Renewable and Low Carbon Energy Resource Assessment and Feasibility Study

Presented to: The Councils of Stratford-On-Avon, Warwick, North Warwickshire, Nuneaton & Bedworth, Rugby, Solihull and Warwickshire County

Author: Robert Clark, Luke Purse and Duncan Price

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Author: Robert Clark, Luke Purse and Duncan Price

Signature

Date: 28 April 2010..

QA: Duncan Price

Signature Duncan Price

Date: 28 April 2010..

Author contact details

Email: robert.clark@camcoglobal.com
Telephone: 0114 2257482

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Introduction

The Renewable Energy and Low Carbon Resource and Feasibility Study has been conducted on behalf of the Local Authorities of Stratford-On-Avon, Warwick, North Warwickshire, Nuneaton & Bedworth, Rugby, Solihull and Warwickshire County. The aim of the study is to inform the partner Authorities about the potential viability and the deliverability of the various renewable and low carbon options (within development and as decentralised generation) through the preparation of an evidence base. The intention is for the Authorities to take relevant evidence and recommendations made from this report to inform the preparation of their Local Development Frameworks in accordance with the requirements of Planning Policy Statements 1 and 22. The evidence base has been developed with the project steering group as described in the report and stakeholder consultation of the conclusions has been carried out through a workshop held on 14th January in Rugby (see Appendix II).

Urban development within the study area will have an influence on the delivery of low carbon technologies, not least because of proposed lower carbon standards. 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 expects provision of 55,800 dwellings between 2006 and 2026. This is broken down as follows: Solihull (13,100), North Warwickshire (3,000), Nuneaton & Bedworth (10,800), Rugby (12,700), Warwick (11,000) and Stratford-On-Avon (5,600).

In late 2009 the on-going partial review of the West Midlands Regional Spatial Strategy (RSS) suggested changes to the development forecasts across the region. Overall this recommends a total of the 54,000 new dwellings in the study area. The Panel Report[1] also recommended changes to the Regional Spatial Strategy aimed at strengthening policies around climate change, to support the regional goal of becoming a low carbon region, to support the aim of achieving a 30% carbon reduction cut by 2020 (with highlighted action including decentralising energy supply, waste reduction and reuse and retrofit of the existing housing stock) and placing obligations on Local Authorities with respect to climate change to include policies and proposals (in their plans, strategies and programmes) 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 level that can be locally justified, with a suggest interim minimum 10% (of residual energy) for all “significant” development”
- Requiring Design and Access Statements to fully consider sustainability

Other than the above stated 30% carbon reduction target there has been no recent reviews of regional carbon or energy targets/policy. The 2004 West Midlands energy strategy is consequently somewhat out step with national policy which has jumped ahead with legally binding carbon targets (culminating in 80% of 1990 targets by 2050), dramatically revised renewable energy target of 15% of total energy (including transport) by 2020 and requirements for increasing carbon efficiency within development.

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

The Government announced in the policy statement Building a Greener Future 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. The government has also identified that the planning system has a key role to play in supporting the delivery of this timetable for reducing carbon emissions from domestic and non-domestic buildings by providing evidence for and helping to secure the delivery of low or zero carbon development.

Key Findings

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

Current and Future Energy Consumption

The first step to determine future energy consumption is 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 27,000 GWh (including transport) per annum with 8.6 million tonnes CO_2 emitted per annum (from NI 186 data).

Energy consumption is dominated by heat whereas CO_2 emissions are more balanced between heat and electricity. Solihull is the highest consuming authority in the study area, reflecting the high density of commercial and industrial activities as well as the large number of existing dwellings.

Baseline consumption is likely to increase in the absence of policy levers. However, the Low Carbon Transition Plan[2] sets a path for lower consumption as a result of a series of binding and non-binding policy levers leading to the deployment of energy efficiency. We have taken the conclusions of recent studies to 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 future renewable energy potential are measured.

Existing low and zero carbon energy generation capacity

Existing low and zero carbon energy generation capacity is then described on the basis of evidence assembled for this study. It was found that the availability of information about existing or planned installations is, like for most Local Authorities, patchy; however, information has been drawn from a range of different sources. The identified installed capacity within the study area is approximately 28MW, equating to less than 1% of energy demand across the study area (1.7% if transport is excluded), with a further 57MW described as being “planned”. Landfill gas dominates current installed capacity whilst energy from waste[3], biomass and proposed landfill accounts for the majority of the planned new capacity. It should be recognised that landfill gas generation will rapidly tail-off as a potential resource because of the diversion of organic waste from landfill sites and production life cycle of existing landfill gas sites.

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

[3] *Includes a single 35MW EfW project in Rugby*

Low carbon policies and targets

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

The Low Carbon Transition Plan and the Renewable Energy Strategy[4] present significant policy changes relevant to this study. However, there are a number of issues relevant to this study that remain unresolved or are likely to change in the near future, for example, the definition of zero carbon homes and non-residential buildings.

A range of policy and market mechanisms are intended to support low and zero carbon technologies, which are designed to therefore reduce the burden on developers of delivering lower carbon buildings. These include two 'Clean energy cash-back' schemes: Renewable Heat Initiative (RHI) and Feed-in Tariffs (FITs). The Renewable Energy Strategy also announced the establishment of the Office for Renewable Energy Deployment (ORED) which will drive delivery of these targets.

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

Zero carbon definition

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

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

- 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 increasingly stringent mandatory requirements, and all development after 2016 is likely to need to meet zero carbon standards. However, the aspiration for zero carbon development by 2016 is very challenging and will require innovative approaches from both the public sector as well as the development industry.

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

The government is proposing to introduce a more flexible definition of 'zero carbon' to guide building policy, but this has yet to be fully agreed and may not be fully defined for a number of years. In simple terms it will require the mitigation of all carbon (regulated and unregulated[5]) 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, development and 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 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.

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 in future new development and retrofit within existing buildings. The methodology used is set out, including key assumptions and reference sources, the analysis results are presented for two scenarios representing 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.

Wind energy

Wind energy resources and constraints have been mapped using GIS. These have been overlaid to form composite maps of 'constrained' and 'less constrained' areas of possible development, which have then been used to calculate the technical potential for wind energy development. This technical potential has then been discounted to reflect development viability. Decentralised generation has been deemed viable for all sites with the potential for at least three large turbines where development costs and risks can potentially be justified. Smaller areas deemed possible when developed on a 'merchant wind power'[6] or community basis, but only 10% of these sites are assumed to developable.

For both scales of development, the potential number of turbines has been discounted further to reflect potential planning approval rates. We have paid particular attention to Rugby and Stratford-On-Avon, since the limited existence of absolute constraints suggest large swathes of each being technically suitable for development. We have produced an additional scenario to take some account of the landscape carrying capacity, which we recommend is considered in further detail. In the absence of this a simple 75% reduction factor has been applied to within the assessment scenarios.

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[5] *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.*

[6] *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.*

The GIS mapping shows that 93% of the study area experiences average (annual) wind speeds[7] in excess of 6 ms^{-1} (metres per second) at a height of 45m above ground level. This threshold is commonly used by wind developers as a gauge of potential viability, and has been taken as the threshold of project viability. However, the analysis also showed that only 30% of the total study area has a wind speed above 6.5 ms^{-1}, and only 2% is above 7ms-1, hence, where land may potentially be available for wind energy it will typically offer a marginal opportunity and therefore may only attract limited commercial interest. During the lifetime of the Core Strategies (and beyond) technology and economic developments will occur that should see lower wind speed locations becoming more viable.

The results of the analysis suggests that 115 to 214 wind turbines could be developed (by 2026) in Stratford-On-Avon supplying, electricity equivalent to between 97 and 181 % of its predicted electricity demand. Likewise Rugby has the potential for 25 to 48 wind turbines, supplying 17 to 32 % of the borough's predicted electricity demand.

The other Authorities have much smaller estimated capacities, by 2026 as follows: North Warwickshire (9 to 18 turbines, 9 to 18% of electricity demand), Nuneaton & Bedworth (4 to 7 turbines, 4 to 7% of electricity demand), Solihull (0 to 1 turbines, 0 to 0.5 % of electricity demand) and Warwick (21 to 40 turbines, 14 to 27% of electricity demand).

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

Biomass

The overall approach to assessing the biomass resource potential has been to assess the resource information provided by the Local Authorities, Department for Environment Food and Rural Affairs (Defra) and other cited sources then apply resource uptake curves produced for Department of Energy and Climate Change (DECC) 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 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 good potential biomass resource in Stratford-On-Avon, which could deliver an equivalent of over 22% of energy needs potentially met by 2025/26. There is also good potential for biomass heat and power serving North Warwickshire

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

and Warwick with an estimated potential of 7.4% and 5.5% respectively. Rugby, Nuneaton and Bedworth and Solihull have an estimated potential of 3.1%, 2.6% and 1.5% of total energy consumption.

New build development – low and zero carbon potential

The precise nature of the technical solutions for a specific new build development will vary depending on the scale, density and mix of development, together with site specific constraints and opportunities and financial viability considerations. 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 simplify developments types and to identify typical technical responses. Five development types and associated technical solutions have been presented: Urban infill; Rural infill; Settlement extension; Urban extension and Large urban extension/ new settlement.

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 rules 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 measures and 2019 for non-domestic measures. 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 development has 20% renewables in the period 2010-2013. After this date, Code Level 4 (44% regulated carbon reduction) is assumed to be required for by revised Building Regulations residential schemes which will supersede the Elevated Case target. Large urban extensions / new settlements (residential & non-residential) are assumed to be able to achieve zero carbon as of 2013.

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

Uptake in the existing built environment

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

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[8] *The growth potential for Microgeneration in England, Wales and Scotland, Element Energy, June 2008*

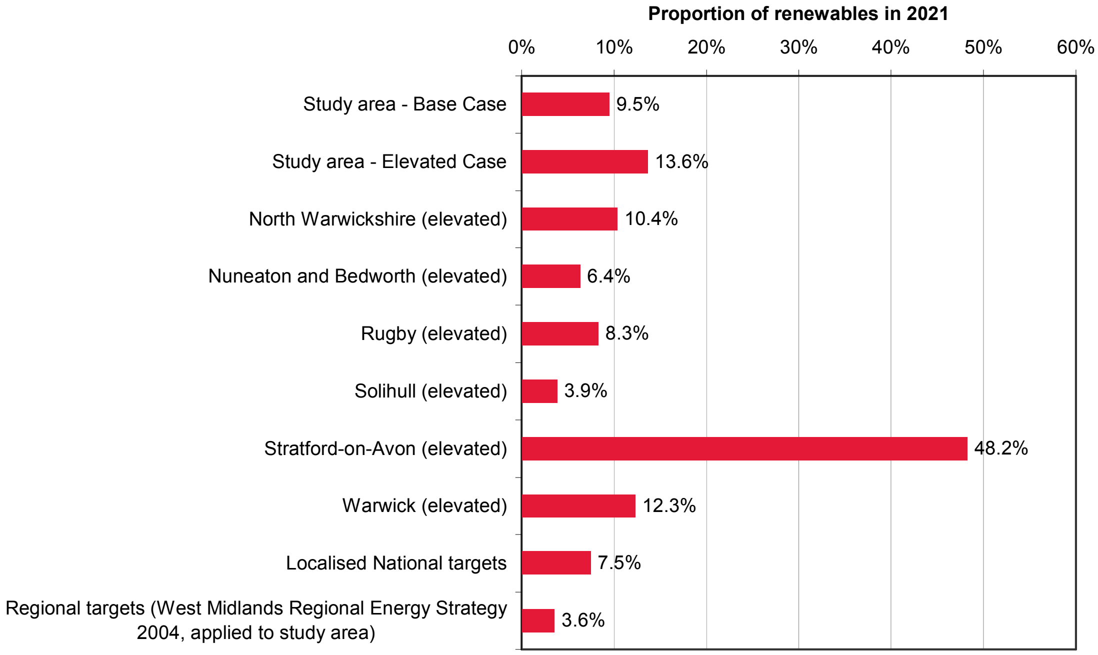
uptake is based on the policy scenario of implementing both power and heat tariffs at a national level, which is currently in train. These tariffs are likely to be the key drivers in this market sector. The Elevated Case is a 30% increase on the Base Case to reflect additional local and regional support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

The results of this analysis are that by 2025, micro generation can typically meet 1.3% to 3.9% of the Authorities' heat and power energy in the base case, rising to 1.7% to 5% of energy in the Elevated Case scenario.

Bringing it all together – impact of development standards and decentralised generation

The overall results of low and zero carbon generation potential have then been benchmarked against regional and national targets for 2021.

The results show that, for the study area, under Base Case scenario, around 5.7% of heating energy could come from low carbon sources whilst 18.8% of electricity could be generated, which is significantly influenced by the wind energy potential in Stratford-On-Avon and Rugby. Overall, 9.5% of heat and electricity needs could be met from low carbon sources, significantly exceeding the 4% target in the current regional energy strategy. The Elevated Case forecasts 6.1% of heating energy from renewable sources and 32.4% of electricity. Overall, 13.6% of heat and electricity needs could be met from low carbon sources, which is well in excess of the upper level (10%) of the 'localised' national target (used to benchmark each authority). Overall results by authority are shown in table below.



On average for the two scenarios, almost 591,000 tonnes CO_2 per annum could be saved in 2021 compared with 2006 baseline emissions for the study area. This is a saving of around 7.6% of 2007 emission when including transport emissions, or 13.3% when only considering emissions from thermal or electrical energy consumption.

On the basis of the analysis it is recommended that Stratford-On-Avon establishes a target below the base case assessment, whereas all other authorities should set stretching targets based upon the Elevated Case scenario.

New build development –carbon standards

Within the study the options for setting development carbon standards, in particular the viability of exceeding the nationally proposed zero carbon buildings roadmap, has been considered to achieve greater carbon reduction, to instigate early action within the local development market and ensure opportunities for achieve higher standards, particular within major development sites are not lost.

In summary, the areas of acceleration considered were:

- Requiring 10% (against regulated and unregulated emissions) low or zero carbon supply in all development from 2010
- Requiring 20% (against regulated and unregulated emissions) low or zero carbon supply in all development from 2013 and from 2010 where lower cost solutions are available
- Requiring 44% (regulated) carbon reduction 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 (in comparison to the national zero carbon routemap) a target framework has been established as shown below.

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% (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 development including those of less than 10 dwellings to ensure consistency with Code for Sustainable Homes

$^{\chi}$ where lower costs 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.

Within the framework, 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 in the case of 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. 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

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. However, we propose only to require this on larger schemes, where economics are anticipated to be more favourable.

For larger development (generally over 1,000 units) or where low costs solutions are available, we are proposing that a target of meeting zero carbon standards ahead of 2013 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.

To provide additional support for the achievement of the zero carbon standards, the development of local ‘allowable solutions’ strategies (and delivery vehicles) ahead of the 2016 milestone, should be considered. This will enable authorities to present the lowest costs 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 / LZC supply targets are established from 2010 and 2013 respectively, to be applied to regulated and unregulated emissions (taken as a fixed 20% of regulated emissions for all development types over 1,000m^2).

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 can not 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 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
- 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 needs to be considered. However, overall the conclusions of the costs 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 add the introduction of a zero carbon standard.

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 development as set out in the carbon targets framework and 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, capitalization of the renewable energy tariffs and ‘allowable solutions’.

Recommendation 3: Conduct site energy studies on all major developments indentified through the land allocation process within each authority. This should specifically be conducted to examine the technical and financial viability to achieve the carbon standards set out in the targets framework.

Recommendation 4: 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 5: Conduct high resolution heat mapping and feasibility analysis (including market assessment) of district heating and CHP around locations identified to as having potential, i.e. where major development and/or surplus heat occur alongside existing high energy consumption intensity

Recommendation 6: 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 7: 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, particular with the introduction on the Renewable Heat Incentive in 2011.

Recommendation 8: Provide specific planning protocols for those small-scale technologies not classed as Permitted **Development**

Decentralised generation

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

Recommendation 10: Provide maps showing indicative areas of potential for wind energy development

Recommendation 11: Conduct a review of the landscape impact from wind energy in the Area of Outstanding Beauty designation within Stratford-On-Avon

Recommendation 12: Conduct a cumulative landscape impact study for wind energy to inform a review of the wind energy capacity within Rugby and Stratford-On-Avon.

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 in comparison to national and regional benchmarks

Develop effective compliance enforcement and the monitoring

Recommendation 14: Establish a monitoring mechanism and conduct detailed annual monitoring of Low and Zero Carbon (LZC) energy uptake in each authority. LZC not subject to local planning approval (Permitted Development, +50MW schemes approved by Infrastructure Planning Commission or were installed in existing buildings) will need a different approach from that which passes through the planning system.

Recommendation 15: Establish expert low carbon planning assessments services, either on an individual Authority basis, or more cost effectively through shared working across a number of authorities, e.g. CSWAPO. 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. The development of the CSWAPO low carbon development toolkit should help to used to support the technical assessment of carbon standards.

Recommendation 16: 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 17: Require suitable on-site carbon monitoring to be installed in major new development to enable assessment of long-term (carbon) performance compliance

Recommendation 18: In supporting Recommendation 17, conduct a study to establish a financial penalty scheme based upon a financial bond returnable on achievement of long term (carbon) performance compliance

Non-Planning Delivery Mechanisms

Planning policy is 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 aneorobic 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 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.

1 Introduction

This study has been jointly commissioned by the following Authorities with the aim of informing the Partner Authorities about the potential, viability and the deliverability of the various renewable and low carbon options:

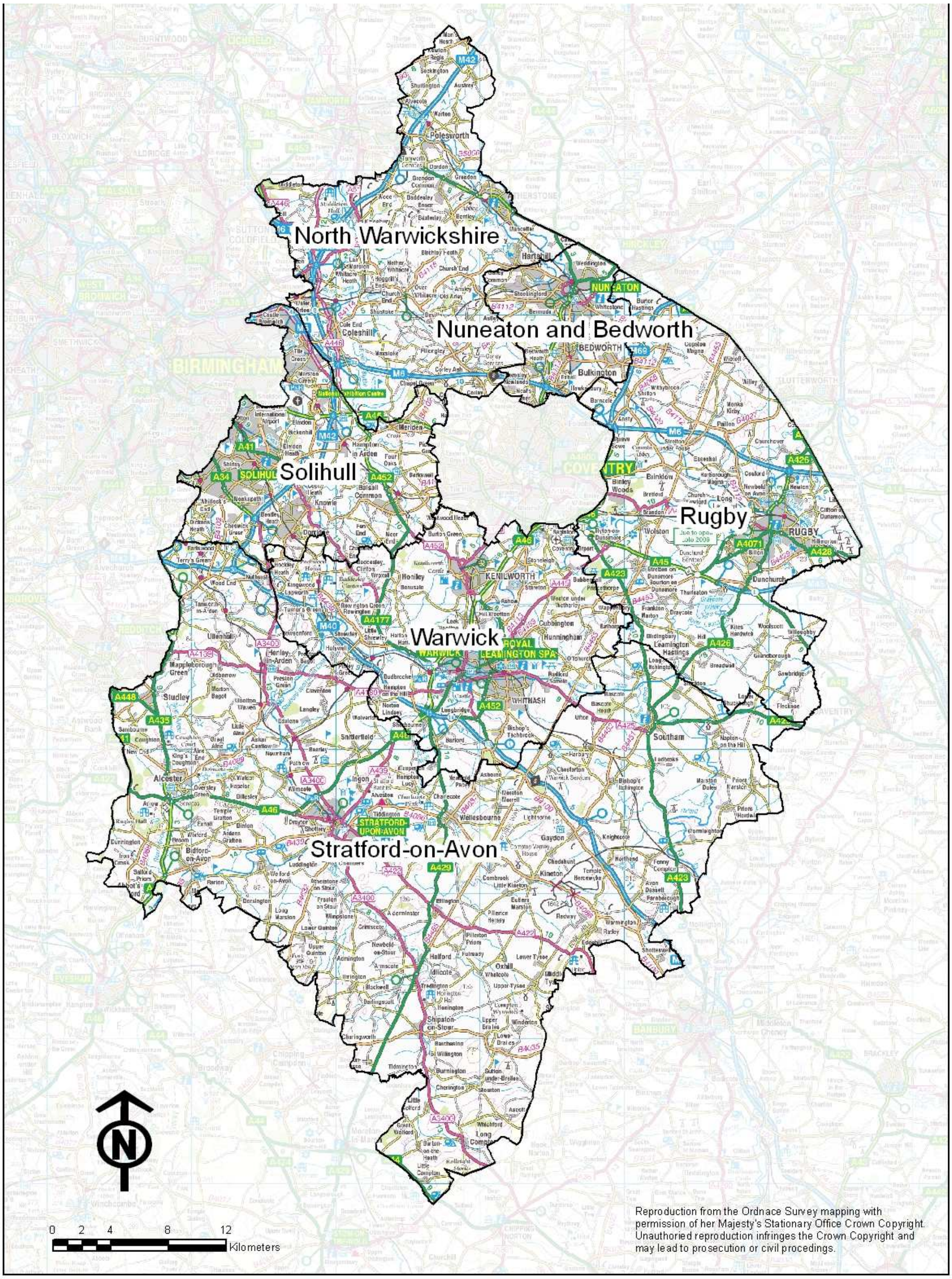
- Stratford-On-Avon
- Warwick
- North Warwickshire
- Nuneaton & Bedworth
- Rugby
- Solihull
- Warwickshire County

This aim is achieved through the preparation of an evidence base for the Partner Authorities' Local Development Frameworks in accordance with the requirements of Planning Policy Statements 1 and 22.

1.1 Study Area Context

The study area, shown in Figure 1, covers the five district councils within Warwickshire County Council and Solihull Unitary Authority. These Authorities combine to make a ring of land to the South East of the West Midlands region with Coventry in the Centre and Birmingham to the West. Coventry is excluded from the study because it did not wish to take part as it was at the latter stages of completing its Core Strategy.

Figure 1. Image of study area



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The individual council areas that form the study are as follows:

1.1.1 North Warwickshire Borough Council

Situated in the most northern part of Warwickshire, North Warwickshire Borough covers an area of 110 square miles (or 28,418 hectares). At its focus lie the market towns of Atherstone, Polesworth and Coleshill. The remainder of the Borough is rural with a number of small villages.

The Council is currently preparing its Core Strategy which will provide a framework of planning policies up to 2026. The West Midlands Regional Spatial Strategy Phase Two Revision—Draft Preferred Option (RSS) has proposed 3000 new homes and 33 hectares of employment land (with a rolling 5 year reservoir of 11 hectares). The Panel Report to the RSS, however, recommends a further 11ha of employment land, although it is suggested that the whole 44ha would not need to be identified. Nonetheless, as a minimum, the panel recommends that a requirement for a 10-year period should be identified so that land will be available to top-up the continuous 11ha reservoir as needed.

There is also a requirement within the Panel Report for over 200-250ha of land for Regional Logistics use (across the entire region), adding pressure on the Borough to provide an additional 20ha at Hams Hall and 40ha at Birch Coppice.

The development forecasts (for 2006/7 to 2025/6) as provided by the authority of 3,000 new dwellings and 138,000 m^2 of non-residential floor area have been used within the analysis of the low carbon solution in the new development, as discussed in section 8.

1.1.2 Nuneaton and Bedworth Borough Council

Nuneaton and Bedworth Borough Council (NBBC) is located to the north of Warwickshire County. The borough lies adjacent to North Warwickshire Borough Council to the west and Rugby Borough Council to the east. North east of the Borough is Leicestershire and Hinckley and Bosworth Borough Council, to the south is Coventry City Council. NBBC is the second most populated borough in the county with a population of 121,200 yet it is by far the smallest in area, measuring approximately 30 square miles (7 miles north to south and 6.5 miles east to west or 7,898 ha), with a population density of 15.3 per ha.

Nuneaton is one of 25 identified strategic town and city centres in the West Midlands. Additionally, the West Midlands Regional Spatial Strategy Phase Two Revision—Draft Preferred Option (RSS) has proposed 10,800 net dwellings between 2006-2026; a rolling 5 year reservoir of employment land of 32ha up to 96ha over the plan period (subject to testing and possible revision); up to 35,000 square metres of retail floor space up to 2026 for Nuneaton and 10,000 square metres of retail floor space for Bedworth; as well as 30,000 square feet of office development in Nuneaton.

The recent Panel Report to the RSS, however, made a number of recommendations, specifically, a further 200 dwellings and an additional 32ha of employment land up to 2026, suggesting that the whole 128ha would not need to be identified [within the Local Development Framework]. Nonetheless, as a minimum, the panel recommends that a requirement for a 10-year period should be identified so that land will be available to top-up the continuous 32ha reservoir as needed.

This represents exceptional challenges for the Council to balance competing land use issues and create a quality environment adapted to climate change that also meets the social and economic aspirations of those living, working and visiting the Borough.

The development forecasts (for 2006/7 to 2025/6) as provided by the authority of 10,800 new dwellings and 158,000 m^2 of non-residential floor area have been used within the analysis of the low carbon solution in the new development, as discussed in section 8.

1.1.3 Rugby Borough Council

Rugby is located in the north east of Warwickshire, situated in the West Midlands region but also bordering directly onto the East Midlands region. The Borough covers an area of 138 square miles (or 35,742 ha) encompassing the town of Rugby, 39 Parishes and a large swathe of Green Belt between the City of Coventry and the west of Rugby. Two thirds of the Borough's 91,600 residents live in the town with the remainder residing in rural settlements ranging in size from 20 to 3000 people.

The West Midlands Regional Spatial Strategy Phase Two Preferred Option Panel Report recommends a residential allocation in Rugby Borough of 11,000 dwellings by 2026. It also recommends an indicative long-term employment land requirement of 144ha by 2026.

In July 2009 Rugby Borough Council published its Proposed Submission Core Strategy. The Housing Trajectory contained within this document has been used to predict the level of residential development that will occur in the Borough to 2026. Between 2006-2026 approximately 12,700 dwellings are expected to be delivered in the Borough.

The development forecasts (for 2006/7 to 2025/6) as provided by the authority of 12,274 new dwellings and 1,070,200 m^2 of non-residential floor area have been used within the analysis of the low carbon solution in the new development, as discussed in section 8.

1.1.4 Solihull Metropolitan Borough Council

Solihull is situated at the southeast edge of the Birmingham Conurbation and has physical links to Coventry to the east and Warwickshire. It has two main urban areas, one in the north around Chelmsley Wood Town Centre where some wards are within the East Birmingham and North Solihull Regeneration Zone. The other is in the southwest around Solihull Town Centre. Both urban areas adjoin Birmingham. Solihull's rural area covers about two thirds of the Borough and embraces a number of villages of varying size.

The population of Solihull is about 203,900 people. About 80% of people live in the main urban areas, 9% in the larger settlements of Knowle and Dorridge and the remainder in smaller settlements or elsewhere in the rural area. The administrative area covers about 17,832 hectares.

The West Midlands Regional Spatial Strategy Phase Two Revision--Draft Preferred Option (RSS) proposes 7,600 new dwellings for Solihull (2006-2026). In terms of employment land, the RSS requires a continuous 15ha reservoir of land to be maintained throughout the RSS period and for provision to be made, as appropriate, for a longer-term 'indicative' requirement of 45ha of employment land. Within Solihull Town Centre the RSS requires the LDF to provide for 55,000 sqm of comparison retail floorspace 2006-2021and to have regard to a further 25,000 sqm 2021-2026.

The Examination in Public Panel Report (September 2009) recommends that the number of new dwellings is increased to 10,500 (net) and that the 'longer term' employment land requirement is increased to 60ha, suggesting the whole 60 ha would not need to be identified. As a minimum, the panel recommends that a requirement for a 10-year period should be identified so that land will be available to top-up the continuous 15 ha reservoir as needed. The office floorspace requirement for Solihull Town Centre is reduced to 35,000 sqm. The Secretary of State will have regard to the panel recommendations in finalising the RSS.

The development forecasts (for 2006/7 to 2025/6) as provided by the authority of 13,190 new dwellings and 618,287 m^2 of non-residential floor area have been used within the analysis of the low carbon solution in the new development, as discussed in section 8.

1.1.5 Stratford-on-Avon District Council

SDC is the southernmost district in Warwickshire with a population of 115,500 (2001 census). At 378 square miles (or 97,901ha) it is one of the largest districts in England, with about 250 communities of varying sizes spread across a predominantly rural area. The town of Stratford-On-Avon is the largest settlement with a population of only 23,000. There are also a number of important rural centres, including the market towns of Alcester, Shipston-on-Stour and Southam.

The Draft West Midlands Regional Spatial Strategy Preferred Option (Draft RSS) has proposed 5,600 new dwellings between 2006-2026. 51 ha of employment land for the period 2006-2021, and 20,000 m^2 of office floorspace and 25,000 m^2 of retail comparison floor space in Stratford-On-Avon town between 2006 and 2026. The Panel Report[9] of the RSS recommended the housing numbers be increased to 7,500 and employment land increased by 17ha to 68ha by 2026. The 68ha would not need to be identified, although a 10-year supply should be in place in order for the 17ha reservoir to be maintained.

The development forecasts (for 2006/7 to 2025/6) as provided by the authority of 5,602 new dwellings and 520,000 m^2 of non-residential floor area have been used within the analysis of the low carbon solution in the new development, as discussed in section 8.

1.1.6 Warwick District Council

Warwick District is situated south of the city of Coventry and covers an area of 28,226 hectares. Approximately 81% of the district's rural area lies within the West Midlands Green Belt and approximately 80% of its population of 132,900 (2006 mid year estimates) live within its four towns of Royal Leamington Spa, Warwick, Kenilworth and Whitnash.

The Council is currently preparing its Core Strategy which will provide a framework of planning policies up to 2026. Following examination of the Draft West Midlands RSS the Panel Report recommended that a total of 11,000 new homes and an indicative target of 120 hectares of employment land (with a rolling 5 year reservoir of 30 hectares) should be provided for within the district between 2006 and 2026. The Panel report also indicates that a further 3,500 dwellings will be needed south of Coventry to accommodate a proportion of Coventry's RSS requirement which cannot be provided for within their administrative area.

The development forecasts (for 2006/7 to 2025/6) as provided by the authority of 10,939 new dwellings and 813,384 m^2 of non-residential floor area have been used within the analysis of the low carbon solution in the new development, as discussed in Section 8.

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[9] *West Midlands Regional Spatial Strategy Phase Two Revision Report of the Panel: September 2009, R3.1*

1.2 Aims and objectives of this report

The evidence base is intended to provide the necessary evidence to meet the following requirements (as identified in the PPS1 Climate Change Supplement):

1. To understand the local feasibility and potential for renewable and low-carbon technologies, including microgeneration, to supply new development in their area.
2. To establish a target percentage of the energy to be used in new development to come from decentralised and renewable or low-carbon energy sources. Consideration should be given to local viability and feasibility, and whether targets will harm economic performance or the provision of forecast housing numbers.
3. To set site-specific targets for greater use of decentralised energy on development where there is the potential and it is viable (this must be evidence–based as above)
4. To identify suitable areas for renewable energy schemes, where possible
5. To enable the potential for renewable and decentralised energy to be considered when selecting development sites

1.3 Structure of report

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

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 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 low and zero carbon / renewable energy generation potential then follows. This section looks, in particular, at the major opportunities surrounding decentralised wind and biomass development, 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 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.

2 Energy Consumption and Carbon Emissions

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

2.1 Current energy consumption

Figure 2 shows that thermal and transport energy dwarf that of electricity. Solihull is the highest consuming authority in the study area, reflecting the high density of commercial and industrial activities as well as large number of dwellings. However, Rugby closely rivals Solihull owing to a substantial thermal demand. The remaining Authorities demonstrate similar profiles in both the energy split (transport being the largest) and the total consumption (4,000-4,500 GWh/yr).

CO_2 emissions are illustrated in Figure 3 and tell a very similar story, except that Rugby is the largest contributor on this basis. Rugby's thermal emissions are considerably larger compared to other Authorities in the study area, suggesting that its fuel mix must be markedly different. Greater breakdown of these emissions can be found in section 2.3.

Figure 2. Estimated energy consumption for 2007 (Source: BERR and DECC)

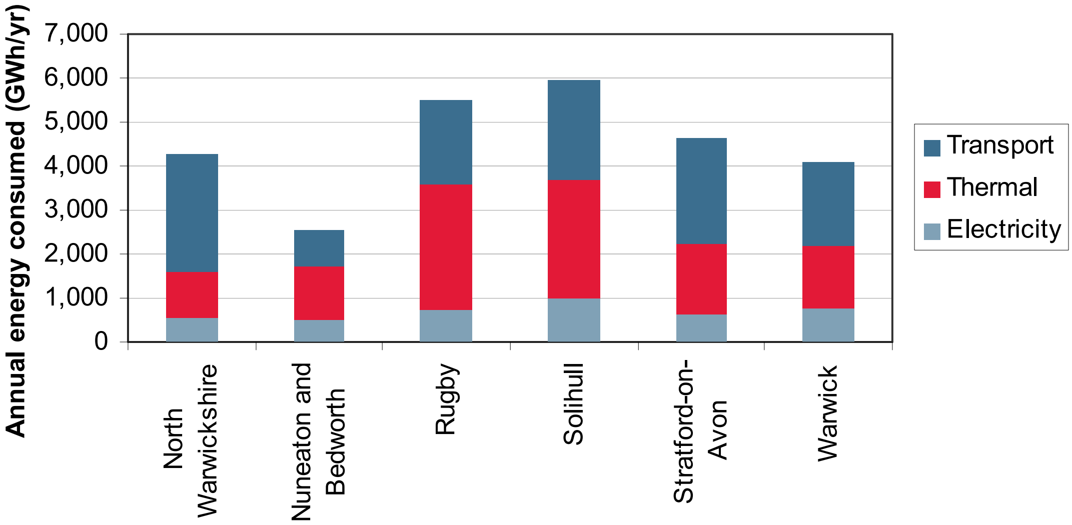
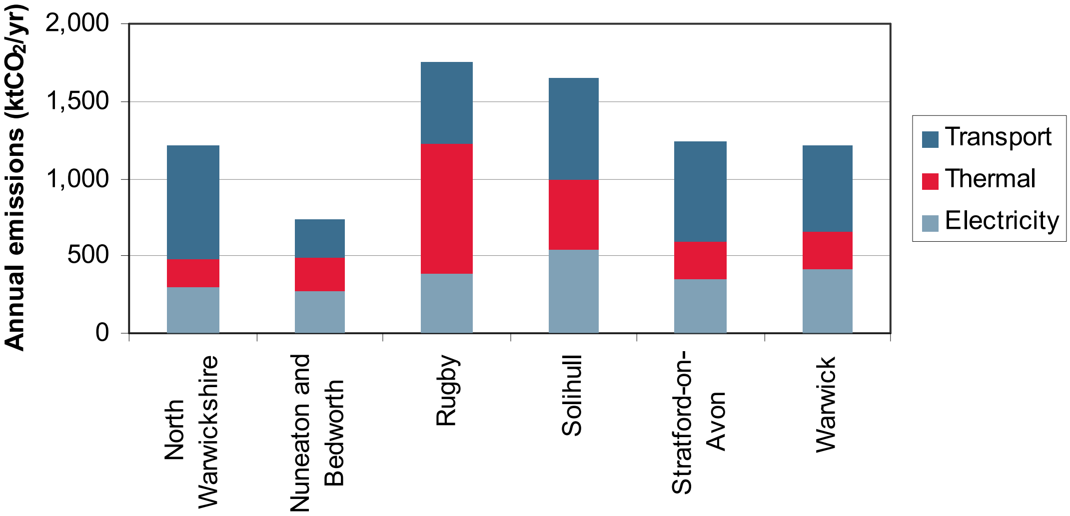


Figure 3 CO_2 emissions for 2007 (Source: DECC NI186 data release[10])



Although Rugby has the highest CO_2 emissions, Table 1 demonstrates that it is not the least 'carbon efficient' on a per capita basis for its domestic component – Stratford-on-Avon fares worse with 2.55 tCO_2 per capita, which is not untypical for more rural areas. Nuneaton and Bedworth has the least emissions, and is the only Authority in the study area with a lower per capita figure than the West Midlands region average. This study has not sought to examine the difference between authorities.

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

Per capita emissions (2007)			
	Emissions from domestic energy ($ktCO_2$)	**Population ('000s, mid-year estimate)**	**Per capita emissions (tCO_2)**
North Warwickshire	149	62.2	2.39
Nuneaton and Bedworth	273	121.2	2.25
Rugby	228	91.0	2.50
Solihull	501	203.6	2.46
Stratford-on-Avon	300	117.8	2.55
Warwick	315	134.6	2.34
West Midlands	***12,273***	***5,382***	***2.28***

2.2 Spatial distribution of heat consumption

Figure 4 and Figure 5 demonstrate the spatial distribution of heat consumption on a Lower Super Output Area (LSOA) basis. They clearly illustrate that the developed areas of each authority consume heat more intensively.

Understanding the spatial distribution of off-gas areas and high heat consuming localities can help to identify areas for intervention for communal heating and Combined Heat and Power

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

(CHP), which can include the use of low carbon biomass fuels. By considering the location of new development it is possible to identify areas of opportunity to link new build community energy infrastructure with high energy consuming existing settlements and also existing major heat sources, e.g. incineration plant, power generation sites and energy intense industrial processes. This is discussed further in Section 8 (new build development).

Finally, Figure 6 illustrates the distribution of non-gas connected domestic properties. We have taken the comparison of the numbers of domestic electricity meters to gas meters in each MLSOA of the study area, as a reasonable proxy, i.e. the difference between the two is assumed to be the number of domestic properties which do not have a gas connection. Consequently, care should be taken interpreting this analysis. In rural areas, many buildings will be located where it is uneconomic to invest in gas grid connections, and so the majority of these properties can be deemed to be ‘off-gas-grid’, with limited (and often costly) heating alternatives. However, in urban areas the properties identified are more likely to not be using gas for other reasons, principally because electricity was preferred at the time the building was being developed or the communal heating is being used in multiple-occupancy buildings. It is the rural properties we are most interested in because they offer the greater potential to fuel switch to biomass heating, small wind turbines and the other microgeneration, particular once Feed-in-tariff and the Renewable Heat Incentive are operational. It is recommended that further consideration be given to the rural clusters of the non-gas connection to explore opportunities for the fuel switching (and energy efficiency support).

The analysis suggests that there are in the region of 46,000 off-gas domestic properties, which is equivalent to 15% of the domestic properties in the study area. As the map shows, a significant proportion (35%) of these are located in Stratford-On-Avon.

