.

4.1 Current energy consumption

Figure 5 illustrates the annual energy consumption for each authority, as provided by the Department of Business, Enterprise and Regulatory Reform (BERR) and the Department for Energy and Climate Change (DECC). This shows that electricity use is the smallest energy demand across all authorities, and that thermal demand is the largest in most cases. This is not uncommon, and is evidence as to why national government is beginning to focus its efforts on heat. Three bands of energy consumer can be identified: Cannock Chase and Tamworth have a considerably smaller energy demand relative to the other authorities. A middle band of three authorities have a similar demand of 29 to 32 MWh per person per year, leaving South Staffordshire, Stafford and Staffordshire Moorlands as the largest with over 37 to 39 MWh per person per year of energy consumed. Transport plays a more significant role for authorities who have a motorway running through their boundary (namely Newcastle-under-Lyme, Stafford, South Staffordshire, and Lichfield). Although motorway through-traffic is not counted in the dataset, vehicles turning off onto A- and B-roads would be counted as local energy consumption. Cannock Chase has a much lower level of transport emissions than the other authorities.

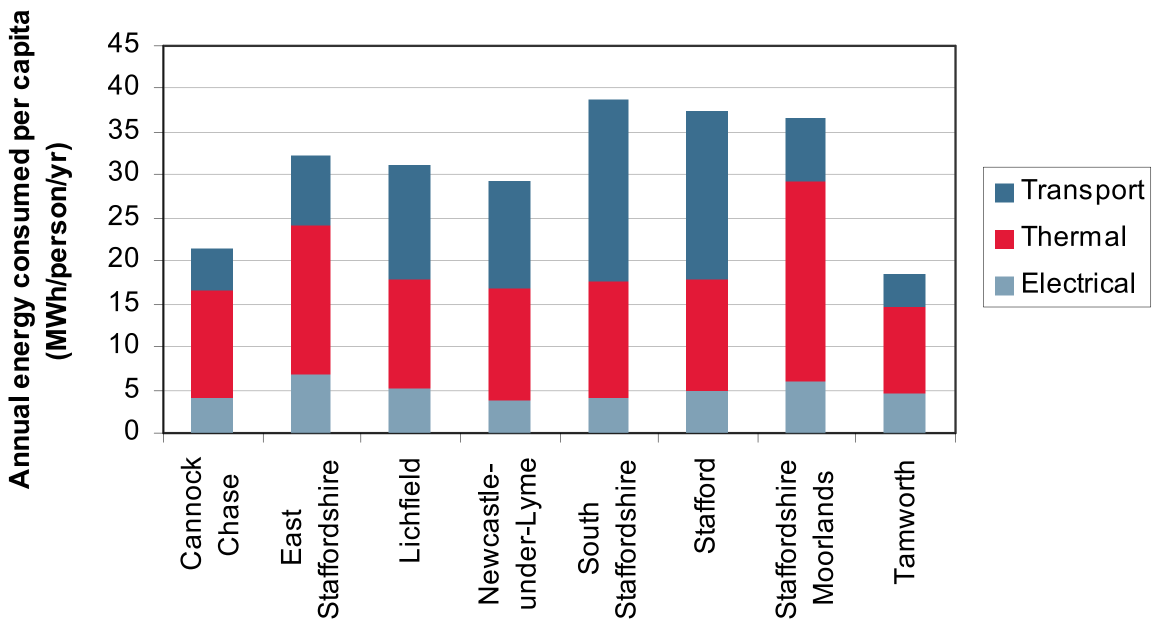

Figure 5: Estimated per capita energy consumption for 2007 (Source: DECC Sub-national energy consumption statistics[24])

[23] *The UK's target is to supply 15% of total energy needs in 2020 from renewable energy sources.*
[24] *http://www.decc.gov.uk/en/content/cms/statistics/regional/regional.aspx*

Carbon emissions for each authority, as provided by DECC (for the purposes and assessing National Indicator 186), are illustrated in Figure 6 (with further detail available in Appendix IV). The carbon emitted by every unit of energy differs between energy sources, hence the results do not directly mirror the energy graph above. For example, electricity emits over two times as much CO_2 per kWh compared with natural gas, and hence it accounts for a greater proportion of total CO_2 emissions than it does for energy consumption. In the majority of cases, thermal energy has been reduced to the smallest component. A further breakdown of these emissions can be found in section 4.3. Note that the carbon emissions data does not include emissions sources over which local authorities have no influence, for example motorways and some very large scale point source emitters[25].

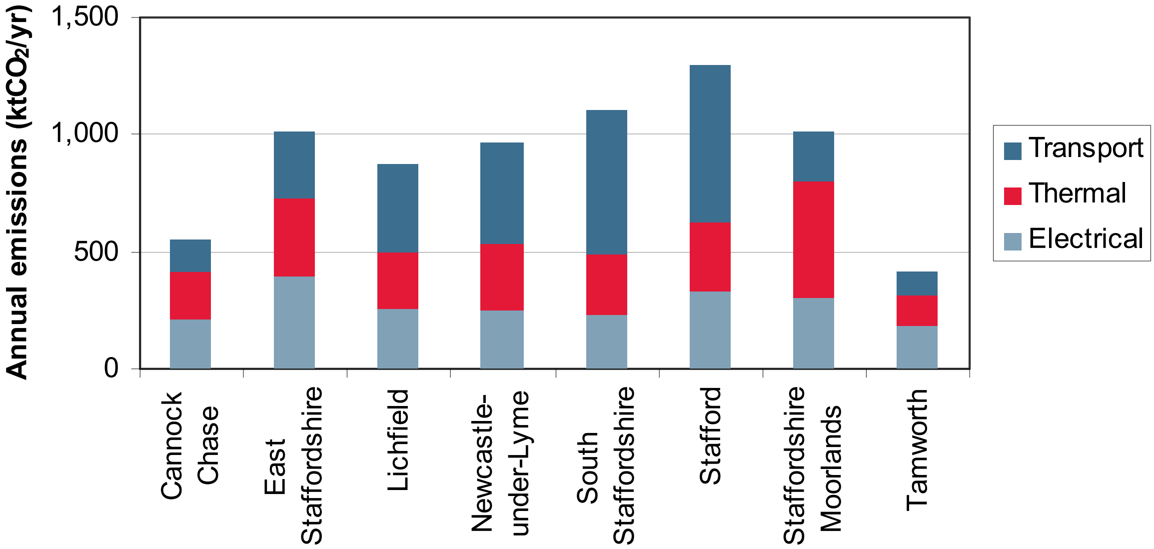

Figure 6: CO_2 emissions for 2007 (Source: DECC NI186 data release[26])

Table 2 looks at domestic CO_2 emissions on a per capita basis. Staffordshire Moorlands is the least 'carbon efficient' authority in the study area, where as Tamworth fairs the best. Only Cannock Chase and Newcastle-under-Lyme join Tamworth as being below the West Midlands average.

[25] *Significant point source emitters fall under the European Union's Emissions Trading System (EU ETS) which covers electricity generation and the main energy-intensive industries – power stations, refineries and offshore, iron and steel, cement and lime, paper, food and drink, glass, ceramics, engineering and the manufacture of vehicles. Combined, these account for around 43 percent of UK CO_2 emissions*

[26] *Some assumptions have been made to establish which components of the NI186 data relates to thermal. Both the background data and assumptions are clearly set out in Appendix IV.*

	Total emissions ($ktCO_2$)	Population ('000s, mid-year estimate)	Per capita emissions (tCO_2)
Cannock Chase	559	94.4	5.9
East Staffordshire	1,023	108.3	9.4
Lichfield	876	97.5	9.0
Newcastle-under-Lyme	976	124.3	7.9
South Staffordshire	1,119	106.3	10.5
Stafford	1,321	124.0	10.7
Staffordshire Moorlands	1,443	95.4	15.1
Tamworth	413	75.6	5.5
West Midlands	***43,994***	***5,382***	***8.2***

Table 2: Per capita emissions (buildings, transport and land use change), 2007 (Source: DECC NI186 release)

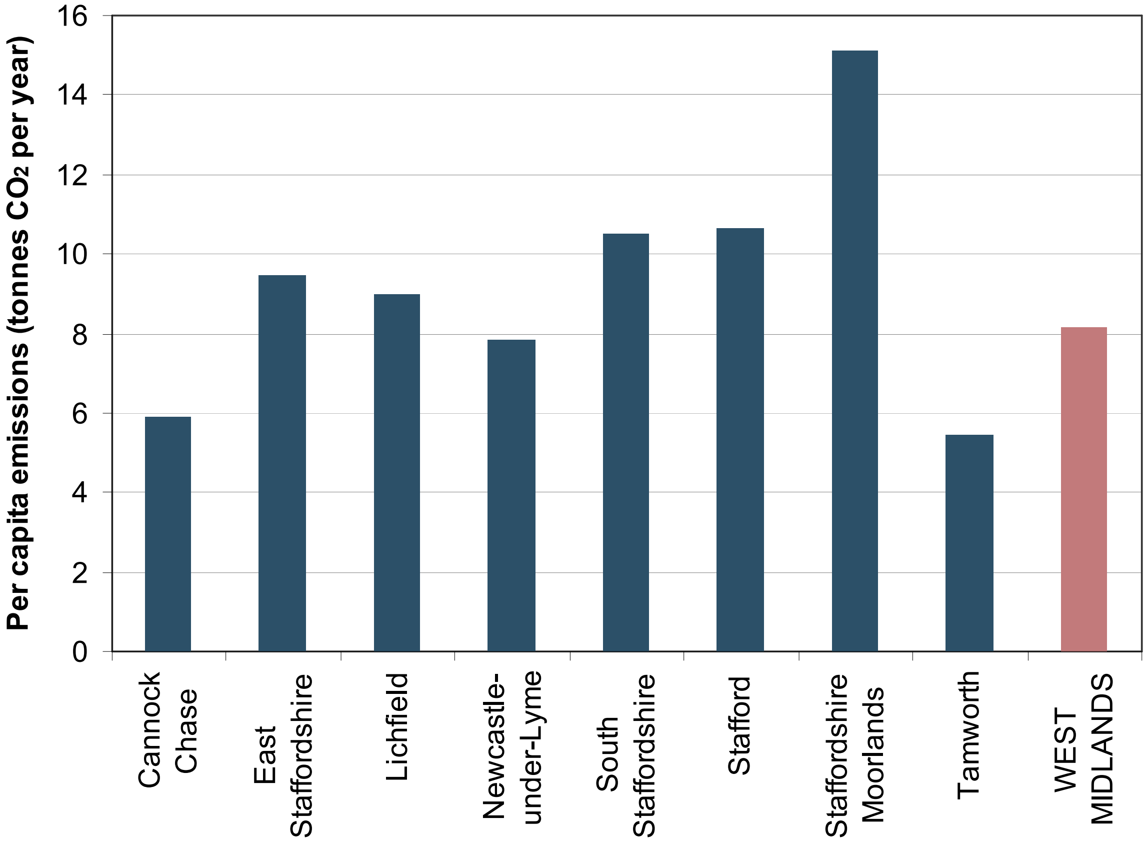

Figure 7: Per capita CO_2 emissions, 2007 (Source: DECC NI186 release)

4.2 Spatial distribution of heat consumption

Understanding the spatial distribution of high heat consuming localities and off-gas areas can help to identify areas for the application of biomass heating, district heating and combined heat and power (CHP). By overlaying the potential pattern of new development we can begin to identify areas of opportunity to link new build community energy infrastructure with high energy consuming existing settlements.

4.2.1 Domestic, commercial and industrial heat consumers

Figure 8 and Figure 9 demonstrate the spatial distribution of heat consumption on a Lower Super Output Area (LSOA) basis. The resolution of this data does not enable specific sites of heat demand to be identified, rather, it begins to identify 'areas of search' for a more detailed study. Overlaid onto the heat maps are several specific sites which can be considered as relatively large point source heat consumers (red dots). Detailed in Table 3, these sites are of interest since they are likely to be significant single contributors to the heat demand in the LSOA within which they are sited. Furthermore, their large heat demand may be optimal for connection to district heating – any sizable future developments near these sites are likely to see an enhanced viability of district heating if the existing facility is connected. Energy consumption data of individual organisations is not generally held in the public domain and so this is not intended to be a complete set of data representing all large energy users within the study area. It serves merely to provide some early reference points.

Operator Name	Post Code	Sector	Heat Load (MW_{th})
RAF Stafford	ST18 0AQ	Services	4.688
Johnson Matthey Plc #1 Johnson Matthey Plc #2	ST11 9RD	Chemicals Chemicals	2.496 Unknown
North Staffordshire Hospital NHS Trust	ST4 6QG	Services	Unknown
Tessenderlo Fine Chemicals Ltd	ST13 8UZ	Chemicals	2.274
Croda Leek Ltd	ST13 5QJ	Chemicals	5.453
Cauldon Cement Works	ST10 3EQ	Construction	Unknown
Stafford Hospital	ST16 3	Services	Unknown
Royal Ordnance	CW2 5PR	Manufacture	Unknown

Table 3: Large heat consumers in the study area (Source: Industrial Heat Map[27])

Additionally, large heat generators are illustrated as blue triangles on the map. Rugeley Power Station is rated at 1,056 MW_e, and a proposed power station at Blythe Bridge will bring a further 950 MW_e to the county. Both such facilities will produce significant heat which may be available for local use if a district heating system were to be developed. Any future developments nearby could benefit from this heat so long as guarantees are in place that the power station will be in operation for an extended lifetime. However, a recent study[28] indicates that Rugeley Power Station has a below average potential for heat recovery compared to other major UK power stations.

Figure 8 shows that overall heat demand is low across the vast majority of the study area, and that the developed areas of each authority present the areas of most intensive heat consumption. Figure 9 looks solely at domestic heat demand, and illustrates that many rural LSOA areas do in fact have a domestic heat demand comparable to some of the semi-urban areas (i.e. suburban or edge of town locations). It can be inferred that commercial and industrial heat demands are concentrated in the urban centres, and that these are relatively significant in scale – the highest domestic heat demand is up to 67,500 MWh/km^2 compared to

[27] *http://www.industrialheatmap.com/, data extracted December 2009*
[28] *University of Southamption, 2009, Potential Heat Supply from Current UK Electricity Generation and its Contribution to the UK's Energy Scenarios and Emissions, <URL: http://www.ice.org.uk/downloads//heat_research.pdf>*

420,000 MWh/km^2 when including commercial and industrial requirements. Thus, if looking to connect a district heating system to existing heat demands, it would be wise to seek commercial and industrial connections.

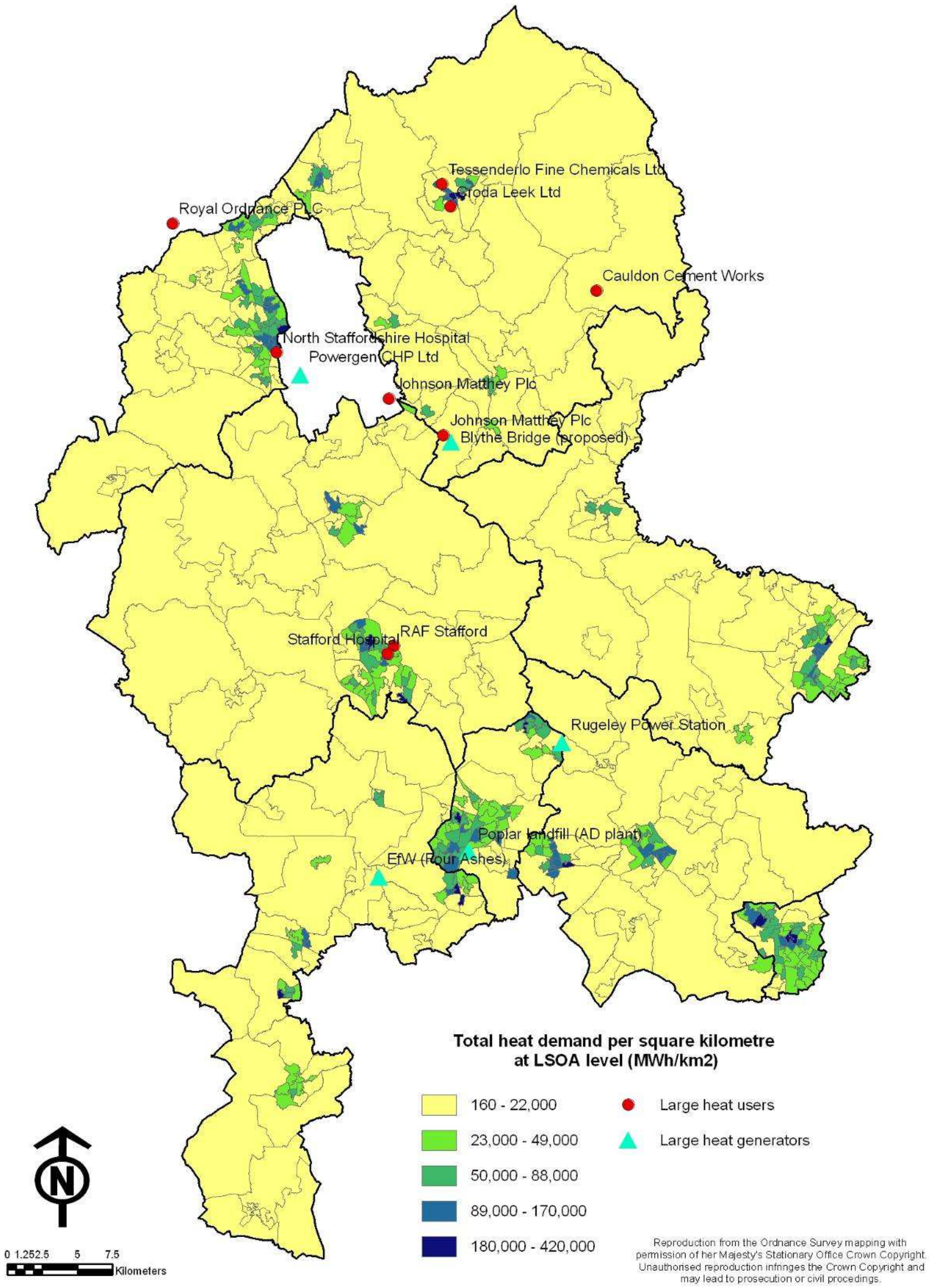

Figure 8: Total (Domestic, Commercial & Industrial) heat demand per square kilometre (MWh/yr/km^2)

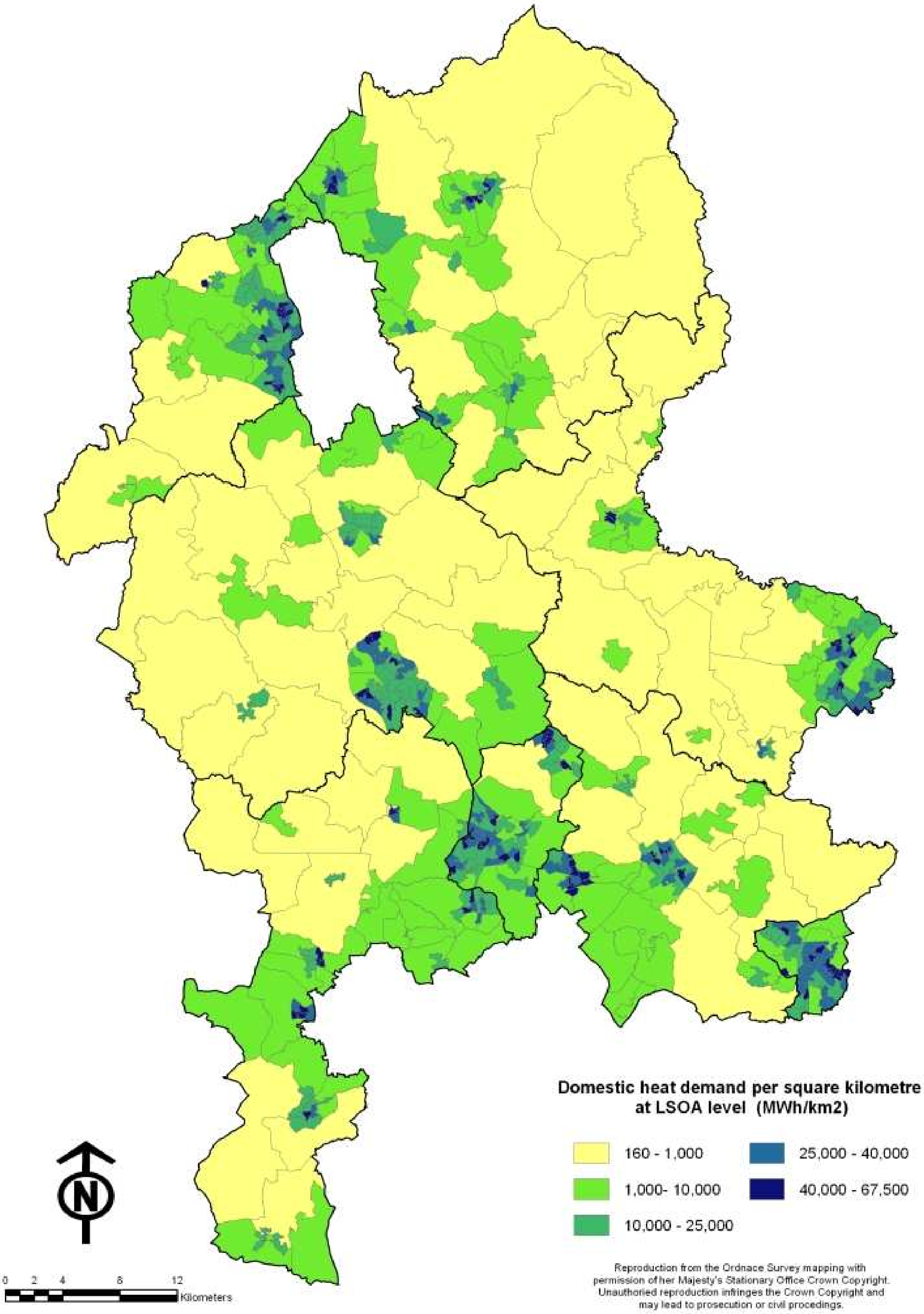

Figure 9: Domestic heat demand per square kilometre (MWh/yr/km^2)

4.2.2 District heating viability

District heating requires significant infrastructural investment to enable heat to be distributed over a given area. To enable this investment to be recouped at a rate attractive to a developer or Energy Service Company (ESCO), schemes are optimised by connecting to:

- large heat consumers;
- a number of consumers whose aggregated heat demands produce a constant heat load; and
- consumers whose locations are tightly clustered (reducing pipe distances).

A recent DECC study[29] provides a methodology to assess the technical viability of district heating based on heat densities. This infers that areas with a heat density exceeding 3,000 kW/km^2 are more viable for district heating. Figure 10 replicates this methodology on a LSOA basis for heat demands of the existing built environment – it does not include future developments. Data from a previous regional study of the CHP potential for the West Midlands region[30] has been used to establish heat demands within the study area.

This kind of analysis can identify areas for further and more detailed analysis in subsequent studies. Industrial heat demands have been excluded from this analysis due to the lack of certainty regarding what form that heat demand takes[31]. Principally, the wide use of compressed steam in industrial processes represents a heat demand which cannot be provided by district heating. Much more certainty surrounds the medium/low grade hot water based heating which is required in most domestic and commercial settings.

Figure 10 indicates that, based upon existing domestic and commercial heat demands, the most technically viable locations for district heating correlate closely with spatial distribution of heat consumption (shown in Figure 8). LSOA areas in Green exceed the DECC threshold of 3,000 kW/km^2, and areas in Blue represent zones which provide particularly favourable conditions for district heating. Also present on the map are possible future development sites (red hatched zones), provided from each of the local authorities' Strategic Housing Land Availability Assessment (SHLAA). This shows a number of instances where favourable district heating conditions coincide with future development pressures, particularly around Leek, Newcastle-under-Lyme, Werrington, Stone, Burton upon Trent, Burntwood, Lichfield and Tamworth.

It is recommended that further examination of those specific areas where high heat density and large new development coincide is conducted to explore the potential for district heating and interconnection between the two, particularly where each on their own would not justify investment. For reference Table 11 (section 8.1.4) provides an indication of the types of future developments which may best suit district heating / CHP.

[29] *DECC, 2009, District Heating: Economic Assessment and Evaluation of Evidence, <URL: http://bis.ecgroup.net/Publications/EnergyClimateChangeDECC/HeatandEnergySaving.aspx>*

[30] *http://www.wmro.org/displayResource.aspx/6681/Heat_mapping_and_decentralised_energy_study.html*

[31] *Halcrow split non-domestic energy consumers into commercial and industrial according to their SIC (Standard Industry Classification) code, where 14 to 41 are considered industrial and 45 to 99 commercial (for further information, see http://www.statistics.gov.uk/statbase/Product.asp?vlnk=14012)*

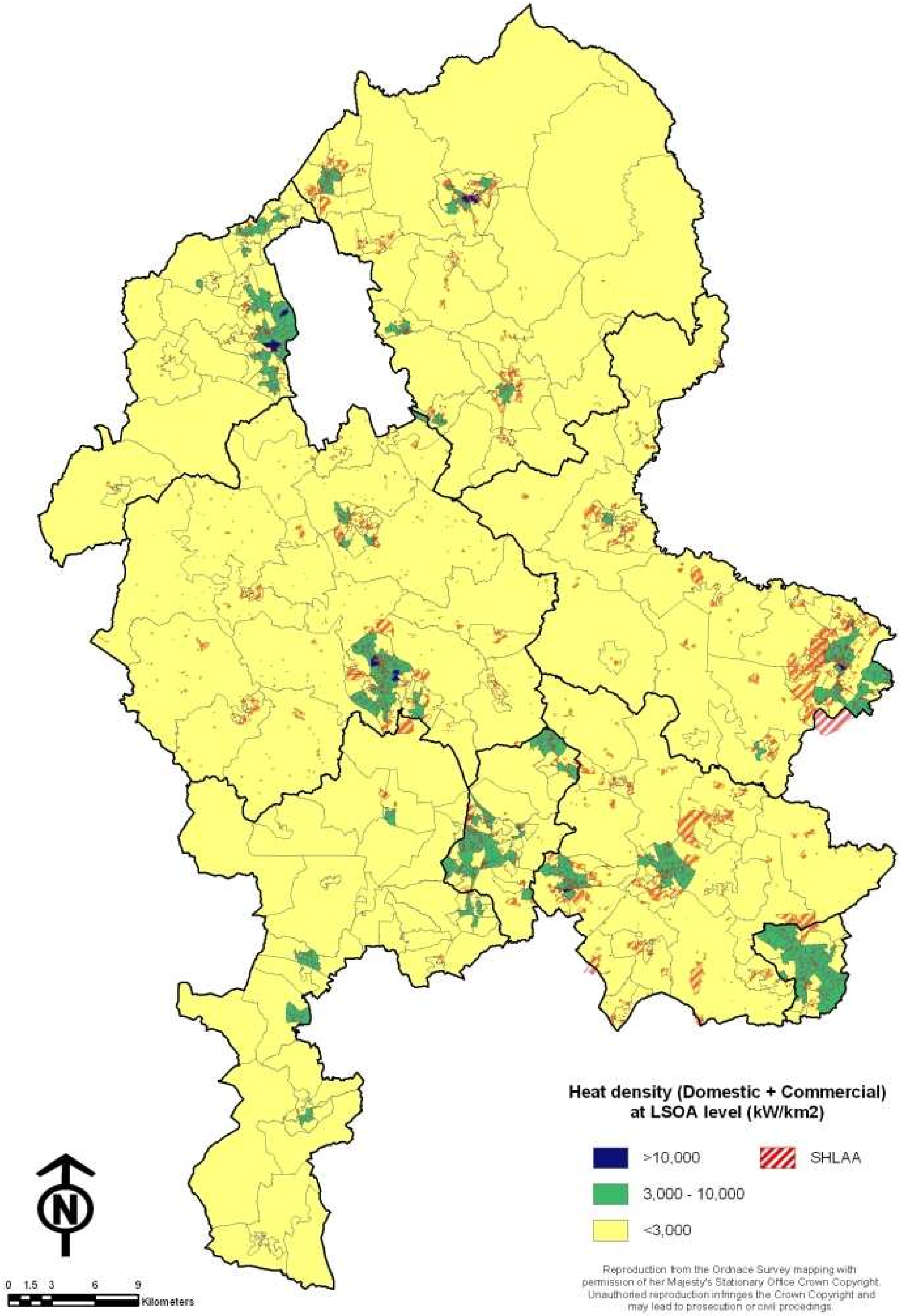

Figure 10: Spatial heat density distribution and identified SHLAA sites

4.2.3 Off gas locations

Figure 11 illustrates the distribution of non-gas connected domestic properties, the data for which is produced by comparing the numbers of domestic electricity meters to gas meters in each MLSOA of the study area, as a proxy. In other words, the difference between the two is assumed to be the number of domestic properties which do not have a gas connection. Consequently, care should be taken interpreting this analysis.

In rural areas, many buildings will be located where it is uneconomic to invest in gas grid connections, and so the majority of these properties have been deemed to be ‘off-gas-grid’, with limited (and generally more expensive) options for energy alternatives (LPG, coal, oil, electricity). However, in urban areas the properties identified are more likely not to be using gas for other reasons, principally because electricity was preferred at the time the building was being developed or that communal heating is being used in multiple-occupancy buildings. It is the rural properties that are of most interest because they offer the greater potential to fuel switch to biomass heating, small wind turbines and the other microgeneration options. The Feed-in Tariff, which is operational, and the proposed Renewable Heat Incentive will significantly support the economic justification for fuel switching. It is recommended that further consideration be given to the rural clusters of the non-gas connection to explore opportunities for the fuel switching (and energy efficiency support).

In some MLSOA areas, up to 80% of dwellings are estimated to be off gas, concentrated along the north eastern boundary of the study area, and a high frequency can also be found at the western fringes. Of the urban areas, Stafford appears to show the highest rate of off gas dwellings, with many of the other significant urban centres having below 5% off gas.

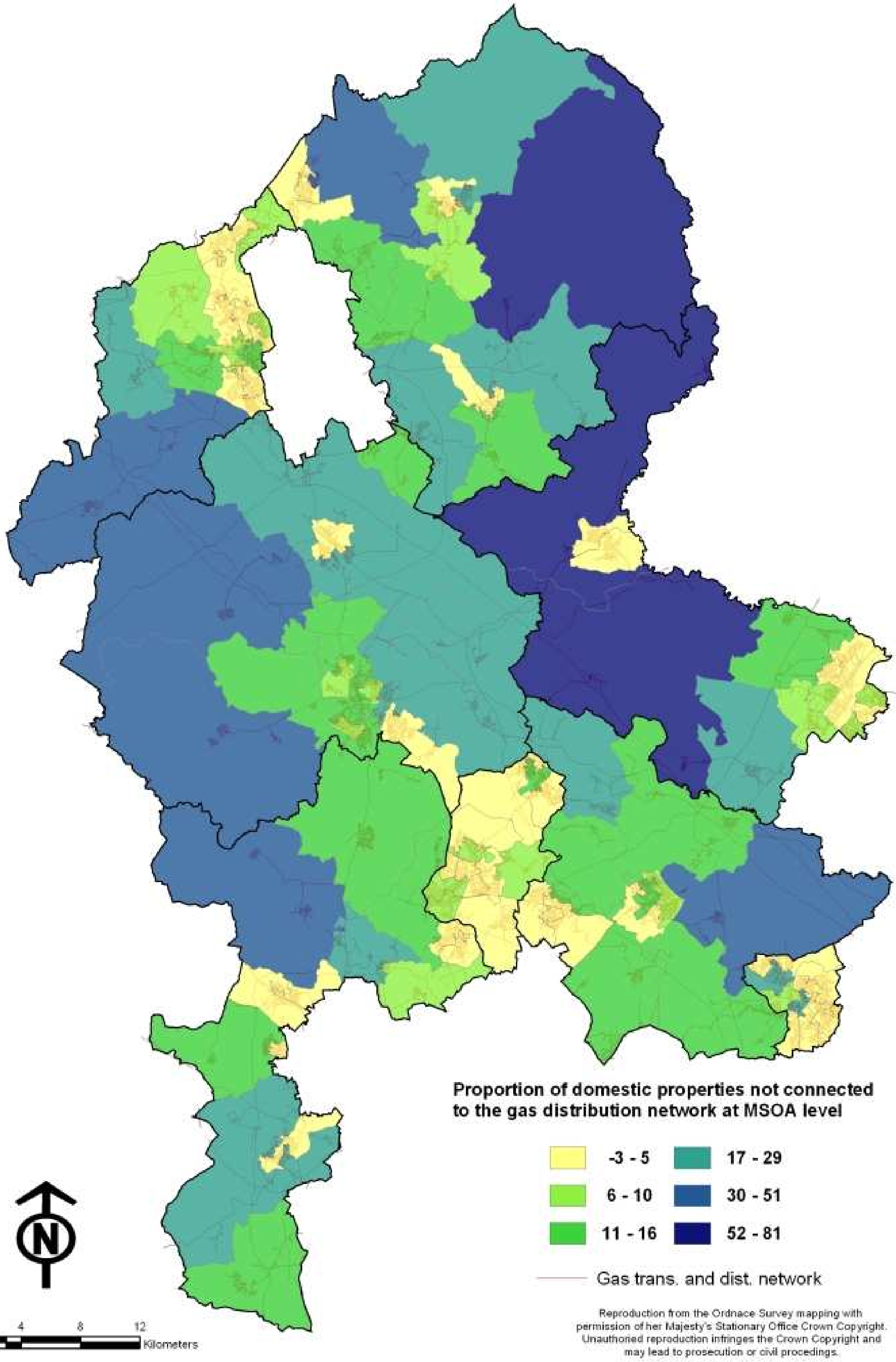

Figure 11: Number non-gas connected dwellings (MSOA level)

4.3 Breakdown of 2007 emissions baseline by fuel type and sector

It is important to consider each authority's carbon emissions arising from the built environment, as this is the key focus of the study. Energy statistics available from BERR demonstrate the electrical and thermal (coal, oil and gas) energy consumption for each Authority. This data is illustrated for commercial & industrial and domestic sources (Figure 12 and Figure 13 respectively). Initial observations include:

- Electricity is the major energy demand for commercial & industrial (C&I) sectors, whereas there is a more even split between electricity and gas in the domestic sector.
- There is relatively little coal and oil consumption in domestic properties.
- In almost all instances, C&I coal and oil usage is less than the national average, and broadly in line with the regional average.
- Staffordshire Moorlands C&I sector consumes coal at a rate almost six times above the national average, and 7.5 times above the regional average. However, similar trends are not present for domestic settings.
- Very little variation is demonstrated between domestic energy sources, except for Cannock Chase and Tamworth which appear to have almost no coal consumption and minimal oil, which it is presumed to be consequence of the limited rural development and more recent age of construction.

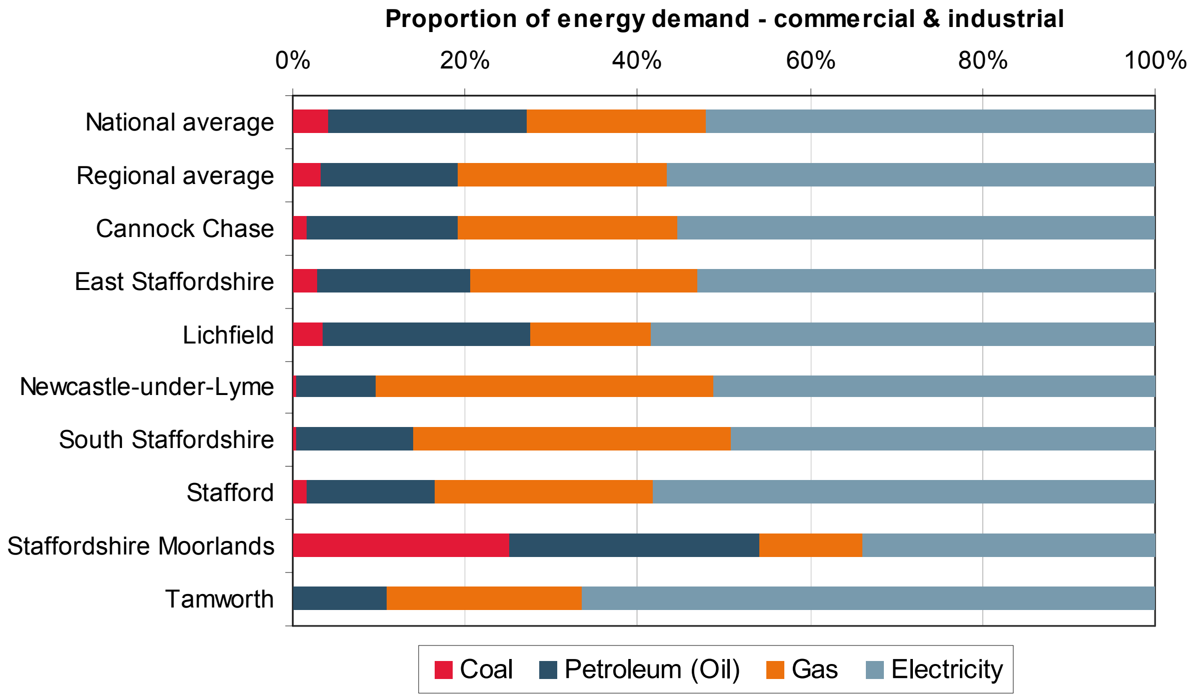

Figure 12: Source of thermal and electrical energy from commercial and industrial sources

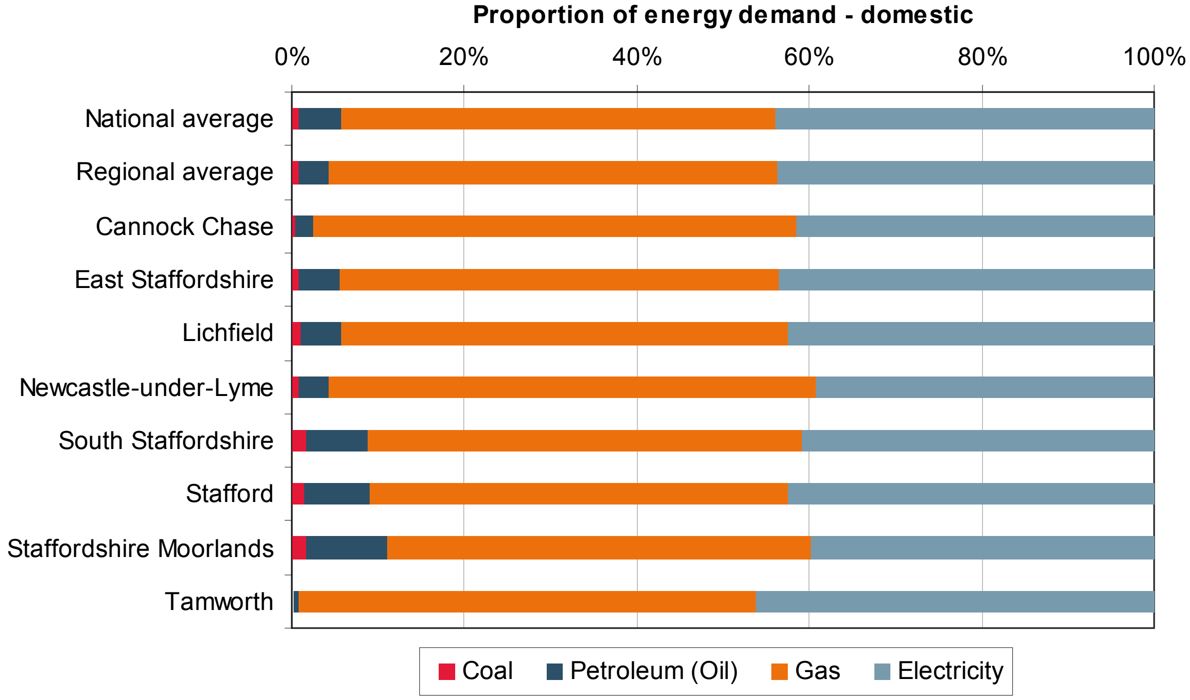

Figure 13: Source of thermal and electrical energy from domestic sources

4.4 Projected energy consumption

It is necessary to project forward energy demands, since national and regional targets are measured in terms of the proportion of energy demand delivered by renewable technologies in a given year. The scale of energy consumption in that year is a major factor which will influence whether a target will be met. Reducing consumption is equally important for meeting the targets as installing renewable energy systems.

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

It is not possible to accurately predict energy trends over an extended period, particularly during the current climate of policy changes and fluctuating energy prices. However, DECC has released a set of scenarios which model energy consumption for combinations of three critical factors:

- Energy prices
- Policy impact
- Expected growth

The central scenarios for each of these factors is illustrated in Figure 14 and Figure 15. These charts normalise the forecasted energy consumption against that in 2007 (hence 2007 is indexed to equal 100). The energy demand for 2007 (as presented previously in Figure 5) was then extrapolated forward using the scaling factors. Transport is omitted as is it outside the scope of this study. Full details and references of these energy projections can be found in Appendix V, where projections for individual authorities can also be found.

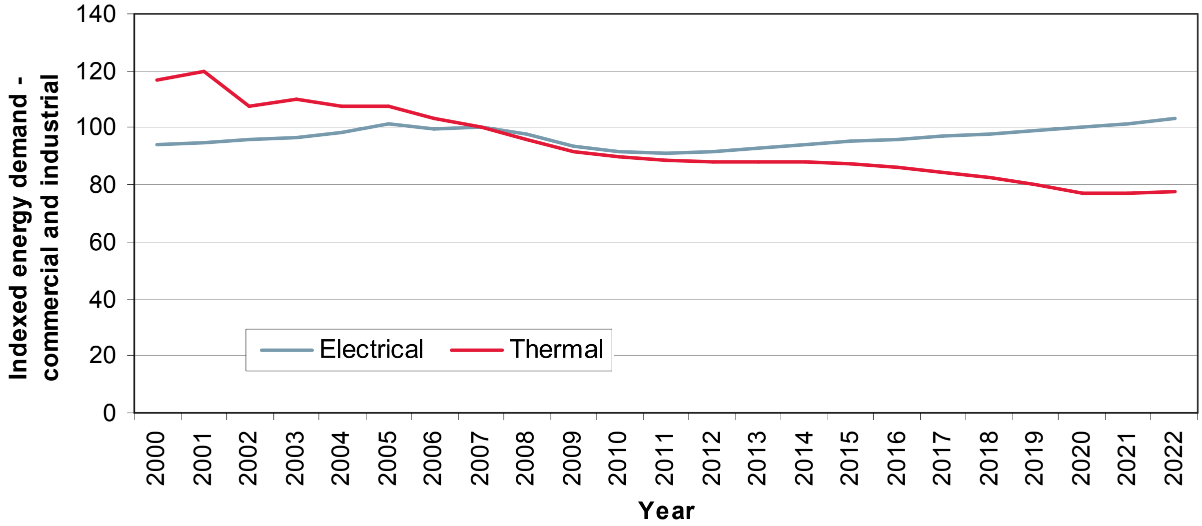

Figure 14: Future energy demand for commercial & industrial, indexed where year 2007 = 100 (Source: DECC)

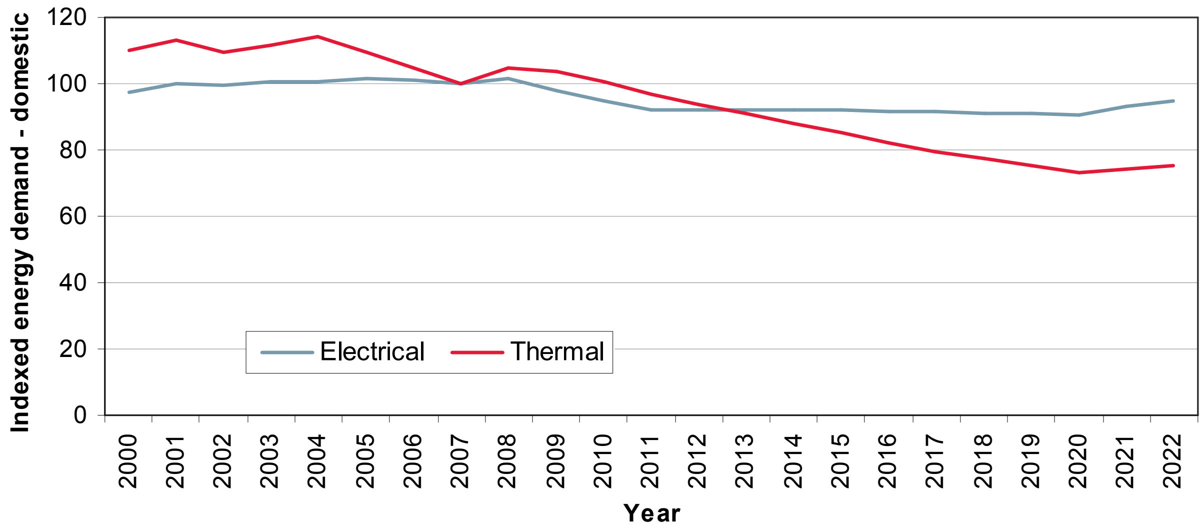

Figure 15: Future energy demand for domestic, indexed where year 2007 = 100 (Source: DECC)

Since the above projections include growth (i.e. new developments), it would be incorrect to add the energy demands of future residential and non-residential buildings onto these values. Instead, the benchmarked energy demands of these new developments are subtracted from the DECC projections in order to separate new build from existing build.

5 Existing and Proposed Renewable Energy Capacity

This section summarises the current information available regarding the capacity of renewable energy that is either in operation (existing) or is identified as proposed, i.e. specific projects that have been indentified and are at some stage of the implementation process, but not yet operational. There are no comprehensive Local Authority monitoring programmes in existence and so the data is drawn from a variety of sources, with varying degrees of confidence regarding accuracy and reliability. For example, data regarding grid connection agreement or planning permission has high certainty, whereas data, particularly for thermal energy projects and for planned and for pre-consented projects is often uncorroborated.

Many renewable energy technologies, particular those used in domestic / microgeneration applications, do not require planning or other regulatory approval and the significance of these will be underestimated. This issue is likely to become more significant as the number of smaller installations increases due to the proposed changes to the General Permitted Development Order surrounding microgeneration which came into force on the 9th September 2009 requiring fewer technologies to apply for planning permission. In contrast, the existence in the near future of heat and electricity tariffs may provide a sounder basis for monitoring.

The availability of information about existing or proposed installations is an important issue. Poor availability of information affects Authorities' willingness to establish targets, since if it is hard to accurately monitor performance then this undermines the setting of challenging targets. This could potentially become more important in the future if the government introduces a National Indicator for renewable energy, which would be in addition to the existing Planning Authority reporting requirements (through the Annual Monitoring Report (AMR) process). Approaches to data collection for future reporting is discussed in the recommendations section of the report.

For this study a range of data sources were reviewed as detailed in Appendix VI. The data sources were combined to give a total renewable energy capacity for Staffordshire. Each data source was cross referenced to minimise double counting. Where there was no installed system capacity (kW) available, estimates were made.

Figure 16 and Table 4 provide an overview of the estimated installed energy generation for each authority, as well as for schemes indentified as proposed, which covers a broad range of status from early feasibility to having an established commissioning date . Table 5 through to Table 8 breaks down this data by technology.

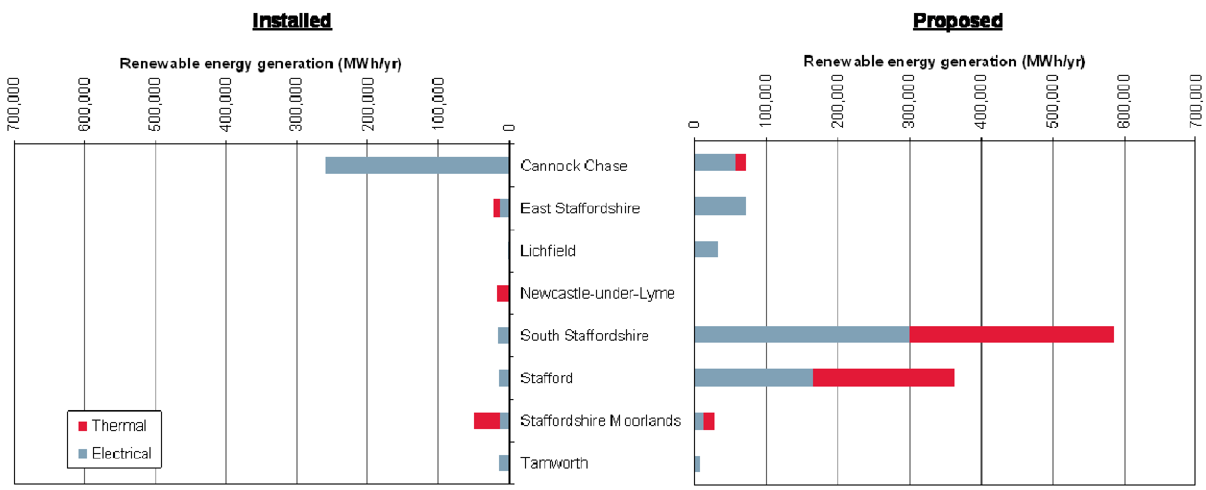

Figure 16: Installed and proposed renewable energy annual generation estimates (MWh/yr)

Results vary significantly between authorities. Low and zero carbon technologies which are already installed are dominated by biomass co-firing which is taking place at Rugeley Power Station, Cannock Chase. This equates to 16.7% of the Authority's energy demand. Other notable installed schemes include the 2.65 MW_e Eccleshall Biomass CHP Plant in Staffordshire Moorlands , and the Blue Planet building in Newcastle-under-Lyme which includes a 10.8 MW_{th} biomass boiler. Overall, research suggests a 2.5% existing supply contribution from current installed renewable energy sources (as a percentage of 2007 energy demand excluding transport). By comparison the West Midlands region in 2004 was estimated at have a generation capacity of 1% of electricity consumption[32], but this is anticipated to have grown significantly during the intervening period.

For low and zero carbon projects which are identified as proposed, the collated data suggests a wide range between the authorities. South Staffordshire has the most considerable prospective projects, namely a biomass and anaerobic digestion facility at Cocksparrow Lane (1 MW_e and 1.5 MW_e respectively), and a 29 MW_e energy from waste plant at The Dell. Each of these has been awarded planning permission. The Authority also has 10 wind turbines (totalling 20 MW_e) which have either made a planning application, or are at the pre-application stage. Stafford also has a 20 MW_e energy from waste plant at Felthouse Lane which has submitted a planning application.

If all prospective in-development projects were to come to fruition, they are estimated to provide 7.2% of the study area's current electrical and thermal energy needs. Clearly, even if a small proportion of this is delivered it will make a significant contribution.

Appendix VII details all of the low and zero carbon energy sources which were collected within the study.

[32] *West Midlands Regional Energy Strategy, 2004*

		Cannock Chase	East Staffordshire	Lichfield	Newcastle-under-Lyme	South Staffordshire	Stafford	Staffordshire Moorlands	Tamworth	Study area
Installed	MWh	260,369	22,203	2,483	18,368	16,461	14,564	50,117	15,479	400,045
	% energy	16.7%	0.9%	0.1%	0.9%	0.9%	0.7%	1.8%	1.4%	2.5%
Proposed	MWh	70,982	71,330	32,850	438	585,846	363,953	26,641	7,573	1,159,612
	% energy	4.6%	2.7%	1.9%	0.02%	31.4%	16.3%	1.0%	0.7%	7.2%
Installed + Proposed	MWh	331,350	93,533	35,333	18,806	602,307	378,516	76,758	23,052	1,559,657
	% energy	21.3%	3.6%	2.0%	0.90%	32.3%	16.9%	2.7%	2.1%	9.8%

Table 4: Estimated installed and proposed[33] renewable energy generation

Technology	Electrical / Thermal	Cannock Chase	East Staffordshire	Lichfield	Newcastle-under-Lyme	South Staffordshire	Stafford	Staffordshire Moorlands	Tamworth	Grand Total
Biomass CHP	E							2,650		**2,650**
	T							13,000		**13,000**
Biomass co-firing	E	50,000								**50,000**
	T									
Biomass heat	E									
	T	90			10,800					**10,890**
Gas CHP	E		1,001	180						**1,181**
	T									
Hydro	E		68			10				**78**
	T									
Landfill gas	E	3,900	970			1,972	1,750		1,860	**10,452**
	T									
Small wind	E				3	1		31		**35**
	T									
Solar PV	E				8	4		3		**15**
	T									
Solar thermal	E									
	T		13			2		3		**18**
Total	**E**	**53,900**	**2,039**	**180**	**11**	**1,987**	**1,750**	**2,684**	**1,860**	**64,410**
Total	**T**	**90**	**13**		**10,800**	**2**		**13,003**		**23,908**

Table 5 Estimated Installed capacity (kW)

[33] *This captures projects that will be at various stages of completion from those that are not fully formed proposals through to those that are constructed but not yet commissioned and operational*

Technology	Electrical / Thermal	Cannock Chase	East Staffordshire	Lichfield	Newcastle-under-Lyme	South Staffordshire	Stafford	Staffordshire Moorlands	Tamworth	Grand Total
Biomass CHP	E							13,250		**13,250**
	T							36,835		**36,835**
Biomass co-firing	E	227,760								**227,760**
	T									
Biomass heat	E									
	T	153			18,360					**18,513**
Gas CHP	E		5,524	993						**6,518**
	T		8,286	1,490						**9,777**
Hydro	E		310			46				**355**
	T									
Landfill gas	E	32,456	8,072			16,411	14,564		15,479	**86,982**
	T									
Small wind	E				2	1		27		**30**
	T									
Solar PV	E				6	3		2		**11**
	T									
Solar thermal	E									
	T		10			1		3		**14**
Total	**E**	**260,216**	**13,906**	**993**	**8**	**16,460**	**14,564**	**13,280**	**15,479**	**334,906**
Total	**T**	**153**	**8,297**	**1,490**	**18,360**	**1**		**36,838**		**65,139**

Table 6 Estimated annual generation from installed systems (MWh)

Technology	Electrical / Thermal	Cannock Chase	East Staffordshire	Lichfield	Newcastle-under-Lyme	South Staffordshire	Stafford	Staffordshire Moorlands	Tamworth	Grand Total
Anaerobic digesti	E	4,500				1,500				**6,000**
	T	2,000								**2,000**
Biomass heat	E						3,935			**3,935**
	T		49							**49**
Biomass power	E					1,000				**1,000**
	T									
Energy from Was	E					29,000	20,000	1,500		**50,500**
	T									
Gas CHP	E						180			**180**
	T									
GSHP	E									
	T		4							**4**
Hydro	E		249							**249**
	T									
Landfill gas	E	775							910	**1,685**
	T									
Large wind	E	6,500	26,400	12,500		20,000				**65,400**
	T									
Small wind	E		816		500	1		37		**1,354**
	T									
Solar PV	E		1			27				**28**
	T									
Solar thermal	E									
	T		7							**7**
Total	**E**	**11,775**	**27,467**	**12,500**	**500**	**51,528**	**24,115**	**1,537**	**910**	**130,331**
Total	**T**	**2,000**	**60**							**2,060**

Table 7 Potential identified as proposed – Capacity (kW)

Technology	Electrical / Thermal	Cannock Chase	East Staffordshire	Lichfield	Newcastle-under-Lyme	South Staffordshire	Stafford	Staffordshire Moorlands	Tamworth	Grand Total
Anaerobic digesti	E	32,850				10,950				**43,800**
	T	14,600								**14,600**
Biomass heat	E						6,690			**6,690**
	T		83							**83**
Biomass power	E					7,884				**7,884**
	T									
Energy from Was	E					228,636	157,680	11,826		**398,142**
	T					285,795	197,100	14,783		**497,678**
Gas CHP	E						993			**993**
	T						1,490			**1,490**
GSHP	E									
	T		11							**11**
Hydro	E		1,136							**1,136**
	T									
Landfill gas	E	6,450							7,573	**14,023**
	T									
Large wind	E	17,082	69,379	32,850		52,560				**171,871**
	T									
Small wind	E		715		438	0		32		**1,186**
	T									
Solar PV	E		1			20				**21**
	T									
Solar thermal	E									
	T		5							**5**
Total	**E**	**56,382**	**71,231**	**32,850**	**438**	**300,051**	**165,363**	**11,858**	**7,573**	**645,746**
Total	**T**	**14,600**	**99**			**285,795**	**198,590**	**14,783**		**513,867**

Table 8 Potential identified as proposed – Estimated annual generation from (MWh)

6 Low Carbon Policy and Targets

6.1 Emerging National Policy

Published in July 2009, The Low Carbon Transition Plan and the Renewable Energy Strategy present significant policy changes relevant to this study. Whilst the statements represent

key milestones in the development of new policy, setting out long term aspiration and policy direction and specific commitments, there are a number of issues of relevance to this study that remain unresolved or are likely to change in the near future. Examples include the definition of zero carbon homes (and non-residential buildings) and re-classification of organic wastes (to enable greater use for energy purposes). This section summarises elements relevant to this study.

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

To achieve these targets, the Government has created three five-year 'carbon budgets' to 2022, which mark a cap on the total quantity of GHG emissions released in the UK over a specified time. The budget system allows an element of 'banking' and 'borrowing' between carbon budgets periods to increase the system's flexibility. Potentially this could affect the overall carbon target within a set period, however, we have assumed here that the government's 15% renewable energy target by 2020 will not change as this responds to the relevant European Directive which carries more weight. Figure 17 below shows how these carbon budgets compare to the 1990 and 2008 emissions baselines, while Figure 18 shows how different sectors are expected to make reductions over each of the three carbon budgets.

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

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

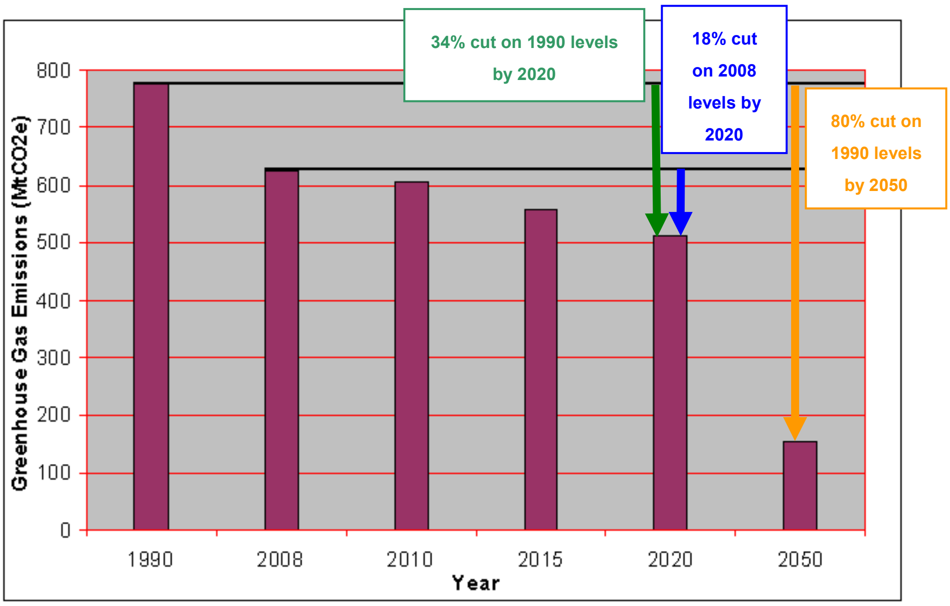

Figure 17: National greenhouse gas emission reduction timeline (Source: Low Carbon Transition Plan)

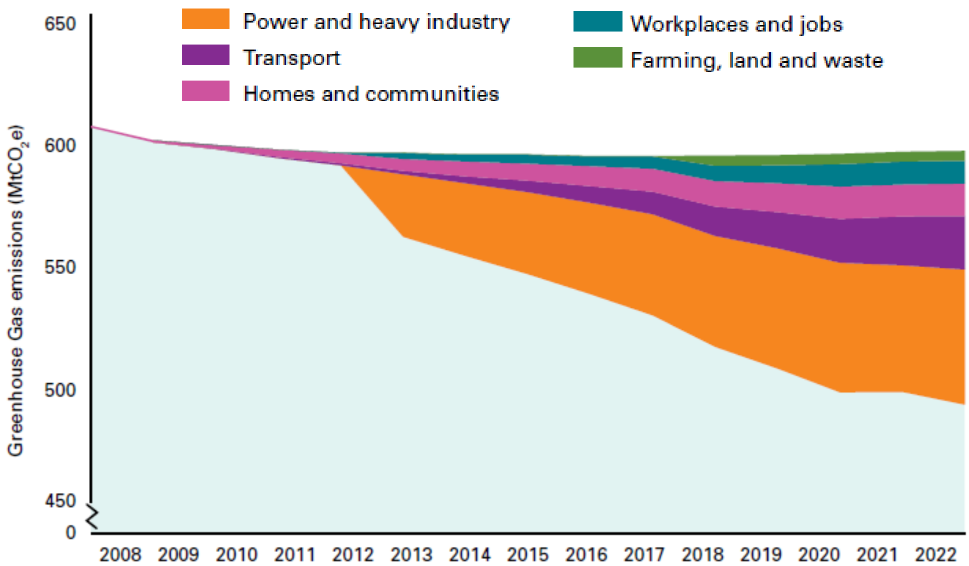

Figure 18: Estimated emissions savings ($MtCO_2e$) in different sectors of the UK resulting from the measures set in the Low Carbon Transition Plan from 2008 to 2022 (Source: Low Carbon Transition Plan)

6.1.1 Power Sector

Figure 19 illustrates the anticipated changes in the UK energy mix in the coming decade:

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

The 2020 electricity mix is based on total consumption of 370 TWh which assumes significant savings through energy efficiency.

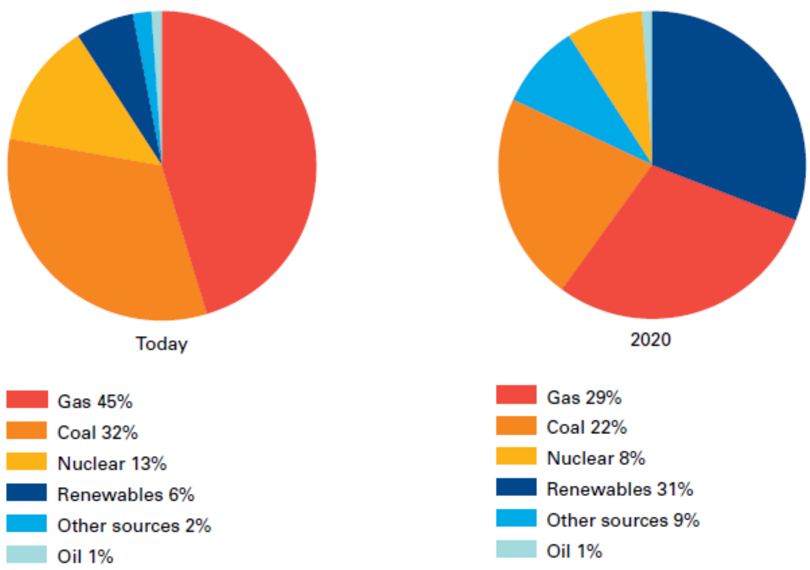

Figure 19: Estimated electricity mix – today and 2020 (Source: Low Carbon Transition Plan)

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

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

6.1.2 Homes and Communities

The plan to 2020 requires an emissions reduction from both existing and new homes of 29% on 2008 levels (27 $MtCO_2e$). The expected emissions savings from this sector from 2008 to

2022 is shown in Figure 20 below, which shows that domestic energy efficiency is expected to deliver over two-thirds of emissions savings from homes.

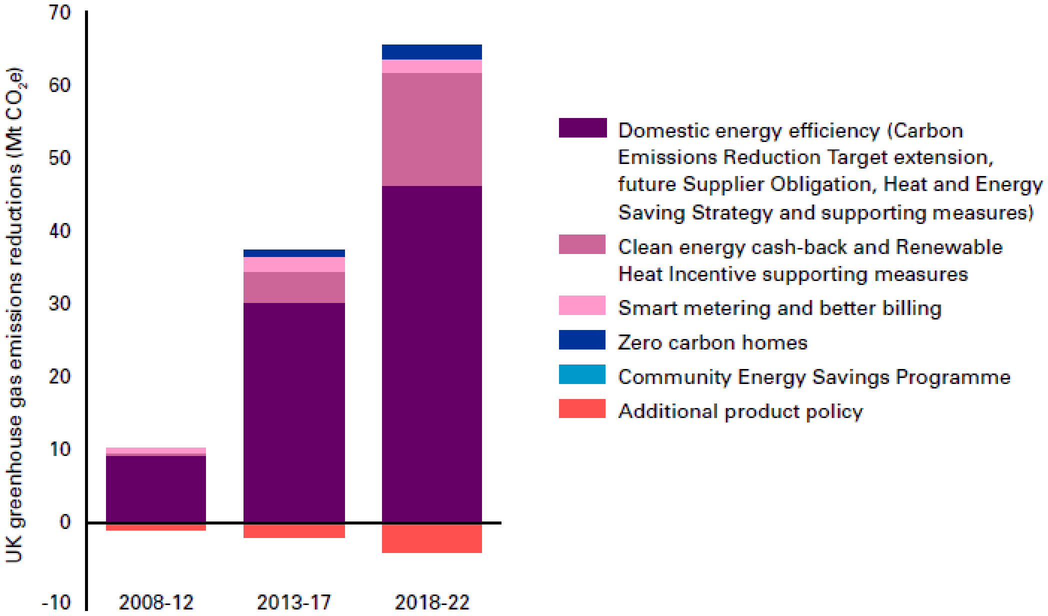

Figure 20. Estimated carbon savings in the homes and communities sector (Source: Low Carbon Transition Plan)

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

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

The Renewable Energy Strategy announced the establishment of The Office for Renewable Energy Deployment (ORED) which will have the responsibility to drive delivery of the national targets, based on the 'lead scenario'[34], which anticipates:

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

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

Note, the new administration's policies on energy security and green economy will be set out in a bill to be put before parliament at the end of 2010. The implications of any policy changes need to be kept under close review.