Figure 4 Combined Domestic, Commercial & Industrial heat demand density MWh/yr/km^2

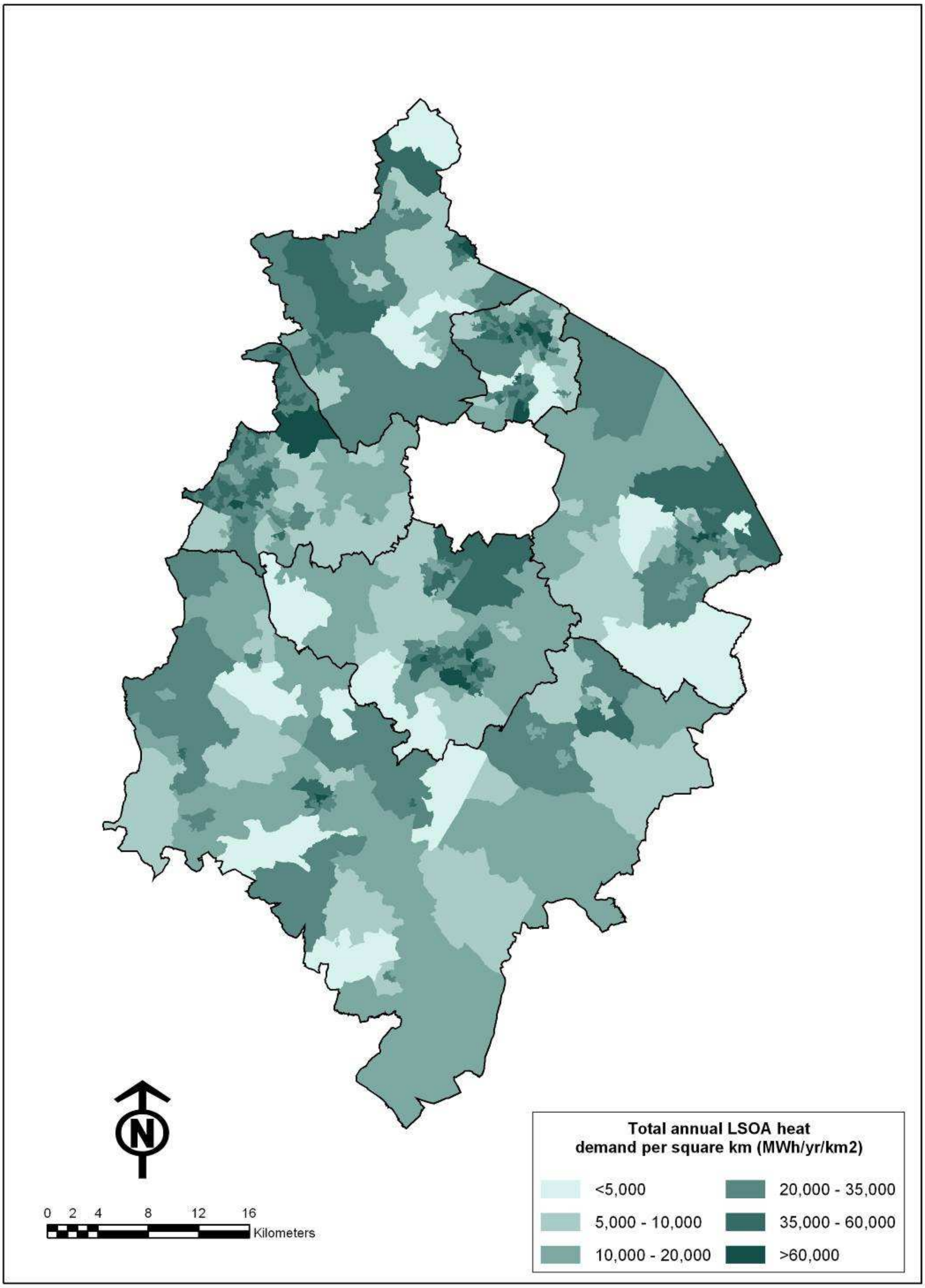


Figure 5 Domestic heat demand density MWh/yr/km^2

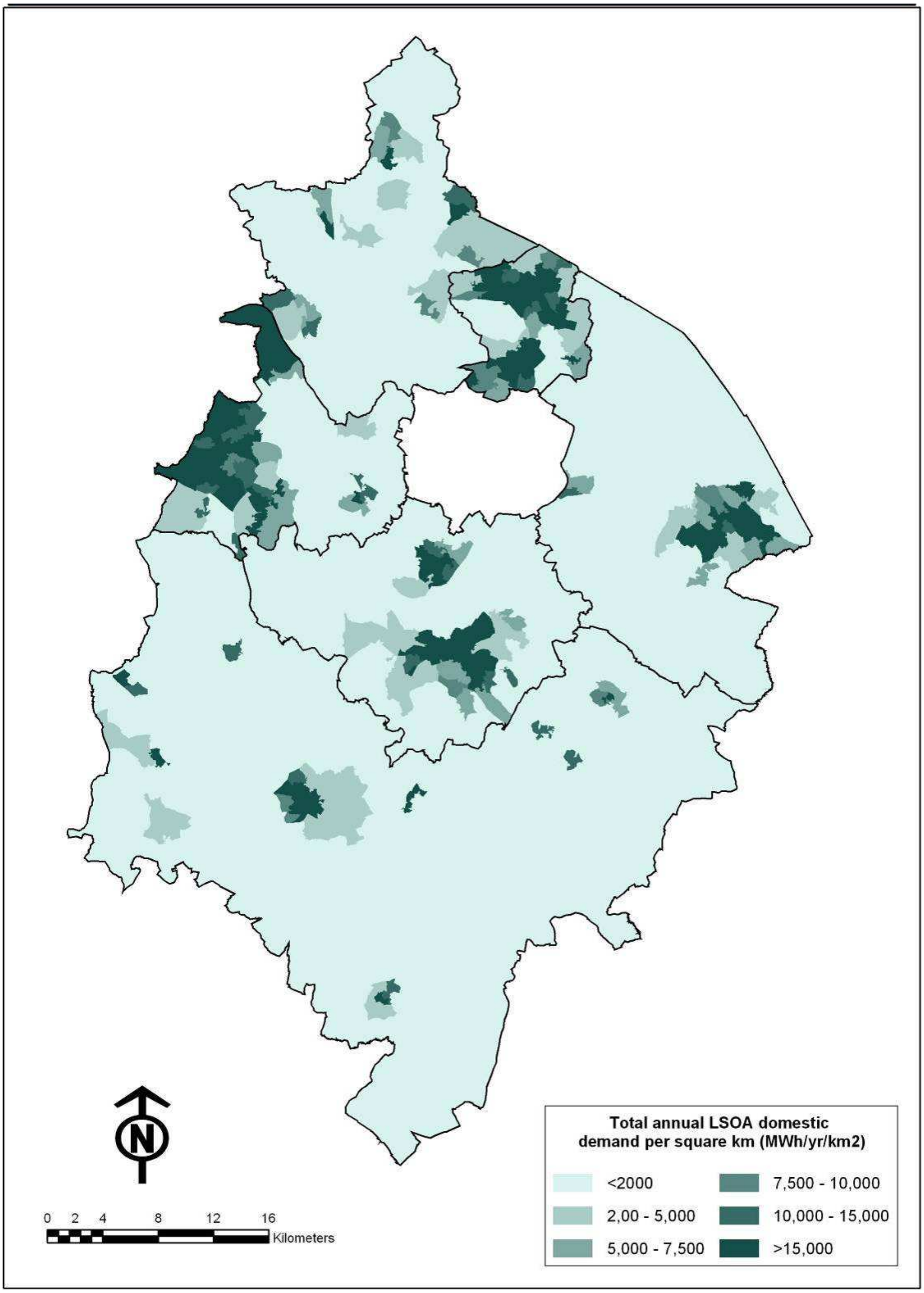
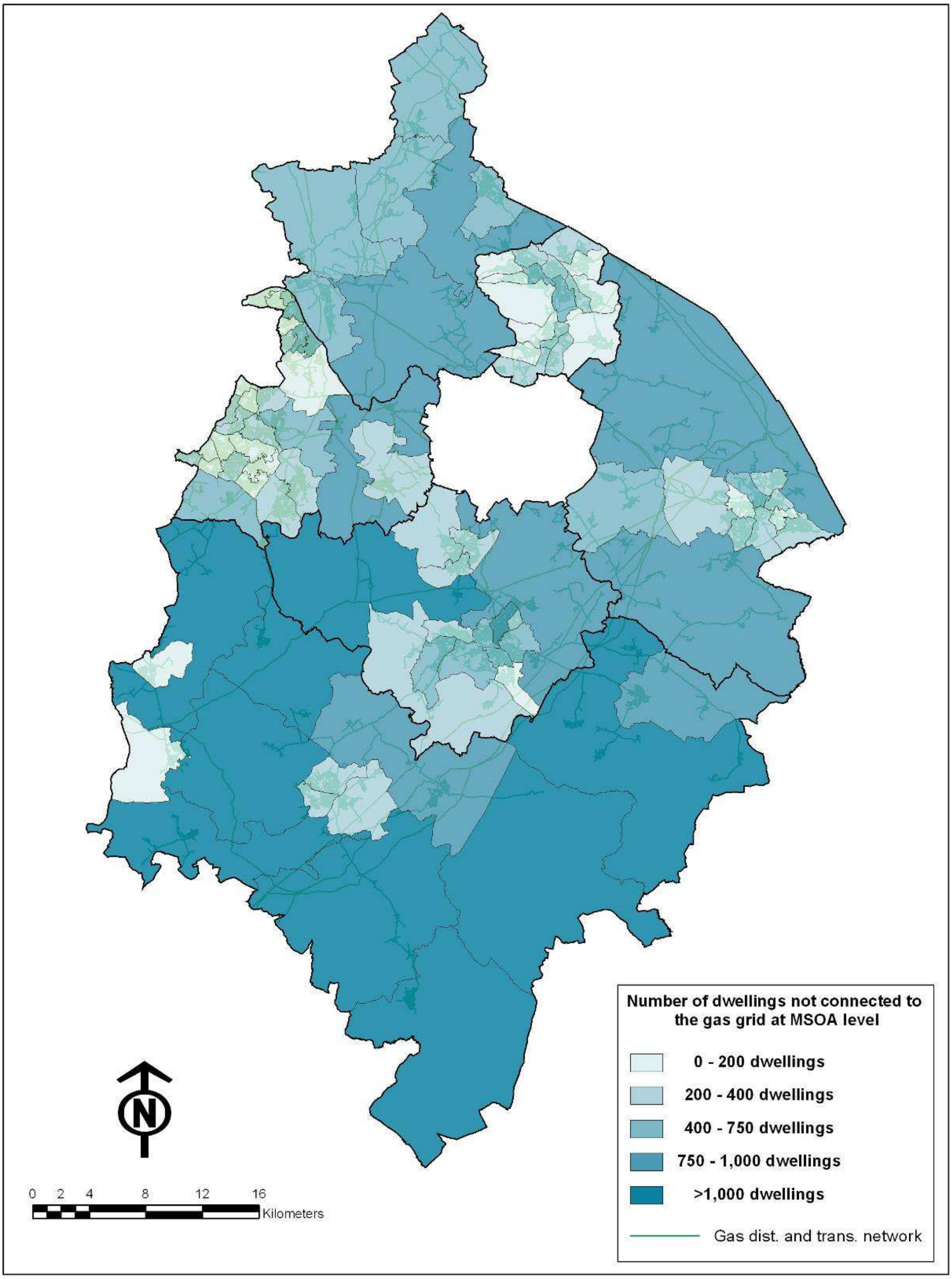


Figure 6 Number non-gas connected dwellings (MSOA level)



2.3 Breakdown of 2007 emissions baseline by fuel type and sector

It is important to consider each authority's carbon emissions arising from the built environment, as this is the key focus of the study. This data is illustrated for each Authority over the following pages, as well as being set out in Table 2 below.

Energy statistics available from BERR demonstrate the electrical and thermal (coal, oil and gas) energy consumption for each Authority. The contributions that each of these energy sources make vary considerably between Authorities. Initial observations include:

- Aside form Rugby, emissions for gas and electricity are broadly in line with national averages, and these two sources dominate built environment CO_2.
- Generally, all Authorities exceed national average electricity consumption.

Warwick's commercial & industrial electricity consumption is significant at 71.9%. This is likely to result from process energy (such as assembly and specialist manufacturing machinery) as well as lighting, cooling and ventilation of factories and offices.

- Rugby's commercial and industrial gas consumption is half of the national average, whereas its coal consumption is over four times larger than the national average, and oil consumption is almost twice the national average. It would appear that considerable coal and oil consumption is skewing gas and electricity results for the commercial and industrial sector.
- Rugby has below average coal and oil consumption in the domestic sector.

Table 2. Proportion of CO_2 emissions arising from key energy sources

Proportion of CO_2 emissions arising from key energy sources				
	Coal	**Petroleum (Oil)**	**Gas**	**Electricity**
Commercial & Industrial				
National average	*4.1%*	*22.2%*	*20.9%*	*52.8%*
North Warwickshire	2.8%	12.7%	21.5%	62.9%
Nuneaton and Bedworth	1.9%	15.3%	19.2%	63.6%
Rugby	18.1%	38.7%	10.4%	32.7%
Solihull	0.3%	11.3%	30.3%	58.2%
Stratford-on-Avon	1.6%	14.8%	25.3%	58.3%
Warwick	0.1%	11.9%	16.1%	71.9%
Dwellings				
National average	*0.9%*	*4.7%*	*50.8%*	*43.6%*
North Warwickshire	1.1%	4.2%	48.7%	46.0%
Nuneaton and Bedworth	0.1%	0.8%	54.9%	44.2%
Rugby	0.5%	2.1%	51.9%	45.6%
Solihull	0.4%	1.7%	54.5%	43.4%
Stratford-on-Avon	1.4%	7.6%	48.5%	42.5%
Warwick	0.9%	4.7%	50.8%	43.6%

Figure 7: Annual built environment CO2 emissions for North Warwickshire (2007) (Source: BERR)

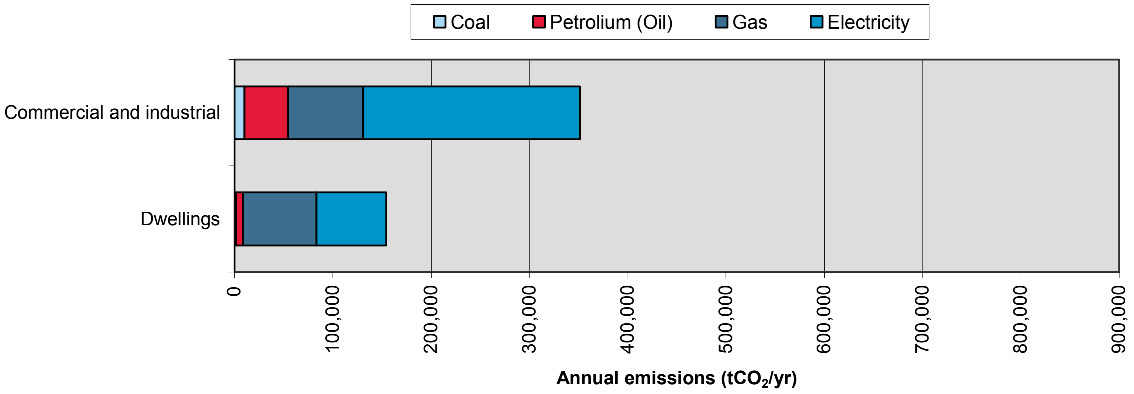


Figure 8: Annual built environment CO2 emissions for Nuneaton and Bedworth (2007) (Source: BERR)

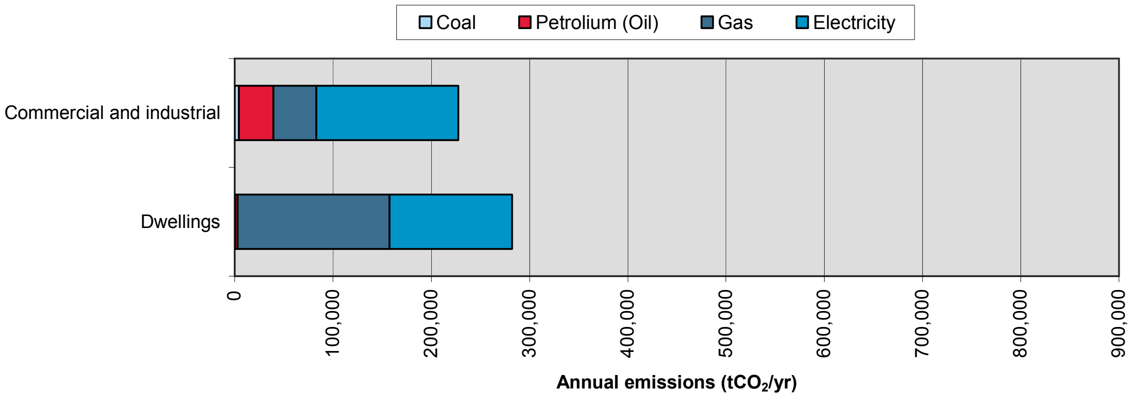


Figure 9: Annual built environment CO2 emissions for Rugby (2007) (Source: BERR)

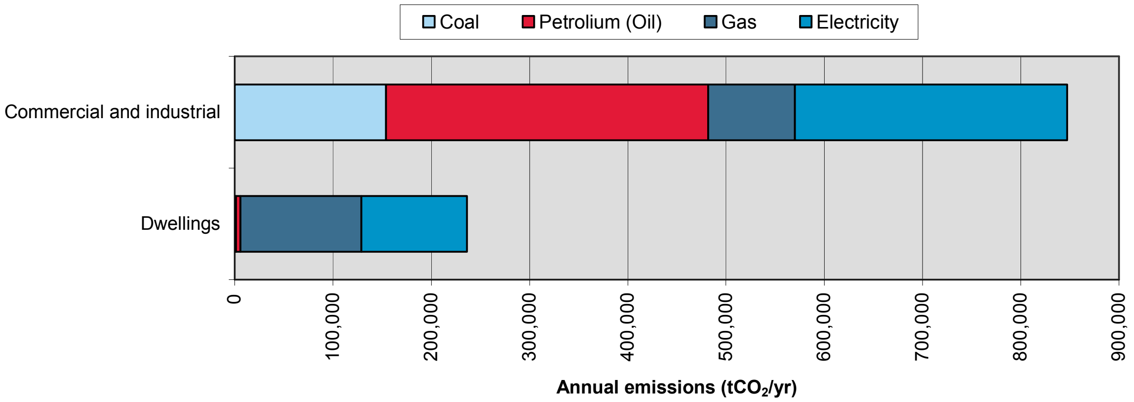


Figure 10: Annual built environment CO2 emissions for Solihull (2007) (Source: BERR)

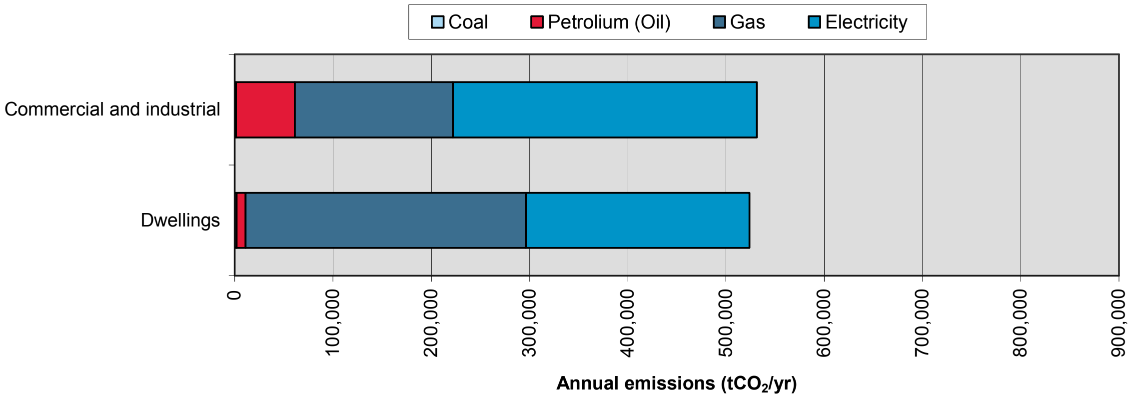


Figure 11: Annual built environment CO2 emissions for Stratford-on-Avon (2007) (Source: BERR)

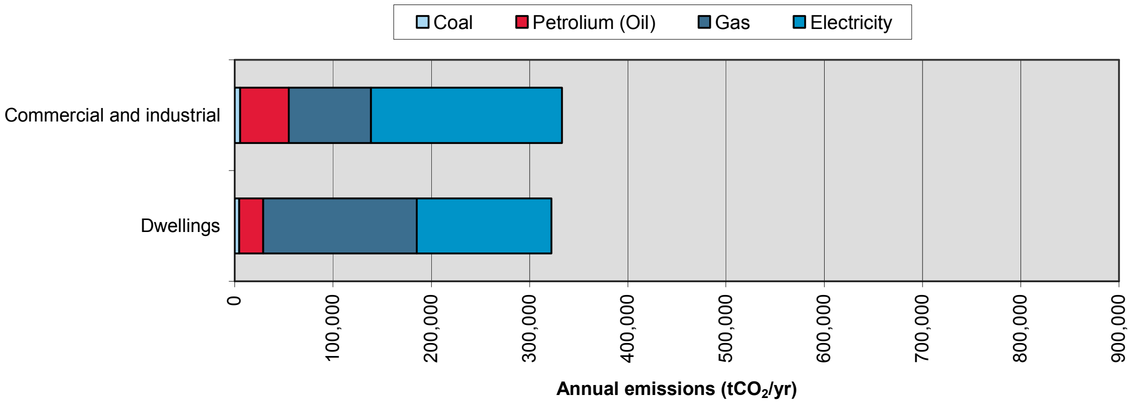
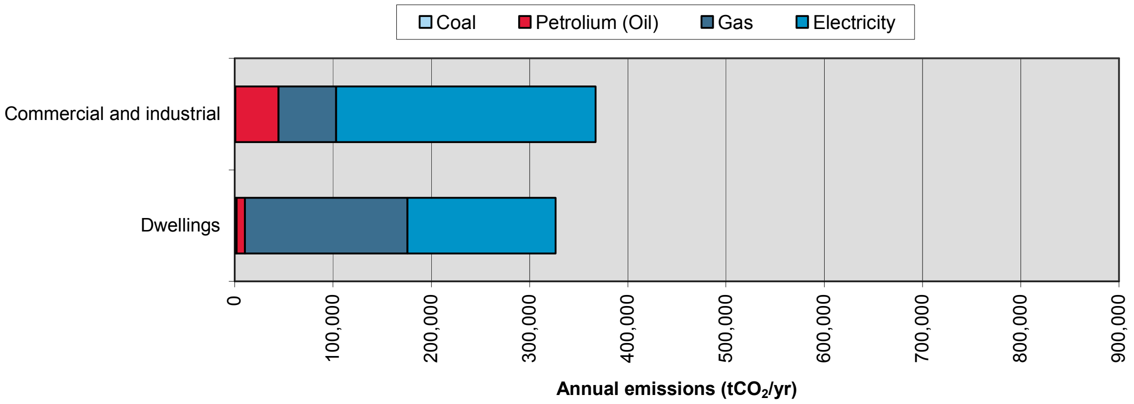


Figure 12: Annual built environment CO2 emissions for Warwick (2007) (Source: BERR)



2.4 Projected consumption including energy efficiency baseline

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

In the absence of local studies into projected energy demands for the West Midlands, reference has been made to a recent study commissioned by East Midlands Regional Assembly (EMRA)[11] to enable forward projections. This takes into account a range of policies and measures in forecasting the implementation of viable energy efficiency initiatives in both residential and non-residential buildings. . The study forecasts energy reductions through energy efficiency in the built environment, taking into consideration the existing situation through review of:

- Home Energy Conservation Association (HECA) returns;
- Estimated SAP ratings of social and private homes;
- Proportion of homes filing the Decent Homes thermal comfort criteria; and
- Proportion of homes with solid walls.

The study projects forward energy consumption based upon future interventions designed to improve building efficiency.

The English House Condition Survey 2003 Regional Report (the most recent undertaken with a regional breakdown) indicates that in the West Midlands, the average SAP score of existing dwellings was 49.5, compared to 50.8 for the East Midlands region. On the basis of the similarity of housing stock performance, it has been assumed that the two regions will present similar future performance in terms of energy efficiency. Hence the East Midlands performance projections have been used within this study. The projections for the study area, across the RSS period, are shown in the following graphs. The graphs, which include growth in demand from forecasted new development, are shown by authority, with the same vertical scale to aide comparison.

Energy demands of new buildings are included by applying benchmarks and estimated floor areas to projected residential and non-residential buildings. Overall energy demand is predicted to fall by 4-8% from 2007 levels under these projections.

The purpose of the baseline consumption projection is simply to provide a comparative basis on which to identify the contribution to consumption from Low and Zero carbon technology and the allow this to be benchmarked against national targets.

Further information regarding the graphs can be found in Appendix V.

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[11] *Reviewing renewable energy and energy efficiency targets for the East Midlands, EMRA*

Figure 13: Projected energy demand for both new and existing buildings in North Warwickshire

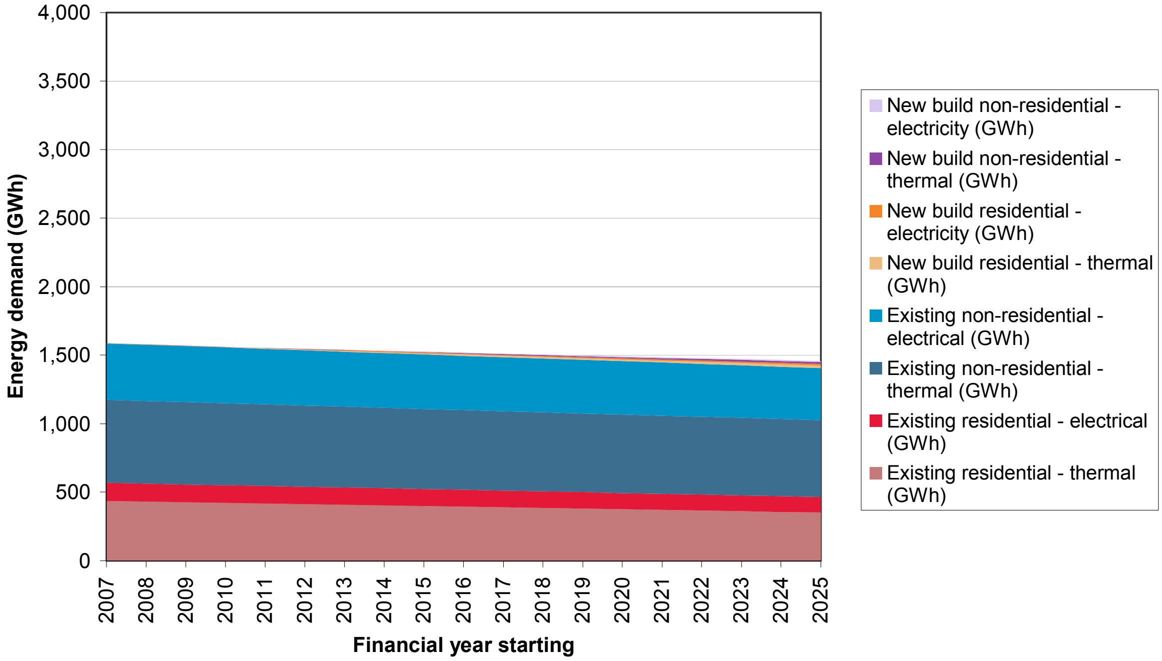


Figure 14: Projected energy demand for both new and existing buildings in Nuneaton & Bedworth

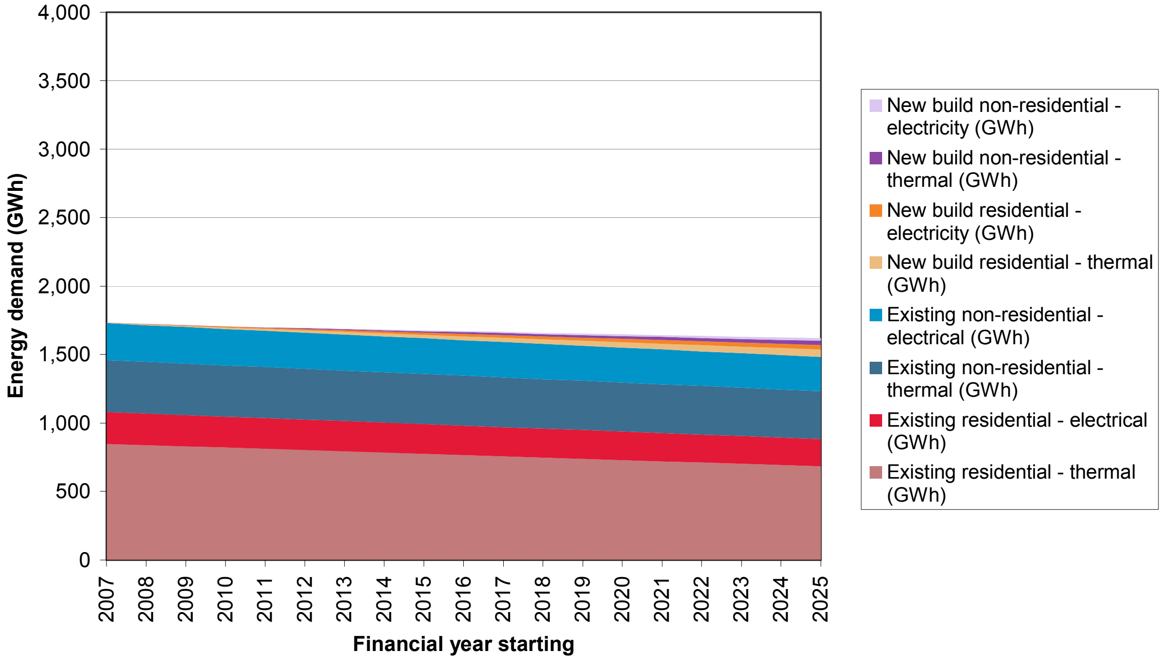


Figure 15: Projected energy demand for both new and existing buildings in Rugby

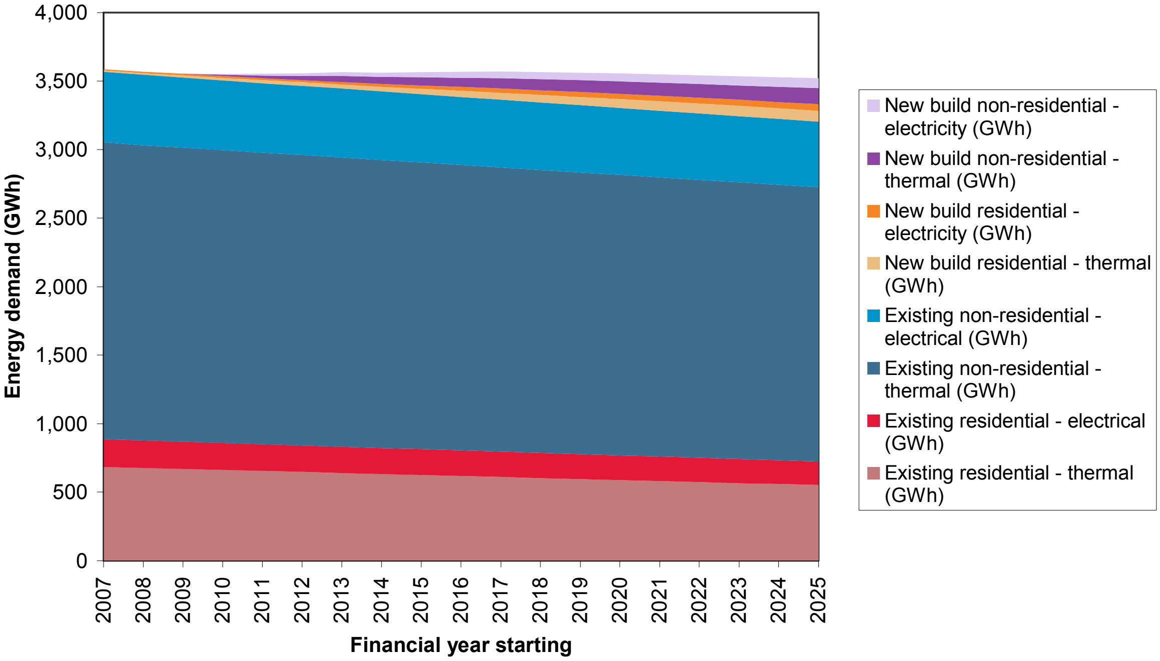


Figure 16: Projected energy demand for both new and existing buildings in Solihull

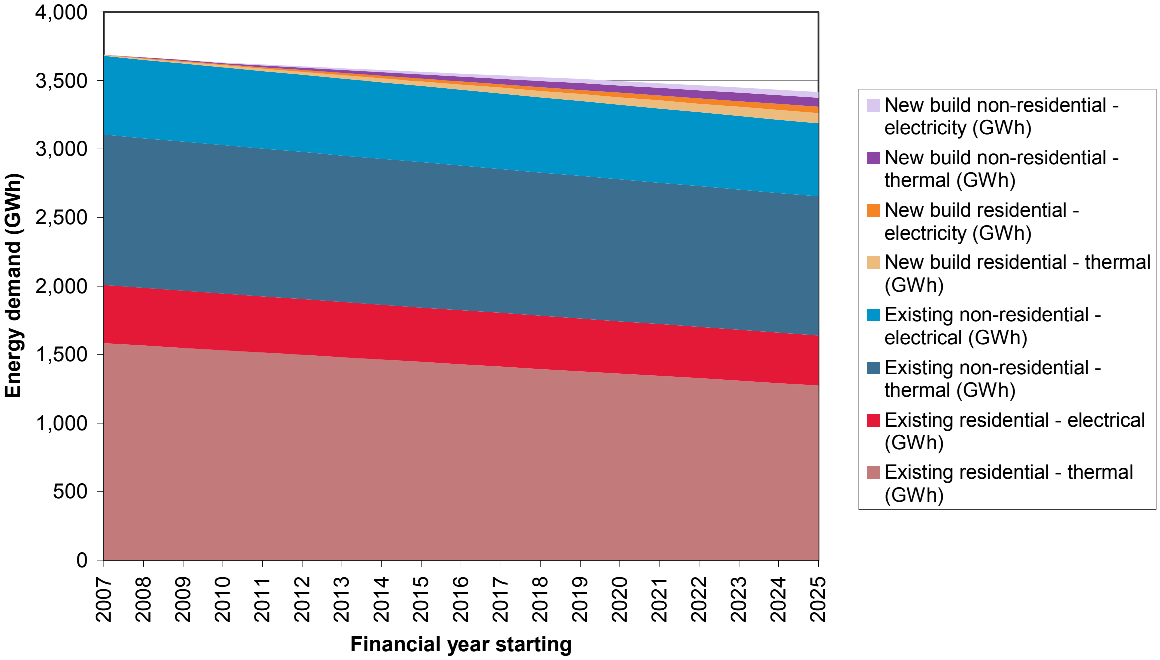


Figure 17: Projected energy demand for both new and existing buildings in Stratford-on-Avon

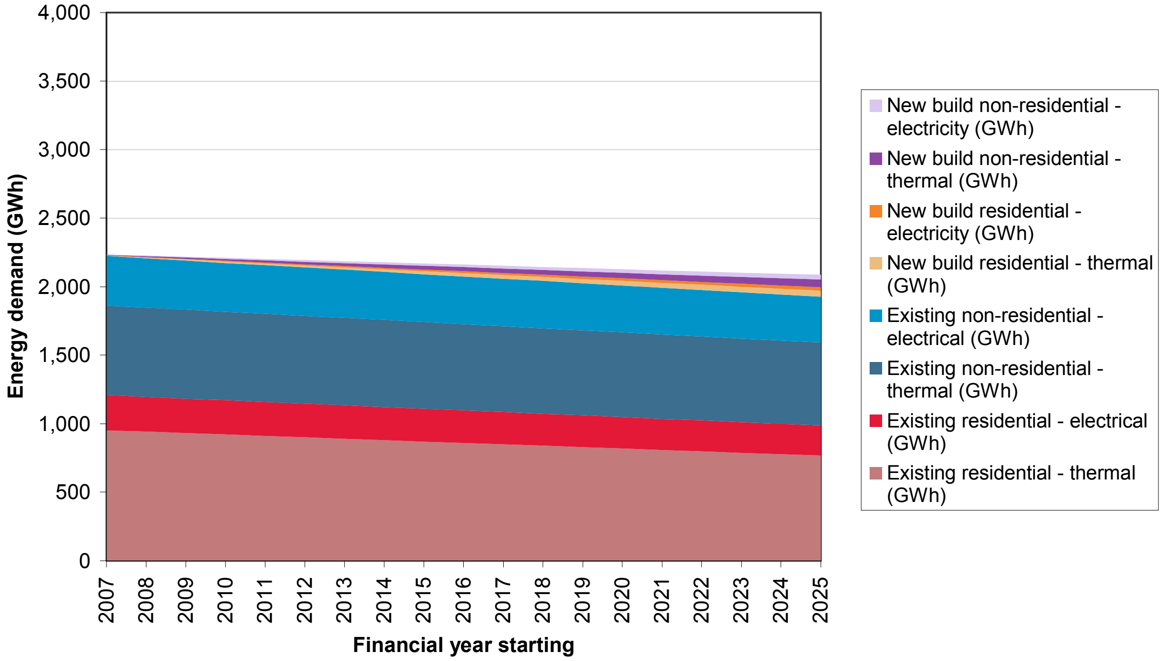
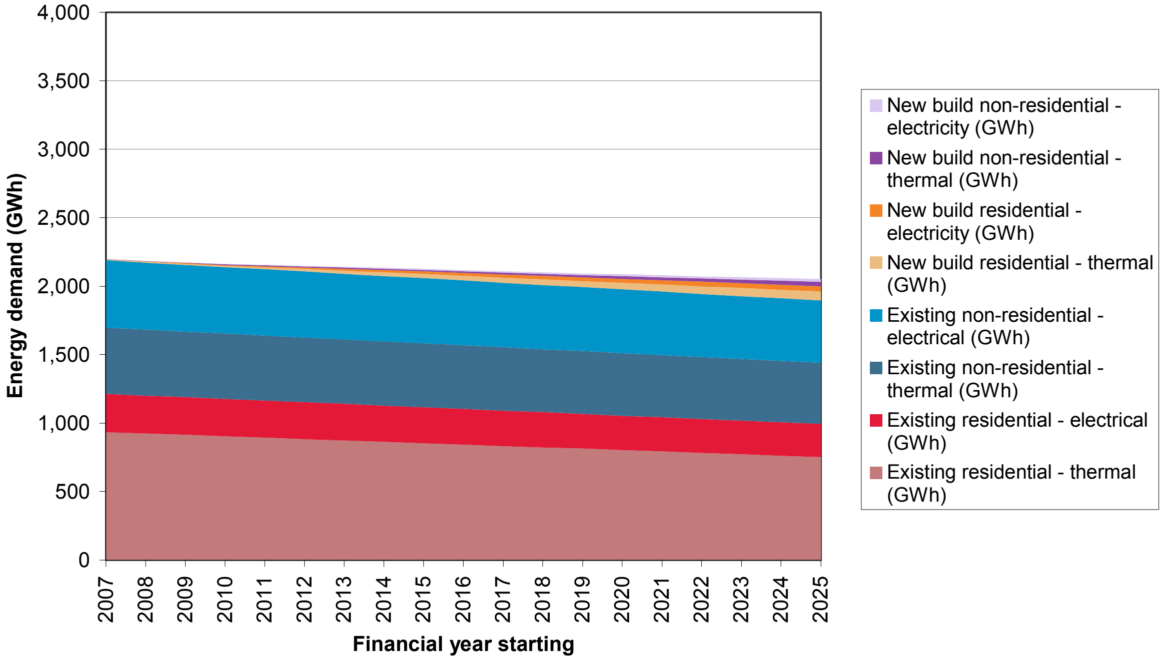


Figure 18: Projected energy demand for both new and existing buildings in Warwick



3 Existing Renewable Energy Capacity

This section summarises the current information available regarding capacity of renewable energy in operation or currently known to be under development. There are no comprehensive Local 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 projects is often uncorroborated.

Many renewable energy technologies, particular those used in the domestic / microgeneration applications, do not require planning or other regulatory approval and the significance of these will be under estimated. This issue is likely to become more significant as the number of smaller installations increase due to the proposed changes to the General Permitted Development Order surrounding micro-generation 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 planned 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 why set challenging targets. This will potentially become more important in the future as government is considering the introduction of a National Indicator for renewable energy, which will be in addition to the existing Planning Authority reporting requirements (through the AMR process). Approaches to data collection for future reporting, is discussed in the recommendations section of the report.

For this study a range of data sources was reviewed including data provided by the Local Authorities, www.renewables-map.co.uk, RESTATS, British Wind Energy Association, UK Small hydro website, Renewable Energy Association and Eon Central Networks (who log electricity generator connections) and previous data collection for Warwickshire County Council[12]. Table 3 provides a breakdown of the estimated existing Low and Zero Carbon generation capacity (GWh) compared with estimated energy demand (excluding that associated to transport). This shows a range of the 7.1% - 0.2% contribution to demand by authority and 1.6% for the study area. When including energy consumption from transport the contribution reduces to 0.9% across the study area. By comparison, at the West Midlands level renewables capacity was estimated in 2004 at 1% of electricity consumption[13], but this is anticipated to have grown significantly during the intervening period from 2004-2009. For Warwickshire a 2.5% supply capacity (as a % of energy demand) was estimated for 2007[14] .

Table 4 to Table 7 then shows this data broken down by technology both as rated power (kW) and estimated power generation (MWh). A full list of the installed and planned projects, by name and location is included in Appendix VI.

It can be seen that landfill gas dominates current installed capacity. Wind energy is conspicuous by its total absence other than a small number of small and micro-scale projects. Planned development is dominated by Energy from Waste (single project in Rugby) but also significant is a biomass heating scheme in North Warwickshire, as well as a number of landfill gas developments.

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[12] *Warwickshire Energy Statistics 2007, Climate Change Strategy Update, Warwickshire County Council*

[13] *West MidlandsRegional Energy Strategy, 2004*

[14] *Warwickshire Energy Statistics 2007, Climate Change Strategy Update, Warwickshire County Council*

Table 3 Summary of the installed low / zero carbon generation within the study area

	North Warwickshire	Nuneaton and Bedworth	Rugby	Solihull	Stratford	Warwick	Total Study Area
Total 2007 Energy consumption (inc. transport) (GWh)	4,291	2,554	5,482	5,961	4,629	4,088	**27,005**
Total installed generation (GWh)	113	26	60	7	9	22	**237**
% LZC (against total energy conumption)	**2.6%**	**1.0%**	**1.1%**	**0.1%**	**0.2%**	**0.5%**	**0.9%**
% LZC (against total energy consumption except transport)	**7.1%**	**1.5%**	**1.7%**	**0.2%**	**0.4%**	**1.0%**	**1.6%**

Table 4 Estimated Installed capacity (kW)

Technology	Electical / Thermal	North Warwickshire	Nuneaton and Bedworth	Rugby	Solihull	Stratford	Warwick	Grand Total
Anaerobic digestion	E						2,096	**2,096**
	T							
Biomass heating	E							
	T		150	240	200	100		**690**
Energy from Waste	E				355			**355**
	T							
Gas CHP	E	3,065	140	190				**3,395**
	T							
GSHP	E							
	T							
Landfill gas	E	8,470	2,880	6,880		1,006	800	**20,036**
	T							
Small wind	E	2	1	5		43	14	**64**
	T							
Total	**E**	**11,537**	**3,128**	**7,083**	**357**	**1,160**	**2,955**	**26,220**
Total	**T**		**150**	**264**	**200**	**100**		**714**

Table 5 Estimated Installed generation (MWh)

Technology	Electical / Thermal	North Warwickshire	Nuneaton and Bedworth	Rugby	Solihull	Stratford	Warwick	Grand Total
Anaerobic digestion	E						15,301	**15,301**
	T							
Biomass heating	E							
	T		255	408	340	170		**1,173**
Energy from Waste	E				2,799			**2,799**
	T				3,499			**3,499**
Gas CHP	E	16,915	773	1,049				**18,736**
	T	25,373	1,159	1,573				**28,104**
GSHP	E							
	T							
Landfill gas	E	70,487	23,967	57,255		8,372	6,658	**166,740**
	T							
Small wind	E	1	1	4		38	12	**56**
	T							
Solar PV	E		80	6	2	83	34	**205**
	T							
Solar thermal	E							
	T			19				**19**
Total	**E**	**87,404**	**24,821**	**58,314**	**2,800**	**8,493**	**22,004**	**203,837**
Total	**T**	**25,373**	**1,414**	**2,000**	**3,839**	**170**		**32,795**

Table 6 Identified planned capacity (kW)

Technology	Electical / Thermal	North Warwickshire	Nuneaton and Bedworth	Rugby	Solihull	Stratford	Warwick	Grand Total
Anaerobic digestion	E		190					**190**
	T							
Biomass heating	E							
	T	5,000						**5,000**
Energy from Waste	E			35,000				**35,000**
	T							
Landfill gas	E		1,150			664	2,402	**4,216**
	T							
Small wind	E				6			**6**
	T							
Solar PV	E				2			**2**
	T							
Solar thermal	E							
	T				3			**3**
Total	**E**		**1,340**	**35,000**	**8**	**664**	**2,402**	**39,414**
Total	**T**	**5,000**			**3**			**5,003**

Table 7 Estimated generation from identified planned capacity (MWh)

Technology	Electical / Thermal	North Warwickshire	Nuneaton and Bedworth	Rugby	Solihull	Stratford	Warwick	Grand Total
Anaerobic digestion	E		1,387					**1,387**
	T							
Biomass heating	E							
	T	8,500						**8,500**
Energy from Waste	E			275,940				**275,940**
	T			344,925				**344,925**
Landfill gas	E		9,570			5,526	19,989	**35,086**
	T							
Small wind	E				5			**5**
	T							
Solar PV	E				2			**2**
	T							
Solar thermal	E							
	T				3			**3**
Total	**E**		**1,387**	**275,940**	**7**	**5,526**	**19,989**	**302,849**
Total	**T**	**8,500**		**344,925**	**3**			**353,428**

4 Low Carbon Policy and Targets

4.1 Emerging National Policy

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

The Low Carbon Transition Plan sets out the UK's plan for becoming a low carbon country, with a headline goal to cut emissions by 18% on 2008 levels by 2020 (112 Mt CO_2e – Million Tonnes of Carbon Dioxide equivalent). This strategy is framed by the Climate Change Act (2008) highlighting a legally-binding minimum reduction target of 80% by 2050 (622 $MtCO_2$e), compared to 1990 levels, but confirms an increased target of at least 34% by 2020 (264 $MtCO_2$e) compared to1990 levels

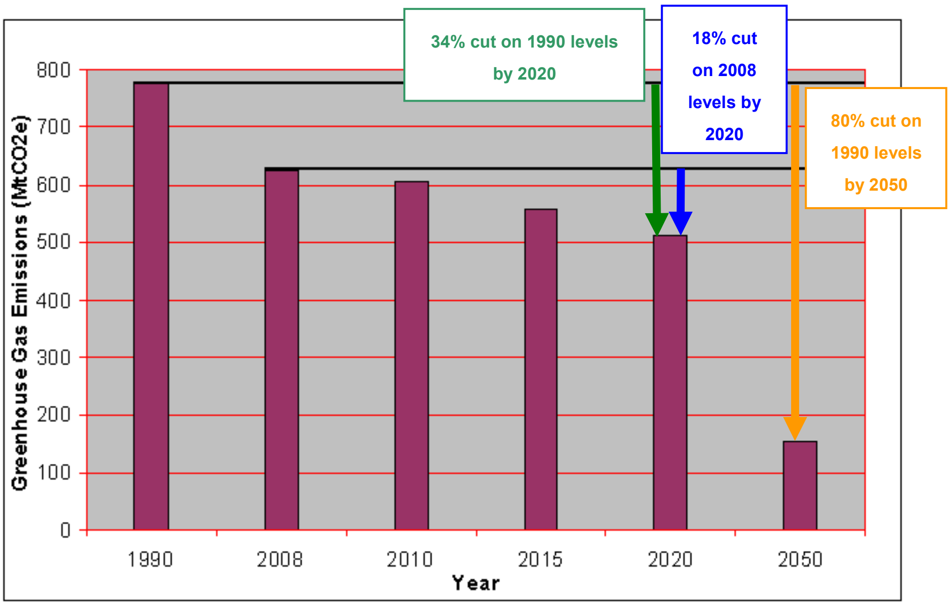
To achieve these targets, the Government has created three five-year 'carbon budgets' to 2022, which mark a cap on the total quantity of GHG emissions released in the UK over a specified time. The budget system allows an element of 'banking' and 'borrowing' between carbon budgets periods to increase 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 19 below shows how these carbon budgets compare to the 1990 and 2008 emissions baselines, while Figure 20 shows how different sectors are expected to make reductions over each of the three carbon budgets.

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

- It can be seen that the largest contribution to reduced emissions is likely to be low carbon 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 19 National greenhouse gas emission reduction timeline (Source: Low Carbon Transition Plan)

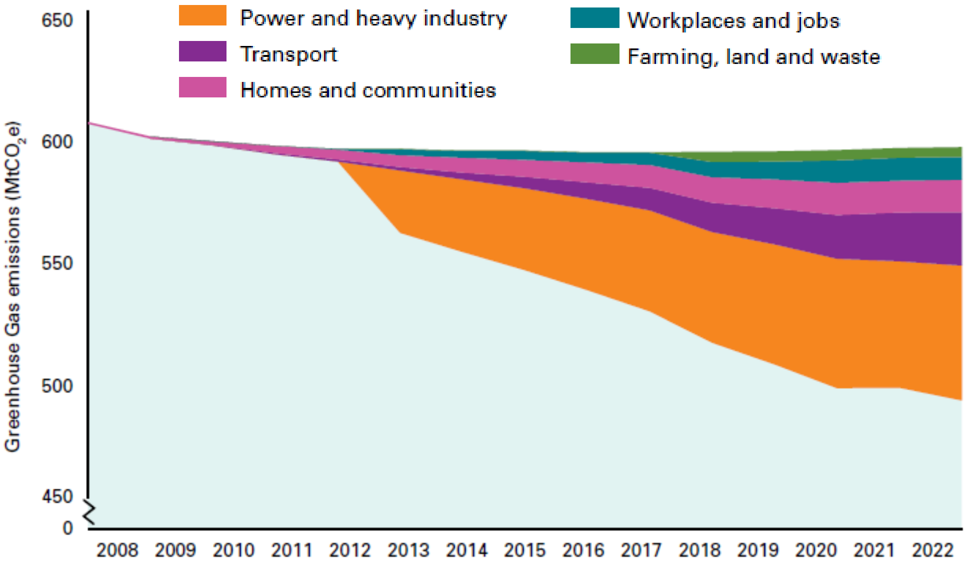


34% cut on 1990 levels by 2020

18% cut on 2008 levels by 2020

80% cut on 1990 levels by 2050

Figure 20 Estimated emissions savings (MtCO2e) in different sectors of the UK resulting from the measures set in the Low Carbon Transition Plan from 2008 to 2022 (Source: Low Carbon Transition Plan)



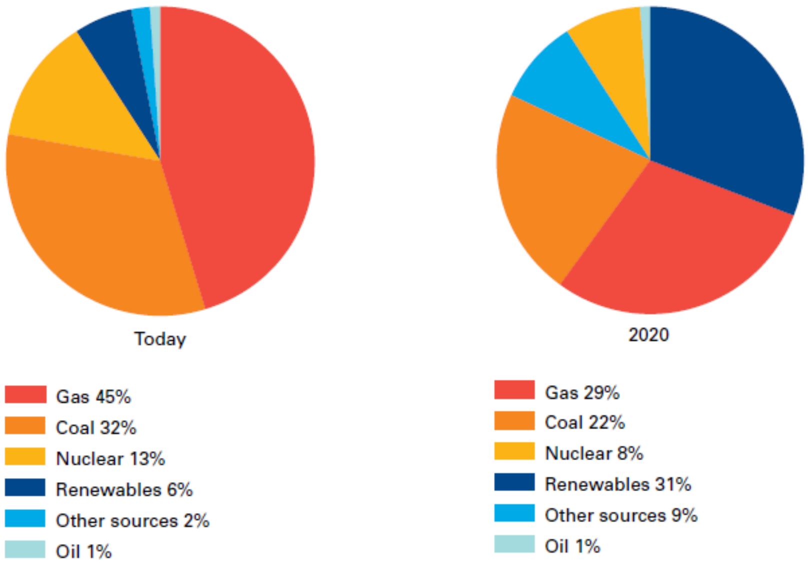
4.1.1 Power Sector

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

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

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

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



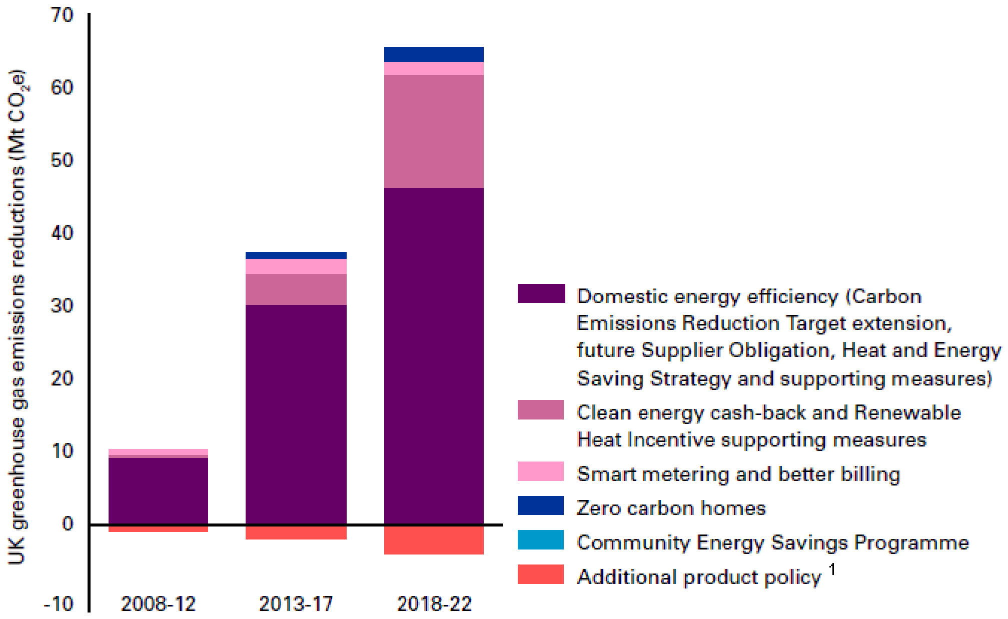
Delivery of this low carbon mix is expected through the following key measures:

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

4.1.2 Homes and Communities

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

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



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

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

- A host of tax measures to help distributed low carbon energy, including: new zero carbon homes receiving stamp duty relief

The Renewable Energy Strategy announced the establishment of The Office for Renewable Energy Deployment (ORED) which will have the responsibility to drive delivery of the national targets, based on the 'lead scenario'[15], 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 is worth noting 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.

4.1.3 Planning policy

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

Key aims identified for the planning process include:

- Establishing the Infrastructure Planning Commission, which will develop national policy and streamline decision-making for a range of infrastructure
- Planning applications for renewable energy projects over 50 MW will be determined by the Infrastructure Planning Commission from 2010
- Ensuring a strategic approach to planning, working with all the English regions (Local Authorities are also mentioned in Renewable Energy Strategy) to help ensure they have robust evidence-based strategies for delivering their renewable potential in line with the UK 2020 target. £1.2m budget was identified to support these efforts.
- Support swifter delivery, helping the planning community as they develop and implement local and regional energy planning and handle renewable and low-carbon energy applications, for example through supporting skills development and by building capacity.
- Address the impacts of renewables deployment by doing more to resolve spatial conflicts and develop generic solutions to mitigate the impacts of renewable technologies, notably air quality, environmental, navigational and aviation radar impacts.

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[15] *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.*

- 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 Renewables and Low-Carbon Planning Performance Agreements for schemes which incorporate renewable heat and electricity technologies and/or a low carbon approach to development (this was recently established through ATLAS - Advisory Team for Large Applications - www.atlasplanning.com).
    - It was found that 65% of appeals for renewable energy projects are successful. This suggested that priority should be given to appeals on renewable energy proposals.
    - Revising the Cost Award procedure.
    - Using Local Development Orders (LDO).
    - Increasing flexibility for planning permissions.
- Generally ORED and CLG are set to support (including the announcement of £10 million funding over two years) the development of skills and knowledge within the planning community at local and regional level through, for example, the set up of an ‘Expert Support Network’

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

Planning Policy Statement 22 (PPS22): Renewable Energy

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

Local policies should reflect paragraph 8 of PPS22 which says:

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

Planning Policy Statement 1 (PPS1): Planning and Climate Change Supplement

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”.*
>
> *“Planning authorities should:*

- set out a target percentage of the energy to be used in new development to come from decentralised and renewable or low-carbon energy sources where it is viable;
- where there are particular and demonstrable opportunities for greater use of decentralised and renewable or low-carbon energy than the target percentage, bring forward development area or site-specific targets to secure this potential;
- set out the type and size of development to which the target will be applied; and
- ensure there is a clear rationale for the target and it is properly tested.”

The PPS1 supplement also states that:

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

4.1.4 Local Authority powers / obligations

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

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

The Energy and Planning Act 2008 formalises the legal right of local authorities to establish their own carbon reduction targets for development, in line with the PPS1 guidance.

4.1.5 Building a Greener Future: Towards zero carbon development

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

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

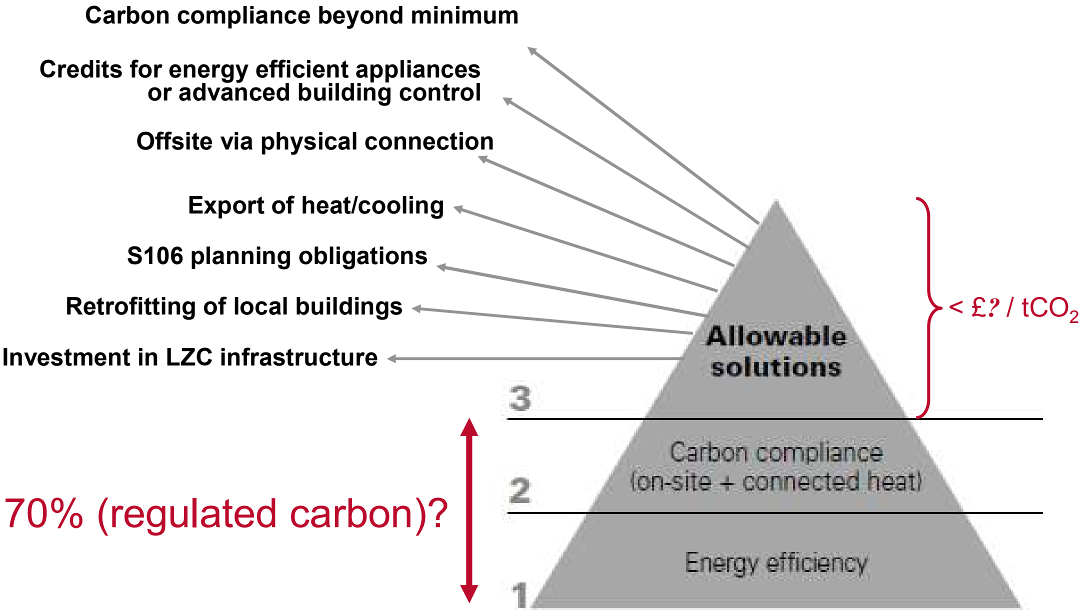
In the March 2008 budget Government also announced its intentions for all non-domestic buildings to be zero carbon by 2019. Therefore, the various phases of development in the district will face stricter and stricter mandatory requirements, and all development after 2016 is likely to need to be zero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

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

Government has proposed that a maximum cost of the 'Allowable Solutions' be set out. If costs stay high, more flexibility will be allowed in the future. The 'allowable solutions' will not be fully defined until 2012 so the total cost of carbon is likely to be capped at somewhere between £100 -£150 per annual tonne CO_2 to provide some cost certainty in the meantime.

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

Figure23 Schematic of zero carbon policy options under consideration



Estimates based on published data[16] 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 Photovoltaic panels. 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.

Where low cost decentralised energy / low carbon energy generation solutions exist to achieve a greater proportion or all of the carbon reduction for a development these may present costs lower than the Allowable Solutions price cap, resulting in delivery through a 'carbon compliance' only. Moreover where decentralised energy / low carbon solutions exist to provide a greater supply than the 70% carbon compliance minimum but the costs are in excess of Allowable Solutions then consideration should also be given to the wider benefits of going beyond the 70% figure, e.g. supporting decentralised energy infrastructure, clearly this may warrant some public investment as it may support carbon reduction targets overall.

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

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[16] *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*

4.2 Regional Planning Policy

4.2.1 Development allocations

Phase II partial review of the Regional Spatial Strategy recently went through an Examination in Public (28th April 2009 – 24th June 2009). Subsequently the Report of Panel was published in September 2009 with recommendations for alterations to the existing document. There are a number of key changes that impact upon the completion of this study. Obviously the quantum of development within the study area has a significant impact and proposed changes are highlighted in Table 8 , with Solihull and Stratford-On-Avon shown to have significant increases.

Table 8 Housing proposed housing allocations changes from partial review of RSS

Planning Area	RSS PO (Net) 2006-2026	Panel (Net) 2006-2026	Increase	Comment
Solihull	7,600	10,500	+2,900	Additional capacity substantially as identified by LPA
North Warwickshire	3,000	3,000		
Nuneaton & Bedworth	10,800	11,000	+200	Rounding
Rugby	10,800	11,000	+200	Rounding
(of which) Rugby town	*9,800*	-	-	*Indicative*
Warwick	10,800	11,000	+200	Rounding
Stratford-On-Avon	5,600	7,500	+1,900	

It should be noted that development forecasts are not static, for example, the RSS panel also identified an overspill of 3,500 dwellings needing to be accommodated in the surrounding Authorities. Within the analysis conducted in this study the following forecasts, provided by each authority, were used[17]: Solihull (13,100), North Warwickshire (3,000), Nuneaton & Bedworth (10,800), Rugby (12,700), Warwick (11,000) and Stratford-On-Avon (5,600). In some cases these differ from the suggested growth numbers from the RSS process. The growth numbers used also show notional annual increments in Appendix IV.

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[17] *Numbers rounded*

4.2.2 Climate change / sustainable development

The second key area of change proposed for the Regional Spatial Strategy is strengthening of policies around climate change. The Panel Report[18] recommends 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 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 CO2e, 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 reprocessors within the region; and
    - the retrofit of the existing housing stock with improved insulation and water saving devices and its effective use, as this will make more of an impact than new build, even with zero carbon homes and the high concentration of construction and building technology companies within the region.

Regarding climate change, recommendation R2.2 of the Panel Report[19] strengthens the obligation placed on Local Authorities as follows:

“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

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

[19] *West Midlands Regional Spatial Strategy Phase Two Revision Report of the Panel: September 2009.*

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*[20]

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 proposed new policy on Sustainable Construction is also relevant. The review recommends that:

- 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.
- 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

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[20] *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,*

5 Introduction to assessing the local potential for Decentralised Generation

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

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

1. Wind energy projects – standalone development of decentralised wind energy projects, assumed to be at least one turbine of megawatt scale.
2. Biomass energy projects – biomass power, biomass heat and CHP of a variety of scales typically up to a maximum of 30MWe. It includes a variety of feed stocks such as forestry residues, energy crops, sawmill residues, agricultural straw, agricultural animal waste, organic waste currently land-filled and green waste currently diverted from landfill. Conversion technologies include steam turbines, gasification systems, pyrolysis and anaerobic digestion.
3. Hydro power – hydro power will typically only provide a small contribution to authority-wide renewable energy potential and this would appear to hold for the study area. Whilst there are a number of existing weirs on the Avon and Stour, previous investigations into these[21] suggest that 'low head' (the height of the fall of water) limits the viability of these projects. Those sites that were previously identified have been reviewed through a desk study, from which the future capacity is estimated to be in the region of 4-700 kW across 12 sites. See Appendix XIII for further details.
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 targets, 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 – micro generation heat and power projects integrated within existing buildings. This will include solar thermal, solar PV, ground source and air source heat pumps and small scale biomass boilers.

These categories have been chosen to reflect the range of the most significant applications for low and zero carbon technologies within the study area. Clearly, over the LDF plan period, other technologies may become more significant relative to those considered here. Non-renewable energy from waste, offshore wind and nuclear power are excluded from the calculations. Background information, together with analysis methodology notes (where relevant) are included in Appendix VII through to Appendix XIV.

DECC is due to publish renewable energy capacity assessment methodology in the near future which will present a consistent approach for regional studies, much of which should also be consistent for the local and sub-regional studies. The methodology for the assessment used within this study has been assessed against the Nov 2009 draft of the DECC methodology and where inconsistencies occur, these are identified.

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[21] *Small scale hydroelectric generation potential in the UK, Vol3, Department of Energy, 1989*

6 Wind energy potential

6.1 Methodology

6.1.1 Identifying potential wind locations - GIS Mapping

A GIS[22] 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 with 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 '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. Some pose a high degree of constraint ("Constrained") and for the purposes of calculating renewable energy potential are considered effectively to rule out wind farm development. The other "less constrained" land-use are not considered within the spatial analysis because the applicability of wind energy can only be determined by further detailed work (at the level of the study area or each authority) or through consideration of individual developments as they come forward.

The land parcels that come through this analysis are considered to have the technical potential to accommodate at least a single turbine. Larger sites are assumed to allow multiple turbines (the potential for the larger sites has been limited to 13 large turbines[23]).

6.1.2 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 draft 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 draft DECC methodology, however, it is assumed to be "constrained" in this study because there are no large scale wind energy development in the National Parks to date in UK[24].

International, national and local designations for ecology

Whilst the draft 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

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[22] Geographic Information Systems

[23] The approximate UK Average, with small and very large sites discounted

[24] http://www.telegraph.co.uk/earth/environment/climatechange/5894601/Natural-England-will-consider-wind-farms-in-national-parks.html

therefore inconsistent 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.

Table 9 GIS Layer Information (Red = “constrained”, Blue = “less constrained”)

GIS Layers					
Name	**Buffer**	**Type**	**Name**	**Buffer**	**Type**
Wind speed			Space requirements		
Average wind speed @ 45m above ground level < 5.9m/s		🟥	Open water		🟥
International, national & local designations for heritage			Woodland		🟥
World Heritage Sites		🟥	Dwellings	600m	🟥
Registered Historic Parks & Gardens		🟥	Commercial buildings	50m	🟥
Heritage Coast (not relevant for this study)		🟦	Motorways, A roads & B roads	150m	🟥
International, national and local designations for landscape			Railways	150m	🟥
Areas of Outstanding Natural Beauty		🟦	Bridleways	250m	🟥
Greenbelt		🟦	Other Public Rights of Way	50m	🟥
National Parks		🟥	Air safeguarding and radar constraints from MOD and civil aviation interests		
Sites of Importance for Nature Conservation		🟦	Civil airports	30km	🟦
Historic Environment Record Sites		🟦	MoD airbases	30km	🟦
Environmentally Sensitive Areas		🟦	Small civil airfields	10km	🟦
International, national and local designations for ecology			Electromagnetic interference to communications radar		
Sites of Special Scientific Interest		🟥	Primary TV transmission masts	100m	🟥
Special Areas of Conservation		🟥	Secondary TV transmission masts	100m	🟥
Special Protection Areas		🟥	TV broadcast links	100m	🟥
Ramsar Sites		🟥	Radio transmission masts	100m	🟥
RSPB Reserves		🟦	Radio broadcast links	100m	🟥
Important Bird Areas		🟦	Weather radar stations	10km	🟦
National Nature Reserves		🟦	Other		
Local Nature Reserves		🟦	Steep terrain > 20°		🟥
Ancient Woodland		🟥	Cumulative impact		
Designations for archaeology			Existing or consented wind farms	5km	🟥
Scheduled Ancient Monuments		🟥			

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 DECC methodology discusses 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 draft 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. However, this merely reflects the fact that owners of all properties, even isolated rural properties, can and will raise objections, e.g. on noise and visual amenity grounds, with 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 with this analysis is appropriate, but will present a conservative result.

The project steering group also asked Camco to explore the impact of lower proximity buffer distances since the 600m is only identified as a 'rule of the thumb' and because previous practice in area-wide studies and within wind energy development have range between 400m and 700m. In practice, the determination of acceptable distances will be on a case by case basis though the planning process and specifically through the testing of nuisance (e.g. noise, dominating visual impact, shadow flicker).

Table 10 illustrates the percentage increase in the suitable land area and the technical potential for wind energy (no. of turbines, accounting for development constraints in 2020/21) when moving between the dwelling proximity buffers of 600m and 500m and between 600m and 400m. We see that the absolute impact is greatest in those authorities which have the greatest capacities to start with. A 65% increase in suitable land area in Stratford-On-Avon leads to a maximum additional capacity of 114* turbines and a 90% increase in suitable land area in Rugby leads to a maximum additional capacity of 39* turbines. However, the relative change is most significant on the most constrained locations: Solihull (with a five fold land increase in suitable land area, changing capacity from zero turbines to maximum of 14 turbines), North Warwickshire (two-fold land increase, 50 additional turbines) and Warwick (two-fold land increase, 72 additional turbines). The impact in Nuneaton and Bedworth is a 135% change in the suitable land area and a maximum increase of 12 turbines.

Table 10 Variation in land availability and wind energy technical potential (number of turbines) in 2020/21 with range of proximity buffers

	North Warks	Nuneaton and Bedworth	Rugby	Solihull	Stratford-on-Avon	Warwick
% Increase in **land available** (technical potential) from 600m to 400m buffer	218%	135%	92%	507%	64%	195%
Increase in **wind energy technical potential** (elevated case) from 600m to 400m buffer	+50	+12	+39*	+14	+114*	+72
% Increase in **land available** (technical potential) from 600m to 500m buffer	93%	52%	40%	167%	32%	82%
Increase in **wind energy technical potential** (elevated case) from 600m to 500m buffer	+14	+5	+16*	+2	+51*	+30

** Rugby and the Stratford numbers are addition to the capacity which are notional reduced by 75% in lieu of a landscape impact assessment, as discussed later.*

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 consistent with the draft DECC methodology that confirms that developers will not typically consider development at sites below this wind speed. The draft methodology suggests that over the longer term wind energy development viability may be possible at lower wind speeds (down to $5ms^{-1}$), but since there is no experience of this in UK this study has opted to use the $6ms^{-1}$ threshold. In practice the lower threshold will have little difference to the analysis since only 7% of the study area has a wind speed lower than $6ms^{-1}$.

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).

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 excluded in the spatial analysis.

Air safeguarding needs 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. In practice sections of power networks may have inherent load or power quality constraints, particularly at lower voltage levels. It 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. As described later this issue has arisen for both Stratford-on-Avon and Rugby within this study, and, as a consequence there is a danger of overstating the real technical potential.

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 which may change over time. They could therefore lead to unreasonably restricting available land. The draft 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.

When considering the specific situation of Rugby and Stratford-On-Avon, in response to the very large areas of land highlighted as being "unconstrained", we have included an arbitrary 75% reduction factor scenario based upon a simple evaluation of the proximity of potential sites. It is recommended that a cumulative landscape impact study for wind energy is conducted to attempt to inform the technical potential within these two districts.

6.1.3 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[25] we have assumed a separation of distance of five rotor diameters, which is consistent with the draft 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 suggests 2.5 MW turbines (approximately 120m to the tip of the blade at the top of its swept area) and this has been applied as a typical wind turbine for the study period, although it should be recognised that the wind turbines will be selected to suit each specific location. A simple method to quickly understand the likely electricity generated from a wind turbine is to apply a capacity factor (or load factor): actual annual generation as a percentage of a turbine's theoretical maximum output. The 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% to account for the relatively low wind speeds within the study area compared with the UK average. In addition to the capacity factor, it is assumed that any wind turbine will be taken off line for maintenance for 5% of the time. The calculation below sets out how these factors are combined to estimate the energy generation from a single 2.5 MW large scale wind turbine.

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

6.1.4 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 less 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 less 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'[26] projects; which will either require lower rates of return or benefit from direct electricity

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[25] *www.windpower.org*

[26] *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.*

sales to an on-site user. Examples of this type of smaller scale of development are the community project in Swaffham (Norfolk)[27] 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.

6.1.5 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.

6.1.6 Scenarios

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

Base Case

- 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 6.1.3 enables greater than this number. This threshold has been derived by assessing British Wind Energy Association (BWEA) data of operational UK wind farms[28]. 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
- 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 rates 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.

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[27] *www.ecotricity.com*

[28] *Available from http://www.bwea.com/ukwed/operational.asp. The threshold of 13 turbines has been derived taking the average number of turbines from all multi-turbine sites within the data set.*

6.2 Wind energy results

6.2.1 Overall (GIS mapping of resource and constraints)

Figure 24 shows the wind speed across the study area, based upon the national NOABL database. This clearly shows that the majority (93%) of the study area is greater than the 6ms^{-1} used as the viability threshold in the study. It also shows that a much smaller proportion of the study area (30%) is above 6.5ms^{-1} and only half a dozen individual locations are above 7ms^{-1}. This suggests that whilst the resource potential is large (in land terms) it would be considered relatively marginal (being slightly above the threshold of viability) and therefore may struggle to interest the development market in favour of windier locations. Over time viability should improve through technology development and system costs reductions. Naturally wind development will tend to move to less windy locations when other options become harder to find.

Figure 25 illustrates those sites indentified as ‘unconstrained’ or ‘less constrained’, i.e. those sites which are technically possible to be developed based upon the parameters considered within the study.

Figure 26 shows the same zones overlaid with those areas identified by each authority’s Strategic Housing Land Allocation Areas (SHLAA). This coincides with a number of potential development opportunities and wind energy potential at a number of locations, including to the East of Hillmorton (Rugby), Drayton on the eastern edge of Stratford and the major site on the eastern edge of Nuneaton. This provides a basis on which to consider linking development sites with wind energy development. Locations of major economic development sites have not been available during the study but once locations are known they should be considered in the context of potential ‘on-site’ or ‘near-site’ wind energy development. Opportunities for co-locating will be limited because of the many constraints that will exist on specific sites. However, where is possible it would be a cost competitive option for achieving low carbon development.

Figure 24 Wind speed classifications (by km square)

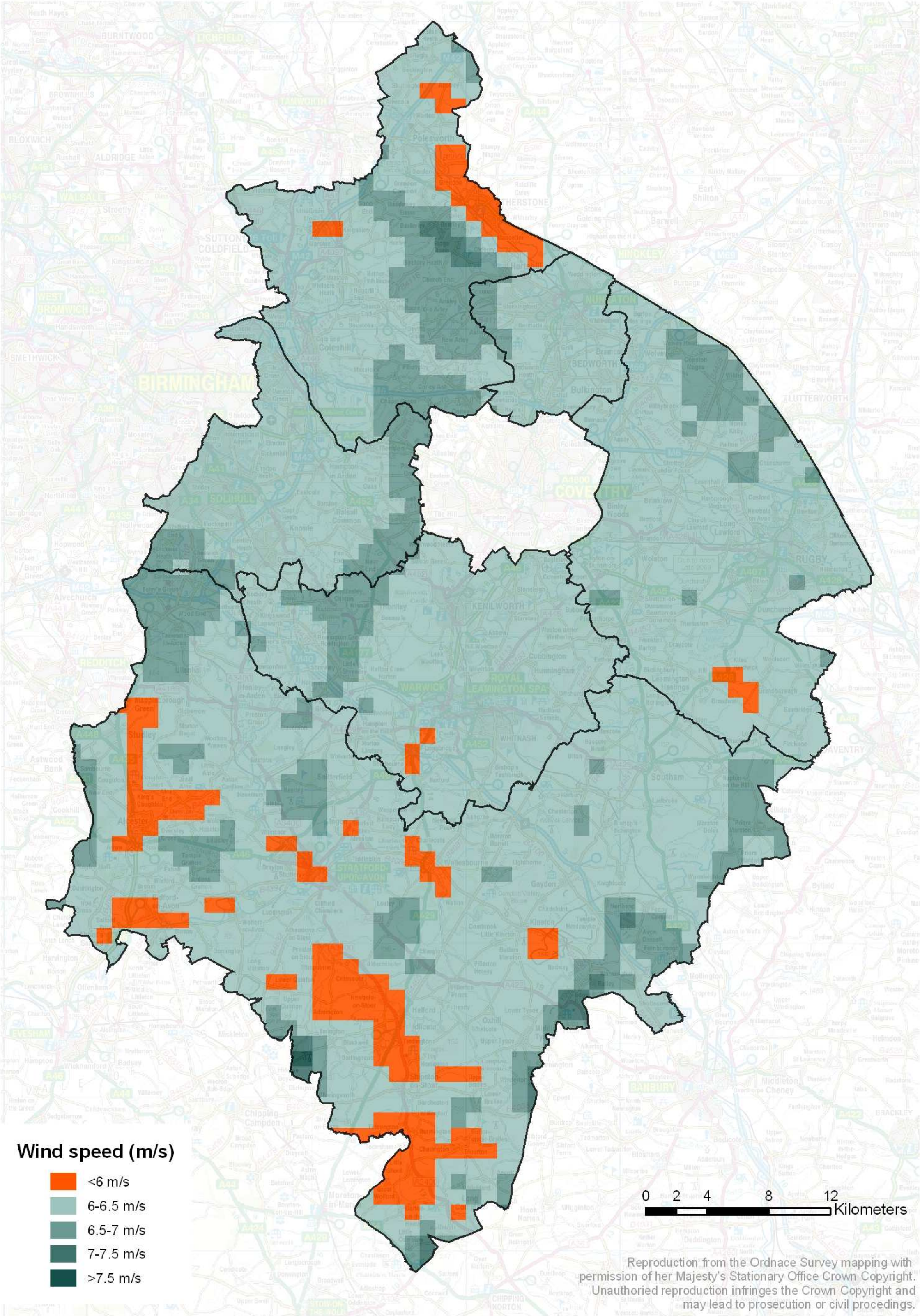

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Figure 25 Zones of varying constraint within the study area (6ms-1 threshold)

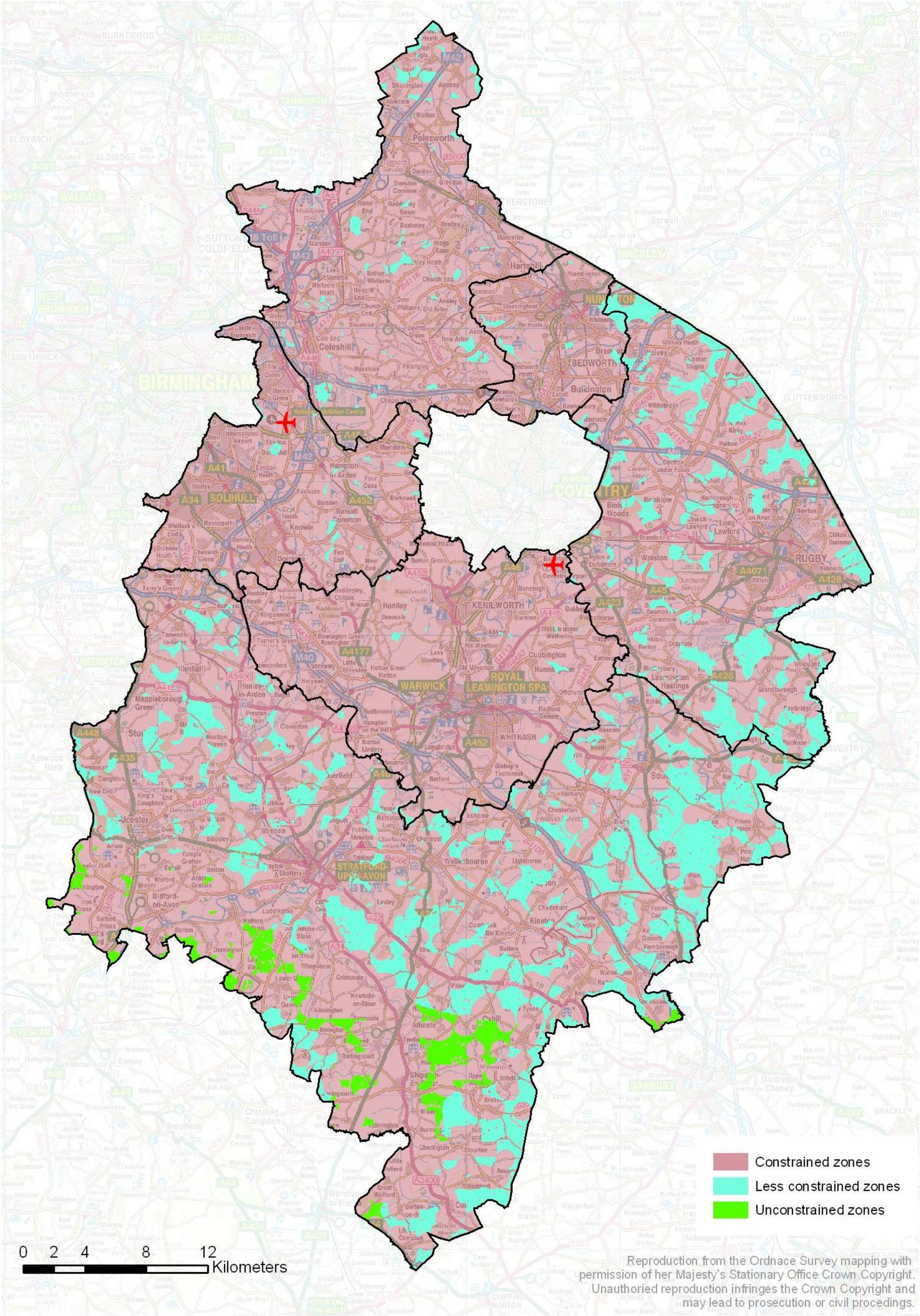

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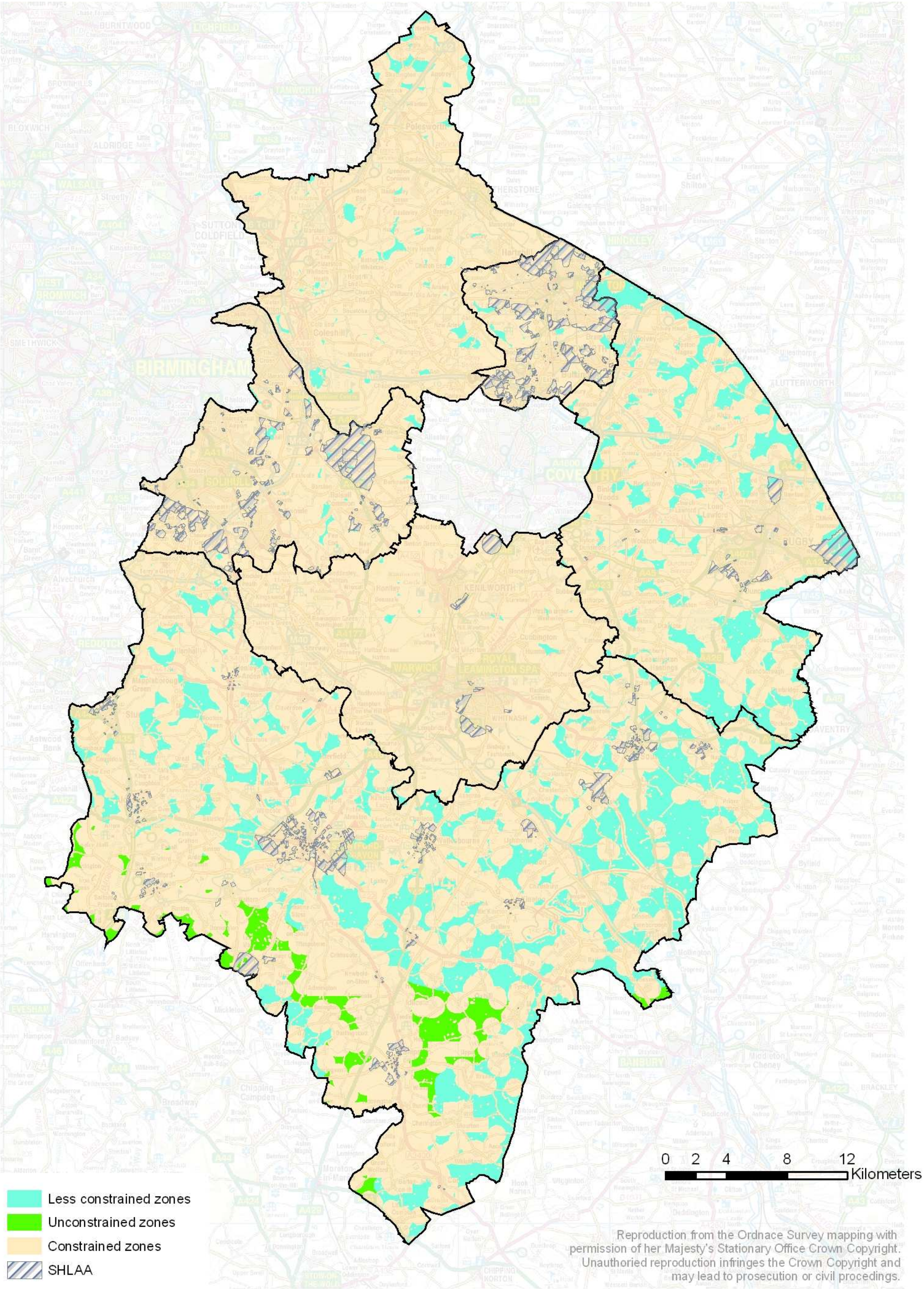
Figure 26 **Zones of varying constraint overlaid with Strategic Land Housing Area Allocations (SHLAA)**



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6.3 Individual authorities - wind energy potential (base case)

The results of the base case analysis are shown below for each Local Authority area below. The overall numbers of wind turbines and the uptake of these overtime are representations of how the capacity (as identified by the spatial GIS analysis) could be developed based around the assumptions of uptake as set out in section 6.1.6.

Most of the districts within the study area are highly constrained for wind energy development principally because land areas are severely restricted due to proximity to buildings, particularly housing (for which the 600m buffer is used). Rugby and Stratford-On-Avon are the least restricted, however, the potential in these two district is artificially constrained to take some account of cumulative impacts within the landscape. It is recommended that this figures for these two authorities are reviewed in following completion of landscape impact assessments.

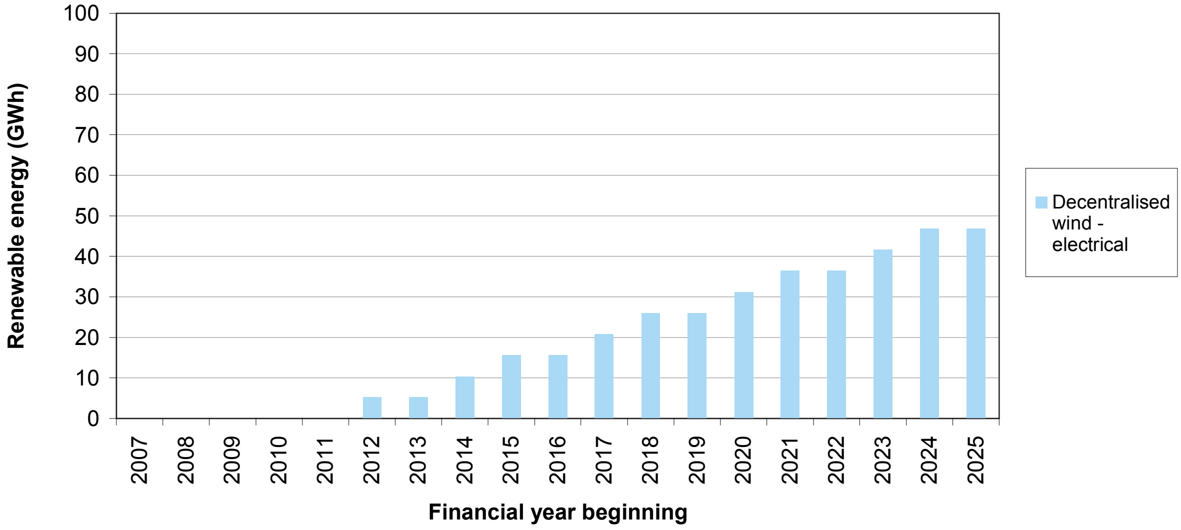
The uptake profiles are based on a linear growth assumption.