6.1.3 Planning policy

Planning is often cited a major constraint to the implementation of the renewable energy systems.

The approach to developing planning policy for renewable energy generation and low carbon development standards is going to continue to change. The new government has suggested it wishes to introduce significant change to the planning system in general terms, with a strong drive to towards locally developed policy. The proposal to scrap Regional Spatial Strategies is a clear sign of intent.

In 2009 the UK Renewable Energy Strategy specifically identified the need to speed up planning decisions and to make them more predictable, whilst ensuring future decisions are deemed to be appropriate.

Key aims identified for the planning process include:

- Establishing the Infrastructure Planning Commission to develop national policy and streamline decision-making for a range of infrastructure including energy projects over a 50MW scale. Note, the new government has stated its intention not to proceed with the IPC. (NB. The new coalition has announced that the IPC is to be abolished, with infrastructure decisions due to be made by ministers)
- Ensuring a strategic approach to planning, working with all the English regions (Local Authorities are also mentioned in Renewable Energy Strategy) to help ensure they have robust evidence-based strategies for delivering their renewable potential in line with the UK 2020 target. £1.2m budget was identified to support these efforts.
- Support swifter delivery, helping the planning community as they develop and implement local and regional energy planning and handle renewable and low-carbon energy applications, for example through supporting skills development and by building capacity.

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

- Address the impacts of renewables deployment by doing more to resolve spatial conflicts and develop generic solutions to mitigate the impacts of renewable technologies, notably air quality, environmental, navigational and aviation radar impacts.
- To ensure a "clear and challenging" planning framework, Planning Policy Statements 1 and 22 (PPS1 & PPS22) will be reviewed and consultation will commence on a combined Climate Change PPS within 2009 (as stated in the Renewable Energy Strategy), with a view towards making them more complementary.
- The 2008 Killian Pretty Review considered improving the process of application determination and there were several recommendations relevant to renewable energy :
  - Overall reduce the number of small-scale developments that require full planning permission
  - Encourage the wider use of Planning Performance Agreements (PPAs) and specifically establish a Renewables and Low-Carbon Planning Performance Agreements demonstration project (this was recently established through ATLAS - Advisory Team for Large Applications - www.atlasplanning.com).
  - It was found that 65% of appeals for renewable energy projects are successful. This suggested that priority should be given to appeals on renewable energy proposals.
  - Revising the Cost Award procedure.
  - Using Local Development Orders (LDO).
  - Increasing flexibility for planning permissions.
- Generally ORED and CLG are set to support (including the announcement of £10 million funding over two years) the development of skills and knowledge within the planning community at local and regional level through, for example, the set up of an 'Expert Support Network'

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

Planning Policy Statement 22 (PPS22): Renewable Energy

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

Local policies should reflect paragraph 8 of PPS22 which says:

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

Planning Policy Statement 1 (PPS1): Delivering Sustainable Development

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

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

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

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

The PPS1 supplement also states that:

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

Consultation on new Climate Change Planning Statement

The Department of Communities and Local Government is seeking to introduce a new national planning statements which is intended to bring together and update the provisions under Planning Policy Statements 1 and 22 (Climate Change and Renewable Energy). The published documents suggested moving away from locally specific carbon standards in recognition that these become obsolete as significantly higher standards post-2013 become enshrined in the Building Regulations. It also proposed a greater focus on developing local authority policy (supported by suitable evidence) that seeks to support the delivery of low carbon development solutions (and stand-alone low carbon energy generation), with spatial mapping having an important role, where it is relevant.

Other proposals within the consultation include:

- ensuring adaptation to climate change is adequately included in policy
- encouraging authorities to refuse permission where low carbon design criteria are not met
- approaches to expressing carbon standards where they are established locally
- encouraging the use of planning to provide the support required to achieve low carbon solutions, e.g. using policy to support district heating
- considering viability
- the need to demonstrate "very special circumstances" to allow renewable energy development within area of green belt. These circumstances, however, include wider environmental benefits associated with renewable energy and suggests that green belt is viewed as a very useful opportunity.

The consultation finished in June 2010 and government is anticipated to issue revised policy in due course. The Planning Advisory Service intends to develop guidance to support implementation of the final planning statement, for which there is not yet a published timetable.

Clearly, the introduction of new government priorities and approach to policy direction, e.g. more localised decision-making and establishment of new “green space” land allocations, may lead to changes to the PPS not envisaged in the consultation.

6.1.4 Local Authority powers / obligations

Effective from 18th August 2010, the government has removed the restriction, within Section 11 of the Local Government Act 1976, on Local Authorities to sell power. This adds to previous powers to lay heat networks, develop district heating schemes and operate CHP (from which electricity could be sold). This will unlock significant opportunities for local authorities to own and operate renewable energy generation assets and to benefit from the Feed in Tariff.

We anticipate that Government will propose changes to current reporting for greenhouse gas emissions to explicitly identify the (positive) contribution from renewable energy. However, this is expected to rely on easily accessible data, and is therefore likely to be insufficient to monitor all generation, e.g. renewable heat. The introduction of a Renewable Heat Incentive may address the monitoring of renewable heat installations. Where local authorities are setting local energy generation targets bespoke monitoring will probably be required.

6.1.5 Building a Greener Future: Towards zero carbon development

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

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

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

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

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

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

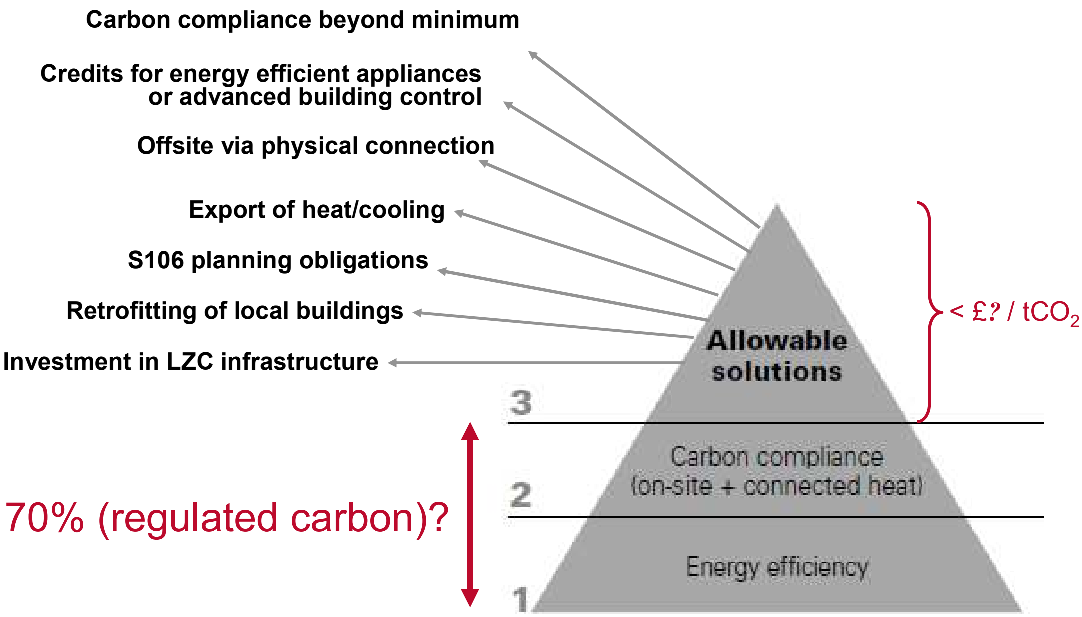

Figure 21: Schematic of zero carbon policy options under consideration

Estimates based on published data[35] suggest a cost range of £10.5k – £15k per dwelling for 100% reduction in regulated emissions on-site depending on the dwelling type. Biomass CHP is a key technology in delivering this target along with energy efficiency measures and PVs. Based on the guideline figure of £100/tonne over 30 years in the consultation document, the total estimated costs for allowable solutions adds another £2,400 - £4,000 to the total for the different dwelling types. At £200/tonne, the costs will be double that indicative range. As a guideline, at the median figure of £150/tonne, the total cost of compliance with zero carbon including both on-site and off-site measures is £14.1-£21k per dwelling.

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

The cost range for compliance with 70% on-site carbon reduction target using micro-renewables is estimated at £8.7k – £11.6k depending on dwelling type. At the median figure of £150/tonne over 30 years, the cost of allowable solutions to achieve the remainder off-site ranges between £5.4k- £9.2k. This also suggests the total cost of compliance to be between

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

£14.1- £20.8k as with the 100% on-site scenario above. However, this option would additionally require gas distribution infrastructure and gas boilers to be put in place, and therefore where these costs are taken into account, the total cost per dwelling would be significantly higher for the overall delivery of low carbon energy.

6.2 Regional Planning Policy

The new government has recently revoked the regional spatial strategies that are intended to establish regional planning policy and to provide guidance to local authorities in addition to that provided nationally.

Whilst the RSS is no longer in force to provide policy direction, the latest documents provide sound supporting evidence for local authority policy, particularly as it has passed through a rigorous assessment process including public consultation. The Phase 2 review report[36] included a clear move towards stronger policies around climate change and these are discussed below. The report also proposed changes housing development allocations but for the purposes of the analysis conducted in this study, housing projections provided directly by the authorities have been used (shown in Appendix VIII).

With respect to the Climate Change / Sustainable Development, the Phase 2 review recommended that the revised RSS:

- draws greater attention to the RES ‘Connecting to success’, the UK’s first low carbon regional economic strategy and its associated delivery framework and its key components related to climate change; and;
- refers to the work by the West Midlands Regional Observatory (WMRO) drawing on the WMRES and WMRSS Phase Two Revision and based on a 30% reduction target for 2020 which has identified the scale of a ‘carbon reduction gap’ for the region after application of international and national policies and the likely means to address this gap of 1.75 million tonnes of CO_2e, namely:
    - decentralising energy in the form of local heat and electricity networks using existing heat and energy loads identified through the regional heat and energy maps, powered by gas initially and later by a variety of other power sources such as biomass, bio-digestion and energy from waste;
    - managing the existing use of the transport networks, not just through the extensive promotion of walking, cycling, public transport and electric car infrastructure, but also through more flexible and smarter working practices combined with open access local tele-work centres to ensure overall productivity and carbon reduction gains are realised.
    - waste reduction and reuse as this is a key action that will help reduce carbon and provide economic benefit and which also reflects regional expertise through initiatives such as the National Industrial Symbiosis programme and the high concentration of waste re-processors within the region; and
    - the retrofit of the existing housing stock to improve the efficiency of energy and water use. Since the existing building stock has significantly more floor area than proposed new developments, this will have a greater impact upon CO_2 emissions compared to the transition towards zero carbon new developments.

Regarding climate change, recommendation R2.2 of the Panel Report[38], which recommended change to RSS Policy SR1, strengthens the obligation placed on Local Authorities as follows:

[36] *West Midlands Regional Spatial Strategy Phase Two Revision of the Panel: September 2009, R2.1 and R2.7*
[38] *West Midlands Regional Spatial Strategy Phase Two Revision Report of the Panel: September 2009.*

"Regional and local authorities, agencies and others shall include policies and proposals in their plans, strategies and programmes to both mitigate and adapt to the worst impacts of climate change through:

A. Exploiting opportunities to both mitigate and adapt to the worst impacts of climate change by Significant Development and other settlements which are capable of balanced opportunities for housing employment and local services as defined in LDDs by:

(i) developing and using renewable energy;

(ii) reducing the need to travel; and

(iii) reducing the amount of biodegradable waste going to landfill;

(iv) enhancing, linking and extending natural habitats so that the opportunities for species migration are not precluded and biodiversity can adapt to climate change and hence helping to mitigate its affects by reducing 'heat islands', acting as carbon 'sinks', absorbing flood water and providing renewable energy; and

B. Requiring all new development and encourage the retro-fitting of existing development to:

(i) minimise resource demand and encourage the efficient use of resources, especially water, energy and materials;

(ii) encourage the construction of climate-proofed developments and low-carbon sustainable buildings to help ensure their long-term viability in adapting to climate change;

(iii) avoid development in areas at risk of flooding and direct development away from areas at highest risk;

(iv) promote the use of sustainable drainage techniques and encourage investment in low carbon vehicle infrastructure in appropriate developments and locations

(v) facilitate walking, cycling and public transport

(vi) protect, conserve, manage and enhance natural, built and historic assets in both urban and rural areas

(vii) enhance, link and extend natural habitats as part of green infrastructure provision[39]

Adopting sustainability targets in LDDs and implementing them through SPDs for sustainable development. Targets should cover all aspects of design and layout, energy, water supplies and waste reduction. There should be regular monitoring of progress against these targets with review of policies as necessary in order to achieve the regional targets for carbon reduction.

The then proposed policy on Sustainable Construction is also relevant. The review makes the following recommended amendments to Policy SR3:

- Design and Access Statements include a sustainability statement that has regard to the contents of the West Midlands Sustainability Checklist. This should demonstrate that at least the 'good' standards and wherever possible the 'best practice' standards are achieved for each category. Appropriate targets should be set for substantial developments (over 10 residential units or 1,000 square metres) through dialogue between Local Planning Authorities and developers in AAPs, or through a planning brief or masterplan approach.
- Local Planning Authorities, in preparing DPDs, should consider whether there is local justification for acceleration of progress towards securing zero-carbon development at an earlier date than that required under national policy. Such consideration must include the viability of development.

[39] Green Infrastructure is the network of green spaces and natural elements that intersperse and connect cities, towns and villages. It is the open spaces, waterways, gardens, woodlands, green corridors, wildlife habitats,

- Local Planning Authorities, in preparing DPDs, should consider whether there is local justification for requiring a proportion of on-site or locally generated energy from renewable sources in all new medium and large scale developments. In the interim pending adoption of DPD policies all substantial developments (over 10 residential units or 1,000 square metres) shall incorporate measures to ensure that at least 10% of the development's residual energy requirements are met from renewable sources whether on-site or as part of a local network

7 Assessing local potential for Decentralised Generation

This section deals with the analysis methodology with results shown in section 10.

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

The assessment of renewable energy potential has been separated into five key areas of energy generation potential:

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

These categories have been chosen to reflect the range of the most significant applications for renewable energy within the study area. Clearly, over the LDF plan period, other technologies may become more significant relative to those considered here. Background information and analysis methodology notes (where relevant) are included in the following sections and in Appendix IX through to Appendix XVI.

During the closing phase of the study, the Department for Energy and Climate Change (DECC) published a methodology which intends to standardise assessments for the potential of renewable energy on a regional basis. One important limitation of this methodology is that it only considers approaches to assessing the technical potential and chooses not to prescribe how to identify uptake over a period of time, which will also influence decision-making and target setting at a local level.

The methodology is not intended for sub-regional studies, however the findings of a regional assessment would no doubt be disaggregated on an authority by authority basis. It is understood that a regional study for the West Midlands is due to be commissioned, with the results from this due to be disseminated to each authority. There will be some variations to the methodologies applied in the analysis reported here and the regional study and these should be considered once the latter is published to review whether additional amendments to authority planning policy is necessary.

7.2 Wind energy generation analysis

7.2.1 Identifying potential wind locations - GIS Mapping

A GIS analysis has been undertaken to identify sites which are suitable for large scale wind energy, where 'large' is assumed to mean developments using turbines of a power rating greater than 1MW. Within the analysis of potential described in this section, wind turbines of 2.5MW are used as the default case, since this is a typical size of machine deployed. Over time it is expected that the typical turbine power rating will increase through on-going development of the technology. The analysis conducted considers a range of wind resource, spatial and social constraints, to identify zones which would be more technically viable for the location of large scale wind turbines.

The constraint 'layers' included in the GIS analysis are listed in Table 9. These have been overlaid to form composite maps of constrained and less constrained zones of potential, such that the sites of potential development are identified. The sites identified could (technically) accommodate at least a single turbine. However, some of the larger sites would allow multiple turbines although the potential for the larger sites has been limited to 13 large turbines[40].

Alongside the constraint 'layers' Table 9 identifies the relevant buffer distances (where applicable), and degree of constraint that they impose on wind development, as defined below:

> ***Constrained***: *Where a land characteristic / designation a firm constraint to the wind energy development*
>
> ***Less constrained***: *Where a land characteristic / designation factor has an impact which should be assessed on a site-by-site basis. The impact and the possibilities for mitigation may be lower or higher for differing sites and the nature of the constraint.*

7.2.2 Comments on land-use constraints for wind energy

AONB and National Parks

Areas of Outstanding Natural Beauty (AONB) in this study have been considered as 'less constrained' and as such are not excluded from the spatial analysis. The DECC regional renewable energy capacity assessment methodology suggests that local studies need to be conducted to determine whether development is constrained, with the suggestion that "small scale" development is more likely within areas under this designation. Since there is precedent for wind development within the AONB, e.g. Goonhilly Wind Farm in Cornwall (6x2.5MW), this designation has not been considered an absolute constraint.

The National Park designation is treated in the same way as AONB in the DECC methodology, however, it is assumed to be "constrained" in this study because there are no large scale wind energy developments in the National Parks to date in the UK[41].

[40] *The approximate UK Average, with small and very large sites discounted*
[41] *http://www.telegraph.co.uk/earth/environment/climatechange/5894601/Natural-England-will-consider-wind-farms-in-national-parks.html*

GIS Layers

Name	Buffer	Type
Wind speed		
Average wind speed @ 45m above ground level < 5.9m/s	-	Constrained
International, national & local designations for heritage		
World Heritage Sites	-	Constrained
Registered Historic Parks & Gardens	-	Constrained
Heritage Coast (not relevant for this study)	-	Less constrained
International, national and local designations for landscape		
Areas of Outstanding Natural Beauty	-	Less constrained
Greenbelt	-	Less constrained
National Parks	-	Constrained
Sites of Importance for Nature Conservation	-	Less constrained
Historic Environment Record Sites	-	Less constrained
Environmentally Sensitive Areas	-	Less constrained
International, national and local designations for ecology		
Sites of Special Scientific Interest	-	Constrained
Special Areas of Conservation	-	Constrained
Special Protection Areas	-	Constrained
Ramsar Sites	-	Constrained
RSPB Reserves	-	Less constrained
Important Bird Areas	-	Less constrained
National Nature Reserves	-	Less constrained
Local Nature Reserves	-	Less constrained
Ancient Woodland	-	Constrained

Name	Buffer	Type
Space requirements		
Open water	-	Constrained
Woodland	-	Constrained
Dwellings	600m	Constrained
Commercial buildings	50m	Constrained
Motorways, A roads & B roads	150m	Constrained
Railways	150m	Constrained
Bridleways	250m	Constrained
Other Public Rights of Way	50m	Constrained
Air safeguarding and radar constraints from MOD and civil aviation interests		
Civil airports	30km	Less constrained
MoD airbases	30km	Less constrained
Small civil airfields	10km	Less constrained
Electromagnetic interference to communications radar		
Primary TV transmission masts	100m	Constrained
Secondary TV transmission masts	100m	Constrained
TV broadcast links	100m	Constrained
Radio transmission masts	100m	Constrained
Radio broadcast links	100m	Constrained
Weather radar stations	10km	Less constrained
Other		
Steep terrain > 20°	-	Constrained
Designations for archaeology		
Scheduled Ancient Monuments		Constrained

Constrained

Less constrained

Table 9. GIS Layers included in the analysis, plus prescribed buffer zones (where applicable)

International, national and local designations for ecology

Whilst the DECC methodology recognises sensitivity around these classifications, where there are no local studies to draw upon it recommends that "…….regions should undertake a high level assessment of the potential within these areas." The approach taken here is therefore inconsistent with the DECC methodology for Sites of Special Scientific Interest, Special Areas of Conservation, Special Protection Areas and Ramsar Sites as these have been assessed as “constrained”. However, they will make little difference to overall capacity in the study, because of the relative land area, and so, have not been further considered.

Whilst impact upon birds is a specific concern for wind energy development it is very dependent on the specific nature of habitat and migration paths and so can only be assessed on a specific site basis.

Proximity to buildings / settlements

Within this analysis the minimum distance from housing has been taken as 600m, whilst 50m has been taken as the minimum allowable distance from commercial buildings. The analysis has been conducted using OS Address Point data, which identifies all buildings, with the appropriate buffer being applied to each building. The draft version of the DECC methodology discussed different approaches to take account of proximity to buildings, particularly housing, and it states that 600m should be the distance applied for larger turbines (circa 2.5MW), which accords with this analysis. The final version of the DECC methodology, however, suggests that the buffer should be applied to Settlement polygons rather than to individual buildings, suggesting that the latter significantly limits the land identified as suitable for wind energy. The DECC methodology will lead to overestimation of the resource since it does not reflect the fact that owners of all properties, even isolated rural properties, can and will raise development objections, e.g. on noise and visual amenity grounds. Moreover, there is a reasonable likelihood that if a development is closer than a stated ‘rule of thumb’ (600m in this case) then it not likely to achieve planning permission, unless the developer and property owner come to a negotiated settlement. It is therefore contended that the approach taken within this analysis is appropriate, but it will result in a conservative result. Figure 22 shows the variation in constraint using the different habitation / settlement data, on a cross section of the study area across Stafford and East Staffordshire.

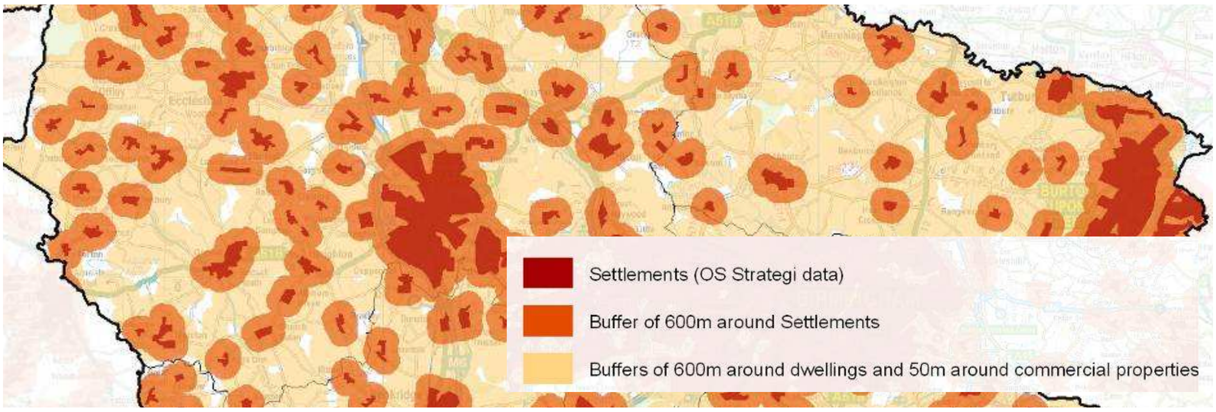

Figure 22; Comparison of spatial constraints alternative data defining habitation/settlement

Wind Speed

Wind speed is a significant parameter to consider. Within the analysis a financial viability threshold has been taken as $6ms^{-1}$ at 45m (above ground level). This is inconsistent with the DECC methodology that confirms that assessment should take the threshold as $5ms^{-1}$, although it was recognised, in the draft version of the methodology, that developers will not typically consider development at sites below this wind speed. To date there is no experience of developing sites at these low wind speeds in UK, and hence this study has opted to use the $6ms^{-1}$ threshold. Since the majority of the study area receives annual mean wind speeds above 6ms^{-1}, using this as a threshold will not provide significantly different results compared to using 5ms^{-1}.

Historic Environment settings

The setting of certain assets, particularly historic environment assets, can prove to be a constraint but these need to be considered on a site by site basis and hence no buffers have been applied.

Air safeguarding

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

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

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

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

Other parameters <u>not</u> accounted for

The spatial analysis presents a view of the potential sites for wind energy development, based upon the constraints considered. It does not directly take account of the ease of connection to the electrical distribution network which is largely an economic issue, i.e. larger projects will be able to carry larger capital costs for connection to the network or for network upgrades (see Appendix IX for further details). In practice sections of power networks may have inherent load or power quality constraints, particularly at lower voltage levels. The study also does not consider landscape / visual amenity constraints (other than by excluding certain designations of land) which would need to be considered on a project-by-project basis. Additionally, telecommunications masts have been excluded from the analysis due to a lack of relevant GIS data for such a large area, and again this should be considered on a project-by-project basis.

The study identifies the key constraints that are likely to rule out wind turbine developments but there are a number of additional local issues and preferences that could constrain any specific wind turbine location. These include local landscape considerations (such as

AONBs as discussed above), site access (for construction), contamination and private airstrips.

As the GIS maps illustrate, the analysis has only been conducted up to the boundary of the study area and as such the constraints outside of this boundary will naturally impact on suitability of sites through, for example, proximity to housing. The identified land area for potential wind development would also need to be considered against the local landscape character assessments to ascertain their potential impact on character areas.

Cumulative landscape impact of multiple turbines is an important issue and one that is of critical concern for more rural districts, particularly where there are no major landscape designation constraints. In such locations the GIS analysis described above may suggest a larger capacity for wind energy development than would actually be developed in practice because of additional landscape impact of each new development. Accounting for cumulative landscape impact of wind energy across an area is problematic. Local studies can be commissioned but they will fundamentally rely on the subjective evaluations of landscape sensitivities which may change over time. They could therefore lead to unreasonably restricting available land. The DECC methodology specifically recommends not to account for the cumulative impact of wind energy when assessing resource capacity because of its subjective nature and the fact that views around this issue may change over time. It does, however, also identify that accounting for landscape impact could provide supporting analysis of the targets for a local authority area.

7.2.3 Potential energy supply from identified wind energy sites

This section provides a brief overview of the methodology to convert technically viable sites ("unconstrained" and "less constrained") identified from the GIS analysis, into an estimate of the number of wind turbines and quantity of electricity delivered from these. The number of wind turbines is determined by assessing separation distances between turbines. With consideration of guidance from the Danish Wind Energy Association[42] we have assumed a separation of distance of five rotor diameters, which is consistent with the DECC methodology. This separation allows for adequate spacing between turbine blades to prevent air stream interference to the operational detriment of the turbines.

The size of the wind turbine is proportional to its energy output, and onshore wind developers will look to install the largest turbines viable for a given site. The current market for large scale wind turbines is largely focused on 2.5 MW turbines (approximately 120m to the tip of the blade at the top of its swept area) and this has been used as a default size across the study period (up to 2026), although it should be recognised that the wind turbines will be selected to suit each specific location. A simple method to quickly understand the likely electricity generated from a wind turbine is to apply a capacity factor (or load factor): actual annual generation as a percentage of a turbine's theoretical maximum output. The 10-year UK average annual capacity factor (for all wind energy projects) as reported by DECC in 2009 is 28%, however we have assumed a more conservative view of 25% since many of the monitored wind farms will have been situated in very high wind speed locations. In addition to the capacity factor, it is assumed that any wind turbine will be taken off line for maintenance for 5% of the time. The calculation below sets out how these factors are combined to estimate the energy generation from a single 2.5 MW large scale wind turbine.

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

[42] *www.windpower.org*

7.2.4 Discounting for development viability

The technical potential assessed through GIS mapping has then been discounted to reflect development viability. The technically viable sites were split into two categories: sites capable of including 3 or more wind turbines, and sites with fewer than 3 wind turbines.

For sites with 3 or more wind turbines, development has been deemed viable for all 'unconstrained' and 'less constrained' sites, since these sites offer 'economies of scale' (where development costs and risks can be justified).

Sites which can include fewer than 3 wind turbines are likely to be less attractive to major wind developers, who will prefer to invest in a larger number of turbines on a single site. These single or double wind turbine sites are more likely to attract 'community' or 'merchant wind power'[43] projects which will either require lower rates of return, or benefit from direct electricity sales to an on-site user. Examples of this type of smaller scale development are the community project in Swaffham (Norfolk)[44] and the single turbine projects at Ford Dagenham and Green Park, Reading. It has been assumed that only 10% of these smaller sites will go forward for development.

7.2.5 Discounting for planning approval rates

For both scales of development, the potential number of turbines has been discounted further to reflect potential planning approval rates. The proportion of turbines that receive planning approval has been set in each of the scenarios based upon recent experience of minimum and maximum approval rates.

7.2.6 Scenarios

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

Base Case

- A cap of 13 wind turbines is assumed to be the maximum for a single site for situations where the methodology set out in section 7.2.3 enables greater than this number. This threshold has been derived by assessing British Wind Energy Association (BWEA) data of operational UK wind farms[45]. By its very nature the GIS spatial constraints analysis may identify some large sites and so this limitation (approximating the average number of turbine in UK on-shore wind farms), ensures inappropriately large sites are not identified.
- It is assumed that there is development interest for all sites with potential for three or more turbines and 10% of sites suitable for single/double turbines
- The planning approval rate for all sites of interest is taken to be 36%. This is based upon the proportion of the positive local planning decisions in 2007.

Elevated Case

- The cap of 13 wind turbines per site is applied as for the base case.
- It is assumed that there is development interest for all sites with potential for three or more turbines and 10% of sites suitable for one turbine

[43] The term Merchant wind power refers to the development of wind turbine(s) to power a dedicated on-site energy demand.
[44] www.ecotricity.com
[45] Available from http://www.bwea.com/ukwed/operational.asp. The threshold of 13 turbines has been derived by taking the average number of turbines from all multi-turbine sites within the data set.

- The planning approval rate for all sites of interest is taken to be 67%, which was the approval rate recorded in 2003 as discussed above. The increased rate therefore reflects the highest known approval rates which is used as an upper limit. This then reflects a future scenario of increased acceptance at a local level and supportive decision-making by officers and elected members and/or better constructed planning submissions.

7.2.7 GIS mapping of resource and constraints

Figure 23 shows the wind speed across the study area, based upon the national Windspeed Database[46]. The map shows that the majority of the study area has a wind speed in the region of 6-6.5ms^{-1}, with large parts of the north of the study area, around Leek, that have both significant areas of low wind speeds (below 5.9ms^{-1}) and significant areas of higher wind speeds, above 7.4ms^{-1}. There are other discrete locations of higher wind speeds around the study areas such as the outskirts of Stoke-on-Trent and to the East and North of Cannock. Overall the map suggests that if all other constraints are ignored then there is generally a good resource potential across the study area with significant incidences of very good potential. It is worth noting that over time viability should improve through technology development and system costs reductions, so that even the low wind speed area present a useable resource over the plan period (up to 2026).

Figure 24 illustrates the outcomes of applying the constraints set out in Table 9.

Both Blue and Green shading represent those areas that offer potential for development, i.e. no absolute constraints have been identified. However, the Blue areas present some level of constraint which would require local consultation/investigation. The two most significant 'less constrained' issues are environmental designations and airport consultation zones. The former may become a more significant constraint if the designation protects species/habitats which are sensitive to wind turbines. The airport consultation zones do not instantly imply that wind turbines cannot be located within the zone. Green shading illustrates areas where none of the 'constrained' or 'less constrained' designations exist. From a desk based perspective, these sites appear technically suitable for the development of wind energy, while noting the scope and limitations of the GIS analysis as set out in section 7.2.1. Figure 24 also shows areas designated as Special Areas of Conservation which are significant absolute constraints within the study area. It is worth noting that the Mottey Meadows SAC is actually two separate sites and hence the GIS analysis identified the land between as not being constrained by this designation.

[46] *http://www.decc.gov.uk/en/windspeed/default.aspx*

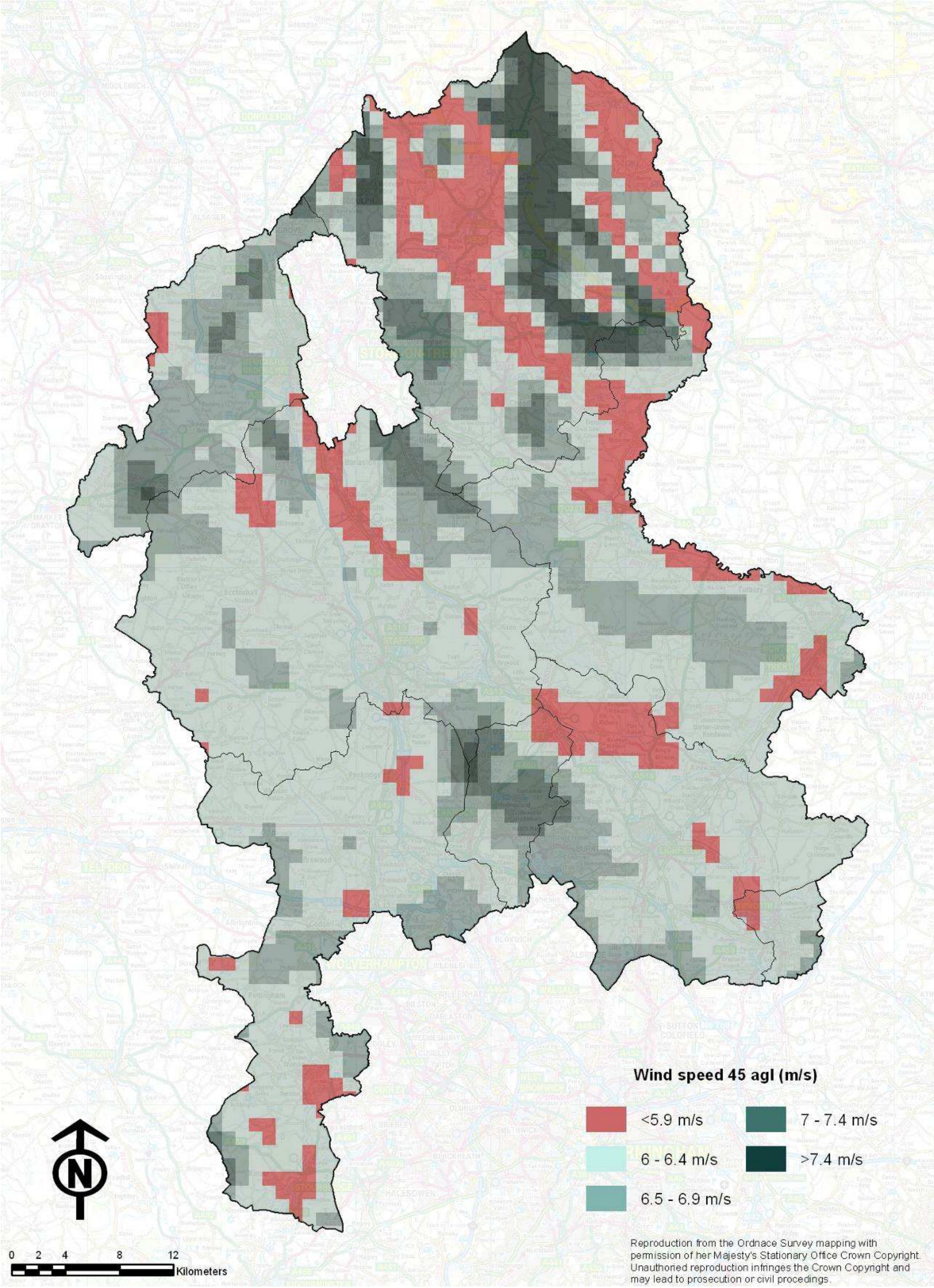

Figure 23: Map of wind speeds (1km^2 resolution)

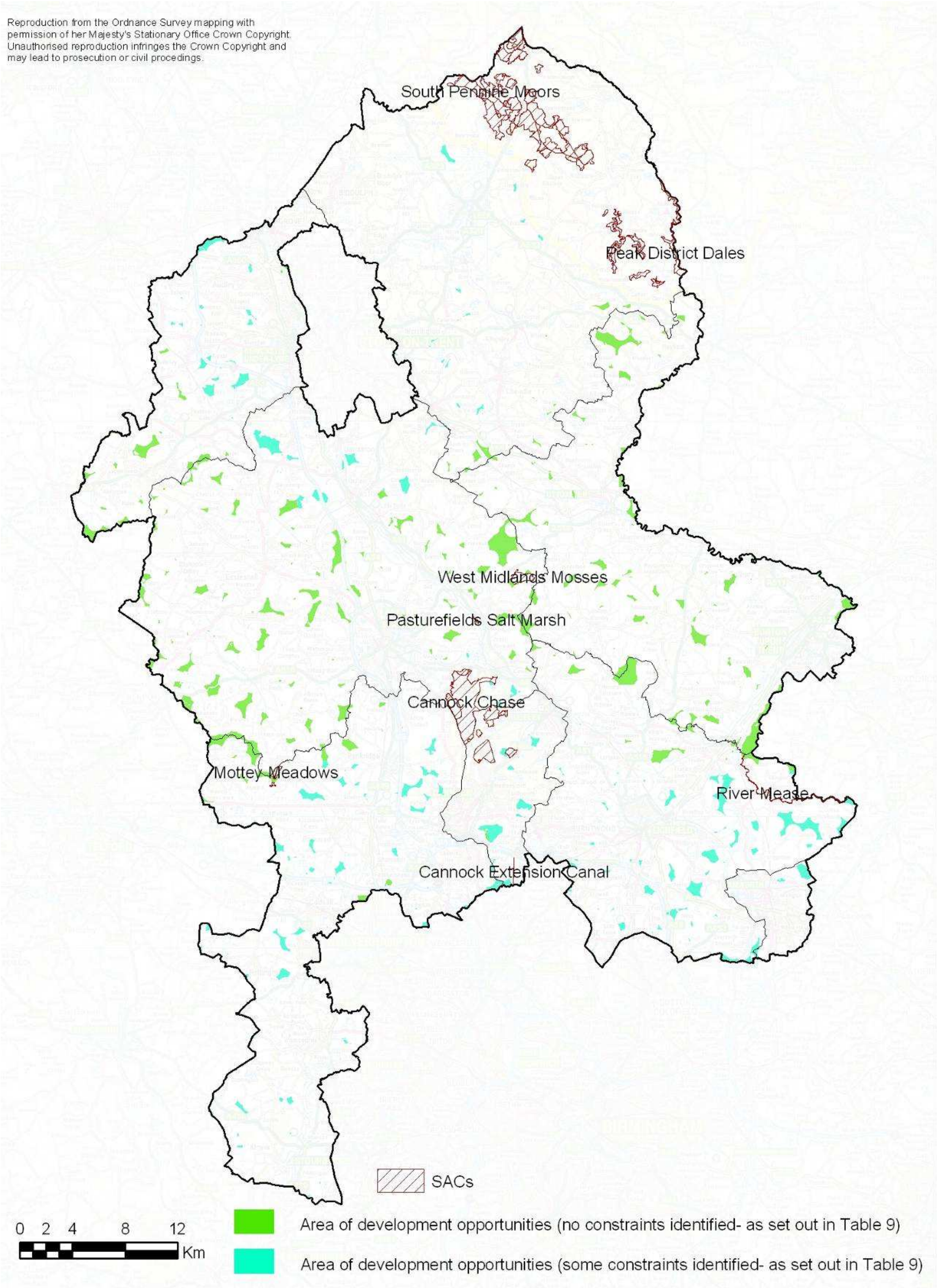

Figure 24: Zones of varying constraint within the study area

7.3 Hydro energy

7.3.1 Overview

Small Hydro schemes were assessed where civil infrastructure exists and a height drop (or head) presented conditions which could be viable for some form of hydro power development.

Hydro sites were identified by reviewing two existing studies – one national and one local:

- Department of Energy, 1989, Small scale hydroelectric generation potential in the UK
- Friends of the Peak District, 2010, Peak power: developing micro hydro power in the Peak District

The Department of Energy report identifies numerous weirs within the study area. However, it only provides specific data for sites with heads (the distance the water falls) greater than 2 metres. For sites where the head is less than 2 metres, flow data from the nearest gauging station was sourced from the National River Flow Archive as an estimate. Improvements in micro hydro technology since the study was commissioned mean that heads of less than 2m can be viable, and a recent report for Sheffield Council[47] used a minimum head for potential hydro developments as 1.2 metres. This head has been applied as an estimate where the UK report does not provide detail.

The local study focussed on the Peak District National Park, the south of which lies within Staffordshire Moorlands, outlining seven sites but only providing data for one.

The Department of Energy study has recently been updated by the Environment Agency, and a large number of additional sites are identified. However, the results are only presently available in a limited form; it has been possible to map the potential locations but not to analyse and report the potential resource. Consequently there is some discrepancy between the assessed potential and the identified development locations across the study area and individual districts.

7.3.2 Study Area Potential for Small Hydro

An estimated maximum capacity of hydro installations within the study area is 1.5MW. In total 17 sites were assessed which were all located either on the rivers Dove and Churnet, with a single site located on the Trent. These sites could generate approximately 12,500 MWh per year, equating to 0.1% of the energy demand (excluding transport) of the study area in 2020/21. Sites were only identified in Staffordshire Moorlands, Tamworth and East Staffordshire, and are detailed in Table 10. A simple ranking criteria was applied to the prospective hydro sites, based upon :

- the scale of power generation (where 1 = pico <10kW, 2 = micro 10-100kW, 3= mini <1MW);
- the likely distance to an energy user, established using an OS map (1 = 500m-1km, 2 = 100-500 m, 3 = <100m);
- site access, assessed using an OS map (1 = poor, 2 = possible/reasonable, 3 = good).

It is recommended that the Environment Agency should be approached with the intention to obtain site specific data as and when it becomes available. The results should be cross-referenced with the findings of this study.

[47] *http://www.sheffield.gov.uk/planning-and-city-development/planning-documents/background-reports/renewable-energy-study*

Table 10: Assessed Hydro Sites in Staffordshire

Site no	Site Name / Location	River	Site Grid Ref	Local Authority	Max Hydro Capacity (kW)	Ranking Criteria* Power generation	Distance to grid	Site access	Total Ranked Score
1	Far Kingstley Bank	Churnet	SK003483	Staffordshire Moorlands	63	2	1	1	4
2	Crumpwood Weir	Churnet	SK094425	Staffordshire Moorlands	21	2	1	1	4
3	Snelston	Dove	SK140437	East Staffordshire	66	2	1	2	5
4	Alton Mill	Churnet	SK066429	Staffordshire Moorlands	21	2	1	2	5
5	Marchington	Dove	SK144313	East Staffordshire	82	2	1	2	5
6	Marston	Dove	SK235288	East Staffordshire	155	3	1	2	6
7	Ellastone	Dove	SK124424	East Staffordshire	21	2	2	3	7
8	Mapleton	Dove	SK162484	East Staffordshire	21	2	3	2	7
9	Church Mayfield	Dove	SK153443	East Staffordshire	66	2	2	3	7
10	Cheddleton Plant Mill	Churnet	SJ973527	Staffordshire Moorlands	21	2	2	3	7
11	Mayfield Mill	Dove	SK158458	East Staffordshire	66	2	3	3	8
12	Church Mayfield 2	Dove	SK158448	East Staffordshire	90	2	3	3	8
13	Rocester Mill	Dove	SK113393	East Staffordshire	91	2	3	3	8
14	Rolleston	Dove	SK268275	East Staffordshire	155	3	3	2	8
15	Weir 1 Oakamoor	Churnet	SK053449	Staffordshire Moorlands	21	2	3	3	8
16	Smurfit Paper Mill	Trent	SK192044	Tamworth	143	3	3	3	9
17	Winshall Weir	Trent	SK255232	East Staffordshire	401	3	3	3	9

* ranking criteria set out as follows
Power Generation ((1 = pico (<10kW), 2 = micro (10-100kW), 3= mini (<1MW))
Distance to user connection (1 = 500m-1km, 2 = 100-500 m, 3 = <100m)
Site Access (1 = poor, 2 = possible/reasonable, 3 = good)

7.4 Biomass energy

7.4.1 Overview of approach

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

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

The procedure followed for this assessment is outlined below:

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

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

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

   1.3. Estimate available potential. This is the technical potential minus competing demands for the resource that is assumed need to be met before resources can be diverted for purpose of energy generation; specifically:
   - for sawmill co-products, the wood processing industry's needs are supplied first
   - for crop residues, feed and bedding needs are supplied first
   - for wastes, recycling is supplied first. Composting is not treated as competing demand.
   - for energy crops, arable land required for food production is excluded

2. Define uptake curves for each feedstock considered. The fraction of the available resource that can be realistically extracted now is estimated based on current capabilities and practices. This is then increased gradually over time up to the full available resource, taking into consideration the rate at which each sector could develop. The principles upon which the uptake curves have been defined are drawn from a recent study commissioned by DECC[48], as well as previous experience in other EU countries. Resource uptake curves for each feedstock are then converted into primary energy curves using calorific values specific to each feedstock[49].

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

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

The methodological principles and criteria used in this study to quantify the biomass resource available for energy generation are broadly in line with those provided by the DECC

[48] To inform the government's Renewable Energy strategy, the Department of Energy and Climate Change (DECC) [48] commissioned research to forecast the likely roll-out / uptake of generation capacity across the UK. E4tech, 2009, Biomass supply curves for the UK, available at http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/renewable/res/res.aspx
[49] It should be noted that for anaerobic digestion feedstocks, the energy content of the biogas yield expected has been used rather than the calorific value of the feedstock.

methodology; as mentioned above in Section 7.1, the DECC methodology does not provide any guidance on how to identify uptake over a period of time. Specific assumptions used in this study to assess the resource potential for particular fuel types and any discrepancies with DECC methodology are described in Appendix X.

7.4.2 Avoiding double counting

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

As outlined in section 9, renewable energy generation within the existing built environment is derived from a study at the regional and national level[50]. The scenario which was used to inform our analysis for uptake in the study area included no microgeneration-scale biomass installations by 2020. Whilst this is a pessimistic view of the potential for retrofit biomass, it is considered that the uptake will not be significant due to technical difficulties such as space requirements for wood chip/pellet stores. Hence, it is viewed that although double counting may exist, it will be negligible.

7.4.3 Uptake scenarios

The following scenarios have been defined for biomass.

Base Case

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

Elevated Case

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

7.4.4 Delivering biomass energy

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

[50] *Element Energy, 2008, The growth potential for microgeneration in England, Scotland and Wales*

and Humber and in the North West of England, with growing amounts of investment for infrastructure projects.

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

- Develop a comprehensive medium term (say 5 year) strategy, ideally at a county / sub-regional level with sufficient resolution to support planning and delivery at local authority level.
- Take advantage of the work undertaken by Advantage West Midlands (AWM) in relation to the Landfill Diversion Strategy to help bring forward infrastructure development; in particular, the Location Analysis Tool[51]. This Tool provides evidence to help identify potential locations for new waste infrastructure developments. Taking into account a wide range of criteria, the tool can help match sites being proposed with the most appropriate waste technologies or generate a series of locations suited to a specific type of facility. Using the Tool, AWM has already identified and ranked an initial shortlist of potential sites.
- Raise awareness of bio-energy among key stakeholders, including the development industry, waste managers, e.g. municipal waste and land owners / farmers
- General education and advocacy on the opportunities presented by bio-energy to overcome any public concerns.
- Review funding opportunities, e.g. Defra Bio-energy Capital Grants Scheme, the Bio-energy Infrastructure Grants Scheme and the Regional Development Agency, and co-ordinate strategic applications, learning from actions/best practice elsewhere.
- Review specific opportunities around the estates of the partner authorities, e.g. anchor for community heating or fuel switching within council buildings.
- Take advantage of existing resources/expertise of UK-wide bodies and UK-wide schemes (e.g. the Carbon Trust’s Biomass Heat Accelerator Scheme, the National Non Food Crop Centre and the Biomass Energy Centre).
- Consider access and costs issues for bio-energy power plants seeking to connect to the grid.
- Consider opportunities to increase the use of bio-energy through planning guidance and building regulations.
- Consider local air quality of emissions from bio-energy heat and power plants to ensure that bio-energy plants meet air quality legislation.
- Develop funding scheme for pilot projects. Support a limited number of representative projects in each sector with good dissemination potential.
- Consider potential for the Anaerobic Digestion plant not just wood based projects.
- Develop an understanding of the market potential of the existing feed stocks and seek to quantify potential, as an initial step to developing the business case for strategic investment, and encourage prime movers.

[51] *See main report: The Regional Approach to Landfill Diversion Infrastructure (DTZ & SLR 2009) http://www.advantagewm.co.uk/Images/Landfill%20Diversion%20Strategy%20Full%20Report_tcm9-25143.pdf*

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8 New Build Development- low carbon energy potential and carbon standards

8.1.1 Methodology – potential for low carbon solutions

The assessment of renewable/low carbon energy generation potential in new build development has taken on board a range of factors including policy trajectories for compliance with building regulations, technical potential in different development types, capital cost, whole life cost, carbon cost effectiveness and deliverability. This is explained in following sections, with section 8.1.2 and 8.1.3 providing an overview of the communal energy and microgeneration opportunities.

8.1.2 Communal energy supply systems

Combined heat & power (CHP) systems and district heating networks, can enable significant carbon reductions in new developments, particularly where they are operated with low carbon / renewable fuels. However, the viability and effectiveness of CHP is dependent on the scale, density and mix of development. In general, CHP requires large numbers of units at high density with a mix of building types that provide a good spread of daily and seasonal energy demand. The guide 'Community Energy: Urban Planning for a Low Carbon Future' produced by the CHPA and TCPA[52] provides a useful overview of the types of development that suit CHP and district heating and the range of issues that need to be considered in the development of CHP and district heating networks. In fact, the practical achievement of very low to zero carbon developments through an on-site approach tends to require a communal energy system as the basis of the energy strategy, although there are alternatives. The development of district heating should also be considered in the context of providing opportunities for adjacent existing buildings and future developments, which in turn can support the viability of low carbon heating sources for smaller developments. Moreover, existing heat sources, e.g. incineration plant, power generation sites and energy intense industrial processes could also be available to support the viability of communal energy supply, where they have surplus heat available.

Figure 25 overlays the Strategic Housing Land Availability Assessment (SHLAA) identified by each authority, against the background of heat demand density. From this it is possible to identify incidences of potential new development in areas of high heat consumption density such as around the outskirts of the principal towns in the study area. In addition the major development sites in the following locations (see Table 18 for further detail, including those with locations specified) will also present high density energy demands worth further consideration:

- Anker Valley
- South Lichfield
- Streethay
- Fradley

Previous work[53] at regional level considered the viability of CHP and district heating and this spatially identified the viability of CHP in commercial building applications. This is represented in Figure 26.

[52] *Community Energy: Urban Planning for a Low Carbon Future, TCPA & CHPA 2008*
[53] *Halcrow Consulting, Heat Mapping and Decentralised Energy Feasibility Study, Phase 2 Report, A Report for Advantage West Midlands, April 2008*

Overall district heating, community heating and CHP are most likely to be viable in those locations where areas of high heat demand density and larger, higher density development coincide within or around adjoining locations of sources of surplus heat.

It is recommended that these areas are further explored through localised heat mapping, to include review of:

- current and future heat demands;
- potential “anchor” consumers, e.g. new development, public buildings, swimming pools, flats;
- “spare” heat supply capacity;
- principal routes for heat network infrastructure;
- costs for heat network infrastructure and the other major items; and;
- delivery vehicles.

Such studies could be conducted on a study area-wide basis by the Local Authorities or by developers when bringing sites forward.

Thresholds for density & scale

Although density is vitally important in determining the practicality and viability of CHP and community heating, average density threshold guidelines are indicative only. Other characteristics such as scale and building mix are equally important in determining viability. Any specific development will have different densities across the site, and a communal system may be appropriate for various pockets within the development (for example in the central areas).

Clearly the existence of the heating networks and the potential to connect to adjacent sites and existing heat sources can have a significantly positive impact on viability, although practical and contractual constraints are often difficult to overcome.

Typically communal heating systems are only viable above a development scale of at least 1000 dwellings and a density of more than 50 units per hectare. The number of dwellings can be lower if non-domestic buildings are in the mix, or if appropriate existing development is located nearby, or where densities are much greater, e.g. apartments. Examples of smaller scale systems include that developed by Perthshire Housing Association[54].

Large scale wind turbines also represent a lower cost means of achieving a very low to zero carbon development. For example, two of the Homes and Communities Agency’s Carbon Challenge sites Brodsworth (Doncaster) and Bickershaw (Wigan) proposed inclusion of large scale wind turbines to achieve the Code 6 / zero carbon standards required[55].

Larger development sites could support a supply contract with a wind developer or co-development agreement, however, the number of suitable locations where wind energy is suitable close to development areas will be limited.

[54] *Small Scale Community Heating, Energy Savings Trust / Carbon Trust, 2005*
[55] *http://www.englishpartnerships.co.uk/carbonchallenge.htm*

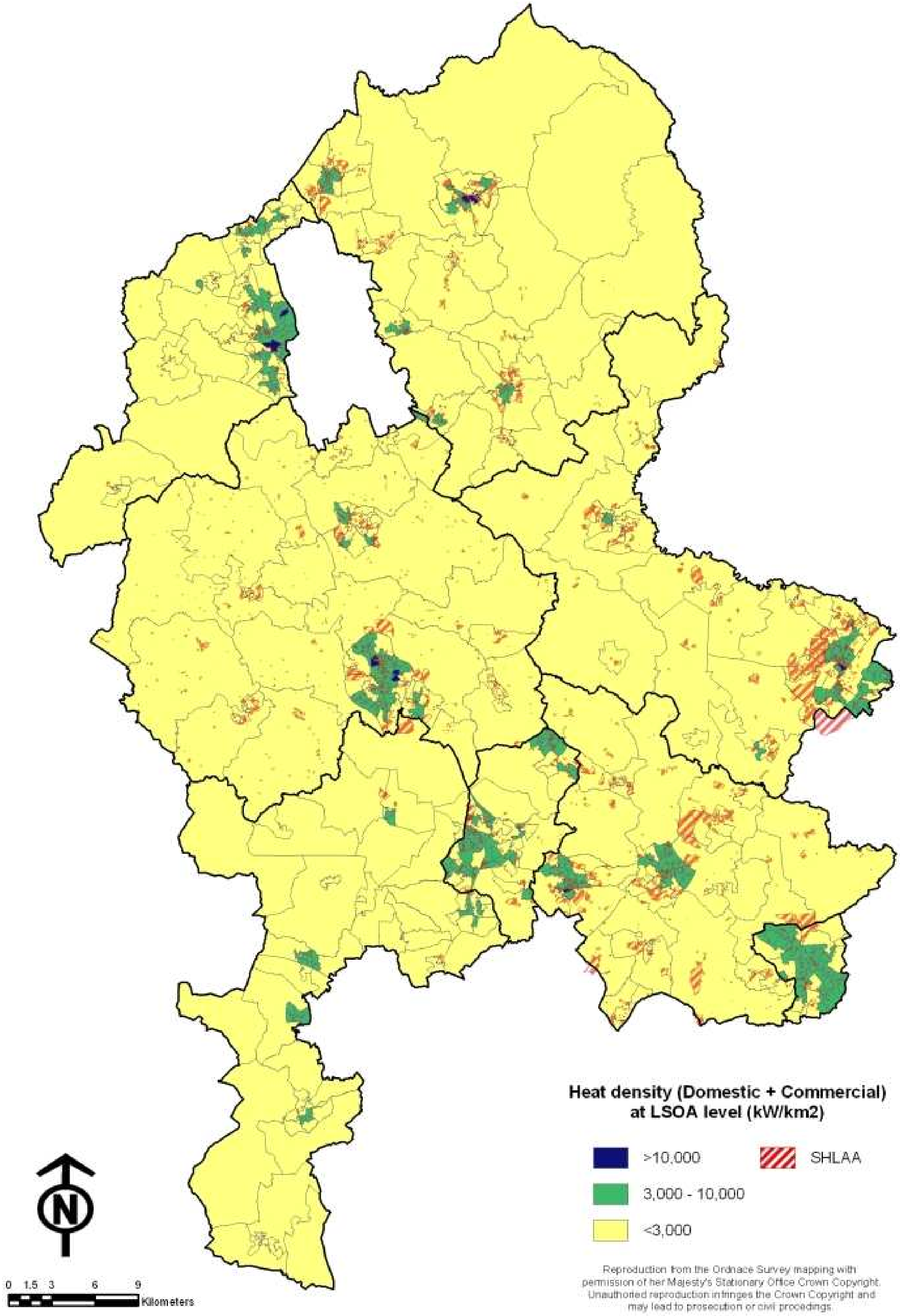


Figure 25: Spatial heat density distribution and identified SHLAA sites

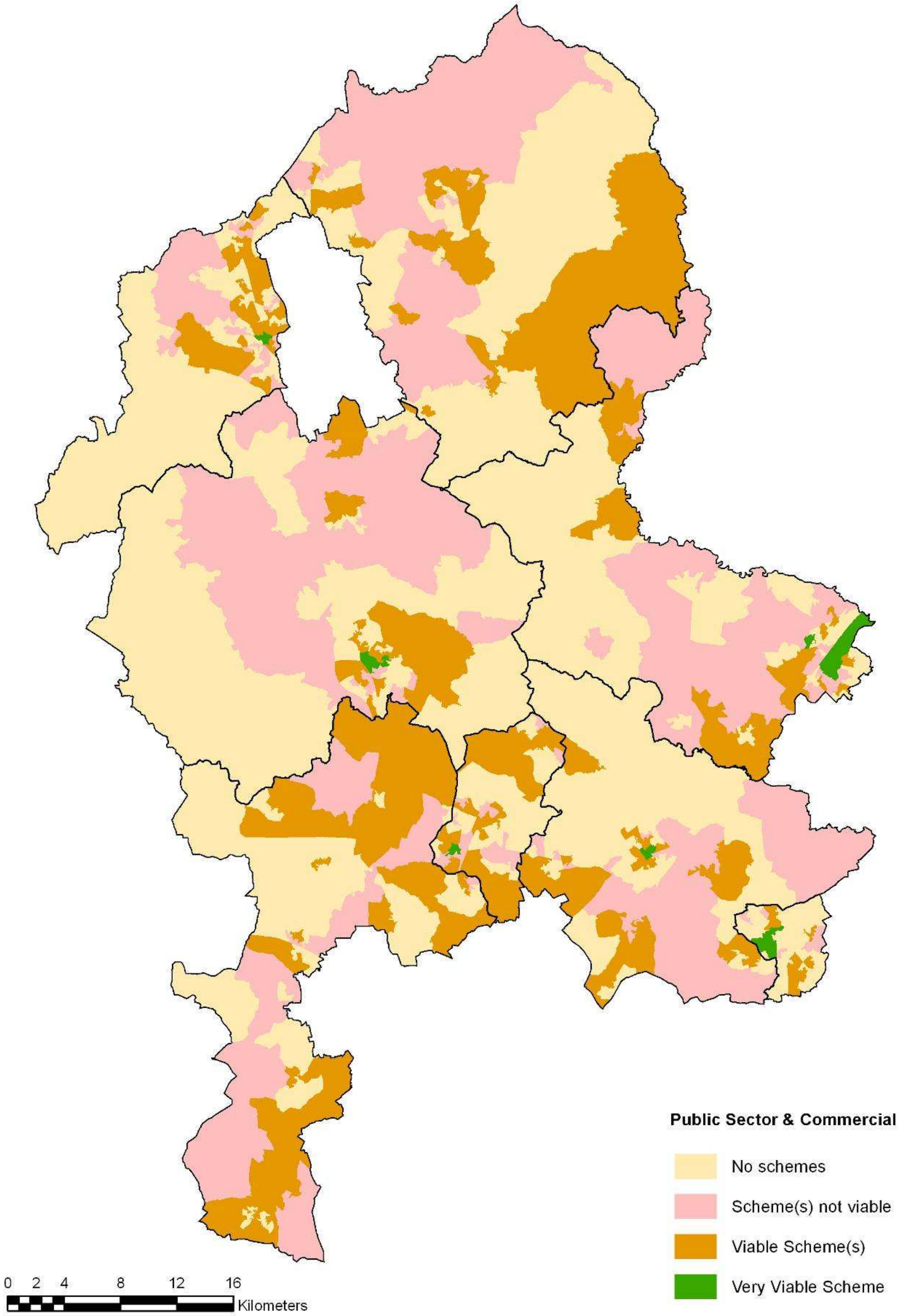


Figure 26 Economic viability of the CHP in the non-domestic building applications

8.1.3 Microgeneration energy supply systems

Individual buildings with integrated low carbon technologies such as photovoltaics, solar water heating, ground sourced heat pumps and improved energy efficiency standards can deliver substantial carbon reductions in new developments. Carbon savings are ultimately limited by technical constraints such as roof space, which are site specific, and by cost. Biomass heating provides an important opportunity for more significant carbon reductions. However, the use of microgeneration technologies (other than biomass) will struggle on a technical basis to achieve the very low carbon requirements of Code for Sustainable Homes Levels 5 and 6 (currently requiring 100% mitigation of regulated and unregulated emissions) due to the space requirements and costs.

The introduction of renewable energy incentives (Feed-inTariff and Renewable Heat Incentive) support the viability of achieving higher carbon reductions but only where developers can capitalise these long term revenues, through higher sale / rental values or Energy Services arrangements.

The full definition of a zero carbon home is not yet set but the government position[56] is likely to require at least 70% of a zero carbon dwelling's 'regulated'[57] emissions to be abated 'on-site' (see section 0). Even if the remaining emissions were abated through 'off-site' Allowable Solutions, e.g. investment in remote wind farms or local energy efficiency programmes, this 70% on-site target will remain challenging.

8.1.4 Characterising the main developments and modelling indicative energy supply strategies

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

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

The smaller developments that constitute urban and rural infill are typically not appropriate for communal systems (unless they can connect to adjoining existing or planned systems) and therefore the optimum energy strategy will consist of highly energy efficient buildings with individual building integrated technologies, i.e. microgeneration. The urban extensions are at the larger size and density necessary to support a communal system in some or all of their development areas, and are large enough to potentially establish a long term power purchase agreement with a wind turbine developer or justify the creation of a local community owned ESCO on behalf of the future development. As discussed earlier it is deemed that projects over 1,000 dwellings could offer the right conditions to support biomass community heating / CHP serving the highest density zones.

[56] *http://www.communities.gov.uk/publications/planningandbuilding/zerocarbondefinition*
[57] *Regulated emissions arise from fuel consumption for space heating and hot water, as well as electricity for lighting, fans and pumps. Electricity consumed by appliances are not included, and are known as 'unregulated' emissions sources*

Table 11 outlines the general principles regarding the most appropriate energy supply strategies for different development types, and relates these approaches to the key development sites proposed for the study area. These strategy descriptions are developed from a wide range of design studies completed by Camco. They are not intended to prescribe specific solutions for development types as developments need to respond to site-specific constraints and opportunities. In particular the specific characteristics of a site will determine the technical and financial suitability of CHP and district heating systems. The number of dwellings and densities in the table are indicative only. Although high density developments are generally needed to reduce the costs of district heating systems, lower density developments can still install communal systems but at a higher cost per housing unit.

There are a number of developments within each Local Authority area which correspond to these development types and it may be appropriate for the Council's Local Development Framework to point towards such solutions for development types, whilst not being prescriptive over the technology choice. It would certainly be important that larger developments give due consideration to 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.

Development types and typical low carbon energy strategies	
Category / Low carbon/ renewable energy supply options	
Urban Infill: Small numbers of dwellings (typically 10-100 units) integrated into existing urban environment/settlement framework. High density (50 dwellings/ha).	
	Due to restricted land area available, building integrated micro-renewables are the only option available in almost all cases, except where a communal energy system exists or is planned near/adjoining the site. Due to the limited renewable energy options, high levels of energy efficient design (e.g. working towards 'PassivHaus'[58] standards) could act to mitigate the difficulties found with installing renewable technologies on these sites. **Difficult to achieve very low or zero carbon development.**
Rural infill: Small numbers of housing units situated within existing settlement framework - ranging from 1 to 100 Medium density (40 dwellings/ha).	
	As with urban infill, except that existing communal systems are less likely. **Difficult to achieve very low or zero carbon development.**
Settlement extension: Up to 1,000 dwellings adjoined to existing town or village with limited mix of other building types. Medium density (40 dwellings/ha).	
	Currently more suited to communal biomass heating as opposed to biomass CHP technology due to scale and mix of uses, communal heating (CH) / CHP starts to become more suitable on larger developments. Mixed development is more likely to support the use of CH / CHP at lower development scales. In future, biomass CHP will become more viable as technology matures and supply chains evolve. Less dense may require microgeneration. Potential contribution from medium to large scale wind on appropriate sites. **Potential to achieve low carbon development. Harder to achieve zero carbon unless a communal heating or medium to large scale wind energy is viable.**
Urban extension / major regeneration site: Over 1,000 housing units adjoined to existing town and mix of other building types. Medium density (40 dwellings/ha).	
	Meets indicative criteria for CHP and communal heating in terms of size and mix. The development mix will be an important parameter since density is generally below the typical threshold level. Urban location provides greater likelihood of connection into adjoining heat networks. Use of biomass derived fuels is a key opportunity to deliver very low carbon solutions. Also potential contribution from medium to large scale wind energy on appropriate sites. **Good potential to achieve very low carbon developments**
Large urban extension / new settlement: Large number of housing units adjoined to existing town - up to 4,000 dwellings - good mix of other building types. High density (greater than 50 dwellings/ha).	
	As above. **Good potential to achieve very low or zero carbon developments.**

Table 11: Development types and typical low carbon energy strategies

[58] *Commonly regarded as a dwelling with advanced building fabric and spatial design which does not require traditional heating and/or cooling systems to maintain a comfortable internal environment (http://www.passivhaus.org.uk/index.jsp?id=668)*

8.2 New development carbon standards

8.2.1 UK carbon reduction roadmap for buildings – baseline carbon standards

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

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

Whilst the definition of the zero carbon homes is still being resolved, the roadmap for reduction is well established. The situation for non-domestic buildings is more complex, because of the wide range of buildings involved and is currently under going a more fundamental review as set out in the current consultation[59,60]. The consultation reviews the range of emissions between buildings types and identifies options for addressing unregulated emissions, the staging of progress towards the 2019 zero carbon target as well as resolving the final definition of zero carbon, including the extent to which 'off-site' allowable solutions would be acceptable.