6.3.1 North Warwickshire

Table 11 Energy produced by decentralised wind in North Warwickshire – base case

Year		**2015/16**	**2020/21**	**2025/26**
Energy generated (GWh)	Electrical	15.6	31.2	46.8
Proportion of demand	Electrical	4%	6%	9.1%
	Total	1%	2.1%	3.2%
No. of turbines (cumulative)		3	6	9

Figure 27: Uptake curve of energy produced by decentralised wind in North Warwickshire – base case

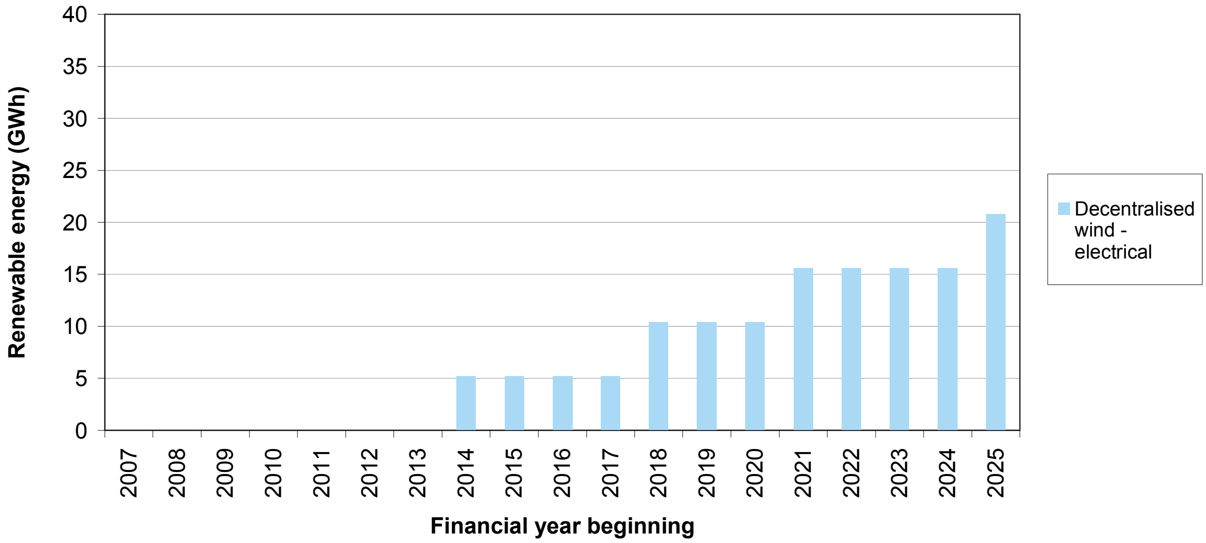


6.3.2 Nuneaton & Bedworth

Table 12 Energy produced by decentralised wind in Nuneaton & Bedworth – base case

Year		**2015/16**	**2020/21**	**2025/26**
Energy generated (GWh)	Electrical	5.2	10.4	20.8
Proportion of demand	Electrical	1%	2.1%	4.2%
	Total	0.3%	0.6%	1.3%
No. of turbines (cumulative)		1	2	4

Figure 28: Uptake curve of energy produced by decentralised wind in Nuneaton & Bedworth – base case



6.3.3 Rugby

The GIS analysis for Rugby identifies a large number of sites (and total land area) as being suitable for the wind development. In the absence of a Landscape Impact study, we present a discounted base case scenario which notionally limits the calculation of uptake by a further 75%.

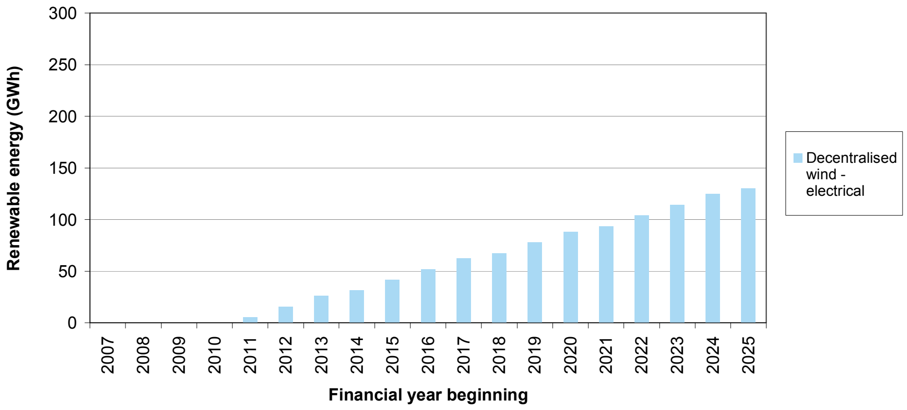
- Reducing the uptake of single turbine sites from 10% to 2.5%
- Reducing the uptake of sites with 3 or more wind turbines from 100% to 25%

It is recommended that a Landscape Impact is undertaken to cover both Rugby and Stratford-On-Avon.

Table 13 Energy produced by decentralised wind in Rugby – discounted base case

Year		**2015/16**	**2020/21**	**2025/26**
Energy generated (GWh)	Electrical	41.6	88.4	130.0
Proportion of demand	Electrical	5.5%	11.5%	16.6%
	Total	1.2%	2.5%	3.6%
No. of turbines (cumulative) *(with notional cumulative landscape impact reduction)*		8	17	25

Figure 29: Uptake curve of energy produced by decentralised wind in Rugby – discounted base case



6.3.4 Solihull

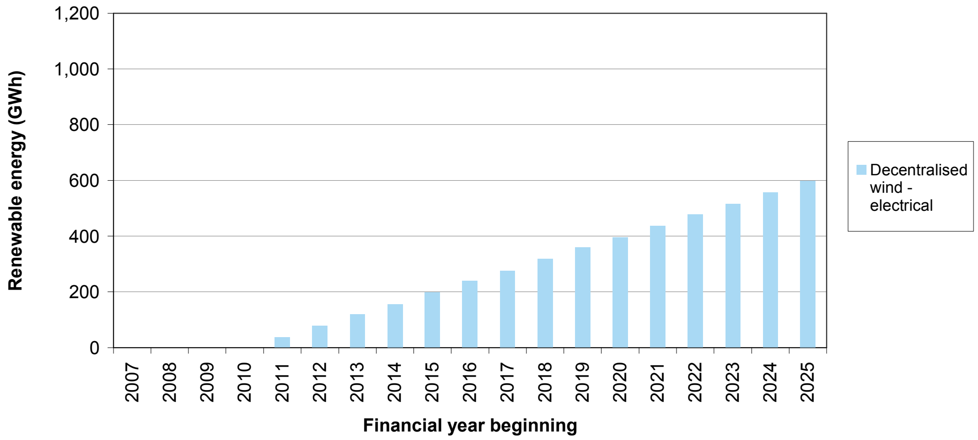
Solihull presents no capacity for large scale wind energy development based upon the assumptions used in the base case, principally because of proximity to buildings.

6.3.5 Stratford-On-Avon

Table 14 Energy produced by decentralised wind in Stratford-On-Avon – discounted base case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Electrical	197.6	395.3	598.1
Proportion of demand	Electrical	32%	64%	97%
	Total	9.1%	18.6%	28%
No. of turbines (cumulative) *(with notional cumulative landscape impact reduction)*		38	76	115

Figure 30: Uptake curve of energy produced by decentralised wind in Stratford-On-Avon – discounted base case



The GIS analysis for Stratford-On-Avon identifies a large number of sites (and total land area) as being suitable for the wind development. In the absence of a Landscape Capacity study, we present a discounted base case scenario which notionally limits the calculation of uptake by a further 75%.

This has the effect of:

- Reducing the uptake of single turbine sites from 10% to 2.5%
- Reducing the uptake of sites with 3 or more wind turbines from 100% to 25%

It is recommended that a cumulative landscape impact study is undertaken to cover both Rugby and Stratford-On-Avon to help to inform a future review of the technical potential for wind energy.

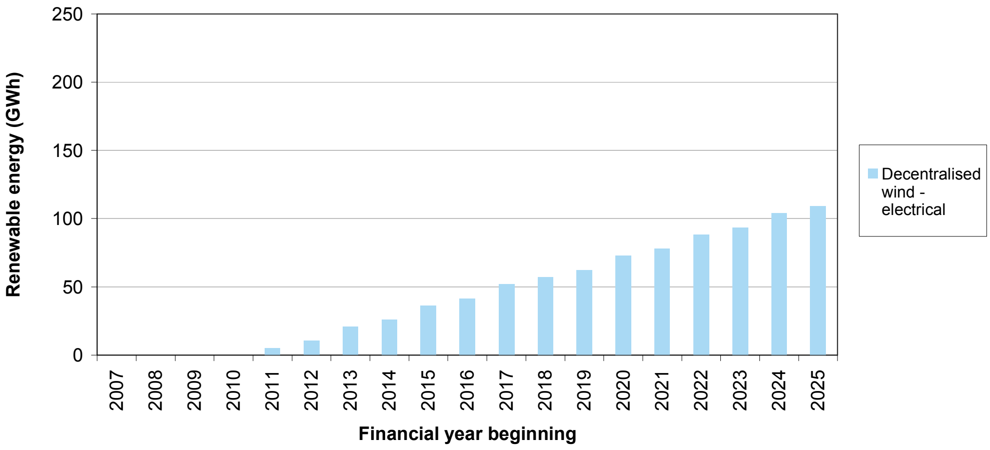
It is also worth noting that of Stratford's total land area (approx 97,800 ha), approximately 10% (10,345 ha) is designated as Area of Outstanding Natural Beauty (AONB). As discussed in the earlier section with spatial parameters used within the GIS constraints analysis, AONB has been considered as "less constrained", i.e. the land area passes through the GIS analysis as suitable for the development (other constraints aside). Of the total 21,060 ha of land area that passed through GIS analysis, 3,276ha falls within the AONB designation. In practice AONB areas are likely to be constrained to some degree, although this should be determined by specific landscape assessment of area in question. If the entire area were to be viewed as constrained then the available land assumed to have technical potential for wind energy within Stratford-On-Avon will be reduced by a further 15%.

6.3.6 Warwick

Table 15 Energy produced by decentralised wind in Warwick – base case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Electrical	36.4	72.8	109.2
Proportion of demand	Electrical	4.7%	9.5%	14.2%
	Total	1.7%	3.4%	5.2%
No. of turbines (cumulative)		7	14	21

Figure 31: Uptake curve of energy produced by decentralised wind in Warwick – base case



6.4 Individual authorities - wind energy potential (elevated case)

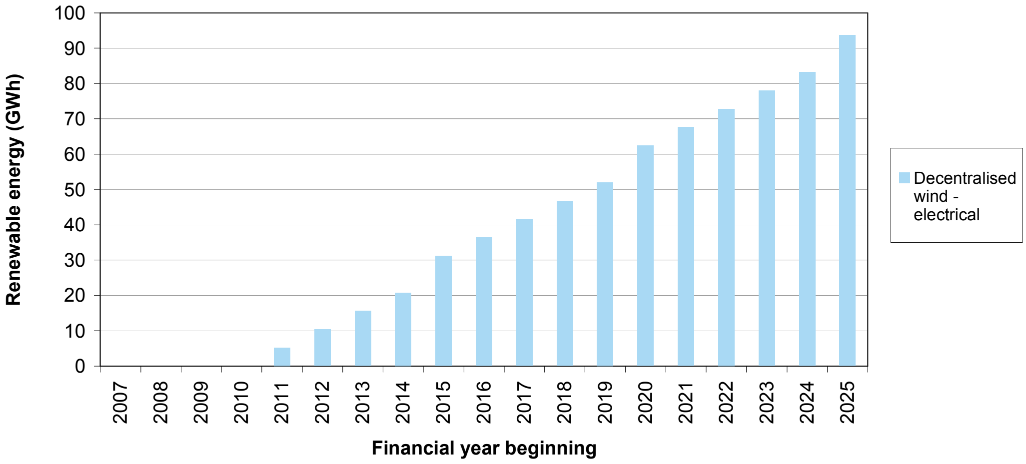
The results of the elevated case analysis are shown below for each Local Authority area. Section 6.1.6 discusses the assumptions used in the elevated scenario.

6.4.1 North Warwickshire

Table 16 Energy produced by decentralised wind in North Warwickshire – elevated case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Electrical	31.2	62.4	93.6
Proportion of demand	Electrical	5.9%	11.9%	18.2%
	Total	2.1%	4.2%	6.4%
No. of turbines (cumulative)		6	12	18

Figure32: Uptake curve of energy produced by decentralised wind in North Warwickshire – elevated case

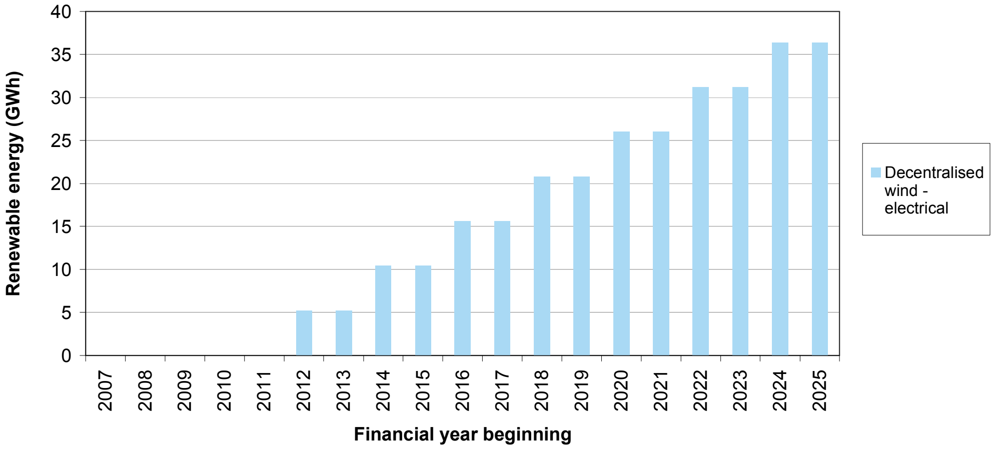


6.4.2 Nuneaton & Bedworth

Table 17 Energy produced by decentralised wind in Nuneaton & Bedworth – elevated case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Electrical	10.4	26.0	36.4
Proportion of demand	Electrical	2.1%	5.2%	7.4%
	Total	0.6%	1.6%	2.3%
No. of turbines (cumulative)		2	5	7

Figure 33: Uptake curve of energy produced by decentralised wind in Nuneaton & Bedworth – elevated case



6.4.3 Rugby

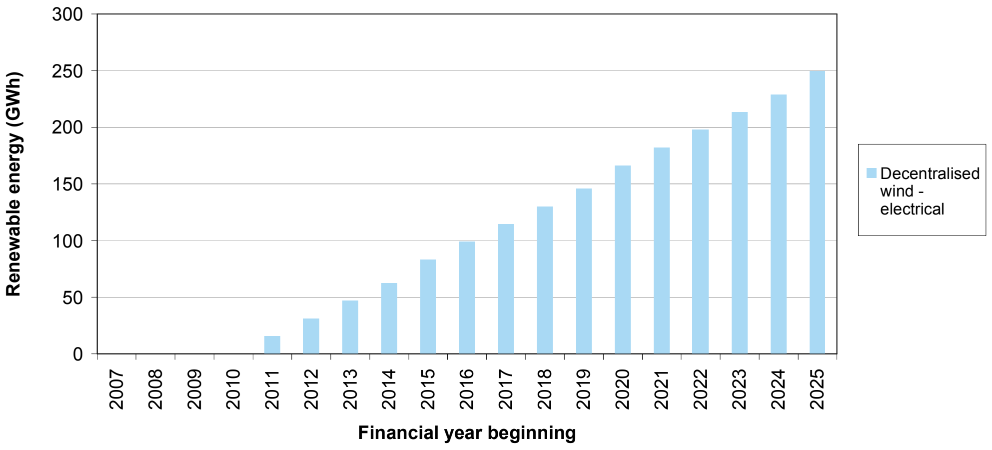
As with the base case, the GIS analysis for Rugby identifies a large land area as being suitable for the wind development. In the absence of a Landscape Capacity study, we present a discounted base case scenario which notionally limits the calculation of uptake by a further 75%. This has the effect of:

- Reducing the uptake of single turbine sites from 10% to 2.5%
- Reducing the uptake of sites with 3 or more wind turbines from 100% to 25%

Table 18 Energy produced by decentralised wind in Rugby – discounted elevated case

Year		**2015/16**	**2020/21**	**2025/26**
Energy generated (GWh)	Electrical	83.2	166.4	249.7
Proportion of demand	Electrical	11.1%	21.6%	32%
	Total	2.3%	4.6%	7%
No. of turbines (cumulative) *(with notional cumulative landscape impact discount)*		16	32	48

Figure 34: Uptake curve of energy produced by decentralised wind in Rugby – discounted elevated case

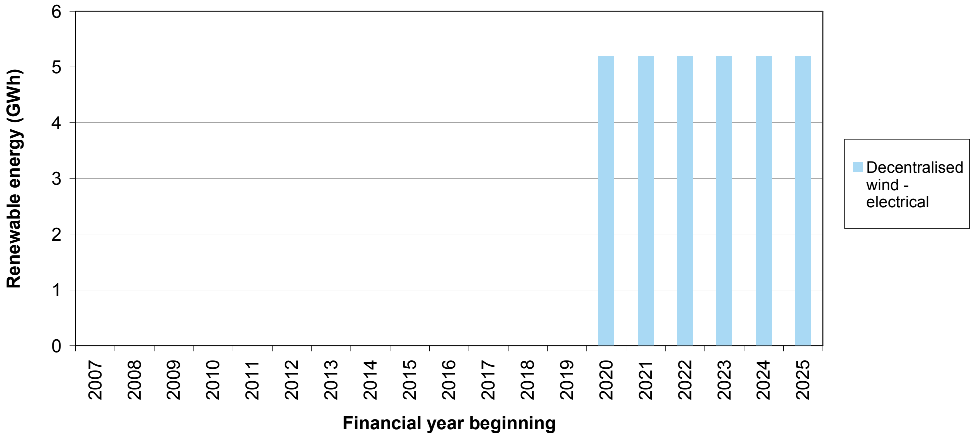


6.4.4 Solihull

Table 19 Energy produced by decentralised wind in Solihull – elevated case

Year		**2015/16**	**2020/21**	**2025/26**
Energy generated (GWh)	Electrical	0	5.2	5.2
Proportion of demand	Electrical	0%	0.5%	0.5%
	Total	0%	0.2%	0.2%
No. of turbines (cumulative)		0	1	1

Figure 35: Uptake curve of energy produced by decentralised wind in Solihull – elevated case



6.4.5 Stratford-On-Avon

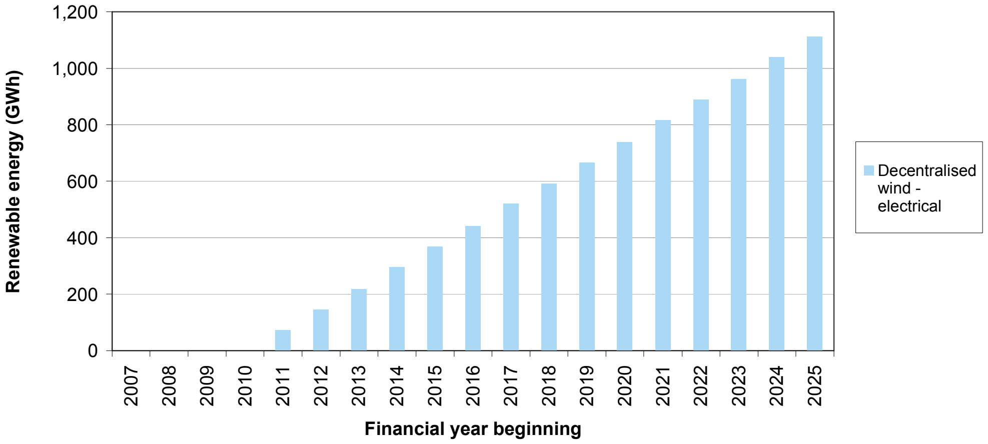
The GIS analysis for Stratford-On-Avon identifies a large number of sites (and total land area) as being suitable for the wind development. In the absence of a Landscape Capacity study, we present a discounted base case scenario which notionally limits the calculation of uptake by a further 75%. This has the effect of:

- Reducing the uptake of single turbine sites from 10% to 2.5%
- Reducing the uptake of sites with 3 or more wind turbines from 100% to 25%

Table 20 Energy produced by decentralised wind in Stratford-on-Avon – discounted elevated case

Year		**2015/16**	**2020/21**	**2025/26**
Energy generated (GWh)	Electrical	369.3	738.6	1,113.1
Proportion of demand	Electrical	59.7%	119.9%	181.1%
	Total	17%	34.7%	53.4%
No. of turbines (cumulative) *(with notional cumulative impact discount)*		71	142	214

Figure 36: Uptake curve of energy produced by decentralised wind in Stratford-on-Avon – discounted elevated case

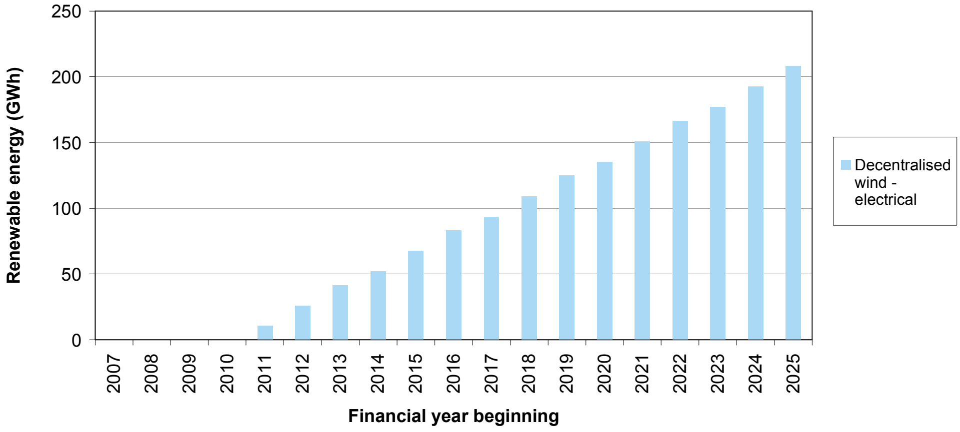


6.4.6 Warwick

Table 21 Energy produced by decentralised wind in Warwick – elevated case

Year		**2015/16**	**2020/21**	**2025/26**
Energy generated (GWh)	Electrical	67.6	135.2	208.1
Proportion of demand	Electrical	8.8%	17.6%	27%
	Total	3.2%	6.4%	9.9%
No. of turbines (cumulative)		13	26	40

Figure 37: Uptake curve of energy produced by decentralised wind in Warwick – elevated case



7 Assessment of biomass energy

7.1 Methodology

7.1.1 Overview of approach

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

- 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 <u>available potential resource</u>:

   1.1. Estimate theoretical potential i.e. the total quantity of feedstock generated in the study area (see Appendix VIII 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 needs 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[29],

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[29] To inform the government's Renewable Energy strategy, the Department of Energy and Climate Change (DECC) [29] 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

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[30].

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

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

Specific assumptions regarding resource potential for particular fuel types are described in Appendix VIII.

7.1.2 Avoiding double counting

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

As outlined in section 9, renewable energy generation within the existing built environment is derived from a study at the regional and national level[31]. The scenario which was used to inform our analysis for uptake in the study area included no microgeneration-scale biomass installations by 2020. Whilst Camco see this as a pessimistic view of the potential for retrofit biomass, it is considered that the uptake will not be significant due to technical difficulties such as space requirements for wood chip/pellet stores. Hence, it is viewed that although double counting may exist, it will be negligible.

This position can be substantiated by quickly looking at the scales of biomass required in a retro-fit installation compared to that diverted to decentralised energy generation. A single biomass boiler for a dwelling would produce approximately 0.002% of the decentralised thermal energy provided by biomass within the study area in 2025[32]. Therefore even if a thousand household systems were installed this would only deliver 2% of the total biomass resource within the study area.

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[30] 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.

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

[32] Based upon 283,559 MWh/yr thermal energy from decentralised biomass in the study area in 2025, and the thermal demand of an existing dwelling being 6.6 MWh/yr.

7.2 Uptake Scenario

With biomass there is no differentiation between a Base Case and Elevated Case since it is difficult to isolate individual parameters that can justifiably be adjusted to represent the different scenarios, hence the there is only one scenario which:

- Assumes 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; and;
- Assumes no net import of biomass fuels from beyond the study area since looking beyond the study implies identifying resources that that are more likely to be used elsewhere. It also avoids any double counting between studies (assuming other studies also look within administrative boundaries.

7.3 Base Case Potential – biomass

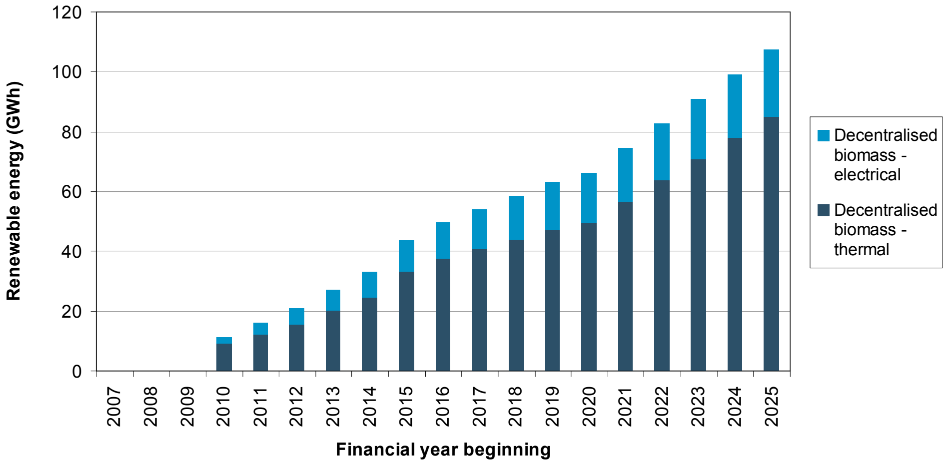
The results of the biomass analysis for the base case scenario are shown below.

7.3.1 North Warwickshire

Table 22 Energy produced by decentralised biomass in North Warwickshire – base case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	33.2	49.6	85.1
	Electrical	10.5	16.9	22.2
	Total	43.7	66.5	107.3
Proportion of demand	Thermal	3.33%	5.11%	9.02%
	Electrical	1.98%	3.23%	4.31%
	Total	2.86%	4.46%	7.36%

Figure38: Uptake of energy produced by decentralised biomass in North Warwickshire – base case

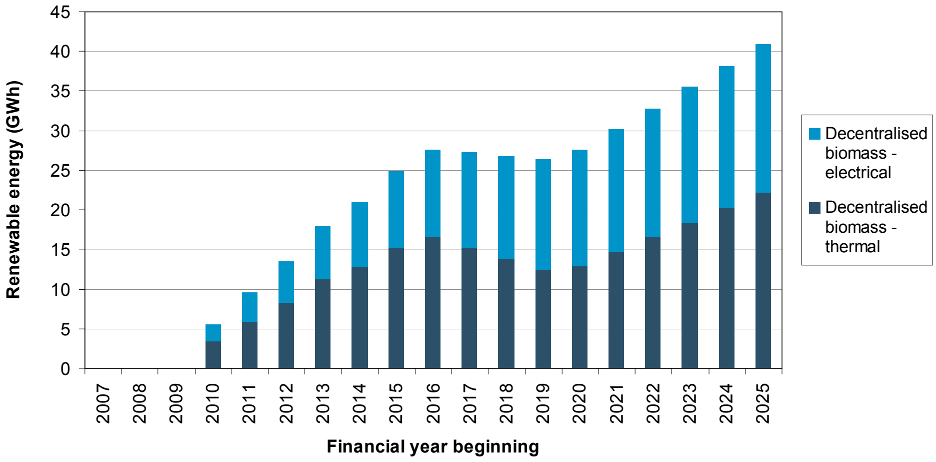


7.3.2 Nuneaton & Bedworth

Table 23 Energy produced by decentralised biomass in Nuneaton & Bedworth – base case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	15.1	12.9	22.1
	Electrical	9.8	14.7	18.7
	Total	24.9	27.6	40.8
Proportion of demand	Thermal	1.29%	1.13%	2.00%
	Electrical	1.96%	2.95%	3.79%
	Total	1.49%	1.69%	2.56%

Figure39: Uptake of energy produced by decentralised biomass in Nuneaton & Bedworth – base case

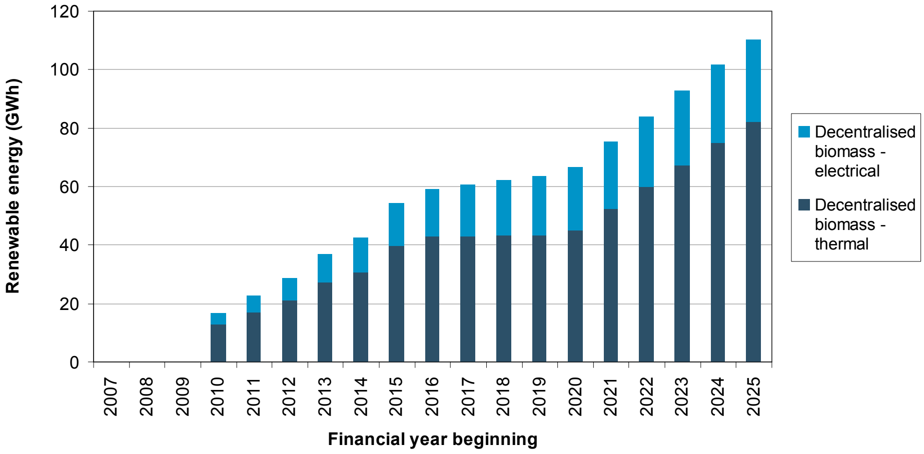


7.3.3 Rugby

Table 24 Energy produced by decentralised biomass in Rugby – base case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	39.8	45.1	82.1
	Electrical	14.3	21.6	28.2
	Total	54.2	66.7	110.3
Proportion of demand	Thermal	1.41%	1.60%	2.96%
	Electrical	1.90%	2.79%	3.61%
	Total	1.51%	1.86%	3.10%

Figure40: Uptake of energy produced by decentralised biomass in Rugby – base case

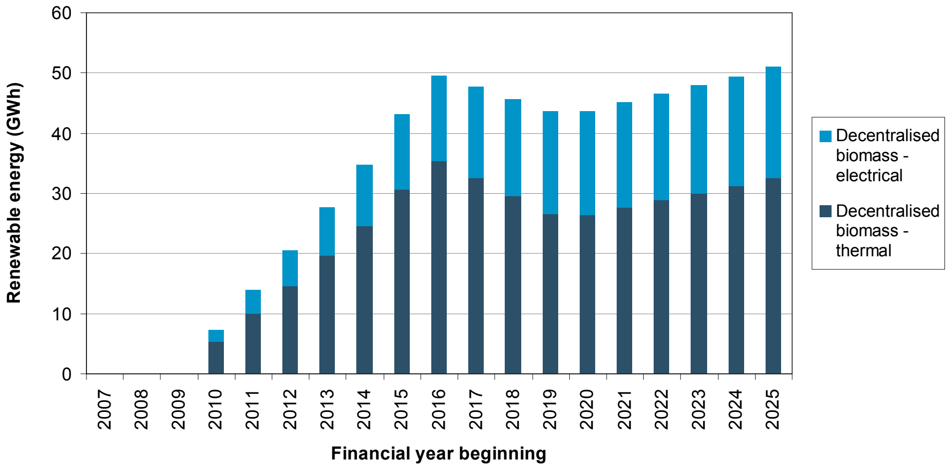


7.3.4 Solihull

Table 25 Energy produced by decentralised biomass in Solihull – base case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	30.7	26.3	32.6
	Electrical	12.5	17.3	18.4
	Total	43.1	43.6	50.9
Proportion of demand	Thermal	1.18%	1.03%	1.30%
	Electrical	1.24%	1.72%	1.82%
	Total	1.20%	1.23%	1.45%

Figure41: Uptake of energy produced by decentralised biomass in Solihull – base case

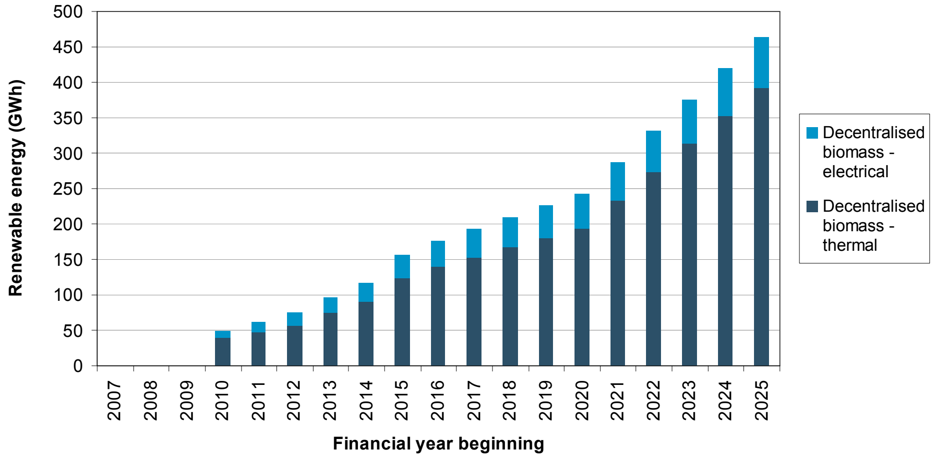


7.3.5 Stratford-On-Avon

Table 26 Energy produced by decentralised biomass in Stratford-on-Avon – base case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	123.9	193.7	392.7
	Electrical	33.1	49.0	70.9
	Total	157	242.7	463.6
Proportion of demand	Thermal	8.0%	12.8%	26.7%
	Electrical	5.4%	8.0%	11.5%
	Total	7.2%	11.4%	22.2%

Figure42: Uptake of energy produced by decentralised biomass in Stratford-On-Avon – base case

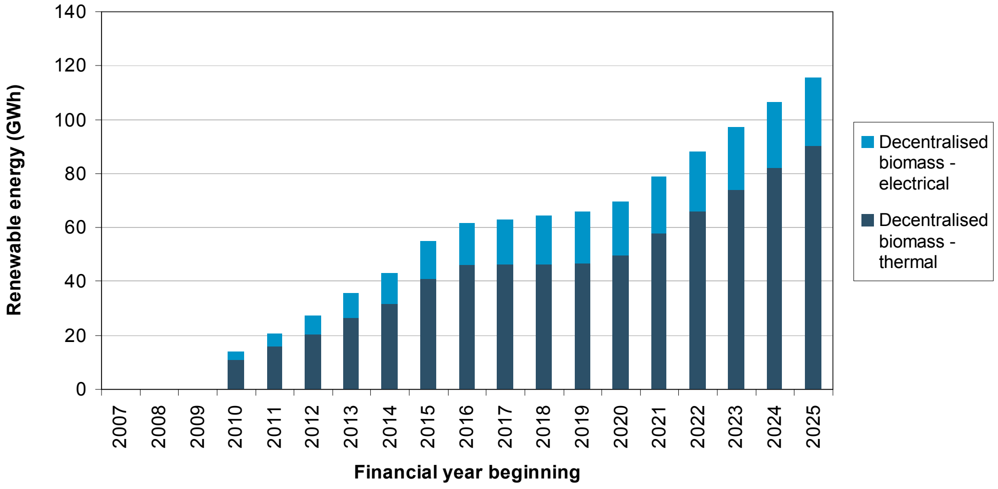


7.3.6 Warwick

Table 27 Energy produced by decentralised biomass in Warwick – base case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	40.8	49.7	90.4
	Electrical	14.0	19.9	25.4
	Total	54.8	69.6	115.8
Proportion of demand	Thermal	3.9%	3.7%	6.8%
	Electrical	1.8%	2.6%	3.3%
	Total	2.6%	3.3%	5.5%

Figure43: Uptake of energy produced by decentralised biomass in Warwick – base case



7.4 Elevated Case Potential

This is taken to be the same as the Base Case Potential.

7.5 Delivering biomass energy

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

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

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

8 New Build Development – carbon standards and low carbon energy supply potential

8.1 Approaches to Low Carbon Development

8.1.1 Communal energy supply systems

Combined heat & power (CHP) systems and district heating networks, can enable significant carbon reductions in new developments, particular where they are operated 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[33] 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 the 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 44 overlays the Strategic Housing Land Allocation Assessments (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 Table 34 for further detail) will also present high density energy demands worth consideration:

- Nuneaton & Bedworth: Camp Hill
- Rugby: Rugby Gateway, Rugby Radio Station
- Solihull: Part of North Solihull Regeneration Zone
- Stratford-on-Avon: West of Shottery
- Warwick: Europa Way, Heathcote, Thickthorne
- North Warwickshire: Birch Coppice,

Previous work[34] 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 45.

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.

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

[34] *Halcrow Consulting, Heat Mapping and Decentralised Energy Feasibility Study, Phase 2 Report, A Report for Advantage West Midlands, April 2008*

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 significant 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[35].

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[36].

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.

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[35] *Small Scale Community Heating, Energy Savings Trust / Carbon Trust, 2005*

[36] *http://www.englishpartnerships.co.uk/carbonchallenge.htm*

Figure 44 Total heat demand density with SHLAA

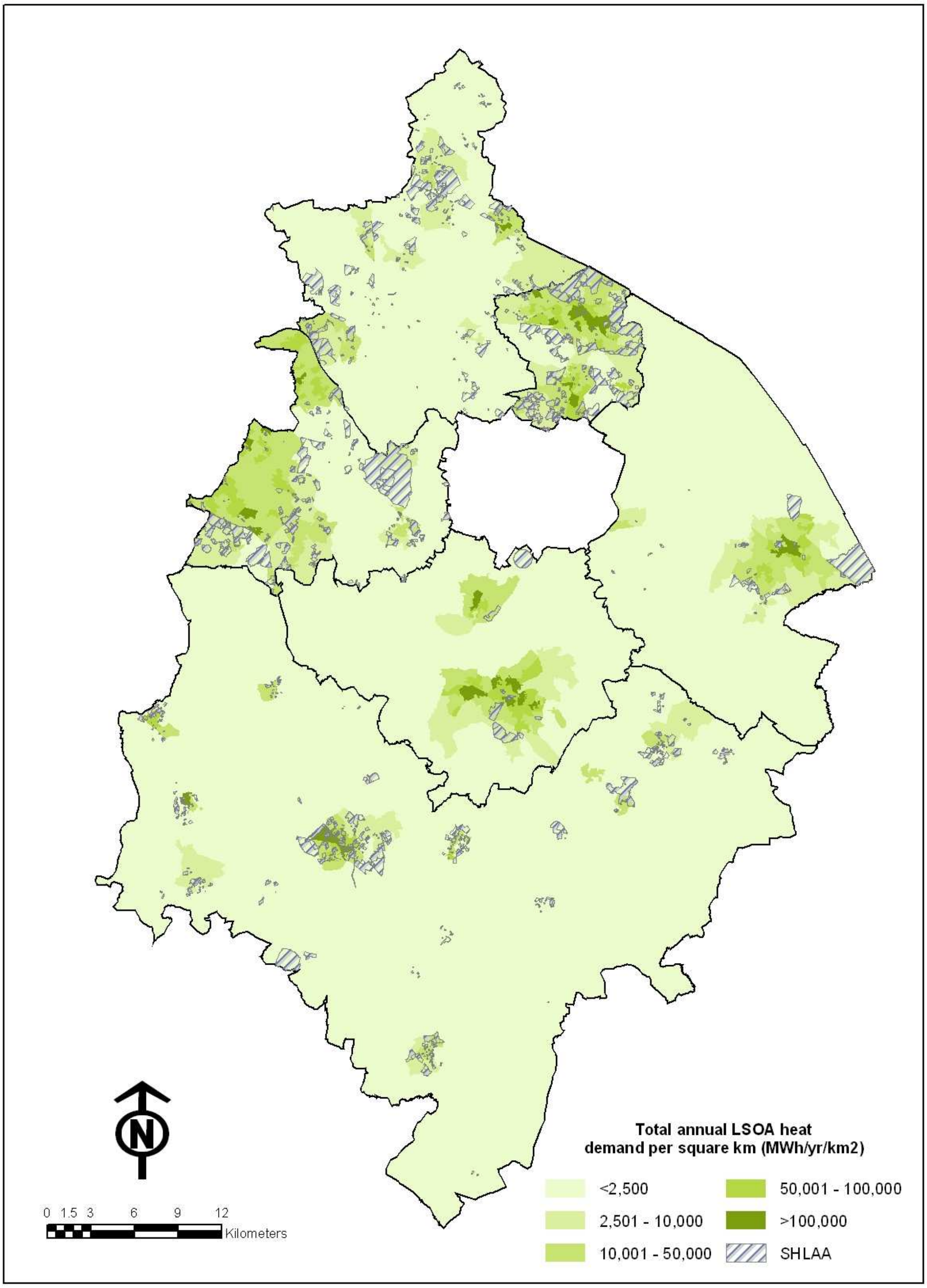
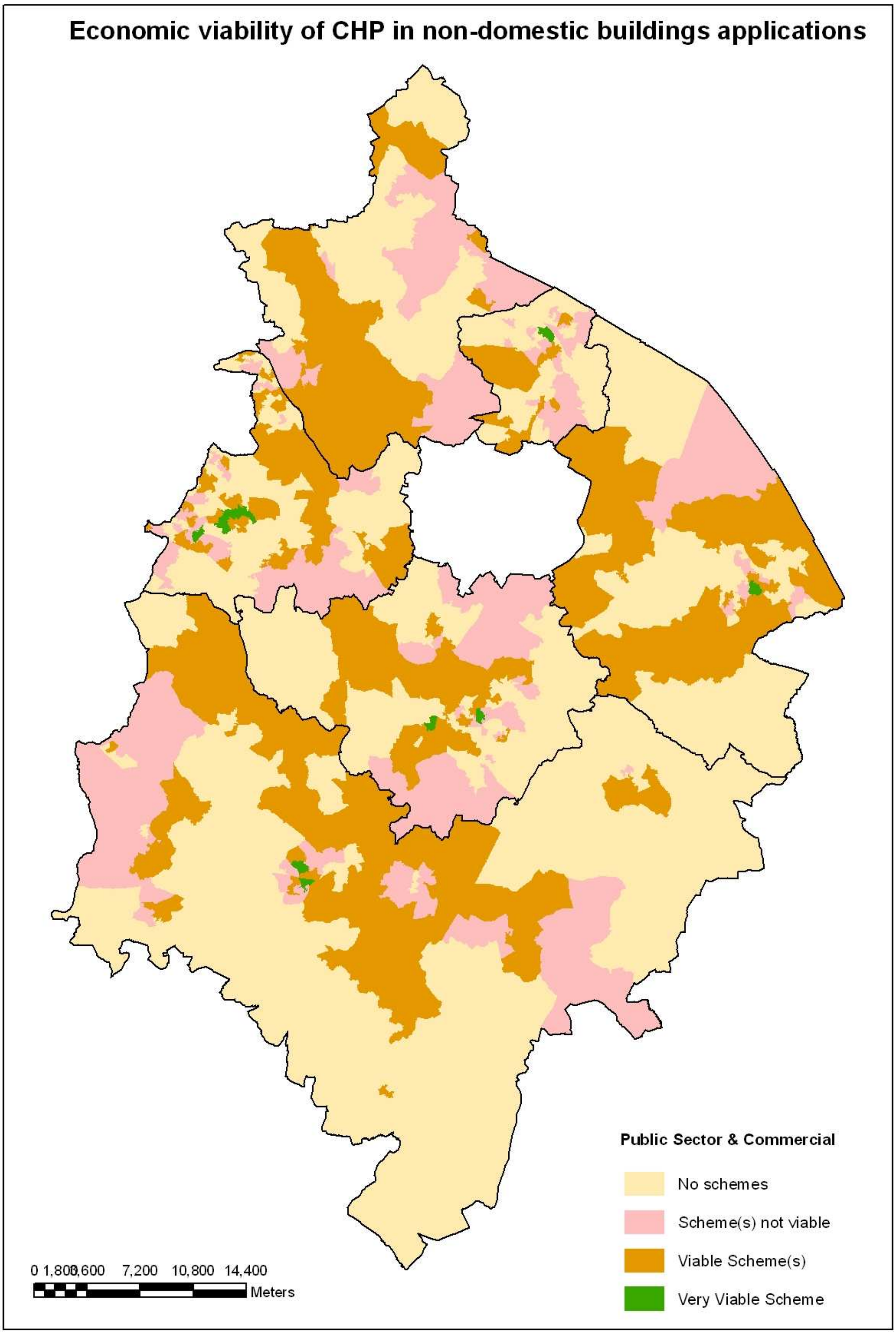


Figure 45 Economic viability of the CHP in the non-domestic building applications



8.1.2 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 tariffs (Feed-in-Tariff 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[37] is likely to require at least 70% of a zero carbon dwelling's 'regulated'[38] emissions to be abated 'on-site' (see section 4.1.5). 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.

8.1.3 Characterising development types and 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 the proposed new development in the study area, it is necessary to identify the characteristics of the developments and their suitability for installing low to zero carbon technologies. To enable this analysis we have characterised 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

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

[38] *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*

1,000 dwellings could offer the right conditions to support biomass community heating / CHP serving the highest density zones.

Table 28 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.

Table 28. Development types and typical low carbon energy strategies

<table>
<tr><th colspan="2">Development types and typical low carbon energy strategies</th></tr>
<tr><td colspan="2">Category / Low carbon/ renewable energy supply options</td></tr>
<tr><td colspan="2">Urban Infill: Small numbers of dwellings (typically 10-100 units) integrated into existing urban environment/settlement framework. High density (50 dwellings/ha).</td></tr>
<tr><td></td><td>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’[39] standards) could act to mitigate the difficulties found with installing renewable technologies on these sites. Difficult to achieve very low or zero carbon development.</td></tr>
<tr><td colspan="2">Rural infill: Small numbers of housing units situated within existing settlement framework - ranging from 1 to 100 Medium density (40 dwellings/ha).</td></tr>
<tr><td></td><td>As with urban infill, except that existing communal systems are less likely. Difficult to achieve very low or zero carbon development.</td></tr>
<tr><td colspan="2">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).</td></tr>
<tr><td></td><td>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.</td></tr>
<tr><td colspan="2">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).</td></tr>
<tr><td></td><td>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</td></tr>
<tr><td colspan="2">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).</td></tr>
<tr><td></td><td>As above. Good potential to achieve very low or zero carbon developments.</td></tr>
</table>

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[39] *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 Baseline carbon standards

8.2.1 UK carbon reduction roadmap for buildings

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 – a zero carbon reduction beyond current (2006) requirements

Whilst the definition of the zero carbon homes is still being resolved, the road map 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[40,41]. 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 29 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 29. 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% (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 Carbon Compliance or AS**)
	Zero Carbon			

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

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

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

**AS = Allowable solutions

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 or unregulated emissions in the non-domestic buildings is a more complex issue because of the wide range of building types, and figures vary significantly as seen in Table 30. 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.

Table 30. Unregulated emissions as proportion of the regulated in non-domestic buildings

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

Non-domestic buildings also have process energy consumptions which are not directly linked to the building type per se and can vary greatly 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[42] and many have sought to go beyond the original 10% standard (e.g. 20% in London Borough, 20% in Manchester) and a number of authorities have established sliding targets to keep apace with changing building regulations).

The Regional Spatial Strategy suggests the inclusion of 10% Merton-style policies within LDF policies (as discussed in Section 4.2), and it suggests 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 include ‘unregulated’ emissions. For reference, Table 31 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.

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[42] *Renewable Energy Association website*

Table 31. Relationship between 10% and 20% renewable energy targets and reductions in 'regulated' emissions – domestic development

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

8.3 Accelerating carbon targets in new development

For new non-domestic development the base position, .i.e. UK zero carbon road map, 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 they are 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, it will support the local development sector to implement low carbon solutions, and, it will 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).

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 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 also offer the potential to support microgeneration in new build development. Whilst mechanisms have yet to be proved, given the large amount of activity in the industry seeking to develop these to realise this value (such as PAYS, leasing schemes and low interest finance facilities) it seems justifiable to establish targets that take account of capitalised revenue.

The burden on developers must ultimately be assessed through planning negotiations (or discrete Carbon Investment Fund agreements) using a viability model, 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 potentially viable in projects above 1000 units where at least half of the development is a suitable density (e.g. developments at Northstowe (South Cambridgeshire, Bath Western Riverside). Delivery would be through an Energy Services Company responsible for some or all of finance, design, build, ownership and operation of district heating and CHP energy centres. Experience in the UK is extremely limited therefore development risk is high but there are a number of European examples, e.g. Hammarby Sjostad, Sweden[43] 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 low costs 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[44] long term energy sales opportunity available, although detailed evaluation will be required on a case-by-case basis.

Table 32 summarises the proposed acceleration for carbon reduction targets and renewable energy generation for new residential development. For new non-domestic development only 10% and 20% Merton rule targets are proposed to be applied for 2010 and 2013 (onwards).

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[43] *http://www.cabe.org.uk/case-studies/hammarby-sjostad*

[44] *Prior European legal precedent effective rules out sole supplier scenarios*

Table 32 Proposed Carbon Targets for New 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% (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 development including sub 10 developments to ensure consistency with Code for Sustainable Homes

$^{\chi}$ where lower costs 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 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

In addition, and 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 12 recommends policy approaches that could be included with the emerging LDFs within the Study Area to support this.

8.4 Costing of proposed carbon target acceleration

Cost modelling has been carried out utilising the data provided in the zero carbon definition impact assessment. This 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 house
    - End-terrace / semi-detached house
    - Detached house
- 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)[45]
- 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 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

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

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 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 Government has established 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 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 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, and this is an issue that needs further consideration.

As the FIT and RHI have not yet entered the market place, and there is some uncertainty over how the sector will respond, we have used a conservative figure of a 25% contribution to the energy costs for microgeneration technologies (PV, solar water heating and heat pumps) in the viability analysis.

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 PV or heat pumps.

8.4.1 Resulting additional (net) costs for residential development

From Figure 46 through to Figure 51, 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. Where an asterix on the technical solutions is used 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 XV, which also includes details of the estimated net costs on the basis of proportion of the total capital cost.

Acceleration test 1:

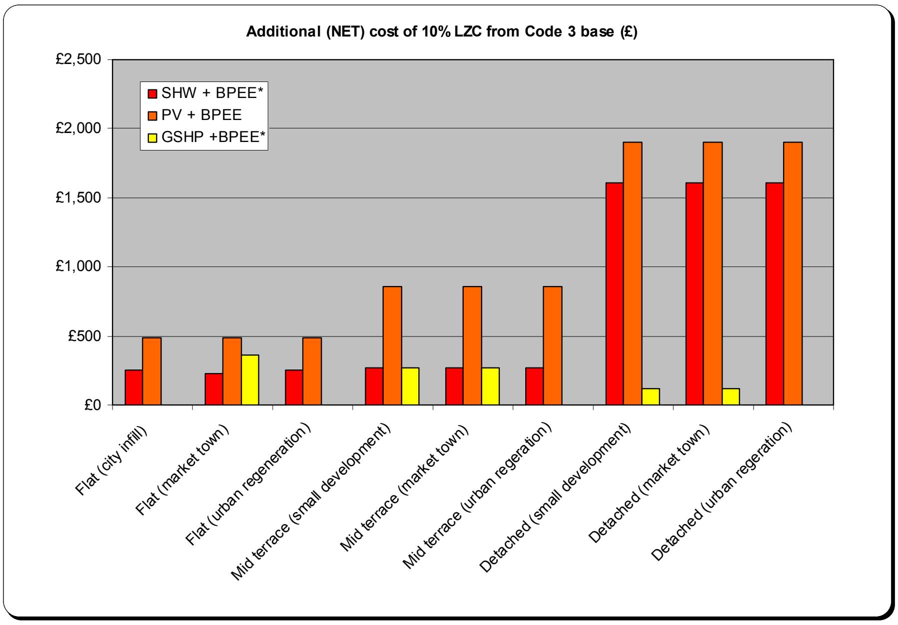
From 25% carbon reduction (against Building Regulations Part L 2006) to 25% Part L reduction PLUS a 10% specific low zero carbon (LZC) technology target against total carbon (which can form part of the solution for the Part L target)

Figure 46 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 46 Test 1: all development types



Acceleration test 2:

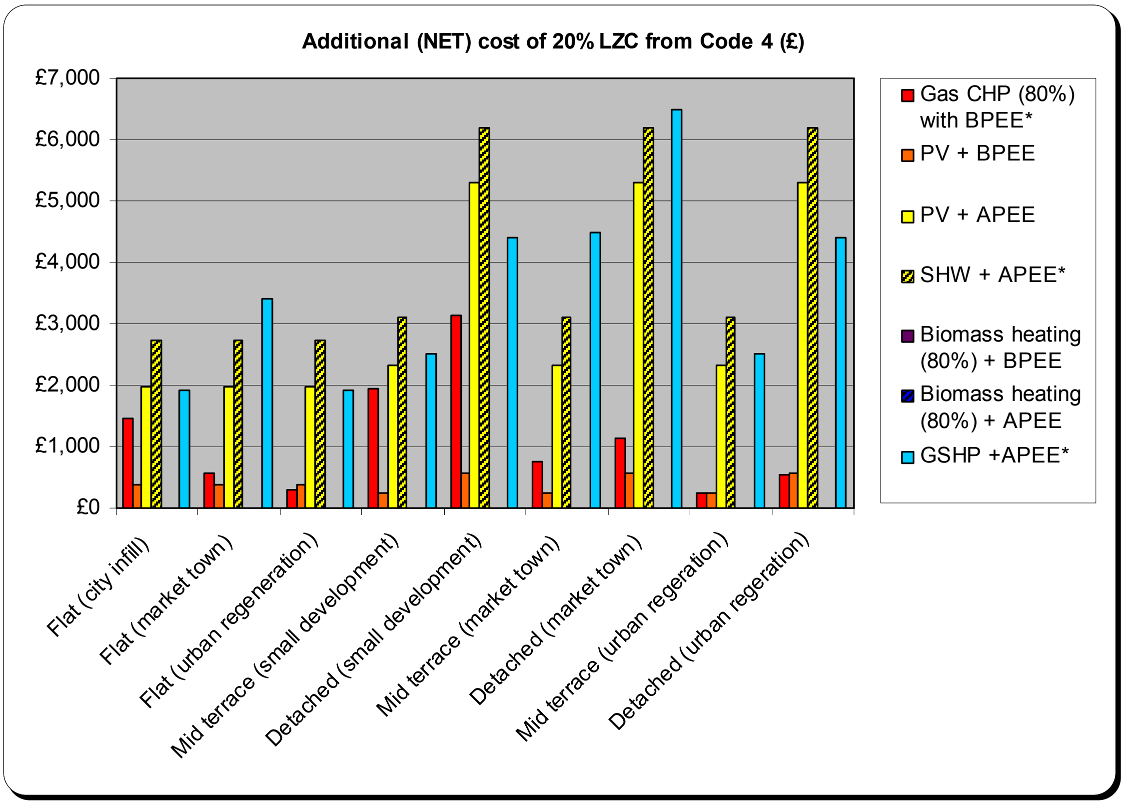
From 44% carbon reduction (against Part L 2006) to 44% Part L reduction PLUS a 20% specific LZC technology target against total carbon (which can form part of the solution for the Part L target)

Figure 47 shows that a wider range of technical solutions that 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 47 Test 2: all development types



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 48 and Figure 49 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 48 Test 3: flats

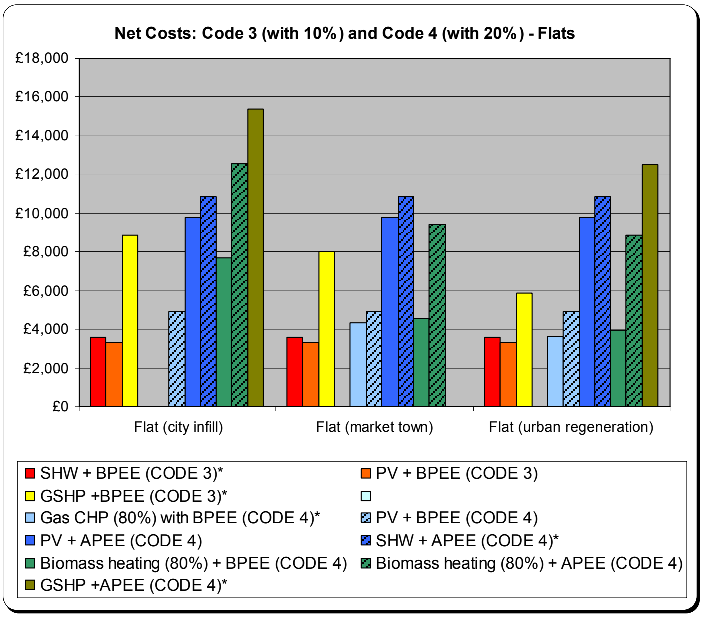
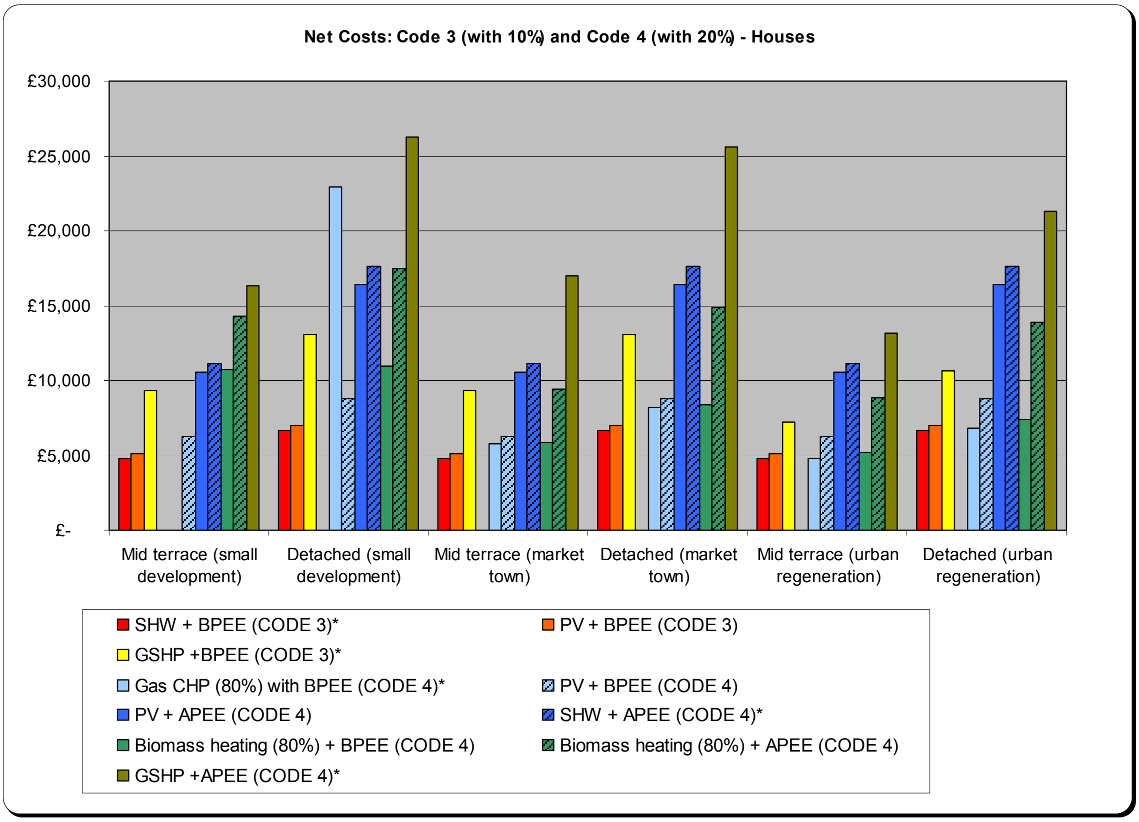


Figure 49 Test 3: houses



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 scenarios is referred to below as 'Code 4 + 20%'.

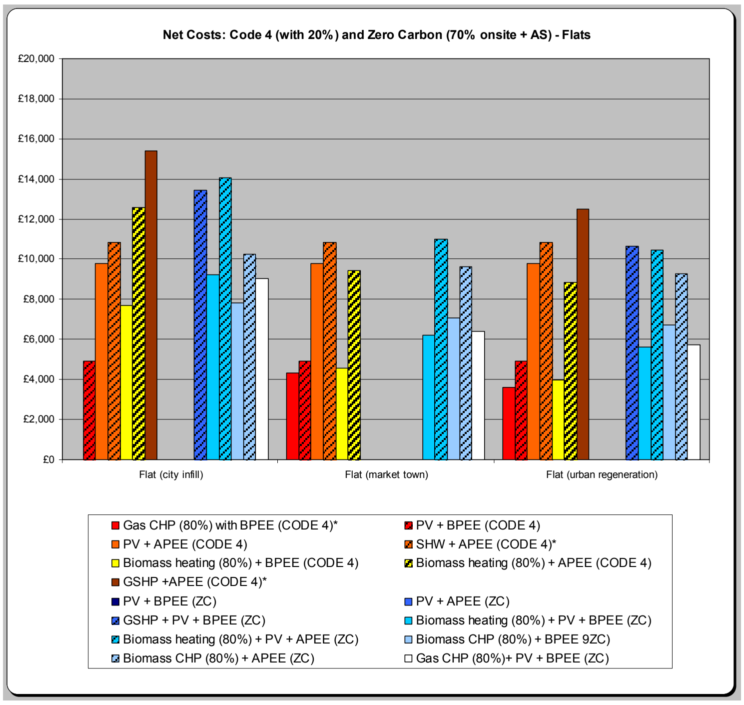
Figure 50 and

Figure 51**Error! Reference source not found.** 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 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.

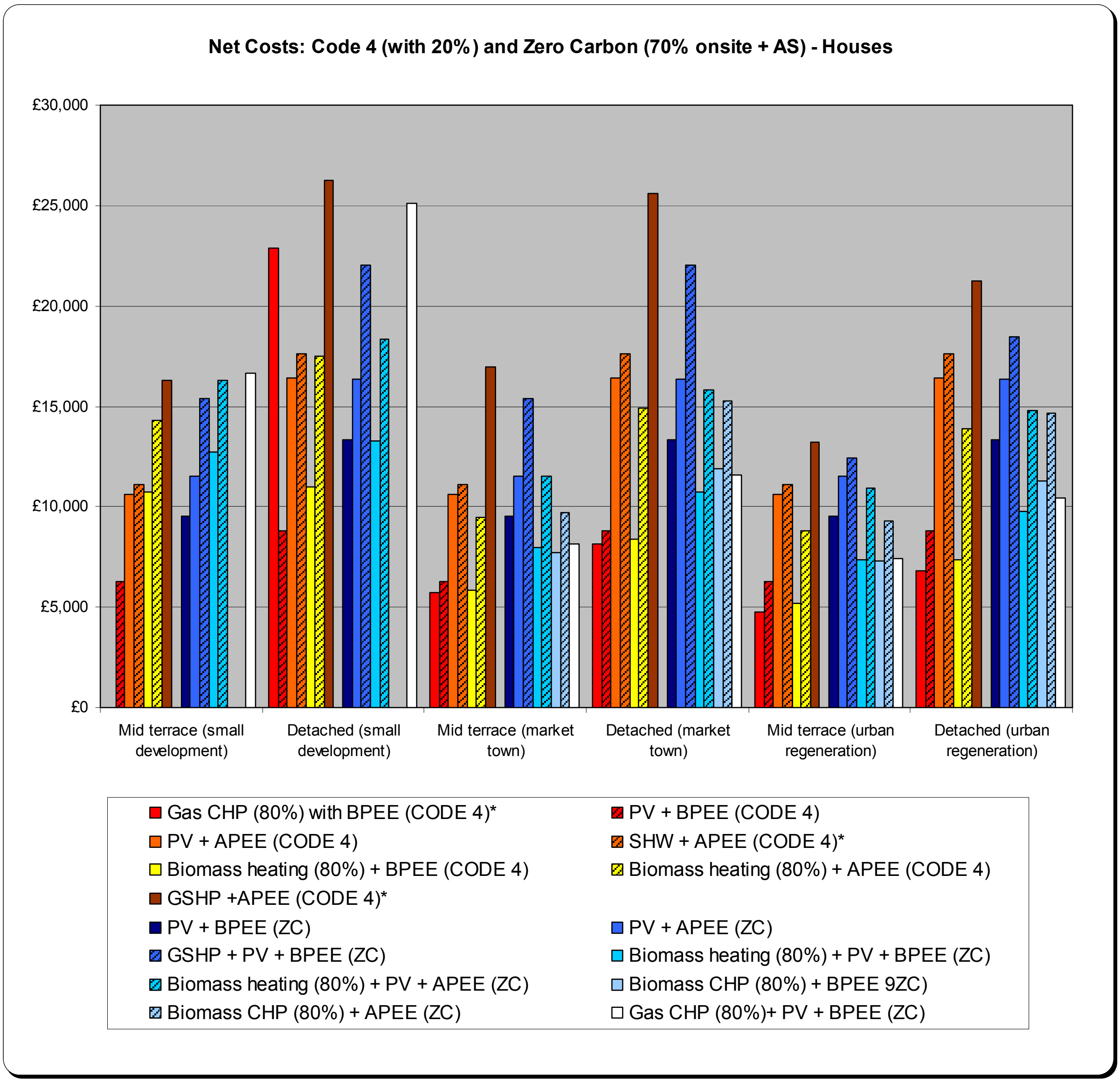
Comparing the minimum cost solutions within each of the carbon standards we see a range (across the development types) of just under £2,000 to £4,500. In terms of the percentage construction costs the range is 2.7% and 5.0%. Comparing the maximum cost solutions within each of the carbon standards we see a range (across the development types) of negative £2,800 (GSHP + APEE + PV vs Biomass CHP + APEE + PV) to just under negative £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%.

Figure 50 Test 4: flats



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 51 Test 4: houses



8.5 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 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 can not 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. 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.

8.6 Estimating the Low carbon energy supply impact of new development standards

8.6.1 Growth Plans for Study Area

Planned or anticipated residential and non residential development forecasts and characteristics (assumed development typologies) have been supplied by each of the participating Authorities as set out in Appendix IV. These forecasts vary from those within the proposed revision to the Regional Spatial Strategy since these were published after the analysis was completed. The development assumptions used within this study are summarised in Table 33; Table 34 highlights the anticipated major developments.

Additional development has been identified as presented in the inspection panel report for the Regional Spatial Strategy, which may result in further major development sites being identified but lack of certainty regarding the quantum of development on individual sites (since development could be more widely dispersed) has meant they have been excluded from evaluation as major development sites.

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.

Although not committed development sites, the various SHLAA sites identified by each authority have been mapped to illustrate possible distribution across the study area which mapped against heat demand density (Figure 44, in section 8.1.1) and also against sites that have technical potential for wind energy development (Figure 26 in wind energy section of report), could be used to inform decisions made through the LDF of the Authorities within the study area.

Table 33 Development Forecasts and Residential Development Types[46]

Housing Growth Numbers and Residential Development Types						
	North Warwickshire	Nuneaton & Bedworth	Rugby	Solihull	Stratford-on-Avon	Warwick
No. of dwellings (2006-26)	3,000	10,800	12,274	13,190	5,602	10,939
Urban infill		44%	29%	81%	32%	40%
Rural infill	50%		12%	2%	26%	3%
Settlement extension	50%				42%	13%
Urban extension		56%	10%	17%		44%
New settlement			49%			
Economic development (floor area x1000m^2)	138	157*	1,070	618	520	813

* since the analysis was completed the actual forecasted development has been re-appraised to approximately 465,000m^2

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[46] *Definitions of development type is set out in Table 28*

Table 34 Major development sites within study area

Summary of major developments						
Site	Development type	Residential		Non-residential		Expected construction period
		No. of dwellings	Residential type	Floor area (m^2)	Planning class	
North Warwickshire						
Birch Coppice	Mixed use	300	Urban Extension	210,000		
Nuneaton & Bedworth						
Camp Hill	Residential	806	Settlement extension	39,700		2010-18
Rugby						
Rugby Gateway	Mixed use	1,200	Urban extension	35,000	B2 / B8	2011-2021
Rugby Radio Station	Mixed use	6,200	Urban Extension	60,000	B1	2013-2026 and beyond plan period
Solihull						
Part of North Solihull Regeneration Zone	Residential	1,501	Urban extension			2013-16
Stratford-on-Avon						
West of Shottery	Mixed use	800	Settlement extension	20,000	D2	2013-18
Warwick						
Europa Way	Mixed use	1,250	Urban extension	52,000	B1 / B2 / B8	2015-2019
Heathcote	Mixed use	2,500	Urban extension	92,500	B1 / B2 / B8	2017-2024
Thickthorne	Mixed use	800	Settlement extension	82,500	B1 / B2 / B8	2022-2025

8.6.2 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 29 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 28).
- Assumes that proposed Building Regulations will be met and not exceeded, with the exception of a 10% reduction from LZC energy generation.

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 at 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

8.7 Overall renewable energy potential from New Development - Base Case

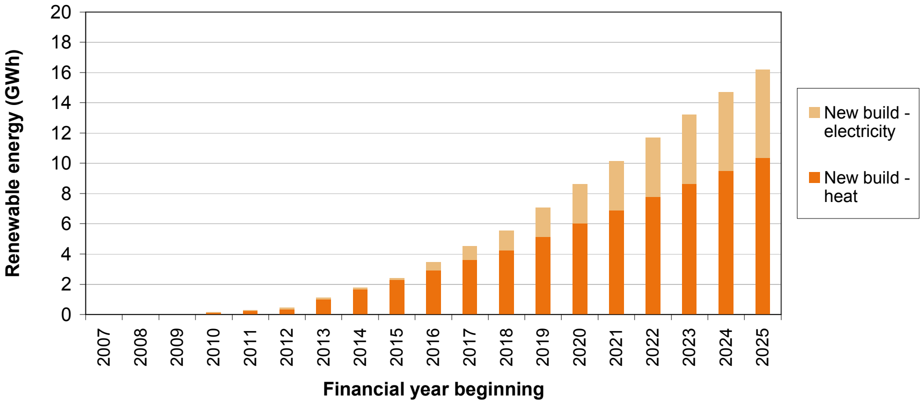
The base case potential from renewable energy associated with new build development is as follows:

8.7.1 North Warwickshire

Table 35 Energy produced by low and zero carbon within North Warwickshire's new build – base case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	2.3	6.0	10.4
	Electrical	0.1	2.6	5.8
	Total	2.4	8.6	16.2
Proportion of demand	Thermal	0.2%	0.6%	1.1%
	Electrical	0.02%	0.5%	1.1%
	Total	0.2%	0.6%	1.1%

Figure52: Low and zero carbon generation within North Warwickshire's new build – base case

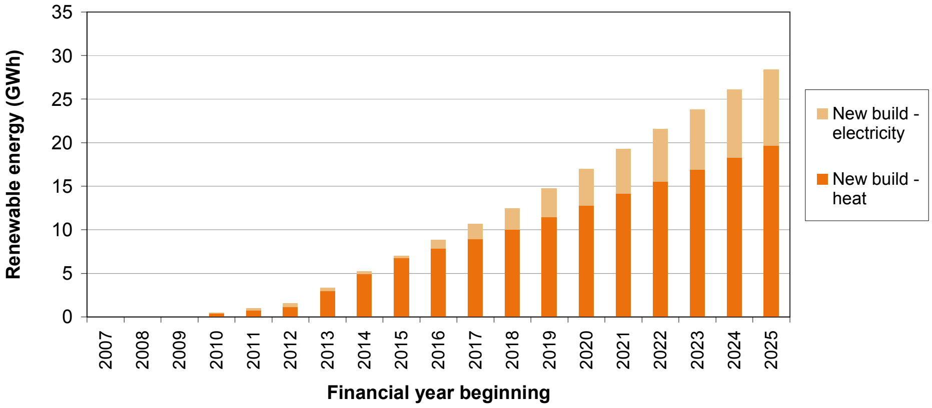


8.7.2 Nuneaton & Bedworth

Table 36 Energy produced by low and zero carbon within Nuneaton & Bedworth's new build – base case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	6.8	12.8	19.6
	Electrical	0.3	4.2	8.7
	Total	7.0	17.0	28.4
Proportion of demand	Thermal	0.6%	1.1%	1.8%
	Electrical	0.05%	0.9%	1.8%
	Total	0.4%	1.0%	1.8%

Figure53: Low and zero carbon generation within Nuneaton & Bedworth's new build – base case

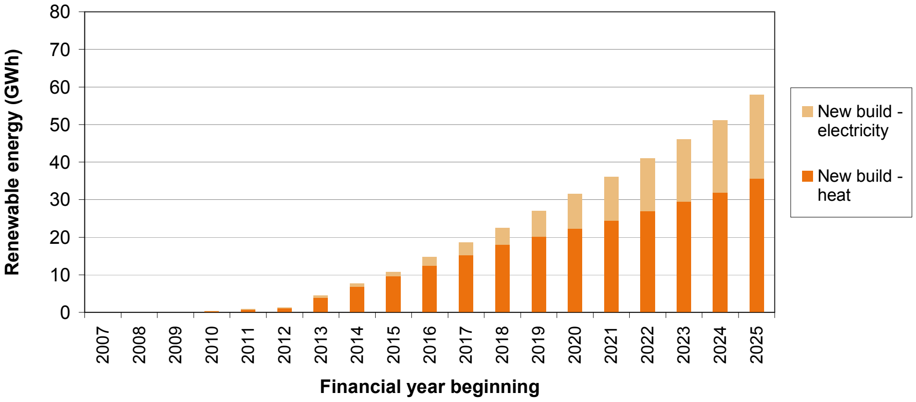


8.7.3 Rugby

Table 37 Energy produced by low and zero carbon within Rugby's new build – base case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	9.6	22.3	35.7
	Electrical	1.1	9.3	22.2
	Total	10.7	31.5	57.9
Proportion of demand	Thermal	0.3%	0.8%	1.3%
	Electrical	0.2%	1.2%	2.9%
	Total	0.3%	0.9%	1.6%

Figure54: Low and zero carbon generation within Rugby's new build – base case

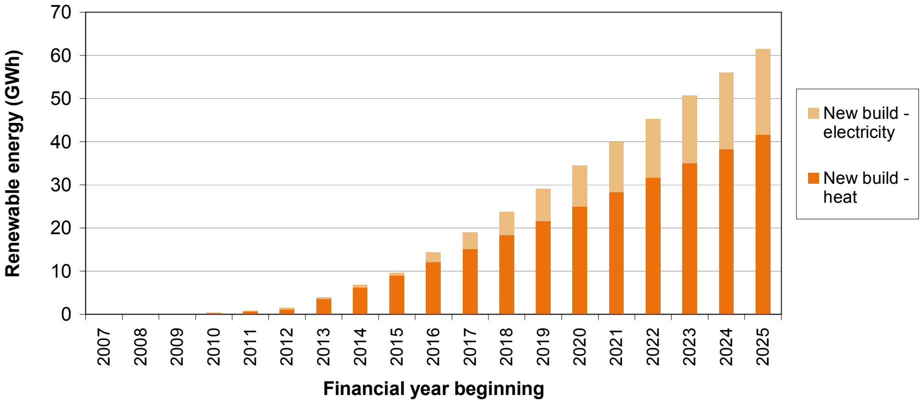


8.7.4 Solihull

Table 38 Energy produced by low and zero carbon within Solihull's new build – base case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	8.9	24.9	41.6
	Electrical	0.7	9.6	19.8
	Total	9.6	34.5	61.5
Proportion of demand	Thermal	0.3%	1.0%	1.7%
	Electrical	0.1%	1.0%	2.0%
	Total	0.3%	1.0%	1.8%

Figure55: Low and zero carbon generation within Solihull's new build – base case

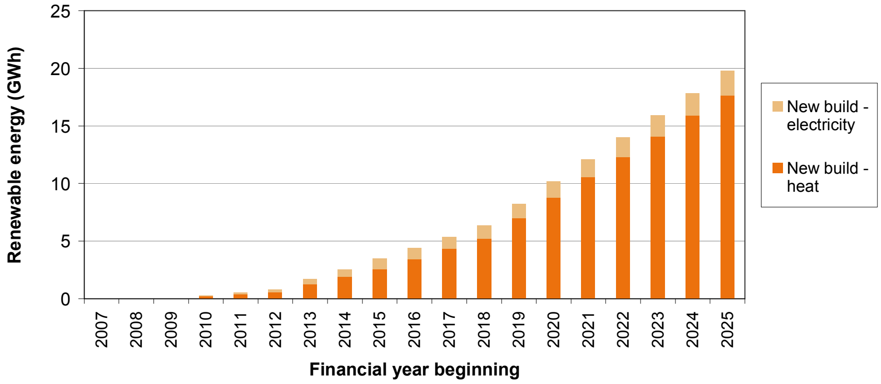


8.7.5 Stratford-On-Avon

Table 39 Energy produced by low and zero carbon within Stratford-On-Avon's new build – base case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	2.6	8.8	17.7
	Electrical	0.9	1.4	2.1
	Total	3.5	10.2	19.8
Proportion of demand	Thermal	0.2%	0.6%	1.2%
	Electrical	0.2%	0.2%	0.4%
	Total	0.2%	0.5%	1.0%

Figure56: Low and zero carbon generation within Stratford-On-Avon's new build – base case

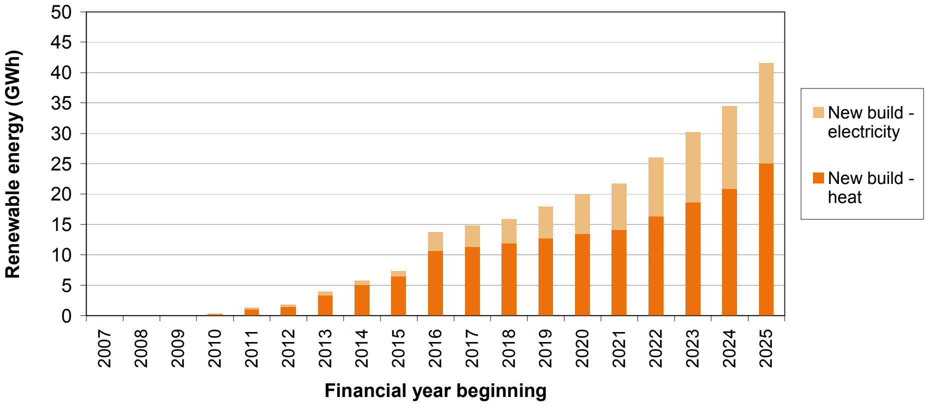


8.7.6 Warwick

Table 40 Energy produced by low and zero carbon within Warwick's new build – base case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	6.5	13.5	25.0
	Electrical	0.9	6.5	16.5
	Total	7.4	19.9	41.6
Proportion of demand	Thermal	0.5%	1.0%	1.9%
	Electrical	0.1%	0.8%	2.2%
	Total	0.3%	0.9%	2.0%

Figure57: Low and zero carbon generation within Warwick's new build – base case



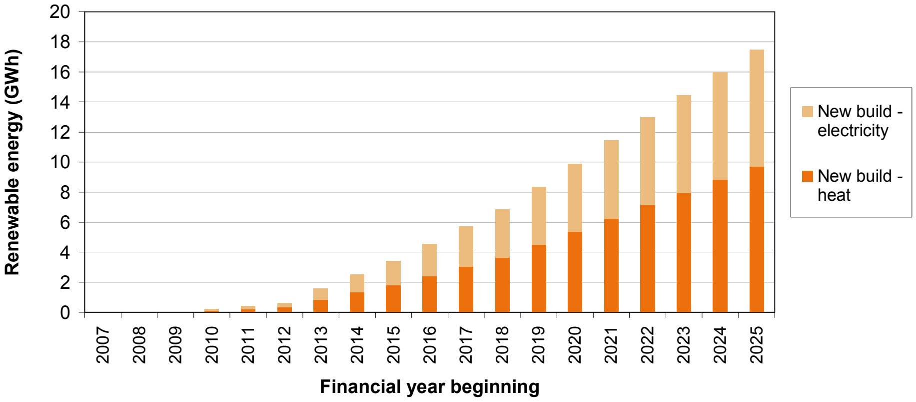
8.8 Overall renewable energy potential from New Development - Elevated Case

8.8.1 North Warwickshire

Table 41 Energy produced by low and zero carbon within North Warwickshire's new build – elevated case

Year		**2015/16**	**2020/21**	**2025/26**
Energy generated (GWh)	Thermal	1.8	5.4	9.7
	Electrical	1.6	4.5	7.8
	Total	3.4	9.9	17.5
Proportion of demand	Thermal	0.2%	0.6%	1.0%
	Electrical	0.3%	0.9%	1.5%
	Total	0.2%	0.7%	1.2%

Figure58: Low and zero carbon generation within North Warwickshire's new build – elevated case

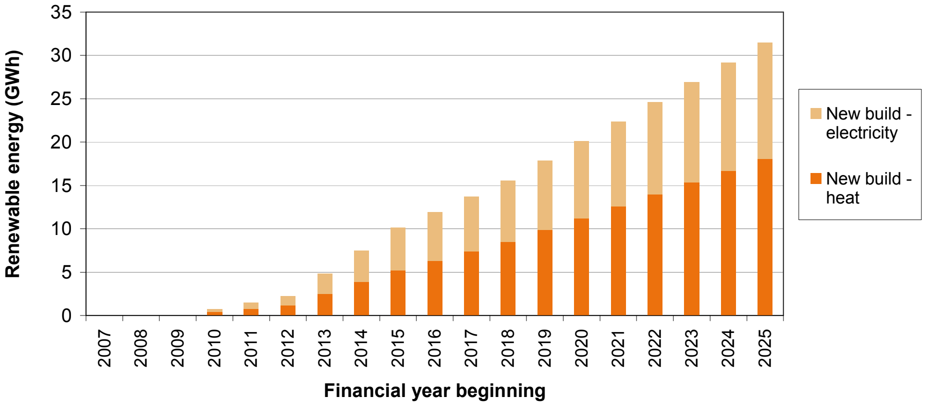


8.8.2 Nuneaton & Bedworth

Table 42 Energy produced by low and zero carbon within Nuneaton & Bedworth's new build – elevated case

Year		**2015/16**	**2020/21**	**2025/26**
Energy generated (GWh)	Thermal	5.2	11.2	18.1
	Electrical	4.9	8.9	13.4
	Total	10.1	20.1	31.5
Proportion of demand	Thermal	0.4%	1.0%	1.6%
	Electrical	1.0%	1.8%	2.7%
	Total	0.6%	1.2%	2.0%

Figure59: Low and zero carbon generation within Nuneaton & Bedworth's new build – elevated case

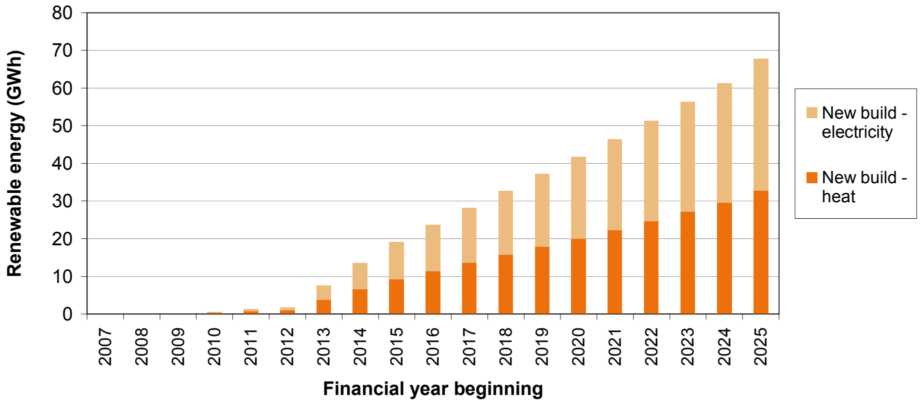


8.8.3 Rugby

Table 43 Energy produced by low and zero carbon within Rugby's new build – elevated case

Year		**2015/16**	**2020/21**	**2025/26**
Energy generated (GWh)	Thermal	9.2	20.1	32.8
	Electrical	10.0	21.7	35.0
	Total	19.2	41.8	67.8
Proportion of demand	Thermal	0.3%	0.7%	1.2%
	Electrical	1.3%	2.8%	4.5%
	Total	0.5%	1.2%	1.9%

Figure60: Low and zero carbon generation within Rugby's new build – elevated case



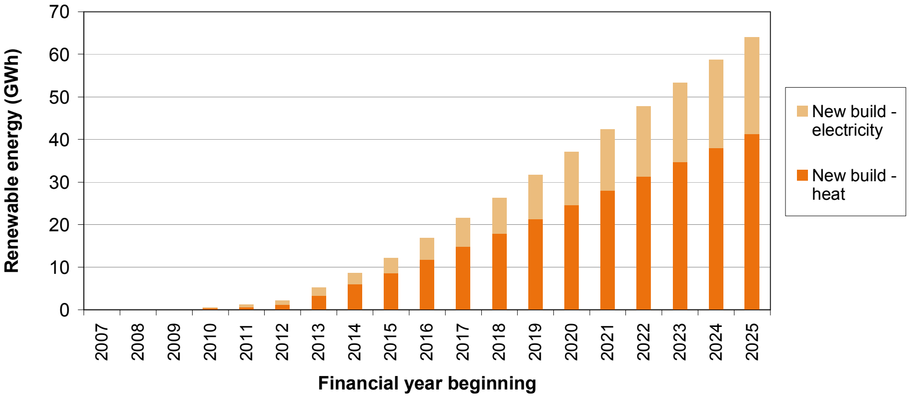
8.8.4 Solihull

A significant part of Solihull's residential development is expected to lie within the North Solihull Regeneration Zone. This sits inside of the existing urban boundary but is too large in scale for the category of 'urban infill' to be wholly applied. It has been assumed that around 1,800 units are of a scale to be treated as an urban extension for the sake of this analysis, even though the site is not an extension to the edge of the urban boundary. These dwellings have been identified as viable to accelerate to zero carbon as of 2013, as set out in the definition of the elevated scenario.