Table 12 shows the carbon reductions expected over time for both domestic and non-domestic development. For non-domestic development, the range shown illustrates the policy options considered within the consultation. It also highlights the uncertainty around the definition of zero carbon, particularly regarding how unregulated emissions (see definition below) should be dealt with across the range of non-domestic buildings, i.e. variable 0%-100% of unregulated being mitigated (depending on building type) or it being dealt with on a fixed 20% basis across all building types.

Table 12 Current Zero Carbon roadmap – domestic and non-domestic buildings

Period	Residential Reductions		Non-domestic	
	Regulated (vs Part L 2006)	Unregulated	Regulated (vs Part L 2006)	Unregulated
2010-13	25%	0%	25%	0%
2013-16	44%	0%	30-44%	0%
2016-19	100% (min. 70% Carbon compliance + 30% AS**)	100% (Additional Carbon Compliance or AS**)	37-53%*	0%
Post 2019			100% (44-63% through carbon compliance + reminder through AS**)	TBC: Variable or fixed flat rate (0%, 20% or 100%). Through Additional Carbon Compliance or AS**)
	Zero Carbon			

*consultation identifies options of the allowable solutions being part of the solution from 2016 for non-domestic buildings

**AS = Allowable solutions

[59] *Department of Communities and Local Government, Zero carbon for new non-domestic buildings - Consultation on policy options, November 2009*

[60] *Department of Communities and Local Government, Zero carbon for new non-domestic buildings - Impact Assessment, November 2009*

For domestic development these carbon standards are proposed to be achieved through the tightening of Building Regulations (Part L), with the Code for Sustainable Homes remaining a voluntary tool for commercial development. Where developments are in receipt of public funds (or where they are part of the government estate) it is expected they will continue to be required to achieve standards ahead of the UK roadmap, to support the process of the identifying and developing low carbon solutions (and associated supply chains). The same approach is anticipated for non-domestic buildings.

8.2.2 Unregulated and regulated emissions

It is important to note that Building Regulations do not regulate all emissions from new development. ‘Unregulated’ emissions (IT, appliances and small power in the case of dwellings) are ignored within buildings regulations however they are considered within the Code for Sustainable Homes, and more importantly are included within the zero carbon buildings definition which therefore means that currently ‘unregulated’ carbon emissions will in some way become regulated, presumably through changes in the Building Regulations.

For dwellings, regulated emissions typically range from 60-65% of total carbon, i.e. regulated plus unregulated, and the zero carbon definition for homes proposes that these should be entirely mitigated.

The proportion of unregulated emissions in non-domestic buildings is a more complex issue because of the wide range of building types; consequently figures vary significantly as shown in Table 13. It is worth noting that the non-domestic consultation document confirms that estimates of the regulated emissions are developed through building modelling (SBEM) which examines non-regulated emissions to determine the associated heat gains, and hence they typically under-represent the extent of emissions not considered by Building Regulations.

The options set out in the non-domestic consultation range from not addressing regulated emissions, to addressing them entirely and then more balanced approaches, which present simplification for compliance, including setting a fixed flat-rate of 20% (above the regulated emissions) on all non-domestic buildings.

Building type	Unregulated emissions as % regulated emissions
5* hotel	24
3* hotel	24
2* hotel	24
Shopping centre	7
Mini-supermarket	7
Large supermarket	7
Distribution warehouse	15
Retail warehouse	5
City centre HQ	37
Speculative office	37
Small office	67

Table 13 Unregulated emissions as proportion of the regulated in non-domestic buildings

Non-domestic buildings also have process energy consumptions (e.g. operation of manufacturing plant, computer equipment and refrigeration) which are not directly linked to the building type per se, and can vary significantly between developments. The consultation confirms the intention not to attempt to address these as they are dealt with by other mechanisms, such as Carbon Reduction Commitment, Emissions Trading Scheme and Climate Change Agreements.

Clearly the outcomes from this consultation should influence final development standards policies for non-domestic properties.

8.2.3 Specific renewable energy targets for development

Many authorities in the UK have already adopted so-called Merton targets. A 2006 survey by the Town and Country Planning Association stated 56 authorities (15%) had adopted a Merton-rule policy and that a further 30% were either "drafting" or "developing" such policies. It is now believed that at least 80 authorities have such a policy[61] and many have sought to go beyond the original 10% standard (e.g. 20% in Greater London Borough, 20% in Manchester). A number of authorities have established sliding targets to keep apace with changing building regulations.

The Regional Spatial Strategy Phase Two Revision suggests the inclusion of 10% Merton-style policies within LDF policies (as discussed in Section 6.2). It goes on to suggest that a 10% requirement is "generally viable across the UK".

If authorities are to establish Merton-type policies it will be important to ensure they are consistent with current and developing standards/compliance methodologies. To ensure consistency with the Code for Sustainable Homes and the zero carbon buildings definition, targets within LDFs should:

- Be expressed in terms of carbon and not energy;
- Be applied to total carbon and not just regulated emissions as is used in the Code for Sustainable Homes and include 'unregulated' emissions. For reference, Table 14 illustrates the equivalent affect on 'regulated' emissions if a 10% or 20% renewables target (expressed in carbon terms) is applied.
- Be applied to all dwellings, as is the case for the Code for Sustainable Homes, resulting in no minimum development scale threshold
- Take account of the final definition of the zero carbon non-domestic buildings (when resolved), for example, applying a Merton-rule to 10% of actual unregulated (and regulated) emissions would be far more onerous for some building types than, say, a fixed value of 20% of regulated emissions.

Building Type	Proportion of regulated emission of total emissions	Reduction in the ALL emissions, i.e. regulated PLUS unregulated	Equivalent reduction in 'regulated' emissions
Flat	60%	10%	= 17%
House	65%	10%	= 15%
Flat	60%	20%	= 33%
House	65%	20%	= 31%

Table 14 Relationship between 10% and 20% renewable energy targets and reductions in 'regulated' emissions – domestic development

[61] *Renewable Energy Association website*

8.2.4 Accelerating carbon and LZC generation targets in new development

For new non-domestic development the base position, i.e. UK zero carbon roadmap, has yet to be fully established and therefore it is not possible to propose acceleration. However, proposing specific carbon reduction targets by requiring specific renewable energy targets (Merton rule) is recommended since it will encourage the adoption of the renewable energy within the study area, and ensure the various supply chains for renewable energy start to evolve at a local level. A non-domestic Merton-rule policy will also ensure consistency with a similar target for domestic development. In line with the Regional Spatial Strategy it is recommended that the non-domestic target should apply only to developments greater than 1,000 m^2.

For new residential development the base position is well established and it is recommended that targets are accelerated where this is determined to be viable. The general justification for this is that it will:

- support the development of local supply chains for low carbon supply solutions;
- support the local development sector to implement low carbon solutions; and
- support authority-wide carbon reduction and renewable energy generation aspirations.

Moreover, it avoids viable acceleration opportunities being lost, e.g. on large, long term developments, where current national policy would only require a minimal response in the short term.

There are two key opportunities for acceleration:

- Merton-type renewable energy targets between 10% and 20% in the early years of the UK roadmap (in later years they become obsolete as carbon targets alone require increasing proportions of renewable energy)
- Around major development where lower cost carbon reduction solutions are available now or will be in the near future, with proposed changes around the milestones for Building Regulation changes (2010 and 2013).

The Merton-type policies for the authorities within the study area are justified on the following basis

- Councils have the legal right to implement such targets through the Planning and Energy Act 2008
- The proposed amendments to the West Midlands RSS which included requiring a minimum 10% target, states that a 10% requirement is widely considered viable in most circumstances and this was published prior to the introduction of the Feed-in Tariff and Renewable Heat Incentive. Costing and viability analysis in later sections adds additional weight to this position.
- Many councils have already adopted Merton-type targets as discussed above and their experiences have generally been positive
- As a simple and consistent planning rule it will support the understanding of low carbon buildings within local development markets and support investor confidence going forward, encouraging early development of local supply chains
- The policy covering a minimum target would have a viability clause, so that if on any individual development it was proved unviable then the development would not be required to achieve it.

In general terms acceleration in both cases will be supported by the introduction of the Feed-in Tariff (FIT) and Renewable Heat Incentive (RHI). The former has been set at rates designed to provide real-terms Internal Rates of Return of around 5-8%, meaning that they are potentially viable for individual, community and public sector investors and can contribute to meeting commercial returns (but still requiring adjustment of land values and/or developer contributions).

Capitalising this revenue from FIT/RHI at the point of sale of a property will be important for reducing the burden on developers. Mechanisms such as delivery through an Energy Services Company or the establishment of low interest loans to consumers may allow this to happen. Financial arrangements such as Pay As You Save (PAYS) could also offer the potential to support microgeneration in new build development. Whilst PAYS and RHI mechanisms have yet to be introduced, given the large amount of activity in the industry seeking to develop these to realise them as practical financial support mechanisms it is considered justifiable to establish targets that take account of capitalised revenue.

The burden on developers must ultimately be assessed through planning negotiations which can be supported by viability models, such as the Economic Appraisal Tool provided by the Homes and Communities Agency, to assesses construction costs, land values and developer margins in order to set a tariff and attract housing grants.

Experience on a range of development projects suggests that biomass CHP is viable in projects above 1,000 units where at least half of the development is a suitable density, e.g. developments at Northstowe (South Cambridgeshire) and Bath Western Riverside. In practice, where circumstances are favourable, viability may also be possible at smaller scales of development. Delivery would be through an Energy Services Company responsible for some or all of finance, design, build, ownership and operation of district heating and CHP energy centres. Experience in the UK is extremely limited, therefore development risk is high but there are a number of European examples, e.g. Hammarby Sjostad, Sweden[62] to learn from, as well as gas CHP systems within the UK. Gas CHP could well form the basis of earlier developments with a progressive move towards bio-energy (or energy from waste) over time.

Wind energy development associated with new development is also viable for large turbines in windy locations. Projects of at least one turbine can be potentially viable when supported by a developer contribution in lieu of Code targets. Existing examples of large-scale wind energy close to development include Green Park, Reading and Ford Dagenham. There are many examples where smaller scale wind energy development on or around existing or new development such as Kirklees Council Civic Centre, Huddersfield and the Sheffield College, Sheffield.

For most sites it will be technically possible to achieve a 20% reduction in total carbon (regulated and unregulated) emissions using on-site renewable technologies such as PV, solar water heating and biomass boilers. However, acceleration is only proposed to this level on larger schemes, where economics are anticipated to be more favourable and on schemes that can access lower costs solutions.

For larger residential-led development (generally over 1,000 units) or where lower cost solutions are available, we are proposing that a target of meeting zero carbon standards ahead of 2016 is set, given that the FIT and RHI can now support these schemes and help to deliver Code for Sustainable Homes credits in a viable way. At this scale it is considered that infrastructure could in many cases be supported through an Energy Services Company (ESCO). Capital could be secured on the strength of the relatively secure[63] long term energy sales opportunity available, although detailed evaluation will be required on a case-by-case basis.

Table 15 summarises the proposed acceleration for carbon reduction targets and renewable energy generation for new residential development. For new non-domestic development

[62] *http://www.cabe.org.uk/case-studies/hammarby-sjostad*
[63] *Prior European legal precedent effective rules out sole supplier scenarios*

only 10% and 20% Merton rule targets are proposed to be applied for 2010 and 2013 (onwards).

Table 15 Proposed Carbon Target Framework for New Development

<table>
<tr><th rowspan="2">Period</th><th colspan="3">Domestic Reductions</th><th rowspan="2">Resulting range in carbon reduction (Regulated emission equivalent)</th></tr>
<tr><th>Regulated (vs Part L 2006)</th><th>Minimum Proportion of Low and Zero Carbon energy generation* (against total carbon**)</th><th>Un-regulated</th></tr>
<tr><td>2010-13</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Minimum***</td><td>25%</td><td>10%</td><td>0%</td><td>25 - 42%</td></tr>
<tr><td>Maximum[χ]</td><td>44%</td><td>20%</td><td>0%</td><td>44 -78%[χχ]</td></tr>
<tr><td>2013-16</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Minimum***</td><td>44%</td><td>20%</td><td>0%</td><td>44 -78%[χχ]</td></tr>
<tr><td>Maximum[χ]</td><td rowspan="4">100%
(min. 70% Carbon compliance + 30% AS)</td><td rowspan="4">Obsolete at this carbon standard</td><td rowspan="4">100%
(Carbon compliance or AS)</td><td rowspan="5">100 – 150%</td></tr>
<tr><td>2016-19</td></tr>
<tr><td>Minimum***</td></tr>
<tr><td>Maximum[χ]</td></tr>
<tr><td>Post 2019</td><td colspan="3">Zero Carbon</td></tr>
</table>

*Depending on the technical solutions this may not result in additional carbon savings.

** total carbon = 100% regulated plus 100% unregulated emissions

***To be applied to all housing development including sub 10 developments to ensure consistency with Code for Sustainable Homes

[χ] where lower cost solutions are available because of technical opportunities, e.g. community heating, biomass heating / CHP, large wind energy, surplus heat or scale of the development

[χχ] unlikely to result in this maximum level of savings since the 44% regulated emissions reduction target will typically require a significant element of renewable energy.

The framework establishes standards in terms of carbon reduction and as such does not set specific standards for energy efficiency. This then leaves developers to decide on the appropriate mix of energy efficiency and low carbon energy supply (and allowable solutions when the target is zero carbon). With Building Regulations already demanding high levels of energy fabric performance, energy efficiency will already form the cornerstone of most low carbon solutions. Even more advanced levels of energy efficiency will generally deliver diminishing returns per pound spent and renewable energy technologies start to become a lower capital cost solution to meeting advanced carbon standards. Furthermore, financial incentives such as the Feed-in Tariff and potential Renewable Heat Incentive may in future present an additional disincentive for advanced energy efficiency. Therefore compliance against the framework should be monitored over time, such that Authorities collate evidence to support the adoption of minimum energy efficiency standards where necessary.

The targets are set out on a minimum and maximum basis to provide a clear basis for the developer and for the Planning Authority to review each development that comes forward what the appropriate target should be. The expectation would be that the planning policy for carbon targets would be framed such that the onus would be placed upon the developer to prove that the maximum targets were not viable, in the context of the specific carbon reduction solutions available, i.e. to prove that the specific constraints of the site do not make the maximum target viable. Thereafter the developer would be required to justify what target could be achieved between the minimum and maximum standards, with a backstop requirement of the minimum target. In general the maximum target would apply only to those development sites that can viably incorporate lower cost solutions (which the Planning Authority would need to test), i.e.:

- Connecting to existing communal heating network near the development site or connect to appropriate source of surplus heat
- Developing communal heating and / or CHP on site, particularly where biomass can be the principal fuel
- Developing wind energy on or near to the development site, with a physical connection to the development site
- Other low cost solutions that become available in future

The framework does not require estimated "unregulated" emissions to be mitigated until after the zero carbon standard comes into force.

To support the achievement of the zero carbon standards, authorities should develop Allowable Solutions strategies (and delivery vehicles) ahead of the 2016 milestone. This will enable authorities to present the lowest cost options to the development sector at an early stage and also ensure that investment for local carbon reduction priorities, e.g. communal heating infrastructure or civic renewable energy projects, is captured at an early stage.

Section 11 recommends policy approaches that could be included with the emerging LDFs within the study area to support this.

8.2.5 Costing of proposed carbon target acceleration

Cost modelling of proposed carbon target acceleration for residential development has been carried out. Modelling has not been conducted for non-residential development since, as discussed in the sections above, there is no carbon reduction roadmap to use as a baseline from which to derive additional costs (assuming the LZC generation targets presented here did in fact represent acceleration above the eventual national roadmap). The residential modelling utilises data provided in the zero carbon definition impact assessment, issued as part of the definition consultation. The data sets out a range of technical solutions for achieving the various domestic carbon standards 25%, 44% and zero carbon (70% on & 30% Allowable Solutions) for a range of domestic development and dwelling types as follows:

Development types

- Dwelling type:
  - Flats
  - Mid-terrace, end-terrace / semi-detached and detached housing
- Development types 'Small scale' – development of 9 houses
  - 'City infill' – 18 flats
  - 'Market town' – 100 dwellings, including 27 flats
  - 'Urban regeneration' – large scale, high density development of 750 dwellings, including 697 flats

Technical solutions considered:

- Best Practice Energy Efficiency (BPEE)[64]
- Advanced Practice Energy Efficiency (APEE)
- Solar hot water (SHW) + BPEE
- Solar photovoltaic (PV) + BPEE
- Ground source heat pump (GSHP) + BPEE
- Gas combined heat & power (CHP) + BPEE
- PV + APEE
- SHW + APEE
- Biomass heat + APEE
- GSHP + APEE
- GSHP + PV + BPEE
- Biomass heat + PV + BPEE
- Biomass heat + PV + APEE
- Biomass CHP + BPEE
- Biomass CHP + APEE
- Gas CHP + PV + BPEE
- Biomass CHP + PV + BPEE
- Biomass CHP + PV + APEE

In addition, to these base costs, additional costs have been added to achieve the specific renewable energy targets of 10% and 20% (of total carbon), by consideration of additional generation options for development types. Where the technical solutions presented in the consultation impact assessment do not achieve the necessary proportion of the LZC supply, the inclusion of additional solar PV has been assumed and costed.

Within the cost modelling, the following incomes have also been taken into account to provide an assessment of projected net costs anticipated to fall on the development / developer:

- Capitalisation of renewable energy tariffs which is assumed to be only available for the microgeneration solutions.
- ESCOs finance where CHP / communal heating solutions are proposed (where an ESCO operation is viable it can typically provide around 60-70% of capital.
- Allowable Solutions for achieving the zero carbon standard are assumed to be available from 2013. It is not possible to predict with certainty the relative amounts of the different types of allowable solutions available from 2013 (or 2016) and so it is difficult to estimate the costs that would be associated with these offsite solutions. Therefore we took a similar approach to that of the zero carbon definition consultation, where the price of allowable solutions is capped at £100/tonne of CO_2 (per year over a 30 year period).

Potential market uplift in sales or rental values due to lower utility costs and higher sustainability standards, compared to more conventional development, is presently hard to quantify with only limited market experience. As such this has not been considered as an additional income.

The costs for achieving higher carbon standards should reduce over time through technology development, improved supply chain efficiencies and learning within construction management (especially with energy efficiency). ‘Learning rates’ are included within the data taken from the zero carbon definition consultation analysis.

An Energy Services Company (ESCO) is a specialist energy services company that can design, build and operate communal energy infrastructure such as biomass heating systems or combined heat and power systems. ESCO companies have formed partnerships with housing developers on a number of low carbon housing projects that are installing communal boilers and site-wide heat distribution infrastructure in the development. Although the precise arrangements vary from case to case, these ESCOs typically provide a proportion of the

[64] *The Energy Saving Trust’s BPEE and APEE energy efficiency standards were used with the consultation guidance.*

capital for covering the costs of the energy infrastructure and then own and operate the plant, including selling the heat to residents. The terms of reference for the heat sales to residents are carefully determined so to safeguard resident energy costs (and are often linked to general market prices) and usually involve the local authority.

In the analysis of the potential impact that ESCO involvement could have on additional costs, we have assumed that ESCO contributions could amount to 60-70%, although for the analysis we have assumed a conservative 50%, of the cost of the plant for communal energy networks (biomass heating, biomass combined heat and power and gas combined heat and power).

The previous Government developed two renewable energy tariffs schemes to provide direct support to smaller scale renewable electricity generation and renewable heat (of all scales):

- the Feed-In Tariffs (FIT) will provide an annual income stream for renewable electricity such as from photovoltaics from April 2010; and,
- the Renewable Heat Incentive (RHI) will provide an annual income stream for renewable heat such as, biomass heating (including anaerobic digestion), solar water heating and heat pumps from April 2011.

Although both of these mechanisms will potentially provide an income stream to owners of renewable energy technologies, they could also stimulate the marketplace to provide a business offering of upfront capital for investment in these technologies so that the long term FIT and RHI income streams can be claimed by these companies. Housing developers could form a partnership with a FIT/ RHI investment company, a new type of ESCO, and secure finance to cover some, or all, of the costs of installing microgeneration technologies. The rights to the FIT and RHI income stream from the installations would however need to be signed over to the investment company rather than the householder who eventually lives in the home, and this is an issue that needs further consideration.

As the FIT has only recently entered the market place and RHI is still in development, and there is some uncertainty over how the sector will respond. Therefore the conservative estimate of a 25% contribution to the capital costs for microgeneration technologies (PV, solar water heating and heat pumps) in the viability analysis has been used.

The income assumptions are therefore set at 50% for those developments with an energy package that includes biomass heating or gas CHP, and 25% for those with an energy package of solar energy or heat pumps.

8.2.6 Resulting additional (net) costs for residential development

From Figure 27 through to Figure 32 the results of the costs analysis on the range of residential development options considered are illustrated.

The graphs present only the additional net costs (accounting for potential revenues) in each of the four acceleration scenarios required to examine the impact of the proposed carbon targets. It is important to note that the costs presented in each case are the increases between the stated initial carbon standard and the stated accelerated standard, i.e. they do not account for the costs of achieving the initial carbon standard, which will in some cases mean an additional uplift from today's Building Regulation standards. For example Test 2 does not include the cost of achieve the initial carbon standard of 44% carbon reduction (against Part L 2006) which is higher than current standards. The analysis seeks to purely examine the additional uplift of acceleration beyond the proposed national road map of carbon standards (along with a Merton rule requirement which is taken as 10% as a base case from 2010).

Where an asterisk is marked next to the technical solutions this denotes the assumption of additional solar PV added to achieve the requisite renewable energy supply proportion. The data tables from which the graphs are produced are shown in Appendix XVII, which also includes details of the estimated net costs on the basis of proportion of the total capital cost.

Acceleration test 1:

From 25% carbon reduction (against Building Regulations Part L 2006) to 25% Part L reduction PLUS a 10% specific low zero carbon (LZC) technology target against total carbon (which can form part of the solution for the Part L target)

Figure 27 shows that the solutions available to achieve the 10% Merton rule policy are limited, for example, with some property types not being able to utilise Ground Source Heat Pumps. The additional net costs are relatively small. The highest cost option sits at just under £2,000 for a detached property, in any setting. Detached properties will always tend to present the largest cost as a consequence of greater energy consumption (and associated carbon emissions).

Based on the construction cost averages within the Zero Carbon Definition consultation, additional costs related to between 0% and 2.0% with the latter applying to detached properties using the solar PV + BPEE strategy.

It is worth noting that the costs of smaller development types do not fair any worse than other development types, which supports the case for applying the Merton rule to all housing development rather than setting a 10 dwellings threshold.

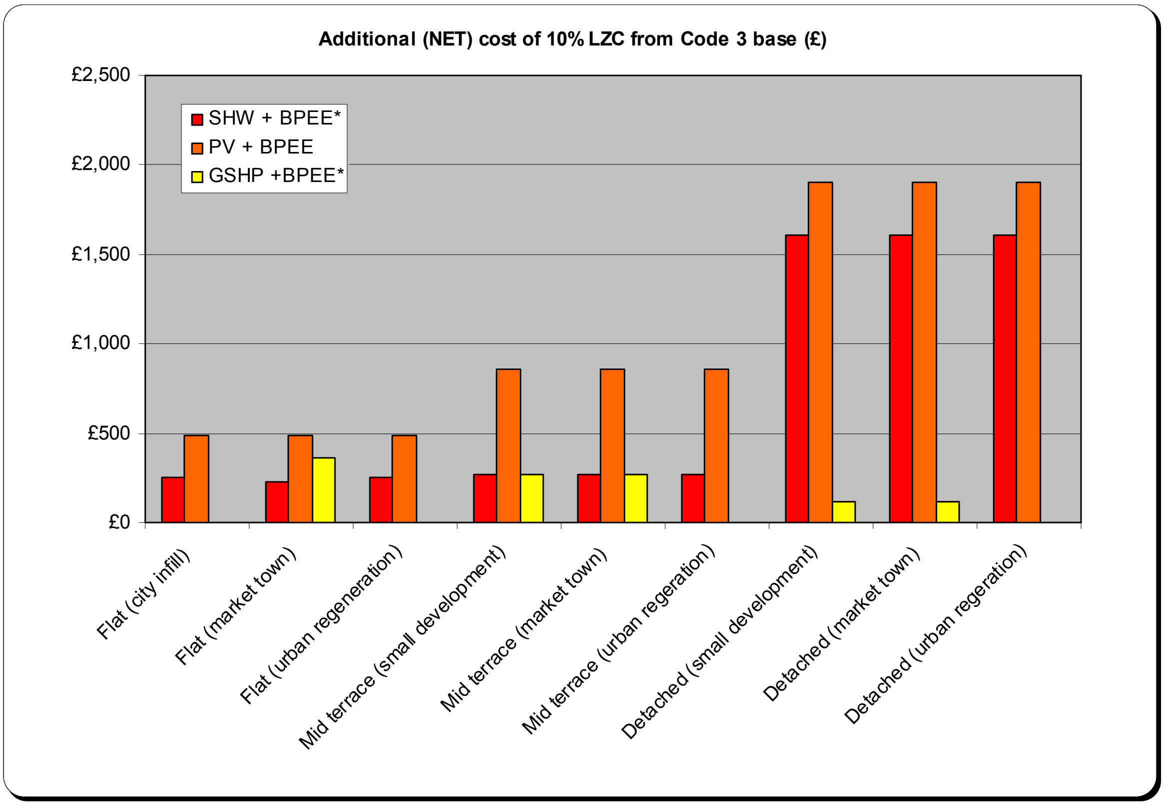


Figure 27 Test 1: all development types (£/dwelling)

Acceleration test 2:

From 44% carbon reduction (against Part L 2006) to 44% Part L reduction PLUS a 20% specific LZC technology target against total carbon (which can form part of the solution for the Part L target)

Figure 28 shows that a wider range of technical solutions are available to achieve this more difficult standard. It is important to note that the graph includes biomass heating but there is no additional cost associated to this since a development using biomass heating to achieve the original standard (44% carbon reduction) will by default achieve the higher standard (original + 20% LZC). Additional costs range significantly from zero for biomass heating, to sub £500 for PV + BPEE in all development types, through to over £6,000 for SHW + APEE and GSHP + APEE in detached developments (both solutions require additional solar PV to achieve the higher standard).

The net additional costs as expressed as a proportion range from 0% (biomass heating), to 0.5% for PV + BPEE, through to a maximum of 7% for detached market town development using a GSHP + APEE strategy (with additional solar PV).

As with the early test, small developments do not appear to be penalised in comparison with other development types but detached properties appear to be affected to a much higher extent.

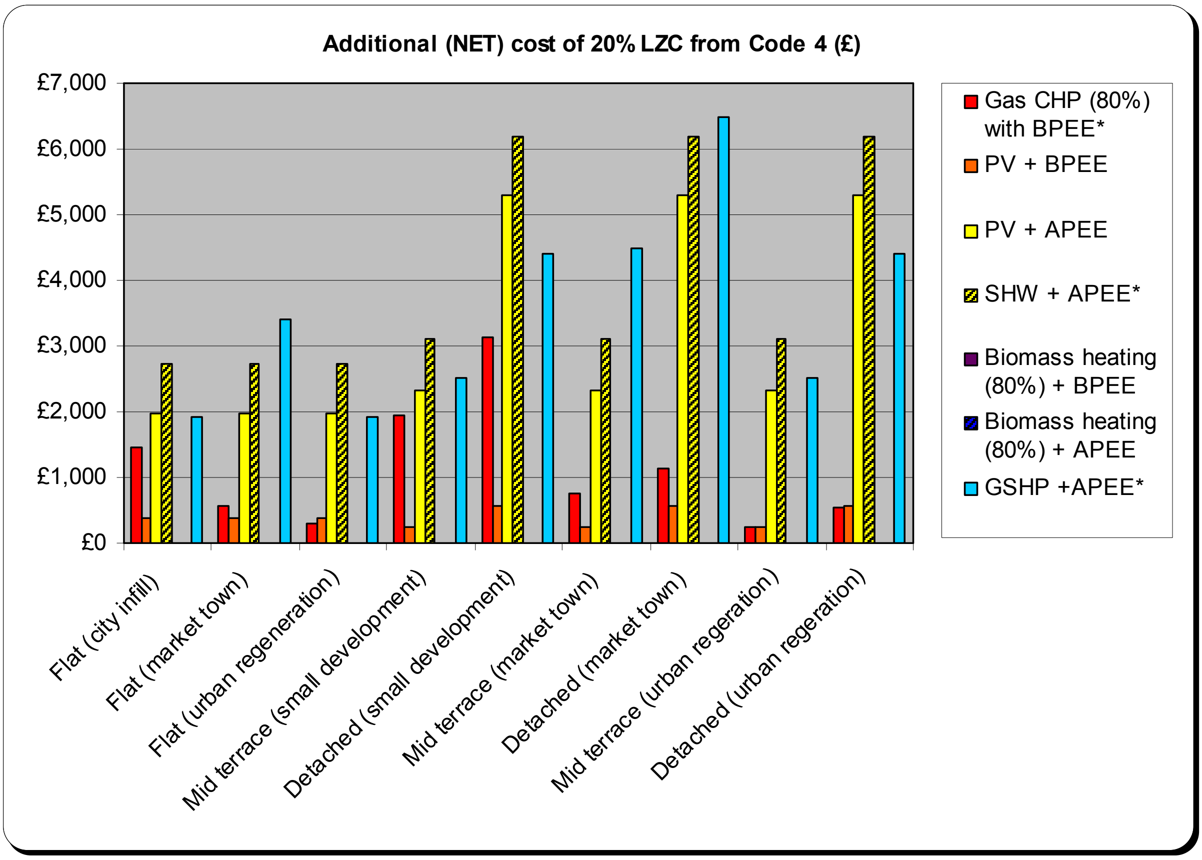


Figure 28 Test 2: all development types (£/dwelling)

Acceleration test 3:

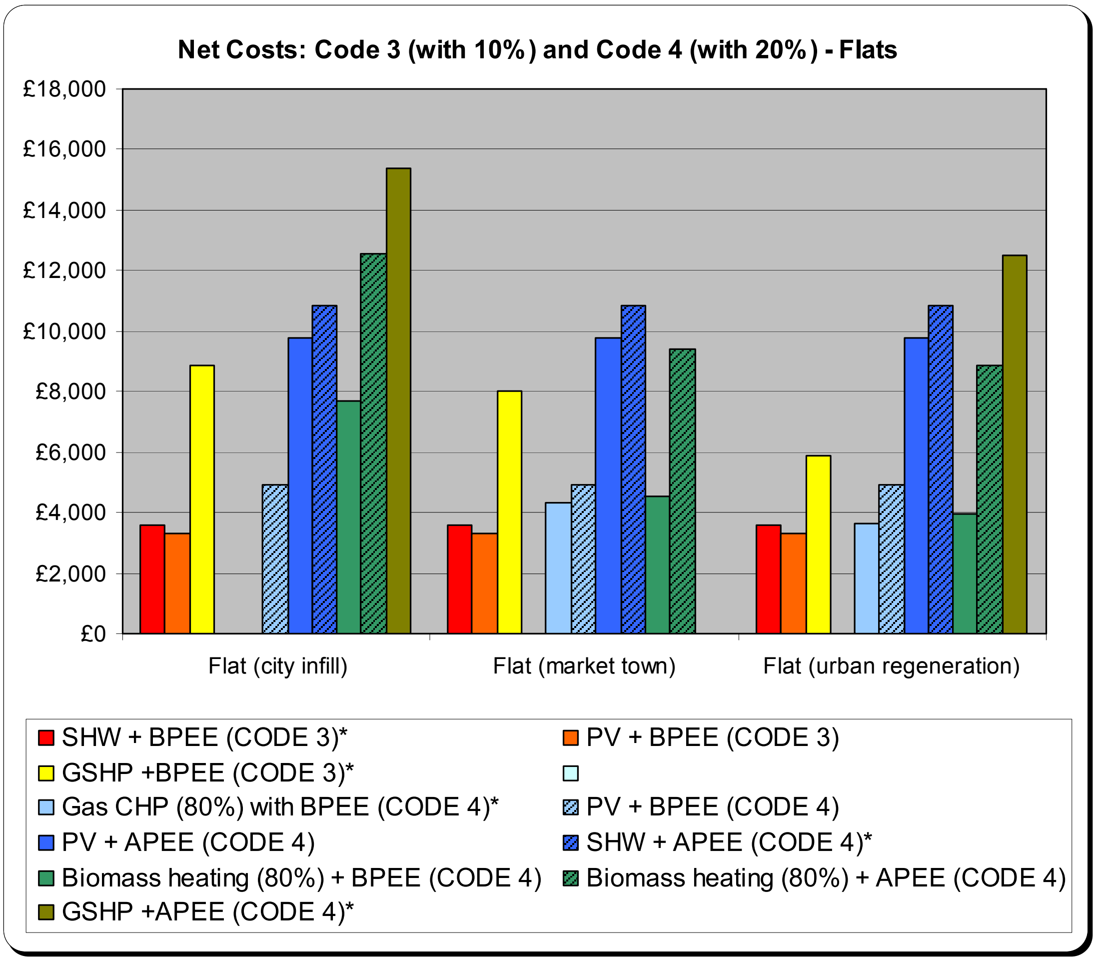
From 25% carbon reduction (against Part L 2006) + 10% LZC target to a 44% carbon reduction + 20% LZC target. NB. These scenarios are referred to below as 'Code 3 + 10%' and 'Code 4 + 20%'.

Figure 29 and Figure 30 show the results of the net costs analysis for this acceleration scenario. Here each graph shows the range of options available for each of the carbon standards (the first standard being represented by the left hand bars in the colours red through to yellow and the second standard being represented by the remaining bars in each development type). Again, since more challenging standards are attempted, a greater number of technical options become available.

In certain circumstances, e.g. GSHP (Code 3 +10%) vs Biomass heating (Code 4 +20%), the higher standard is cheaper. Additional costs for the Code 4 (+20%) standard range from under £4,000 to over £25,000 (GSHP in the small detached development).

To interpret the results it is worth considering the range of differences between the available options. Comparing the minimum cost solutions within each of the carbon standards across the development types we see a range of under £100 to just over £2,000. In terms of the percentage construction costs this equates to less than 0.1% and 2.2%. Comparing the maximum cost solutions within each of the carbon standards we see a range (across the development types) of under £3,000 to just over £12,500, with these top-end figures being heavily skewed by Gas fired CHP and the GSHP solutions. In terms of the percentage increase in construction costs, this equates to 3.6% and 13.3%.

Figure 29 Test 3: flats (£/dwelling)



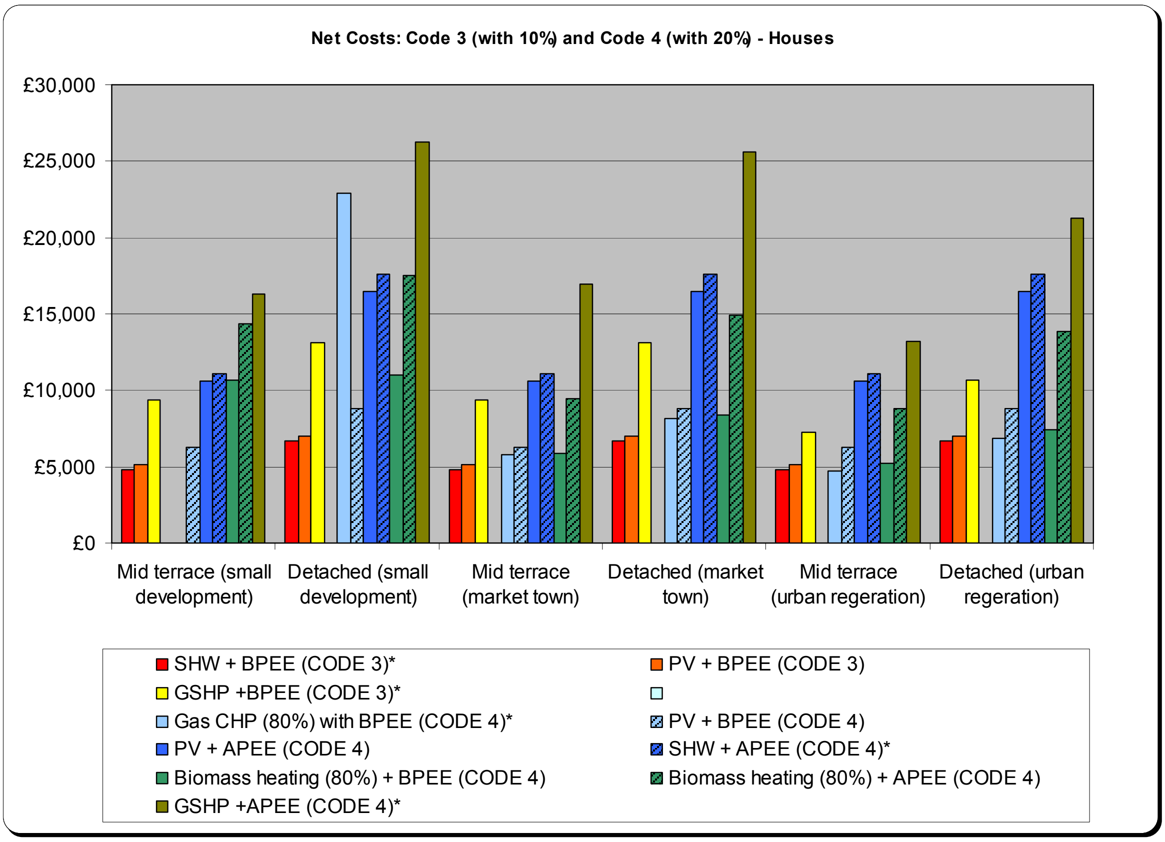


Figure 30 Test 3: houses (£/dwelling)

Acceleration test 4*:*

From 44% carbon reduction (against Part L 2006) + 20% LZC target to a zero carbon target (100% total carbon with 70% on-site carbon compliance). NB. The first scenario is referred to below as 'Code 4 + 20%'.

Figure 31 and Figure 32 show the results of the net costs analysis for this acceleration scenario. Here again, each graph shows the range of options available for each of the carbon standards (the first standard being represented by the left hand bars in the colours red through to brown, and the second standard being represented by the remaining bars to the right in each development type). We see an increasing number of options being available at the higher standard. It is important to recognise that under the zero carbon scenario assumptions the 'carbon compliance' response is capped at 70%, i.e. only 70% of regulated emissions need to be dealt with on-site, with a fixed cost of £100/tCO_2 being applied to the remainder of the total carbon emissions, as an indicative costs for 'allowable solutions'.

It is immediately obvious from the graphs that there is not a significant differential between the Code 4 (+20%) and the zero carbon standard and in some cases cheaper solutions exist for the zero carbon standard. The latter is counter-intuitive but is explained by the fact that in some cases more expensive Code 4 +20% solutions are being compared with lower cost zero carbon solutions, e.g. biomass CHP, with a 70% on-site cap and a relatively low cost 'allowable solutions' response to the remaining carbon.

Comparing the minimum cost solutions within each of the carbon standards we see a range (across the development types) of just under £2,000 to £4,500. In terms of the percentage construction costs the range is 2.7% and 5.0%. Comparing the maximum cost solutions within each of the carbon standards we see a range (across the development types) of minus £2,800 (GSHP + APEE + PV vs Biomass CHP + APEE + PV) to just under minus £1,800, with GSHP (+APEE + PV) significantly skewing these figures. In terms of the percentage construction costs this equates to an approximate range in the difference of -3.0% to +0.5%.

The range of technical solutions together with the marginal net additional costs associated to move from Code 4 (+20%) and zero carbon would suggest the early adoption of the zero carbon standard could be justifiable particularly where developments have access to CHP and/or biomass heating.

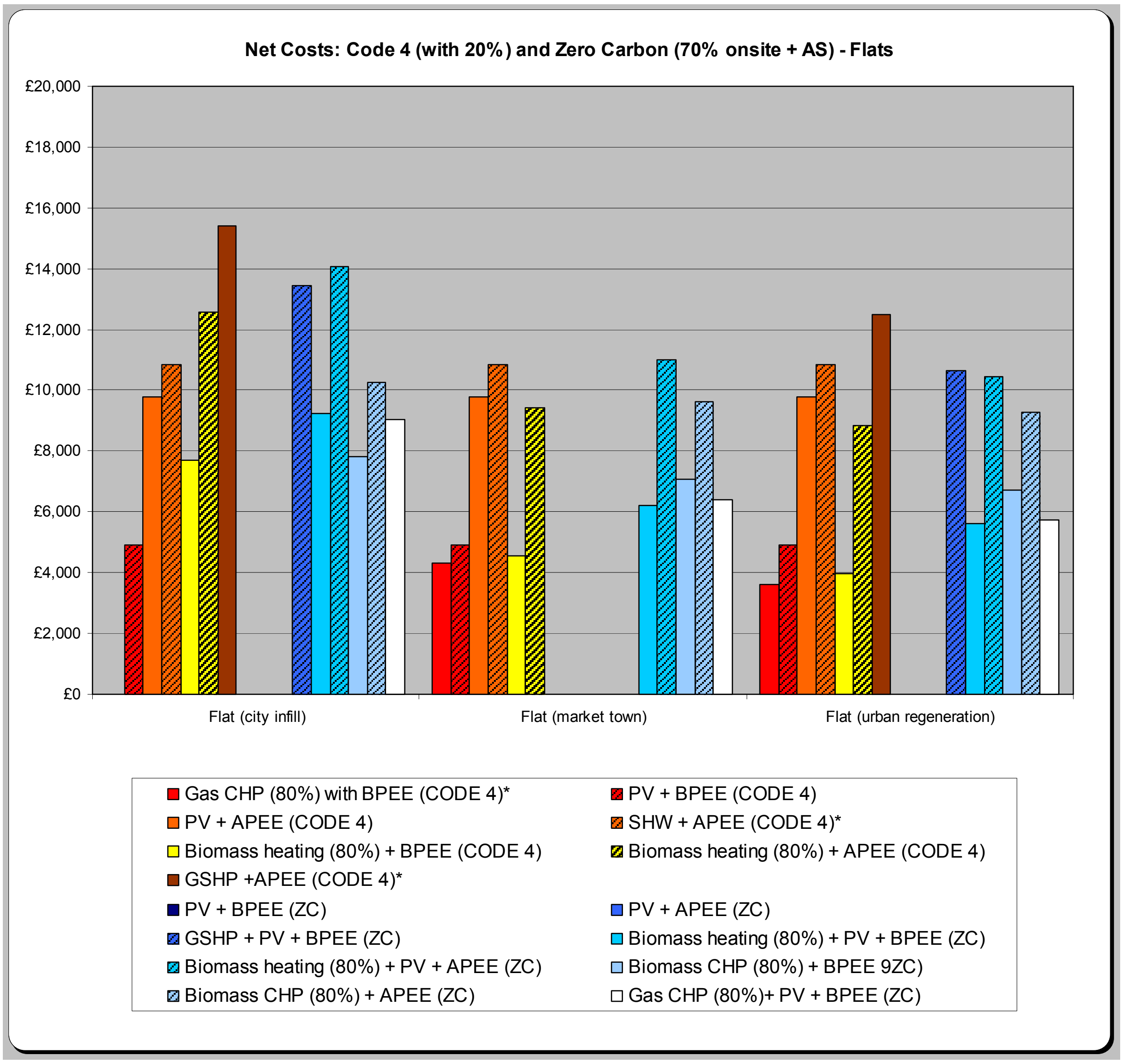


Figure 31 Test 4: flats (£/dwelling)

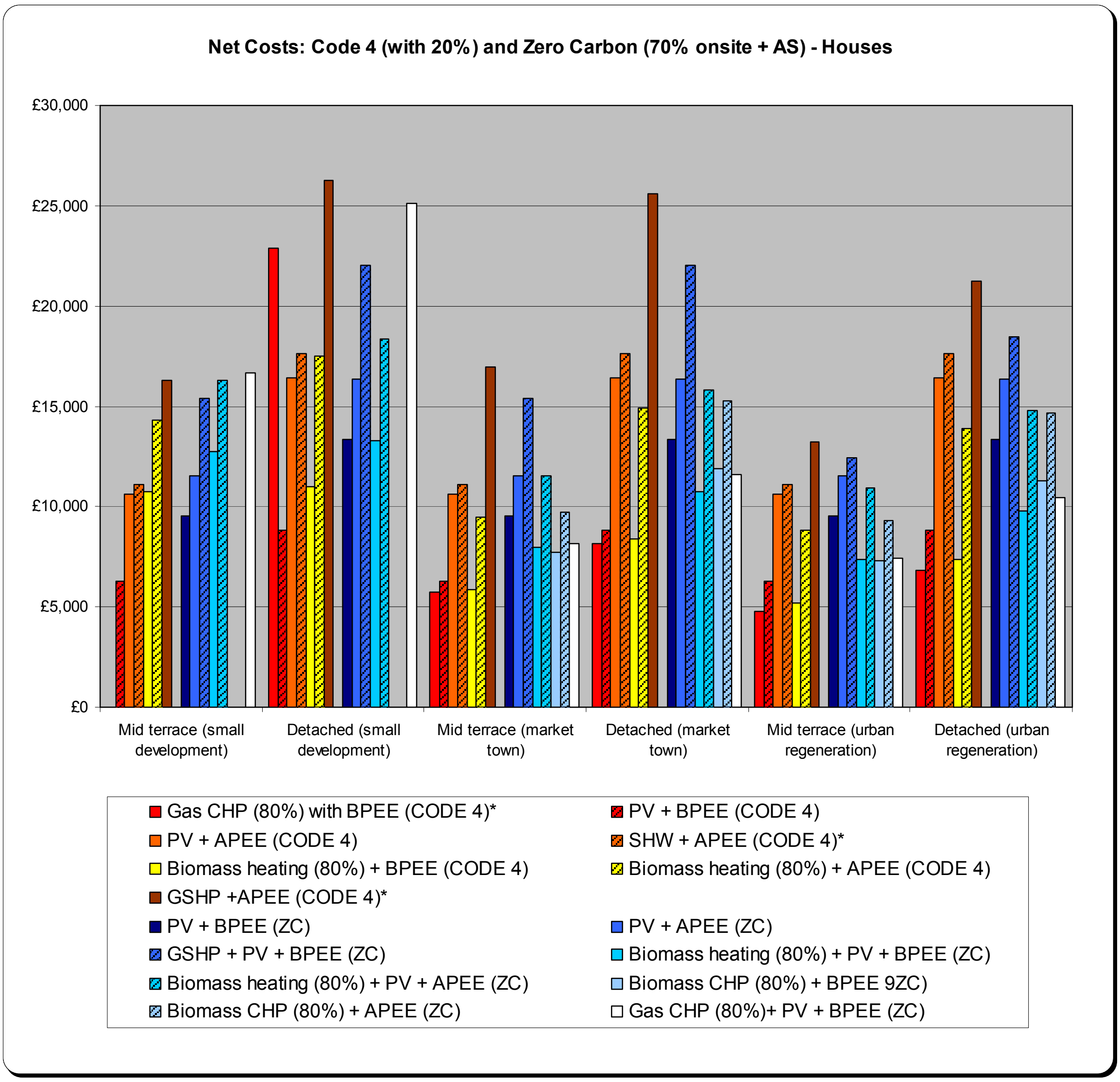


Figure 32 Test 4: houses

8.3 Examining Policy Viability

Viability of the higher carbon standards needs to be considered on a local authority basis to ensure targets are generally deliverable in the local area without conflicting with other key objectives, such as the provision of housing, appropriate proportions of affordable housing and bringing forward economic development sites. At the same time it is imperative to recognise the significant impact of development with respect to carbon emissions and the potential role it has to reduce emissions overall and to create economic demand for low and zero carbon supply markets.

Each of the Planning Authorities needs to satisfy itself that the targets as they are framed are generally viable within the current development markets. They should also review potential market changes to examine whether future market conditions will support higher targets (assuming direction of travel in the development market is positive).

Carbon reduction targets cannot be considered in isolation and viability needs to be considered alongside viability of the development generally against prevailing market conditions, whilst considering additional costs such as including affordable homes, providing

Section 106 contributions and delivering against other sustainability standards such as Lifetime Homes and the Code for Sustainable Homes / BREEAM.

In order to do this, a development viability assessment needs to be conducted, which would take a range of development sites and compare original land values against post-development land values whilst taking account of costs and revenue associated to the development. Existing and planned affordable housing viability assessments by the local authorities could factor in these costs and revenues.

In general terms, to take full account of the carbon reduction standards it will be important to examine the following costs and potential incomes associated to low carbon development:

- Additional costs of energy efficiency measures
- Additional costs of renewable / low carbon supply technologies
- Additional maximum costs of Allowable Solutions
- Potential capitalised revenue from renewable energy tariffs (FIT and RHI)
- Potential capital contribution for an Energy Services Company
- Potential additional sales / rental value

All but the last item is considered in the previous section and each should be included in viability studies.

8.4 Worked examples – site energy strategies

As an exercise in parallel to this main study Camco have conducted a site energy strategy studies on four development sites within the study are. The purpose of this was to:

- Review the potential for energy efficiency and renewable energy for development sites, which were selected as examples that illustrate typical forms of development.
- Test how these example development sites might meet the different carbon standards set out within the recommended targets framework, and consider cost and other implications.
- Highlight the key considerations at the planning stage for compliance against sustainable energy / carbon standards.
- Demonstrate the approach to assessing compliance against carbon standards for new developments. This was achieved through the preparation of Sustainable Energy Strategies (SES) containing the type of information typically required to support planning applications.

The four sites assessed were varied from small rural infill to major mixed used urban regeneration as follows:

- Lower Milehouse Lane, Newcastle-under-Lyme – a development of circa. 210 houses
- Anker Valley, Tamworth – an urban extension of 900 to 1,150 dwellings
- Holt Lane, Kingsley, Staffordshire Moorlands – 8 semi-detached houses in a rural village
- Tipping Street, Stafford – an office and restaurant/retail development in the centre of Stafford.

Full details of the study are available in the Camco Report entitled “Staffordshire development-specific sustainable energy strategies – worked examples” from April 2010.

In summary the findings of this study were as follows:

- The larger developments present a greater range of options for renewable energy, as communal energy systems can be incorporated. Providing a large amount of heat demand from a single source benefits significantly from economies of scale.
- For small developments where communal energy is not feasible, options are limited. For higher carbon targets, which will only be required in line with national policy, photovoltaic panels are often the only option, with estimated capital costs of up to £14,000 per dwelling.
- The Feed-in Tariff (FIT) and proposed Renewable Heat Incentive (RHI) can potentially provide long term revenue for renewable energy installations. By capitalising the benefit of this revenue, we can reduce the net capital cost of the renewable energy, for a more realistic comparison against energy efficiency costs. However, this assumes the developer will be able to claim the revenues, which in some cases might be difficult.
- The study has shown that, in most cases, energy efficiency improvements cost more than renewable energy. Hence the cheapest option is not to improve energy efficiency over the Building Regulations Part L 2006 standard, and to instead install more renewable energy. The benefit from FIT/RHI helps make renewable energy more attractive. It is essential therefore that good standard energy efficiency performance is included within the target framework in order to lock in long term carbon savings arising from efficient buildings.
- For non-domestic developments, options for energy efficiency and renewable energy will vary greatly depending on the design and site constraints. Our analysis of Tipping St has shown biomass heating to be the most suitable option. However, this assumes biomass will be available and that the building is designed for a water-based heating system (rather than air or conditioning or direct radiant heating).
- It is important for developers to consider energy efficiency and renewable energy targets from the earliest stage of development, to ensure designs can accommodate the most suitable sustainable energy solution.
- As an example, Figure 33 shows the net cost implications for Lower Milehouse Lane for the range of carbon standards considered. On the graph BPEE refers to Best Practice Energy Efficiency Standard and APEE refers to the Advanced Practice Energy Efficiency Standard. In essence the site energy strategies from the lowest to highest carbon targets, transition from solar water heating, through to solar PV, through to biomass heating and “allowable solutions” (for zero carbon). The uses of APEE typically presents a much higher (net) cost solution

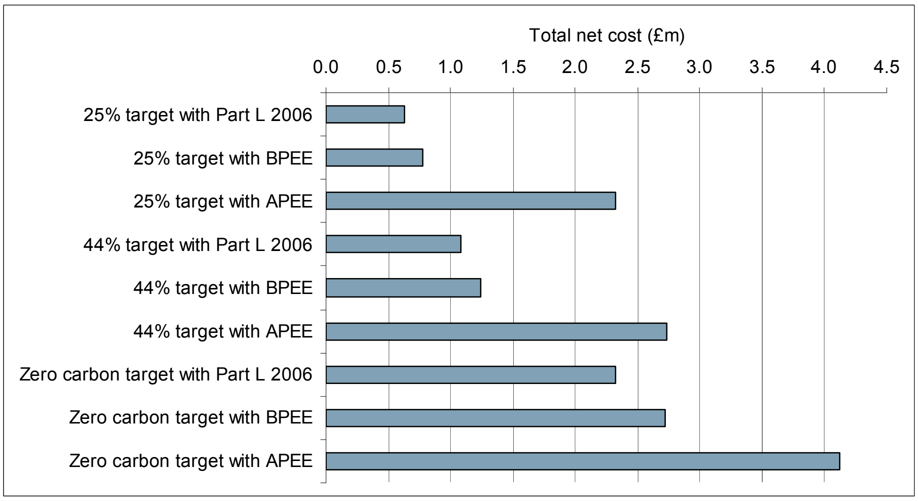


Figure 33 Resulting net cost from worked example site energy strategy for Lower Milehouse Lane.

8.5 Estimating the Low and Zero Carbon energy supply impact of new development

8.5.1 Growth Plans for Study Area

Planned or anticipated residential and non-residential development numbers and characteristics up to 2025/26 have been supplied by the councils as set out in Appendix VIII. The analysis of new build development uses the anticipated build rates from the Regional Spatial Strategy (RSS) to model growth over the plan period, which enables the analysis to apply varying carbon standards over time. RSS projections are superseded by monitored data between 2006/07 and 2008/09, and as a result the overall figures may contain slight discrepancies compared to the forecast RSS. However, since the revocation of the RSS, this is no longer an issue. The housing numbers and residential development types assumptions used in this study are summarised in Table 16 and Table 17 below. Major developments are also highlighted in Table 18 for reference. The analysis of new build development uses the anticipated build rates from the Regional Spatial Strategy to model growth over the plan period, enabling the analysis to apply varying carbon standards over time.

Development type	Cannock Chase	East Staffordshire	Lichfield	Newcastle-under-Lyme
No. of dwellings (2006-26)	6,010	13,022	8,903	6,250
Urban infill	58%	41%	41%	65%
Rural infill	1%	5%	4%	10%
Settlement extension	41%	19%	32%	25%
Urban extension	-	35%	23%	-
Large urban extension / new settlement	-		-	-

Table 16 Housing Growth Numbers and Residential Development Types[65]

Development type	South Staffordshire	Stafford	Staffordshire Moorlands	Tamworth
No. of dwellings (2006-26)	3,507	10,100	5,977	2,925
Urban infill	28%	40%	36%	65%
Rural infill	22%	20%	33%	-
Settlement extension	50%	20%	31%	-
Urban extension	-	20%	-	35%
Large urban extension / new settlement	-	-	-	-

Table 17 Housing Growth Numbers and Residential Development Types[65]

[65] *Definitions of development type are set out in Table 11*

Summary of major developments						
Location	Development type	Residential		Non-residential		Expected construction period
		No. of dwellings	Residential type	Development area (m^2)	Planning class	
East Staffordshire						
(Unspecified)	Residential	4,500	Urban extension			Unspecified
Lichfield						
South Lichfield	Mixed	1,650	Urban extension	Unknown	B1 Business - Offices, research and development, light industry appropriate in a residential area.	After 2019
Streethay	Residential	850	Settlement extension			2016 to 2019
Fradley	Residential	1,000	Settlement extension			2013 to 2016
Stafford						
(Unspecified)	Residential	2,020	Urban extension			
South Staffordshire						
No major sites identified						
Cannock Chase						
Land West of Pye Green Road (potential Core Strategy strategic allocation)	Residential	750	Settlement extension			After 2015
Newcastle-under-Lyme						
No major sites identified						
Staffordshire Moorlands						
No major sites identified						
Tamworth						
Anker Valley	Residential	1,000	Urban extension	Unknown	C3	After 2012

Table 18 Summary of Major Developments

8.5.2 Scenarios

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

Base Case

- Meets the proposed changes to national building regulations including achieving zero carbon through on-site and off-site measures from 2016 for domestic measures and 2019 for non-domestic measures.
- The UK roadmap for residential development construction standards demonstrated in Table 12 is used. The roadmap for non-domestic buildings is not fully resolved so for simplicity it is assumed that non-domestic development will follow that set out for residential buildings improvement in standards (25%, 44% and 100%), except with a three year lag.
- Low and zero carbon energy technologies solutions are applied based upon the solutions against development types (see Table 11).
- Assumes that proposed Building Regulations will be met and not exceeded, with the exception of a 10% reduction from LZC energy generation against total carbon, i.e. regulated and unregulated.

Elevated Case

- All larger development types (Urban extension, Large urban extension / new settlement) are assumed to have at least 20% of total carbon emissions abated by renewables. In practice, these will have a reduced impact as Building Regulation standards beyond the 25% (Code for Sustainable Homes Level 3) an increasingly significant contribution from low and zero carbon technologies is necessary to achieve the core standards. Smaller development types (Settlement extension, Urban Infill and Rural Infill) retain the minimum 10% renewable requirement, again until the Building Regulations are assumed to require a greater contribution.
- For modelling purposes large urban extensions/new settlements and urban extensions (residential & non-residential) are assumed to be zero carbon as of 2013. Half of the dwellings are assumed to be supplied by large wind energy, the other half by biomass CHP plus large wind top-up. All non-residential development is abated by biomass CHP plus large wind top-up.

The analysis of overall renewable energy uptake within new-build development considers a range of the technologies including wind energy, biomass and microgeneration all of which are also considered within the analysis of Decentralised Energy and the Existing Built Environment elements of this study (next section). However, we avoid double counting between these because:

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

9 Existing Buildings – low carbon energy potential

9.1.1 Methodology

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

A recent study commissioned by a range of regional and central government bodies investigated the uptake of microgeneration within Great Britain[66]. This provides scenarios for the energy delivered by renewable sources for Great Britain as a whole, and a number of individual regions. This study presents a range of uptake scenarios and we contend that the scenario that best fits current policy for renewable energy generation is that which considered the implementation of the renewable power and heat tariffs, which have subsequently been announced as government policy. The scenario models uptake of microgeneration based upon technologies receiving 2p/kWh for heat and 40p/kWh for electricity. Support is assumed to run for 10 years at a 3.5% discount rate, with the level of support for future installations being degressed[67]. It is considered that this is the closest match to the current Feed-in Tariff for electricity, and Renewable Heat Incentive for thermal systems.

The study provides overall energy generation for Great Britain. These figures have been scaled down for the local authorities using the number of dwellings as a scaling factor.

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

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

9.1.2 Scenarios

Base case

- The base case is the deployment of two-thirds of the technologies as set out in the Great Britain study and scaled down for the Study Area and each district.

Elevated case potential

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

[66] *Element Energy, 2008, The growth potential for microgeneration in England, Scotland and Wales*
[67] *The annual payment is set for 20 years but the value reduces depending on the year of commencement of the project*

10 Results, benchmarking and targets for energy generation

This section firstly reviews local area benchmarking. It then brings together the various streams of the Low and Zero Carbon supply potential identified for existing capacity, new decentralised generation, new-build development and the new uptake in the existing built environment.

10.1 Local Benchmarking of targets

The UK has established a national target to supply 15% of total energy demand through renewable sources by 2020. This target is applicable to electricity, heat and transport energy sources. The 'lead scenario' for delivering this national target is illustrated in Figure 34.

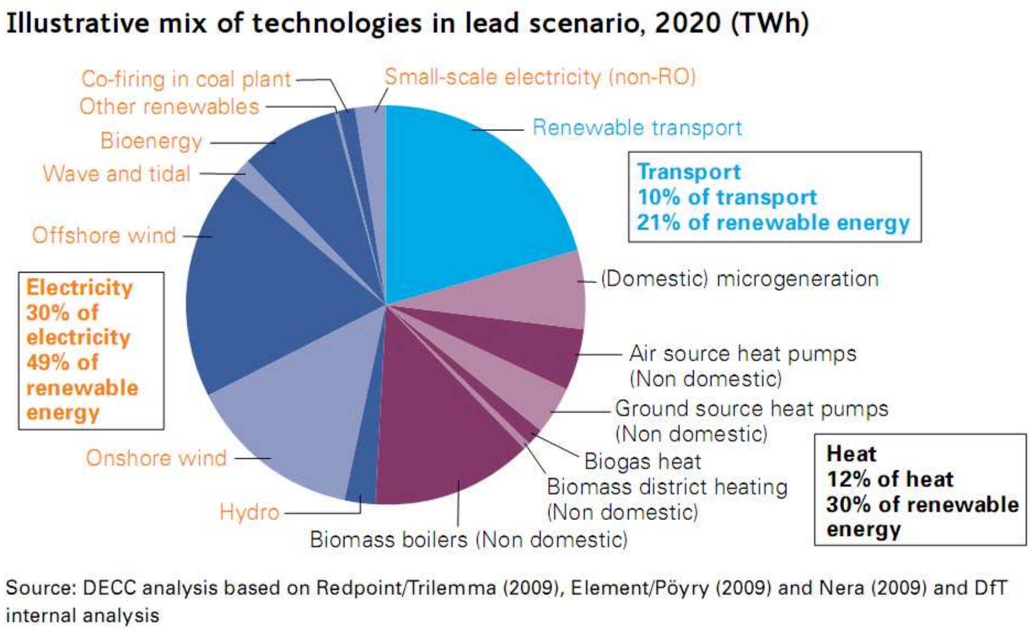


Figure 34 Lead Scenario for meeting 2020 UK renewable energy target

This lead scenario includes a number of elements which, it can be argued, are either not deliverable within the study area or are not influenced at a regional/local level. Table 19 seeks to make these distinctions and justifies the rationale for separating the renewable energy sources into local and non-local categories. When those components that are defined as 'non locally influenced' are excluded from the government's lead scenario, and then compared to the pie chart above, it can be concluded that somewhere between a half to two-thirds, i.e. 7.5% to 10%, of the 15% national target can be influenced 'locally'. This provides a useful benchmark of the overall renewable energy target for heat and power of relevance to the study area.

The 'localised national targets' are shown as a range since the government's lead scenario is open to interpretation as to which components can be influenced at a regional/local level. If non-locally influenced energy sources are ignored, then a local target of 7.5% renewable energy can be derived.

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

Table 19 Analysis of components of the UK 'lead scenario' that can be influenced at a local level

As a high scenario, if all 'non-local' sources are included, aside from transport and offshore wind, then the local target could instead be derived as 10% of the energy demand in 2020/21. It can be concluded that, while the national target for renewable energy generation rests at 15% of demand in 2020/21, it is reasonable to assume that 7.5 – 10% would be the maximum that is deliverable at a local level. This range is used to benchmark and give context to the results of the study presented in the rest of this chapter.

10.2 Results by authority

The following sections provide the summary results table for each authority individually, illustrating scenarios for the growth in LZC energy generation at 2015, 2020 and 2025. Additional graphs in Appendix XVIII split the results by major application definitions, i.e. new build, existing built environment, and the decentralised sources of wind, biomass and hydroelectricity.

10.2.1 Cannock Chase

Cannock Chase can generate over 12% of its energy demand from renewable sources by 2025/26 under the elevated scenario. At this point, the majority of renewable energy generation could be through retrofit to existing buildings, however the role of new buildings is more prominent than for other authorities due to the relatively significant scales of development that is expected: approximately a 14% increase in dwellings and a 42% non-residential floor area. It is notable that the elevated energy standards for new build developments produce only marginally more energy than in the base case where only building regulations are met.

Despite being the second smallest authority in terms of land area, Cannock has a collection of sites which are technically viable to support multiple wind turbines. No data to support analysis of the potential for hydropower was available and so the potential is recorded as zero for Cannock. However, a number of possible development sites are identified in the recent national Environment Agency study, from which site specific data should be made available in future and this should be reviewed to update this assessment. Biomass is Cannock's smallest contributor due to minimal agricultural arisings in the largely urban/semi-urban district. The availability of biomass for decentralised generation declines over time, which results from the modelling assumption that biomass resources are used for 'new build' and 'existing development'. In relative terms, development has a bigger impact on biomass availability than for other authorities.

Overall, the elevated case closely matches the lower of the localised national targets as set out in section 10.1.

Year (financial, beginning)	**2015**		**2020**		**2025**	
Scenario	**Base**	**Elevated**	**Base**	**Elevated**	**Base**	**Elevated**
New build	4.4	5.4	21.7	22.7	45.6	46.6
Existing built environment	6.1	7.9	17.9	23.3	47.0	61.1
Decentralised biomass	21.2	21.2	16.7	16.7	12.6	12.6
Decentralised wind	5.2	10.4	10.4	26.0	20.8	41.6
Decentralised hydro	-	-	-	-	-	-
Total	36.8	44.9	66.7	88.7	126.0	161.9
Proportion of demand	2.7%	3.3%	5.3%	7.1%	9.6%	12.4%
CO_2 abatement ($ktCO_2$)	10.8	13.9	20.5	28.9	38.6	51.5
Per capita CO_2 abatement (tCO_2)	0.11	0.15	0.22	0.31	0.41	0.55

Table 20: Summary of scenario results for Cannock Chase (Energy in GWh unless otherwise stated)

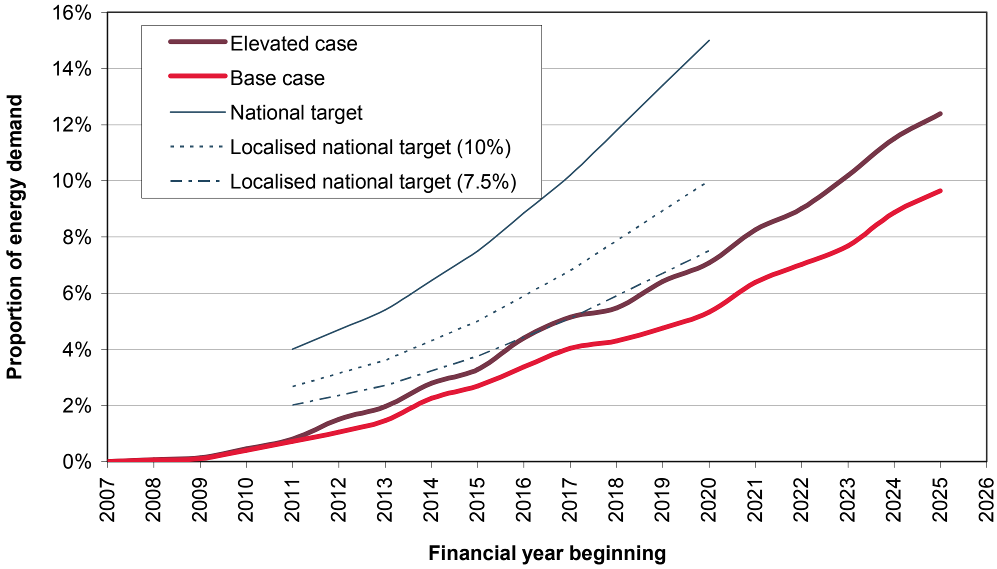
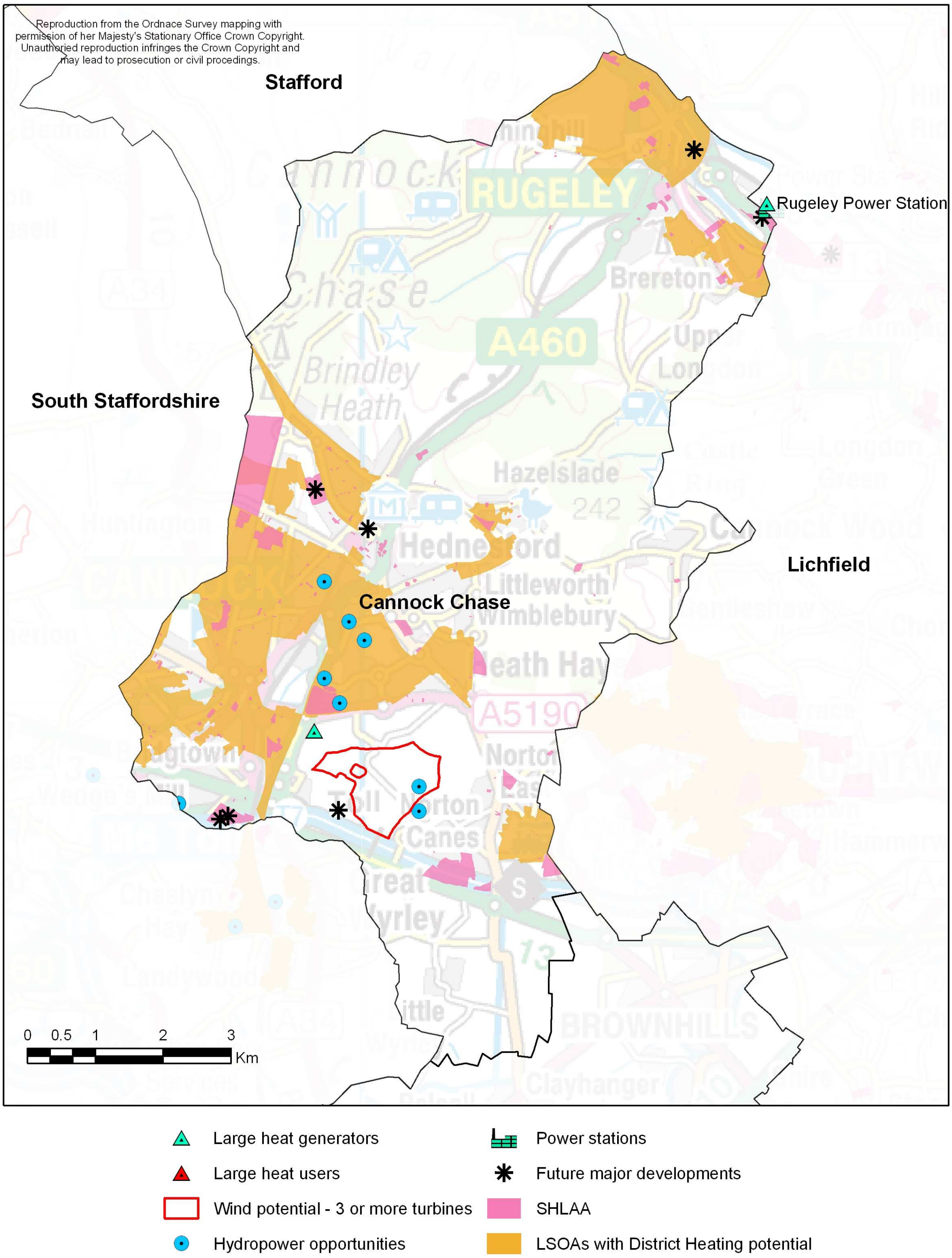


Figure 35: Scenario results set against localised national target for Cannock Chase



Biomass energy sources have not been mapped due to their highly distributed nature.

Figure 36: Energy Opportunity Map for Cannock Chase

10.2.2 East Staffordshire

Under the scenarios tested, East Staffordshire's renewable energy contribution is heavily influenced by wind, mostly due to its highly rural character and hence fewer constraining features such as proximity to buildings and roads. The council is expected to deliver around 13,000 dwellings during the RSS period – the greatest of all partner authorities – therefore East Staffordshire's new build contribution is amongst the largest in the study area. The available data enabled assessment of eleven hydropower sites resulting in the region of the 2.5% to 4% of the generation potential. An additional number of possible development sites are identified in the recent national Environment Agency study, from which site specific data should be made available in future and this should be reviewed to update this assessment.

The base case illustrated in Figure 37 dissects the upper and lower range for the localised national renewable energy target, whereas the elevated case approaches the full national target. This suggests that, under the elevated scenario, East Staffordshire is capable of exceeding the derived localised contributions to renewable energy generation.

Year (financial, beginning)	2015		2020		2025	
Scenario	Base	Elevated	Base	Elevated	Base	Elevated
New build	7.7	9.3	28.7	30.3	72.5	74.1
Existing built environment	7.1	9.3	21.0	27.3	55.1	71.7
Decentralised biomass	46.9	46.9	46.1	46.1	55.9	55.9
Decentralised wind	41.6	83.2	83.2	171.6	130.0	260.1
Decentralised hydro	6.9	6.9	6.9	6.9	6.9	6.9
Total	110.3	155.7	185.9	282.2	320.4	468.6
Proportion of demand	4.8%	6.7%	8.7%	13.2%	14.4%	21%
CO_2 abatement ($ktCO_2$)	38.1	57.5	67.0	107.5	111.3	172.2
Per capita CO_2 abatement (tCO_2)	0.35	0.53	0.62	0.99	1.03	1.59

Table 21: Summary of scenario results for East Staffordshire (Energy in GWh unless otherwise stated)

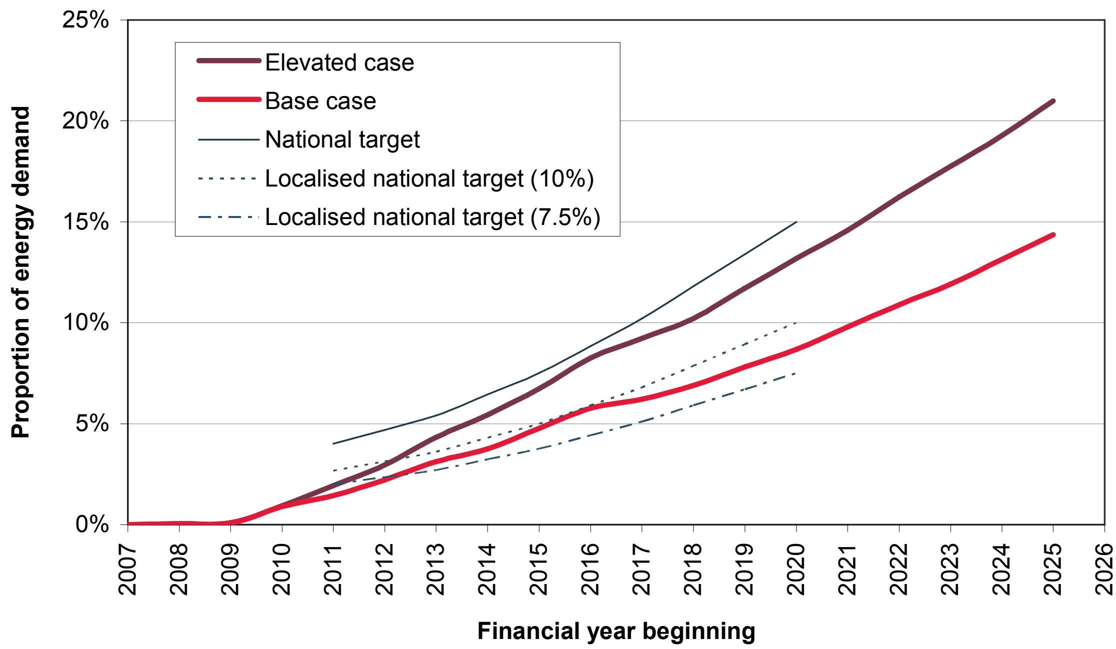
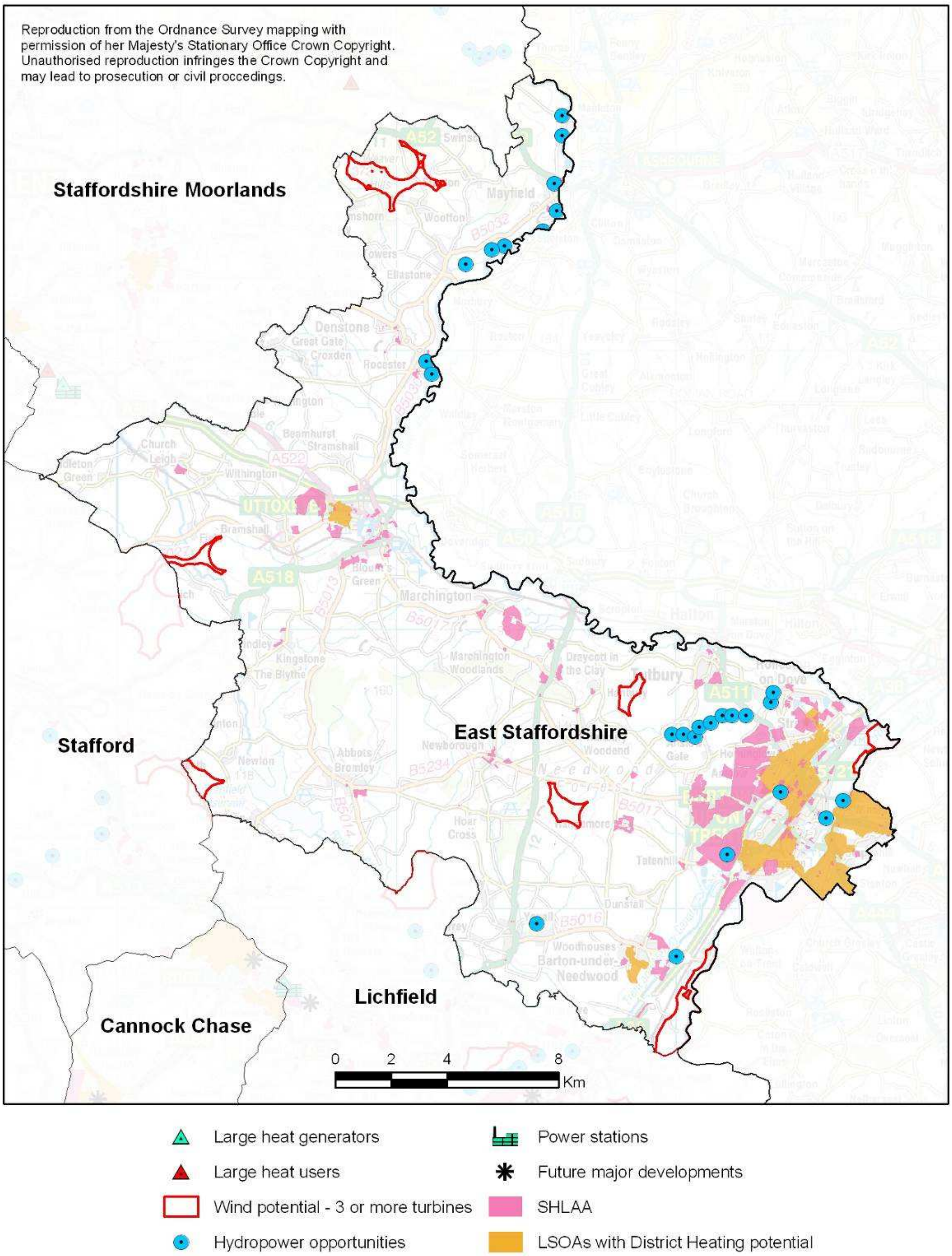


Figure 37: Scenario results set against localised national target for East Staffordshire



Biomass energy sources have not been mapped due to their highly distributed nature.

Figure 38: Energy Opportunity Map for East Staffordshire

10.2.3 Lichfield

For the 2020 reference year the analysis suggests that Lichfield could achieve between 10 and 13% of the energy and is therefore above the upper localised national renewable energy target. Achieving this relies on development of significant wind and biomass energy projects; for example, under the elevated scenario each constitute a third of the overall capacity

New development makes a significant contribution to the overall resource assessment. The scenarios indicate that Lichfield could generate the most renewable energy from new build compared to the other study area authorities, due in the most part to the significant non residential floor area which is forecast. Wind energy and biomass contribute a third of the potential each with the remainder coming from low and zero carbon generation in the built environment.

No data to support analysis of the potential for hydropower was available and so the potential is recorded as zero for Lichfield. However, nine possible development sites are identified in the recent national Environment Agency study, from which site specific data should be made available in future and this should be reviewed to update this assessment.

Year (financial, beginning)	2015		2020		2025	
Scenario	Base	Elevated	Base	Elevated	Base	Elevated
New build	9.5	12.7	37.4	40.6	77.6	80.8
Existing built environment	6.2	8.1	18.3	23.8	48.1	62.5
Decentralised biomass	52.4	52.4	60.3	60.3	95.3	95.3
Decentralised wind	15.6	31.2	31.2	62.4	46.8	93.6
Decentralised hydro	-	-	-	-	-	-
Total	83.7	104.4	147.2	187.1	267.8	332.3
Proportion of demand	5.4%	6.8%	10.3%	13.1%	17.8%	22.1%
CO_2 abatement ($ktCO_2$)	24.4	33.1	45.4	61.7	80.5	105.8
Per capita CO_2 abatement (tCO_2)	0.25	0.34	0.47	0.63	0.83	1.08

Table 22: Summary of scenario results for Lichfield (Energy in GWh unless otherwise stated)

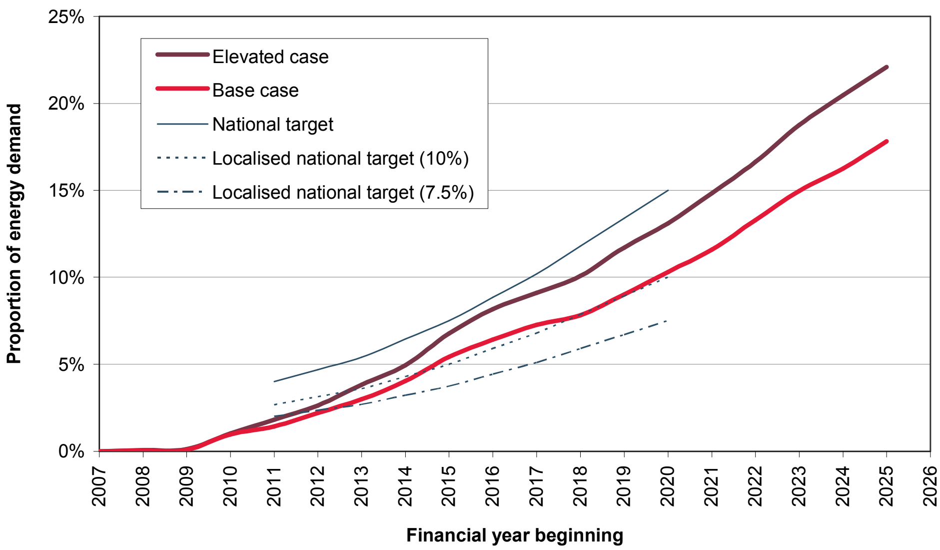
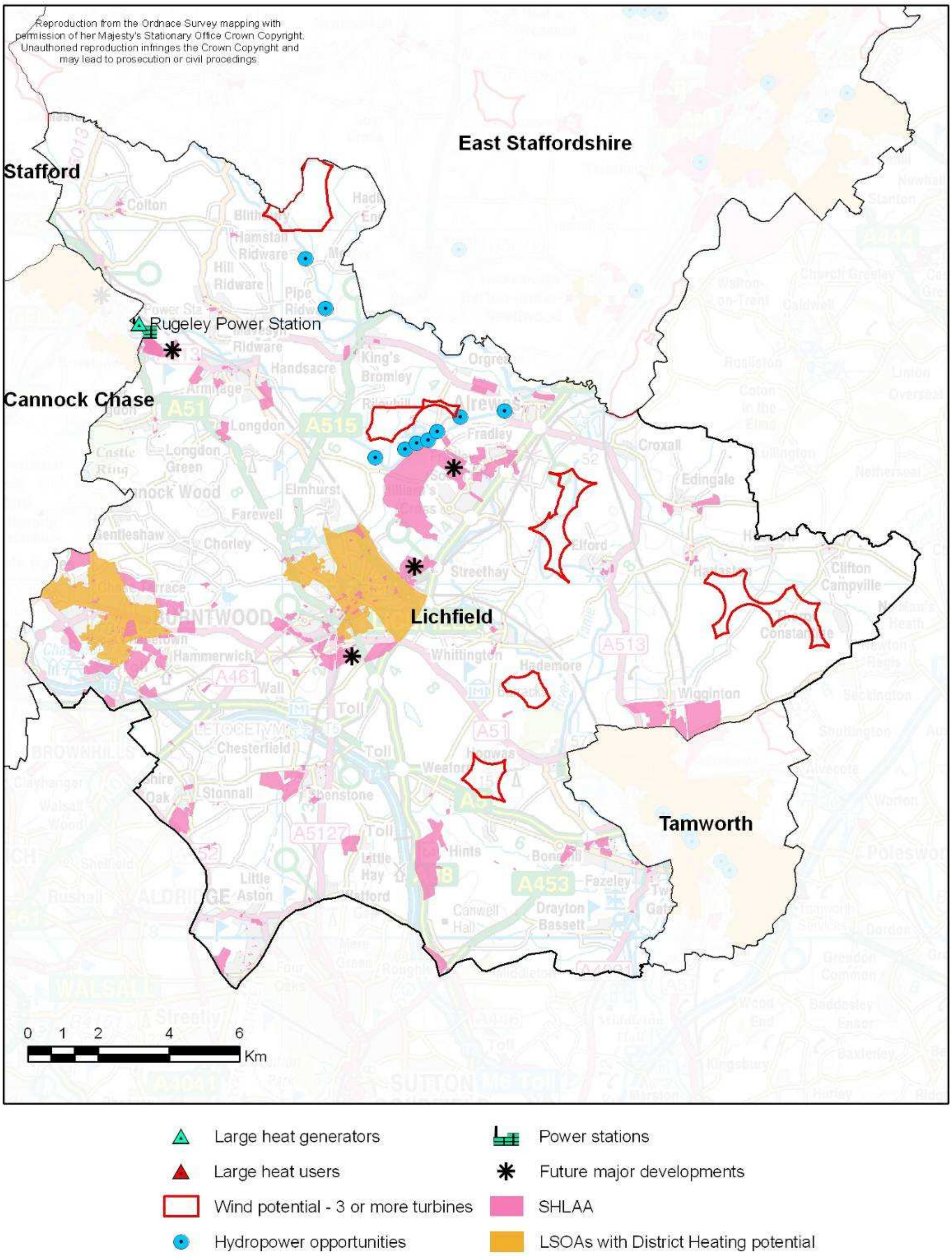


Figure 39: Scenario results set against localised national target for Lichfield



Biomass energy sources have not been mapped due to their highly distributed nature.

Figure 40: Energy Opportunity Map for Lichfield

10.2.4 Newcastle-under-Lyme

The analysis suggest that by the 2020 reference year Newcastle-under-Lyme will struggle to achieve the upper localised national target, even under the elevated scenario. Decentralised wind opportunities are relatively prevalent (circa 50% of resource potential) despite the largely urban nature of the Authority. However, new build contributions are small due to the relatively low development figures forecast for the Authority, along with few large scale sites which may enable elevated CO_2 targets to be more easily prescribed.

Biomass primary energy potential is the second smallest of the study area. Wood waste is the most significant source, however agricultural waste is limited compared to other Authorities.

No data to support analysis of the potential for hydropower was available and so the potential is recorded as zero for Newcastle. However, two possible development sites are identified in the recent national Environment Agency study, from which site specific data should be made available in future and this should be reviewed to update this assessment.

Year (financial, beginning)	2015		2020		2025	
Scenario	Base	Elevated	Base	Elevated	Base	Elevated
New build	4.9	5.7	21.0	21.8	35.1	36.0
Existing built environment	8.4	10.9	24.6	32.0	64.7	84.1
Decentralised biomass	23.2	23.2	21.1	21.1	23.3	23.3
Decentralised wind	15.6	36.4	36.4	78.0	57.2	114.4
Decentralised hydro	-	-	-	-	-	-
Total	52.0	76.2	103.0	152.9	180.4	257.8
Proportion of demand	2.8%	4.2%	6.2%	9.2%	10.5%	15%
CO_2 abatement ($ktCO_2$)	16.4	26.4	33.9	53.9	57.5	87.3
Per capita CO_2 abatement (tCO_2)	0.13	0.21	0.27	0.43	0.46	0.70

Table 23: Summary of scenario results for Newcastle-under-Lyme (Energy in GWh unless otherwise stated)

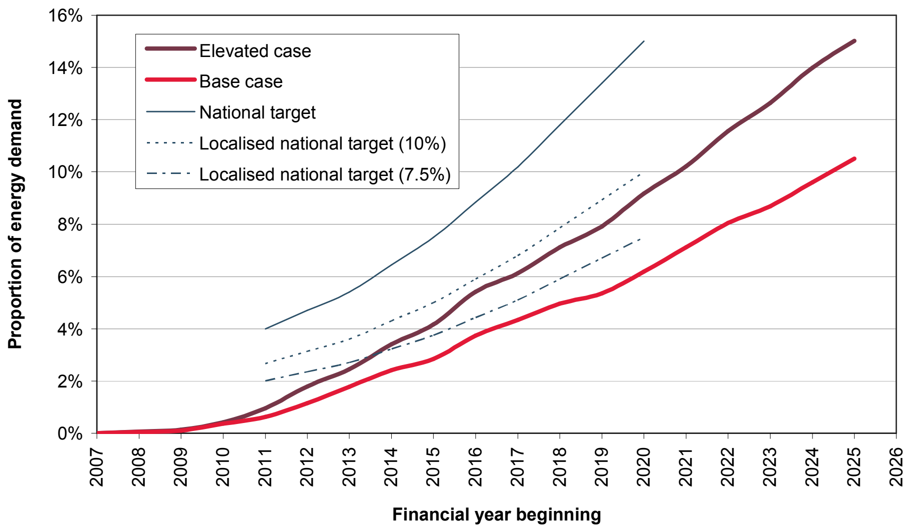
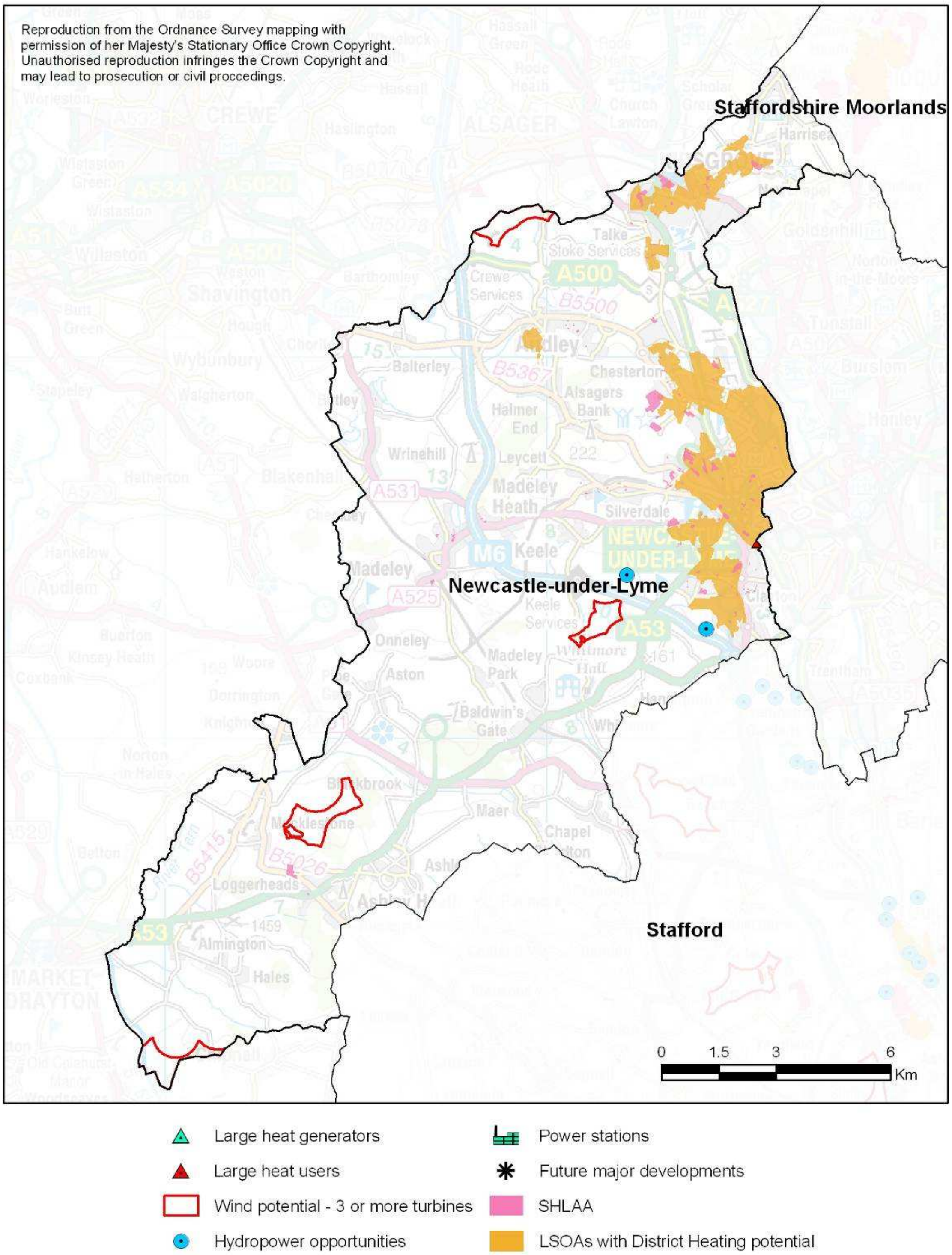


Figure 41: Scenario results set against localised national target for Newcastle-under-Lyme



Biomass energy sources have not been mapped due to their highly distributed nature.

Figure 42: Energy Opportunity Map for Newcastle-under-Lyme

10.2.5 South Staffordshire

For the 2020 reference year the analysis suggests that South Staffordshire could achieve between 9.6% and 12% of energy demand within the council boundary, and is therefore above the upper localised national renewable energy target. Biomass is very significant contributor to the overall potential for the district (50-65% of low and zero carbon energy supply) and as such has a very significant role to play. Wind is the next most significant resource opportunity, delivering 26% of the total potential supply under the elevated scenario in 2020.

No data to support analysis of the potential for hydropower was available and so the potential is recorded as zero for South Staffordshire. However, approximately thirty possible development sites are identified in the recent national Environment Agency study, from which site specific data should be made available in future and this should be reviewed to update this assessment.

Year (financial, beginning)	2015		2020		2025	
Scenario	Base	Elevated	Base	Elevated	Base	Elevated
New build	1.7	2.0	9.8	10.1	13.9	14.2
Existing built environment	6.9	9.0	20.2	26.3	53.2	69.2
Decentralised biomass	63.3	63.3	92.5	92.5	147.4	147.4
Decentralised wind	10.4	20.8	20.8	46.8	31.2	67.6
Decentralised hydro	-	-	-	-	-	-
Total	82.3	95.1	143.3	175.7	245.8	298.4
Proportion of demand	5%	5.8%	9.6%	11.8%	16.1%	19.6%
CO_2 abatement ($ktCO_2$)	24.0	29.1	42.0	54.7	69.2	89.0
Per capita CO_2 abatement (tCO_2)	0.23	0.27	0.39	0.51	0.65	0.84

Table 24: Summary of scenario results for South Staffordshire (Energy in GWh unless otherwise stated)

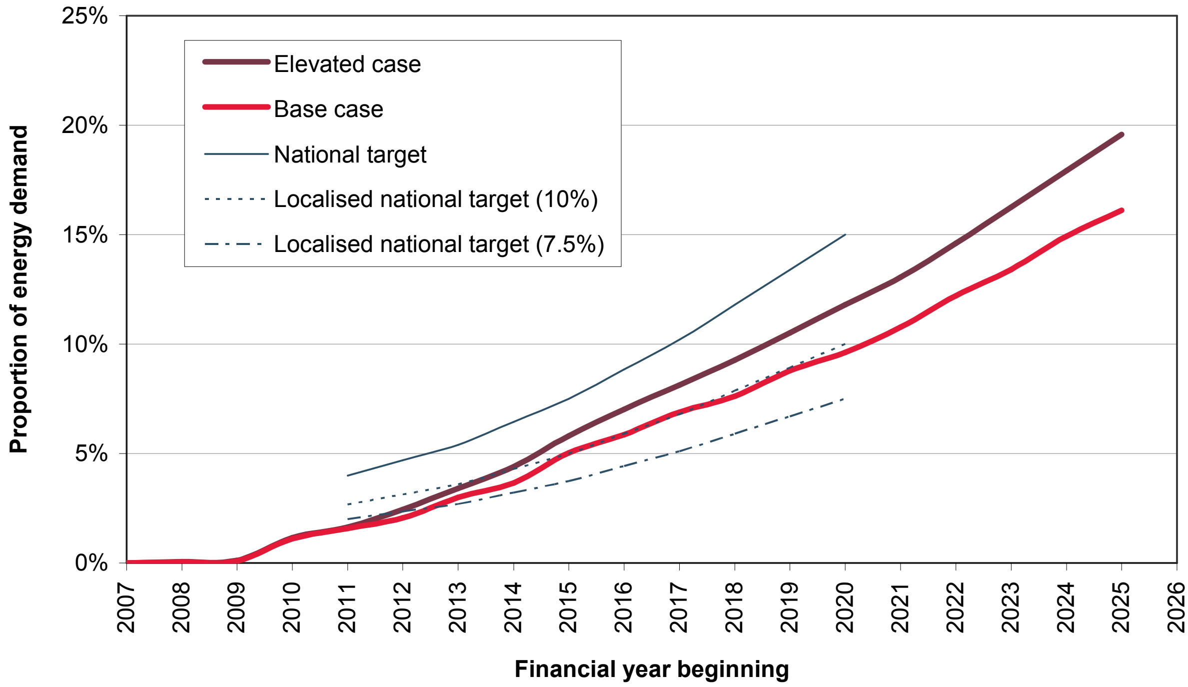
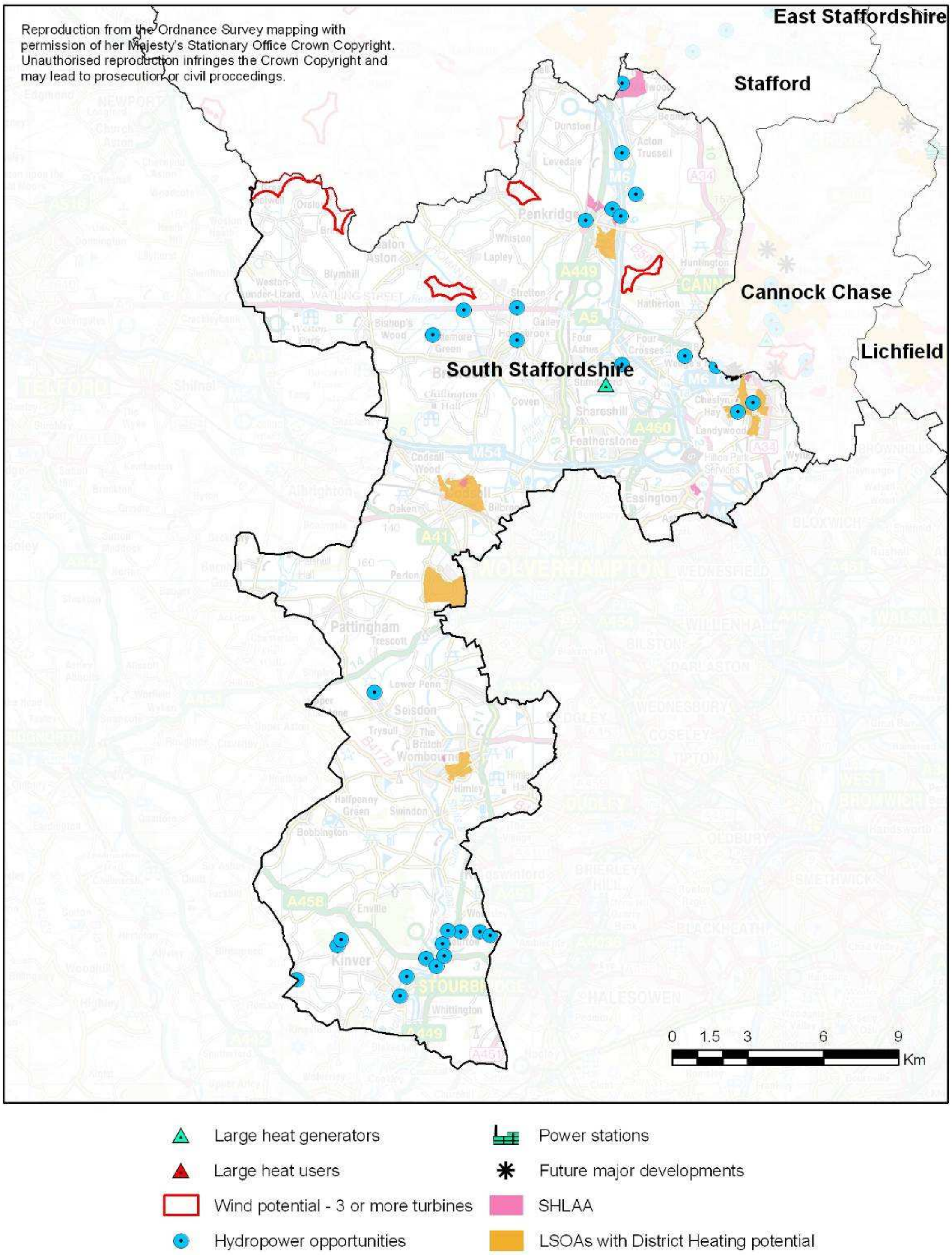


Figure 43: Scenario results set against localised national target for South Staffordshire



Biomass energy sources have not been mapped due to their highly distributed nature.

Figure 44: Energy Opportunity Map for South Staffordshire

10.2.6 Stafford

Stafford's resource potential is very significant and in both scenarios far outstrips the upper and lower benchmark figures.

The resource potential is significantly supported by the potential for wind energy, although it is important to recognise that the analysis undertaken does not take any account of cumulative landscape impact, which is likely to limit the exploitation of the resource. In the elevated scenario by 2020 wind energy could supply 64% of the low and zero carbon supply potential. The elevated scenario for wind energy delivers approximately twice as much renewable energy as in the base scenario.

Biomass is the next most significant resource potential at between 26% and 34% of the total resource identified.

No data to support analysis of the potential for hydropower was available and so the potential is recorded as zero for Stafford. However, approximately thirty possible development sites are identified in the recent national Environment Agency study, from which site specific data should be made available in future and this should be reviewed to update this assessment.

Year (financial, beginning)	2015		2020		2025	
Scenario	Base	Elevated	Base	Elevated	Base	Elevated
New build	7.4	9.2	25.0	26.9	54.6	56.5
Existing built environment	8.3	10.8	24.4	31.7	64.0	83.2
Decentralised biomass	75.6	75.6	96.0	96.0	140.2	140.2
Decentralised wind	67.6	135.2	135.2	270.5	202.8	410.9
Decentralised hydro	-	-	-	-	-	-
Total	158.9	230.9	280.6	425.0	461.7	690.8
Proportion of demand	8%	11.7%	15.4%	23.4%	24.4%	36.5%
CO_2 abatement ($ktCO_2$)	53.9	84.5	99.0	159.8	157.1	252.2
Per capita CO_2 abatement (tCO_2)	0.43	0.68	0.80	1.29	1.27	2.03

Table 25: Summary of scenario results for Stafford (Energy in GWh unless otherwise stated)

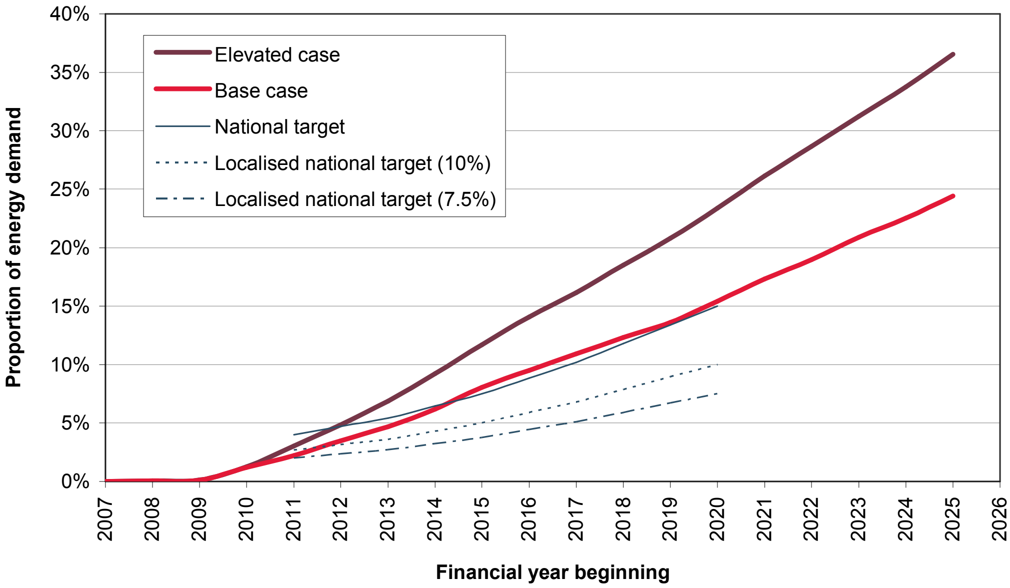
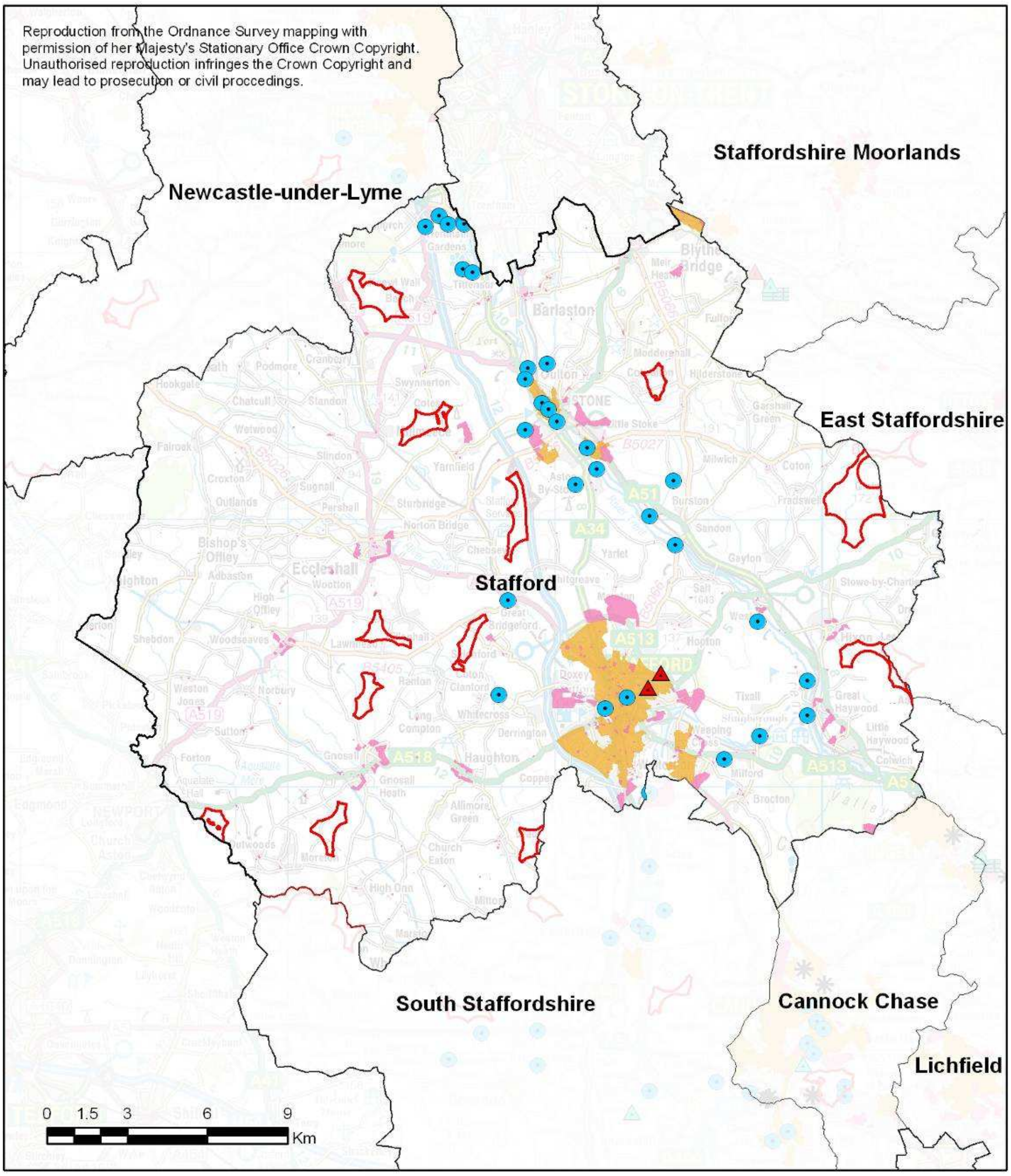


Figure 45: Scenario results set against localised national target for Stafford



Biomass energy sources have not been mapped due to their highly distributed nature.

Figure 46: Energy Opportunity Map for Stafford

10.2.7 Staffordshire Moorlands

The renewable energy resource potential for Staffordshire Moorlands is limited which is somewhat surprising since it covers a large area with significant rural elements. Overall for the 2020 reference year the resource potential lies between 3.6% and 4.1%. Biomass is the most important contributor at 45-50% of the total identified resource. Wind energy is restricted due to the existence of two large area of land designated as Special Areas of Conservation and the restriction of proximity to housing. Also since planned development is limited in number and generally to smaller sites then the potentially for low and zero carbon energy supply in the built environment is also limited. The available data enabled assessment of five hydropower sites but these are relatively small and only result in just over 1% of the resource potential. In total sixteen possible development sites are identified in the recent national Environment Agency study, from which site specific data should be made available in future and this should be reviewed to update this assessment.

Year (financial, beginning)	2015		2020		2025	
Scenario	Base	Elevated	Base	Elevated	Base	Elevated
New build	3.8	4.4	14.9	15.5	26.7	27.4
Existing built environment	6.5	8.5	19.2	24.9	50.4	65.5
Decentralised biomass	35.2	35.2	41.0	41.0	42.5	42.5
Decentralised wind	-	5.2	5.2	10.4	10.4	20.8
Decentralised hydro	1.2	1.2	1.2	1.2	1.2	1.2
Total	46.7	54.5	81.5	93.0	131.2	157.3
Proportion of demand	1.9%	2.2%	3.6%	4.1%	5.7%	6.8%
CO_2 abatement ($ktCO_2$)	14.2	17.2	25.5	29.4	39.0	47.4
Per capita CO_2 abatement (tCO_2)	0.15	0.18	0.27	0.31	0.41	0.50

Table 26: Summary of scenario results for Staffordshire Moorlands (Energy in GWh unless otherwise stated)

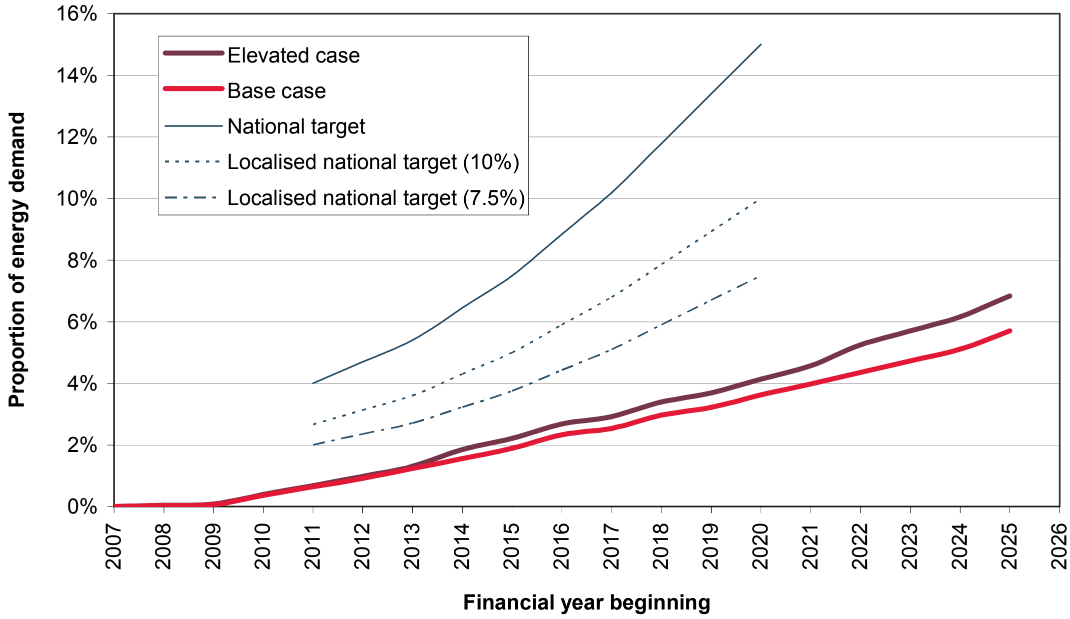
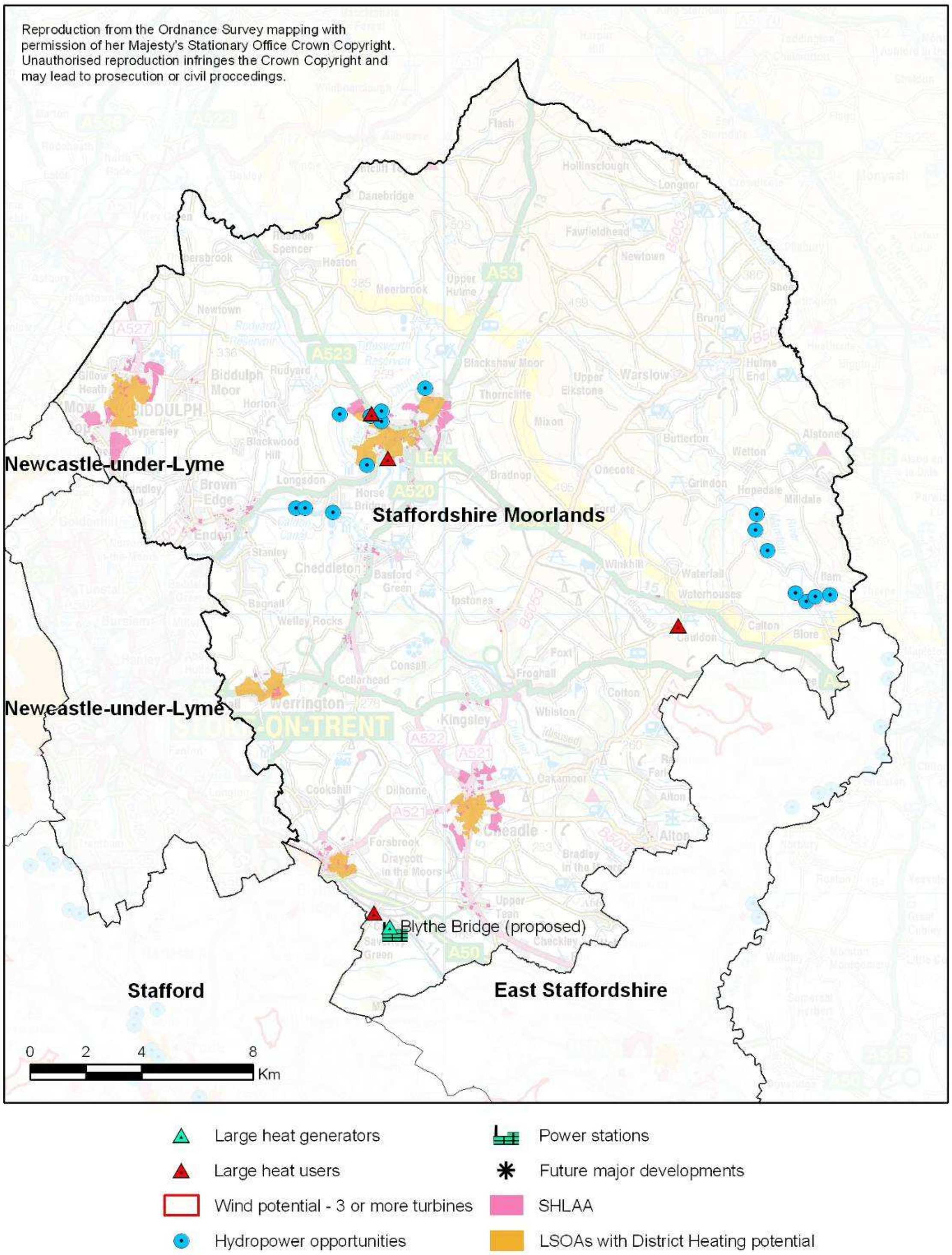


Figure 47: Scenario results set against localised national target for Staffordshire Moorlands



Biomass energy sources have not been mapped due to their highly distributed nature.

Figure 48: Energy Opportunity Map for Staffordshire Moorlands

10.2.8 Tamworth

Overall, neither the base nor elevated cases of resource capacity for Tamworth enable the authority to meet the lower benchmark figure in 2020. When comparing energy generation to the other study area authorities, the analysis suggests that Tamworth has limited resource potential.

Tamworth provides the smallest number of forecast dwellings within the study area (just under 3,000), although their expected non residential floor area is more in line with partner authorities. Hence, compared to the contributions of each study area authorities' new build, Tamworth provides the second lowest after Staffordshire Moorlands.

Year (financial, beginning)	2015		2020		2025	
Scenario	Base	Elevated	Base	Elevated	Base	Elevated
New build	3.4	4.4	10.9	12.0	20.8	21.9
Existing built environment	4.8	6.2	14.0	18.2	36.9	48.0
Decentralised biomass	12.7	12.7	16.9	16.9	12.9	12.9
Decentralised wind	-	5.2	5.2	15.6	10.4	20.8
Decentralised hydro	1.2	1.2	1.2	1.2	1.2	1.2
Total	22.0	29.8	48.2	63.9	82.2	104.8
Proportion of demand	2.3%	3%	5.3%	7%	8.7%	11%
CO_2 abatement ($ktCO_2$)	6.3	9.4	14.6	20.6	25.2	32.9
Per capita CO_2 abatement (tCO_2)	0.08	0.12	0.19	0.27	0.33	0.44

Table 27: Summary of scenario results for Tamworth (Energy in GWh unless otherwise stated)

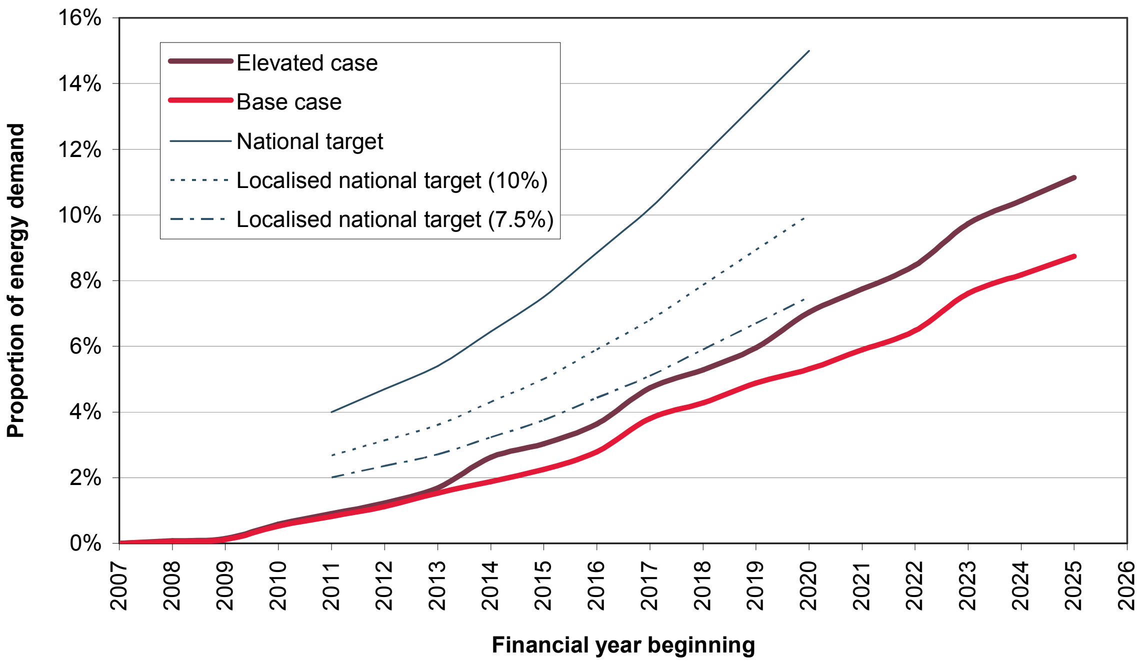


Figure 49: Scenario results set against localised national target for Tamworth

Under the elevated case, the existing built environment provides the largest quantity of renewable energy generation in 2020/21. Biomass is a major resource within the authority. As a largely urban landscape, the relative quantities of municipal and commercial waste provide a good source of biomass feed stock. However, the same characteristics mean that the potential for wind in the 2020/21 base case is considerably less significant than new build and biomass. A single potential hydro installation has been identified at Smurfit Paper Mill, which would contribute to less than 2% of the resource potential. In total six possible development sites are identified in the recent national Environment Agency study, from which site specific data should be made available in future and this should be reviewed to update this assessment.

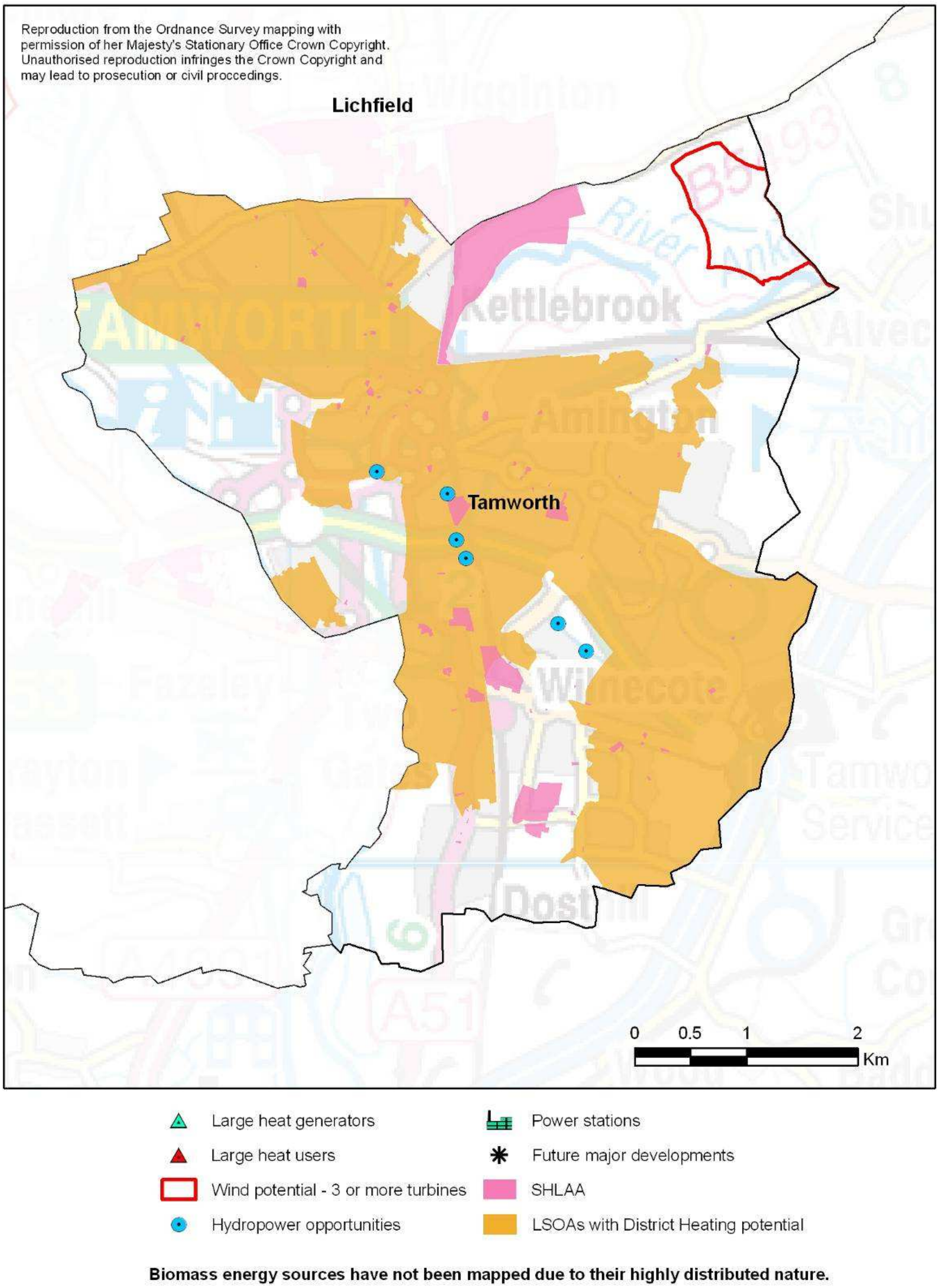


Figure 50: Energy Opportunity Map for Tamworth

10.3 Study area results and target setting

The panel recommendations from the Phase Two Revision of the West Midlands Regional Spatial Strategy suggested that local authorities should seek to support closing of the regional 30% 'carbon gap' through policies that will support greater development and use of renewable energy. This can be through establishing planning policies that will support / encourage increased development and also through the setting and monitoring of authority and study area / county level targets.

10.3.1 Results across study area

Figure 51 summarises the total low and zero carbon (LZC) energy generation under the base and elevated case scenarios which were set out in section 7. This graph and the related data in the subsequent tables (Table 28, Table 29 and Table 30) demonstrate that in the year 2020/21, the proportion of an authority's energy demand which could be met by Renewable / Low and Zero Carbon technologies varies significantly within the study area. The results are benchmarked against the 7.5 – 10% contribution of 'local' renewable energy towards the national 15% target, as derived in section 10.1

Referring initially to the base case scenario, it can be concluded that four of the eight authorities could be expected to generate less than 7.5% of energy demand under the modelled scenario. Of the four authorities which exceeded this nominal threshold, two surpassed the upper range of 10%. For the study area as a whole, 8.16% of energy demand could be expected to be generated.

In the elevated case, five of the authorities exceeded the 7.5% benchmark, and four exceeded 10% - both a rise of one upon the base case. 11.34% of the study area's energy was calculated as being supplied by LZC sources.

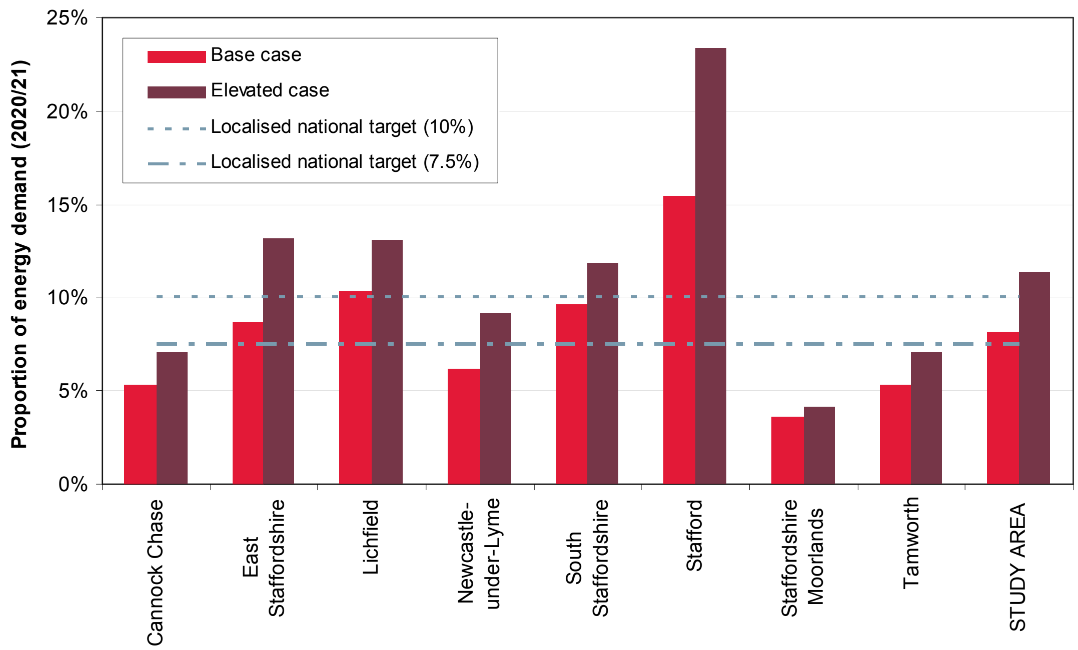


Figure 51 Estimated renewable energy capacity across study area (results for 2020/21)

Table 28 summarises the base case results of potential across all authorities and all technologies. Table 29 summarises the elevated case results across all authorities and all technologies. Table 30 compares the study area potential for base case and elevated case scenarios and summarises the potential CO_2 abatement from renewables by 2021. The elevated case represents a 39% increase in renewable energy compared with the base case.