Table 44 Energy produced by low and zero carbon within Solihull's new build – elevated case

Year		**2015/16**	**2020/21**	**2025/26**
Energy generated (GWh)	Thermal	8.6	24.6	41.3
	Electrical	3.5	12.4	22.7
	Total	12.2	37.1	64.0
Proportion of demand	Thermal	0.3%	1.0%	1.7%
	Electrical	0.4%	1.2%	2.3%
	Total	0.3%	1.0%	1.8%

Figure61: Low and zero carbon generation within Solihull's new build – elevated case

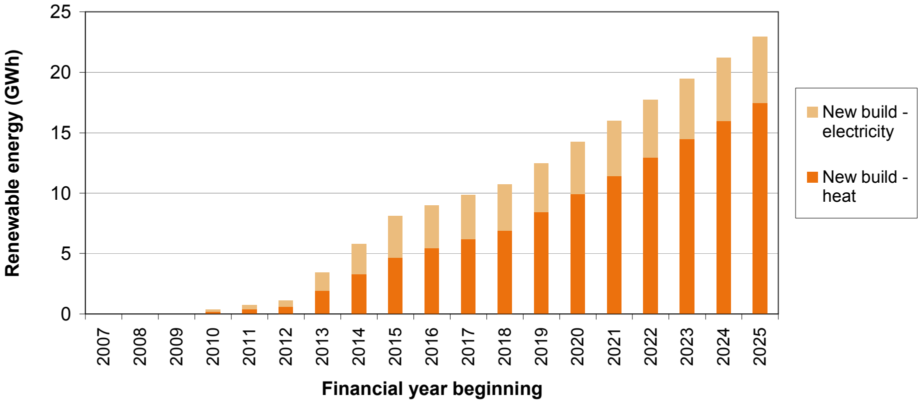


8.8.5 Stratford-On-Avon

Table 45 Energy produced by low and zero carbon within Stratford-On-Avon's new build – elevated case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	4.7	9.9	17.5
	Electrical	3.5	4.3	5.5
	Total	8.1	14.2	23.0
Proportion of demand	Thermal	0.3%	0.7%	1.2%
	Electrical	0.6%	0.7%	0.9%
	Total	0.4%	0.7%	1.1%

Figure62: Low and zero carbon generation within Stratford-On-Avon's new build – elevated case

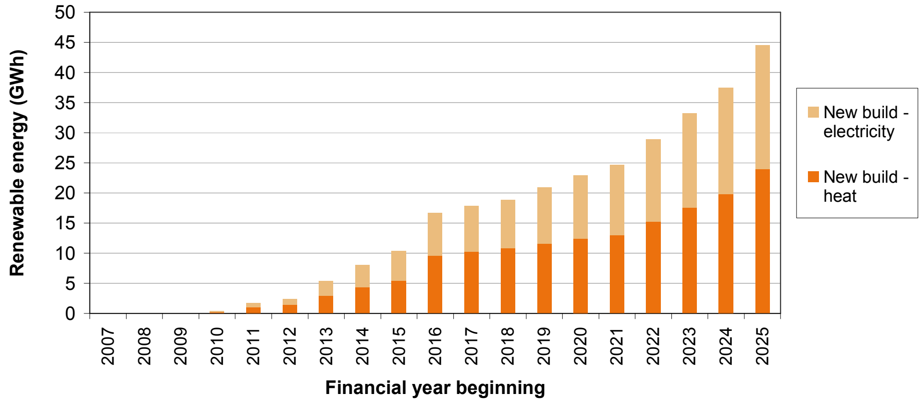


8.8.6 Warwick

Table 46 Energy produced by low and zero carbon within Warwick's new build – elevated case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	5.4	12.4	24.0
	Electrical	5.0	10.5	20.6
	Total	10.4	22.9	44.5
Proportion of demand	Thermal	0.4%	0.9%	1.8%
	Electrical	0.7%	1.4%	2.7%
	Total	0.5%	1.1%	2.1%

Figure63: Low and zero carbon generation within Warwick's new build – elevated case



9 Existing Buildings

9.1 Methodology

Prior to reviewing the approach taken to assess the potential role for low and zero carbon technologies in the existing built environment, it is worth reflecting on the fact that local planning policy 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[47]. 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[48]. 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, as outlined in Table 47 .

Table 47 Scaling factors used to disaggregate regional data for microgeneration uptake

Scaling factors by no. of dwellings		
	No. of dwellings[49]	Proportion of GB
Great Britain	24,730,887	100%
North Warwickshire	25,759	0.10%
Nuneaton & Bedworth	49,500	0.20%
Rugby	37,768	0.15%
Solihull	83,440	0.34%
Stratford-on-Avon	49,382	0.20%
Warwick	55,138	0.22%

The results of the study include uptake of microgeneration technologies within the new build as well as within the existing built environment. It is not possible to disaggregate the existing

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

[48] *The annual payment is set for 20 years but the value reduces depending on the year of commencement of the project*

[49] *National Statistics, 2009, Neighbourhood statistics – household spaces (UV56), data from 2001*

build component from the results, hence a conservative scenario assumption has been made that 2/3$^{\text{rds}}$ of the delivered energy is generated on/in existing buildings. The remaining 1/3$^{\text{rd}}$ is ignored to avoid double counting with the new build analysis.

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

9.2 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 be established.

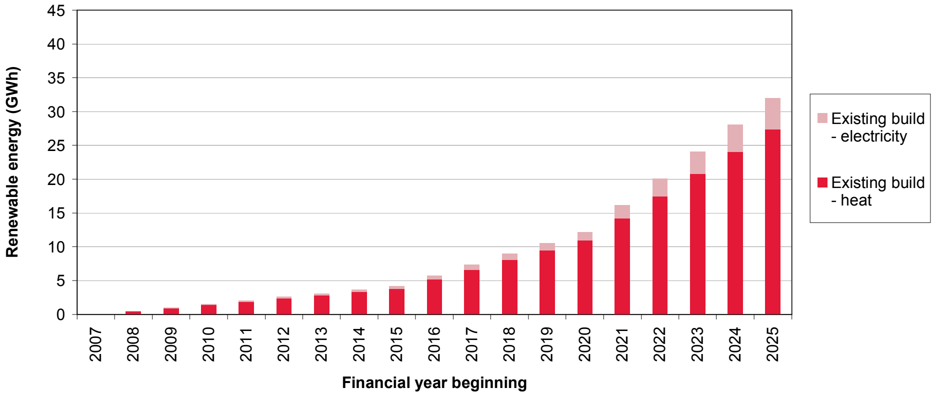
9.3 Base Case Potential

9.3.1 North Warwickshire

Table 48 Energy produced by low and zero carbon within North Warwickshire's existing build – base case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	3.8	10.9	27.3
	Electrical	0.4	1.3	4.7
	Total	4.1	12.2	32.0
Proportion of demand	Thermal	0.38%	1.13%	2.90%
	Electrical	0.07%	0.24%	0.91%
	Total	0.27%	0.82%	2.19%

Figure64 Low and zero carbon generation within North Warwickshire's existing build – base case

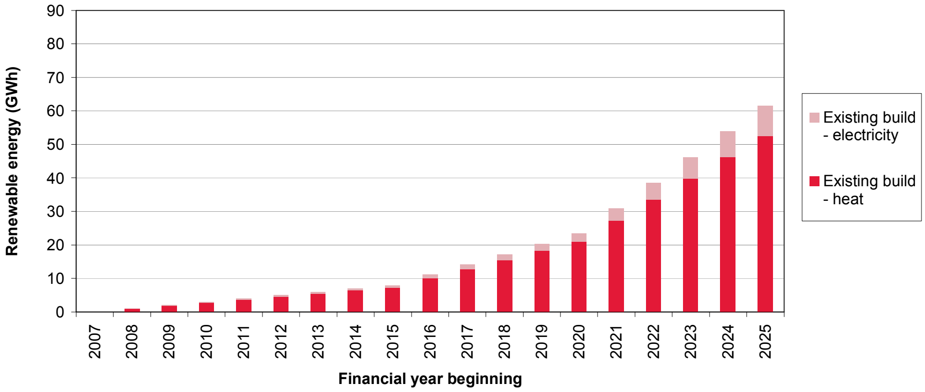


9.3.2 Nuneaton & Bedworth

Table 49 Energy produced by low and zero carbon within Nuneaton & Bedworth's existing build – base case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	7.2	20.9	52.4
	Electrical	0.7	2.4	9.0
	Total	8.0	23.4	61.4
Proportion of demand	Thermal	0.61%	1.84%	4.76%
	Electrical	0.15%	0.49%	1.82%
	Total	0.48%	1.43%	3.85%

Figure65: Low and zero carbon generation within Nuneaton & Bedworth's existing build – base case

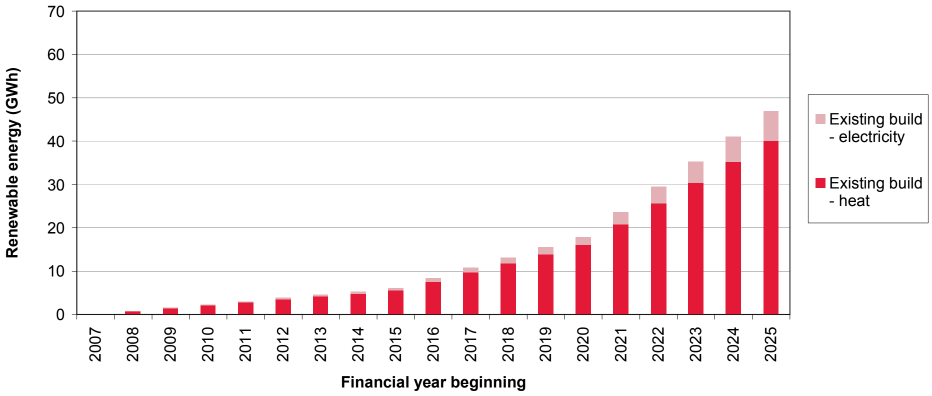


9.3.3 Rugby

Table 50 Energy produced by low and zero carbon within Rugby's existing build – base case

Year		**2015/16**	**2020/21**	**2025/26**
Energy generated (GWh)	Thermal	5.5	16.0	40.0
	Electrical	0.6	1.8	6.9
	Total	6.1	17.8	46.9
Proportion of demand	Thermal	0.19%	0.57%	1.44%
	Electrical	0.08%	0.24%	0.88%
	Total	0.17%	0.50%	1.32%

Figure66: Low and zero carbon generation within Rugby's existing build – base case

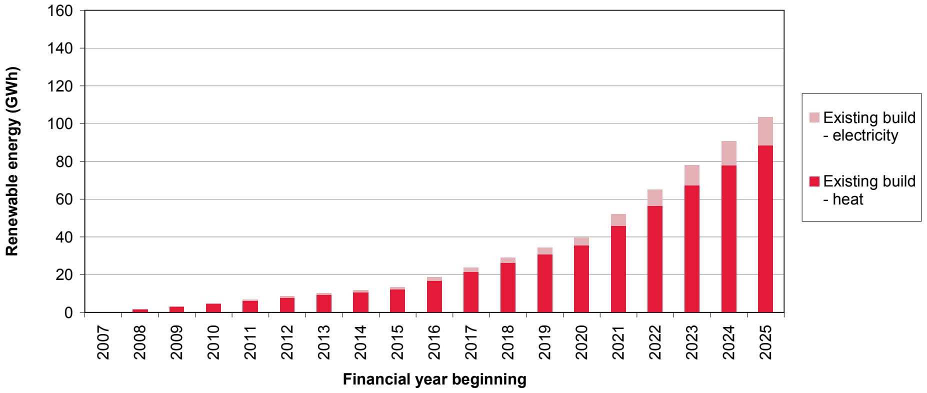


9.3.4 Solihull

Table 51 Energy produced by low and zero carbon within Solihull's existing build – base case

Year		**2015/16**	**2020/21**	**2025/26**
Energy generated (GWh)	Thermal	12.1	35.3	88.4
	Electrical	1.3	4.1	15.1
	Total	13.4	39.4	103.5
Proportion of demand	Thermal	0.47%	1.38%	3.54%
	Electrical	0.13%	0.40%	1.50%
	Total	0.37%	1.11%	2.95%

Figure67: Low and zero carbon generation within Warwick's existing build – base case

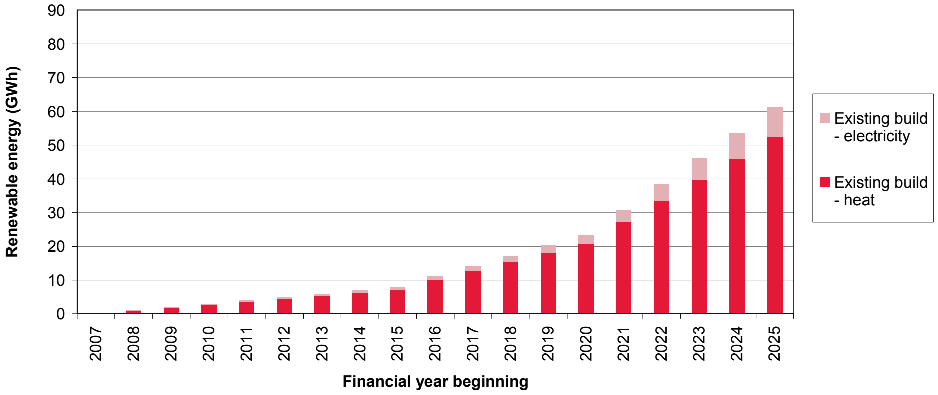


9.3.5 Stratford-On-Avon

Table 52 Energy produced by low and zero carbon within Stratford-On-Avon's existing build – base case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	7.2	20.9	52.3
	Electrical	0.7	2.4	9.0
	Total	7.9	23.3	61.3
Proportion of demand	Thermal	0.46%	1.38%	3.56%
	Electrical	0.12%	0.39%	1.46%
	Total	0.37%	1.10%	2.94%

Figure68: Low and zero carbon generation within Stratford-On-Avon's existing build – base case

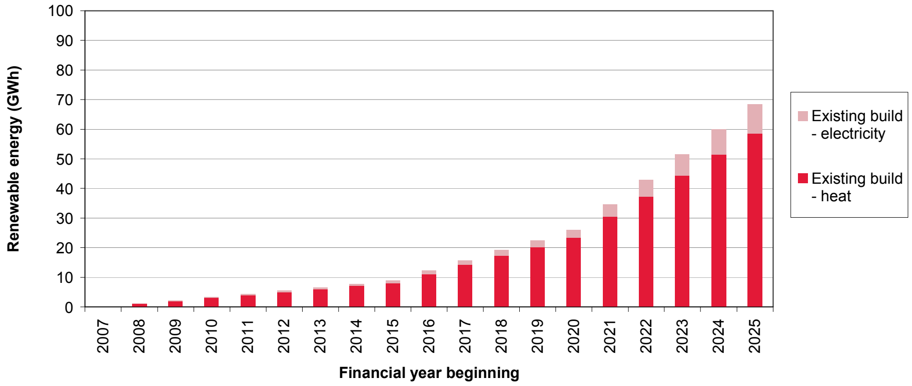


9.3.6 Warwick

Table 53 Energy produced by low and zero carbon within Warwick's existing build – base case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	8.0	23.3	58.4
	Electrical	0.8	2.7	10.0
	Total	8.9	26.0	68.4
Proportion of demand	Thermal	0.58%	1.72%	4.37%
	Electrical	0.11%	0.35%	1.30%
	Total	0.41%	1.22%	3.25%

Figure69: Low and zero carbon generation within Warwick's existing build – base case



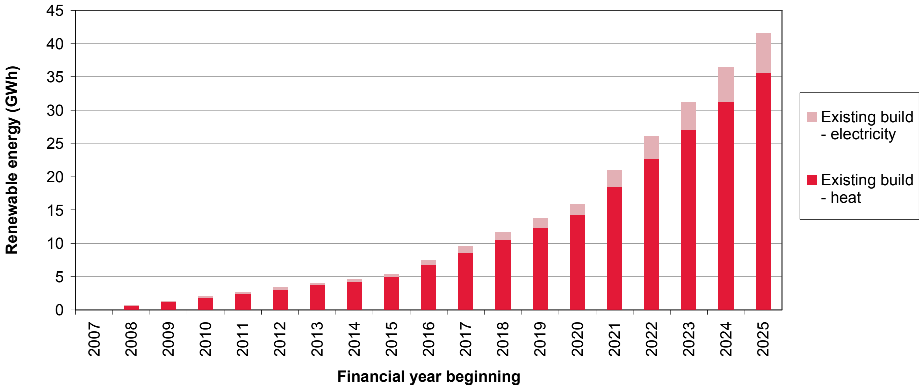
9.4 Elevated Case Potential

9.4.1 North Warwickshire

Table 54 Energy produced by low and zero carbon within North Warwickshire's existing build – elevated case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	4.9	14.2	35.5
	Electrical	0.5	1.6	6.1
	Total	5.4	15.8	41.6
Proportion of demand	Thermal	0.49%	1.46%	3.77%
	Electrical	0.10%	0.31%	1.18%
	Total	0.35%	1.06%	2.85%

Figure70: Low and zero carbon generation within North Warwickshire's existing build – elevated case

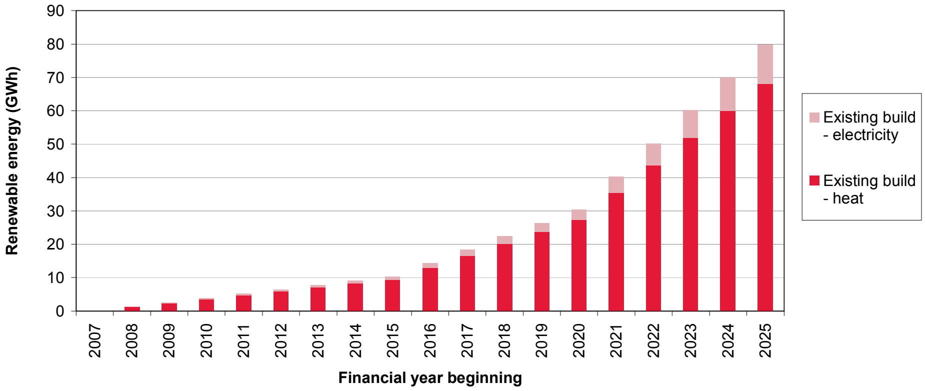


9.4.2 Nuneaton & Bedworth

Table 55 Energy produced by low and zero carbon within Nuneaton & Bedworth's existing build – elevated case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	9.4	27.2	68.2
	Electrical	1.0	3.1	11.7
	Total	10.3	30.4	79.8
Proportion of demand	Thermal	0.80%	2.39%	6.18%
	Electrical	0.20%	0.63%	2.36%
	Total	0.62%	1.86%	5.00%

Figure71: Low and zero carbon generation within Nuneaton & Bedworth's existing build – elevated case

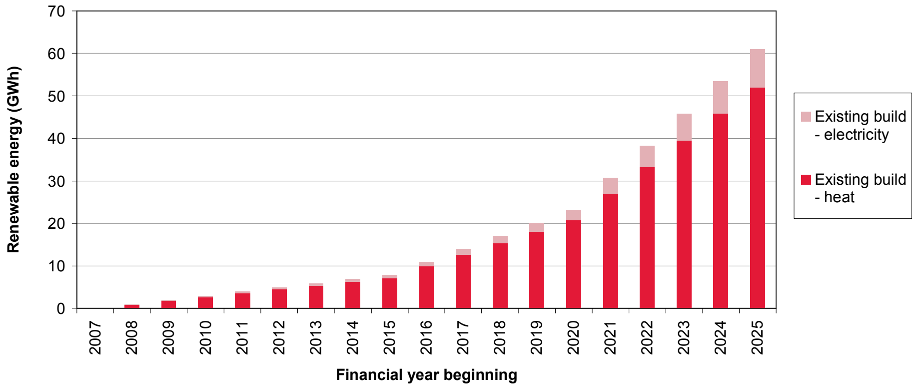


9.4.3 Rugby

Table 56 Energy produced by low and zero carbon within Rugby's existing build – elevated case

Year		**2015/16**	**2020/21**	**2025/26**
Energy generated (GWh)	Thermal	7.1	20.8	52.0
	Electrical	0.7	2.4	8.9
	Total	7.9	23.2	60.9
Proportion of demand	Thermal	0.25%	0.74%	1.87%
	Electrical	0.10%	0.31%	1.14%
	Total	0.22%	0.65%	1.71%

Figure72: Low and zero carbon generation within Rugby's existing build – elevated case

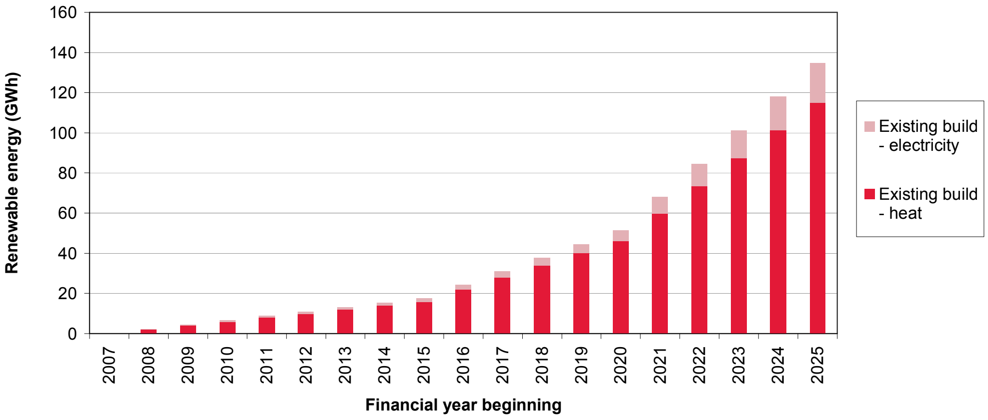


9.4.4 Solihull

Table 57 Energy produced by low and zero carbon within Solihull's existing build – elevated case

Year		**2015/16**	**2020/21**	**2025/26**
Energy generated (GWh)	Thermal	15.8	45.9	114.9
	Electrical	1.6	5.3	19.7
	Total	17.4	51.2	134.6
Proportion of demand	Thermal	0.61%	1.80%	4.60%
	Electrical	0.16%	0.53%	1.95%
	Total	0.48%	1.44%	3.84%

Figure73: Low and zero carbon generation within Solihull's existing build – elevated case

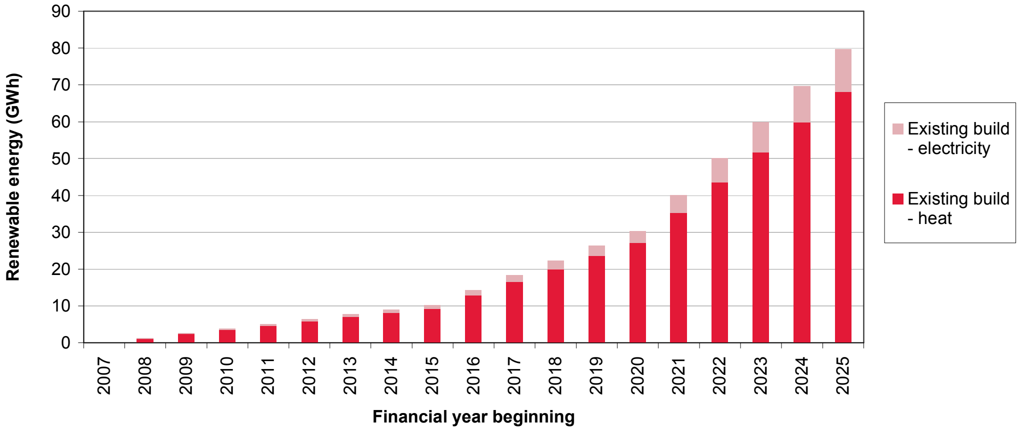


9.4.5 Stratford-On-Avon

Table 58 Energy produced by low and zero carbon within Stratford-On-Avon's existing build – elevated case

Year		**2015/16**	**2020/21**	**2025/26**
Energy generated (GWh)	Thermal	9.3	27.2	68.0
	Electrical	1.0	3.1	11.6
	Total	10.3	30.3	79.7
Proportion of demand	Thermal	0.60%	1.80%	4.62%
	Electrical	0.16%	0.51%	1.90%
	Total	0.48%	1.42%	3.82%

Figure74: Low and zero carbon generation within Stratford-On-Avon's existing build – elevated case

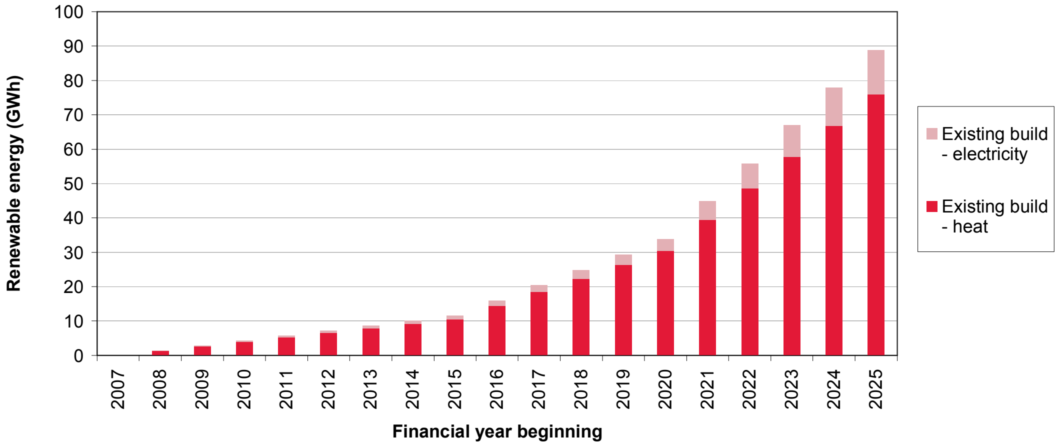


9.4.6 Warwick

Table 59 Energy produced by low and zero carbon within Warwick's existing build – elevated case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	10.4	30.3	75.9
	Electrical	1.1	3.5	13.0
	Total	11.5	33.8	88.9
Proportion of demand	Thermal	0.76%	2.24%	5.68%
	Electrical	0.14%	0.45%	1.69%
	Total	0.54%	1.59%	4.22%

Figure75: Low and zero carbon generation within Warwick's existing build – elevated case



10 Bringing it all together – potential of low and zero carbon energy generation

This section brings together the results the analysis of low and zero carbon generation uptake potential for each of the key opportunity scenarios: existing/installed capacity, new Decentralised Generation (Section 5 to 7), new-build development (Section 8) and within the existing built environment (Section 9). Care has been taken to avoid double counting between the various assessments, for example, a potential equivalent to the biomass assumed to be delivered through new buildings has been removed from the decentralised biomass resource assessment. Some double counting is likely, e.g. between the decentralised biomass estimate and the biomass element of the existing built environment uptake, but this is anticipated to be small.

10.1 Base Case

Table 60 summarises the base case results across all Authorities and all technologies. The results are benchmarked against regional targets for 2021. This date has been chosen as it approximately coincides with the national 2020 target for renewable energy so further comparison can reasonably be drawn.

Table 60 Base Case forecast of total renewable energy generation

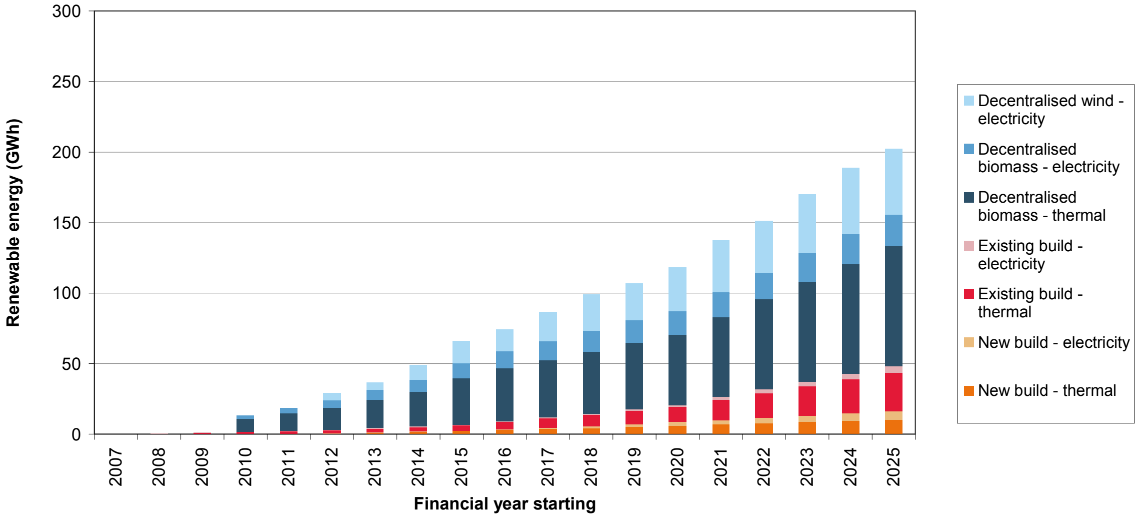
	Low and zero carbon generation for 2021 (GWh)							2021 consumption	2021 Low and zero carbon generation contribution (%)
	North Warks.	N& B	Rugby	Solihull	Stratford-on-Avon	Warwick	Study Area		
Thermal	67	47	83	87	223	87	593	10,339	5.73%
Electrical	52	32	121	31	448	102	786	4,184	18.78%
Total	119	78	204	118	672	188	1,379	14,523	9.49%
% RE potential by authority (2021)	7.9%	4.8%	5.7%	3.3%	31.6%	8.9%	9.5%		

10.1.1 North Warwickshire

Table 61 Energy produced by low and zero carbon solutions within North Warwickshire– base case

Year		**2015/16**	**2020/21**	**2025/26**
Energy generated (GWh)	Thermal	39.3	66.5	122.8
	Electrical	26.6	52.0	79.5
	Total	65.9	118.5	202.3
Proportion of demand	Thermal	3.94%	6.86%	13.02%
	Electrical	5.02%	9.95%	15.45%
	Total	4.32%	7.94%	13.87%
Estimated emissions abated (ktCO_2/yr)	*Thermal*	8.4	14.3	26.4
	Electrical	11.4	22.3	34.2
	Total	19.9	36.6	60.6

Figure76: Low and zero carbon generation within North Warwickshire– base case

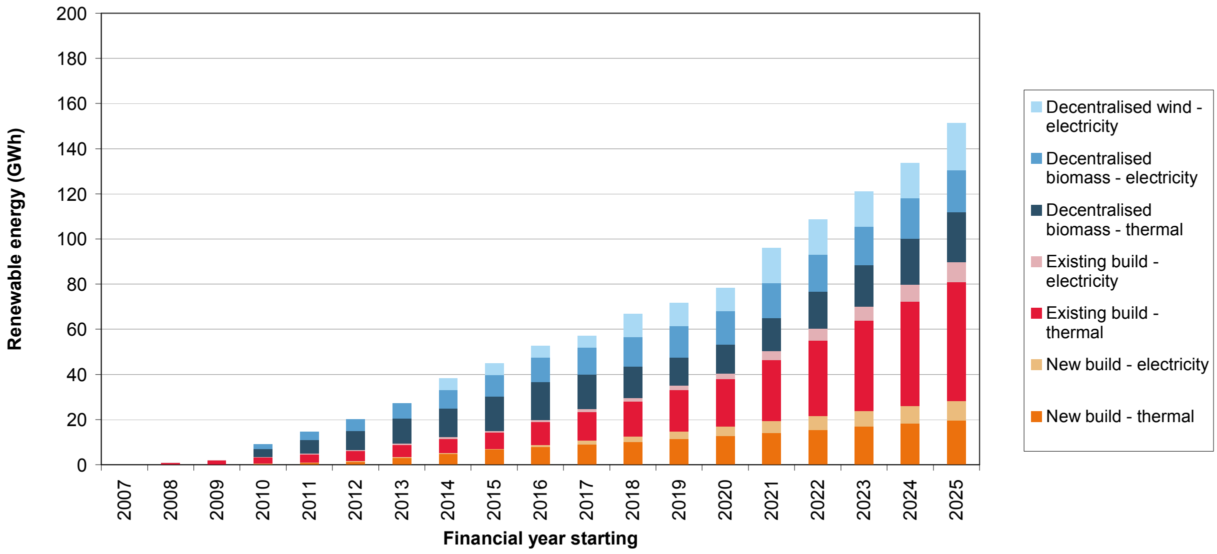


10.1.2 Nuneaton & Bedworth

Table 62 Energy produced by low and zero carbon solutions within Nuneaton & Bedworth– base case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	29.1	46.6	94.2
	Electrical	16.0	31.7	57.3
	Total	45.1	78.4	151.4
Proportion of demand	Thermal	2.48%	4.10%	8.54%
	Electrical	3.20%	6.38%	11.59%
	Total	2.70%	4.79%	9.48%
Estimated emissions abated ($ktCO_2/yr$)	Thermal	6.3	10.0	20.3
	Electrical	6.9	13.6	24.6
	Total	13.1	23.7	44.9

Figure77 Low and zero carbon generation within Nuneaton & Bedworth– base case

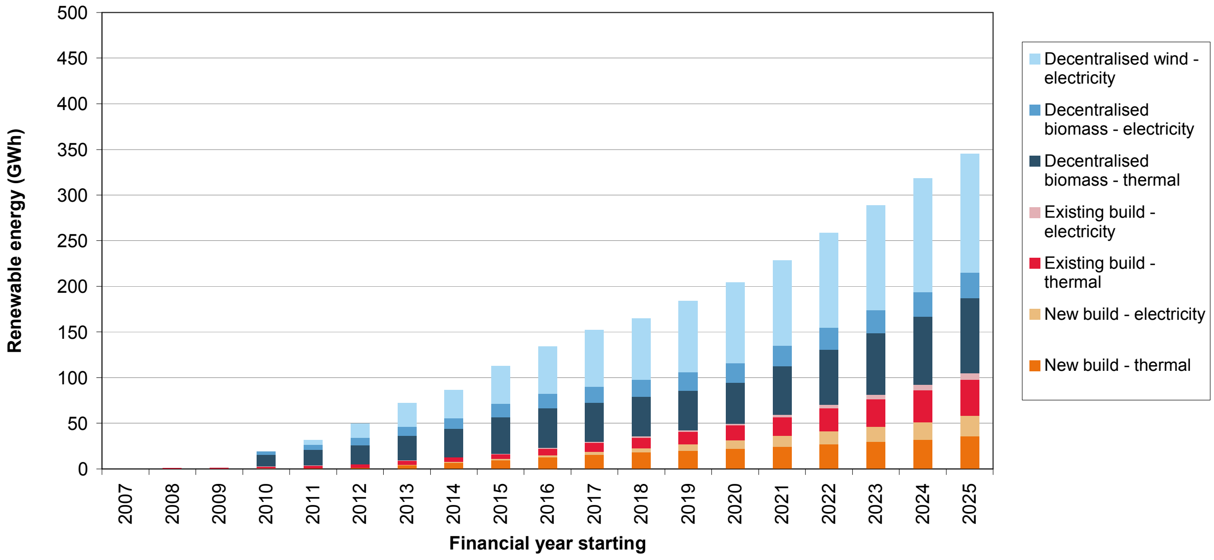


10.1.3 Rugby

Table 63 Energy produced by low and zero carbon solutions within Rugby– base case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	56.2	83.4	157.8
	Electrical	108.3	121.1	187.3
	Total	164.5	204.4	345.1
Proportion of demand	Thermal	1.99%	2.96%	5.68%
	Electrical	14.38%	15.69%	23.99%
	Total	4.59%	5.70%	9.70%
Estimated emissions abated (ktCO$_2$/yr)	Thermal	12.1	17.9	33.9
	Electrical	46.5	52.1	80.5
	Total	58.6	70.0	114.5

Figure78 Low and zero carbon generation within Rugby– base case

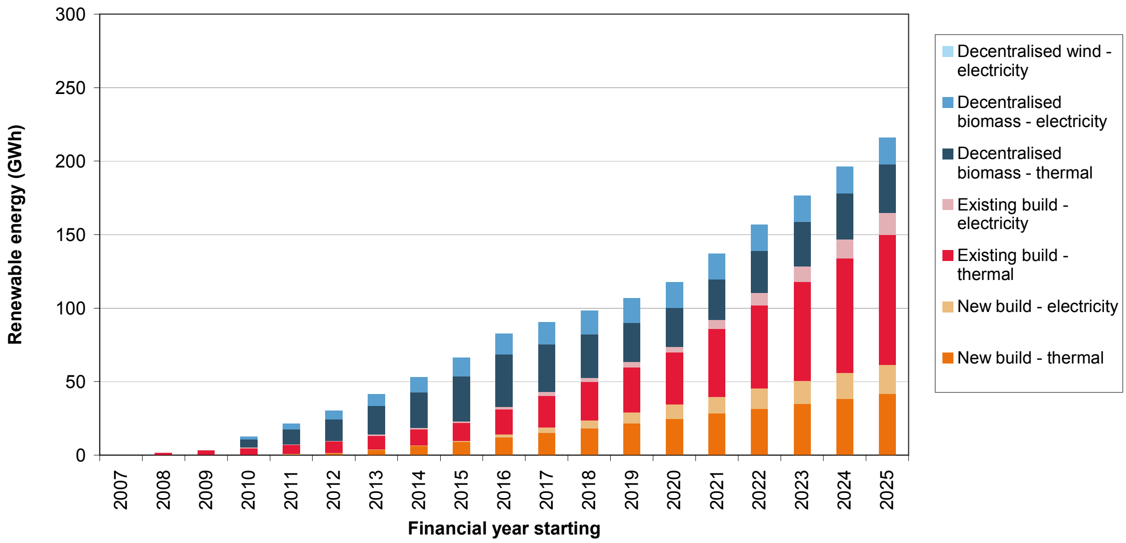


10.1.4 Solihull

Table 64 Energy produced by low and zero carbon solutions within Solihull– base case

Year		**2015/16**	**2020/21**	**2025/26**
Energy generated (GWh)	Thermal	51.8	86.6	162.6
	Electrical	14.4	30.9	53.3
	Total	66.2	117.5	215.9
Proportion of demand	Thermal	1.99%	3.39%	6.51%
	Electrical	1.43%	3.07%	5.30%
	Total	1.84%	3.30%	6.16%
Estimated emissions abated ($ktCO_2/yr$)	Thermal	11.1	18.6	35.0
	Electrical	6.2	13.3	22.9
	Total	17.3	31.9	57.9

Figure79: Low and zero carbon generation within Solihull– base case

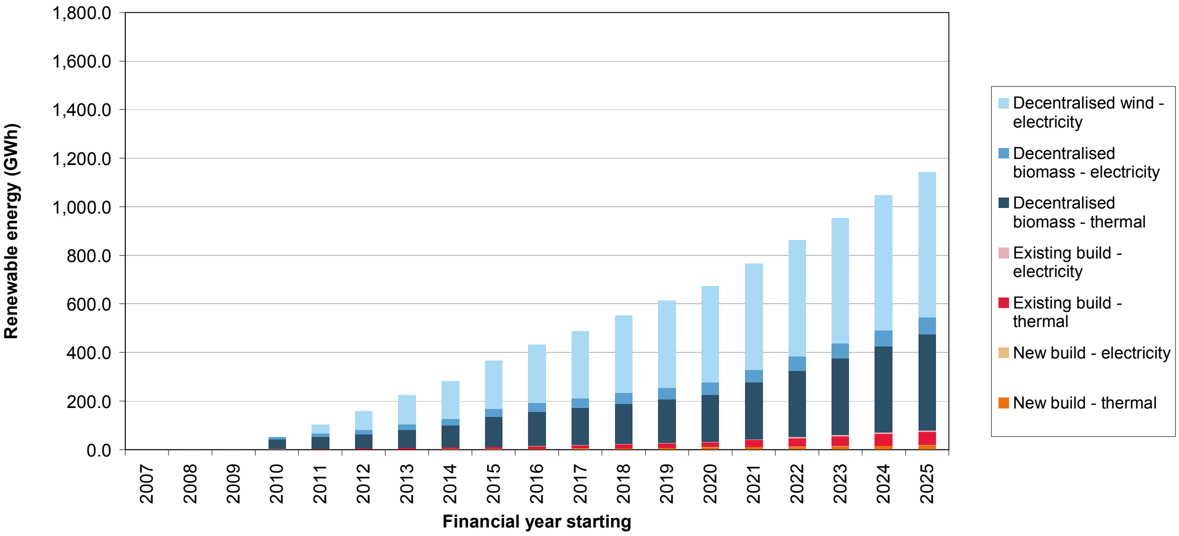


10.1.5 Stratford-On-Avon

Table 65 Energy produced by low and zero carbon solutions within Stratford-On-Avon– base case

Year		**2015/16**	**2020/21**	**2025/26**
Energy generated (GWh)	Thermal	133.7	223.3	462.7
	Electrical	232.4	448.2	680.1
	Total	366.1	671.5	1,142.8
Proportion of demand	Thermal	8.62%	14.79%	31.46%
	Electrical	37.59%	72.73%	110.67%
	Total	16.88%	31.58%	54.80%
Estimated emissions abated (ktCO$_2$/yr)	Thermal	28.8	48.0	99.5
	Electrical	99.9	192.7	292.4
	Total	128.7	240.7	392.0

Figure80: Low and zero carbon generation within Stratford-On-Avon– base case

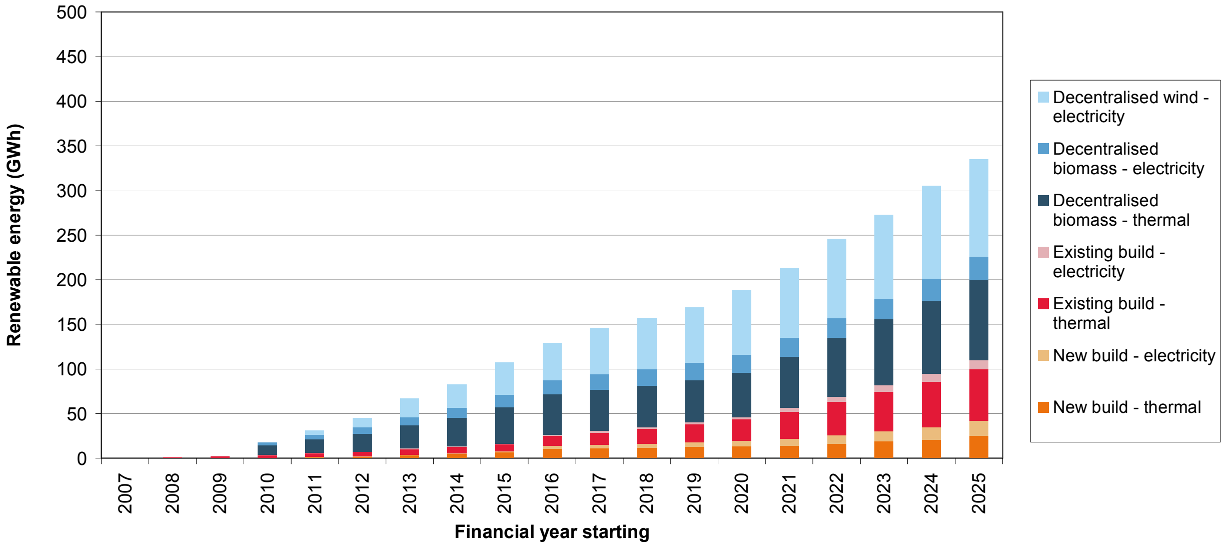


10.1.6 Warwick

Table 66 Energy produced by low and zero carbon solutions within Warwick– base case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	55.4	86.5	173.8
	Electrical	52.2	101.9	161.2
	Total	107.5	188.4	335.0
Proportion of demand	Thermal	4.01%	6.38%	13.01%
	Electrical	6.77%	13.25%	20.93%
	Total	5.00%	8.86%	15.91%
Estimated emissions abated ($ktCO_2/yr$)	Thermal	11.9	18.6	37.4
	Electrical	22.4	43.8	69.3
	Total	34.3	62.4	106.7

Figure81: Low and zero carbon generation within Warwick– base case



10.2 Elevated Case

Table 67 summarises the elevated case results across all Authorities and all technologies. Again, the results are benchmarked against regional targets for 2021.