Benchmarking of Base Case Total Renewable / LZC Energy Generation									
	Cannock Chase	East Staffordshire	Lichfield	Newcastle-under-Lyme	South Staffordshire	Stafford	Staffordshire Moorlands	Tamworth	Study Area Total
Thermal	38	60	83	48	91	101	44	28	494
Electrical	28	126	64	55	52	180	37	20	562
Total	67	186	147	103	143	281	81	48	1,056
% renewables	5.3%	8.7%	10.3%	6.2%	9.6%	15.4%	3.6%	5.3%	8.2%

Table 28 Base Case forecast of total renewable energy generation

Benchmarking of Elevated Case Total Renewable / LZC Energy Generation									
	Cannock Chase	East Staffordshire	Lichfield	Newcastle-under-Lyme	South Staffordshire	Stafford	Staffordshire Moorlands	Tamworth	Study Area Total
Thermal	43	64	87	55	97	107	49	32	535
Electrical	46	218	100	98	79	318	44	32	934
Total	89	282	187	153	176	425	93	64	1,468
% renewables	7.1%	13.2%	13.1%	9.2%	11.8%	23.4%	4.1%	7%	11.3%

Table 29 Elevated Case forecast of total renewable energy generation

Comparison of base case and elevated case potential – study area totals 2021						
	GWh Renewable Energy	renewable heat	renewable electricity	renewable heat and electricity	Annual CO_2 reduction ($ktCO_2/yr$)	CO_2 reduction on 2007 baseline
Base Case	1,056	5%	14%	8%	348	5%
Elevated Case	1,468	6%	24%	11%	517	7%

Table 30 Comparison of base case and elevated case potential – study area totals

As a consequence of the results above it is recommended that each authority considers establishing authority-wide renewable energy targets. Targets could also be set on a study area / county basis.

Some authorities have a far greater potential available to them and this particularly relates to those that are less populated and more rural. Table 31 illustrate the percentage contribution that the each authorities makes to the aggregated resource potential for the study area. From this we see that 50% (elevated case) of the study area resource potential is delivered from East Staffordshire and Stafford. Thereater the next most significant contributions come from Lichfield, South Staffordshire and the Newcastle-Under-Lyme. It is clearly important to consider authority targets in the context of the study area / county, with the expectation that the some authorities should achieve targets greater than others. In other words, authority level targets (and subsequent policy) should be guided by the strategy to maximise the implementation of low carbon energy resources across the county. Moreover, it is contended that those authorities with apparently limited potential should establish ambitious targets (relative to potential) to ensure they are making a effective contribution to the overall target.

Proportion of Study Area Renewable Energy potential from each Authority (2021)		
	Base Case	**Elevated Case**
Cannock Chase	6.3%	6.0%
East Staffordshire	17.6%	19.2%
Lichfield	13.9%	12.7%
Newcastle-Under-Lyme	9.8%	10.4%
South Staffordshire	13.6%	12.0%
Stafford	26.6%	28.9%
Staffordshire Moorlands	7.7%	6.3%
Tamworth	4.6%	4.4%

Table 31 Authority contributions to study area resource potential

With respect to individual authorities the analysis results suggest that East Staffordshire, Lichfield and Stafford have the potential to exceed the upper level of the 'localised national target' target of 10%, when considering the Elevated Case scenarios. South Staffordshire can be added to this group to achieve the lower range of the 'localised national target' of 7.5% based upon the Base Case scenario, but all other authorities would fail to do so. It should be noted that the results for most authorities are significantly influenced by the wind energy potential and the assumptions made within this part of the analysis.

The potential for Stafford far exceeds the other authorities and this is due to the concentration of both biomass and wind energy resources available. Wind energy, for example, makes up approximately 45% of the estimated resource for 2020.

It is recommended that each authority establishes renewable energy targets with reference to the analysis of potential completed. In order for Staffordshire Moorlands, Tamworth, Newcastle, and Cannock to attempt to hit the localised national benchmarks (see Figure 51) it is necessary for each to establish targets, policies and support measures aimed at delivering the Elevated Case scenarios. For the other authorities, achieving targets at some level between the Base Case and Elevated scenarios, achieving the 7.5% targets as a minimum, would be reasonable. Achieving the Base Case potential in each district would enable the lower level benchmark to be achieved at the county level, but only by a small margin. It is important therefore that district targets are established in the context of the results achieved at a county level with some authorities going beyond Base Case potential to provide headroom above the lower benchmark at study area / county level and to aspire towards the upper benchmark.

In developing such targets existing renewable / low carbon generation, as identified in section 5 should be accounted for as should renewable energy projects excluded from the "localisation" of the national targets are discussed in Section 10.1, as they would otherwise distort locally driven performance. This notably includes co-firing of renewable fuels in power stations and transport fuels.

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

10.4 Energy opportunity mapping

The results above quantify and benchmark the potential for low carbon energy sources across the study area. In addition, it is important to understand, spatially, where this resource/potential resides. The Energy Opportunity Map in Figure 52 attempts to do this. It is not possible to map all resources, for example, microgeneration technologies can be developed across most locations within the existing built environment and only certain biomass resource are geographically defined. However, those that can be geo-referenced have been included within the map. It is worth noting that the hydropower sites identified in the map come from a recent Environment Agency report. However, the report does not include site specific data and so it has not been possible to include evaluation of hydropower resources, which instead is based upon other data sources.

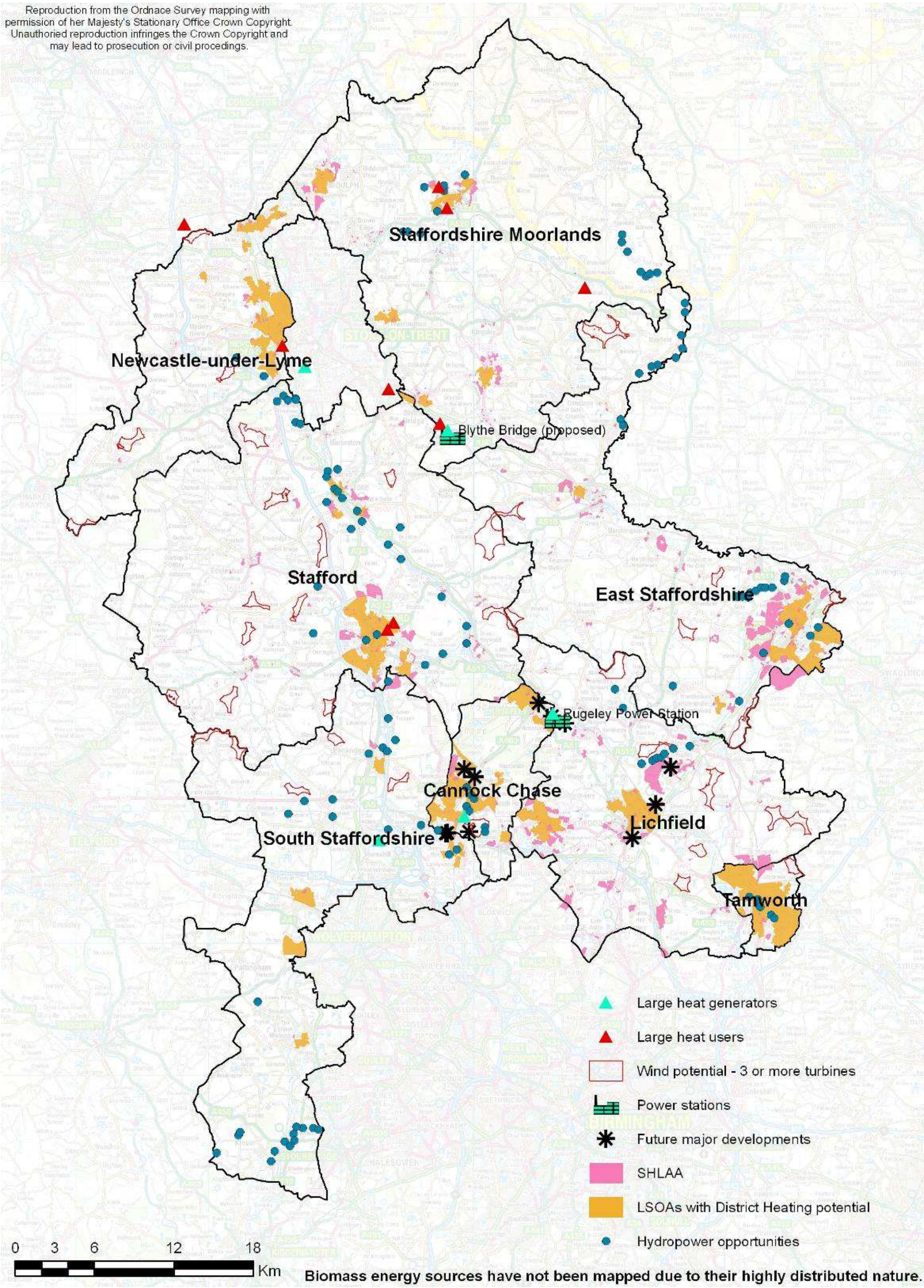


Figure 52. Study area Energy Opportunities Map

11 Recommendations for Local Development Framework Policies

11.1 New development

For new build development, it is proposed that the Authorities establish the target framework presented in and discussed in further detail from Section 8.2.4.

The development target framework only considers residential development. Since a zero carbon roadmap for non-domestic buildings does not exist, it is impossible to review opportunities for acceleration. However, ahead of the conclusion of the on-going national policy review in the area, it is recommended that 10% and 20% renewable / low carbon energy generation targets are established from 2010 and 2013 respectively, to be applied to regulated and unregulated emissions for all development types over 1,000m^2. It is proposed that unregulated emissions are calculated as a fixed 20% of regulated emissions to ensure simplicity in applying the policy (see Section 8.2.2 for further information relating to variability of unregulated emissions in non-domestic buildings).

Table 32: Proposed carbon reduction framework for new domestic development

Period	Domestic Reductions			Resulting range in carbon reduction (Regulated emission equivalent)
	Regulated (vs Part L 2006)	Minimum Proportion of Low and Zero Carbon energy generation* (against total carbon**)	Un-regulated	
2010-13				
Minimum***	25%	10%	0%	25 - 42%
Maximum$^{\chi}$	44%	20%	0%	44 -78%$^{\chi\chi}$
2013-16				
Minimum***	44%	20%	0%	44 -78%$^{\chi\chi}$
Maximum$^{\chi}$	100% (min. 70% Carbon compliance / 30% AS)	Obsolete at this carbon standard	100% (Additional Carbon Compliance or AS)	100 – 150%
2016-19				
Minimum***				
Maximum$^{\chi}$				
Post 2019		**Zero Carbon**		

*Depending on the technical solutions this may not result in additional carbon savings.

** total carbon = 100% regulated plus 100% unregulated emissions

***To be applied to all housing developments including sub 10 developments to ensure consistency with Code for Sustainable Homes

$^{\chi}$ where lower cost solutions are available because of technical opportunities, e.g. community heating, biomass heating / CHP, large wind energy, surplus heat or scale of the development

$^{\chi\chi}$ unlikely to result in this maximum level of savings since the 44% regulated emissions reduction target will typically require a significant element of renewable energy.

The framework establishes standards in terms of carbon reduction to be consistent with the Code for Sustainable Homes. As such it does not set specific standards for energy efficiency. This then leaves developers to decide on the appropriate mix of energy efficiency and low carbon energy supply (and allowable solutions when the target is zero carbon). With Building Regulations already demanding high levels of energy fabric performance, energy efficiency will already form the cornerstone of most low carbon solutions. Even more advanced levels of energy efficiency will generally deliver diminishing returns per pound spent and renewable energy technologies start to become a lower capital cost solution to meeting advanced carbon standards. Furthermore, financial incentives such as the Feed-in Tariff and potential Renewable Heat Incentive may in future present an additional disincentive for advanced energy efficiency. Therefore compliance against the framework should be monitored over time, such that Authorities collate evidence to support the adoption of minimum energy efficiency standards where necessary.

The net additional costs (accounting for future energy revenues) and overall viability of the carbon targets, where they exceed the anticipated national standards, is discussed from Section 8.2.4. In addition, a study of four example sites has been completed as worked examples to illustrate how the target framework standards could be met, and the cost implications that this may present. See Camco report entitled "Staffordshire development-specific sustainable energy strategies – worked examples" from August 2010. This provides evidence of the viability of the carbon framework. The framework will be tested over time as developments go through the planning process, however, we do also recommend that authorities conduct further financial analysis to assess viability of the carbon targets when combined with other planning obligations, e.g. affordable homes. It should also be recognised that the use of a variable framework is proposed to for developers and planners to settle on appropriate targets for each development, which is intended to account for variable economic conditions.

Planning policies should require evidence from developers as to how they intend to meet targets, identifying how they could achieve maximum targets where lower cost solutions are viable (such as CHP, existence of communal heating infrastructure, access surplus heat or biomass heating). Where developers are unable to achieve the maximum standard they should set out what target they intend to achieve, with the minimum targets as the lowest standard acceptable. Developers should be required to at least set out the following, with development specific carbon statements:

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

Authorities should require evidence of a viability assessment to accompany planning applications, with assessments to include:

- Technical feasibility – including space availability, integration with building energy systems, impact on townscape, running hours of plant

- Financial viability – including capital cost and whole life cost over plant lifetime taking into account market mechanisms such as feed-in tariffs. Measures using indices such as Internal Rate of Return for benchmarking against typical investment hurdle rates for delivery by ESCOs.
- Deliverability – including opportunities and requirements for delivery of infrastructure through Energy Services Companies
- Impact on overall viability of the development using an assessment method such as the Economic Appraisal Tool[68] model that will examine factors such as land value, sale value, construction costs and other S106 contributions

Recommendation 1: Require developers to achieve carbon reduction targets for new residential development as set out in the carbon targets framework. Require developers to achieve 10% and 20% renewable / low carbon energy supply targets from 2010 and 2013 respectively for all non-residential development types over 1,000m^2. Require developers to specifically consider the viability (technical and otherwise) of community heating, biomass heating, CHP and utilising surplus heat

Recommendation 2: Conduct development viability assessment(s) to collectively consider the full range of planning obligations, e.g. affordable homes, S106, alongside the estimated additional costs and potential incomes associated with achieving lower carbon development from ESCOs, capitalisation of the renewable energy tariffs and 'allowable solutions'.

If the achievement of advanced targets is deemed viable then set these targets as planning conditions and agree these as part of the planning approval process. If the achievement of these targets through on-site measures alone is not possible then the Authorities should test the viability of the development with a "buy out" price for off-site solutions, and should set a formula for updating this "buy out" price periodically in line with emerging government policy. In the absence of further national guidance the "buy out" price could be set at a minimum of £100/tonne CO_2 and a 30 years project life in line with current thinking in the industry[69]. However, authorities should give consideration to setting locally evidenced price designed to support local 'allowable solution' projects. Furthermore, in the absence of a standard national mechanism for securing off-site 'allowable solutions', the Authorities should support the identification of potential off-site solutions for direct investment by the developer. This would be critical in achieving the zero carbon standard proposed from 2013.

It is recommended that the Authorities consider the establishment of a Local Authority controlled Carbon Investment Fund to channel discrete funds (or planning obligations through S106 or Community Infrastructure Levy if this becomes the dominant approach) for off-site solutions into local low carbon projects. If such a mechanism were to be used then it will be important to choose projects that are demonstrably "additional" to current activity, i.e. projects that wouldn't have gone ahead without the investment. This might include wind energy projects on marginal sites or advanced energy efficiency measures in existing buildings that are not already subsidised through CERT. Examples of this approach exist in other Authorities such as Milton Keynes. Further comment is included in section 0. In addition, where infrastructure needs for low carbon energy supply are known - particularly district heating infrastructure - this should be included in future local infrastructure plans.

[68] *http://www.homesandcommunities.co.uk/economic-appraisal-tool*
[69] *www.zerocarbonhub.org.uk*

It should be noted that we have not recommended the establishment of the financial capitalisation measures (for the Feed-in Tariff or Renewable Heat Incentive) to facilitate uptake of low carbon technologies, since the market should bring these forward. However, where authorities identify market failures in this respect then they should consider the establishment of supporting measures.

Recommendation 3: Establish a Carbon Investment Fund mechanism, either unilaterally, or as a group, to support implementation of the 'allowable solutions', particularly aimed at supporting the proposed acceleration to the zero carbon standard to 2013 for major development.

We also recommend that authorities conduct heat mapping to further refine the understanding of the district heating. Specifically, we recommend that heating and technical / financial appraisal is conduct where there is coincidence of the favourable conditions as discussed in Section 8.1.2. Where this or other existing evidence indicates the opportunity for district heating then it is recommended infrastructure requirements are included within the authority's Infrastructure Plan.

Recommendation 4: Conduct high resolution heat mapping and feasibility analysis (including market assessment) of district heating and CHP around locations identified as having potential, i.e. where major development and/or surplus heat occur alongside existing high energy consumption intensity

Recommendation 5: Include infrastructure requirements for the low carbon energy technologies, particularly for district heating, where they are known within local infrastructure plans.

11.2 Existing development

Whilst a number of the policy recommendations above will have some impact on the existing built environment, notably the Carbon Investment Fund and analysis of District Heating opportunities, there are a number of further recommendations explicitly aimed at the existing built environment.

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

Recommendation 6: Provide specific planning protocols for those small-scale technologies not classed as Permitted Development.

In addition, whilst it is outside the scope of planning policy, it is recommended that the authorities and the County authority gives due consideration to supporting and encouraging the uptake of retrofitting of energy efficiency and low carbon energy supply measures within the existing built environment. Specifically, it is recommended that authorities develop delivery strategies and investment plans for retrofitting their own estate of buildings, e.g. schools and civic buildings and that they develop strategies to support the funding and delivery of other sectors of the built environment, particularly major public sector buildings, managed housing and private sector housing. Such strategies should seek to secure funding which is available from a diverse range of sources such as:

- housing grants through the Community Energy Saving Programme (CESP) and the Carbon Emissions Reduction Target (CERT) programme
- loan financing for housing retrofit projects through the proposed Pay as You Save scheme
- Prudential borrowing and funding from the Salix programme which can be available for public sector buildings
- EU funding, e.g. funds from European Regional Development programmes and from the European Investment Bank
- Private sector finance

Such strategies could also look to utilise Allowable Solutions revenue (from new development) to contribute to the costs of delivery. Various councils and Housing Association around the country have already or are developing programmes like this, such as Kirklees Council and Affinity Sutton (Housing Association). Moreover, the proposed introduction of a national Green Investment Bank should simplify the process as it is designed to bring funding streams together (as well as levering in significant private finance).

Recommendation 7: Develop delivery and funding strategies to maximise the uptake of energy efficiency and low carbon energy supply in the existing built environment, notably around public sector buildings, managed housing and private sector housing. Where Carbon Investment Funds are developed these could support investment in this area.

In addition, there are specific opportunities to identify and implement fuel switching initiatives in the locations (individual buildings or communities) that are not connected to the Natural Gas network. Under these circumstances heating will be provided from a range of fuels including Liquid Petroleum Gas (LPG), Coal, electricity and fuel oil, which in turn means the cost of heat supply will be high in comparison to the use of Natural Gas. Moreover these buildings and communities will typically be in rural locations where is also likely to be the opportunity to source biomass fuels. We recommendation therefore to identify and implement the key opportunities for fuel switching from conventional fuels to renewable energy systems which could include the use of biomass, solar thermal technologies and heat pumps. In addition, microgeneration power generation technologies (wind energy, solar PV and the CHP) should also be considered.

Recommendation 8: Conduct analysis of the potential for fuel switching in off-gas grid locations, since this provides discrete opportunities for the switching to lower carbon fuels, particularly with the introduction of the Renewable Heat Incentive in 2011.

11.3 Decentralised Generation

For decentralised generation this study provides an estimate of the potential uptake of the most relevant technologies, notably wind energy and bio-energy (in its many forms). It is recommended that the Authorities further develop their existing planning guidance on these (and other relevant) technologies, providing clear criteria-based planning policies to simplify determination. In the case of wind energy, each authority should provide indicative areas of potential within their boundary.

It is also recommended that where authorities feel there are significant landscape constraints to deployment of wind energy and biomass then localised landscape impact studies should be conducted. This could include cumulative landscape impact (which has not been considered in this study) in areas where significant potential is identified. Care should be taken, however, to not present a fixed presentation of landscape constraints based upon subjective judgement, where this may be better tested through the determination of individual planning applications.

Finally, it is also recommended that further analysis be completed on hydro power resource, in particular to seek access to site specific data from the Environment Agency for a UK-wide resource study which is due to be completed in the near future (NB. the Agency were unable to confirm a date by which this data would be made available).

Recommendation 9: Develop clear criteria-based planning policy for the key stand-alone generation technologies, notably wind energy and bio-energy projects

Recommendation 10: Publish maps showing indicative areas of potential for wind energy development and spatial distribution of other resources and consider establishing appropriate targets at local authority level and/or study area/county level.

Recommendation 11: Conduct a review of the landscape impact from wind energy and biomass in sensitive parts of the study area

Recommendation 12: Review hydropower potential across the study area as and when site specific energy data is made available from the on-going Environment Agency UK-wide resource study

11.4 Other recommendations

Overall this study has assessed the potential for renewable energy generation within each of the Authorities. Absolute targets are not recommended because it is hard to see how they could be enforced, since the planning system only influences certain elements of the uptake of the potential resources. However, it is recommended that Local Development Frameworks for each authority include a description of the estimated resources, the relative contribution from key technologies and the overall potential in comparison to future energy consumption and how this compares with national and regional benchmarks.

In addition, we recommend that a county-wide steering group be established with representation from the county authority and each of the district authorities involved (ideally also including Stoke on Trent which has not been involved in this study) to support complimentary planning policy and non-planning measures and strategies. In particular the group's remit should cover

- implementation of compatible development carbon targets
- developing supporting information
- developing shared resource, e.g. planning approval technical support, assessment tools
- developing shared delivery mechanisms ,e.g. Carbon Investment Fund, joint funding applications
- knowledge sharing and pooling of resources, e.g. cover costs of follow-up work where if it can be more cost effectively delivered across a group of authorities

Representation for the steering group could most simply be drawn by those who have formed the steering group during the course of this study.

Recommendation 13: Publish, within each authority's LDF documents, summaries of the Low and Zero Carbon (LZC) energy resource potential and its potential long term contribution when benchmarking against national targets (and regional targets as and when they are updated to reflect national targets)

Recommendation 14: Establish a low carbon / renewable energy planning steering group with a remit covering the strategic issues raised within this study, and with representation from all authorities within the county (including the county council)

11.5 Recommendations for monitoring and enforcing targets

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

We recommend that renewable energy deployment is monitored on an annual basis (see Table 34 for further detail). Many low and zero carbon developments will not require local planning permission, including:

- Permitted Development,
- development greater than 50MW which is approved by Infrastructure Planning Commission (NB. the new UK government has confirmed their intention to scrap this institution); and;
- generation technologies installed within the curtilage of existing buildings not requiring planning approval.

Recommendation 15: Establish a monitoring mechanism and conduct detailed annual monitoring of Low and Zero Carbon (LZC) energy uptake in each authority. LZC that is not subject to local planning approval will need a different approach from that development passing through local planning.

11.5.1 Decentralised generation and existing buildings

When dealing with urban development Planning Authorities can significantly influence the uptake of Low and Zero Carbon technologies by setting policy and ensuring that carbon standards are achieved through effective development control. With respect to decentralised generation or existing buildings, Planning Authorities are effectively not in a position to encourage uptake other than through demonstrating support. For existing buildings (other than major refurbishment) planning permission is not required, particularly with existing and proposed Permitted Development rules. For decentralised generation, the Planning Authority can establish the planning framework, with stretching targets, clear criteria based policies and some degree of spatial identification of areas of suitability, (where relevant) and this can encourage delivery of projects. However, the many commercial factors affecting the individual projects are also key determinants of whether schemes will come forward.

Planning Authorities will, potentially, have greater influence over the implementation of decentralised generation and existing building schemes, where they opt to establish direct links between new-build and so-called 'allowable solutions', by presenting local solutions. As demonstrated in this study, where we see a high degree of co-operation between neighbouring Authorities, it may be appropriate to restrict implementation to a number of jurisdictions. The contribution of 'allowable solutions' to the overall authority-wide target is likely to be small.

Authorities, in addition to their planning role, should also take a leading role in the development of renewable energy initiatives, which will support delivery against the authority-wide targets

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

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

11.5.2 New-build development

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

Clarity in the planning policy / guidance is critical, in the first instance. The key operational terms need to be well defined and described in sufficient detail. Also planning policy needs to call for standardised data, in a format that the Planning Authority can readily interpret. This will be useful to also ensure the authority is able simply to report and monitor performance. Development Control officers should rely on on-site built information, and not just design information, ensuring that site inspection staff are adequately included within the compliance checking process. Clearly the authority needs to be prepared to 'call-in' poor performance and to take appropriate action to ensure the local development market understands that these standards are a key feature of building compliance.

In addition, Authorities should consider requiring the installation of on-site monitoring equipment capable of capturing sufficient data to assess long-term building (carbon) performance against the stated claims during the development phase. This is particularly relevant to major development. This would help to inform future changes to compliance and assessment and future evolution of planning policy, e.g. through Supplementary Planning Guidance. The requirement to provide on-going monitoring could also be coupled with a financial bond requirement, which would be returned if the development achieves the long term performance standards proposed. Whilst this is not commonplace and the mechanics of delivery would need to be resolved, it offers a clear proposition of monitoring and managing performance over time, which is ultimately what is sought through increasing carbon standards on buildings. The move towards zero carbon buildings will inevitably begin to focus on the operational performance of buildings as standards continue to improve in design and construction. Therefore investigating how such a mechanism might be established in practice, e.g. resolving metering solutions, establishing and legally testing the financial mechanism, and negotiating its application in a development, would be useful preparatory work. Moreover, it would also demonstrate to the development community the level of aspiration to tackle the difficult issue of operational performance.

Recommendation 16: Establish expert low carbon planning assessment services, either on an individual Authority basis, or more cost effectively through shared-working across a number of authorities or across the county. Assessment services would need to adequately deal with the technical and financial aspects of low carbon standards, and enable critical negotiation around development as it comes forward.

Recommendation 17: Provide training for Development Control officers to assess energy and carbon reduction strategies. Implementation of this recommendation will need to be consistent with the recommendation to establish expert low carbon planning assessments services, which if conducted on a shared working basis, would externalise the approach to assessment.

Recommendation 18: Require suitable on-site carbon monitoring to be installed in major new development to enable assessment of long-term (carbon) performance compliance.

Recommendation 19: In supporting **Recommendation 18** conduct a study to establish a financial penalty scheme based upon a financial bond returnable on achievement of long term (carbon) performance compliance

Table 33 and Table 34 summarise key elements of good performance for monitoring and compliance against the proposed carbon targets.

<table>
<tr><th colspan="3">Enforcement</th></tr>
<tr><th>New-build</th><th>Existing build (and associated land)</th><th>Decentralised generation</th></tr>
<tr><td>• Very clear planning policy & guidance
• Require standardised data for compliance
• DC officers should rely on on-site built information, and not just design information.
• Ensure building inspectors adequately include LZC investigation
• Ensure DC staff are adequately trained or provide external expert service
• Authority willing to call-in poor performance (avoiding local perception that this aspect of compliance is less important).
• Require long-term performance monitoring (perhaps with financial bond arrangement)</td><td colspan="2">• Establish strong planning framework (ambitious targets, clear criteria based policies and some degree of spatial identification of areas of suitability)
• Developing local ‘allowable solutions’ measures
• The Local Authority (rather than the Planning Authority) may be able to take a leading role in the development of renewable energy initiatives</td></tr>
</table>

Table 33: Key features of effective enforcement

<table>
<tr><th colspan="3">Monitoring</th></tr>
<tr><th>New-build</th><th>Existing build (and associated land)</th><th>Decentralised generation</th></tr>
<tr>
<td>• Use standard compliance data, from planning permission & Building Control processes
• Require on-site monitoring, particularly for major development</td>
<td>• Monitoring of existing buildings is the most difficult area.
• Collate data associated to those projects requiring planning permission, e.g. for small wind turbines and biomass boilers (with certain height flues)
• Collate data for electrical installation which require power connection agreements (from Distribution Network Operators)
• For remaining thermal-based energy systems collate market data from stakeholders, e.g. Natural England for biomass systems, and suppliers.</td>
<td>• Collate planning application information
• Could be supplemented power network connection agreement data from Distribution Network Operators
• Easy to collate on an annual basis and to then account for large proportion of the overall implementation</td>
</tr>
<tr><td colspan="3">• Conduct a detailed survey of renewable energy uptake, collating the information from planning applications (stand-alone generation, new build development and those small-scale projects in the existing built environment that are not classed as Permitted Development)
• Data can be collated from a number of key data sources: regional studies, RESTATS, ROC register, databases operated by renewable energy agencies such as the British Wind Energy Association and the Renewable Energy Association
• It is anticipated that information covering small-scale projects, in particular, will be difficult to collate directly and hence it is recommended that an annual external survey is conducted, asking local active stakeholders to provide information on existing or planned systems. This in particular should seek to gain insight on the areas for which it is hard to gain information with any degree of confidence, e.g. thermal installations in existing built applications and installations on new developments where insufficient data has been provided by the developer or reported by Development Control. As this will be a survey (of a sample) the results will need to be statistically interpreted to provide results for the entire authority. In the future, the introduction of the Feed-in Tariff and the Renewable Heat Incentive may make data collection easier for smaller scale projects.</td></tr>
</table>

Table 34: Key features of effective monitoring

12 Non-Planning Delivery Mechanisms

12.1 Introduction

Planning policy is the core plank of local strategies for delivering decentralised energy generation and low carbon development, however, to maximise the chances of success it has to be married with a range of non-planning measures that should attempt to:

- Create local delivery leadership
- Promote demand for low carbon solutions and the supply of services required to deliver these
- Facilitate the delivery of the key solutions, particularly:
    - Low carbon infrastructure (communal heating networks), to enable connections between new development, the existing built environment, sources of surplus heat and waste-to-energy opportunities (incineration and anaerobic digestion of municipal waste)
    - Provide or facilitate financing mechanisms that support delivery of local Allowable Solutions that enable zero carbon development to be achieved, whilst supporting priority carbon measures, e.g. communal heating infrastructure, civic renewable energy projects and carbon reduction measures in the existing built environment
    - Provide or facilitate financing measures that enable access to capitalisation of the future revenues from energy generation or energy saving, e.g. Energy Services Company solutions, Renewable Tariff capitalisation and low interest loans, to minimise direct cost for land development
    - Capture external grants such as innovation funding and structural funds. Examples of this include European Regional Development Funds (that have been used to support the development of biomass CHP in the East of England), European Investment Bank investment (such as being sought for low carbon refurbishment of existing buildings in the South East), development and planning funding for Ecotowns, and Housing Growth Funds from CLG that may be able to support the development of low carbon infrastructure projects in support of growth.

Local Authorities are in a prime position to see the “big picture” of development in their area and would be well placed to coordinate the establishment of low carbon delivery solutions. Given the challenges of meeting the various milestones along the zero carbon roadmap whether the targets are accelerated ahead of the national plan or not, the development industry will need both carrots and sticks to achieve quite radical standards (compared to current construction practice).

Finally, the Authorities should continue to demonstrate leadership by developing low carbon projects within their own estate, e.g. providing public buildings to be anchor projects for low carbon district heating schemes or developing council-managed renewable energy generation or energy efficiency programmes.

12.2 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 Authorities need to encourage developers to engage with expert entities in order to most effectively progress energy infrastructure within their developments. Key steps include:

- Carrying out planning & delivery of low carbon infrastructure by an entity with long term interest in assets, such as an Energy Services Company (ESCO);
- Encouraging developers to engage early with ESCOs to facilitate a more effective approach to rolling out low carbon infrastructure;
- Considering the establishment of a Special Purpose Vehicle to lead early client negotiation and mitigate risk before bringing proposals to market.

Authorities need, in the first instance, to understand the viability of district heating networks and hence it is important that this comes from the implementation of the planning recommendations stated early:

- to require individual new developments to consider district heating
- to conduct heating mapping and district heating viability in key areas of opportunity.

In addition, developing infrastructure and major generation projects to enable the production and use of the wide range of biomass fuels within the study area is also important. Biomass represents a significant element of the renewable energy resources within the study area and so plays a critical role in achieving local targets. It will also be increasingly important to enable the delivery of low carbon development. It is recommended that a study area / county level biomass energy strategy is developed which should seek to support commercial activity in this area. Such a strategy should review the following issues:

- Identify major sources and existing supply chain
- Identify major supply chain gaps and develop solutions
- Identify major biomass heat consumer opportunities, including new district heating scheme, public building, proposed major development (which will have to achieve increasingly higher carbon standards) and off-grid fuel switching
- Identify large power generation opportunities (in addition to existing biomass co-firing) Raise awareness of bio-energy among key stakeholders
- Identify and implement strategic implementation measures that will support the establishment of local markets
- Review funding opportunities, e.g. Defra Bio-energy Capital Grants Scheme, the Bio-energy Infrastructure Grants Scheme and the Regional Development Agency, and co-ordinate strategic applications, learning from actions/best practice elsewhere.
- Consider local air quality of emissions from bio-energy heat and power plants to ensure that bio-energy plants meet air quality legislation.
- Develop funding scheme for pilot projects. Support a limited number of representative projects in each sector with good dissemination potential.

Recommendation 20: Develop a county-wide biomass supply chain infrastructure strategy

12.3 Financing low carbon infrastructure

12.3.1 Addressing investment challenges for communal infrastructure

A 'carbon investment fund' could help overcome the high upfront costs of energy infrastructure with the public sector providing the initial investment which is then repaid through developer's energy contributions. It would also provide a proactive response to the Government's aspiration to support future carbon reductions through a variety of 'off-site' means, and ensure greater local control of delivery. A council (or joint council) operated ring fenced carbon investment fund could provide the upfront capital needed for financing large scale low carbon infrastructure such as CHP/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. Provisions such as this should be incorporated into LDF infrastructure planning and could also be linked to Section 106 (or Community Infrastructure Levy) arrangements as an alternative to a discrete carbon investment fund, although it would be important for the incomes to be ring-fenced.

Key actions to support investment shortages:

- A ring fenced carbon investment fund may be needed to bring forward value of staged developer contributions 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 funds could manage this role.
- Additional measures needed to mitigate early stage infrastructure development risk;
- Increased support for renewable energy development with mechanisms to contractually link off-site renewable energy infrastructure to new developments.

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

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

12.3.2 Special purpose vehicles / ESCOs

Each Authority or group of Authorities could seek to establish a municipal Energy Services Company (ESCO) as others, such as the councils of Woking and Sheffield, have previously done. This would work to develop / install sustainable energy systems within both the new development and existing buildings. A special purpose vehicle could particularly help in rolling out CHP and district heating to existing communities, and thereby help realise the substantial carbon reductions that CHP can deliver to existing buildings. Whilst direct development is an option, there are risks for public sector agencies in doing so. This option should therefore be considered against the options of working with commercial operators or developing public / private partnerships.

The term 'Energy Services Company' 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 can be structured so that they are part, or wholly, owned by the residents of the development, and are therefore often referred to as 'community ESCOs'.

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

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

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

An ESCO or special purpose vehicle led by a public sector organisation may be needed if a low carbon project is not being taken forward by the market place due to financial or technological risks. An ESCO can be designed so as to manage these risks and enable a project to proceed. Nonetheless, a Local Authority or community group will only want to proceed with 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 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.

12.4 Councils leading by example

Each authority or group of authorities has a great opportunity to directly progress renewable energy installations and decentralised 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 also 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

13 Conclusion

This report and its companion report (of worked examples applying higher carbon standards in new development) constitute a comprehensive evidence base to support the preparation of land-use policies in the areas of carbon reduction and renewable energy generation for each of the Local Authorities involved. It does so largely in response to the existing national planning guidance for climate change mitigation and renewable energy (Planning Policy Statements 1 and 22). The study was also directed by the latest version of the West Midlands Regional Spatial Strategy, which has since been revoked but provides a source of additional supporting evidence for some of the analysis conducted and some of the recommendations made.

Clearly even before the change of government this year, policy around renewable energy and climate change was a fast moving area, presenting uncertainty in certain aspects of the study. With a new government, this uncertainty has been compounded. For example, we anticipate significant change to land-use planning in general terms, to follow a strategy of greater local decision making. This has already seen the abolition of Regional Spatial Strategies. It is possible that we will see changes to previously proposed fiscal incentives important in this area, e.g. for renewable heat. In addition, we still anticipate full definitions of the regulatory approach to delivering zero carbon development to emerge in 2010. Local policy should be developed based upon the existing primary policy and legislation, but it should also be pragmatic so as to allow flexibility over time.

The main report also provides a review of the low and zero carbon energy generation potential across the study area, providing a useful resource base to support implementation programmes and a focus for key non-planning measures, where they interact with planning recommendations.

We strongly recommend that the councils involved in this study continue to work together, ensuring efficiency by sharing resources and developing and implementing complimentary and consistent policies across the study area. To drive this we recommend the establishment of an implementation steering group.

Finally, the subordinate aims of the study have been addressed as follows:

- To assess the viability and applicability of all renewable and low carbon energy sources.
- To identify locations (general areas and, where feasible, specific sites) within the county that may be favoured for renewable energy generation.
- To assess the contribution that proposed developments in Staffordshire could make towards generating renewable and low carbon energy.
- To provide an estimate of the total quantity of energy that could be generated via viable renewable energy sources.

The report conducts a detailed review of the various low carbon energy sources available in the study area, grouping them as Decentralised Energy generation (generally stand-alone power and combined heat and power), implementation within new development and implementation within the existing built environment. The report details the methodologies used (and where relevant the compliance of these with emerging best practice, e.g. DECC regional renewable energy resource assessment methodology). It then presents results of the resource analyses, (taking account of economic and other viability constraints) by authority, and, aggregated across the study area. Where possible the results are also represented spatially using GIS generated images included Energy Opportunity Maps which locate areas of potential by technology.

- To identify potential for CHP deployment for sites with high heat demand.

Zones for the potential implementation of CHP (which we have interpreted as district heating with CHP) have been identified through the appraisal of existing heat demand density and the coincidence of other favourable implementation conditions;

- *large-scale new development;*
- *existing sources of industrial heat; and;*
- *locations identified in the previous regional heat mapping work.*

In addition to these technical parameters there are a range of other parameters that enable or constrain implementation of district heating / CHP projects. For example, accessibility of a critical mass of potential consumers to justify investment; existence of anchor consumers that can support the initial development phases; and; existence of major construction (or cost) constraints to implementing the physical infrastructure, such as rivers, railways and contaminated land. In order to understand these issues to truly determine viability it is necessary, as is recommended, to conduct localised viability studies within the zones that have been identified.

- To identify realistic targets for onsite energy production from renewable and low carbon energy sources that can be required on suitable new developments.
- To establish a size threshold for new developments in which the incorporation of renewable energy technologies is feasible (for example number of dwellings, level of commercial floor space etc), and to establish if the effectiveness of renewable energy technologies varies depending on the scale of the development.
- To identify the barriers to the success of future policies, including perceived financial impact.
- To clarify the relationship between renewable/decentralised energy targets with carbon requirements set out in Building Regulations Part L and the Code for Sustainable Homes.

Within the study a comprehensive review has been completed of possible carbon standards for the quantum and type of new development forecast in the each authorities over the 'plan period' – up to 2026. This has considered onsite generation, energy efficiency and offsite solutions, otherwise known as Allowable Solutions. This draws heavily on the emerging national policy which is seeking to regulate for the implementation of zero carbon development by 2016 for all housing and 2019 for non-domestic development. The review of standards has included technical and financial analysis of accelerating beyond proposed future national standards for housing and the inclusion of specific on-site generation targets, i.e. the Merton rule.

The result has been to construct a variable framework of carbon standards for housing, establishing rising standards in line with the national carbon target roadmap but requiring developments to achieve higher standards where the conditions are favourable, e.g. access to lower cost options. We have also proposed variable on-site generation (Merton rule) targets rising over time for both housing and non-domestic development. The framework deals with threshold issue simply by requiring the standards to apply to all housing development (of any scale) and to non-domestic development over 1,000m^2. It is also links recommended carbon targets to those due to be set out by Building Regulations and the Code for Sustainable Homes, to ensure policy consistency.

The analysis includes assessment of the net additional cost burden associated to the proposed carbon target framework, to help examine its viability. In practice, the application of the framework, particular the requirement of developments to achieve the maximum standards, will require monitoring particularly as economic conditions are likely to be variable over the medium term. We also recommend that the authorities conduct economic testing of the proposed points of acceleration combined with the cost burdens associated to other planning obligations, e.g.

affordable homes. The study has provided a detailed data set of net additional costs that can be used within financial modelling exercises for this purpose.

- To suggest any other LDF policy measures or targets that might contribute towards energy generation.

The report includes a range of other policy recommendations for authorities to consider including within their Local Development Frameworks, ranging from publication of low carbon generation resource information (including spatial distribution), establishment of criteria-based policies for renewable energy and the inclusion of tariff structures for raising development income to support implementation of offsite "allowable solution" carbon reduction projects.

Appendix I: Summaries of study results by authority

Cannock Chase

Background

On a per capita basis, Cannock Chase has the second lowest CO_2 emissions of the study Authorities, significantly below the West Midlands regional average.

Decentralised energy

Under the modelled scenarios, Cannock Chase offers amongst the smallest potential for meeting its energy needs locally, compared to other partner Authorities largely because of the constraints on wind energy together relative to the future energy demand. Under both 'base' and 'elevated' scenarios, renewable energy generation by 2020 could meet 5.3% and 7.1% of demand respectively, both of which fail to meet the 'lower' benchmark level of 7.5% approximated from national targets (nb. 10% is the upper benchmark value).

In 2020, renewable energy systems directly connected to the built environment offer the largest potential. Unlike many of the partner Authorities, the contribution from new build development is considerable compared to uptake in the existing built environment. This is due to the relatively significant scales of development that is expected within Cannock Chase compared to the scale of existing dwellings and floor space.

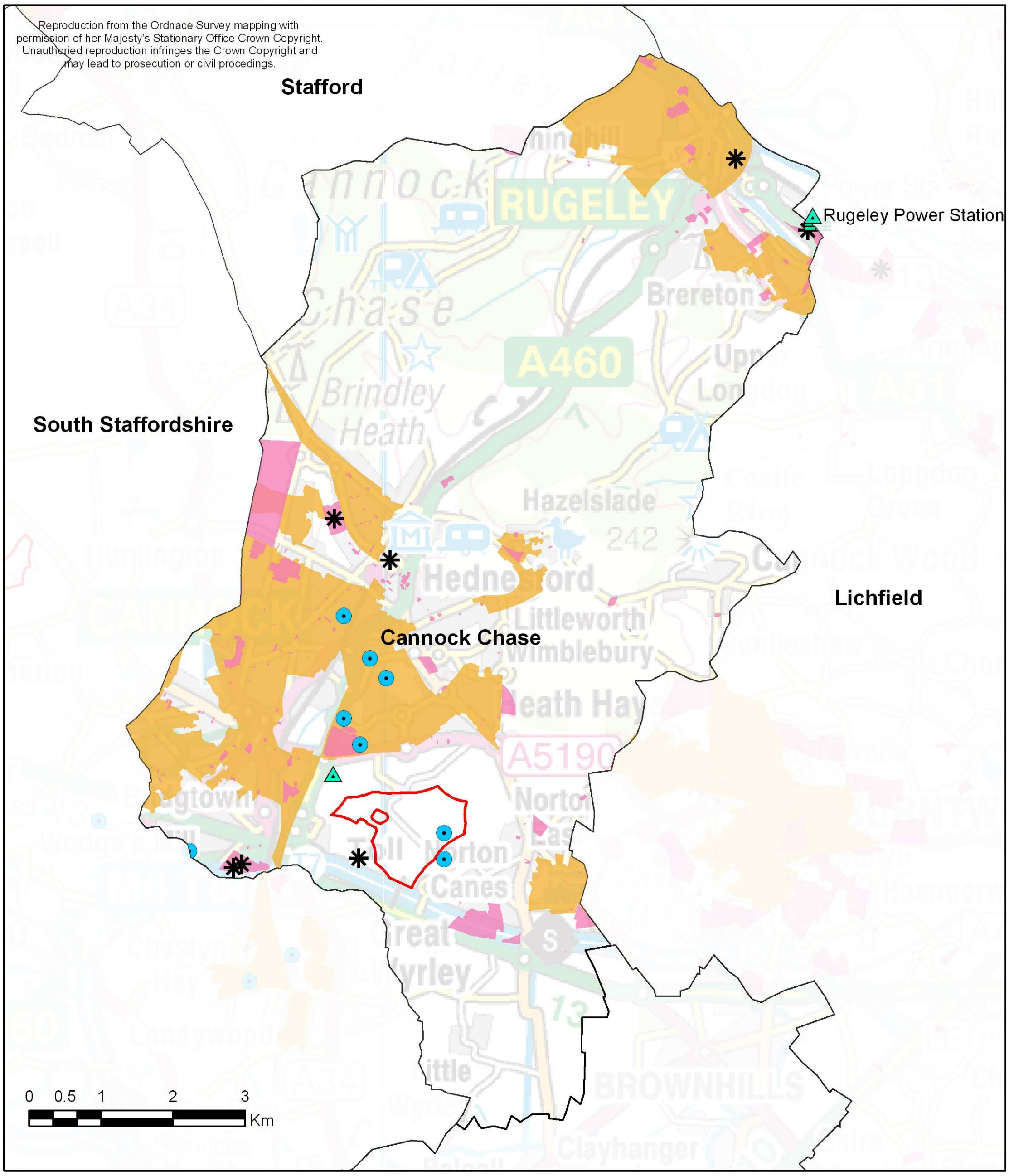
Biomass is the third largest source of renewable energy, with most primary energy locked within commercial wood waste and municipal solid waste, with few agricultural sources. Aside from hydro, where no significant potential was identified, wind is modelled to have the smallest contribution in 2020, providing around half of the potential compared to the largest source - new development. The single wind site is located at the south-east border of Cannock town, however, this excludes those sites which may be still be viable for less than 3 turbines - please see the wind analysis section of main report.

Carbon targets

A framework of minimum and maximum targets for carbon and low carbon / renewable energy supply is proposed for domestic development. Carbon targets for domestic development are proposed to change over time, linked with the national road map for zero carbon buildings. Low carbon / renewable energy supply targets (only) are proposed for non-domestic development.

Since a large proportion of Cannock Chase's dwellings are expected to be within small sites of 10 units or less, the likelihood of development being able to go significantly beyond the minimum carbon standards is limited. However, the district is considering some larger scale development in the form of extensions which would offer greater opportunity to achieve elevated standards.

Theoretical potential for district heating is present in Cannock Chase, focussed around the urban centres of Cannock and Rugeley. No major heat users were identified who could provide a significant anchor load, although Rugeley Power Station is present as a substantial generator of waste heat. Note that a study of all major UK power stations identified Rugeley as having a low potential for district heating.



Large heat generators

Large heat users

Wind potential - 3 or more turbines

Hydropower opportunities

Power stations

Future major developments

SHLAA

LSOAs with District Heating potential

Biomass energy sources have not been mapped due to their highly distributed nature.

East Staffordshire

Background

On a per capita basis, East Staffordshire's annual CO_2 emissions were slightly above the West Midlands regional average, and around the mid range within the study area.

Decentralised energy

Under the modelled scenarios, East Staffordshire appears reasonably capable of meeting its energy needs locally, compared to other partner Authorities. Forecast renewable energy generation by 2020 shows the Authority as capable of generating almost 9% of its expected energy demand, meeting and exceeding benchmark levels approximated from national targets.

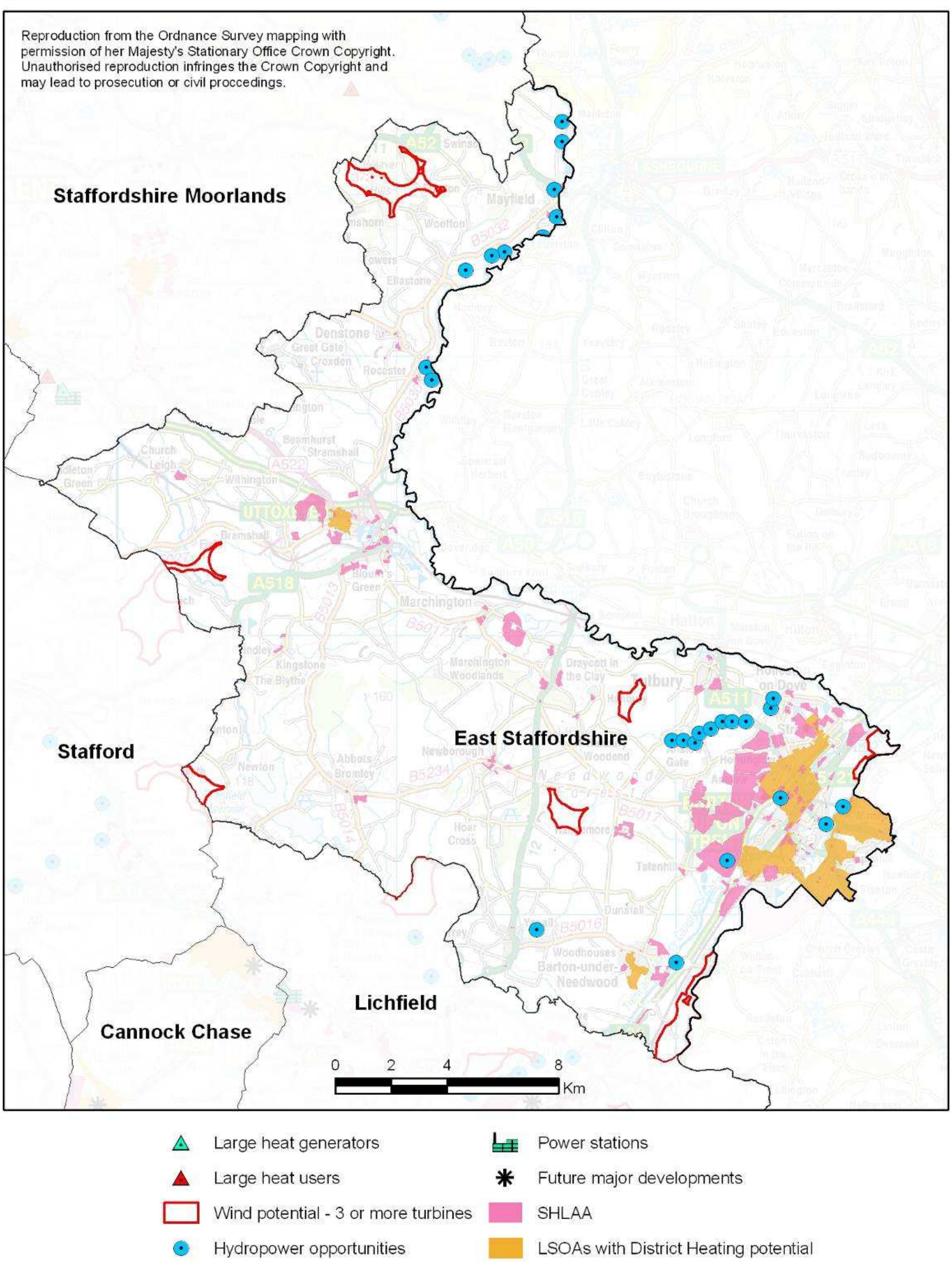
Modelling results present wind as the largest potential contributor of renewable energy in 2020, amounting to some sixteen turbines. Seven medium sized sites have been identified as theoretically viable, spread around the authority. Wind is forecast to produce double the energy of the next largest source: biomass, which is sourced largely from agricultural arisings. Despite having the largest allocation, new developments provide significantly less renewable energy compared to wind and biomass, and opportunities in the existing built environment offers less still. East Staffordshire has eleven potential hydro sites, the greatest number in the study area. All offer a small contribution, with the largest being Winshall Weir, which has a maximum capacity of 400kW.

Carbon targets

A framework of minimum and maximum targets for carbon and low carbon / renewable energy supply is proposed for domestic development. Carbon targets for domestic development are proposed to change over time, linked with the national road map for zero carbon buildings. Low carbon / renewable energy supply targets (only) are proposed for non-domestic development.

East Staffordshire is expecting to develop large urban extension sites which may enable higher carbon standards to be achieved. Nonetheless, the largest proportion of the Borough's future housing will be upon small sites of less than 10 dwellings; these will have a low likelihood of going significantly beyond the minimum carbon standards.

East Staffordshire's rural nature means that the potential for district heating within the existing built environment is limited to pockets in the south east of the Borough. Some of these areas adjoin sites of possible future development, demonstrating an opportunity for district heating viability in new build to be enhanced by connection to existing heat loads.



Biomass energy sources have not been mapped due to their highly distributed nature.

Lichfield

Background

On a per capita basis, Lichfield's annual CO_2 emissions were slightly above the West Midlands regional average, and around the mid range within the study area.

Decentralised energy

Under the modelled scenarios, Lichfield appears amongst the most capable of meeting its energy needs locally, compared to other partner Authorities. Forecast renewable energy generation by 2020 shows the Authority as capable of meeting around 10% of its energy demand through renewable energy sources, meeting and exceeding an 'upper' benchmark level approximated from national targets.

Lichfield's greatest opportunity lies in the diversion of biomass sources as alternative fuel sources; contributing 40% of the base case scenario in 2020. The District has amongst the largest biomass fuel potential within the study area, particularly from wood waste, straw and energy crops. Installation of renewables within new development presents the second largest opportunity, since the number of new dwellings forecast is significant and the second largest in the study area. Furthermore, the extent of non-residential construction is expected to be double the next largest Authority in the study area.

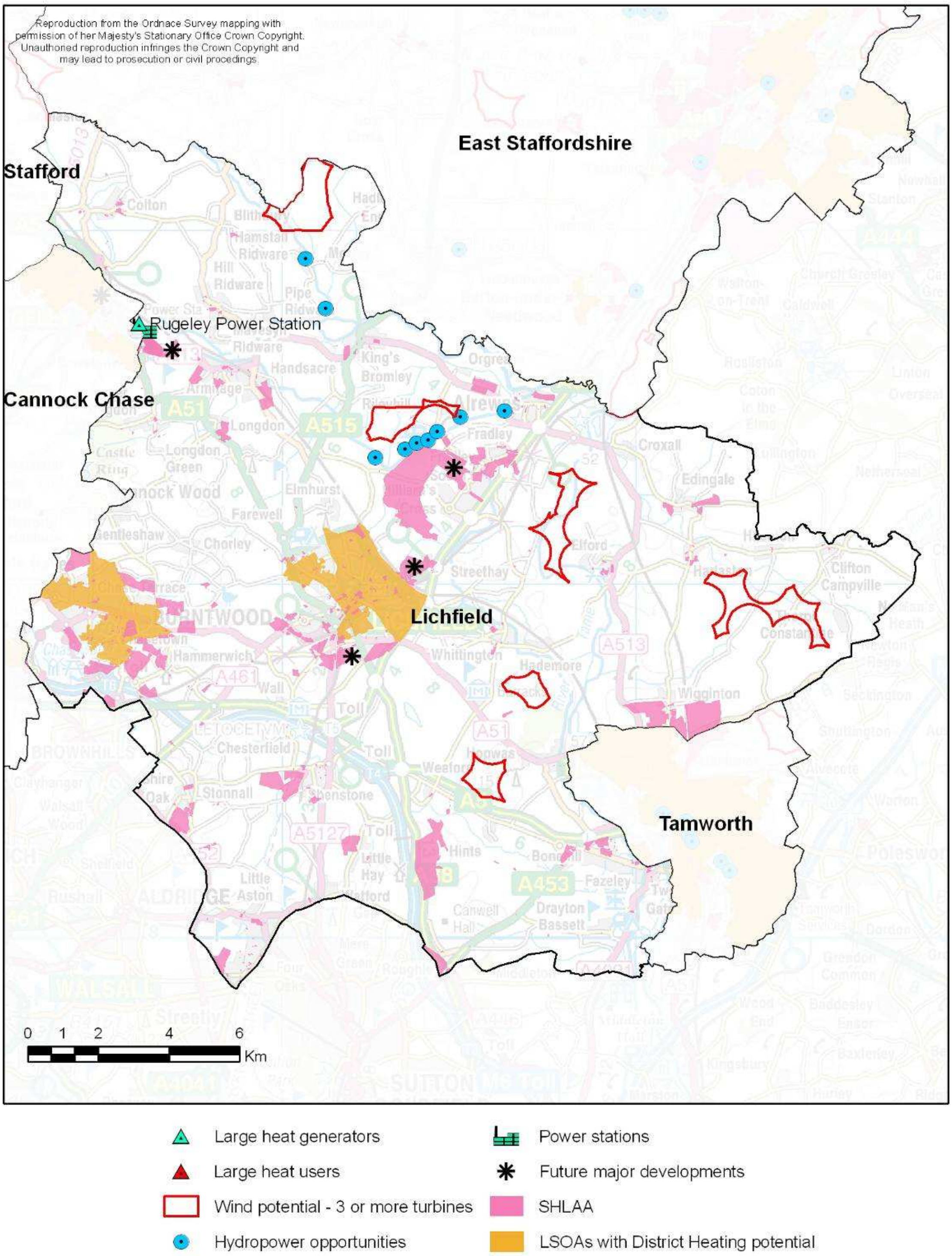
The wind scenarios deduced that six wind turbines could be installed within the Authority, generating 21% of the modelled renewable energy in 2020. There are six individual sites of greatest opportunity for wind development, most of which have room for multiple turbines. The retrofit of renewables in the existing built environment presents the smallest opportunity, and no hydro sites were identified with significant potential.

In 2020, approximately 75% of renewable energy would be provided outside of the new build environment, indicating that standalone generation presents the greatest opportunity.

Carbon targets

A framework of minimum and maximum targets for carbon and low carbon / renewable energy supply is proposed for domestic development. Carbon targets for domestic development are proposed to change over time, linked with the national road map for zero carbon buildings. Low carbon / renewable energy supply targets (only) are proposed for non-domestic development.

Lichfield may see a number of large developments come forward in the near future which could support carbon standards above the minimum set out in the proposed framework. Phasing could be an issue, however, since some of these sites are expected to have made significant progress before Building Regulations turn to 'zero carbon' homes in 2016, and even before the framework's 2013-16 maximum target could be applied. District heating potential from existing buildings is restricted to the urban areas of Lichfield and Burntwood. A succession of small future development sites can be found within or adjoining these zones, which may offer enhanced district heating opportunities.



Biomass energy sources have not been mapped due to their highly distributed nature.

Newcastle-under-Lyme

Background

On a per capita basis, Newcastle-under-Lyme's annual CO_2 emissions were marginally below the West Midlands regional average, and around the mid range within the study area.

Decentralised energy

Under the modelled scenarios, Newcastle-under-Lyme has amongst the lowest potential for meeting its energy needs locally, compared to other partner Authorities. Under an 'elevated' scenario, the forecast renewable energy generation by 2020 enables the Authority to meet 9.2% of its expected energy demand, and exceed a 'lower' benchmark level approximated from national targets.

Wind turbines have been found to offer the greatest potential within the Borough, with 7 turbines generating over a third of the renewable energy modelled in the base case for 2020. Despite this contribution, only four significant sites have been identified as suitable for the development of wind power; largely in rural areas with the exception of one site close to the crossing of the M6 and A53.

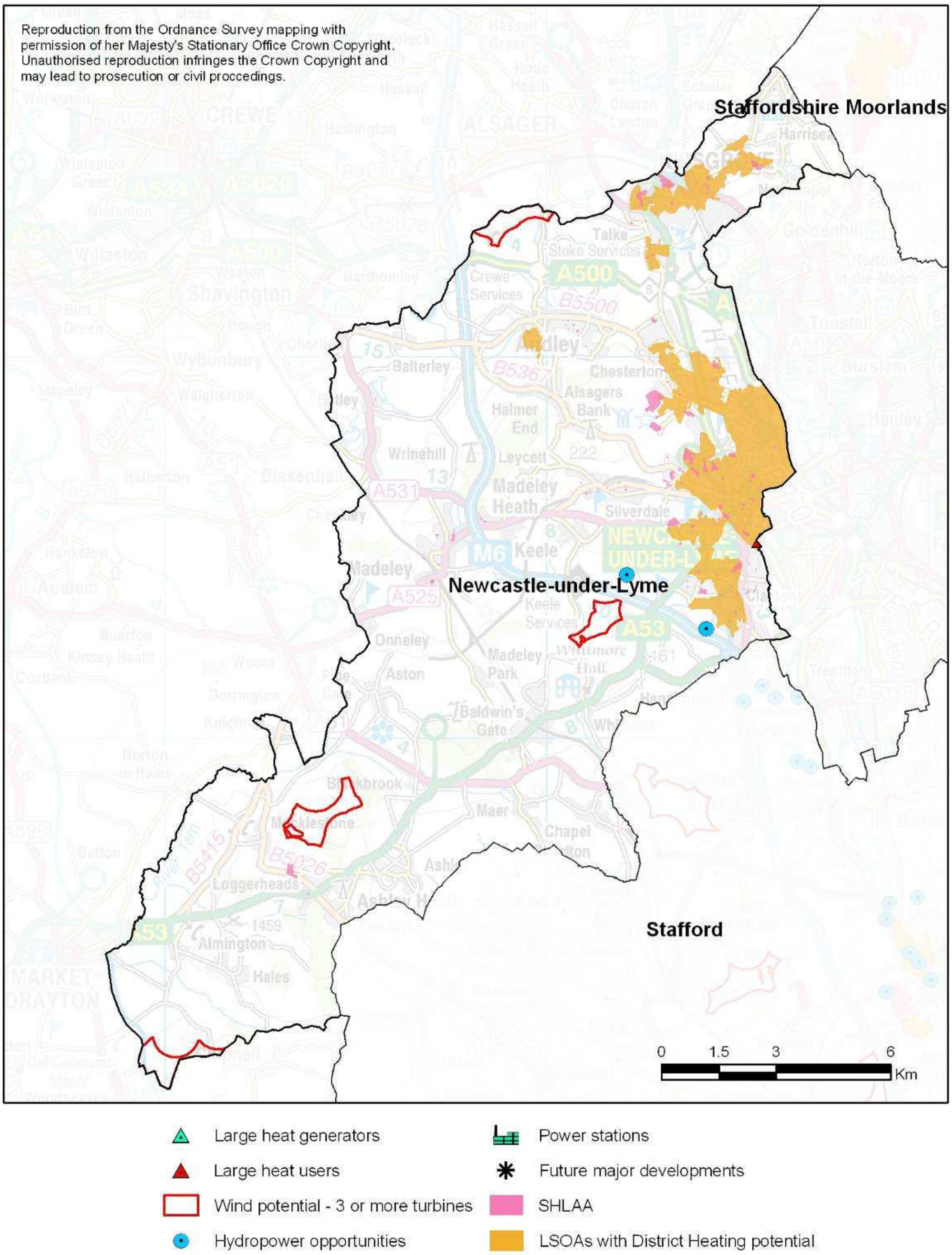
After wind, broadly equal contributions of 21-24% are then seen from new build developments, the existing built environment, and biomass fuel sources. Primary energy demand from biomass is the second smallest of the study area, with wood waste being the most significant source. Interestingly, housing completions are expected to peak in the period 2016-19 for Newcastle-under-Lyme, coinciding with the national objective for all new housing to be 'zero carbon' as of 2016. No significant hydro sites were identified.

Carbon targets

A framework of minimum and maximum targets for carbon and low carbon / renewable energy supply is proposed for domestic development. Carbon targets for domestic development are proposed to change over time, linked with the national road map for zero carbon buildings. Low carbon / renewable energy supply targets (only) are proposed for non-domestic development.

Around 75% of Newcastle-under-Lyme's future housing is likely to come forward as part of small scale developments of less than 10 dwellings. These sites will struggle to go beyond the framework's minimum carbon standards. However, the remaining 25% of dwellings may be delivered through a larger scale extension (or extensions) to an existing settlement. Depending upon the scale, density, and mix of building uses, this may provide an opportunity to go beyond the minimum targets.

As would be expected, heat demand is concentrated mostly along the eastern boundary of the Borough, along with another significant pocket in the Kidsgrove locale. Many instances occur whereby sites for future development sit within on adjoining these high heat consuming areas, offering opportunities for district heating. However, all of the SHLAA sites are relatively small in scale and may not be large enough to facilitate district heating.



Biomass energy sources have not been mapped due to their highly distributed nature.

South Staffordshire

Background

On a per capita basis, South Staffordshire has amongst the largest annual CO_2 emissions of the study area, exceeding the West Midlands regional average. Interestingly, it consumed the largest amount of energy per capita compared to the partner Authorities.

Decentralised energy

Under the modelled scenarios, South Staffordshire appears reasonably capable of meeting its energy needs locally, compared to other partner Authorities. Forecast renewable energy generation by 2020 shows the Authority as capable of meeting almost 10% of its energy needs via low carbon sources by 2020, and exceeding benchmark levels approximated from national targets.

Modelling suggests that biomass is by far the most significant source of renewable energy, contributing almost 65% of the total low and zero carbon energy available in the 2020 base case. The District has the second largest biomass resource of the study area, with the most significant sources being agricultural and wood waste streams. Wind energy provides around half of the energy potential as biomass, with the scenarios indicating that 4 turbines could be installed on viable sites by 2020. There are four key sites which are theoretically suitable for the development of wind turbines: at the north westerly boarder with Stafford, near Wheaton Aston, east of the M6 near Penkridge, and the last in the Mitton area.

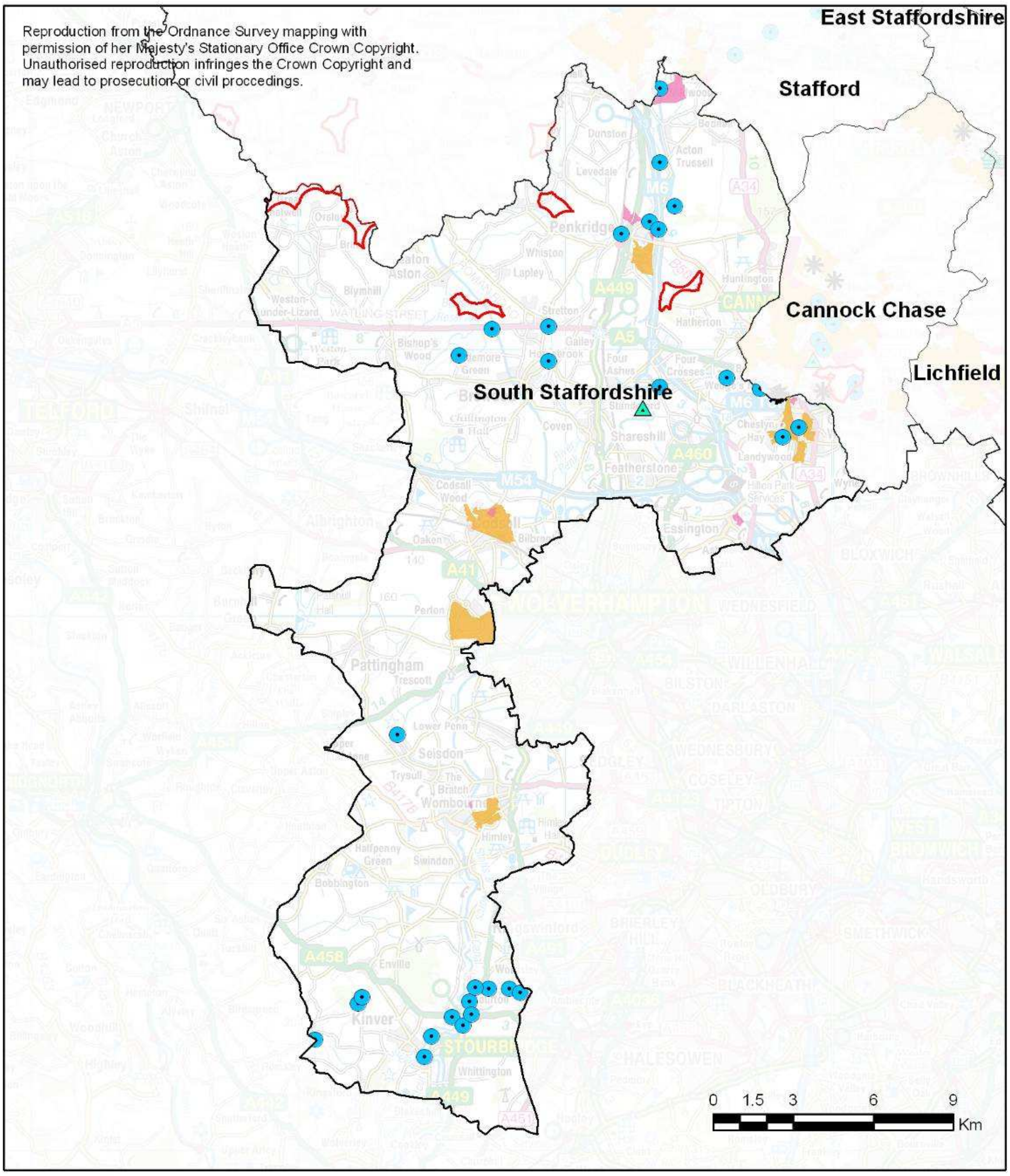
Uptake of renewable energy technologies in the existing built environment offers similar potential to wind, and the installation of renewables within new buildings provides the smallest contribution. South Staffordshire has the second smallest forecast for new dwellings within the study area, and the smallest expected development of non-residential uses. No significant hydro potential has been identified.

Carbon targets

A framework of minimum and maximum targets for carbon and low carbon / renewable energy supply is proposed for domestic development. Carbon targets for domestic development are proposed to change over time, linked with the national road map for zero carbon buildings. Low carbon / renewable energy supply targets (only) are proposed for non-domestic development.

Half of the District's future dwellings are likely to be built in small pockets of up to 10 units, and will typically struggle to go beyond the minimum carbon standard as set out in the proposed framework. There is a likelihood that some settlement extensions will occur which may be able to go beyond the minimum.

Few pockets of high heat demand are present within the existing built environment, and few major development sites are present in these locales. District heating is unlikely to benefit from significant existing heat loads within the District.



- Large heat generators
- Large heat users
- Wind potential - 3 or more turbines
- Hydropower opportunities
- Power stations
- Future major developments
- SHLAA
- LSOAs with District Heating potential

Biomass energy sources have not been mapped due to their highly distributed nature.

Stafford

Background

On a per capita basis, Stafford has amongst the largest annual CO_2 emissions of the study area, exceeding the West Midlands regional average.

Decentralised energy

Under the modelled scenarios, Stafford is seen to generate more than double the energy of many other Authorities in the study area. It significantly outstrips the 2020 benchmark levels approximated from national targets, providing over 15% of its energy needs through renewable sources.

The bulk of this is forecast to be delivered through wind, with an estimate of 26 turbines installed by 2020 under the base case. The Borough contains the greatest number of theoretically feasible sites for the development of wind, and many of these are a size which could hold multiple turbines.

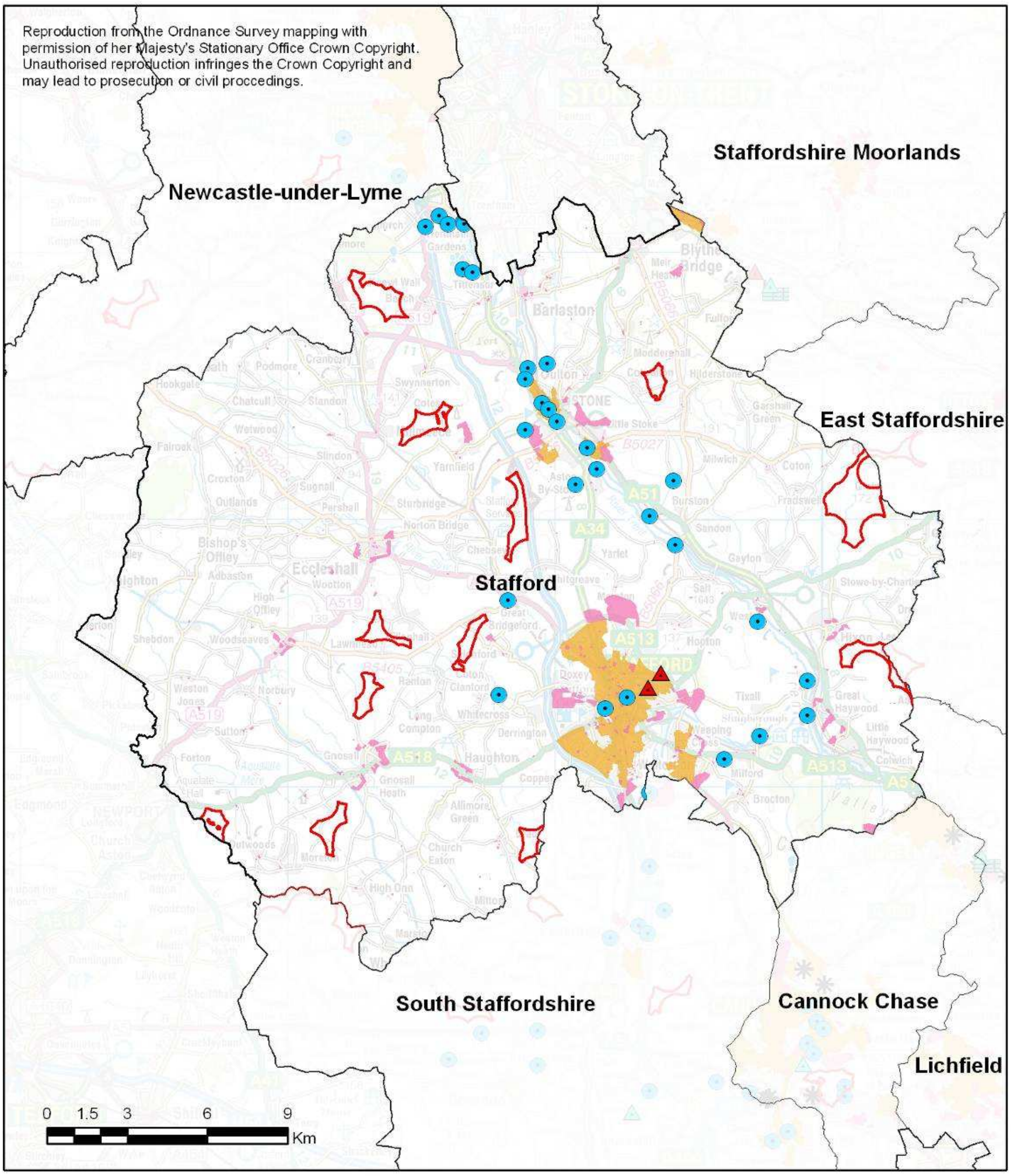
Stafford also has the largest biomass potential within the study area, with significant sources being animal manure, wood waste, and straw. Biomass is the second largest source, significantly outstripping contributions from the built environment. Opportunities for microgeneration within new build and existing build appear to be similar in scale. Stafford has the second largest housing allocation of the study area, and the second largest development of non-residential uses.

Carbon targets

A framework of minimum and maximum targets for carbon and low carbon / renewable energy supply is proposed for domestic development. Carbon targets for domestic development are proposed to change over time, linked with the national road map for zero carbon buildings. Low carbon / renewable energy supply targets (only) are proposed for non-domestic development.

Urban extensions within Stafford will present the best opportunities for going beyond the minimum carbon standards as presented in the proposed framework, since these sites have enough scale for larger scale energy systems to become competitive.

The existing built environment offers minimal district heating viability outside of the urban area of Stafford. A number of significant sized sites outlined for future development adjoin the high heat areas, and would be worth further investigation for district heating.



Large heat generators

Large heat users

Wind potential - 3 or more turbines

Hydropower opportunities

Power stations

Future major developments

SHLAA

LSOAs with District Heating potential

Biomass energy sources have not been mapped due to their highly distributed nature.

Staffordshire Moorlands

Background

On a per capita basis, Staffordshire Moorlands has the third highest annual energy consumption of the study area, but the highest per capita CO_2 emissions. This could be explained by the relatively high use of solid fuels due to extensive areas which are not connected to mains gas.

Decentralised energy

Under the modelled scenarios, Staffordshire Moorlands offers the smallest potential for meeting its energy needs locally, compared to other partner Authorities. Under both scenarios, renewable energy generation by 2020 struggles to meet half of the 'lower' benchmark level approximated from national targets.

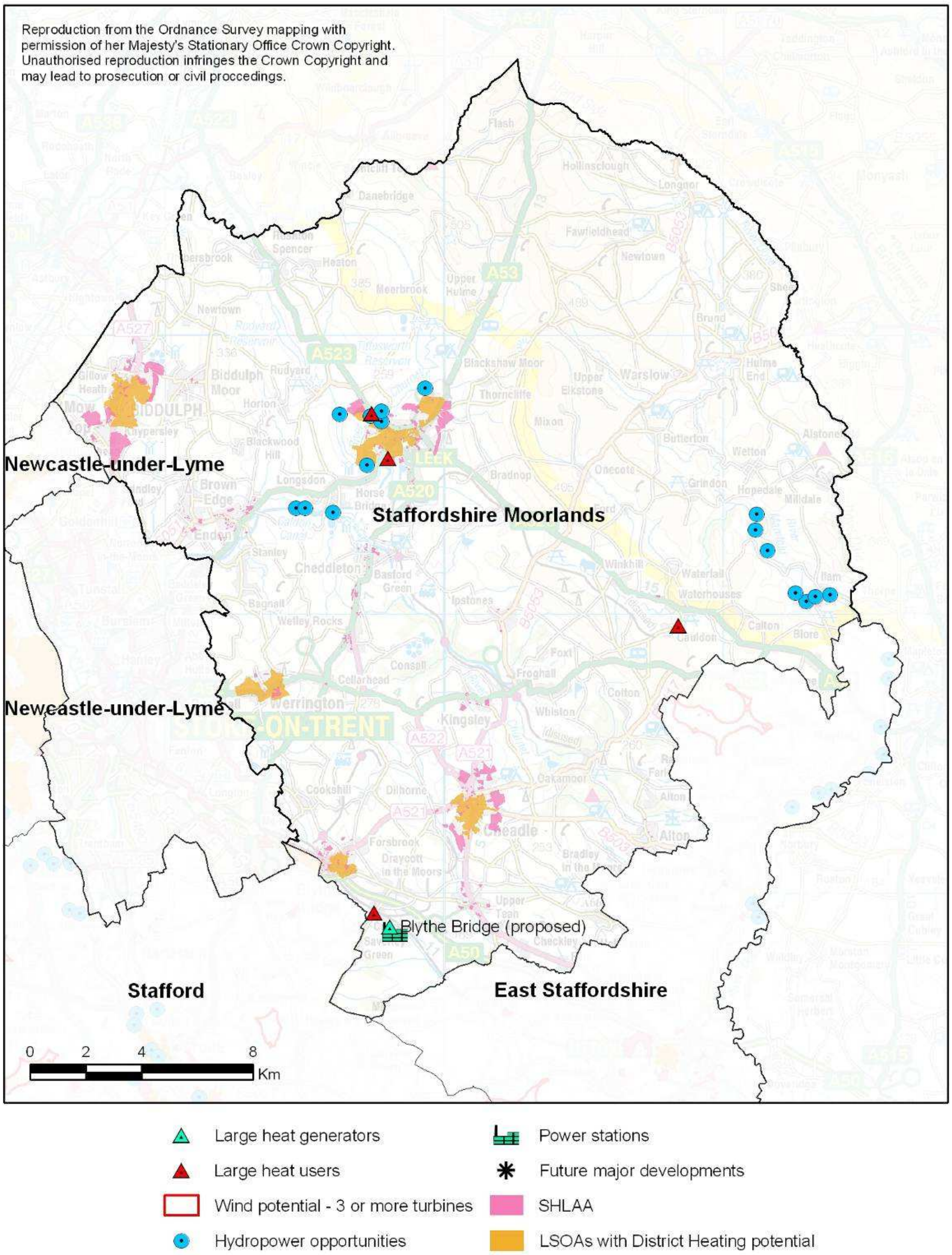
Biomass contributes half of the District's low carbon energy supply for the 2020 base case, despite four of the eight study area authorities having a larger physical biomass resource. In terms of primary energy, animal manure and wood waste are the largest potential sources. The analysis suggests that the existing built environment could contribute 24% towards of overall resource, which is more than that available from new build development. Staffordshire Moorlands has the third smallest allocation for new dwellings, and the second smallest area of non-residential development.

Despite its rural nature, then analysis suggests that wind offers relatively little potential. Any appropriate sites identified were too small to hold multiple turbines, which would still leave opportunities for single turbine development (and development closer than 600m to houses, where it is deemed acceptable to residents). Five hydro sites were found to offer some potential to supply electricity locally, of which Far Kigstley Bank is the most significant.

Carbon targets

A framework of minimum and maximum targets for carbon and low carbon / renewable energy supply is proposed for domestic development. Carbon targets for domestic development are proposed to change over time, linked with the national road map for zero carbon buildings. Low carbon / renewable energy supply targets (only) are proposed for non-domestic development.

Since the majority of Staffordshire Moorland's dwellings are expected to be within small sites of 10 units or less, the likelihood of developers being able to go significantly beyond the minimum carbon standards is limited. However, the District is expecting some larger scale development in the form of extensions to existing settlements. There may be the opportunity to seek higher standards in these instances.



Biomass energy sources have not been mapped due to their highly distributed nature.

Tamworth

Background

On a per capita basis, Tamworth has the lowest annual energy consumptions of the study authorities, and the lowest per capita CO_2 emissions (approximately one third lower than the West Midlands regional average).

Decentralised energy

Under the modelled scenarios, Tamworth offers amongst the smallest potential for meeting its energy needs locally, compared to other partner Authorities. The 2020 base case shows the Borough to generate only 5.3% of its demand through low carbon technologies, and fails to meet a 'lower' benchmark level approximated from national targets.

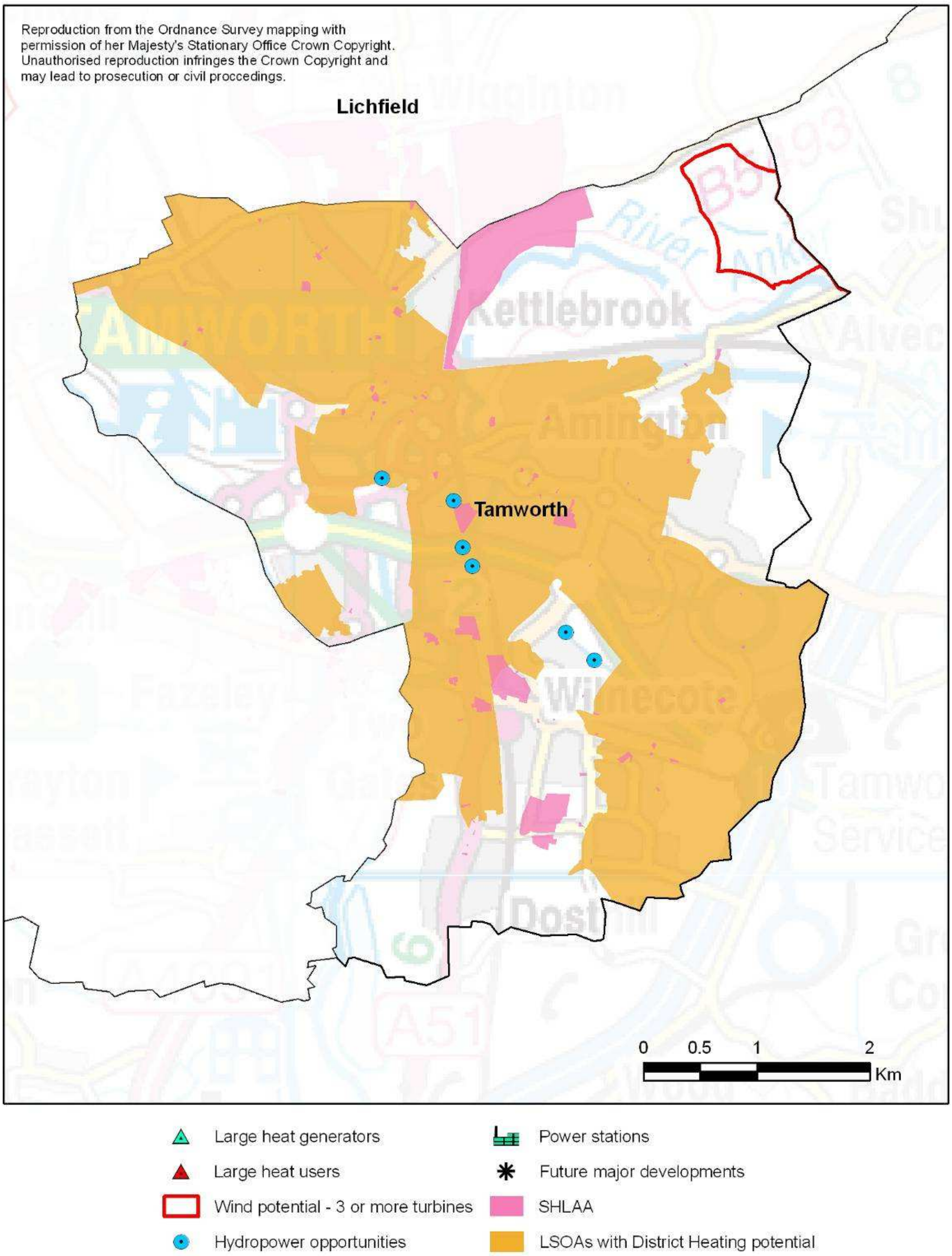
Despite the fact that Tamworth has the smallest biomass resource in the study area, it is the largest single contributor towards low carbon energy generation in the Borough (35%). Tamworth has the smallest allocation of new dwellings in the study area, but quite considerable non-residential floor area given the Borough's size. The installation of microgeneration technologies on these new developments contributes less that the expected uptake in retrofit to existing buildings.

A single site is present which is technically viable for a wind turbine installation, located in the north east corner of the Borough. This site is large enough to help multiple wind turbines, but to account for planning uptake, only a single turbine has been modelled as being present by 2020. A single favourable hydro site at Smurfit Pater Mill is seen as viable.

Carbon targets

A framework of minimum and maximum targets for carbon and low carbon / renewable energy supply is proposed for domestic development. Carbon targets for domestic development are proposed to change over time, linked with the national road map for zero carbon buildings. Low carbon / renewable energy supply targets (only) are proposed for non-domestic development.

Urban extensions within Tamworth will present the best opportunities for going beyond the minimum carbon standards as presented in the proposed framework, since these sites have enough scale for larger scale energy systems to become competitive. Approximately 50% of other dwellings are likely to be delivered in urban sites of 10 units or less, which will have fewer energy supply options and will find it comparatively difficult to go beyond the minimum standards.



Biomass energy sources have not been mapped due to their highly distributed nature.

Appendix II: Notes of Consultation Workshop

The following notes were recorded for the consultation event held at Cannock Chase Council Civic Offices on the 18th March 2010. The principal purpose of the workshop was to review the findings of the study at that point and to seek views on draft recommendations. A secondary objective was to review aspects of the analysis conducted and to identify where improvements could be made, e.g. with additional local information. The workshop agenda was as follows:

- Introduction to workshop
- Overview of study
- Discussion sessions x 3
    A. Carbon standards for new development
    B. Opportunities and constraints for renewable energy generation
    C. Non-planning measures & financing
- Session Feedback & Plenary discussion

The discussion groups were held in rotating cabaret style such that each participant was able to engage with the three topic areas and also so that comments could be refined through subsequent review of previous discussions. Participants were also invited to make raise other queries following the study overview and during the plenary session. Notes from the workshop are shown below.

All members of the Camco project team were involved in the facilitation of the workshop and following the event the team reviewed the comments received. During the remaining elements of the study the policy (and other) recommendations were further refined in discussion with the project steering group, whilst taking account of the comments received from the workshop.

Workshop notes
Theme: Carbon Standards for new development
Energy efficiency ▪ The presentation focused on LZC and RE technologies. Although energy efficiency measures come under the building regs, it was not made clear that guidance in building regs should be exceeded before RE technologies are applied.
Carbon compliance ▪ Promote role of FiT in short term to facilitate solutions and contributions
Allowable solutions ▪ Could authorities use Community Infrastructure Levy now to facilitate allowable solutions so that when the policy is adopted there are projects initiated and the potential investigated?
Site energy studies to examine ability for major developments to go beyond minimum carbon targets ▪ Front loading from the local authority to identify opportunities in the district/borough is

Workshop notes
critical, which can then in turn be reflected in land values to maintain development viability. ▪ Ensure viable opportunities are considered by LPA and developers from early in the planning process to ensure maximum contributions are achieved for lowest cost ▪ Willingness and input from LA in pre-assessment stage, during application and post approval ▪ High level of support for opportunity mapping to set targets ▪ This information should be publicly available
Development viability assessment to consider the full range of planning demands ▪ Flexible approach to appreciate renewable energy/carbon reduction contributions are one of a number of S106 that may be required – need to keep development viable
Issues relating to multiple targets for developers ▪ Translating overall carbon reduction into Code for Sustainable Homes standards - question the need for separate targets and complexity of doing so ▪ The Code for Sustainable homes addresses the issue of carbon reduction as well as other important issues. More emphasis on delivering better Code levels is likely to be less complex for developers compared to additional renewable energy targets. The latter would mean having to satisfy the renewable target, Code for Sustainable Homes levels and Building Regulations. ▪ Concerns were raised over a policy duplicating Building Regs, which could become outdated very quickly. Is there even a need for a policy? ▪ The emphasis should be on reducing carbon emissions as opposed to stipulating a proportion of renewable energy supply. ▪ It would be more prudent to use existing frameworks as ‘targets’. New developments should be asked to achieve a stipulated Code for Sustainable Homes or BREEAM rating (whichever is applicable). Granted, there are methods within these frameworks to avoiding the installation of renewable technologies, but this could be avoided with the necessary renewable energy ‘credits’ being a requirement of the Planning Approval. This would also bring forward a wider set of good design standards such as Lifetime Homes and Scheme Development Standards, along with ensuring greater building U-Values, lower water consumption, adequate room day lighting and better client usability and much more.
Require developers to meet the carbon target framework ▪ Concern over whether a rigid policy could hinder opportunities ▪ Planning authorities need to adopt a flexible approach to renewable energy targets on a project to project basis. Renewable energy opportunities of a site should be made available via planning consultants/planning policy guidance ▪ Policy needs to be flexible at the local level and set out broad principles while working towards national requirements ▪ Policy must be flexible and not discount off-site allowable solutions ▪ Planning policy should not over complicate the ever tightening national requirements of Building Regulations, but facilitate maximising options and reduce potential barriers ▪ Policy should simply show commitment to finding solutions ▪ Policy should look at local circumstance and start with design/passive architecture etc ▪ Policies which detail what Code for Sustainable Homes levels and BREEAM targets are expected during plan period are easier to use for developers ▪ 10% renewable energy targets are widely accepted across the country and it works to start the ball rolling ▪ 10% renewable energy targets are achievable – RPS example of listed building in conservation area in London doing 20% ▪ Concern that requesting all development to reach 10% renewable energy target is unviable when some sites could find it very difficult, yet other sites could well exceed

Workshop notes
10% where near a renewable opportunity. Need a caveat to policy to consider this. ▪ Concern over blanket 10% renewable energy target that it will result in approving bad development with bolt-on renewable energy additions which are tokenistic. It is more important to show development is making a meaningful contribution to achieving carbon reduction? ▪ Implementing a policy in advance of Code for Sustainable Homes (CSH) is a good way to ensure developers have to meet targets before national CSH requirements are in place
Planning Authority response ▪ Critical role of a Supplementary Planning Document (SPD) – need a recommendation to state design detail and opportunities will be considered in an SPD. ▪ Concern over impact on LA resources, lack of Building Control expertise to check, calculations, compliance, and enforcement ▪ Planning system should be flexible and facilitate Building Control to assess compliance ▪ Role of Building Control as an internal consultee in application process ▪ Consider a shared countywide officer/resource to assess energy efficiency statements.
Monitoring & compliance ▪ Monitoring is critical to ensure the policy is effective ▪ Building Control should take ownership for policy compliance. B.C has better existing mechanisms than planning departments to assess compliance etc ▪ Use SAP design in Building Control resource to assess energy efficiency etc ▪ Concern over impact on LA resources, lack of Building Control expertise to check, calculations, compliance, and enforcement ▪ Should LA’s monitor implications and resource impact in 12 months to see if policy is even workable? ▪ Need to speak to CLG and DECC to agree compliance procedure across all LA’s. ▪ Should there be some assumption of building compliance to reduce burden on monitoring? Is monitoring always possible? Views were expressed that it is essential to ensure compliance. Penalties were debated, but not favoured. Debate of different options of “carrot and stick approach”. ▪ Concern over recommendation 9 (penalties) and impact on enforcement. Penalties do not encourage developers to accept the policy.
Miscellaneous ▪ Real need to develop the supply chain early in plan period ▪ Bigger problems with existing stock – what can be done to support retrofitting? ▪ Need to lower carbon from existing stock – can LA’s adopt a policy to look at existing stock? ▪ Maintain steering group to oversee and monitor implementation ▪ Care needs to be taken to ensure that the scope of these recommendations aligns with the requirements of: the draft PPS; Buildings Regulations; and the Household Energy Management Strategy as hosted on the DECC website.
Theme: Opportunities and constraints for renewable energy generation
District heating opportunities and obligation for major developments ▪ Need clarification around what is meant by a ‘major’ development. CHP potential is dependant more on ‘type’ of development rather than size (for example industrial sites). ▪ The new PPS asks LAs to look at CHP anyway thus complementing these recommendations. ▪ CHP units require demand for heat as well as electricity, and are only likely to work in a

Workshop notes
coordinated mixed-use development where there is demand during day and night. Thus will be difficult to achieve in existing developed areas. ▪ These recommendations need to specify whether CHP opportunities should be looked at in both new and existing developments.
Planning protocols for small scale renewables ▪ Permitted Development rights are set out on a national basis and therefore isn't there potential for duplication if they are also set out in the Local Development Framework (LDF)? ▪ LDF should be changed to a Supplementary Planning Document (SPD), due to the latter supporting the core strategies. LDFs may be too specific to each LA.
Criteria based policy for standalone technologies ▪ LA officers pointed out that developing criteria-based planning policies for specific renewable technologies may be difficult due to lack of expertise in the identified technologies. ▪ This recommendation should state that there should be separate policies for each type of renewable technology, to make them easier to implement.
Provision of maps illustrating indicative areas for wind development ▪ The usefulness of mapping wind energy constraints was questioned. In the past such maps have not provided the opportunity for enough applications, as areas deemed as 'constrained' are seen as total no go areas. ▪ Should there be a 5km constraint between existing and new wind farm development? Why is this so high when there is already resource potential there?
Cumulative impact assessment for wind turbines ▪ An AONB is not seen as constraints in the DECC methodology but given the size of Cannock Chase, perhaps it should be a constraint in this case?
Publish low and zero carbon technology resource within LDFs ▪ LDF should be changed to a Supplementary Planning Document (SPD), due to the latter supporting the core strategies. LDFs may be too specific to each LA.
Monitoring of low and zero carbon energy ▪ Concerns were raised about this recommendation with regards to resources needed to achieve the outcome. The potential cost is the main concern.
Miscellaneous ▪ CHP (and other) RE infrastructure is being developed, LAs can fill in the gaps by implementing energy efficiency projects. LAs and consultants should use current policies (such as the Low Carbon Transition Plan) in order to move forward. ▪ Funding streams are available for developers to tap into in order to develop such schemes, a process and advice about which local authorities can facilitate. ▪ Perhaps there should be a new recommendation which specifies that, if something is not mentioned in the existing recommendations, this does not mean it should be ignored when it comes to developing RE technologies and policies.
Theme: Non-planning measures & financing
Carbon tax (e.g. Milton Keynes) ▪ A carbon tax could be seen as a prevention to development
Carbon investment fund ▪ It may take a long time to build up S106 monies for substantial size allowable solutions ▪ Idea of using carbon tax (as above) as a source to provide a loan to developers to

Workshop notes
achieve both onsite targets and allowable solutions ▪ Plans for the fund should be made public prior to funds being sought
Reducing capital cost to the developer ▪ Example of the 'blue planet' warehouse in Newcastle. The cost savings in operating this are substantial, however the developers do not make these savings and therefore there needs to be a mechanism where the whole cost isn't put on the developer ▪ Example of a partnership agreement such as Pay As You Save could be explored. A case study is currently taking place in Birmingham. ▪ Difficulty with ESCOs – balancing tariffs, number of users, long term commitment and certainty over developments coming forward etc. Sheffield an example of where this has worked ▪ Developers could own the technology used for a FIT – this way there will be profit after selling the development – issue with maintenance, rate of return etc. ▪ Opportunities should be looked at to provide loans to developers to improve low carbon measures on new developments so that the improvements are front-loaded with repayments linked to sales.
Allowable Solutions ▪ National vs local allowable solutions – which is more cost effective and efficient in delivering low carbon savings? Doesn't have to be one of the other. ▪ Advantage West Midlands have created a materials opportunities mapping toolkit – this could guide the development of local allowable solutions and will match demand with supply ▪ Could authorities use Community Infrastructure Levy now to facilitate allowable solutions so that when the policy is adopted there are projects initiated and the potential investigated?
Miscellaneous ▪ Issue of legal frameworks ▪ Issue with the lack of local knowledge to advise on these issues at the moment from a pre application discussion stage ▪ Is there a role for LPA's to map the national grid and assist with any necessary improvements or upgrades? S106 monies could contribute towards this.

Appendix III: Glossary

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

GLOSSARY	
AD	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
Allowable solutions	As part of the Government's consultation for zero carbon buildings (still current at the time of writing), a hierarchy was set out for reducing CO_2 emissions of a new home. The third and final level of this hierarchy, after 'energy efficiency' and 'carbon compliance', is 'allowable solutions'. This sets out a set of proposed 'solutions' for dealing with the residual emissions which were not technically or financially viable to abate via the other hierarchy levels. The consultation's proposed allowable solutions include S106 Planning Obligations paid by the developer towards local LZC energy infrastructure and retrofitting works undertaken by the developer to transform the energy efficiency of existing buildings in the vicinity of the development, amongst others. The consultation can be read on the CLG website.
AMR	Annual Monitoring Report: One of a number of documents required to be included in the Local Development Framework Development Plan Documents, submitted to Government via the Regional Government office by a Local Planning Authority at the end of December each year to assess the progress and the effectiveness of a Local Development Framework
APEE	Advanced practice energy efficiency. A reference energy efficiency specification set out by the Energy Saving Trust as guidance for 'advanced' but achievable practice. http://www.energysavingtrust.org.uk/business/Business/Housing-professionals/New-housing/A-history-of-our-newbuild-standards
Base case	A scenario which reports the extent of renewable energy generation based upon the raw data and core assumptions set out for each contributing energy source.
BERR	UK Department for Business, Enterprise & Regulatory Reform, superseded in June 2009 by the Department of Business, Innovation and Skills
BPEE	Best practice energy efficiency. A reference energy efficiency specification set out by the Energy Saving Trust as guidance for 'advanced' but achievable practice. http://www.energysavingtrust.org.uk/business/Business/Housing-professionals/New-housing/A-history-of-our-newbuild-standards
BWEA	British Wind Energy Association
Installed capacity	A term referring to the rated power (often in mega-watts – MW, MWe (electrical) or MWth (thermal)) of existing (and operating) energy generating plant.
Carbon compliance	As part of the Government's consultation for zero carbon buildings (still current at the time of writing), a hierarchy was set out for reducing CO_2 emissions of a new home. The second level of this hierarchy, after 'energy efficiency', is 'carbon compliance'. This requires at least a minimum level of carbon reduction (compared to current Building Regulations) through a combination of energy efficiency measures, incorporation of onsite low and zero carbon (LZC) energy technologies and directly connected heat (not necessarily onsite).

GLOSSARY	
	The consultation can be read on the CLG website.
CHP	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
CHPA	Combined Heat and Power Association
Co-firing	The use of two or more different materials as a fuel source. In the context of this study, this largely relates to the use of biomass as a part-replacement for fossil fuels in large scale combustion systems.
CSH	Code for Sustainable Homes; also referred to as 'Code': The Code is the national standard in England for the sustainable design and construction of new homes. The Code aims to reduce carbon emissions and create homes that are more sustainable by measuring the sustainability of a new home against nine categories of sustainable design, rating the 'whole home' as a complete package. The Code uses a one to six star rating system to communicate the overall sustainability performance of a new home. From 1 May 2008 it became mandatory for all new homes to be rated against the Code and include a Code or nil-rated certificate within the Home Information Pack.
DECC	Department for Energy and Climate Change: Government department created in October 2008. It is responsible for all aspects of UK energy policy, and for tackling global climate change on behalf of the UK.
Decentralised generati	Centralised energy describes the traditional UK energy supply via relatively few yet large scale sources (e.g. power stations). Decentralised energy describes a shift towards a greater number of smaller generating plant, which may be able to provide energy for dedicated users.
Design and access statement	A statement covering design concepts and principles and access issues which is submitted with an application for planning permission and/or listed building consent.
Elevated case	A scenario which reports the extent of renewable energy generation based upon different assumptions in comparison to the 'base case'. This scenario uses the same raw data as the base case.
ESCO	Energy Service Company: This is a professional business providing a broad range of comprehensive energy solutions including designs and implementation of energy savings projects, energy conservation, energy infrastructure outsourcing, power generation and energy supply, and risk management. The ESCO performs an in-depth analysis of the property, designs an energy efficient solution, installs the required elements, and maintains the system to ensure energy savings during the payback period. The savings in energy costs is often used to pay back the capital investment of the project over a five- to twenty-year period, or reinvested into the building to allow for capital upgrades that may otherwise be unfeasible. If the project does not provide returns on the investment, the ESCO is often responsible to pay the difference.
FIT	Feed-in Tariff: A UK Government cashback scheme outlined in the Energy Act 2008 effective from 1 April 2010 guaranteeing payment to people who generate small scale low carbon electricity.
GHG	Greenhouse Gas: Any gas that absorbs infra-red radiation in the atmosphere. The current IPCC (Intergovernmental Panel on Climate Change) inventory includes six major greenhouse gases. These are Carbon dioxide (CO_2), Methane (CH_4), Nitrous oxide (N_2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), Sulphur hexafluoride (SF_6).

GLOSSARY	
GIS analysis	Geographic Information System analysis: includes data that is referenced by spatial or geographic coordinates
GSHP	Ground Source Heat Pump: A heat pump installation that uses the earth as a heat sink to store heat or as a source of heat.
GWh	Gigawatt hour – 1,000,000 kWh. A convenient unit of energy for power generation equipment.
kW	Kilowatt – unit of power. Can be expressed as thermal power (kW_{th}) and electrical power (kW_e). The productive capacity of small scale renewable generation is usually measured in kW
kWh	kilowatt hour – unit of energy. Can be expressed as thermal energy (kWh_{th}) and electrical energy (kWh_e). A convenient unit for consumption at the household level.
kWp	kilowatt peak – maximum power output of a photovoltaic cell, occurring with intense sunlight.
Large wind	Large scale wind, for this study this is assumed as being above 1 MW in capacity (turbine tip height typically greater than 100 m). Within the analysis of potential for wind energy the default size of large scale wind turbines used was 2.5 MW with a tip height of approximately 125 m
Localised National Targets	This represents Camco attempt to translate national targets to local level by excluding those elements of the national target implementation scenario (used with the UK Renewable Energy Strategy) that are not explicitly relevant at a local level, e.g. off-shore wind energy and renewable transport fuels
LDF	Local Development Framework
LSOA	Lower layer super output area. A geographical scale used by government data analysts for reporting information (e.g. population, housing numbers). Commonly used by the Office for National Statistics and for reporting census data.
LULUCF	Land use, land use change and forestry. This is a CO_2 source or sink depending upon the locale, and is a category for annual reported CO_2 emissions set out under NI186 (see below)
LZC	Low and Zero Carbon
Merton rule	A policy, pioneered by Merton Council, which states a minimum contribution of renewable energy for a new development (as a percentage of energy consumption of the building). Such a policy is applied in parallel to Building Regulation CO_2 requirements.
Microgeneration	The small scale generation of energy, typically providing all or part of the energy demands of a single building or site. There is no formal threshold of size.
MLSOA	Middle Layer Super Output Area; Super Output Areas are a unit of geography used in the UK for statistical analysis. They are developed and released by Neighbourhood Statistics. Middle Layer SOAs have a minimum population 5000, and a mean population 7200. Built from Lower Layer SOAs. There are 7,193 MLSOAs in England and Wales
MOD	Ministry of Defence
MSW	Municipal Solid Waste: Waste type that includes predominantly household waste (domestic waste) with sometimes the addition of commercial wastes collected by

GLOSSARY	
	a municipality within a given area.
$MTCO_2e$	Million Tonnes of Carbon Dioxide Equivalent
MW	Megawatts. The productive capacity of electrical generation plant is often measured in MWe.
MW_e	Megawatts of electrical capacity.
MW_{th}	Megawatts of thermal capacity.
MWh	Megawatt-hour, equal to 1,000 kWh.
NI186	National Indicator 186. Under a performance framework for Local Authorities, NI186 measures the per capita reduction in CO_2 emissions in the Local Authority area. Further details can be found on the DECC website. http://www.decc.gov.uk/en/content/cms/statistics/indicators/ni186/ni186.aspx
NOABL	A wind speed database provided by the Department of Climate Change which gives estimates of the annual mean wind speed throughout the UK
ODT	Oven Dried Tonne – the dry weight of a material which naturally occurs with a significant moisture content
Off gas grid	A geographical area which is not connected to the gas grid (or has sporadic connections)
Per capita emissions	CO_2 emissions of a local authority or region, normalised by the population within that geographical area
Point source emitters	Sites or buildings which contribute significantly towards a locale's CO_2 emissions
PPS	Planning Policy Statement
Regulated energy	Elements of a building's energy consumption to which minimum standards must be achieved to comply with Building Regulations. 'Regulated' energy includes space heating, hot water, lighting and ventilation (fans and pumps), but does not include appliances and small electrical items.
Renewable heat incen (RHI)	A proposed financial incentive, which gives low and zero carbon heat producers a revenue for every unit of heat which is produced. At the time of writing, the RHI is at consultation stage, and is expected to be introduced in April 2011.
RESTATS	Renewable Energy Statistics. A website which contains details of large scale renewable energy installations in the UK. https://restats.decc.gov.uk/cms/welcome-to-the-restats-web-site
Retrofit	In installation of energy efficiency and/or renewable energy technologies to an existing building
ROC	Renewable Obligation Certificate. A green certificate issued to an accredited generator for eligible renewable electricity generated within the United Kingdom and supplied to customers within the United Kingdom by a licensed electricity supplier. One ROC is issued for each megawatt hour (MWh) of eligible renewable output generated. A ROC has a monetary value and hence provides an income stream for large scale renewable energy generators.
SAP	Standard Assessment Procedure. This is the government's adopted methodology for modelling the 'regulated' energy use in domestic buildings, and is used for compliance against Building Regulations (see also 'regulated energy'

GLOSSARY	
	above)
SBEM	Simplified Building Energy Model. SBEM is a computer program that provides an analysis of a build'ng's energy consumption.
SHLAA	Strategic Housing Land Availability Assessment
SHW / STHW	Solar Hot Water; also known as Solar Thermal Hot Water
Small wind	Small scale wind, for this study this is assumed as being below 500 kW in capacity (turbine tip height typically less than 60 m)
Solar PV	Solar Photovoltaic
SPV	Special Purpose Vehicle; a legal entity set up for a specific purpose: to isolate financial risk from a lead organisation.
tCO_2/yr	Tonnes (metric) of CO_2 per year
TCPA	Town and Country Planning Association
U-value	A measure of the heat loss through building fabric for an individual construction material or construction type (measured inM^2/m^2K). A low U-value indicates good levels of insulation for a building element.
UK Road Map	A reference to the Government's tightening of Building Regulations for domestic buildings, moving towards 'zero carbon' in 2016.
Unregulated energy	The expected energy use in a building which is not 'regulated' (see 'Regulated energy' above). Unregulated energy does not fall under Building Regulations, and most typically includes appliances and small electrical items.
Windspeed Database	A wind speed database provided by the Department of Climate Change which gives estimates of the annual mean wind speed throughout the UK http://www.decc.gov.uk/en/windspeed/default.aspx
Zero carbon	A building which will have net zero carbon emissions over the course of a year. Current consultation is seeking to agree what methods will be permitted to achieve this status. Zero carbon is unlikely to require all buildings to meet 100% of their energy demand using on-site systems.

Appendix IV: CO_2 emissions for the study area

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

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

RegionName	LARegionName	Year	A. Industry and Commercial Electricity	B. Industry and Commercial Gas	C. Industry and Commercial Large Gas Users	D. Industry and Commercial Oil	F. Industry and Commercial Solid fuel	G. Industry and Commercial Process gases	H. Industry and Commercial Wastes and biofuels	I. Industry and Commercial Non fuel	J. Industry Offroad	K. Diesel Railways	L. Agriculture Oil	M. Agriculture Solid fuel	N. Agriculture Non fuel	O. Domestic Electricity	P. Domestic Gas
	Cannock Chase	2007	114	49	-	14	3	1	0	-	20	0	1	-	0	96	121
	East Staffordshire	2007	277	129	-	49	13	0	1	0	37	11	14	0	0	118	117
	Lichfield	2007	152	34	-	46	8	1	0	0	19	14	6	0	0	110	124
	Newcastle-under-Lyme	2007	134	95	-	9	1	0	0	-	15	6	7	0	0	118	157
	South Staffordshire	2007	117	81	-	15	1	2	0	-	16	7	9	0	0	112	128
	Stafford	2007	194	78	-	24	5	0	1	-	23	18	19	0	0	137	145
	Staffordshire Moorlands	2007	198	65	-	24	224	0	27	429	18	0	20	0	0	102	116
	Tamworth	2007	109	34	-	4	0	2	0	-	13	6	0	-	-	78	83
West Midlands Total	WEST MIDLANDS	2007	8,886	3,516	339	984	972	276	89	1,174	1,115	246	300	1	3	5,585	6,122

RegionName	LARegionName	Q. Domestic Oil	R. Domestic Solid fuel	S. Domestic House and Garden Oil	T. Domestic Products	U. A-Roads Petrol	V. A-Roads Diesel	W. Motorways Petrol	X. Motorways Diesel	Y. Minor Petrol	Z. Minor Diesel	ZA. Road Transport Other	ZB. LULUCF Emissions Soils & Deforestation	ZC. LULUCF Emissions Other	ZD. LULUCF Removals	Grand Total	Population ('000s, mid-year estimate)	Per Capita Emissions (t)	Domestic emissions fom energy	Domestic per capita emissions (t)
	Cannock Chase	3	7	1	2	27	33	9	12	25	19	1	0	6	- 5	559	94.4	5.9	227	2.41
	East Staffordshire	6	2	1	3	63	96	-	-	41	38	1	2	27	- 23	1,023	108.3	9.4	243	2.24
	Lichfield	9	4	1	2	91	135	29	37	27	23	1	2	24	- 24	876	97.5	9.0	247	2.53
	Newcastle-under-Lyme	8	5	1	3	64	73	42	139	54	41	1	1	15	- 12	976	124.3	7.9	287	2.31
	South Staffordshire	15	7	1	3	61	75	96	286	39	33	2	2	31	- 21	1,119	106.3	10.5	262	2.47
	Stafford	19	7	1	3	77	88	91	287	45	41	2	3	45	- 32	1,321	124.0	10.7	308	2.49
	Staffordshire Moorlands	19	10	1	3	48	67	-	-	36	34	1	1	31	- 30	1,443	95.4	15.1	248	2.60
	Tamworth	1	1	0	2	20	19	-	-	23	17	0	0	2	- 2	413	75.6	5.5	162	2.14
West Midlands Total	WEST MIDLANDS	346	221	35	137	2,173	2,407	1,140	3,042	2,493	1,966	53	66	1,092	- 784	43,994	5,382	8.2	12,273	2.28

LARegionName	Year	Electrical	Thermal	Transport	LULUCF	Other	TOTAL
Cannock Chase	2007	210	199	145	1	3	**559**
East Staffordshire	2007	396	331	288	5	4	**1,023**
Lichfield	2007	262	232	376	2	3	**876**
Newcastle-under-Lyme	2007	251	281	435	4	4	**976**
South Staffordshire	2007	229	258	616	12	4	**1,119**
Stafford	2007	331	298	672	16	4	**1,321**
Staffordshire Moorlands	2007	300	504	204	3	432	**1,443**
Tamworth	2007	187	125	98	0	2	**413**

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

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

Study area equates to 1.5% of UK emissions
Study area equates to 18% of West Midlands emissions

DECC Energy Projections – central energy prices, central policy, central growth

Source: http://www.decc.gov.uk/en/content/cms/statistics/projections/projections.aspx

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Commercial																							
Electricity	5,982	6,192	6,274	6,383	6,381	6,474	6,481	6,469	6,479	6,511	6,517	6,516	6,525	6,534	6,544	6,551	6,537	6,525	6,509	6,489	6,466	6,522	6,576
Gas	5,536	5,550	4,771	5,163	5,089	4,721	4,497	4,580	4,863	5,205	5,406	5,501	5,621	5,741	5,858	5,922	5,975	5,962	5,872	5,783	5,544	5,602	5,660
Petroleum	617	1,073	499	417	657	849	733	719	686	672	656	620	587	550	500	444	442	385	329	307	255	260	266
Solid / manufactured fuels[1]	10	10	5	5	5	6	7	6	7	7	7	6	6	6	5	5	5	5	4	4	3	3	3
Industrial[2]																							
Electricity	9,266	9,117	9,248	9,280	9,495	9,932	9,668	9,700	9,350	8,624	8,269	8,200	8,302	8,500	8,708	8,880	9,029	9,182	9,353	9,539	9,738	9,930	10,107
Gas	15,908	15,548	14,372	14,158	13,513	13,363	12,688	12,063	11,673	10,762	10,337	10,145	10,077	10,061	10,072	10,048	9,986	9,909	9,806	9,581	9,344	9,306	9,293
Petroleum	6,388	6,981	6,337	6,982	6,942	7,308	7,297	6,930	6,302	5,924	5,665	5,493	5,393	5,323	5,238	5,144	4,914	4,746	4,583	4,328	4,146	4,165	4,183
Solid / manufactured fuels[1]	1,855	1,852	1,877	1,702	1,591	1,603	1,555	1,607	1,409	1,238	1,166	1,147	1,137	1,120	1,087	1,045	977	906	836	750	675	666	658
Domestic																							
Electricity	9,617	9,917	9,848	9,954	9,933	10,044	10,013	9,893	10,071	9,710	9,346	9,125	9,125	9,131	9,103	9,087	9,068	9,039	9,030	9,007	8,978	9,203	9,388
Gas	31,806	32,625	32,362	33,232	34,085	33,019	31,371	30,090	31,803	31,696	30,692	29,623	28,772	27,976	27,137	26,349	25,583	24,852	24,438	23,912	23,341	23,791	24,069
Petroleum	3,239	3,527	3,087	3,068	3,265	3,093	3,251	2,877	2,951	2,903	2,841	2,727	2,592	2,452	2,299	2,127	1,928	1,738	1,543	1,395	1,239	1,199	1,162
Solid / manufactured fuels[1]	1,908	1,837	1,425	1,159	999	697	634	678	418	339	260	199	181	165	150	135	120	106	92	78	65	52	39
Indexed change from 2007 levels																							
C&I - electrical	94	95	96	97	98	101	100	100	98	94	91	91	92	93	94	95	96	97	98	99	100	102	103
C&I - thermal[3]	117	120	108	110	107	108	103	100	96	92	90	88	88	88	88	87	86	85	83	80	77	77	77
Domestic - electrical	97	100	100	101	100	102	101	100	102	98	94	92	92	92	92	92	92	91	91	91	91	93	95
Domestic - thermal[3]	110	113	110	111	114	109	105	100	105	104	100	97	94	91	88	85	82	79	77	75	73	74	75

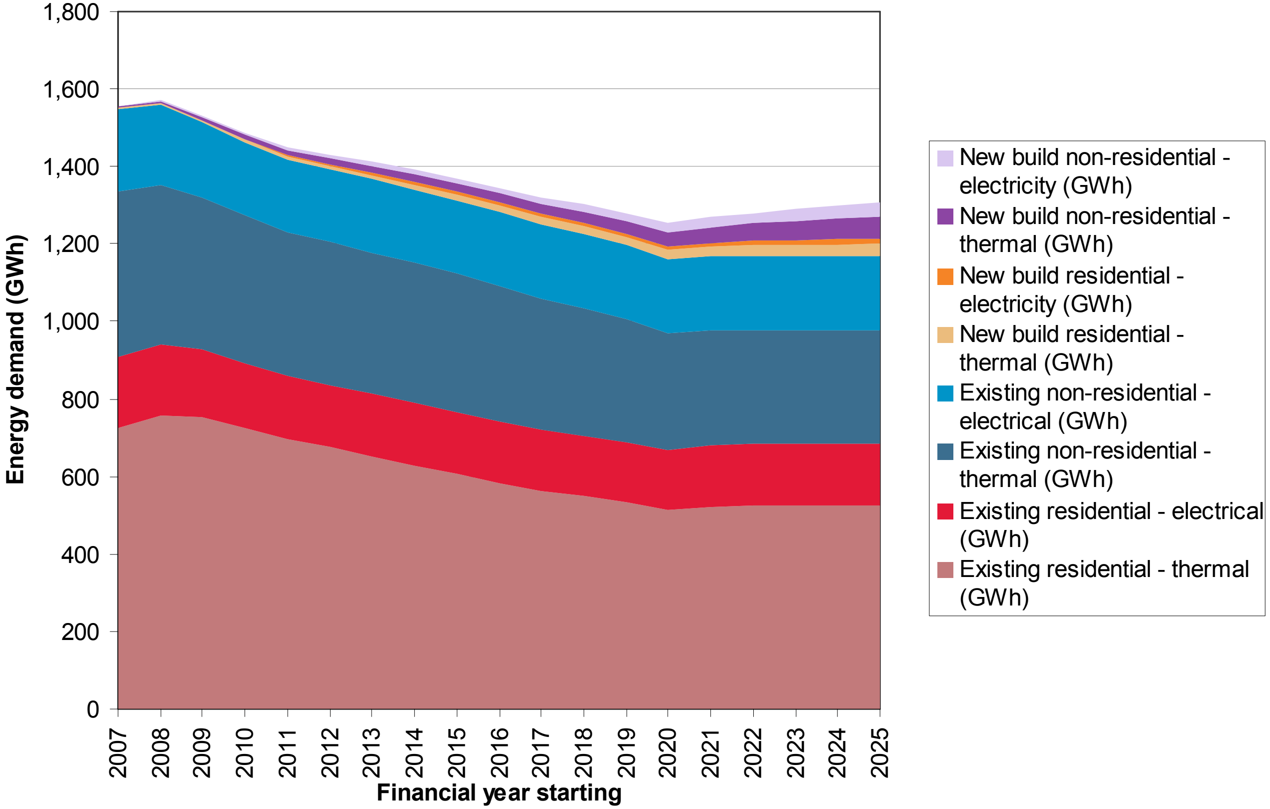
1 Includes coal, manufactured sold fuels, benzole, tars, blast furnace gas and coke oven gas

2 Includes energy used to produce heat sold under the provision of a contract

3 Assumes that all gas, petroleum and solid/manufactured fuels are used for thermal energy alone

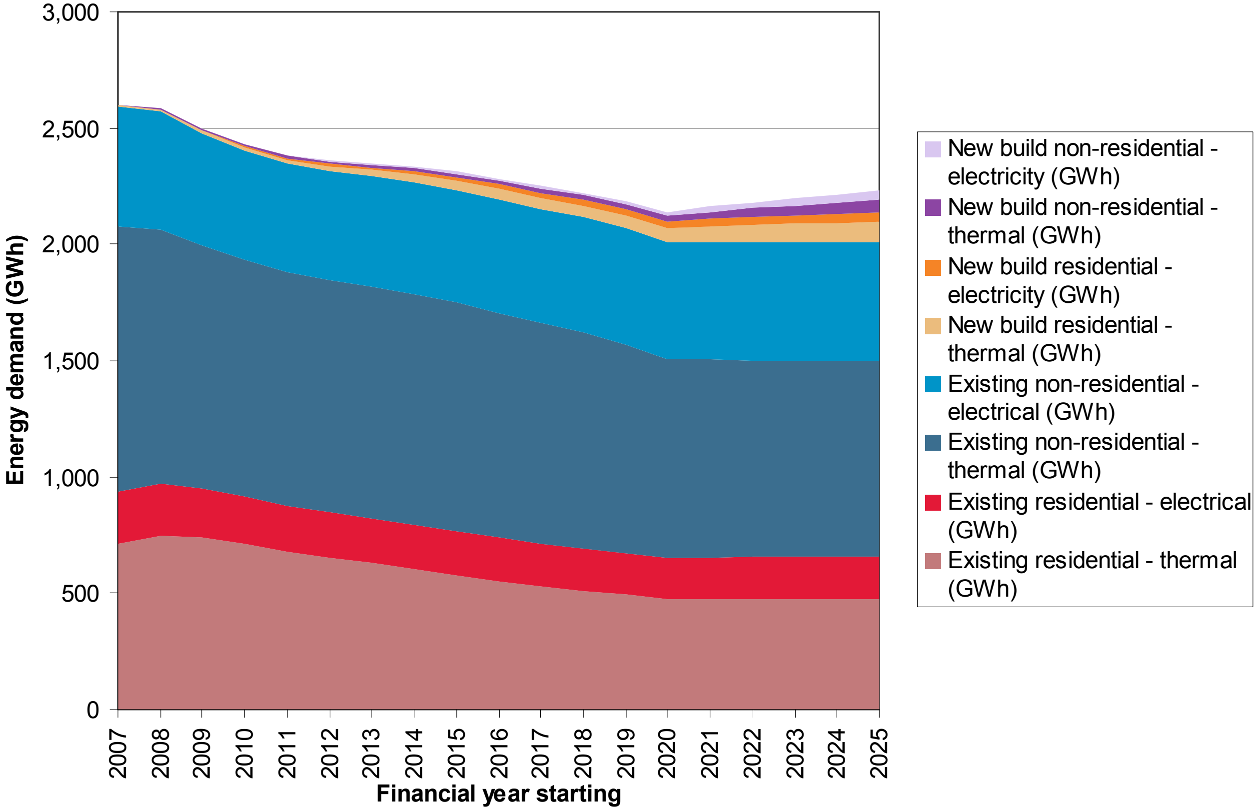
Cannock Chase

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Existing residential - thermal (GWh)	727	759	752	726	697	674	652	629	607	584	563	548	532	515	521	524	524	524	524	524
Existing residential - electrical (GWh)	180	182	175	168	163	162	162	160	159	158	157	156	155	154	157	159	159	159	159	159
Existing non-residential - thermal (GWh)	431	412	391	379	371	367	365	361	357	349	341	331	318	302	298	295	295	295	295	295
Existing non-residential - electrical (GWh)	212	206	196	190	187	187	188	189	190	190	190	191	191	191	191	191	191	191	191	191
New build residential - thermal (GWh)	1.9	3.3	4.8	6.3	8.0	9.6	11.3	13.0	14.6	16.3	18.0	19.6	21.3	22.9	24.6	26.3	27.9	29.6	31.3	31.3
New build residential - electricity (GWh)	0.9	1.5	2.2	2.9	3.7	4.5	5.2	6.0	6.8	7.6	8.3	9.1	9.9	10.6	11.4	12.2	13.0	13.7	14.5	14.5
New build non-residential - thermal (GWh)	2.5	4.9	7.4	9.9	12.3	14.8	17.2	19.7	22.2	24.6	27.1	29.6	32.0	36.2	40.4	44.5	48.7	52.8	57.0	61.2
New build non-residential - electricity (GWh)	1.5	3.1	4.6	6.2	7.7	9.2	10.8	12.3	13.9	15.4	16.9	18.5	20.0	22.6	25.2	27.8	30.4	33.0	35.6	38.2
Thermal energy (GWh/yr)	1,162	1,179	1,155	1,121	1,089	1,066	1,045	1,023	1,000	974	949	928	903	876	884	890	896	902	907	912
Electrical energy (GWh/yr)	395	393	378	367	362	363	366	368	370	371	373	374	376	378	384	390	393	397	400	403
Total (GWh/yr)	1,556	1,572	1,533	1,488	1,451	1,429	1,411	1,391	1,370	1,346	1,321	1,302	1,279	1,253	1,269	1,280	1,289	1,298	1,308	1,314



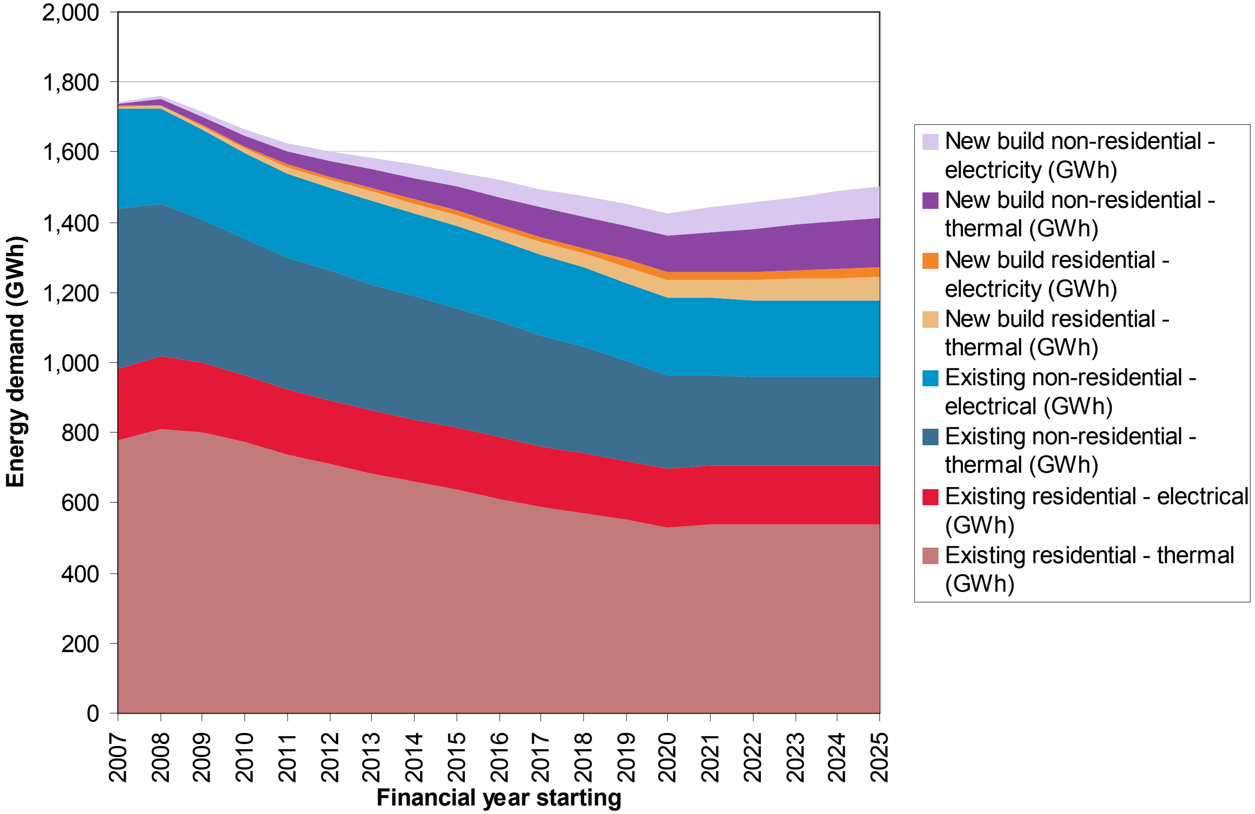
East Staffordshire

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Existing residential - thermal (GWh)	715	745	738	710	679	653	628	602	578	553	529	512	494	475	477	477	477	477	477	477
Existing residential - electrical (GWh)	220	223	214	204	198	195	193	190	188	185	183	180	178	175	177	179	179	179	179	179
Existing non-residential - thermal (GWh)	1,141	1,097	1,046	1,019	1,003	997	995	992	983	968	950	927	897	856	851	848	848	848	848	848
Existing non-residential - electrical (GWh)	517	505	482	470	467	469	475	481	485	489	492	496	500	502	505	508	508	508	508	508
New build residential - thermal (GWh)	4.3	7.3	9.7	13.1	17.6	22.9	28.1	33.2	38.1	42.9	47.8	52.7	57.5	62.4	67.3	72.1	77.0	81.9	86.7	86.7
New build residential - electricity (GWh)	1.9	3.2	4.3	5.8	7.7	10.0	12.3	14.5	16.7	18.8	20.9	23.1	25.2	27.3	29.5	31.6	33.7	35.9	38.0	38.0
New build non-residential - thermal (GWh)	1.6	3.2	4.8	6.4	8.0	9.6	11.2	12.8	14.3	15.9	17.5	19.1	20.7	27.0	33.4	39.7	46.0	52.3	58.6	65.0
New build non-residential - electricity (GWh)	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	16.9	20.9	24.8	28.8	32.7	36.7	40.6
Thermal energy (GWh/yr)	1,862	1,852	1,798	1,748	1,708	1,683	1,662	1,640	1,613	1,580	1,545	1,511	1,469	1,420	1,429	1,436	1,448	1,459	1,470	1,476
Electrical energy (GWh/yr)	740	733	703	684	677	680	687	693	699	703	706	711	716	721	733	743	749	756	762	766
Total (GWh/yr)	2,602	2,586	2,501	2,432	2,385	2,363	2,349	2,333	2,312	2,283	2,251	2,222	2,184	2,141	2,162	2,180	2,197	2,214	2,232	2,242