Table 67 Elevated Case forecast of total renewable energy generation

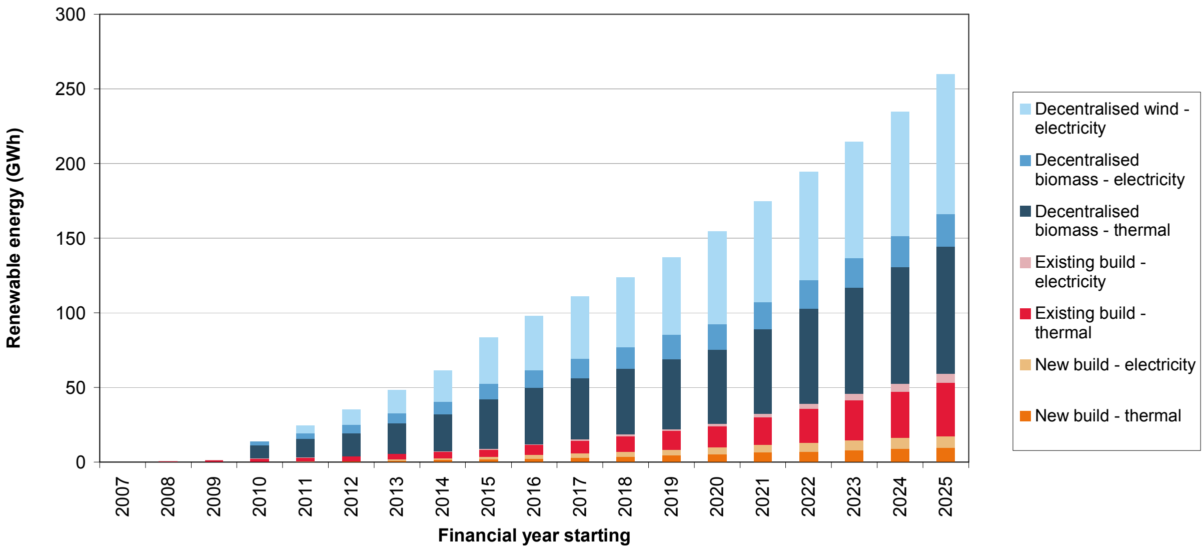
	Renewable Energy Generation for 2021 (GWh)							2021 consumption	2021 renewable energy contribution (%)
	North Warks.	N& B	Rugby	Solihull	Stratford-on -Avon	Warwick	Study Area		
Thermal	69	51	86	97	231	92	627	10,339	6.06%
Electrical	86	53	212	40	795	169	1,355	4,184	32.38%
Total	155	104	298	137	1,026	262	1,981	14,523	13.64%
% RE potential by authority (2021)	10.37%	6.36%	8.32%	3.85%	48.24%	12.31%	13.64%		

10.2.1 North Warwickshire

Table 68 Energy produced by renewable energy system in North Warwickshire– elevated case

Year		**2015/16**	**2020/21**	**2025/26**
Energy generated (GWh)	Thermal	39.9	69.1	130.3
	Electrical	43.8	85.5	129.7
	Total	83.7	154.6	260.0
Proportion of demand	Thermal	4.00%	7.13%	13.81%
	Electrical	8.27%	16.37%	25.19%
	Total	5.49%	10.37%	17.83%
Estimated emissions abated (ktCO$_2$/yr)	Thermal	8.6	14.9	28.0
	Electrical	18.8	36.7	55.8
	Total	27.4	51.6	83.8

Figure82: Low and zero carbon generation within North Warwickshire– elevated case

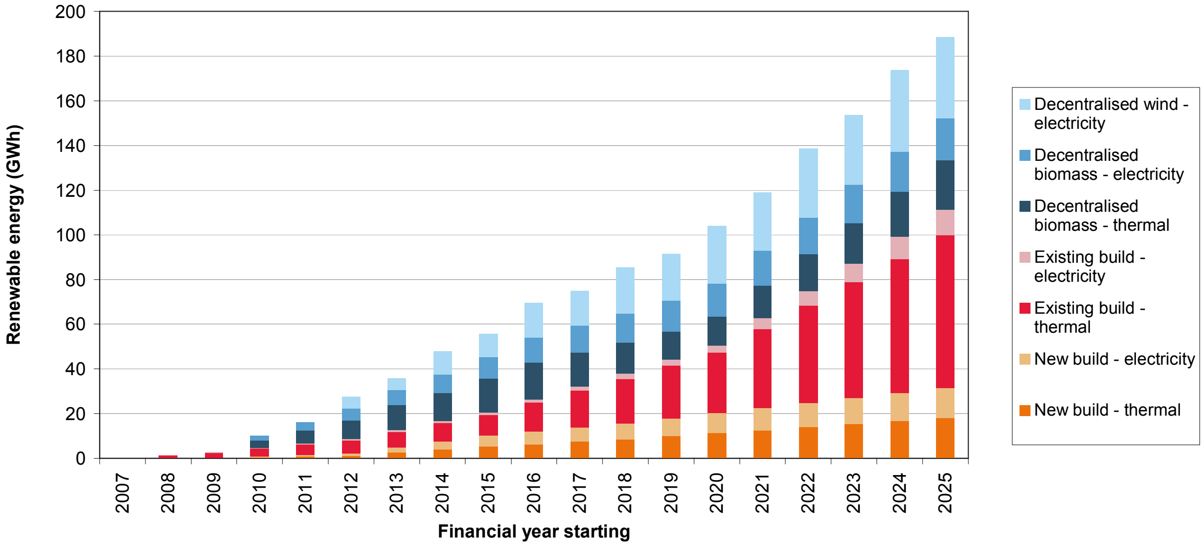


10.2.2 Nuneaton & Bedworth

Table 69 Energy produced by renewable energy system in Nuneaton & Bedworth– elevated case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	29.7	51.4	108.3
	Electrical	26.1	52.7	80.2
	Total	55.8	104.1	188.6
Proportion of demand	Thermal	2.53%	4.51%	9.83%
	Electrical	5.22%	10.60%	16.23%
	Total	3.34%	6.36%	11.81%
Estimated emissions abated (ktCO_2/yr)	Thermal	6.4	11.0	23.3
	Electrical	11.2	22.7	34.5
	Total	17.6	33.7	57.8

Figure83: Low and zero carbon generation within Nuneaton & Bedworth– elevated case

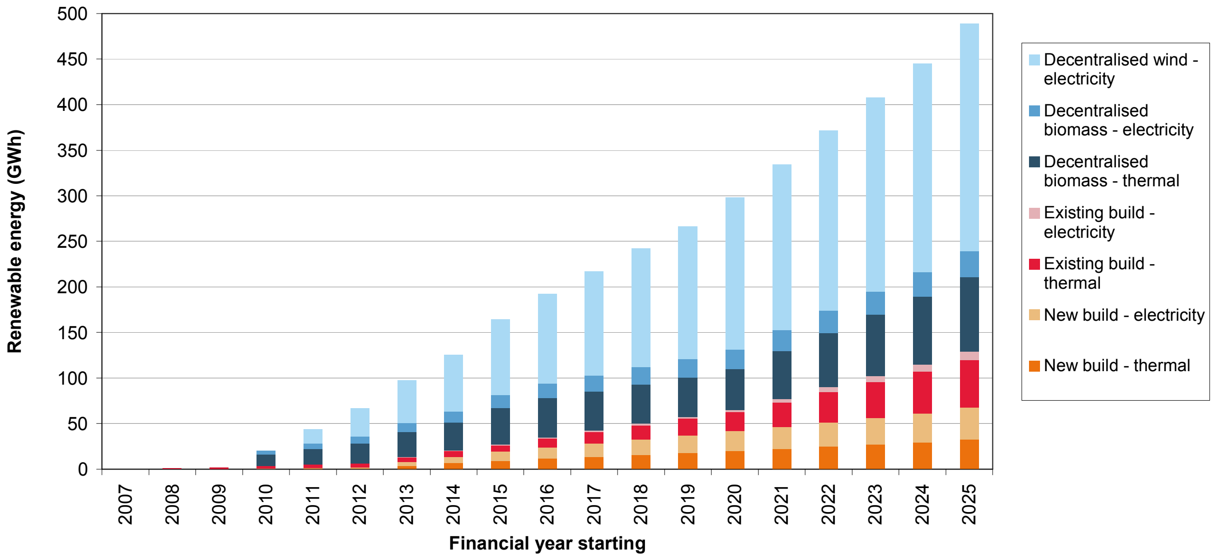


10.2.3 Rugby

Table 70 Energy produced by renewable energy system in Rugby– elevated case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	56.2	86.0	166.9
	Electrical	108.3	212.1	321.8
	Total	164.5	298.1	488.7
Proportion of demand	Thermal	1.99%	3.06%	6.01%
	Electrical	14.38%	27.48%	41.21%
	Total	4.59%	8.32%	13.73%
Estimated emissions abated ($ktCO_2$/yr)	Thermal	12.1	18.5	35.9
	Electrical	46.5	91.2	138.4
	Total	58.6	109.7	174.3

Figure84 Low and zero carbon generation within Rugby– elevated case

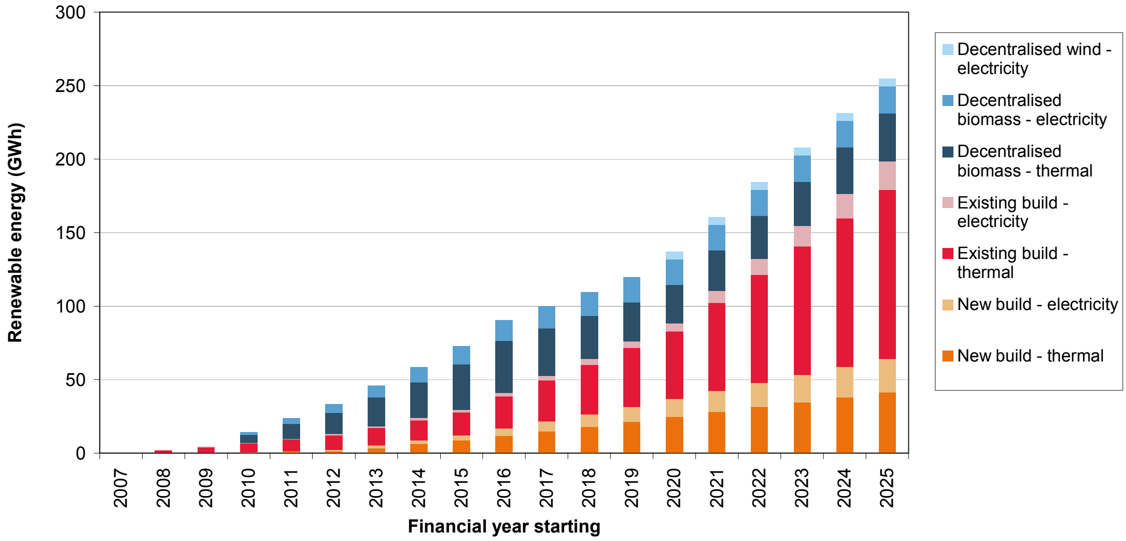


10.2.4 Solihull

Table 71 Energy produced by renewable energy system in Solihull– elevated case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	55.1	96.9	188.8
	Electrical	17.6	40.2	65.9
	Total	72.7	137.1	254.8
Proportion of demand	Thermal	2.12%	3.79%	7.56%
	Electrical	1.76%	3.99%	6.55%
	Total	2.02%	3.85%	7.27%
Estimated emissions abated (ktCO$_2$/yr)	Thermal	11.9	20.8	40.6
	Electrical	7.6	17.3	28.3
	Total	19.4	38.1	69.0

Figure85: Low and zero carbon generation within Solihull– elevated case

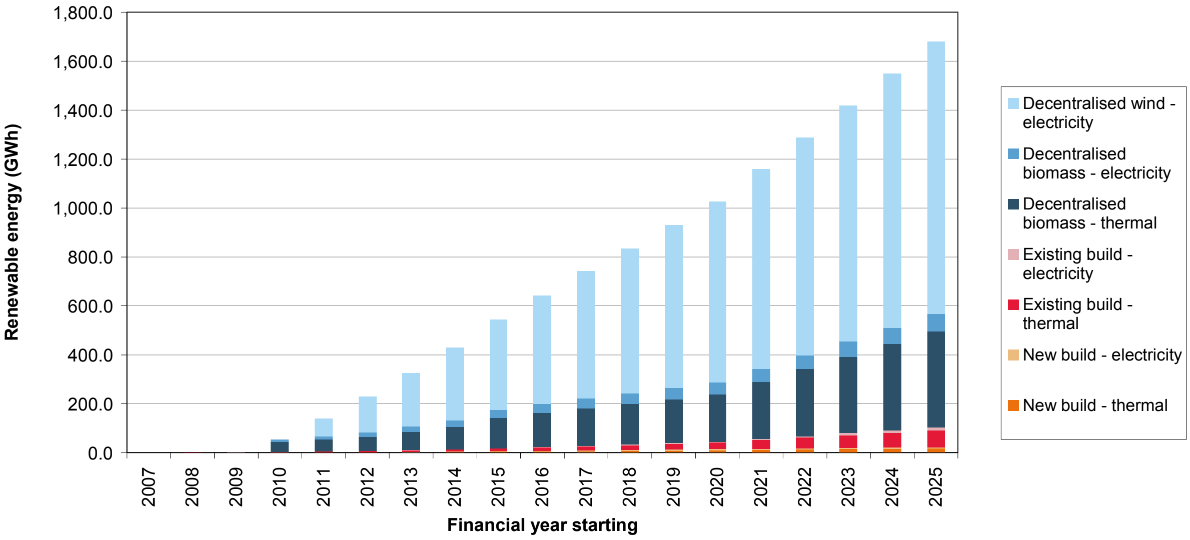


10.2.5 Stratford-On-Avon

Table 72 Energy produced by renewable energy system in Stratford-On-Avon– elevated case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	138.0	230.8	478.2
	Electrical	406.8	795.1	1,201.1
	Total	544.8	1,025.8	1,679.3
Proportion of demand	Thermal	8.90%	15.28%	32.51%
	Electrical	65.81%	129.02%	195.46%
	Total	25.12%	48.24%	80.52%
Estimated emissions abated (ktCO$_2$/yr)	Thermal	29.7	49.6	102.9
	Electrical	174.9	341.9	516.5
	Total	204.6	391.5	619.3

Figure86 Low and zero carbon generation within Stratford-On-Avon– elevated case

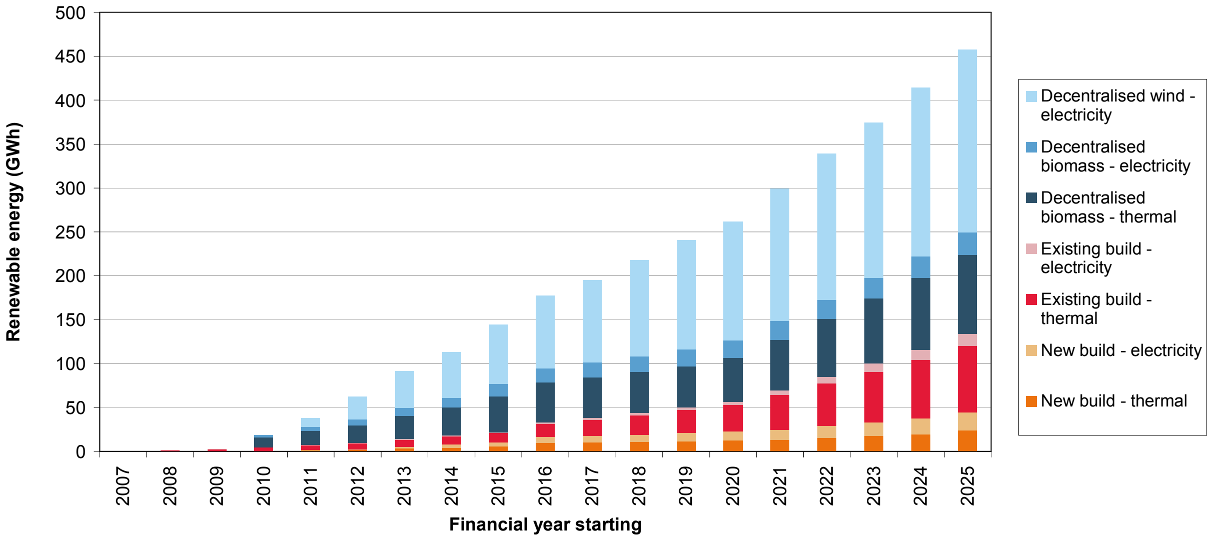


10.2.6 Warwick

Table 73 Energy produced by renewable energy system in Warwick– elevated case

Year		2015/16	2020/21	2025/26
Energy generated (GWh)	Thermal	56.7	92.4	190.3
	Electrical	87.7	169.1	267.1
	Total	144.4	261.6	457.4
Proportion of demand	Thermal	4.11%	6.81%	14.24%
	Electrical	11.38%	21.99%	34.68%
	Total	6.71%	12.31%	21.71%
Estimated emissions abated ($ktCO_2$/yr)	Thermal	12.2	19.9	40.9
	Electrical	37.7	72.7	114.8
	Total	49.9	92.6	155.8

Figure87: Low and zero carbon generation within – elevated case



10.3 Comparison of Base Case and Elevated Case

Table 74 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 33% increase in renewable energy compared with the base case.

The benchmarking of these results against national and regional targets is discussed in the following section.

Table 74 Comparison of Base Case and Elevated Case potential – study area totals

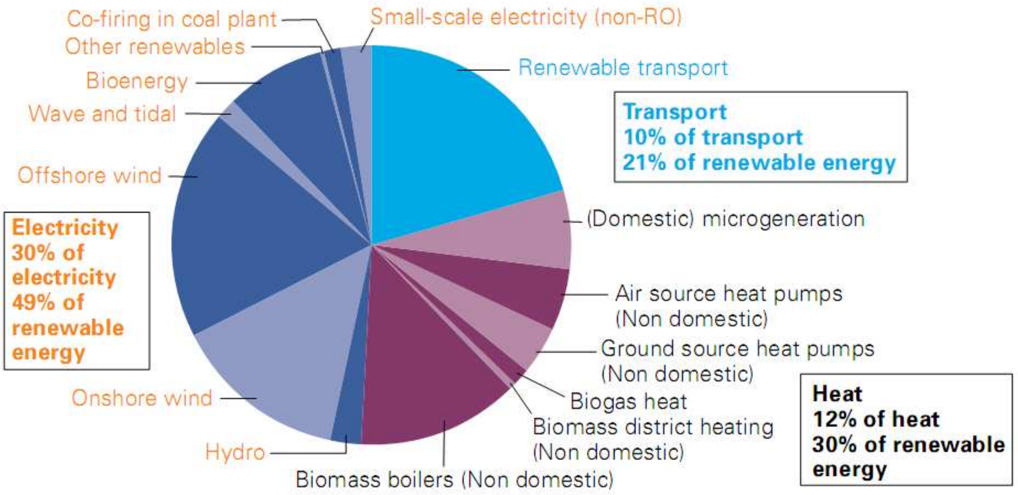
Comparison of base case and elevated case potential – study area totals 2021						
	GWh Renewable Energy	% renewable heat	% renewable electricity	% renewable heat and electricity	kTonnes CO_2 reduction	% CO2 reduction on 2007 baseline
Base Case	1,379	5.7%	18.8%	9.5%	465	6.0%
Elevated Case	1,981	6.1%	32.4%	13.6%	717	9.2%

11 Renewable energy capacity benchmarking and local authority targets

The UK has established a national target to supply 15% of total energy demand through renewable sources by 2021. This target is applicable to electricity, heat and transport energy sources. The ‘lead scenario’ for delivering this national target is illustrated in Figure 88.

Figure 88 Lead Scenario for meeting 2020 UK renewable energy target

Illustrative mix of technologies in lead scenario, 2020 (TWh)



Source: DECC analysis based on Redpoint/Trilemma (2009), Element/Pöyry (2009) and Nera (2009) and DfT internal analysis

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 **75** 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.

Table 75 Identifying which components of the lead scenario can be influenced at a local level

Component of the anticipated 2020 energy mix (UK)		Locally influenced	Non 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 76 goes on to summarise the analysis results, with aggregated energy supply by district and at the study area level. Figure 89 shows the aggregated energy supply potential graphically against the 'localised national target' and clearly demonstrates the variations between Authorities.

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 when 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.

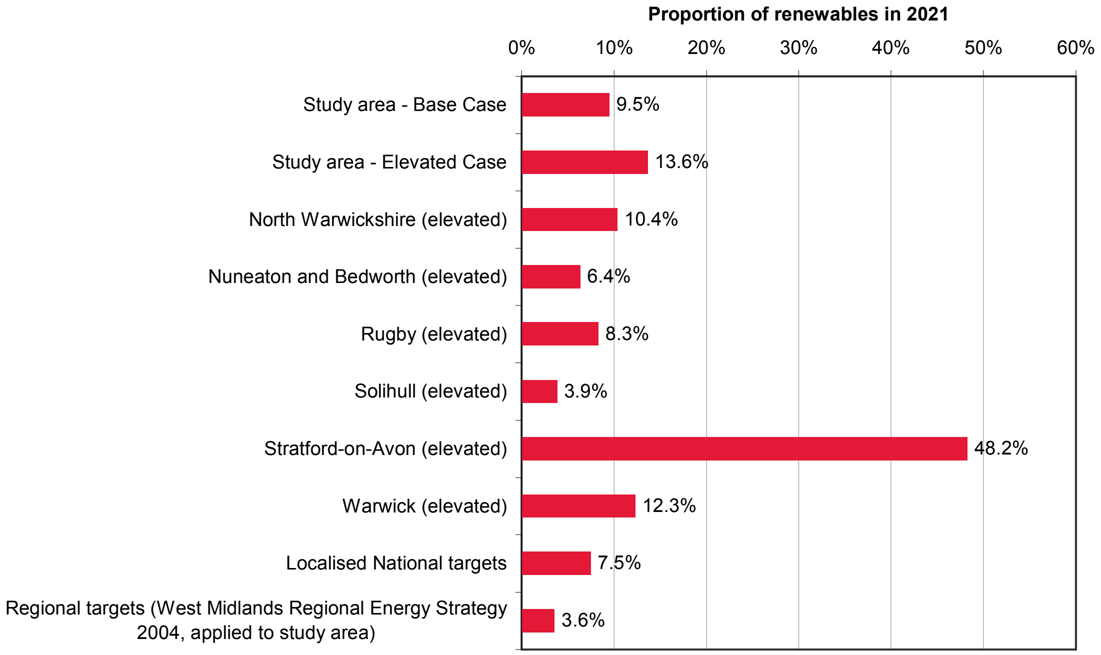
The ‘localised national targets’ are shown as a range since the government’s lead scenario is open to interpretation as to which components can be influenced at a regional/local level. If non-locally influenced energy sources (as set out in

Table **75**) are ignored, then a local target of 7.5% renewable energy can be derived. As a high scenario, if all ‘non-local’ sources are included, aside from transport and offshore wind, then the local target could instead be derived as 10% of the energy demand in 2020/21. Hence, a range of 7.5 – 10% has been referenced in the table below.

Table 76 Comparison of local potential with national and regional targets

Comparison of local potential (2021) with national and regional targets				
	LZC generation (GWh)	**% LZC heat**	**% LZC electricity**	**% LZC energy (heat + power)**
Study Area				
Base Case	1,379	5.7%	18.8%	9.5%
Elevated Case	1,981	6.1%	32.4%	13.6%
Individual Authorities				
North Warwickshire (Base - Elevated)	119 - 155	6.9 - 7.1%	10.0 - 16.4%	7.9 - 10.4%
Nuneaton & Bedworth (Base - Elevated)	78 - 104	4.1 - 4.5%	6.4 - 10.6%	4.8 - 6.4%
Rugby (Base - Elevated)	204 - 298	3.0 - 3.1%	15.7 - 27.5%	5.7 - 8.3%
Solihull (Base - Elevated)	118 - 137	3.4 - 3.8%	3.1 - 4.0%	3.3 - 3.9%
Stratford-on-Avon (Base - Elevated)	672 - 1026	14.8 - 15.3%	72.7 - 129.0%	31.6 - 48.2%
Warwick (Base - Elevated)	188 - 262	6.4 - 6.8%	13.3 - 22.0%	8.9 - 12.3%
National / Regional target benchmarks				
‘Localised’ National targets (excluding offshore wind and other not locally influenced technologies)	-	12%	20%	7.5 - 10%
Regional targets (West Midlands Regional Energy Strategy 2004, applied to study area)	522	1%	10%	4%

Figure 89 Comparison of local, study area, regional and national potential



11.1 Authority-wide renewable / low carbon generation targets

The Panel Report[50] to the Regional Spatial Strategy, suggests that Local Authorities should seek to support the reduction of the 30% regional 'carbon gap' through policies that will support greater development and use of low carbon energy sources.

The benchmarking exercise above showed that North Warwickshire and Warwick could just exceed the 'localised national' target of 7.5%-10%. It is therefore recommend that they establish targets around the 'base case' scenarios and give due consideration to exceeding this to support overall achievement across the study area. Such targets should apply to decentralised generation, retrofit into existing buildings and new development and they should be supported by effective annual monitoring. It is not recommended that targets be split out by technologies.

The analysis results for Stratford-On-Avon show a very significant estimated resource potential at between 672 – 1, 026 GWh/yr (or 31.6 - 48.2% of estimated 2021 energy demand). It is not advisable that the authority adopts either the base or elevated case scenarios since much of the potential relates to wind energy development and development is likely to be significantly constrained because of the cumulative impact of wind energy on the landscape. It is proposed that further work be conducted around landscape constraints across the Authority, paying particular attention the sizeable area of the AONB designated land

For the other Authorities it is recommended that they establish targets around the elevated case estimates, which still fail to achieve the minimum range of the 'localised national' target.

In making these recommendations existing renewable / low carbon generation, as identified in section 3, have not been considered because this existing generation largely (circa 90%)

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

consists of landfill gas generation. Landfill Gas generation is time-limited by the nature of the fall-off of methane gas production from existing landfill sites and the on-going trend to divert organic waste from landfill sites.

12 Recommendations for Local Development Framework Policies

12.1 New development

For new build development, it is proposed that the Authorities establish the minimum and maximum targets presented in section 8, whilst recognising the uncertainty around non-domestic targets in lieu of the conclusion of the current national consultation. Planning policies should require evidence from developers as to how they intend to meet targets, identifying how they could achieve maximum targets where lower costs 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 intended 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 addition income through ESCO and/or capitalisation of renewable energy tariffs

Recommendation 1: Require developers to achieve carbon reduction targets for new development as set out in the carbon targets framework and to specifically consider the viability (technical and otherwise) of community heating, biomass heating, CHP and utilising surplus heat.

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 Homes and Communities Economic Viability model that will examine factors such as land value, sale value, construction costs and other S106 contributions

Proposed carbon reduction targets for new 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% (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 development including sub 10 developments to ensure consistency with Code for Sustainable Homes

$^{\chi}$ where lower costs 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.

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, capitalization of the renewable energy tariffs and 'allowable solutions'.

Recommendation 3: Conduct site energy studies on all major developments indentified through the land allocation process within each authority. This should specifically be conducted to examine the technical and financial viability to achieve the carbon standards set out in the targets framework.

Such site energy studies should be designed to inform current or future developers / land owners as to what was achievable, whilst also providing a good practice learning resource for developers and the planning officers.

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

In the absence of fixed "buy out" price set at a minimum of £100/tonne CO_2 and a 30 years project life in line with current thinking in the industry[51]. 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 S106 contributions (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 13. In addition, where infrastructure needs for low carbon energy supply, particularly district heating infrastructure, are known this should be included in future local infrastructure plans.

Recommendation 4: 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.

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 the 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 the supporting measures.

Recommendation 5: Conduct high resolution heat mapping and feasibility analysis (including market assessment) of district heating and CHP around locations identified to as having potential, i.e. where major development and/or surplus heat occur alongside existing high energy consumption intensity

Recommendation 6: Include infrastructure requirements for the low carbon energy technologies, particularly for district heating, where they are known within local infrastructure plans.

12.2 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

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

opportunities, there are a number of further recommendations explicitly aimed at the existing built environment.

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

Recommendation 7: 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, particular with the introduction on the Renewable Heat Incentive in 2011.

Recommendation 8: Provide specific planning protocols for those small-scale technologies not classed as Permitted Development.

12.3 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 further recommended that a landscape impact study is conducted within Rugby and Stratford-On-Avon to critical appraisal landscape development constraints.

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

Recommendation 10: Provide maps showing indicative areas of potential for wind energy development

Recommendation 11: Conduct a review of the landscape impact from wind energy in the Area of Outstanding Beauty designation within Stratford-On-Avon

Recommendation 12: Conduct a cumulative landscape impact study for wind energy to inform a review of the wind energy capacity within Rugby and Stratford-On-Avon.

12.4 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 would 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. We also recommend that this is monitored on an annual basis (see section below for further detail).

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 in comparison to national and regional benchmarks

Recommendation 14: Establish a monitoring mechanism and conduct detailed annual monitoring of Low and Zero Carbon (LZC) energy uptake in each authority. LZC not subject to local planning approval (Permitted Development, +50MW schemes approved by Infrastructure Planning Commission or were installed in existing buildings) will need a different approach from that which passes through the planning system.

12.5 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 firm up and extend the requirements placed upon the authority to report in the future.

12.5.1 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, which 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 they require formal consent, e.g. planning and power connection, and they are therefore highly traceable. There are likely to only be a small number in any given year and so good information should easily be collated on an annual basis.

Monitoring of uptake in the existing built environment is the most difficult area. To give the slightly fuller definition, by the existing built environment, we mean the development of low or zero carbon energy generation projects in or around existing buildings and associated land, and not associated with new development on that land. So it covers a solar thermal panel on a house, a wind turbine in 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.

12.5.2 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 this. Clearly the authority needs to be prepared to ‘call-in’ poor performance and to take appropriate action to ensure the local development market understands that these standards are a key feature of building compliance. In addition, 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 will help to inform future changes to compliance and assessment and future evolution of planning policy, e.g. through Supplementary Planning Guidance. The requirement to provide on-going monitoring could also be coupled with a financial bond requirement, which would be returned if the development achieves the long term performance standards proposed.

Recommendation 15: Establish expert low carbon planning assessments services, either on an individual Authority basis, or more cost effectively through shared working across a number of authorities, e.g. CSWAPO. 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. The development of the CSWAPO low carbon development toolkit should help to used to support the technical assessment of carbon standards.

Recommendation 16: 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 17: Require suitable on-site carbon monitoring to be installed in major new development to enable assessment of long-term (carbon) performance compliance.

Recommendation 18: In supporting Recommendation 17, conduct a study to establish a financial penalty scheme based upon a financial bond returnable on achievement of long term (carbon) performance compliance

Table 77 and Table 78 summarise key elements of good performance for monitoring and compliance against the proposed carbon targets.

Table 77 Key features of effective enforcement

Enforcement		
New-build	***Existing build (and associated land)***	***Decentralised generation***
• 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)	• 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	

Table 78 Key features of effective monitoring

<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 recommend that an annual external survey is conducted, asking local active stakeholders to provide information on existing or planned systems. This in particular should seek to gain insight on the areas for which is it hard to gain information with any degree of confidence, e.g. thermal installations in existing build applications and installations on new developments where insufficient data has been provided by the developer or reported by Development Control. As this will be a survey (of a sample) the results will need to be statistically interpreted to provide results for the entire authority. In 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>
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13 Non-Planning Delivery Mechanisms

13.1 Introduction

Planning policy is 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 aneorobic 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 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 (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 with 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.

13.2 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:

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

13.3 Financing low carbon infrastructure

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

Key actions to support investment shortages:

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

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

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

13.3.2 Special purpose vehicles / ESCOs

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

The term ‘Energy Services Company’ or ESCO is applied to many different types of initiatives and delivery vehicles that seek to implement energy efficiency measures or local energy generation projects. ESCOs are established in order to take forward projects that the general energy market place is failing to deliver – and in this way ESCOs are designed to overcome the market and policy failures that affect local sustainable energy projects. There are a number of commercial ESCOs in existence which can support developers in designing, installing and operating a communal energy system for a new development. These ESCOs may either operate the energy system entirely themselves or enter into an arrangement with the developer and other entities in order to establish a new ESCO specifically designed to operate the energy infrastructure of the new development. These development-specific ESCOs 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 go down the path of establishing an ESCO if the energy project they wish to pursue is of no interest to an existing ESCO or if certain market risks cannot be reduced through other actions by the public sector, such as guaranteeing revenue streams for the heat or electricity generated by a renewable energy installation. Establishing an ESCO is not a simple short term task and 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.

13.4 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

Appendix I: 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
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
BERR	UK Department for Business, Enterprise & Regulatory Reform, superseded in June 2009 by the Department of Business, Innovation and Skills
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
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 is 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.
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

GLOSSARY	
	greenhouse gases. These are Carbon dioxide (CO_2), Methane (CH_4), Nitrous oxide (N_2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), Sulphur hexafluoride (SF_6).
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 (tip height typically greater than 100 m). Where appropriate, the default size of large scale wind turbines in 2.5 MW with a tip height of approximately 125 m.
LDF	Local Development Framework
LZC	Low and Zero Carbon
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 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.
ODT	Oven Dried Ton; an amount of wood that weighs 2,000 pounds at zero percent moisture content[1][1]; common conversion unit for solid biomass fuel

GLOSSARY	
PPS	Planning Policy Statement
SHLAA	Strategic Housing Land Allocation 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 (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

Appendix II: Notes of Consultation Workshop

Warwickshire workshop 14th January 2010

Attendees

Zahir Lazcano	*Camco*
Ian Andrews	*Camco*
Robert Clark	*Camco*
Luke Purse	*Camco*
Roger Hey	Central Networks
Graham Paling	Central Networks
Matthew Rhodes	Encraft
David Fovargue	Entec
Michael O'Connell	Entec
Mark Hammond	Friends of the Earth
Ewan Calcott	Forestry
Alex Hales	Frampton
Darren Henry	Nuneaton and Bedworth Borough Council
Steph Chettle	Nuneaton and Bedworth Borough Council
Allison Crofts	Natural England
Chris Nash	North Warks Borough Council
Sue Wilson	North Warks Borough Council
Tim Margerison	Rugby Borough Council
Nick Freer	Rugby Borough Council
Stephen Games	Rugby Borough Council
Jamie Tallon	Rugby Borough Council
Sarah Fisher	Rugby Borough Council
Stephen Marks	Rugby Borough Council
Nick Ellison	Stratford upon Avon District Council
Paul Chapman	Stratford upon Avon District Council
Colin Staves	Stratford upon Avon District Council
David Biss	Solihull Metropolitan Council
David Wigfield	Solihull Metropolitan Council
Martin Fletcher	Solihull Metropolitan Council
Paul Slade	Waterloo
Jonathan Horsfield	Warwickshire County Council
Jacky Williams	Warwickshire County Council
Claire Parlett	Warwick District Council
Neil Gilliver	Warkwickshire Rural Housing Association
Colin Morrison	WSP
David Bolus	WSP
Katie Elmer	WSP
Bruce Hayball	Hasker Architects
Jonathan Rigall	Peter Brett
Andrew Hawkes	Gallaghers

Notes.

The following notes were recorded for the consultation event held at Benn Hall, Rugby, on the 14th January 2010. The principal purpose of the workshop was to review the draft recommendations that had been developed. 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:

10.00 Introduction to workshop

10.05 Overview of study

11.00 Discussion sessions x 3

A. Carbon standards for new development

B. Opportunities and constraints for renewable energy generation

C. Non-planning measures & financing

14:15 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 raise other queries following the study overview and during the plenary session.

A range of issues were raised during the workshop and through additional information being sent to the steering group and consultant team (from Hasker Architects). The notes below collate the issues raised.

A. Carbon standards for new development

In general most attendees were supportive of accelerated carbon targets for new development and could see, with additional financial support, e.g. RHI & FiT that these could be achieved. However, opposing views were also expressed. The key issues raised were as follows:

- A number of attendees raised the issue of viability. Those representing development interests suggested that accelerated standards would be difficult for the market to achieve although no specific evidence was provided. Others felt that accelerated timescales, particularly with respect to larger schemes (which inherently have longer timescales) were reasonable since scheme phasing would require higher standards in any case. It was felt this should be further reviewed with the steering group. Themes explored under this issues included:
    - The need to balance carbon standards with other key housing objectives, e.g. affordable housing, educations, transport. Some stated that the market priorities are not CO2.
    - The scale of study area developments were not, in themselves likely to initiate market forces to bring down costs of developments
    - There was a division of opinion around whether to aim towards higher targets (accepting potential failures of achieving this , but content with an acceptable fall-back
    - UK zero carbon roadmap was already seen as challenging by some
    - Some stated that elevated CO2 standard should only be for specific developments
    - Land supply could dry up if land price absorb increasing costs of CO2 abatement
    - Defending policy is problematic/costly - better to encourage and provide incentives
        - Local Authority District Heating networks
        - Tax
        - Partnerships are key

        - Planning delivery grant if above target
        - Public land - can tender with requirements (e.g. EP) - Private land – much less opportunity to influence process / standards
- There should be a strong onus on the developer to prove targets could be achieved.

- Need for co-ordinated expertise across the study area to ensure good consistent delivery

- Local Authorities need to be attuned to the changing style of housing where higher carbon standards are required, e.g. modern materials, more 3-storey housing, sustainable technology Eco-ghetto house types changing within large developments

- It was important to support achievement of higher carbon standards that low carbon development issues trump other planning restrictions (e.g. E-W or N-S)

- A number of attendees suggested that developers would prefer clear targets applied to all (or most) development

B. Opportunities and constraints for renewable energy generation

These discussion groups involved detailed review of the analysis completed and the assumptions therein. There was a strong focus in these sessions on wind energy and biomass as the principal sources of low carbon generation identified. Along with discussions around the analysis a number of key issues where discussed:

- Wind energy:
    - The inclusion of MOD / civil aviation constraints for wind energy
    - Consultation of the land owners regarding future energy generation, e.g. wind, development could help to refine available land
    - Will the publishing of wind potential maps have adverse impacts (e.g. land price)
    - Assess the potential impacts of land allocation for wind development, in a similar fashion to that in which land is allocated for housing, mineral extraction… To reduce potential tensions and opposition from neighbouring land owners and property owners, they could be offered to participate in the development.
    - Low distance from housing to wind development from 600m to 400 m – Steering group suggest this is not changed from 600m
    - LA capability to carry out Landscape Assessments? Do they have the knowledge and training to do this?
    - Need to consider the proximity of grid to wind sites
    - Some doubt was expressed by representatives of Stratford Council over land availability due to previous discussion held with developers.

- Biomass:
    - Should potential resources from woodlands be better included in the analysis
    - The development of the market, particularly around biomass would be the key constraint to uptake
    - Opportunity for wood fuel, activate supply chain (AW brought into manage etc)
    - Encourage processing local timber within the region, diversify farms
    - Flagging up opportunities for potential development with communities (i.e. CHP)
    - Encouraging local funds for local communities

- Other:
    - Phasing of certain developments might affect viability of CHP/District Heating.
    - Educational/awareness campaign required to meet ambitious targets, since support at community level is essential. LA should explore the possibility of developing a community pilot project.

C. Non-planning measures & financing

A wide ranging discussion was held around this area particularly around a Carbon Investment Fund measure, the establishment of ESCO services, requiring annual carbon monitoring on specific development (and linking with a financial bond) and also Development Control to support low carbon delivery. There was good general support for a CIF mechanism but less so for an ESCO. Key issues raised were as follows:

- Carbon Investment Fund
    - A Carbon Investment Fund could be set up with the following advantages:
        - Support locally relevant carbon reduction initiatives (not just renewables)
        - Present 'least cost' solutions for carbon reduction, rather than 'on-site' renewables
    - The concern was raised that a CIF could be inequitable to new development but this was not widely shared
    - Concerns over additionality where raised, i.e. the scheme would need to be developed so as to avoid the funding of the developments that would have happened anyway
    - Contrary to the UK Roadmap the suggestion was made to devolve some of the on-site 70% "compliance" carbon reduction through to the CIF mechanism, i.e. if it is the least cost way then why not do it more through this mechanism?
    - Can community/social schemes be developed from the CIF investment
    - Accountability - will carbon saving/£ be efficient, i.e. how will developers be certain that the public sector will deliver efficiently (compared with what they may deliver)
    - Is Advantage West Midlands developing some kind of CIF facility?
    - Strategic finance initiatives could be considered, e.g. with support from Forum for the Future. Jonathan Horsfield (WCC) may have money to support this

- ESCO
    - Districts and other larger Authorities are quite different - e.g. North Warwickshire has very little housing development planned and the therefore may have little need for the ESCO services
    - Few were sure where ESCO services might support low carbon delivery

- Require performance annual monitoring (with financial bond)
    - Most considered that there needs to be more focus on monitoring
    - This was considered to be a reasonable proposition, but overwhelmingly the groups felt it would be difficult to establish such a scheme. Concerns raised included:
        - Difficult to judge bond value (needs to be significant but not present burden)
        - Seen as "messy" e.g. passing through compliance to new owners (from developer)
        - Breach of planning conditions was an alternative – but recognised that this power is rarely used
        - Mutually enforceable covenants is a further alternative

- Development Control – the discussion moved from non-planning measures towards improving practice in DC, the key issues being identified as follows:
    - Toolkit will help for DC control/scheme planning
    - Relationships between Planning Policy and DC need to be far better at a basic level to manage introduction of workable policy.

- Concerns that DC are simply not able to deliver existing standards let alone significantly shifted standards requiring, for example, time-intensive site visits.
- DC process needs to be delivered consistently, requiring training for staff to take on board these issues
- Communications between Building Control (monitoring delivery) and Planning
- Shared working would be encouraged (to share costs and stretch expertise to where it is needed.
- Shared Services should be considered
- Training is essential

ENDS.