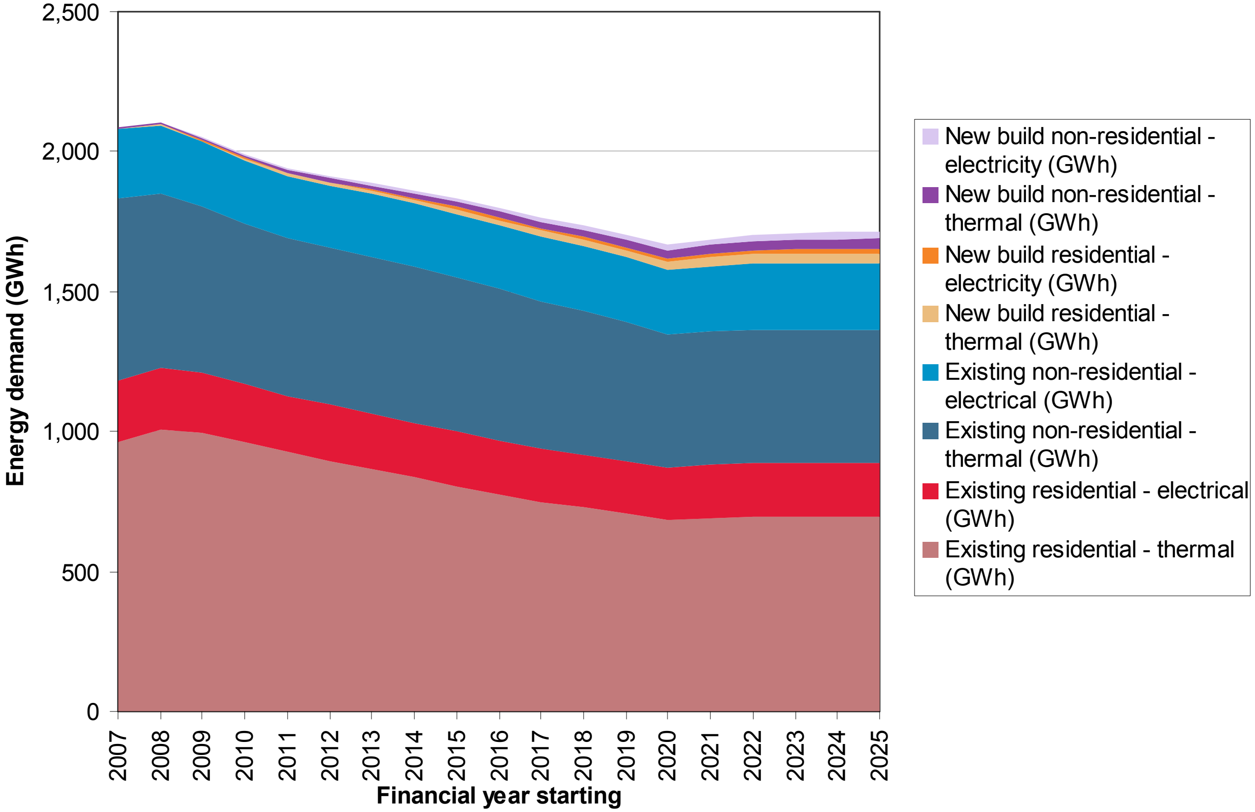
Lichfield

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Existing residential - thermal (GWh)	777	810	802	773	739	711	685	660	637	613	589	571	551	531	536	537	537	537	537	537
Existing residential - electrical (GWh)	204	207	198	190	183	181	179	177	176	175	173	171	169	167	169	171	171	171	171	171
Existing non-residential - thermal (GWh)	460	435	408	390	377	368	360	352	342	330	317	302	285	267	260	253	253	253	253	253
Existing non-residential - electrical (GWh)	284	273	257	246	240	237	236	235	233	230	227	225	223	220	219	217	217	217	217	217
New build residential - thermal (GWh)	4.4	6.5	9.4	12.4	17.6	22.7	27.8	29.4	31.4	33.6	36.9	41.0	45.3	49.5	53.1	57.2	60.2	63.1	65.0	65.0
New build residential - electricity (GWh)	1.9	2.8	4.0	5.2	7.5	9.6	11.8	12.5	13.3	14.3	15.7	17.4	19.2	21.0	22.5	24.3	25.6	26.8	27.6	27.6
New build non-residential - thermal (GWh)	7.5	15.1	22.6	30.1	37.6	45.2	52.7	60.2	67.8	75.3	82.8	90.4	97.9	105.4	112.9	120.5	128.0	135.5	143.1	150.6
New build non-residential - electricity (GWh)	4.7	9.4	14.1	18.8	23.5	28.2	32.9	37.6	42.4	47.1	51.8	56.5	61.2	65.9	70.6	75.3	80.0	84.7	89.4	94.1
Thermal energy (GWh/yr)	1,249	1,267	1,242	1,206	1,172	1,147	1,126	1,102	1,078	1,052	1,025	1,005	980	953	962	968	978	989	998	1,006
Electrical energy (GWh/yr)	495	493	473	460	454	456	459	462	465	466	468	470	472	474	481	488	494	500	505	510
Total (GWh/yr)	1,744	1,759	1,715	1,665	1,626	1,603	1,585	1,565	1,543	1,518	1,493	1,475	1,452	1,427	1,444	1,456	1,472	1,489	1,503	1,516



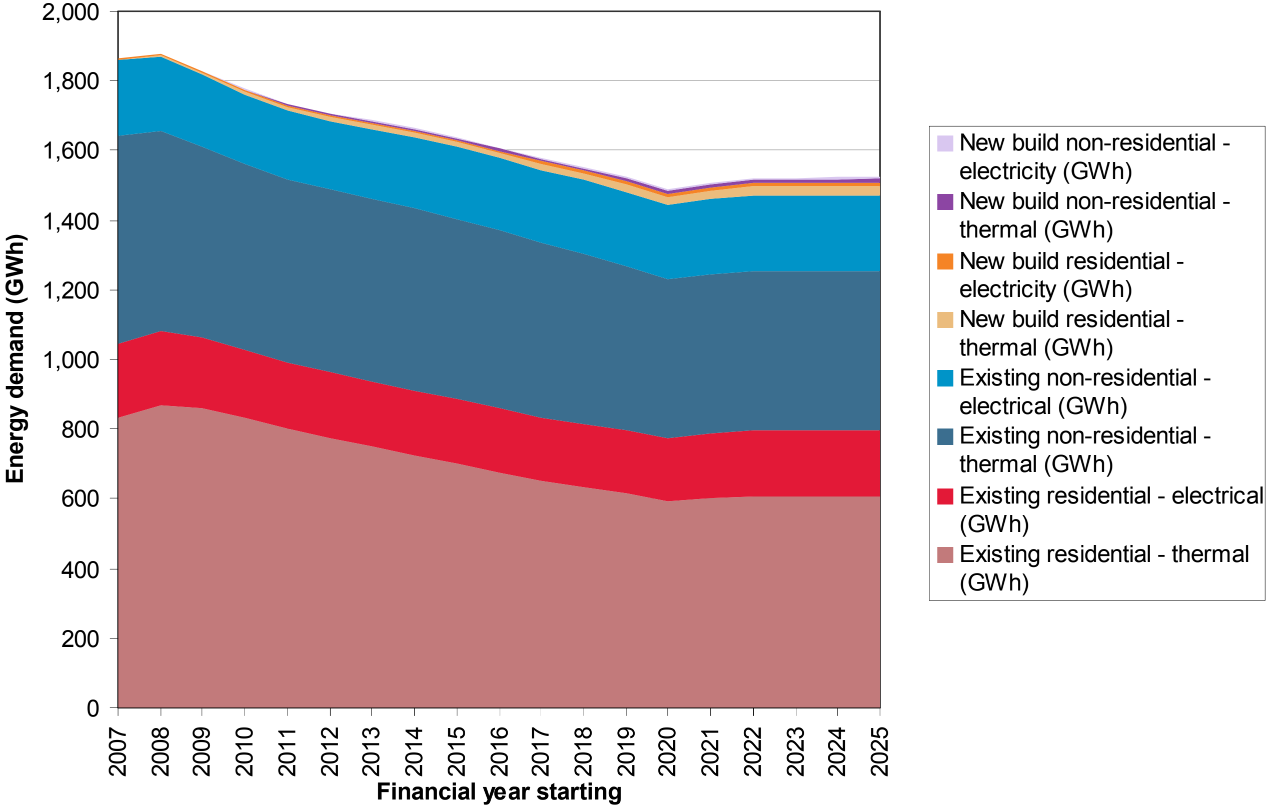
Newcastle-under-Lyme

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Existing residential - thermal (GWh)	964	1,006	998	964	927	896	867	836	806	776	747	727	705	683	692	697	697	697	697	697
Existing residential - electrical (GWh)	219	222	213	205	199	198	197	196	194	193	191	190	188	187	190	193	193	193	193	193
Existing non-residential - thermal (GWh)	648	622	592	576	565	561	559	555	550	540	529	515	497	476	475	474	474	474	474	474
Existing non-residential - electrical (GWh)	250	243	231	224	222	222	224	226	228	228	229	230	231	232	235	237	237	237	237	237
New build residential - thermal (GWh)	1.2	3.3	4.6	5.7	7.3	9.3	11.7	13.9	16.5	18.9	21.5	24.0	26.6	28.1	30.1	31.9	33.5	34.3	35.2	35.2
New build residential - electricity (GWh)	0.6	1.5	2.1	2.6	3.4	4.3	5.4	6.4	7.6	8.7	9.9	11.1	12.2	13.0	13.9	14.7	15.4	15.8	16.2	16.2
New build non-residential - thermal (GWh)	2.1	4.1	6.2	8.3	10.4	12.4	14.5	16.6	18.7	20.7	22.8	24.9	27.0	29.0	31.1	33.2	35.2	37.3	39.3	41.4
New build non-residential - electricity (GWh)	1.3	2.6	3.9	5.2	6.5	7.8	9.1	10.4	11.7	13.0	14.3	15.6	16.9	18.1	19.4	20.7	22.0	23.3	24.6	25.9
Thermal energy (GWh/yr)	1,616	1,635	1,600	1,553	1,510	1,479	1,452	1,422	1,391	1,356	1,320	1,291	1,256	1,216	1,228	1,236	1,239	1,242	1,245	1,247
Electrical energy (GWh/yr)	470	469	450	437	431	433	436	439	441	443	444	446	448	450	458	465	467	469	471	472
Total (GWh/yr)	2,086	2,104	2,051	1,991	1,941	1,912	1,888	1,861	1,832	1,798	1,764	1,737	1,704	1,666	1,686	1,701	1,707	1,711	1,716	1,719



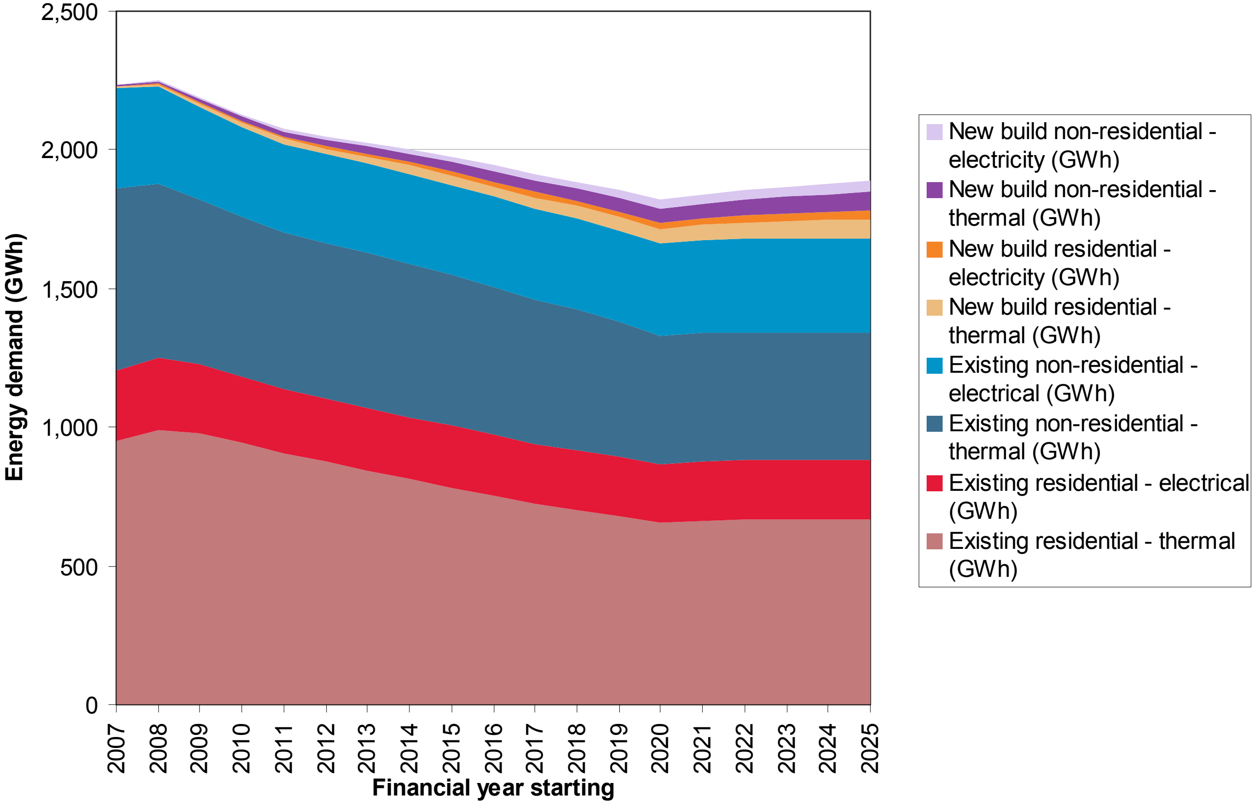
South Staffordshire

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Existing residential - thermal (GWh)	834	870	862	832	800	774	750	724	699	674	650	633	614	594	603	608	608	608	608	608
Existing residential - electrical (GWh)	209	211	203	195	189	189	188	187	187	186	185	184	182	181	185	189	189	189	189	189
Existing non-residential - thermal (GWh)	598	575	548	534	526	524	523	521	517	510	500	489	473	454	455	455	455	455	455	455
Existing non-residential - electrical (GWh)	219	214	204	199	198	199	201	204	206	207	209	211	212	214	217	220	220	220	220	220
New build residential - thermal (GWh)	2.8	5.3	7.4	8.9	10.5	11.8	12.9	13.7	14.5	15.6	17.2	19.1	21.4	22.9	24.3	24.7	25.0	25.3	25.6	25.6
New build residential - electricity (GWh)	1.2	2.2	3.1	3.7	4.4	5.0	5.4	5.8	6.1	6.6	7.2	8.0	9.0	9.7	10.2	10.4	10.5	10.7	10.8	10.8
New build non-residential - thermal (GWh)	0.5	1.1	1.6	2.2	2.7	3.2	3.8	4.3	4.8	5.4	5.9	6.5	7.0	7.5	8.1	8.6	9.1	9.7	10.2	10.8
New build non-residential - electricity (GWh)	0.3	0.7	1.0	1.3	1.7	2.0	2.4	2.7	3.0	3.4	3.7	4.0	4.4	4.7	5.0	5.4	5.7	6.0	6.4	6.7
Thermal energy (GWh/yr)	1,435	1,451	1,419	1,378	1,340	1,313	1,289	1,263	1,236	1,205	1,173	1,147	1,115	1,079	1,090	1,097	1,097	1,098	1,099	1,100
Electrical energy (GWh/yr)	429	428	411	399	393	394	397	400	402	403	404	406	408	410	418	424	425	425	426	426
Total (GWh/yr)	1,864	1,879	1,830	1,776	1,733	1,707	1,686	1,663	1,638	1,608	1,578	1,554	1,523	1,489	1,507	1,521	1,522	1,524	1,525	1,526



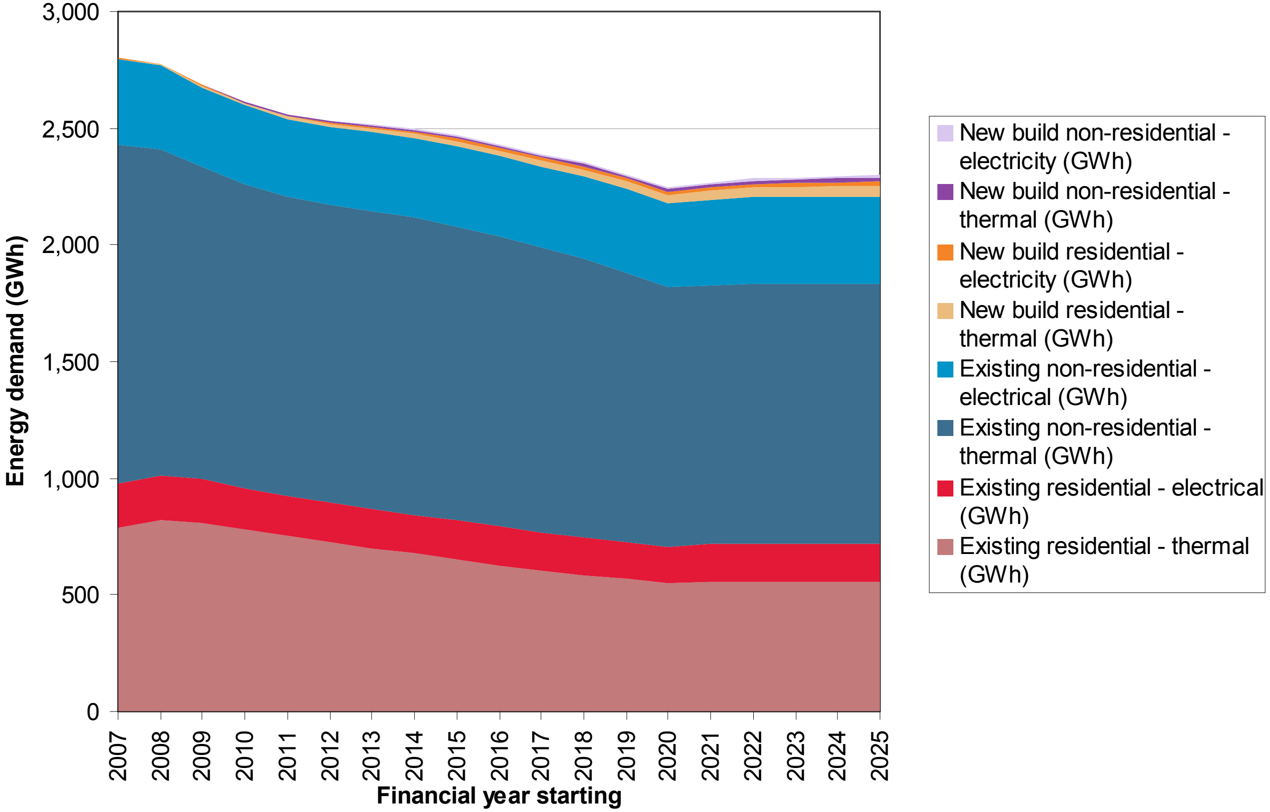
Stafford

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Existing residential - thermal (GWh)	952	991	981	945	906	875	845	813	783	752	723	702	680	656	663	666	666	666	666	666
Existing residential - electrical (GWh)	255	258	248	237	229	228	226	224	222	220	218	216	214	211	215	218	218	218	218	218
Existing non-residential - thermal (GWh)	655	627	595	577	566	560	556	551	544	533	520	505	485	463	461	458	458	458	458	458
Existing non-residential - electrical (GWh)	361	351	334	324	320	320	322	325	326	327	328	329	330	331	334	337	337	337	337	337
New build residential - thermal (GWh)	3.7	7.5	11.2	14.9	18.7	22.4	26.1	29.9	33.6	37.4	41.1	44.8	48.6	52.3	56.0	59.8	63.5	67.2	71.0	71.0
New build residential - electricity (GWh)	1.6	3.2	4.8	6.4	8.0	9.6	11.2	12.8	14.4	16.0	17.6	19.2	20.8	22.4	24.0	25.6	27.2	28.8	30.4	30.4
New build non-residential - thermal (GWh)	3.6	7.2	10.8	14.3	17.9	21.5	25.1	28.7	32.3	35.8	39.4	43.0	46.6	50.2	53.8	57.3	60.9	64.5	68.1	71.7
New build non-residential - electricity (GWh)	2.2	4.5	6.7	9.0	11.2	13.4	15.7	17.9	20.2	22.4	24.6	26.9	29.1	31.4	33.6	35.8	38.1	40.3	42.6	44.8
Thermal energy (GWh/yr)	1,614	1,633	1,598	1,552	1,509	1,478	1,452	1,423	1,392	1,358	1,323	1,295	1,261	1,222	1,234	1,241	1,249	1,256	1,263	1,267
Electrical energy (GWh/yr)	620	617	593	576	569	571	576	580	583	585	588	591	594	597	607	616	620	624	627	630
Total (GWh/yr)	2,235	2,250	2,191	2,127	2,077	2,050	2,027	2,002	1,975	1,943	1,911	1,886	1,854	1,819	1,841	1,857	1,868	1,879	1,891	1,896



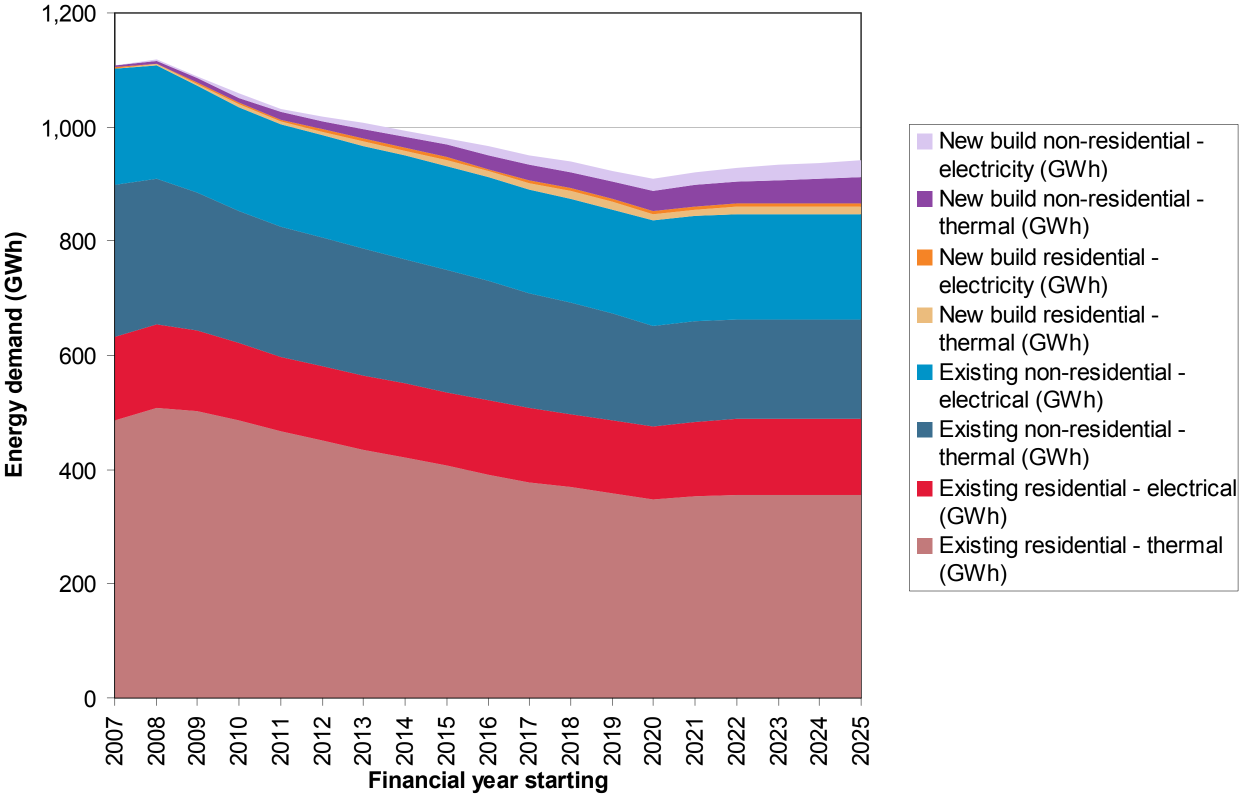
Staffordshire Moorlands

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Existing residential - thermal (GWh)	785	818	811	782	751	725	701	675	651	626	602	585	567	548	554	557	557	557	557	557
Existing residential - electrical (GWh)	191	194	186	178	173	172	171	169	168	167	165	164	162	161	164	166	166	166	166	166
Existing non-residential - thermal (GWh)	1,453	1,399	1,335	1,302	1,282	1,276	1,273	1,270	1,260	1,242	1,219	1,192	1,153	1,109	1,110	1,113	1,113	1,113	1,113	1,113
Existing non-residential - electrical (GWh)	368	360	344	336	333	335	339	343	346	348	351	354	357	361	366	370	370	370	370	370
New build residential - thermal (GWh)	2.1	4.1	6.2	8.4	10.8	13.3	15.7	18.2	20.7	23.3	25.9	28.6	31.2	33.8	36.4	39.1	41.7	44.3	46.9	46.9
New build residential - electricity (GWh)	0.9	1.7	2.5	3.4	4.4	5.4	6.4	7.5	8.5	9.5	10.6	11.7	12.8	13.8	14.9	16.0	17.1	18.2	19.2	19.2
New build non-residential - thermal (GWh)	0.3	0.6	1.0	2.2	3.5	4.8	6.1	7.4	8.7	10.0	10.7	11.5	12.2	13.0	13.7	14.5	15.2	16.0	16.7	17.5
New build non-residential - electricity (GWh)	0.2	0.4	0.6	1.4	2.2	3.0	3.8	4.6	5.4	6.2	6.7	7.2	7.6	8.1	8.6	9.0	9.5	10.0	10.4	10.9
Thermal energy (GWh/yr)	2,241	2,222	2,153	2,095	2,047	2,019	1,996	1,971	1,940	1,901	1,858	1,817	1,764	1,704	1,714	1,723	1,726	1,730	1,733	1,734
Electrical energy (GWh/yr)	560	556	533	518	513	515	520	524	528	531	533	537	540	543	553	561	563	564	566	566
Total (GWh/yr)	2,801	2,778	2,686	2,613	2,560	2,534	2,516	2,495	2,468	2,431	2,391	2,354	2,304	2,247	2,267	2,284	2,289	2,294	2,299	2,300



Tamworth

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Existing residential - thermal (GWh)	487	508	503	485	466	450	435	421	406	392	378	369	359	348	353	356	356	356	356	356
Existing residential - electrical (GWh)	145	147	141	136	132	131	131	130	129	129	128	128	127	127	130	132	132	132	132	132
Existing non-residential - thermal (GWh)	267	255	241	233	227	224	221	218	214	209	203	196	188	178	176	174	174	174	174	174
Existing non-residential - electrical (GWh)	203	198	187	182	179	179	180	181	182	182	182	182	183	183	185	186	186	186	186	186
New build residential - thermal (GWh)	1.1	2.2	3.7	4.9	6.3	7.5	8.8	9.3	9.8	10.3	10.8	11.3	11.7	12.1	12.4	12.7	12.7	12.7	12.7	12.7
New build residential - electricity (GWh)	0.5	1.0	1.7	2.3	3.0	3.5	4.2	4.4	4.7	4.9	5.1	5.4	5.6	5.8	5.9	6.0	6.0	6.0	6.0	6.0
New build non-residential - thermal (GWh)	2.4	4.8	7.2	9.6	12.0	14.4	16.8	19.2	21.6	24.0	26.4	28.8	31.2	33.6	36.0	38.3	40.7	43.1	45.5	47.9
New build non-residential - electricity (GWh)	1.5	3.0	4.5	6.0	7.5	9.0	10.5	12.0	13.5	15.0	16.5	18.0	19.5	21.0	22.5	24.0	25.5	27.0	28.5	30.0
Thermal energy (GWh/yr)	757	769	754	732	711	696	682	667	652	635	618	605	589	571	577	581	584	586	588	591
Electrical energy (GWh/yr)	351	349	335	325	321	323	325	328	329	331	332	334	335	337	343	348	350	351	353	354
Total (GWh/yr)	1,108	1,118	1,090	1,058	1,032	1,019	1,007	995	981	966	950	939	924	908	920	929	933	937	941	945



Appendix VI: Data sources for the existing/planned renewables

Source	Content	Age of data	Accuracy	Web link
Partner Local Authority	Information from planning applications and knowledge from council officers.	Provided Autumn 2009.	Considered low/medium due to the limited data available to local authorities, even as part of planning applications. Varying degrees of data were provided by each authority. Assumptions had to be made in many instances to determine installed capacity using knowledge of typical energy systems.	n/a
Renewable Obligations Certificate Register	Ofgem database of low and zero carbon technologies selling ROCs to energy companies.	'Accredited Stations' as of August 2009	High. Provides installed capacity (kW) and postcode. Many entries were without an address.	http://www.ofgem.gov.uk/Sustainability/Environment/RenewablStat/Pages/RenewablStat.aspx
Renewables Map	Interactive UK map of many technology types currently being built or planned. Tends to contain larger scale installations.	December 2009	Medium but difficult to determine. Very limited detail about each installation. Required to cross-reference with another map to identify relevant local authority.	http://www.renewables-map.co.uk/index.asp
British Wind Energy Association	Large scale wind turbines which are either operational, under construction, consented or in the planning system.	Unknown	High due to large scale of technology thus easily identified and quantified.	http://www.bwea.com/ukwed/index.asp
Small Hydro Website	Installed and planned small hydroelectric sites	Unknown	Difficult to determine. Thorough information on each proposed or existing site and easy to obtain site data for study area.	http://small-hydro.com/index.cfm?fuseaction=welcome.home&ok&CFID=340800&CFTOKEN=94899984
Restats	Larger scale renewable energy systems which are collected by monitoring planning submissions.	November 2008	Medium/high. Contains details of technology, owner/developer, planning outcome. Some errors in location of installations.	http://www.restats.org.uk/2010_target.htm

Appendix VII: Installed and proposed low and zero carbon technologies

Research to identify low and zero carbon technologies which are either installed and operational, or proposed has revealed the following sites.

Project name	Technology	Electrical Installed capacity (kW)	Thermal Installed capacity (kW)	Council	Status	Info source
Marquis Drive Visitor Centre	Biomass heat		90	Cannock Chase	Installed	Data collection form
Rugeley Power Station	Biomass co-firing	50,000		Cannock Chase	Installed	Data collection form
Poplars Landfill	Anaerobic digestion	4,500	2,000	Cannock Chase	In-development	Data collection form
Poplars Landfill	Landfill gas	3,900		Cannock Chase	Installed	Data collection form
Wyrley Power/ Wyrley Grove	Landfill gas	775		Cannock Chase	In-development	Data collection form
Bleak House	Large wind	6,500		Cannock Chase	In-development	Data collection form
Stansley Wood, Dapple Heath, Rugeley	Biomass heat		49	East Staffordshire	In-development	Data collection form
Claymills	Gas CHP	836		East Staffordshire	Installed	Data collection form
Checkley STW	Gas CHP	165		East Staffordshire	Installed	Data collection form
Oak View, Anslow	GSHP		4	East Staffordshire	In-development	Data collection form
Burton Mill	Hydro	68		East Staffordshire	Installed	Data collection form
Tutbury Hydro Electric Project	Hydro	4		East Staffordshire	In-development	Data collection form
Rocester Mill	Hydro	90		East Staffordshire	In-development	Small Hydro
Church Mayfield	Hydro	90		East Staffordshire	In-development	Small Hydro
Mayfield Mill	Hydro	65		East Staffordshire	In-development	Small Hydro
Marchington	Landfill gas	970		East Staffordshire	Installed	Renewables Map
Maer Hills Wind Farm	Large wind	8,000		East Staffordshire	In-development	BWEA
Bagot's Park	Large wind	18,400		East Staffordshire	In-development	Data collection form
Lordswell Road, Burton	Small wind	1		East Staffordshire	In-development	Data collection form
Ferrers Avenue, Tutbury	Small wind	1		East Staffordshire	In-development	Data collection form
Lightwood Road, Yoxall	Small wind	1		East Staffordshire	In-development	Data collection form

Project name	Technology	Electrical Installed capacity (kW)	Thermal Installed capacity (kW)	Council	Status	Info source
West Winds, Rangemore	Small wind	2		East Staffordshire	In-development	Data collection form
Dale Abbey Farm	Small wind	6		East Staffordshire	In-development	Data collection form
Stud Farm, Needwood	Small wind	5		East Staffordshire	In-development	Data collection form
Sainsbury's Distribution Centre, Radial Park	Small wind	800		East Staffordshire	In-development	BWEA
Battlestead Cottage	Solar PV	1		East Staffordshire	In-development	Data collection form
Brookside, Winshill	Solar thermal		2	East Staffordshire	Installed	Data collection form
Captains Lane, Barton under Needwood	Solar thermal		2	East Staffordshire	Installed	Data collection form
Wales Lane, Barton under Needwood	Solar thermal		2	East Staffordshire	Installed	Data collection form
The Yews, Tatenhill	Solar thermal		2	East Staffordshire	Installed	Data collection form
Kestral Barns, Marchington	Solar thermal		2	East Staffordshire	In-development	Data collection form
Adj Winshill Infant School	Solar thermal		2	East Staffordshire	In-development	Data collection form
Rose Cottage, Tatenhill	Solar thermal		2	East Staffordshire	Installed	Data collection form
Rangemore Hall, Rangemore	Solar thermal		2	East Staffordshire	In-development	Data collection form
All Saints Road, Burton upon Trent	Solar thermal		2	East Staffordshire	In-development	Data collection form
Park Road, Barton under Needwood	Solar thermal		2	East Staffordshire	Installed	Data collection form
Jacks Lane, Marchington	Solar thermal		2	East Staffordshire	Installed	Data collection form
Short Lane, Barton under Needwood	Solar thermal		2	East Staffordshire	Installed	Data collection form
Tesco Superstore, Lichfield	Gas CHP	180		Lichfield	Installed	Data collection form
Curborough Sewage Treatment Works	Large wind	2,500		Lichfield	In-development	BWEA
Hogs Hill Wind Energy Project, Harlaston	Large wind	8,000		Lichfield	In-development	Data collection form
Hammerwich Wind Turbine proposals Severn Trent	Large wind	2,000		Lichfield	In-development	Data collection form
Apedale	Small wind	500		Newcastle-under-Lyme	In-development	Renewables Map
Blue Planet (Chatterley Valley)	Biomass heat		10,800	Newcastle-under-Lyme	Installed	Data collection form
Small wind, 14 Watlands Road	Small wind	2		Newcastle-under-Lyme	Installed	Data collection form

Project name	Technology	Electrical Installed capacity (kW)	Thermal Installed capacity (kW)	Council	Status	Info source
Small wind, Green Shutters Farm	Small wind	1		Newcastle-under-Lyme	Installed	Data collection form
PV, Grove Place	Solar PV	8		Newcastle-under-Lyme	Installed	Data collection form
Biomass and anaerobic digestion facility	Biomass power	1,000		South Staffordshire	In-development	Data collection form
Biomass and anaerobic digestion facility	Anaerobic digestion	1,500		South Staffordshire	In-development	Data collection form
Energy From Waste (EfW) Facility	Energy from Waste	29,000		South Staffordshire	In-development	Data collection form
Himley Wood Landfill Site	Landfill gas	1,972		South Staffordshire	Installed	RESTATS
Domestic Wind Turbine	Small wind	1		South Staffordshire	Installed	Data collection form
2 wind turbines at Roundhill Sewage Works	Large wind	4,000		South Staffordshire	In-development	BWEA
2 wind turbines at Rodbaston College (South Staffordshire College)	Large wind	4,000		South Staffordshire	In-development	BWEA
6 wind turbines near Lapley	Large wind	12,000		South Staffordshire	In-development	BWEA
domestic wind turbine	Small wind	1		South Staffordshire	In-development	Data collection form
9 Solar Panels on Dunsley Hall Hotel (LB)	Solar PV	2		South Staffordshire	Installed	Data collection form
Solar Panels on dwelling	Solar PV	2		South Staffordshire	Installed	Data collection form
installation of roof mounted photovoltaic solar tiles on the Council Offices	Solar PV	25		South Staffordshire	In-development	Data collection form
Solar Panels on dwelling	Solar PV	2		South Staffordshire	In-development	Data collection form
Solar Panels on dwelling	Solar thermal		2	South Staffordshire	Installed	Data collection form
Water Turbine, weirs and fish channel at Stourton Castle (LB)	Hydro	10		South Staffordshire	Installed	Data collection form
Biogass plant	Biomass heat	500		Stafford	In-development	Data collection form
Biogas Plant	Biomass heat	3,435		Stafford	In-development	Data collection form
CHP	Gas CHP	180		Stafford	In-development	Data collection form
John Pointons Ltd Energy Resource Centre [proposed]	Energy from Waste	20,000		Stafford	In-development	Data collection form
Meece Landfill	Landfill gas	1,750		Stafford	Installed	Data collection form

Project name	Technology	Electrical Installed capacity (kW)	Thermal Installed capacity (kW)	Council	Status	Info source
Chapel Glassworks, Cellarhead.	Small wind	30		Staffordshire Moorlands	Installed	Data collection form
Stanley Head Outdoor Education Centre	Small wind	1		Staffordshire Moorlands	Installed	Data collection form
Mount Pleasant Farm	Small wind	1		Staffordshire Moorlands	In-development	Data collection form
Greenway Hall, Milton.	Small wind	15		Staffordshire Moorlands	In-development	Data collection form
Calton Moor House Farm, Swinscoe.	Small wind	15		Staffordshire Moorlands	In-development	Data collection form
Householder wind turbine	Small wind	6		Staffordshire Moorlands	In-development	Data collection form
Meadow View', Alton	Solar PV	0		Staffordshire Moorlands	Installed	Data collection form
Norbury Court, Leek	Solar PV	3		Staffordshire Moorlands	Installed	Data collection form
82 Cheadle Road, Upper Tean	Solar thermal		2	Staffordshire Moorlands	Installed	Data collection form
Hillside', Alton [dwelling]	Solar thermal		2	Staffordshire Moorlands	Installed	Data collection form
Eccleshall Biomass Plant	Biomass CHP	2,650	13,000	Staffordshire Moorlands	Installed	Data collection form
Talbotts Heating Ltd	Energy from Waste	1,500		Staffordshire Moorlands	In-development	Data collection form
Dosthill Landfill Site	Landfill gas	910		Tamworth	In-development	RESTATS
Wilnecote Landfill Site	Landfill gas	1,860		Tamworth	Installed	RESTATS

Appendix VIII: Growth projections – new development

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

Year (financial, beginning)	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
Cannock Chase	558	340	242	260	260	290	290	290	290	290	290	290	290	290	290	290	290	290	290	290	**6,010**
East Staffordshire	550	618	429	352	492	633	773	750	725	700	700	700	700	700	700	700	700	700	700	700	**13,022**
Lichfield	304	583	277	387	388	694	675	672	222	261	294	436	544	569	547	475	550	400	375	250	**8,903**
Newcastle-under-Lyme	260	204	364	216	188	269	345	411	375	427	421	432	427	437	267	331	307	268	150	151	**6,250**
South Staffordshire	175	366	323	277	188	206	179	133	110	100	150	200	250	300	200	180	50	40	40	40	**3,507**
Stafford	505	505	505	505	505	505	505	505	505	505	505	505	505	505	505	505	505	505	505	505	**10,100**
Staffordshire Moorlands	260	261	236	260	260	300	300	300	300	300	320	320	320	320	320	320	320	320	320	320	**5,977**
Tamworth	458	210	211	298	226	282	226	258	100	100	100	100	100	76	76	52	52	0	0	0	**2,925**
Study Area	5,076	5,094	4,595	4,564	4,517	5,190	5,305	5,332	4,641	4,698	4,796	5,000	5,154	5,216	4,925	4,874	4,796	4,546	4,404	4,281	**56,694**

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

Year (financial, beginning)	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
Cannock Chase	22,000	22,000	22,000	22,000	22,000	22,000	22,000	22,000	22,000	22,000	22,000	22,000	22,000	37,143	37,143	37,143	37,143	37,143	37,143	37,143	**546,000**
East Staffordshire	14,231	14,231	14,231	14,231	14,231	14,231	14,231	14,231	14,231	14,231	14,231	14,231	14,231	56,429	56,429	56,429	56,429	56,429	56,429	56,429	**580,000**
Lichfield	67,230	67,230	67,230	67,230	67,230	67,230	67,230	67,230	67,230	67,230	67,230	67,230	67,230	67,230	67,230	67,230	67,230	67,230	67,230	67,230	**1,344,608**
Newcastle-under-Lyme	18,525	18,525	18,525	18,525	18,525	18,525	18,525	18,525	18,525	18,525	18,525	18,525	18,525	18,386	18,386	18,386	18,386	18,386	18,386	18,386	**369,525**
South Staffordshire	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	4,800	**96,000**
Stafford	32,000	32,000	32,000	32,000	32,000	32,000	32,000	32,000	32,000	32,000	32,000	32,000	32,000	32,000	32,000	32,000	32,000	32,000	32,000	32,000	**640,000**
Staffordshire Moorlands	2,830	2,830	2,830	11,533	11,533	11,533	11,533	11,533	11,533	11,533	6,659	6,659	6,659	6,659	6,659	6,659	6,659	6,659	6,659	6,659	**155,811**
Tamworth	21,400	21,400	21,400	21,400	21,400	21,400	21,400	21,400	21,400	21,400	21,400	21,400	21,400	21,400	21,400	21,400	21,400	21,400	21,400	21,400	**428,000**
Study Area	185,023	185,024	185,025	193,728	193,729	193,730	193,731	193,732	193,733	193,734	188,861	188,862	188,863	246,066	246,067	246,068	246,069	246,070	246,071	246,072	**4,159,944**

Appendix IX: Large wind – Additional notes

As described in the main report, a spatial analysis using GIS has identified constrained zones (for development of wind energy), i.e. areas where absolute constraints are very likely to prevent wind energy development, and less constrained zones, i.e. areas with constraints that require further local or project specific investigation.

One example for an absolute constraint would be those areas in the district covered by woodland as illustrated in the GIS map in Figure 53.

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

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

Therefore, the air safeguarding zones are only considered 'consultation zones' and were therefore excluded at this stage from the wind energy constraints analysis. Figure 54 illustrates these consultation zones which cover the majority of the study area.

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

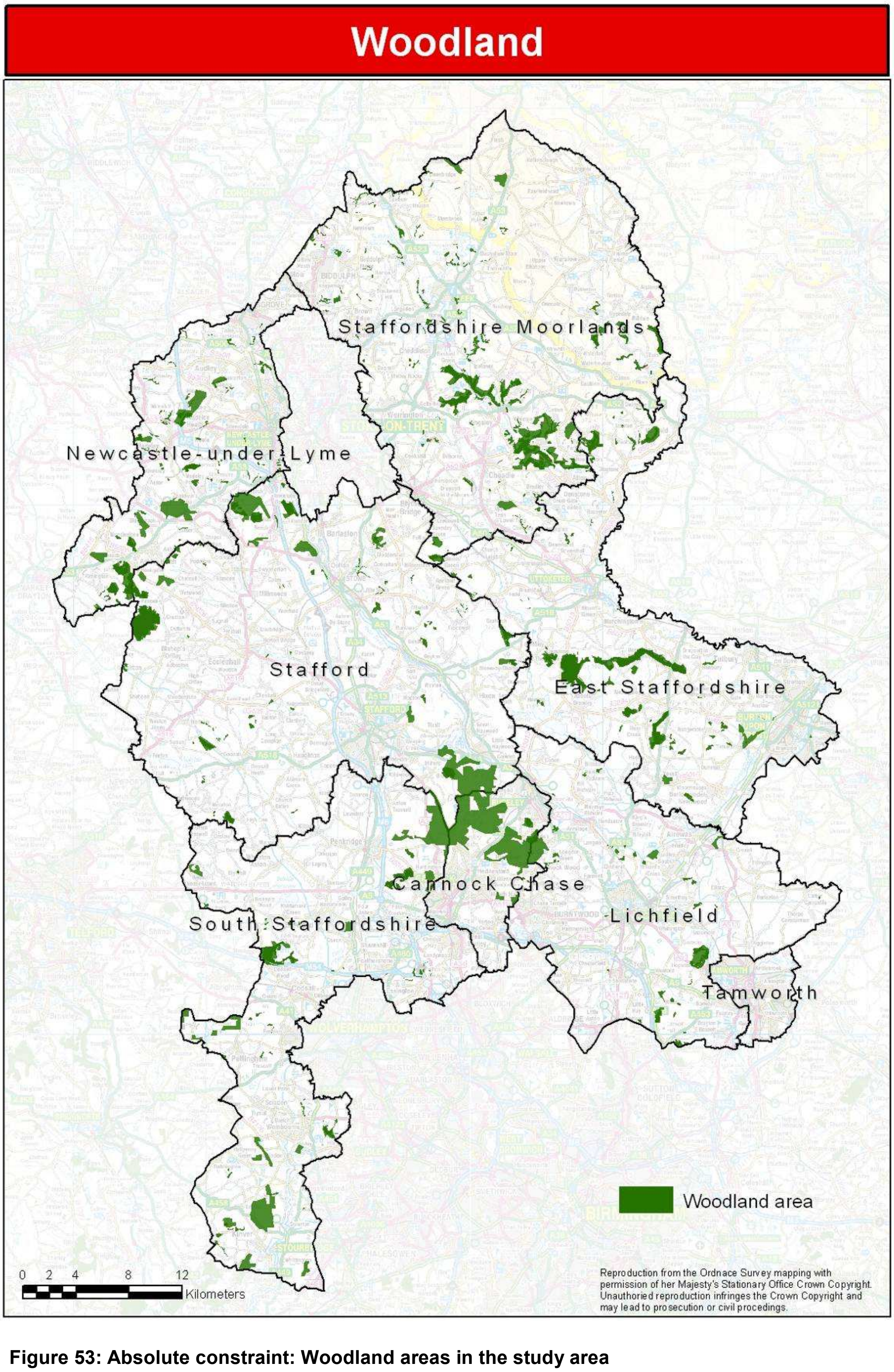


Figure 53: Absolute constraint: Woodland areas in the study area

Figure 54: Consultative zones: Air Safeguarding Zones in the study area

Distribution network within the districts

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.

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 and therefore has not been accounted for in this area-wide study

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

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

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

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

- Regulatory requirements
    - When connecting renewable generation to the distribution network, there are two Electricity Networks Association guidelines, i.e. G83 and G59.

- G83 is for very small embedded generators (up to 16A per phase), whereas G59 is for medium-sized embedded generators, i.e. up to 5MW, connection up to 20kV.

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

Appendix X: Biomass – theoretical resource & analysis assumptions

THEORETICAL RESOURE AT PRESENT – PRIMARY ENERGY

THEORETICAL RESOURCE AT PRESENT											
Local Authority	MSW		Agriculture			Energy crops	Sawmill residues	Forestry residues	C&D + C&I wood waste	Commercial food waste	Total
	Paper&card+wood waste	Green waste + Food/kitchen waste	Animal manure - wet	Animal manure - dry	Straw						
Cannock Chase	76,781	11,395	402	0	0	-	0	7,187	57,501	2,498.4	**155,765**
East Staffordshire	49,042	10,901	37,688	7,985	85,208	-	0	5,376	59,460	1,595.8	**257,256**
Lichfield	77,362	14,574	11,027	19	140,535	-	0	1,904	60,112	2,517.4	**308,052**
Newcastle Under Lyme	0	2,706	20,103	94	20,412	-	0	4,544	48,490	0.0	**96,348**
South Staffordshire	81,142	14,839	24,798	7,150	159,373	-	0	7,927	62,968	2,640.4	**360,836**
Stafford	49,042	11,612	60,984	1,534	169,836	-	38,213	9,494	62,598	1,595.8	**404,909**
Staffordshire Moorlands	0	8,717	54,951	2,599	6,778	-	0	7,595	55,747	0.0	**136,388**
Tamworth	59,129	8,827	333	0	0	-	0	0	35,661	1,924.0	**105,874**
Total	**392,498**	**83,571**	**210,285**	**19,382**	**582,142**	**-**	**38,213**	**44,026**	**442,537**	**12,771.8**	**1,825,426**

TARGET POTENTIAL - PRIMARY ENERGY

Cannock Chase

PRIMARY ENERGY (MWh) - Cannock Chase											
Year	MSW		Agriculture			Energy crops	Sawmill residues	Forestry residues	C&D + C&I wood waste	Commercial food waste	Total
	Paper&card+ wood waste	Green waste + Food/kitchen waste	Animal manure -wet	Animal manure -dry	Straw						
2010	1,324	1,864	34	0	0	0	0	216	2,875	125	6,438
2011	1,845	2,859	65	0	0	0	0	517	7,028	268	12,583
2012	2,381	3,860	96	0	0	0	0	819	11,181	414	18,750
2013	2,932	4,866	126	0	0	0	0	1,121	15,334	562	24,941
2014	3,499	5,878	157	0	0	0	0	1,423	19,486	712	31,155
2015	4,081	6,895	188	0	0	0	0	1,725	23,639	864	37,393
2016	4,958	7,320	219	0	0	0	0	2,242	27,792	1,018	43,550
2017	5,850	7,751	250	0	0	0	0	2,760	31,945	1,175	49,731
2018	6,758	8,188	280	0	0	0	0	3,277	36,098	1,333	55,934
2019	7,681	8,630	311	0	0	0	0	3,795	40,251	1,494	62,162
2020	8,619	9,079	342	0	0	0	0	4,312	40,251	1,656	64,259
2021	9,557	9,532	342	0	0	0	0	4,312	40,251	1,821	65,816
2022	10,511	9,992	342	0	0	0	0	4,312	40,251	1,988	67,396
2023	11,480	10,457	342	0	0	0	0	4,312	40,251	2,157	68,999
2024	12,464	10,928	342	0	0	0	0	4,312	40,251	2,328	70,626
2025	13,464	11,405	342	0	0	0	0	4,312	40,251	2,502	72,276

East Staffordshire

PRIMARY ENERGY (MWh) - East Staffordshire											
Year	MSW		Agriculture			Energy crops	Sawmill residues	Forestry residues	C&D + C&I wood waste	Commercial food waste	Total
	Paper&card+ wood waste	Green waste + Food/kitchen waste	Animal manure -wet	Animal manure -dry	Straw						
2010	846	1,553	3,203	3,394	6,957	0	0	161	2,973	80	19,168
2011	1,178	2,840	6,087	4,073	7,840	0	0	387	7,267	171	29,844
2012	1,521	4,132	8,970	4,751	8,722	0	0	613	11,562	265	40,534
2013	1,873	5,426	11,853	5,430	9,605	1,257	0	839	15,856	359	52,498
2014	2,235	6,725	14,736	6,109	10,487	2,515	0	1,064	20,150	455	64,476
2015	2,607	8,027	17,619	6,788	14,715	4,191	0	1,290	24,445	552	80,233
2016	3,167	8,298	20,502	6,788	14,982	5,867	0	1,677	28,739	650	90,671
2017	3,737	8,573	23,385	6,788	15,249	7,544	0	2,064	33,033	750	101,123
2018	4,316	8,852	26,268	6,788	15,516	9,220	0	2,451	37,327	851	111,591
2019	4,906	9,135	29,152	6,788	15,782	10,897	0	2,838	41,622	954	122,073
2020	5,505	9,421	32,035	6,788	16,049	12,573	0	3,225	41,622	1,058	128,276
2021	6,105	9,711	32,035	6,788	16,049	18,441	0	3,225	41,622	1,163	135,138
2022	6,714	10,005	32,035	6,788	16,049	24,308	0	3,225	41,622	1,270	142,015
2023	7,332	10,302	32,035	6,788	16,049	30,176	0	3,225	41,622	1,378	148,906
2024	7,961	10,603	32,035	6,788	16,049	36,043	0	3,225	41,622	1,487	155,813
2025	8,600	10,907	32,035	6,788	16,049	41,911	0	3,225	41,622	1,598	162,734

Lichfield

PRIMARY ENERGY (MWh) - Lichfield											
Year	MSW		Agriculture			Energy crops	Sawmill residues	Forestry residues	C&D + C&I wood waste	Commercial food waste	Total
	Paper&card+ wood waste	Green waste + Food/kitchen waste	Animal manure -wet	Animal manure -dry	Straw						
2010	1,334	2,188	937	8	11,215	0	0	57	3,006	126	18,872
2011	1,859	3,747	1,781	10	12,887	0	0	137	7,347	271	28,038
2012	2,399	5,311	2,624	12	14,559	0	0	217	11,688	417	37,228
2013	2,954	6,882	3,468	13	16,231	2,631	0	297	16,030	566	49,072
2014	3,525	8,458	4,312	15	17,902	5,262	0	377	20,371	717	60,940
2015	4,112	10,040	5,155	16	24,789	8,770	0	457	24,713	871	78,923
2016	4,995	10,468	5,999	16	25,575	12,279	0	594	29,054	1,026	90,007
2017	5,894	10,903	6,842	16	26,361	15,787	0	731	33,396	1,183	101,114
2018	6,809	11,343	7,686	16	27,147	19,295	0	868	37,737	1,343	112,244
2019	7,739	11,788	8,530	16	27,933	22,803	0	1,005	42,079	1,505	123,398
2020	8,685	12,240	9,373	16	28,719	26,311	0	1,142	42,079	1,669	130,234
2021	9,630	12,697	9,373	16	28,719	38,590	0	1,142	42,079	1,835	144,081
2022	10,590	13,160	9,373	16	28,719	50,868	0	1,142	42,079	2,003	157,951
2023	11,567	13,629	9,373	16	28,719	63,147	0	1,142	42,079	2,173	171,845
2024	12,558	14,104	9,373	16	28,719	75,425	0	1,142	42,079	2,346	185,763
2025	13,566	14,584	9,373	16	28,719	87,704	0	1,142	42,079	2,521	199,704

Newcastle-under-Lyme

PRIMARY ENERGY (MWh) - Newcastle Under Lyme											
Year	MSW		Agriculture			Energy crops	Sawmill residues	Forestry residues	C&D + C&I wood waste	Commercial food waste	Total
	Paper&card+ wood waste	Green waste + Food/kitchen waste	Animal manure -wet	Animal manure -dry	Straw						
2010	0	271	1,709	40	1,715	0	0	136	2,424	0	6,295
2011	0	758	3,247	48	1,886	0	0	327	5,927	0	12,192
2012	0	1,245	4,784	56	2,057	0	0	518	9,429	0	18,089
2013	0	1,732	6,322	64	2,229	396	0	709	12,931	0	24,382
2014	0	2,219	7,860	72	2,400	792	0	900	16,433	0	30,675
2015	0	2,706	9,398	80	3,429	1,320	0	1,091	19,935	0	37,958
2016	0	2,706	10,936	80	3,429	1,847	0	1,418	23,437	0	43,853
2017	0	2,706	12,474	80	3,429	2,375	0	1,745	26,939	0	49,747
2018	0	2,706	14,012	80	3,429	2,903	0	2,072	30,441	0	55,642
2019	0	2,706	15,549	80	3,429	3,431	0	2,399	33,943	0	61,537
2020	0	2,706	17,087	80	3,429	3,959	0	2,726	33,943	0	63,930
2021	0	2,706	17,087	80	3,429	5,806	0	2,726	33,943	0	65,777
2022	0	2,706	17,087	80	3,429	7,653	0	2,726	33,943	0	67,625
2023	0	2,706	17,087	80	3,429	9,500	0	2,726	33,943	0	69,472
2024	0	2,706	17,087	80	3,429	11,348	0	2,726	33,943	0	71,319
2025	0	2,706	17,087	80	3,429	13,195	0	2,726	33,943	0	73,167

South Staffordshire

PRIMARY ENERGY (MWh) - South Staffordshire											
Year	MSW		Agriculture			Energy crops	Sawmill residues	Forestry residues	C&D + C&I wood waste	Commercial food waste	Total
	Paper&card+ wood waste	Green waste + Food/kitchen waste	Animal manure -wet	Animal manure -dry	Straw						
2010	1,399	2,250	2,108	3,039	13,034	0	0	238	3,148	132	25,348
2011	1,949	3,805	4,005	3,647	14,667	0	0	571	7,696	284	36,623
2012	2,516	5,365	5,902	4,254	16,300	0	0	904	12,244	438	47,922
2013	3,098	6,932	7,799	4,862	17,933	2,668	0	1,237	16,791	594	61,914
2014	3,698	8,505	9,696	5,470	19,566	5,336	0	1,569	21,339	752	75,931
2015	4,313	10,083	11,593	6,078	27,481	8,893	0	1,902	25,887	913	97,143
2016	5,240	10,533	13,490	6,078	27,951	12,450	0	2,473	30,434	1,076	109,725
2017	6,182	10,988	15,387	6,078	28,422	16,007	0	3,044	34,982	1,241	122,331
2018	7,142	11,450	17,284	6,078	28,892	19,565	0	3,615	39,530	1,409	134,963
2019	8,117	11,917	19,181	6,078	29,363	23,122	0	4,185	44,077	1,578	147,619
2020	9,109	12,391	21,078	6,078	29,834	26,679	0	4,756	44,077	1,750	155,751
2021	10,100	12,870	21,078	6,078	29,834	39,129	0	4,756	44,077	1,925	169,847
2022	11,108	13,356	21,078	6,078	29,834	51,579	0	4,756	44,077	2,101	183,967
2023	12,132	13,848	21,078	6,078	29,834	64,029	0	4,756	44,077	2,280	198,111
2024	13,172	14,345	21,078	6,078	29,834	76,480	0	4,756	44,077	2,461	212,280
2025	14,229	14,849	21,078	6,078	29,834	88,930	0	4,756	44,077	2,644	226,474

Stafford

PRIMARY ENERGY (MWh) - Stafford											
Year	MSW		Agriculture			Energy crops	Sawmill residues	Forestry residues	C&D + C&I wood waste	Commercial food waste	Total
	Paper&card+ wood waste	Green waste + Food/kitchen waste	Animal manure -wet	Animal manure -dry	Straw						
2010	846	1,624	5,184	652	13,957	0	4,586	285	3,130	80	30,343
2011	1,178	3,040	9,849	782	15,641	0	5,228	684	7,651	171	44,224
2012	1,521	4,459	14,514	913	17,325	0	5,870	1,082	12,172	265	58,120
2013	1,873	5,882	19,179	1,043	19,010	2,481	6,512	1,481	16,693	359	74,512
2014	2,235	7,308	23,845	1,174	20,694	4,961	7,154	1,880	21,214	455	90,918
2015	2,607	8,738	28,510	1,304	29,151	8,269	7,796	2,279	25,735	552	114,939
2016	3,167	9,010	33,175	1,304	29,563	11,577	8,438	2,962	30,256	650	130,100
2017	3,737	9,285	37,840	1,304	29,975	14,884	9,080	3,646	34,777	750	145,277
2018	4,316	9,564	42,506	1,304	30,387	18,192	9,722	4,329	39,298	851	160,468
2019	4,906	9,846	47,171	1,304	30,799	21,499	10,363	5,013	43,818	954	175,674
2020	5,505	10,132	51,836	1,304	31,211	24,807	11,005	5,696	43,818	1,058	186,374
2021	6,105	10,422	51,836	1,304	31,211	36,383	11,638	5,696	43,818	1,163	199,578
2022	6,714	10,716	51,836	1,304	31,211	47,960	12,271	5,696	43,818	1,270	212,796
2023	7,332	11,013	51,836	1,304	31,211	59,536	12,904	5,696	43,818	1,378	226,030
2024	7,961	11,314	51,836	1,304	31,211	71,113	13,537	5,696	43,818	1,487	239,278
2025	8,600	11,619	51,836	1,304	31,211	82,690	14,170	5,696	43,818	1,598	252,541

Staffordshire Moorlands

PRIMARY ENERGY (MWh) - Staffordshire Moorlands											
Year	MSW		Agriculture			Energy crops	Sawmill residues	Forestry residues	C&D + C&I wood waste	Commercial food waste	Total
	Paper&card+ wood waste	Green waste + Food/kitchen waste	Animal manure -wet	Animal manure -dry	Straw						
2010	0	872	4,671	1,105	569	0	0	228	2,787	0	10,232
2011	0	2,441	8,875	1,325	626	0	0	547	6,814	0	20,628
2012	0	4,010	13,078	1,546	683	0	0	866	10,840	0	31,023
2013	0	5,579	17,282	1,767	740	175	0	1,185	14,866	0	41,594
2014	0	7,148	21,486	1,988	797	350	0	1,504	18,892	0	52,165
2015	0	8,717	25,690	2,209	1,139	584	0	1,823	22,918	0	63,079
2016	0	8,717	29,893	2,209	1,139	817	0	2,370	26,945	0	72,090
2017	0	8,717	34,097	2,209	1,139	1,050	0	2,917	30,971	0	81,100
2018	0	8,717	38,301	2,209	1,139	1,284	0	3,463	34,997	0	90,110
2019	0	8,717	42,505	2,209	1,139	1,517	0	4,010	39,023	0	99,120
2020	0	8,717	46,708	2,209	1,139	1,751	0	4,557	39,023	0	104,104
2021	0	8,717	46,708	2,209	1,139	2,567	0	4,557	39,023	0	104,921
2022	0	8,717	46,708	2,209	1,139	3,384	0	4,557	39,023	0	105,738
2023	0	8,717	46,708	2,209	1,139	4,201	0	4,557	39,023	0	106,555
2024	0	8,717	46,708	2,209	1,139	5,018	0	4,557	39,023	0	107,372
2025	0	8,717	46,708	2,209	1,139	5,835	0	4,557	39,023	0	108,189

Tamworth

PRIMARY ENERGY (MWh) - Tamworth											
Year	MSW		Agriculture			Energy crops	Sawmill residues	Forestry residues	C&D + C&I wood waste	Commercial food waste	Total
	Paper&card+ wood waste	Green waste + Food/kitchen waste	Animal manure -wet	Animal manure -dry	Straw						
2010	1,020	1,441	28	0	0	0	0	0	1,783	96	4,368
2011	1,420	2,216	54	0	0	0	0	0	4,359	207	8,256
2012	1,833	2,996	79	0	0	0	0	0	6,934	319	12,162
2013	2,258	3,780	105	0	0	0	0	0	9,510	433	16,085
2014	2,694	4,569	130	0	0	0	0	0	12,085	548	20,027
2015	3,143	5,362	156	0	0	0	0	0	14,661	665	23,986
2016	3,818	5,689	181	0	0	0	0	0	17,236	784	27,709
2017	4,505	6,021	207	0	0	0	0	0	19,812	905	31,449
2018	5,204	6,357	232	0	0	0	0	0	22,387	1,027	35,207
2019	5,915	6,698	258	0	0	0	0	0	24,963	1,150	38,983
2020	6,638	7,043	283	0	0	0	0	0	24,963	1,275	40,202
2021	7,360	7,393	283	0	0	0	0	0	24,963	1,402	41,401
2022	8,094	7,746	283	0	0	0	0	0	24,963	1,531	42,618
2023	8,840	8,105	283	0	0	0	0	0	24,963	1,661	43,852
2024	9,599	8,467	283	0	0	0	0	0	24,963	1,793	45,105
2025	10,368	8,835	283	0	0	0	0	0	24,963	1,926	46,375

Total study area

PRIMARY ENERGY (MWh) - Total study area											
Year	MSW		Agriculture			Energy crops	Sawmill residues	Forestry residues	C&D + C&I wood waste	Commercial food waste	Total
	Paper&card+ wood waste	Green waste + Food/kitchen waste	Animal manure -wet	Animal manure -dry	Straw						
2010	6,768	12,063	17,874	8,237	47,448	0	4,586	1,321	22,127	639	121,063
2011	9,429	21,705	33,961	9,885	53,548	0	5,228	3,170	54,088	1,373	192,386
2012	12,169	31,377	50,048	11,532	59,648	0	5,870	5,019	86,049	2,117	263,829
2013	14,988	41,078	66,135	13,180	65,747	9,608	6,512	6,868	118,010	2,873	344,999
2014	17,886	50,809	82,222	14,827	71,847	19,216	7,154	8,717	149,971	3,640	426,287
2015	20,863	60,569	98,308	16,475	100,703	32,026	7,796	10,566	181,932	4,417	533,654
2016	25,344	62,742	114,395	16,475	102,639	44,837	8,438	13,736	213,893	5,205	607,704
2017	29,905	64,945	130,482	16,475	104,574	57,647	9,080	16,906	245,854	6,004	681,872
2018	34,545	67,177	146,569	16,475	106,510	70,458	9,722	20,076	277,815	6,814	756,160
2019	39,264	69,438	162,656	16,475	108,445	83,269	10,363	23,246	309,776	7,635	830,566
2020	44,062	71,729	178,742	16,475	110,381	96,079	11,005	26,416	309,776	8,467	873,131
2021	48,857	74,049	178,742	16,475	110,381	140,916	11,638	26,416	309,776	9,309	926,558
2022	53,731	76,398	178,742	16,475	110,381	185,753	12,271	26,416	309,776	10,163	980,105
2023	58,683	78,777	178,742	16,475	110,381	230,590	12,904	26,416	309,776	11,027	1,033,770
2024	63,715	81,185	178,742	16,475	110,381	275,427	13,537	26,416	309,776	11,902	1,087,555
2025	68,826	83,622	178,742	16,475	110,381	320,264	14,170	26,416	309,776	12,788	1,141,459

BIOMASS ANALYSIS ASSUMPTIONS

In many instances, biomass uptake curves from E4tech are referenced. There were produced as part of the UK Renewable Energy Strategy in 2009, and can be viewed at http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/renewable/res/res.aspx.

Forestry residues

The Forestry Commission Research tool, suggested by DECC methodology as data source, only provides data at regional level. In this study, total woodland areas have been taken from OS Strategi data and the following assumptions have been used to assess potential from Forestry residues:

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

Energy Crops

- The E4tech report models 4 case scenarios based on data from the Refuel project, all 4 scenarios consider that land available for energy crops in the UK will increase: area of arable land available for energy crops increasing from 605,000 Ha in 2008 to 963-1334,000 Ha in 2030, and pasture area from 290,000 Ha in 2008 to 1,200,000 Ha in 2030. However, for this study it has been considered appropriate to assume that land available for energy crops will remain constant over time and it is only equivalent to arable land currently out of production (i.e. no proportion in pasture land considered available), since:
    - The area of arable land not in production (the equivalent of bare fallow and un-cropped set-aside land in 2007) has fallen steeply, by over 62% between 2007 and 2008, (Defra Agricultural survey, 2008)
    - Defra abolished set aside land in 2008.
    - Current trends of expansion of organic agriculture and farming, which will require wider areas to obtain the same production volumes.

[70] *Forestry Commission 2002, National Inventory of Woodlands and Trees. County report for Staffordshire. http://www.forestry.gov.uk/pdf/staffordshire.pdf/$FILE/staffordshire.pdf*

- There are many environmental restrictions that make very unlikely the conversion of most pastures to energy crops (potentially significant loss of soil carbon, run-off and biodiversity to name a few).

Very slow initial uptake is assumed, to account for required specialised machinery and labour, subsidy schemes, and delay of first harvest (3 years for willow and 5 years for poplar): 10% by 2015, 30% by 2020 and 100% by 2025The scenario defined in this study to estimate the potential contribution of energy crops matches the “Medium scenario” suggested by the DECC methodology. The principle to calculate the technically available resource under the “Medium scenario” is to assume that energy crops are planted in all abandoned arable land and pasture. However, the methodology indicates that permanent pasture/grassland needs to be excluded from the assessment in order to estimate the physically accessible and practically viable resource.

Sawmill residues

The DECC methodology suggest that data from the Forestry Commission Research tool is used to estimate the availability of sawmill residues. As mentioned above, the tool only provides data at regional level. In this study, the potential from sawmill residues has been estimated making the following assumptions:

- The output of residues at each sawmill in the study area is assumed to be equivalent to the average output in England, derived from total volume of residues and total number of sawmills in England as per Forestry Commission’s Sawmill Survey 2008[71]The competing uses are the panel board industry, paper and pulp, exports and fencing. Currently, 12% of co-products are sold for bio-energy (Forestry Commission statistics 2009[72]). It is assumed that availability for bio-energy will increase up to 30% of current total resource by 2020, on the basis that:
    - Softwood availability in the United Kingdom continues to increase over the next 15 years from 12 million m^3 in the period 2007-2011, peaking in the period 2017-2021 at just over 14 million m^3 (Forestry Commission 2006[73]).
    - Increasing recycling rates of waste wood from the construction and other industries will supply part of the panel board industry and therefore release part of the sawmill resource
- Immediate uptake achievable as soon as the resource is made available
- Output of the sawmills in the study area remain constant.

Crop residues – Straw

- This study assumes an availability factor of 35% for cereal straw (Wheat and Barley account for over 95% of land dedicated to cereals in the UK), derived from the UK Biomass Strategy: "*The UK cereal straw (Wheat and Barley) resource is significant (9-10 mt per annum) but much of this is recycled to livestock and much of the rest is ploughed into soil (it has a resource value as a fertiliser and organic matter supplement). It is*

[71] *Forestry Commission Sawmill Survey 2008. http://www.frcc.forestry.gov.uk/website/forstats2009.nsf/0/6322930083F37DA88025731E0047F672*
[72] *Forestry Commission statistics. 2009. http://www.forestry.gov.uk/website/forstats2009.nsf/TopContents?Open&ctx=92B74B2CCD24A56C8025731B0053FB26*
[73] *New forecast of softwood availability (Forestry Commission 2006). http://www.forestry.gov.uk/website/ForestStats2006.nsf/byunique/ukgrown.html*

estimated, that up to 3m tonnes could be made available in the long term without disrupting livestock use/buying costs". This is also supported by Biomass Energy Centre: *"Most Barley straw is used for animal bedding and feed, and figures for Winter wheat straw suggest that in the UK around 40% is chopped and returned to the soil, 30% used on the farm (for animal bedding and feed), and 30% is sold".* Wheat accounts for 70% of all land dedicated to cereals.

- It is assumed that up to 60% of the straw available for bio-energy can be recovered from the field to account for technology limitations.
- Uptake assumption for cereal straw: 50% by 2010, 100% by 2015
- Uptake assumptions from DECC/E4tech for oil seed rape: 10% of this can be collected now, 20% in 2010, 50% in 2015, and 100% from 2020 in all scenarios. The uptake rate is relatively slow, as oilseed rape straw is not currently extracted in large quantities and is more difficult to handle than wheat and barley straw.
- Wheat parameters (yield, moisture and NCV) have been used for cereal straw since practically all cereal straw will come from wheat. Wheat accounts for 70% of all land dedicated to cereals.
- Area of land dedicated to cereal and rape seed oil assumed to remain constant over time.

The DECC methodology suggest an availability factor of 50% but does not reduce the potential further to account for the fraction of straw that cannot be recovered from the field. Therefore, final estimates applying the DECC methodology could be expected to be fairly similar to the results presented in this study.

Agricultural animal waste

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

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

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

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

    - Since digestate from Anaerobic Digestion has a higher nutrient value than manure, farmers are likely to provide manure at zero cost in exchange for returned digestate – which needs to be spread to land (E4tech).
    - Although much poultry litter has been spread on the land as a fertilizer, there has been evidence that when spread on land for cattle grazing or for hay or silage, this can cause botulism in cattle and the practice has been urged against by Defra. Defra advises either incineration or deep ploughing or burial.
    - Animal slurry is widely used as a fertilizer and there are a number of methods to spread it on land, though recent concerns about loss of ammonia to the air means that Defra now advises against broadcast spreading[74]
- Number of livestock to remain constant over time.

[74] •*Biomass energy centre*
http://www.biomassenergycentre.org.uk/portal/page?_pageid=75,17976&_dad=portal&_schema=PORTAL

DECC methodology prescribes that only 50% of the total resource should be considered as available for bioenergy due to competing demands (fertiliser, compost). As implied by the assumptions outlined above, in this study the use of manure as fertiliser has not been considered as a competing demand. It should also be noted that DECC methodology does not propose to discount the technical resource to account for technical limitations of manure collection and handling losses.

Municipal Solid Waste (MSW) currently land-filled

DECC methodology considers incineration as the conversion technology for all components of MSW, providing a benchmark of 10 kilo tonnes of MSW per annum required for 1MW of installed capacity. The approach taken in this study considered the different components of MSW individually, assuming that paper/card and wood waste will be incinerated, and kitchen/food waste and green waste will be sent to anaerobic digestion plants. Other assumptions made are outlined below.

- For this study, slow growth of waste arisings (0.75% annually over current levels) has been assumed. It is acknowledged by a number of sources (Waste Strategy for England 2007[75], ERM[76] and E4Tech reports) that there is great uncertainty regarding future arisings. E4tech assumes static, waste strategy suggests four scenarios (one of them no growth, 3 of them little growth with maximum of 2% a year).
- For paper and card, recycling is supplied first. Overall recycling targets in the waste strategy for household waste assumed to be applicable to individual waste components. This is supported by EU directive that sets specific recycling targets for 2020 of 50% for glass, plastic, paper and metals.
- Maximum recovery levels are set based on best performance across Europe, under the basis that if it has been achieved elsewhere in Europe, it can theoretically be achieved in the study area. These are taken from Table B1.2 of the ERM report.
- Separability of waste will increase linearly to reach maximum recovery levels in 2025/26.
- Initial recovery potential = 5% over recycling rate.
- Alternative disposal routes for kitchen waste and green waste e.g. composting are not considered as competing demand.
- The Waste Strategy for England 2007 sets actions to stimulate energy recovery of wood waste rather than recycling. Therefore, all collectable wood waste over current recycling rates are assumed to be available for energy. From the waste strategy it is clear that wood has relatively low embodied energy (energy consumed in extraction) but high calorific value. Though for some kinds of wood waste re-use or recycling are better options, use as a fuel generally conveys a greater greenhouse gas benefit than recovering the material as a resource (and avoiding primary production).

Green waste currently diverted

This biomass stream is not considered in DECC methodology. In this study, composting is not considered a competing demand and therefore the full resource is considered to be available for energy generation. However, an uptake period of 5 years is assumed.

[75] *Waste strategy for England 2007. http://www.defra.gov.uk/environment/waste/strategy/strategy07/index.htm*
[76] *Carbon Balances and Energy Impacts of the Management of UK Wastes (ERM 2006). http://randd.defra.gov.uk/Document.aspx?Document=WR0602_4746_FRA.pdf*

Appendix XI: Small wind

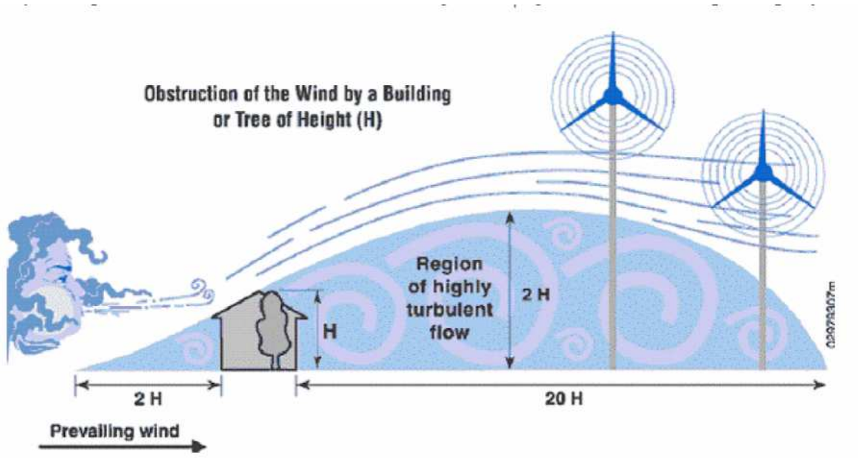
The assessment of the energy potential for small scale wind is based on the most likely application for such turbines:

- 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, 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.

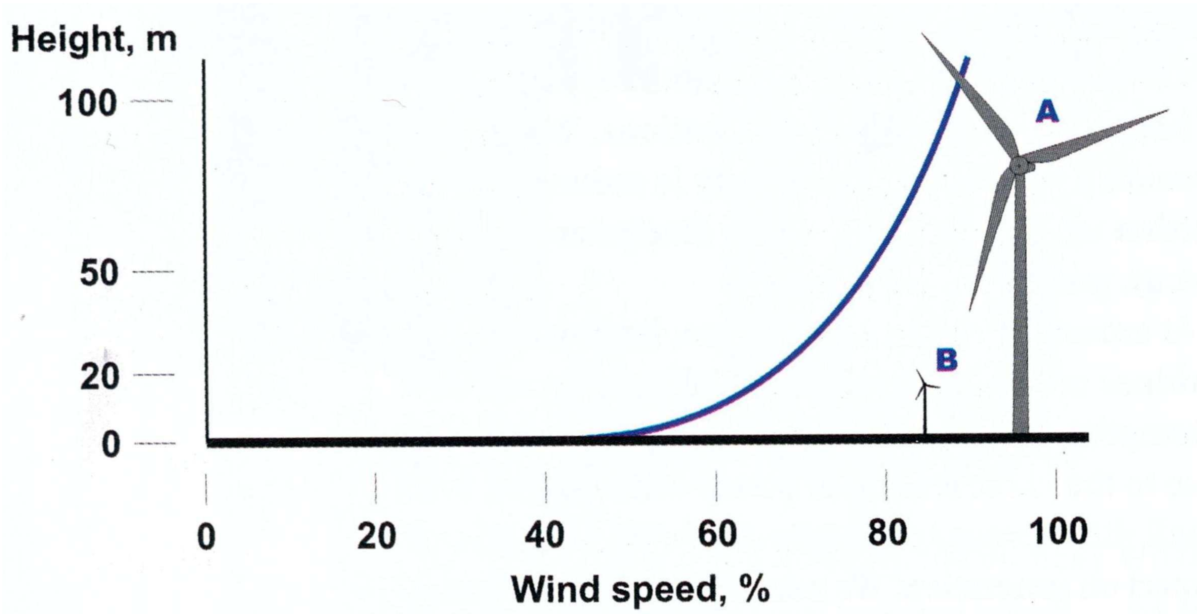
Figure 55: Effects of wind shadowing (Source: www.awea.com)



- 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[82]) 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[83].
- With respect to potential sites for small-scale wind, the technology is particularly suitable for farms, but also for municipal buildings such as community centres or schools (above all in rural areas where the effects of wind shadowing would be smaller than in urban areas and where schools usually have more land to place the turbine on). An additional advantage of these "community" sites would be that they support education. However, for the purpose of this study, only farms under 5ha and over 5ha have been considered.
- Electricity generation is significantly influenced on height and power rating of a turbine. The relationship between power rating and generation is linear. However, the relationship between power and height is more complex. As the figure below illustrates wind speed rapidly tails of when moving towards ground level due to boundary effects (or friction with the surface). This effect is further exacerbated because power generation from a wind turbine is a function of the cube of the wind speed, meaning that marginal changes in wind speed have a significant impact on performance.

Figure 56: Turbine height compared to turbine output



Technical and Development Scenario for small-scale wind

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

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

[82] *http://www.lowcarbonbuildings.org.uk/home/*
[83] *http://www2.valeroyal.gov.uk/internet/vr.nsf/AllByUniqueIdentifier/DOCC3B2E8B8DEF3AD2380257260005AB960*

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

Developing wind

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

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

Appendix XII: 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[84].

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.

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

Appendix XIII: 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 XIV: Ground source heat pumps

According to the Energy Saving Trust[85], 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.

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

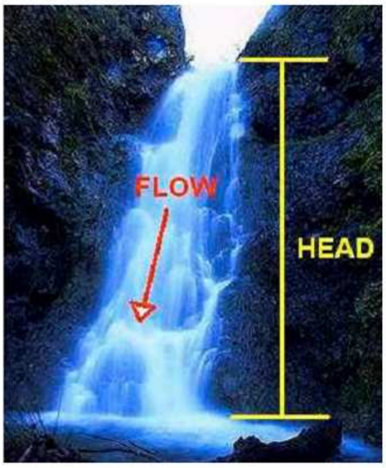
Appendix XV: Hydro energy

Hydro power background and guidance

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

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

Figure 57: 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:

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

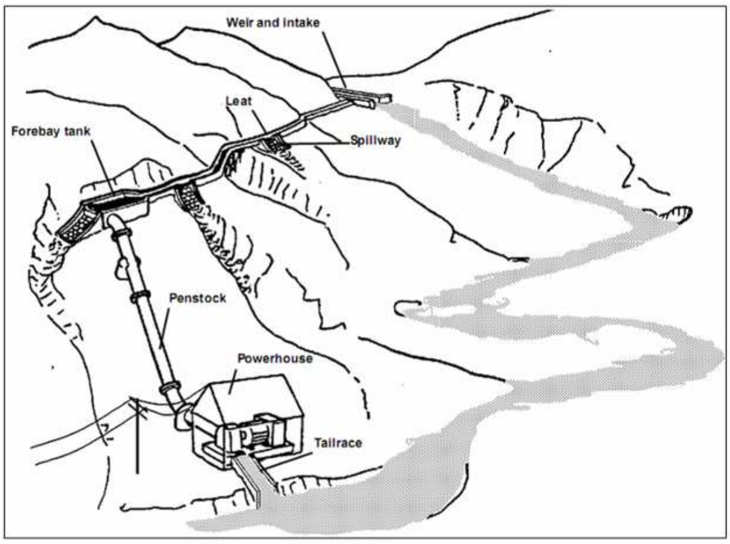


Figure 58: Components of a hydro scheme (Source: British Hydropower Association – Guide to UK Mini-Hydro Developments)

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

- No direct CO_2 emissions
- Small hydro schemes have a minimal 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.

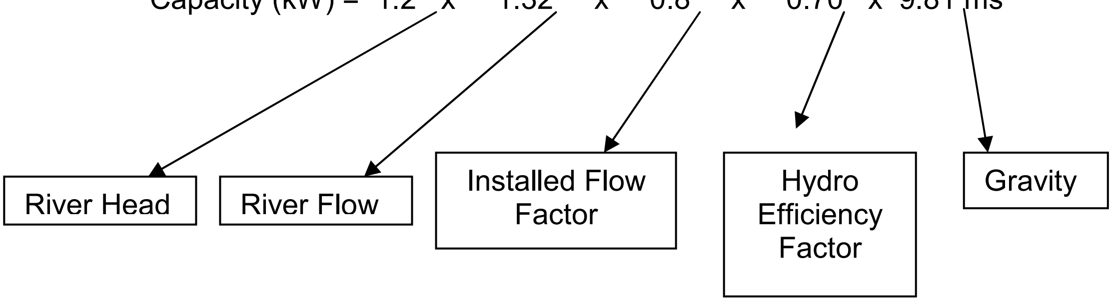
In turning the technical resource of hydro energy into a practical target, the important issues to consider are:

- 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)

Study area potential

The potential from those sites identified with a head less than 2 metres were assumed to be between 1.2 metres and 2 metres. River flow data was taken from the National River Flow Archive[86] and the formula below was used to generate potential capacities for each assessed site (based on basic hydro calculation[87]). From this hydro capacity factors were converted to annual generation (MWh).

$$\text{Capacity (kW)} = 1.2 \times 1.32 \times 0.8 \times 0.70 \times 9.81\ \text{ms}^{-2}$$



[86] The National River Flow Archive http://www.ceh.ac.uk/data/nrfa/index.html
[87] Renewable Energy UK: Calculation of Hydro Power http://www.reuk.co.uk/Calculation-of-Hydro-Power.htm

Appendix XVI: Gas-fired CHP

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:

A 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.

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

C 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[88] would essentially require biomass CHP, where is possible rather than gas-fired CHP.

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

Appendix XVII: Results of acceleration net costs assessments

Test 1: Code 3 with 10% test (additional costs of the Merton only)

Site name	Flat (city infill)	Flat (market town)	Flat (urban regeneration)	Mid terrace (small development)	Detached (small development)	Mid terrace (market town)	Detached (market town)	Mid terrace (urban regeration)	Detached (urban regeration)
SHW + BPEE*	£ 254	£ 224	£ 254	£ 272	£ 1,608	£ 272	£ 1,608	£ 272	£ 1,608
PV + BPEE	£ 492	£ 492	£ 492	£ 862	£ 1,906	£ 862	£ 1,906	£ 862	£ 1,906
GSHP +BPEE*	£ -	£ 358	£ -	£ 272	£ 115	£ 272	£ 115	£ -	£ -

% Capital cost									
SHW + BPEE*	0.3%	0.3%	0.3%	0.4%	1.7%	0.4%	1.7%	0.4%	1.7%
PV + BPEE	0.7%	0.7%	0.7%	1.3%	2.0%	1.3%	2.0%	1.3%	2.0%
GSHP +BPEE*	0.0%	0.5%	0.0%	0.4%	0.1%	0.4%	0.1%	0.0%	0.0%

Test 2: Code 4 with 20% test (additional cost of Merton only)

Site name	Flat (city infill)	Flat (market town)	Flat (urban regeneration)	Mid terrace (small development)	Detached (small development)	Mid terrace (market town)	Detached (market town)	Mid terrace (urban regeration)	Detached (urban regeration)
Gas CHP (80%) with BPEE*	£ 1,462	£ 567	£ 298	£ 1,936	£ 3,139	£ 756	£ 1,148	£ 232	£ 551
PV + BPEE	£ 384	£ 384	£ 384	£ 240	£ 578	£ 240	£ 578	£ 240	£ 578
PV + APEE	£ 1,978	£ 1,978	£ 1,978	£ 2,336	£ 5,310	£ 2,336	£ 5,310	£ 2,336	£ 5,310
SHW + APEE*	£ 2,730	£ 2,730	£ 2,730	£ 3,101	£ 6,201	£ 3,101	£ 6,201	£ 3,101	£ 6,201
Biomass heating (80%) + BPEE	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -
Biomass heating (80%) + APEE	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -
GSHP +APEE*	£ 1,924	£ 3,401	£ 1,924	£ 2,511	£ 4,410	£ 4,477	£ 6,500	£ 2,511	£ 4,410

% Capital cost									
Gas CHP (80%) with BPEE*	2.0%	0.8%	0.4%	2.9%	3.3%	1.1%	1.2%	0.4%	0.6%
PV + BPEE	0.5%	0.5%	0.5%	0.4%	0.6%	0.4%	0.6%	0.4%	0.6%
PV + APEE	2.7%	2.7%	2.7%	3.5%	5.6%	3.5%	5.6%	3.5%	5.6%
SHW + APEE*	3.7%	3.7%	3.7%	4.7%	6.6%	4.7%	6.6%	4.7%	6.6%
Biomass heating (80%) + BPEE	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Biomass heating (80%) + APEE	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
GSHP +APEE*	2.6%	4.6%	2.6%	3.8%	4.7%	6.8%	6.9%	3.8%	4.7%

Test 3: Code 3 with 10% vs Code 4 with 20%

Solution	Flat (city infill)	Flat (market town)	Flat (urban regeneration)	Mid terrace (small development)	Detached (small development)	Mid terrace (market town)	Detached (market town)	Mid terrace (urban regeneration)	Detached (urban regeneration)
SHW + BPEE (CODE 3)*	£ 3,579	£ 3,579	£ 3,579	£ 4,819	£ 6,692	£ 4,819	£ 6,692	£ 4,819	£ 6,692
PV + BPEE (CODE 3)	£ 3,303	£ 3,303	£ 3,303	£ 5,118	£ 6,975	£ 5,118	£ 6,975	£ 5,118	£ 6,975
GSHP +BPEE (CODE 3)*	£ 8,862	£ 8,001	£ 5,858	£ 9,388	£ 13,093	£ 9,388	£ 13,093	£ 7,255	£ 10,654
Gas CHP (80%) with BPEE (CODE 4)*	£ -	£ 4,324	£ 3,622	£ -	£ 22,893	£ 5,749	£ 8,176	£ 4,758	£ 6,832
PV + BPEE (CODE 4)	£ 4,905	£ 4,905	£ 4,905	£ 6,273	£ 8,809	£ 6,273	£ 8,809	£ 6,273	£ 8,809
PV + APEE (CODE 4)	£ 9,787	£ 9,787	£ 9,787	£ 10,604	£ 16,439	£ 10,604	£ 16,439	£ 10,604	£ 16,439
SHW + APEE (CODE 4)*	£ 10,846	£ 10,846	£ 10,846	£ 11,127	£ 17,638	£ 11,127	£ 17,638	£ 11,127	£ 17,638
Biomass heating (80%) + BPEE (CODE 4)	£ 7,688	£ 4,550	£ 3,970	£ 10,718	£ 11,006	£ 5,847	£ 8,397	£ 5,221	£ 7,394
Biomass heating (80%) + APEE (CODE 4)	£ 12,562	£ 9,426	£ 8,845	£ 14,320	£ 17,492	£ 9,449	£ 14,884	£ 8,824	£ 13,881
GSHP +APEE (CODE 4)*	£ 15,399	£ -	£ 12,497	£ 16,321	£ 26,282	£ 16,959	£ 25,608	£ 13,195	£ 21,273

Minimum Code 3 + 10%	£ 3,303	£ 3,303	£ 3,303	£ 4,819	£ 6,692	£ 4,819	£ 6,692	£ 4,819	£ 6,692
Minimum Code 4 + 20%	£ 4,905	£ 4,324	£ 3,622	£ 6,273	£ 8,809	£ 5,749	£ 8,176	£ 4,758	£ 6,832
Difference	£ 1,603	£ 1,022	£ 320	£ 1,455	£ 2,117	£ 930	£ 1,485	-£ 61	£ 140
% Capex equivalent	2.2%	1.4%	0.4%	2.2%	2.2%	1.4%	1.6%	-0.1%	0.1%
Maximum Code 3 + 10%	£ 8,862	£ 8,001	£ 5,858	£ 9,388	£ 22,893	£ 9,388	£ 13,093	£ 7,255	£ 10,654
Maximum Code 4 + 20%	£ 15,399	£ 10,846	£ 12,497	£ 16,321	£ 26,282	£ 16,959	£ 25,608	£ 13,195	£ 21,273
Difference	£ 6,537	£ 2,845	£ 6,639	£ 6,933	£ 3,389	£ 7,571	£ 12,516	£ 5,940	£ 10,619
% Capex equivalent	8.9%	3.9%	9.0%	10.5%	3.6%	11.5%	13.3%	9.0%	11.3%

Test 4: Code 4 with 20% vs zero carbon

Solution	Flat (city infill)	Flat (market town)	Flat (urban regeneration)	Mid terrace (small development)	Detached (small development)	Mid terrace (market town)	Detached (market town)	Mid terrace (urban regeration)	Detached (urban regeration)
Gas CHP (80%) with BPEE (CODE 4)*	£ -	£ 4,324	£ 3,622	£ -	£ 22,893	£ 5,749	£ 8,176	£ 4,758	£ 6,832
PV + BPEE (CODE 4)	£ 4,905	£ 4,905	£ 4,905	£ 6,273	£ 8,809	£ 6,273	£ 8,809	£ 6,273	£ 8,809
PV + APEE (CODE 4)	£ 9,787	£ 9,787	£ 9,787	£ 10,604	£ 16,439	£ 10,604	£ 16,439	£ 10,604	£ 16,439
SHW + APEE (CODE 4)*	£ 10,846	£ 10,846	£ 10,846	£ 11,127	£ 17,638	£ 11,127	£ 17,638	£ 11,127	£ 17,638
Biomass heating (80%) + BPEE (CODE 4)	£ 7,688	£ 4,550	£ 3,970	£ 10,718	£ 11,006	£ 5,847	£ 8,397	£ 5,221	£ 7,394
Biomass heating (80%) + APEE (CODE 4)	£ 12,562	£ 9,426	£ 8,845	£ 14,320	£ 17,492	£ 9,449	£ 14,884	£ 8,824	£ 13,881
GSHP +APEE (CODE 4)*	£ 15,399	£ -	£ 12,497	£ 16,321	£ 26,282	£ 16,959	£ 25,608	£ 13,195	£ 21,273
PV + BPEE (ZC)	£ -	£ -	£ -	£ 9,537	£ 13,366	£ 9,537	£ 13,366	£ 9,537	£ 13,366
PV + APEE (ZC)	£ -	£ -	£ -	£ 11,557	£ 16,346	£ 11,557	£ 16,346	£ 11,557	£ 16,346
GSHP + PV + BPEE (ZC)	£ 13,457	£ -	£ 10,651	£ 15,368	£ 22,028	£ 15,368	£ 22,028	£ 12,417	£ 18,451
Biomass heating (80%) + PV + BPEE (ZC)	£ 9,249	£ 6,190	£ 5,624	£ 12,719	£ 13,283	£ 7,971	£ 10,740	£ 7,360	£ 9,763
Biomass heating (80%) + PV + APEE (ZC)	£ 14,065	£ 11,006	£ 10,440	£ 16,293	£ 18,334	£ 11,544	£ 15,790	£ 10,934	£ 14,812
Biomass CHP (80%) + BPEE 9ZC)	£ 7,827	£ 7,092	£ 6,723	£ -	£ -	£ 7,727	£ 11,900	£ 7,330	£ 11,264
Biomass CHP (80%) + APEE (ZC)	£ 10,267	£ 9,633	£ 9,265	£ -	£ -	£ 9,710	£ 15,289	£ 9,313	£ 14,654
Gas CHP (80%)+ PV + BPEE (ZC)	£ 9,027	£ 6,414	£ 5,744	£ 16,642	£ 25,128	£ 8,169	£ 11,582	£ 7,435	£ 10,417

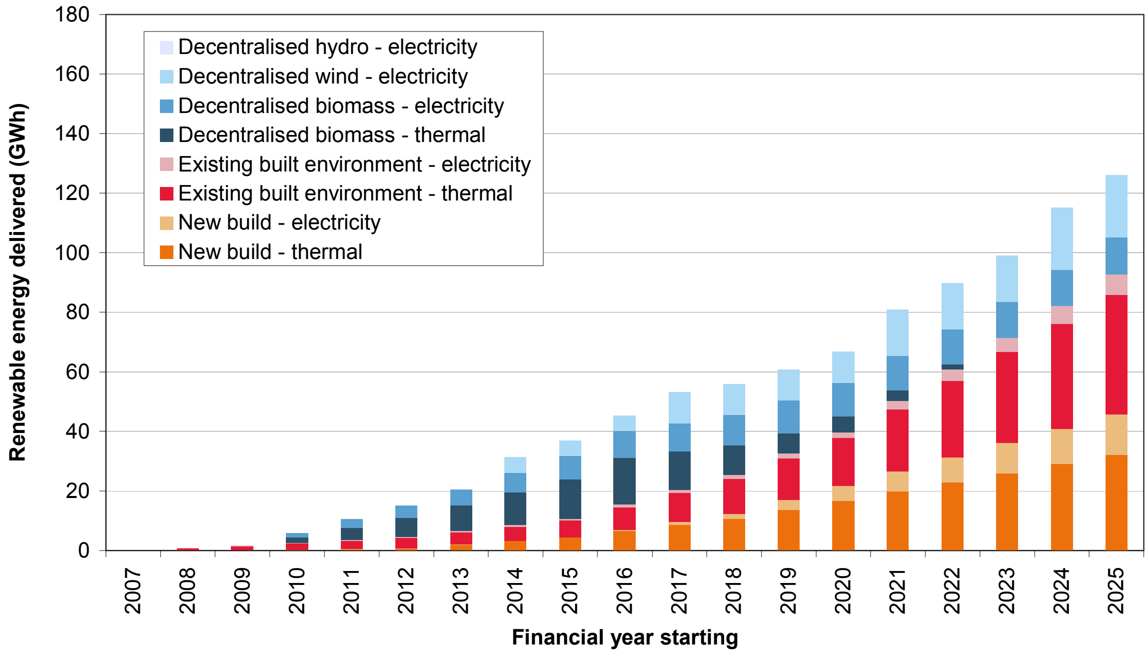
Minimum Code 4 + 20%	£ 4,905	£ 4,324	£ 3,622	£ 6,273	£ 8,809	£ 5,749	£ 8,176	£ 4,758	£ 6,832
Minimum zero carbon	£ 7,827	£ 6,190	£ 5,624	£ 9,537	£ 13,283	£ 7,727	£ 10,740	£ 7,330	£ 9,763
Difference	£ 2,922	£ 1,866	£ 2,002	£ 3,264	£ 4,475	£ 1,978	£ 2,564	£ 2,572	£ 2,931
% Capex equivalent	4.0%	2.5%	2.7%	5.0%	4.7%	3.0%	2.7%	3.9%	3.1%
Maximum Code 4 + 20%	£ 15,399	£ 10,846	£ 12,497	£ 16,321	£ 26,282	£ 16,959	£ 25,608	£ 13,195	£ 21,273
Maximum zero carbon	£ 14,065	£ 11,006	£ 10,651	£ 16,642	£ 25,128	£ 15,368	£ 22,028	£ 12,417	£ 18,451
Difference	-£ 1,334	£ 160	-£ 1,845	£ 321	-£ 1,154	-£ 1,591	-£ 3,581	-£ 778	-£ 2,822
% Capex equivalent	-1.8%	0.2%	-2.5%	0.5%	-1.2%	-2.4%	-3.8%	-1.2%	-3.0%

Appendix XVIII: Summary graphs of results by technology / authority

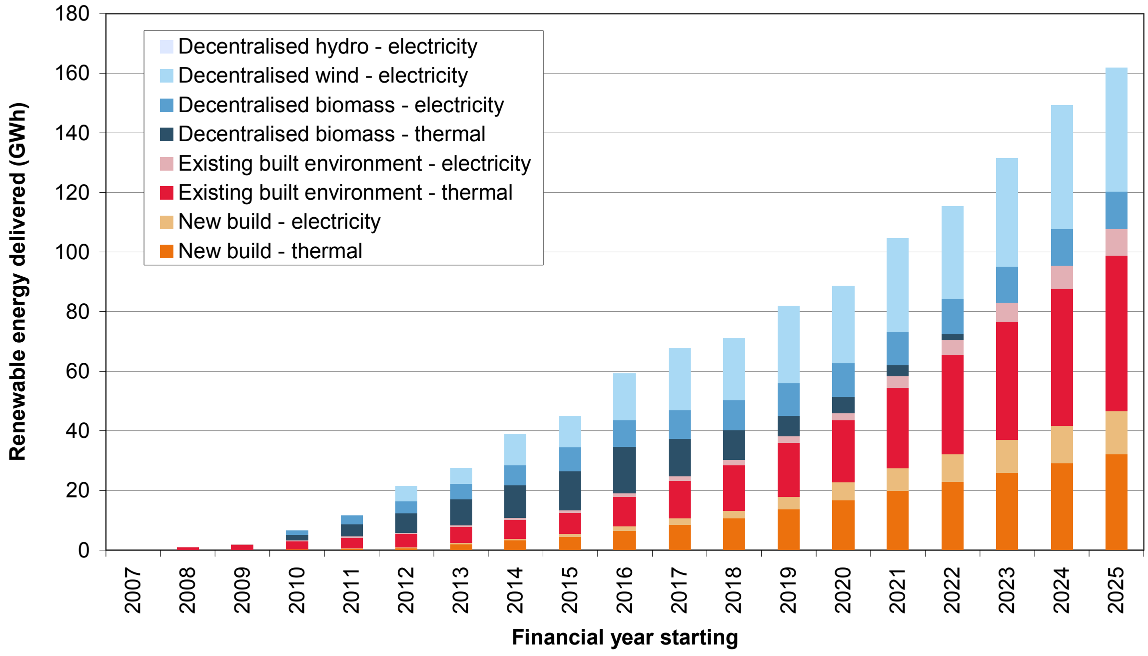
This appendix provides further resolution to the results presented in section 10.2, illustrating the individual low and zero carbon energy sources which have been built up to form the two scenarios – base case and elevated case.

Cannock Chase

Base case

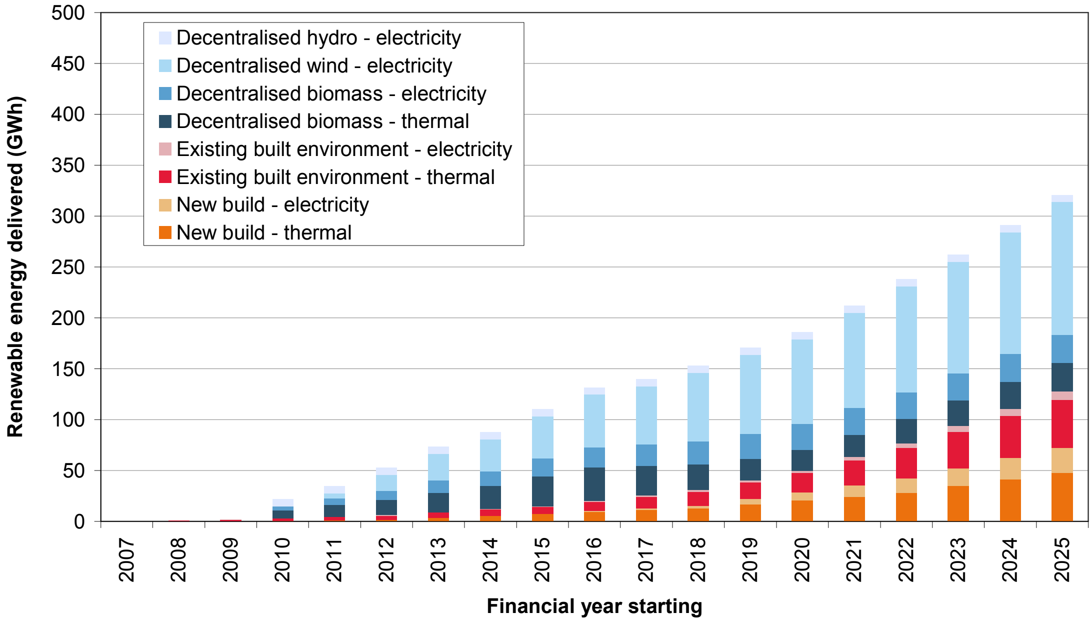


Elevated case

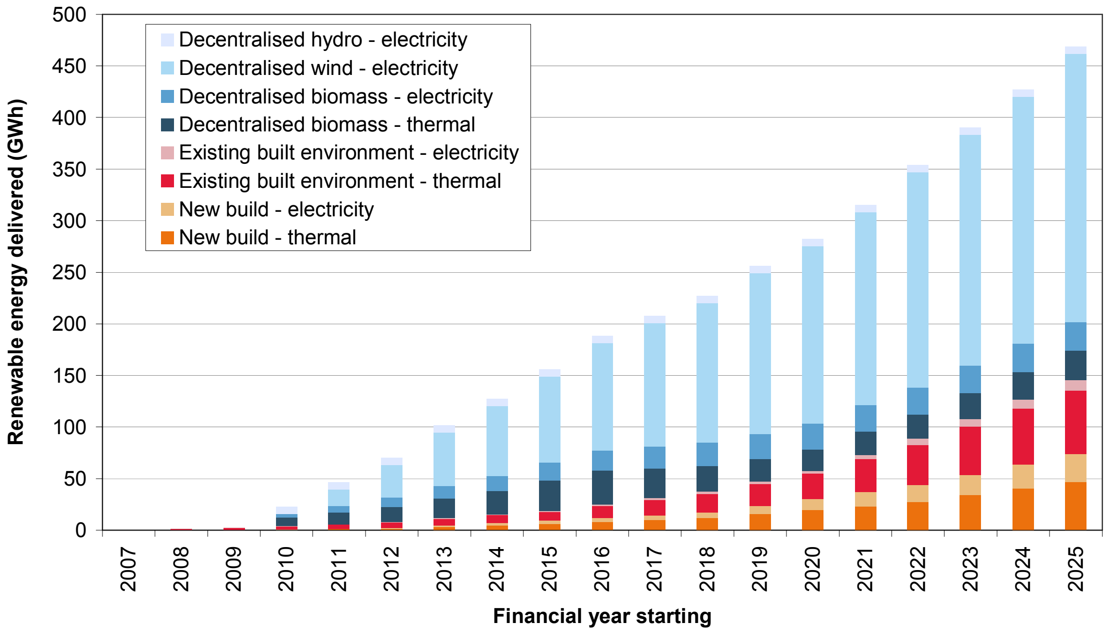


East Staffordshire

Base case

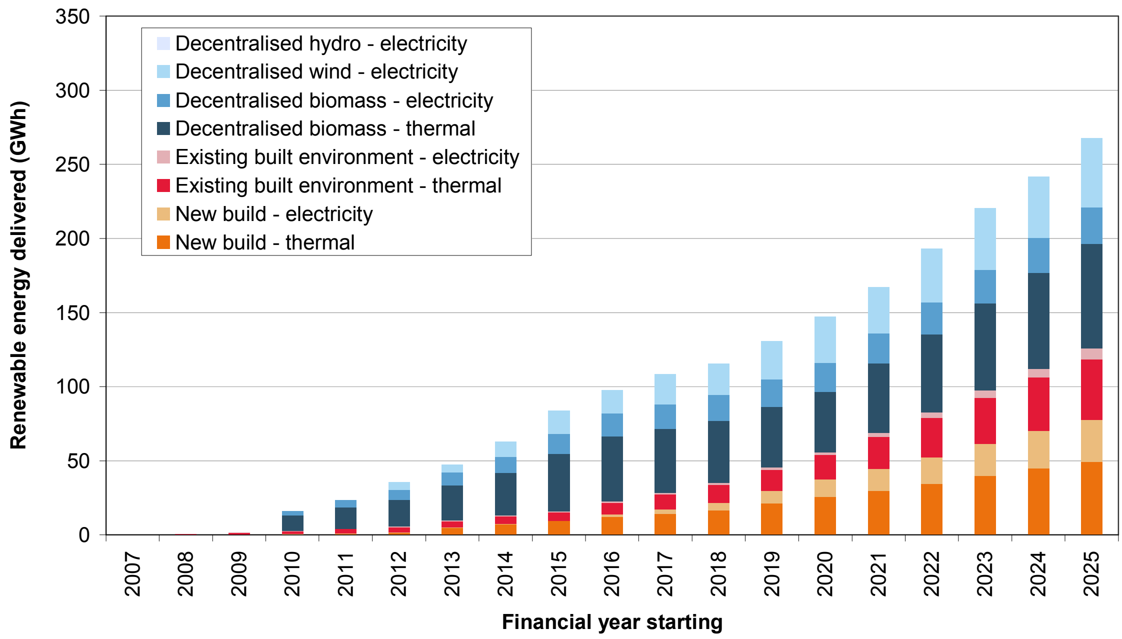


Elevated case

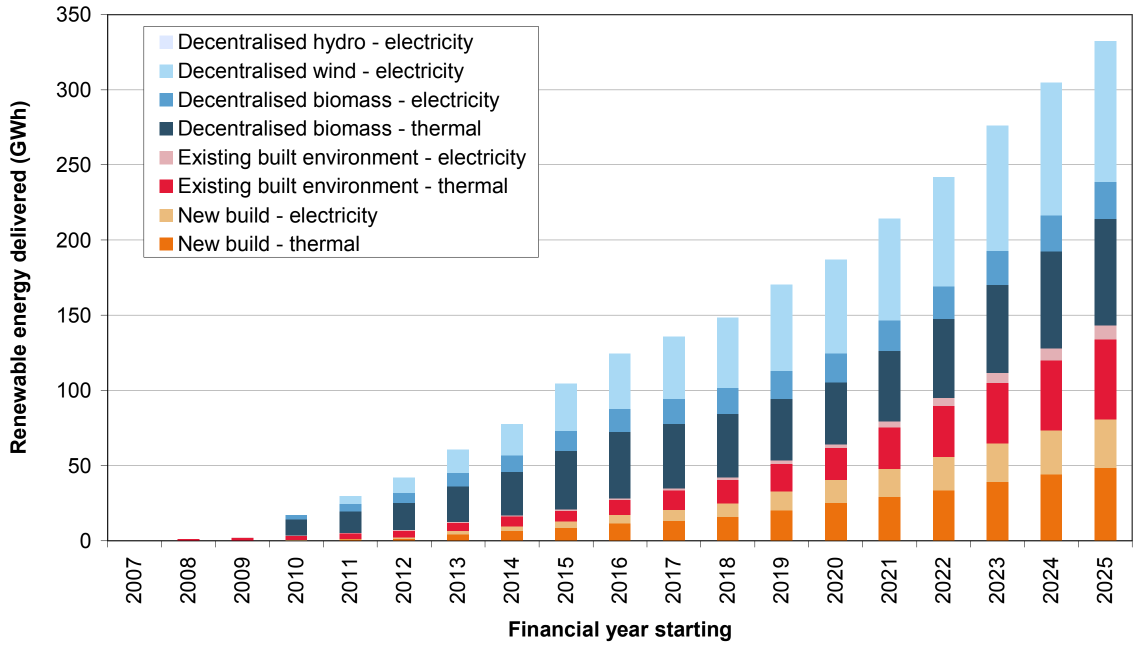


Lichfield

Base case

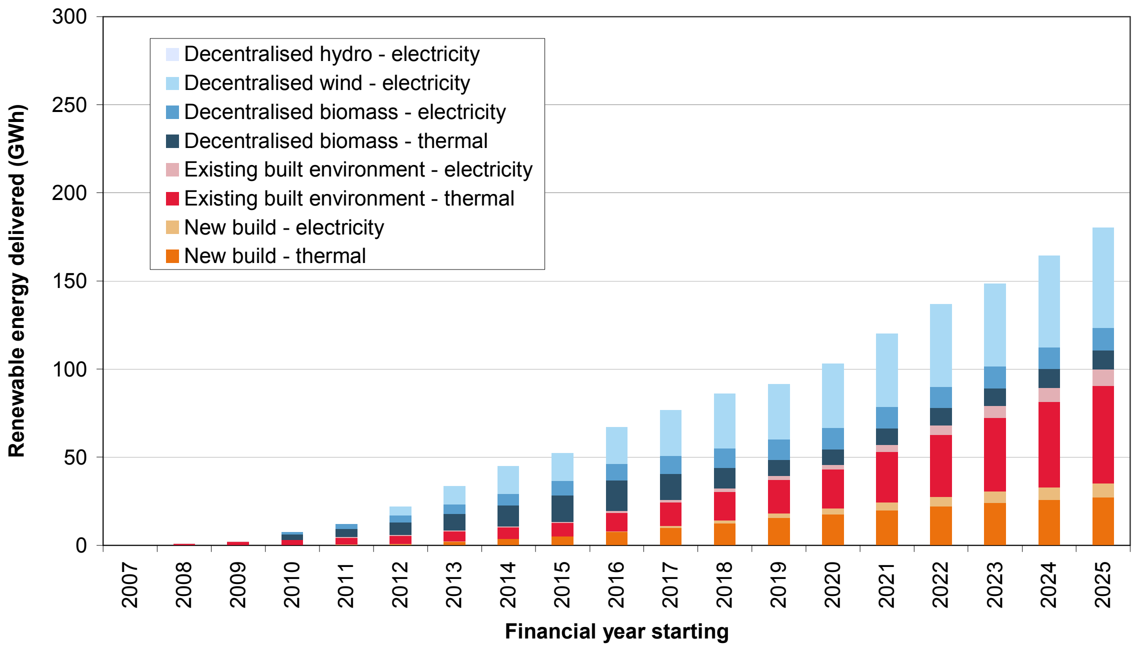


Elevated case



Newcastle-under-Lyme

Base case



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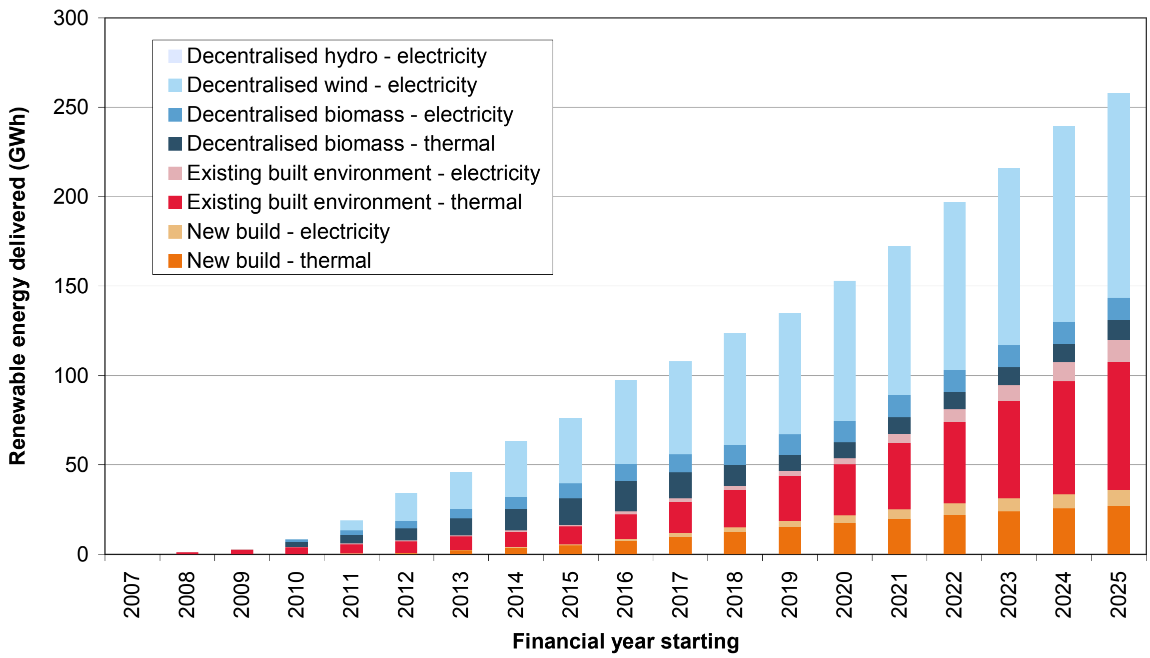
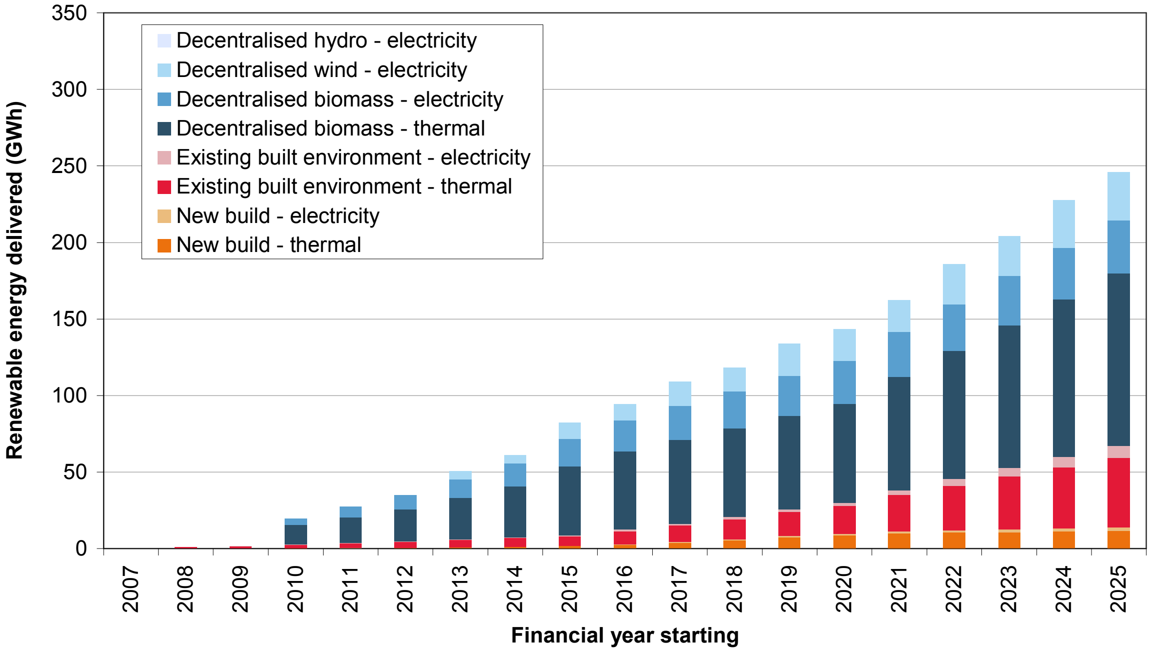
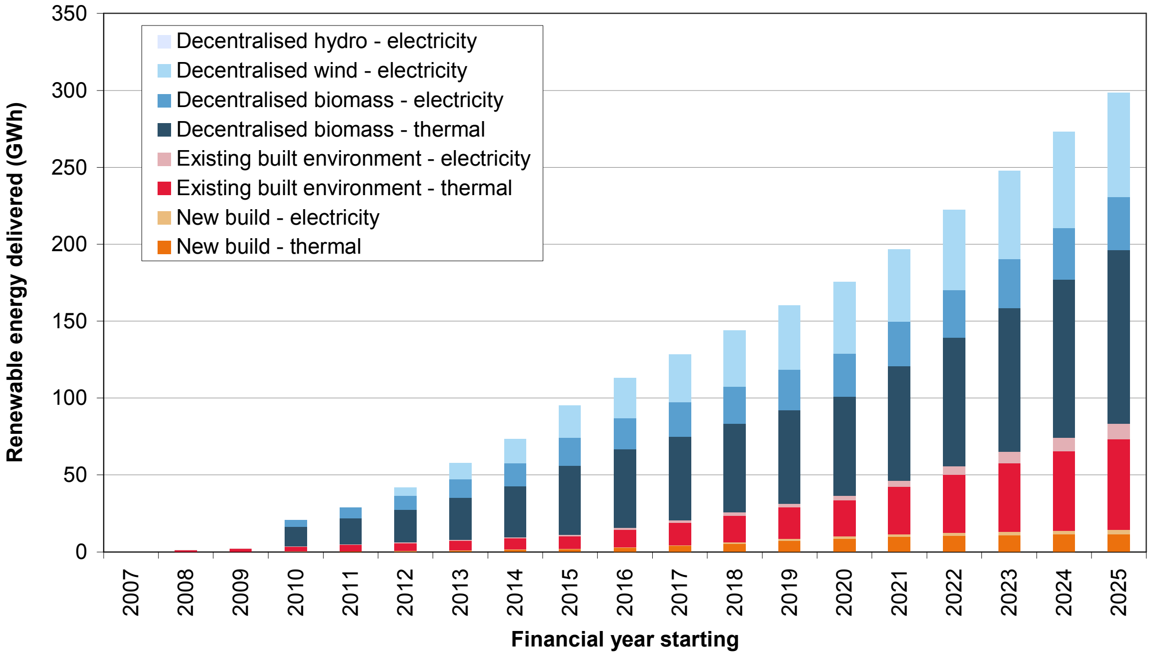


South Staffordshire

Base case

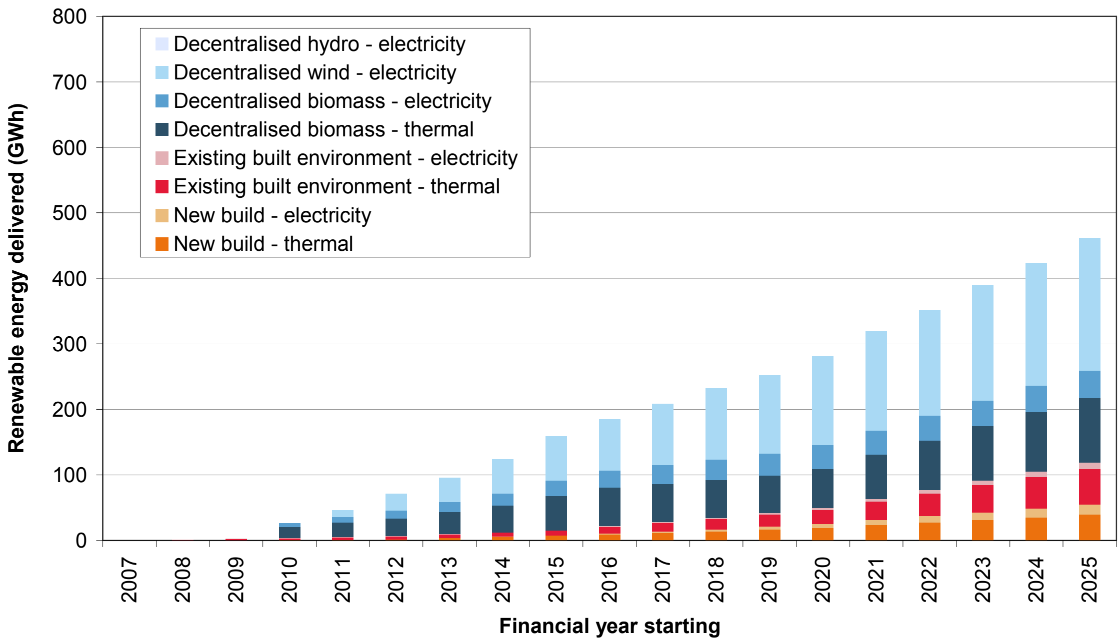


Elevated case

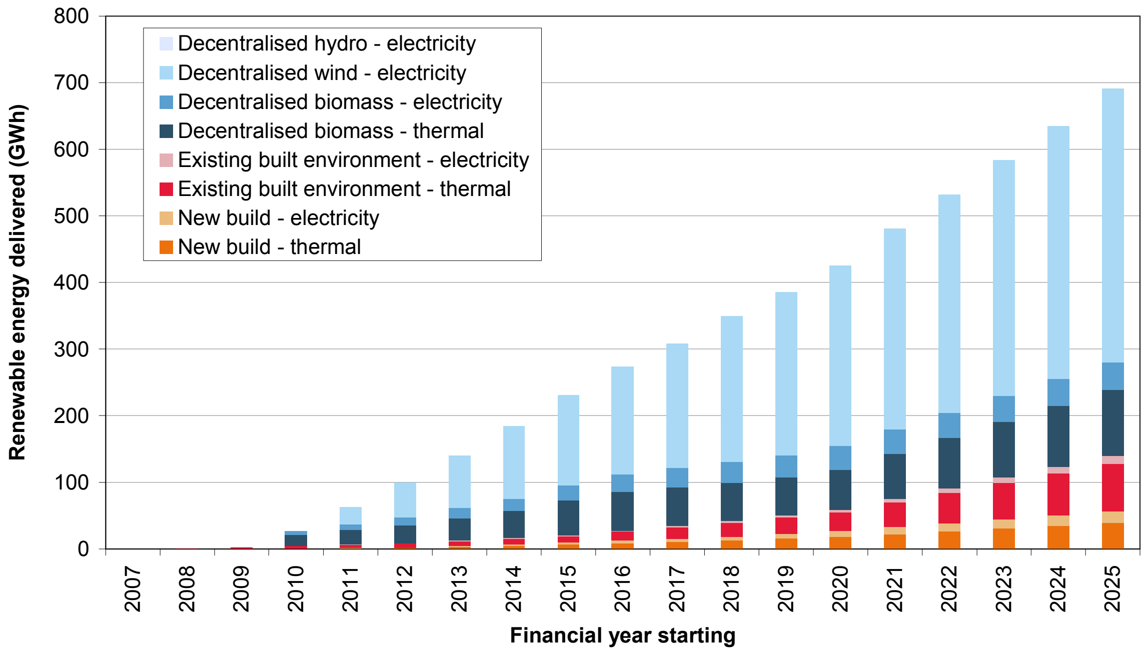


Stafford

Base case

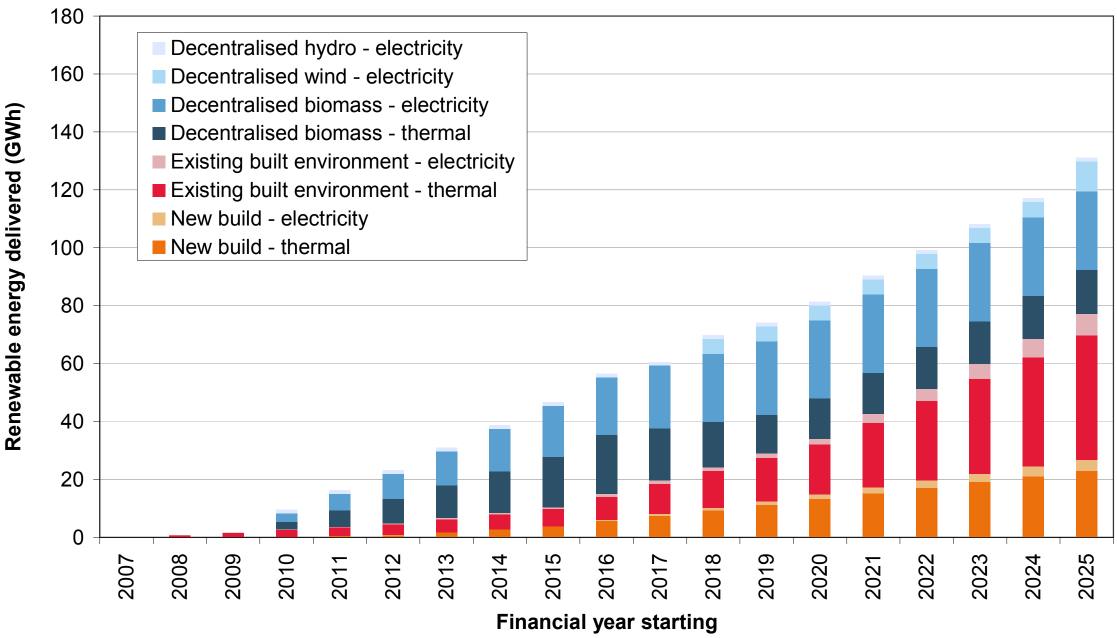


Elevated case

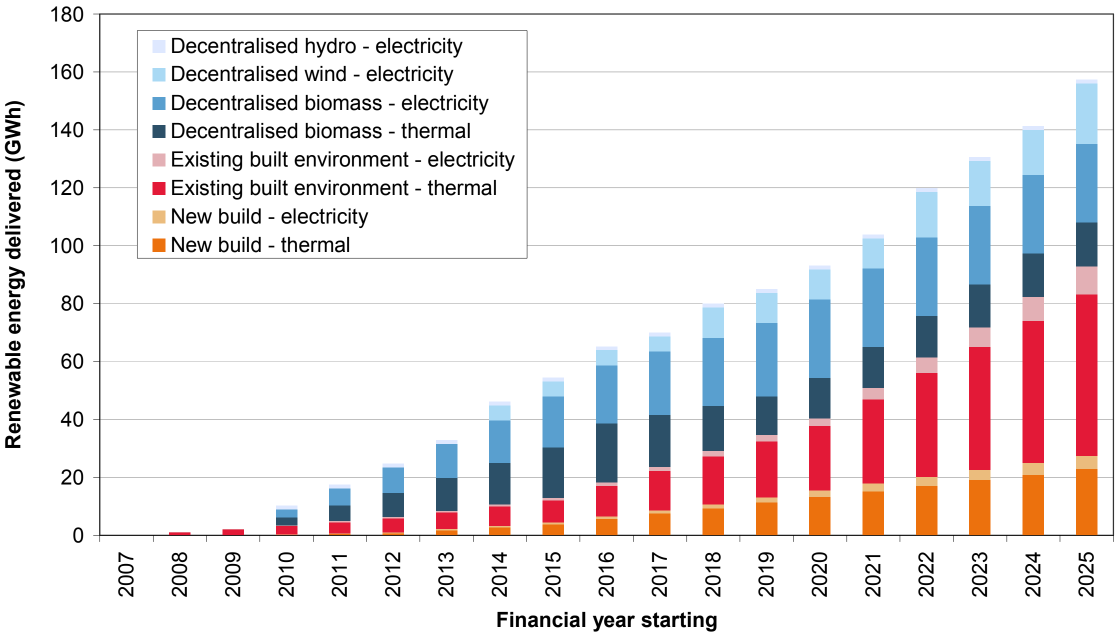


Staffordshire Moorlands

Base case

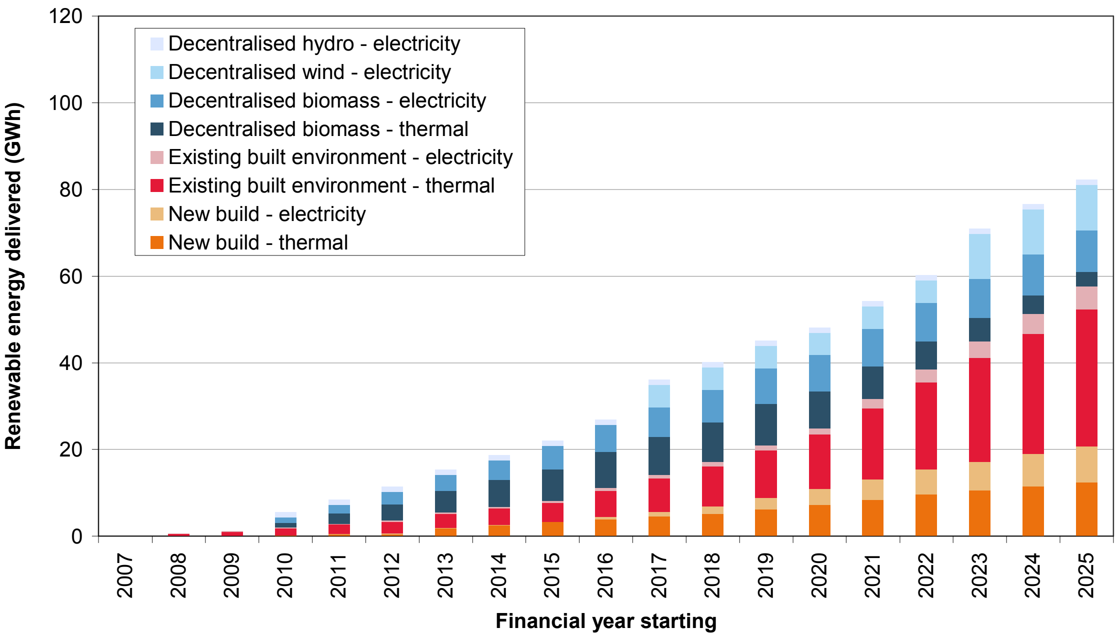


Elevated case

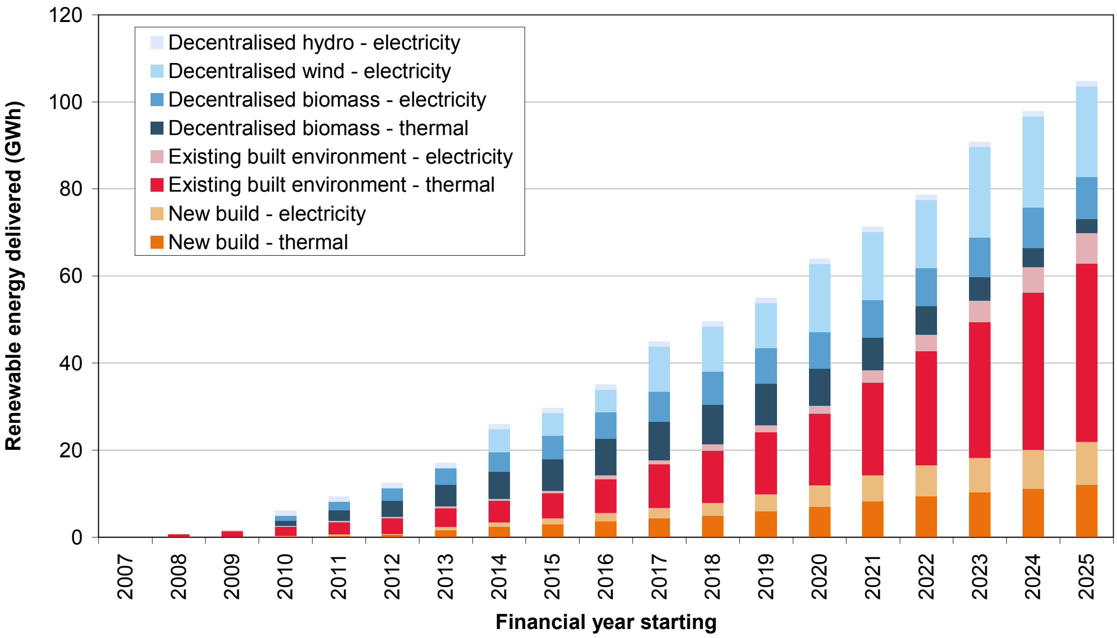


Tamworth

Base case



Elevated case



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