Appendix III: CO_2 emissions for the study area

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

Dataset name	Full Local CO_2 emission estimates, sector and fuel details
Year	2007
Release date	17/09/2009
Units	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	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)**
	North Warwickshire	2007	221	70	-	23	7	0	-	-	16	12	4	0	0	71	70	5	3	0	2	43	64	142	383	39	35	2	1	22	- 19	1,217	62.2	19.6	149	2.39
	Nuneaton and Bedworth	2007	145	41	-	13	4	9	-	0	19	4	1	-	0	125	144	1	3	1	3	30	24	12	39	68	48	1	0	6	- 5	735	121.2	6.1	273	2.25
	Rugby	2007	277	82	-	21	567	0	43	716	19	6	7	0	0	108	114	3	3	1	2	64	86	62	197	51	43	2	2	28	- 18	2,483	91.0	27.3	228	2.50
	Solihull	2007	309	149	-	27	1	-	1	0	41	8	2	0	0	227	265	6	3	1	5	58	50	75	183	144	97	3	1	18	- 11	1,664	203.6	8.2	501	2.46
	Stratford-on-Avon	2007	183	41	-	42	11	1	0	-	24	11	19	0	0	161	107	22	10	1	3	89	107	81	191	69	68	2	6	88	- 58	1,279	117.8	10.9	300	2.55
	Warwick	2007	264	55	-	19	0	1	0	0	30	13	4	0	0	150	154	6	5	1	3	87	88	65	151	63	50	2	1	28	- 21	1,221	134.6	9.1	315	2.34
West Midlands Total		2007	8,886	3,516	339	984	972	276	89	1,174	1,115	246	300	1	3	5,585	6,122	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**
North Warwickshire	2007	292	183	735	5	2	**1,217**
Nuneaton and Bedworth	2007	269	216	244	1	4	**735**
Rugby	2007	385	840	528	12	719	**2,483**
Solihull	2007	536	455	659	7	7	**1,664**
Stratford-on-Avon	2007	344	253	642	36	4	**1,280**
Warwick	2007	414	245	550	9	4	**1,221**

Key

🟦	Electricity emissions source
🟥	Thermal emissions source*
■	Transport emissions source
□	Other emissions source

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

Appendix IV: 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
North Warwickshire	167	142	106	140	140	150	150	170	170	160	160	155	155	150	150	150	150	145	145	145	**3,000**
Nuneaton and Bedworth	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540	**10,800**
Rugby	494	1,429	701	469	230	488	582	523	618	760	770	770	770	770	550	550	450	450	450	450	**12,274**
Solihull	784	606	579	731	402	526	733	549	690	690	690	690	690	690	690	690	690	690	690	690	**13,190**
Stratford-upon-Avon	455	394	265	264	264	264	264	264	264	264	264	264	264	264	264	264	264	264	264	264	**5,602**
Warwick	465	580	410	269	235	743	712	710	640	590	570	570	570	570	570	547	547	547	547	547	**10,939**

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
North Warwickshire	0	0	0	0	7,556	7,556	7,556	7,556	7,556	7,556	7,556	7,556	7,556	10,000	10,000	10,000	10,000	10,000	10,000	10,000	**138,000**
Nuneaton and Bedworth	0	0	0	0	8,360	8,360	8,360	19,660	19,660	19,660	7,393	7,393	7,393	7,393	7,393	7,393	7,393	7,393	7,393	7,393	**157,994**
Rugby	0	0	0	87,500	87,500	87,500	133,724	49,590	82,924	79,557	76,190	42,857	42,857	42,857	42,857	42,857	42,857	42,857	42,857	42,857	**1,070,200**
Solihull	15,870	15,870	15,870	15,870	41,853	41,853	41,853	41,853	41,853	41,853	41,853	41,853	41,853	25,447	25,447	25,447	25,447	25,447	25,447	25,447	**618,287**
Stratford-upon-Avon	30,667	30,667	30,667	24,800	24,800	24,800	24,800	24,800	24,800	24,800	24,800	24,800	24,800	25,714	25,714	25,714	25,714	25,714	25,714	25,714	**520,000**
Warwick	34,576	43,127	30,486	20,002	17,474	55,247	52,942	52,793	47,588	43,870	42,383	42,383	42,383	42,383	42,383	40,673	40,673	40,673	40,673	40,673	**813,384**

Appendix V: Energy projections

North Warwickshire

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)	437	432	427	422	418	413	408	403	399	394	389	384	380	375	370	365	361	356	351	346
Existing residential - electrical (GWh)	132	131	130	129	128	127	126	125	124	123	122	121	120	119	118	117	116	115	114	113
Existing non-residential - thermal (GWh)	606	602	600	597	595	592	590	587	585	582	580	577	575	572	570	567	565	562	560	557
Existing non-residential - electrical (GWh)	411	410	408	406	405	403	401	399	398	396	394	393	391	389	387	386	384	382	381	379
New build residential - thermal (GWh)	0.9	1.6	2.5	3.4	4.4	5.4	6.5	7.6	8.6	9.7	10.7	11.7	12.6	13.6	14.6	15.6	16.5	17.4	18.4	18.4
New build residential - electricity (GWh)	0.6	1.0	1.5	2.1	2.7	3.3	3.9	4.6	5.2	5.8	6.5	7.1	7.7	8.2	8.8	9.4	10.0	10.6	11.1	11.1
New build non-residential - thermal (GWh)	0.0	0.0	0.0	0.0	0.8	1.7	2.5	3.4	4.2	5.1	5.9	6.8	7.6	8.7	9.9	11.0	12.1	13.2	14.3	15.5
New build non-residential - electricity (GWh)	0.0	0.0	0.0	0.0	0.5	1.1	1.6	2.1	2.6	3.2	3.7	4.2	4.8	5.5	6.2	6.9	7.6	8.3	9.0	9.7
Thermal energy (GWh/yr)	1,043	1,036	1,029	1,023	1,018	1,012	1,007	1,002	996	991	985	980	975	969	964	959	954	949	943	937
Electrical energy (GWh/yr)	544	542	540	538	536	534	533	531	530	528	527	525	523	522	521	519	518	516	515	513
Total (GWh/yr)	1,588	1,578	1,569	1,561	1,554	1,547	1,540	1,533	1,526	1,519	1,512	1,505	1,498	1,491	1,485	1,478	1,472	1,465	1,458	1,450

Nuneaton & Bedworth

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)	848	838	829	820	811	801	792	783	774	765	755	746	737	728	719	709	700	691	682	673
Existing residential - electrical (GWh)	232	231	229	227	225	224	222	220	218	217	215	213	211	210	208	206	204	203	201	199
Existing non-residential - thermal (GWh)	379	377	375	374	372	371	369	368	366	364	363	361	360	358	356	355	353	352	350	349
Existing non-residential - electrical (GWh)	270	268	267	266	265	264	263	262	261	259	258	257	256	255	254	253	252	250	249	248
New build residential - thermal (GWh)	2.8	5.6	8.4	11.3	14.1	16.9	19.7	22.5	25.3	28.2	31.0	33.8	36.6	39.4	42.2	45.0	47.9	50.7	53.5	53.5
New build residential - electricity (GWh)	1.8	3.5	5.3	7.1	8.9	10.6	12.4	14.2	16.0	17.7	19.5	21.3	23.1	24.8	26.6	28.4	30.1	31.9	33.7	33.7
New build non-residential - thermal (GWh)	0.0	0.0	0.0	0.0	0.9	1.9	2.8	5.0	7.2	9.4	10.2	11.1	11.9	12.7	13.6	14.4	15.2	16.0	16.9	17.7
New build non-residential - electricity (GWh)	0.0	0.0	0.0	0.0	0.6	1.2	1.8	3.1	4.5	5.9	6.4	6.9	7.4	8.0	8.5	9.0	9.5	10.0	10.5	11.1
Thermal energy (GWh/yr)	1,230	1,221	1,213	1,205	1,198	1,191	1,184	1,178	1,172	1,167	1,159	1,152	1,145	1,138	1,131	1,124	1,117	1,109	1,102	1,092
Electrical energy (GWh/yr)	504	503	501	500	500	499	499	499	499	500	499	498	498	497	497	496	496	495	494	492
Total (GWh/yr)	1,733	1,723	1,714	1,705	1,698	1,690	1,683	1,677	1,672	1,666	1,658	1,651	1,643	1,635	1,628	1,620	1,612	1,604	1,597	1,584

Rugby

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)	685	679	674	668	662	656	651	645	639	633	628	622	616	610	605	599	593	587	582	576
Existing residential - electrical (GWh)	201	200	199	198	197	196	195	194	193	192	191	190	189	188	187	186	185	184	183	182
Existing non-residential - thermal (GWh)	2,167	2,154	2,145	2,136	2,127	2,118	2,109	2,100	2,091	2,082	2,073	2,064	2,055	2,046	2,037	2,028	2,019	2,010	2,001	1,992
Existing non-residential - electrical (GWh)	516	514	512	510	508	505	503	501	499	497	495	493	490	488	486	484	482	480	478	475
New build residential - thermal (GWh)	9.8	14.6	17.9	19.5	22.8	26.8	30.4	34.7	39.9	45.2	50.5	55.8	61.1	64.9	68.6	71.7	74.8	77.9	81.0	81.0
New build residential - electricity (GWh)	5.9	8.7	10.7	11.6	13.6	16.0	18.1	20.7	23.8	27.0	30.1	33.3	36.4	38.7	41.0	42.8	44.7	46.5	48.3	48.3
New build non-residential - thermal (GWh)	0.0	0.0	0.0	9.8	19.6	29.4	44.4	49.9	59.2	68.1	76.7	81.5	86.3	91.1	95.9	100.7	105.5	110.3	115.1	119.9
New build non-residential - electricity (GWh)	0.0	0.0	0.0	6.1	12.3	18.4	27.7	31.2	37.0	42.6	47.9	50.9	53.9	56.9	59.9	62.9	65.9	68.9	71.9	74.9
Thermal energy (GWh/yr)	2,862	2,848	2,837	2,833	2,832	2,831	2,834	2,829	2,829	2,829	2,828	2,823	2,818	2,812	2,806	2,799	2,792	2,785	2,778	2,768
Electrical energy (GWh/yr)	723	722	721	725	730	736	744	747	753	758	764	767	770	772	774	776	777	779	781	781
Total (GWh/yr)	3,585	3,571	3,558	3,558	3,562	3,566	3,578	3,576	3,582	3,587	3,591	3,590	3,588	3,584	3,580	3,575	3,570	3,564	3,559	3,549

Solihull

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)	1,583	1,570	1,556	1,543	1,530	1,517	1,503	1,490	1,477	1,463	1,450	1,437	1,423	1,410	1,397	1,384	1,370	1,357	1,344	1,330
Existing residential - electrical (GWh)	424	422	419	417	415	413	411	409	407	405	403	401	399	397	395	393	391	389	386	384
Existing non-residential - thermal (GWh)	1,098	1,091	1,087	1,082	1,078	1,073	1,068	1,064	1,059	1,055	1,050	1,046	1,041	1,036	1,032	1,027	1,023	1,018	1,014	1,009
Existing non-residential - electrical (GWh)	576	573	571	568	566	564	561	559	556	554	552	549	547	544	542	540	537	535	532	530
New build residential - thermal (GWh)	3.7	7.2	11.7	14.1	17.3	21.8	25.1	29.3	33.5	37.7	41.9	46.1	50.3	54.5	58.7	62.9	67.1	71.3	75.5	75.5
New build residential - electricity (GWh)	2.3	4.4	7.2	8.7	10.6	13.4	15.4	18.0	20.6	23.2	25.7	28.3	30.9	33.5	36.0	38.6	41.2	43.8	46.4	46.4
New build non-residential - thermal (GWh)	1.8	3.6	5.3	7.1	11.8	16.5	21.2	25.9	30.5	35.2	39.9	44.6	49.3	52.1	55.0	57.8	60.7	63.5	66.4	69.2
New build non-residential - electricity (GWh)	1.1	2.2	3.3	4.4	7.4	10.3	13.2	16.2	19.1	22.0	25.0	27.9	30.8	32.6	34.4	36.2	37.9	39.7	41.5	43.3
Thermal energy (GWh/yr)	2,686	2,672	2,660	2,646	2,636	2,628	2,618	2,609	2,600	2,591	2,582	2,573	2,564	2,553	2,542	2,532	2,521	2,510	2,499	2,484
Electrical energy (GWh/yr)	1,003	1,001	1,001	999	999	1,001	1,001	1,002	1,003	1,004	1,005	1,006	1,007	1,007	1,007	1,007	1,007	1,007	1,007	1,004
Total (GWh/yr)	3,689	3,673	3,661	3,645	3,636	3,628	3,619	3,611	3,603	3,595	3,587	3,579	3,571	3,561	3,550	3,539	3,528	3,517	3,506	3,488

Stratford-on-Avon

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	941	931	921	910	900	890	879	869	859	848	838	828	817	807	797	786	776	766	755
Existing residential - electrical (GWh)	255	253	252	250	248	246	244	242	240	238	236	234	232	230	228	227	225	223	221	219
Existing non-residential - thermal (GWh)	655	651	649	646	643	640	638	635	632	629	627	624	621	619	616	613	610	608	605	602
Existing non-residential - electrical (GWh)	361	360	358	357	355	354	352	351	349	348	346	345	343	342	340	339	337	336	334	333
New build residential - thermal (GWh)	3.5	5.8	8.1	10.4	12.7	15.0	17.4	19.7	22.0	24.3	26.6	28.9	31.3	33.6	35.9	38.2	40.5	42.8	45.2	45.2
New build residential - electricity (GWh)	1.9	3.2	4.5	5.8	7.1	8.3	9.6	10.9	12.2	13.5	14.8	16.0	17.3	18.6	19.9	21.2	22.5	23.8	25.0	25.0
New build non-residential - thermal (GWh)	3.4	6.9	10.3	13.1	15.9	18.6	21.4	24.2	27.0	29.7	32.5	35.3	38.1	41.0	43.8	46.7	49.6	52.5	55.4	58.2
New build non-residential - electricity (GWh)	2.1	4.3	6.4	8.2	9.9	11.6	13.4	15.1	16.9	18.6	20.3	22.1	23.8	25.6	27.4	29.2	31.0	32.8	34.6	36.4
Thermal energy (GWh/yr)	1,614	1,605	1,598	1,590	1,582	1,574	1,566	1,558	1,550	1,542	1,534	1,526	1,518	1,510	1,503	1,495	1,487	1,479	1,471	1,461
Electrical energy (GWh/yr)	621	621	621	620	620	619	619	619	618	618	617	617	617	616	616	616	615	615	615	613
Total (GWh/yr)	2,234	2,226	2,219	2,210	2,202	2,194	2,185	2,177	2,168	2,160	2,152	2,143	2,135	2,127	2,118	2,110	2,102	2,094	2,086	2,074

Warwick

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)	933	926	918	910	902	894	886	879	871	863	855	847	839	832	824	816	808	800	792	785
Existing residential - electrical (GWh)	280	279	277	276	275	273	272	271	269	268	267	265	264	262	261	260	258	257	256	254
Existing non-residential - thermal (GWh)	484	481	479	477	475	473	471	469	467	465	463	461	459	457	455	453	451	449	447	445
Existing non-residential - electrical (GWh)	492	489	487	485	483	481	479	477	475	473	471	469	467	465	463	461	459	457	455	453
New build residential - thermal (GWh)	3.6	6.1	7.8	9.2	13.8	18.2	22.6	26.6	30.2	33.8	37.3	40.8	44.3	47.9	51.2	54.6	58.0	61.4	64.8	64.8
New build residential - electricity (GWh)	2.2	3.7	4.8	5.7	8.5	11.2	13.8	16.3	18.5	20.7	22.8	25.0	27.1	29.3	31.4	33.4	35.5	37.6	39.6	39.6
New build non-residential - thermal (GWh)	0.9	1.9	2.8	4.3	5.7	7.2	8.6	10.1	11.5	13.0	14.5	15.9	17.4	19.9	22.3	24.8	27.3	29.8	32.3	34.7
New build non-residential - electricity (GWh)	0.6	1.2	1.8	2.7	3.6	4.5	5.4	6.3	7.2	8.1	9.0	9.9	10.9	12.4	14.0	15.5	17.1	18.6	20.2	21.7
Thermal energy (GWh/yr)	1,422	1,415	1,408	1,401	1,397	1,393	1,389	1,384	1,380	1,375	1,370	1,365	1,360	1,356	1,352	1,348	1,344	1,340	1,336	1,329
Electrical energy (GWh/yr)	774	773	771	770	770	770	770	770	770	770	769	769	769	769	769	769	770	770	770	768
Total (GWh/yr)	2,196	2,188	2,179	2,170	2,167	2,163	2,159	2,155	2,150	2,144	2,139	2,134	2,129	2,125	2,121	2,118	2,114	2,110	2,106	2,097

Appendix VI: Existing & planned renewables

Project name	Local Authority	Technology	Electrical Installed capacity (kW)	Thermal Installed capacity (kW)	Planned / installed	Source
Atherstone Wind	North Warwickshire	Small wind	2		Installed	DNO
Atherstone PV	North Warwickshire	Solar PV	82		Installed	DNO
Mancetter Road/Grange Road	North Warwickshire	Biomass heating		5,000	Planned	RESTATS
Packington Generation Plant Phase 3	North Warwickshire	Landfill gas	8,470		Installed	RESTATS
Pooley Country Park	North Warwickshire	Small wind	??		Unknown	Data collection form
Bedworth CHP	Nuneaton and Bedworth	Gas CHP	50		Installed	DNO
Biomass heat plant by Talbotts	Nuneaton and Bedworth	Biomass heating		150	Installed	REA Database
Chilvers Coton	Nuneaton and Bedworth	Solar PV	2		Installed	DNO
Eliot Park Innovation Centre / Paradise Farm	Nuneaton and Bedworth	Solar PV	105		Installed	REA Database
Hartshill Mini CHP	North Warwickshire	Gas CHP	165		Installed	Data collection form
Hartshill CHP	North Warwickshire	Gas CHP	2,900		Installed	RESTATS
Hartshill STW	North Warwickshire	Anaerobic digestion	190		Planned	Data collection form
Judkins Landfill site	Nuneaton and Bedworth	Landfill gas	2,880		Installed	RESTATS

Project name	Local Authority	Technology	Electrical Installed capacity (kW)	Thermal Installed capacity (kW)	Planned / installed	Source
Judkins Landfill Site Phase 3	Nuneaton and Bedworth	Landfill gas	1,150		Planned	RESTATS
Nuneaton CHP	Nuneaton and Bedworth	Gas CHP	90		Installed	DNO
NUNEATON wind	Nuneaton and Bedworth	Small wind	1		Installed	DNO
Ansty	Rugby	Biomass heating		240	Installed	Data collection form
Boughton Road	Rugby	Solar thermal		24	Installed	Data collection form
Boughton Road	Rugby	GSHP			Installed	Data collection form
Cattle Market	Rugby	Solar thermal		20		Data collection form
Coalpit Lane	Rugby	Landfill gas	950		Installed	RESTATS
COTESBACH LANDFILL GAS PROJECT	Rugby	Landfill gas	3,600		Installed	REA Database
Dunsmore	Rugby	Solar PV	2		Installed	DNO
KILSBY LANDFILL SITE	Rugby	Landfill gas	1,000		Installed	Renewables Map
Lawford Heath Landfill Gas	Rugby	Landfill gas	1,000		Installed	Data collection form
Long Lawford PV	Rugby	Solar PV	2		Installed	DNO
New Bold CHP	Rugby	Gas CHP	190		Installed	Data collection

Project name	Local Authority	Technology	Electrical Installed capacity (kW)	Thermal Installed capacity (kW)	Planned / installed	Source
						form
Newton PV	Rugby	Solar PV	3		Installed	DNO
Rugby Cement	Rugby	Energy from Waste	35,000		Planned	RESTATS
Rugby Wind	Rugby	Small wind	5		Installed	DNO
Ryton Pools Country Park	Rugby	Landfill gas	330		Installed	RESTATS
Warwickshire College	Rugby	Small wind	15			Data collection form
Willoughby PV	Rugby	Solar PV	2		Installed	DNO
Barston	Solihull	Energy from Waste	190		Installed	REA Database
Checkley STW	Solihull	Energy from Waste	165		Installed	REA Database
Dutton Solar PV	Solihull	Solar PV	2		Installed	REA Database
Haslucks Green School	Solihull	Solar PV	2		Planned	Data collection form
Kingfisher School	Solihull	Solar thermal		3	Planned	Data collection form
Langly School	Solihull	Small wind	6		Planned	Data collection form
Moat Lane Depot	Solihull	Biomass heating		??	Planned	Data collection form

Project name	Local Authority	Technology	Electrical Installed capacity (kW)	Thermal Installed capacity (kW)	Planned / installed	Source
SCH PVG 15 high rise blocks	Solihull	Solar PV	??		Planned	Data collection form
SCH PVG 7 high rise blocks	Solihull	Solar PV	??		Planned	Data collection form
Talbotts	Solihull	Biomass heating		150	Installed	REA Database
Talbotts	Solihull	Biomass heating		50	Installed	REA Database
Biomass heat plant by Talbotts at CV37 9NF	Stafford	Biomass heating		100	Installed	REA Database
Kinwarton PV	Stafford	Solar PV	8		Installed	DNO
Lighthorne PV	Stafford	Solar PV	2		Installed	DNO
Long Compton wind	Stafford	Small wind	6		Installed	DNO
Mark Williams	Stafford	Small wind	6		Installed	Data collection form
Mrs Anne Marie Harry	Stafford	Solar PV	5		Installed	REA Database
Oxhill Wind	Stafford	Small wind	6		Installed	DNO
Pillerton PV	Stafford	Solar PV	3		Installed	DNO
Snitterfield PV	Stafford	Solar PV	3		Installed	DNO
Southam PV	Stafford	Solar PV	2		Installed	DNO
Southam Wind	Stafford	Small wind	5		Installed	DNO

Project name	Local Authority	Technology	Electrical Installed capacity (kW)	Thermal Installed capacity (kW)	Planned / installed	Source
Southam Wind	Stafford	Small wind	20		Installed	DNO
Stratford PV	Stafford	Solar PV	3		Installed	DNO
Stratford PV	Stafford	Solar PV	5		Installed	DNO
Studley Landfill Gas	Stafford	Landfill gas	664		Planned	RESTATS
Ufton	Stafford	Landfill gas	1,006		Installed	REA Database
6 Thorn Stile Close	Warwick	Solar PV	3		Installed	REA Database
Ashton Court 1	Warwick	Small wind	1		Installed	Data collection form
Ashton Court 2	Warwick	Small wind	1		Installed	Data collection form
Ashton Court 3	Warwick	Small wind	1		Installed	Data collection form
Bishops Tachbrook PV	Warwick	Solar PV	2		Installed	DNO
Blackdown PV	Warwick	Solar PV	3		Installed	DNO
BUDBROOKE wind	Warwick	Small wind	1		Installed	DNO
Eden Court 1	Warwick	Small wind	1		Installed	Data collection form
Eden Court 2	Warwick	Small wind	1		Installed	Data collection form

Project name	Local Authority	Technology	Electrical Installed capacity (kW)	Thermal Installed capacity (kW)	Planned / installed	Source
Eden Court 3	Warwick	Small wind	1		Installed	Data collection form
Finham STW	Warwick	Anaerobic digestion	2,096		Installed	Data collection form
Hill Close Gardens	Warwick	Small wind	1		Installed	Data collection form
HillCrest Solar	Warwick	Solar PV	3		Installed	REA Database
Kenilworth PV 1	Warwick	Solar PV	3		Installed	DNO
Kenilworth PV 2	Warwick	Solar PV	2		Installed	DNO
Kenilworth PV 3	Warwick	Solar PV	2		Installed	DNO
Kenilworth Wind	Warwick	Small wind	1		Installed	DNO
Leamingington Spa PV	Warwick	Solar PV	1		Installed	DNO
Leamington Spa PV	Warwick	Solar PV	3		Installed	DNO
Leamington Spa PV	Warwick	Solar PV	4		Installed	DNO
Leamington Spa Wind	Warwick	Small wind	1		Installed	DNO
Leamington Spa Wind 2	Warwick	Small wind	1		Installed	DNO
Lillington Road	Warwick	Small wind	1		Installed	Data collection form

Project name	Local Authority	Technology	Electrical Installed capacity (kW)	Thermal Installed capacity (kW)	Planned / installed	Source
Lillington Wind	Warwick	Small wind	1		Installed	DNO
LILLINGTON wind 2	Warwick	Small wind	1		Installed	DNO
Mill Lane	Warwick	Small wind	1		Installed	Data collection form
Rowington PV	Warwick	Solar PV	1		Installed	DNO
Rowington PV	Warwick	Solar PV	2		Installed	DNO
Rowington PV	Warwick	Solar PV	3		Installed	DNO
Rowington PV	Warwick	Solar PV	4		Installed	DNO
Southorn Ct 1	Warwick	Small wind	1		Installed	Data collection form
Southorn Ct 2	Warwick	Small wind	1		Installed	Data collection form
Southorn Ct 3	Warwick	Small wind	1		Installed	REA Database
Sussex court PV	Warwick	Solar PV	2		Installed	DNO
Tannery Court	Warwick	Small wind	1		Installed	Data collection form
Warwick PV	Warwick	Solar PV	1		Installed	DNO
Warwick PV	Warwick	Solar PV	1		Installed	DNO

Project name	Local Authority	Technology	Electrical Installed capacity (kW)	Thermal Installed capacity (kW)	Planned / installed	Source
Warwick PV	Warwick	Solar PV	1		Installed	DNO
Warwick PV	Warwick	Solar PV	1		Installed	DNO
Warwick Wind	Warwick	Small wind	1		Installed	DNO
Wasperton PV	Warwick	Solar PV	2		Installed	DNO
Waverley Wood Farm Landfill Site	Warwick	Landfill gas	800		Installed	RESTATS
Waverley Wood II	Warwick	Landfill gas	2,402		Planned	RESTATS
Total			65,649	5,738		

Appendix VII: Large wind

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

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

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

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

Therefore, the air safeguarding zones are only considered 'consultation zones' and were therefore excluded at this stage from the wind energy constraints analysis. Figure91 illustrates these consultations zones which cover the majority of the study area.

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

Figure90: Absolute constraint: Woodland areas in the study area

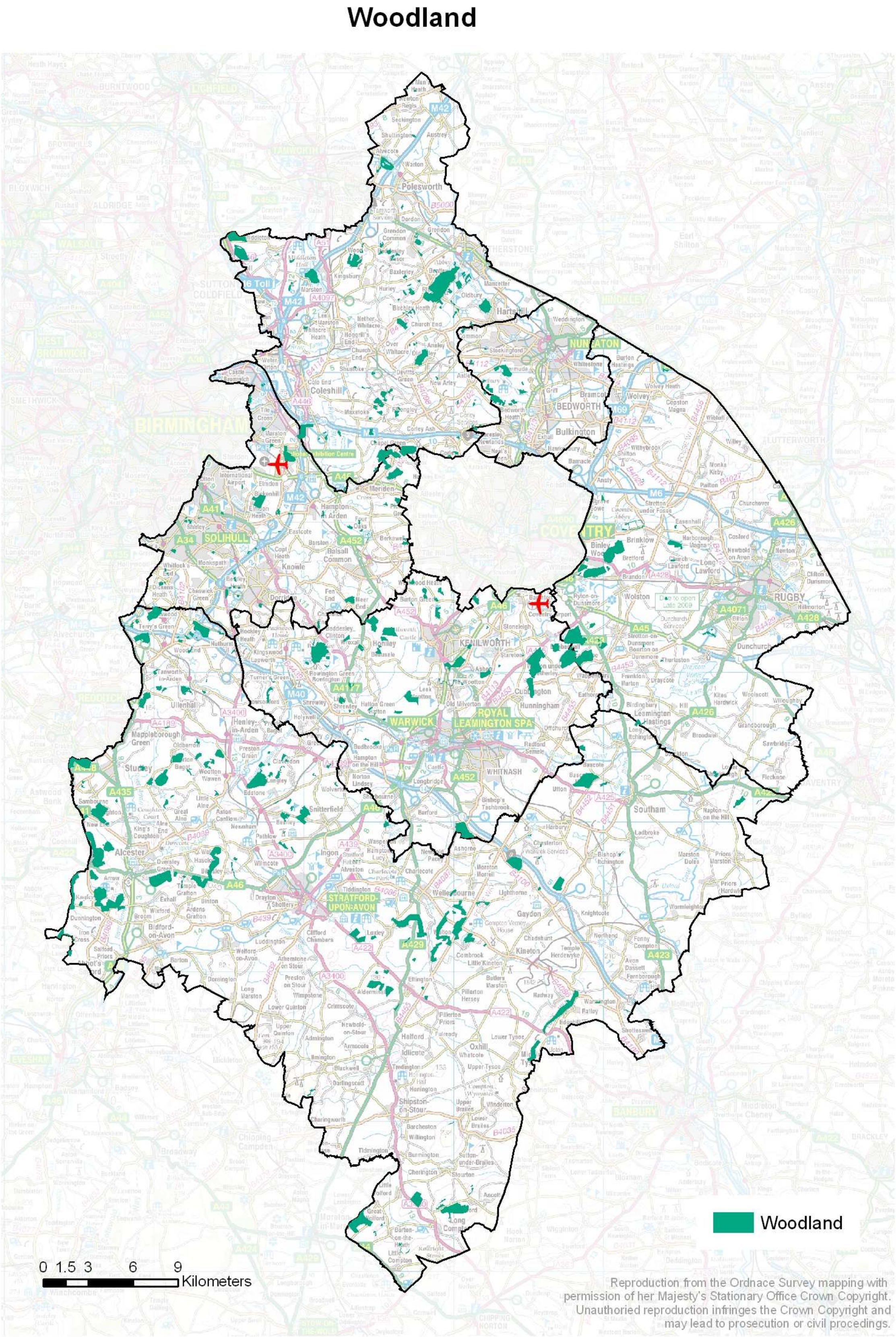

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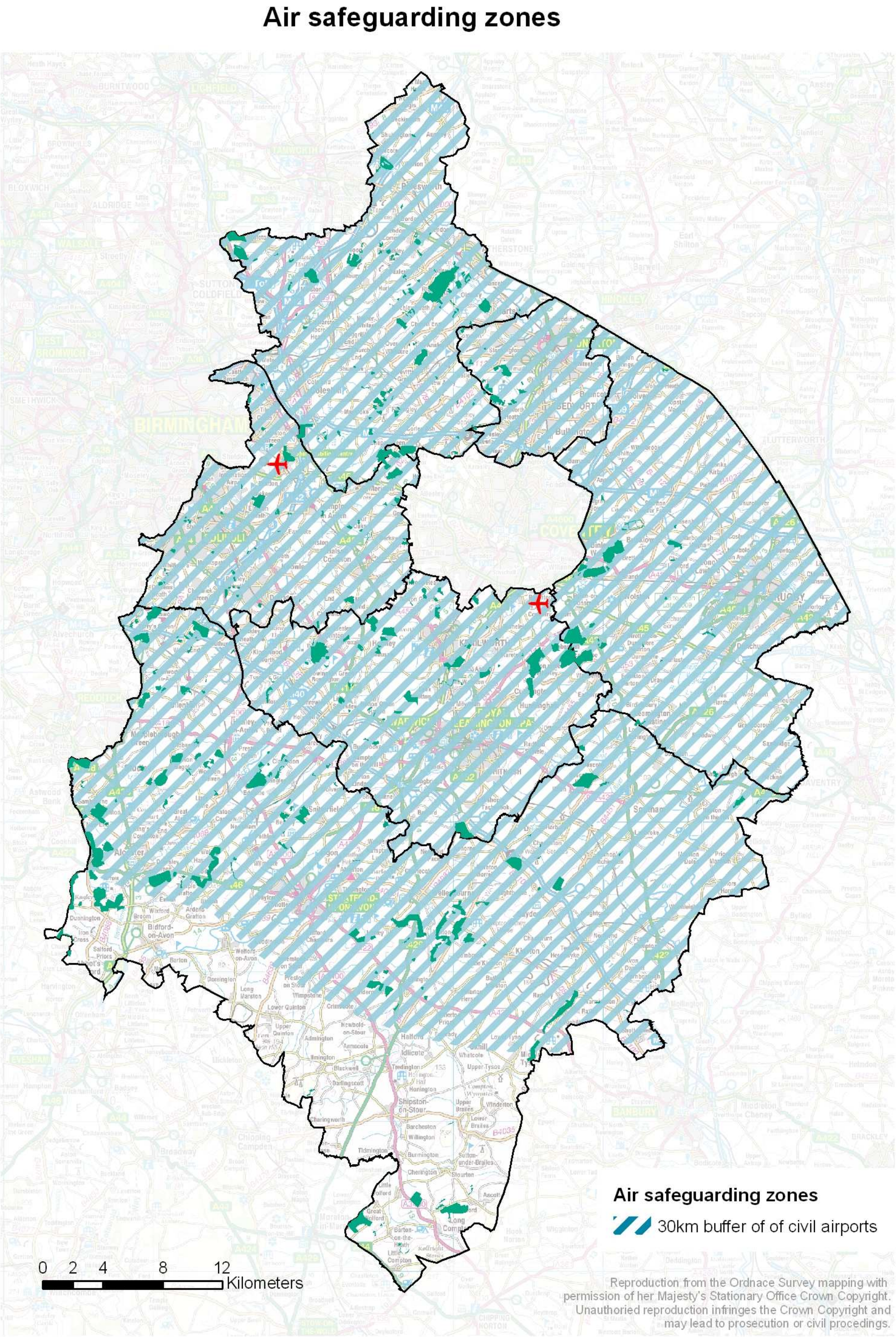
Figure91: Consultative zones: Air Safeguarding Zones in the study area



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Distribution network within the district

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

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 be 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 worth it if losses on the cables are significant; if that’s not the case, connection should happen at the generator voltage.
    - Determining the most suitable connection voltage for various generator capacities can be done by applying the following rule of thumb:
        - Less than 3.6kW – 240V (1-phase)
        - Less than 400kW – 400V (3-phase)
        - Between 400kW and 8MW – 11kV
        - Over 8MW – EHV connection (33kV or higher)
- Switchgear and ratings
    - Extending an existing switchboard (used for isolation of electrical equipment) might be less cost effective than connecting into a cable with a ring main unit – depending on required civil works and distance from generation.
- Regulatory requirements
    - When connecting renewable generation to the distribution network, there are two Electricity Networks Association guidelines, i.e. G83 and G59.
    - G83 is for very small embedded generators (up to 16A per phase), whereas G59 is for medium-sized embedded generators, i.e. up to 5MW, connection up to 20kV.

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

TOTAL TARGET POTENTIAL (decentralised generation + new build sites + existing buildings)

North Warwickshire

PRIMARY ENERGY (MWh) - NORTH WARWICKSHIRE											
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	1,097	1,552	776	21	9,714	0	0	46	2,632	104	15,942
2011	1,529	2,388	1,475	25	11,242	0	0	111	6,433	222	23,425
2012	1,973	3,229	2,174	29	12,769	0	0	176	10,235	343	30,927
2013	2,430	4,075	2,873	33	14,296	2,075	0	240	14,036	466	40,523
2014	2,899	4,925	3,571	37	15,824	4,149	0	305	17,838	590	50,139
2015	3,382	5,781	4,270	41	21,811	6,915	0	369	21,640	716	64,925
2016	4,109	6,133	4,969	41	22,606	9,681	0	480	25,441	844	74,303
2017	4,848	6,490	5,668	41	23,400	12,447	0	591	29,243	973	83,701
2018	5,600	6,852	6,367	41	24,194	15,213	0	702	33,044	1,105	93,118
2019	6,365	7,218	7,065	41	24,988	17,979	0	813	36,846	1,238	102,554
2020	7,143	7,590	7,764	41	25,783	20,745	0	924	36,846	1,373	108,207
2021	7,920	7,966	7,764	41	25,783	30,426	0	924	36,846	1,509	119,178
2022	8,710	8,347	7,764	41	25,783	40,107	0	924	36,846	1,647	130,169
2023	9,513	8,732	7,764	41	25,783	49,788	0	924	36,846	1,788	141,178
2024	10,329	9,123	7,764	41	25,783	59,469	0	924	36,846	1,929	152,207
2025	11,157	9,518	7,764	41	25,783	69,150	0	924	36,846	2,073	163,256

Nuneaton & Bedworth

PRIMARY ENERGY (MWh) - NUNEATON AND BEDWORTH											
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	1,833	2,574	91	6	1,940	0	0	4	3,049	173	9,670
2011	2,553	3,940	173	7	2,215	0	0	10	7,454	372	16,723
2012	3,295	5,314	254	8	2,491	0	0	16	11,858	573	23,809
2013	4,058	6,696	336	9	2,766	567	0	22	16,263	778	31,494
2014	4,842	8,085	418	10	3,042	1,133	0	28	20,667	985	39,211
2015	5,648	9,483	500	12	4,229	1,889	0	34	25,071	1,196	48,061
2016	6,862	10,071	581	12	4,345	2,644	0	44	29,476	1,409	55,444
2017	8,097	10,668	663	12	4,462	3,400	0	54	33,880	1,626	62,860
2018	9,353	11,272	745	12	4,578	4,155	0	64	38,285	1,845	70,308
2019	10,630	11,884	827	12	4,695	4,911	0	74	42,689	2,067	77,788
2020	11,929	12,504	908	12	4,811	5,666	0	84	42,689	2,292	80,897
2021	13,228	13,132	908	12	4,811	8,310	0	84	42,689	2,520	85,695
2022	14,547	13,769	908	12	4,811	10,955	0	84	42,689	2,751	90,526
2023	15,888	14,413	908	12	4,811	13,599	0	84	42,689	2,985	95,389
2024	17,251	15,064	908	12	4,811	16,243	0	84	42,689	3,222	100,285
2025	18,634	15,724	908	12	4,811	18,887	0	84	42,689	3,462	105,212

Rugby

PRIMARY ENERGY (MWh) - RUGBY											
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	1,774	2,450	1,065	883	13,990	0	0	40	3,131	167	23,501
2011	2,471	3,696	2,024	1,060	16,107	0	0	96	7,654	360	33,469
2012	3,190	4,950	2,983	1,237	18,225	0	0	152	12,177	555	43,469
2013	3,928	6,212	3,942	1,413	20,343	2,484	0	208	16,699	753	55,983
2014	4,688	7,481	4,901	1,590	22,461	4,967	0	265	21,222	954	68,529
2015	5,468	8,758	5,859	1,767	31,061	8,279	0	321	25,745	1,158	88,415
2016	6,643	9,328	6,818	1,767	32,088	11,591	0	417	30,268	1,364	100,283
2017	7,838	9,905	7,777	1,767	33,115	14,902	0	513	34,790	1,574	112,182
2018	9,054	10,490	8,736	1,767	34,142	18,214	0	609	39,313	1,786	124,112
2019	10,291	11,083	9,695	1,767	35,169	21,526	0	705	43,836	2,001	136,073
2020	11,549	11,683	10,654	1,767	36,196	24,837	0	802	43,836	2,219	143,543
2021	12,806	12,292	10,654	1,767	36,196	36,428	0	802	43,836	2,440	157,219
2022	14,083	12,907	10,654	1,767	36,196	48,019	0	802	43,836	2,664	170,927
2023	15,381	13,531	10,654	1,767	36,196	59,609	0	802	43,836	2,890	184,665
2024	16,700	14,162	10,654	1,767	36,196	71,200	0	802	43,836	3,120	198,436
2025	18,040	14,801	10,654	1,767	36,196	82,791	0	802	43,836	3,352	212,237

Solihull

PRIMARY ENERGY (MWh) - SOLIHULL											
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	253	885	453	76	3,122	0	0	17	6,240	24	11,070
2011	352	2,026	861	91	3,545	0	0	42	15,253	51	22,221
2012	455	3,168	1,269	106	3,968	0	0	66	24,266	79	33,377
2013	560	4,311	1,677	121	4,391	656	0	90	33,279	107	45,193
2014	668	5,456	2,085	137	4,814	1,312	0	114	42,292	136	57,014
2015	779	6,601	2,493	152	6,720	2,187	0	139	51,304	165	70,540
2016	947	6,683	2,900	152	6,878	3,061	0	180	60,317	194	81,313
2017	1,117	6,765	3,308	152	7,036	3,936	0	222	69,330	224	92,091
2018	1,291	6,848	3,716	152	7,194	4,811	0	263	78,343	255	102,873
2019	1,467	6,933	4,124	152	7,353	5,686	0	305	87,356	285	113,660
2020	1,646	7,018	4,532	152	7,511	6,560	0	346	87,356	316	115,438
2021	1,825	7,105	4,532	152	7,511	9,622	0	346	87,356	348	118,797
2022	2,007	7,193	4,532	152	7,511	12,683	0	346	87,356	380	122,160
2023	2,193	7,282	4,532	152	7,511	15,745	0	346	87,356	412	125,528
2024	2,381	7,372	4,532	152	7,511	18,806	0	346	87,356	445	128,900
2025	2,571	7,463	4,532	152	7,511	21,868	0	346	87,356	478	132,277

Stratford-On-Avon

PRIMARY ENERGY (MWh) - STRATFORD-ON-AVON

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	1,485	2,404	1,882	14,533	39,012	0	4,586	320	5,525	140	69,889
2011	2,069	4,083	3,576	17,440	43,981	0	5,228	769	13,507	301	90,954
2012	2,671	5,768	5,271	20,347	48,950	0	5,870	1,217	21,488	465	112,045
2013	3,289	7,460	6,965	23,253	53,919	10,814	6,512	1,665	29,469	630	143,977
2014	3,925	9,158	8,659	26,160	58,888	21,629	7,154	2,114	37,450	799	175,935
2015	4,578	10,863	10,353	29,067	82,600	36,048	7,796	2,562	45,431	969	230,267
2016	5,562	11,340	12,047	29,067	84,125	50,467	8,438	3,330	53,413	1,142	258,931
2017	6,563	11,823	13,741	29,067	85,651	64,887	9,080	4,099	61,394	1,318	287,621
2018	7,581	12,313	15,435	29,067	87,176	79,306	9,722	4,867	69,375	1,495	316,337
2019	8,617	12,809	17,129	29,067	88,701	93,725	10,363	5,636	77,356	1,676	345,079
2020	9,669	13,312	18,823	29,067	90,227	108,144	11,005	6,405	77,356	1,858	365,867
2021	10,722	13,821	18,823	29,067	90,227	158,612	11,638	6,405	77,356	2,043	418,713
2022	11,791	14,337	18,823	29,067	90,227	209,079	12,271	6,405	77,356	2,230	471,586
2023	12,878	14,859	18,823	29,067	90,227	259,546	12,904	6,405	77,356	2,420	524,485
2024	13,983	15,387	18,823	29,067	90,227	310,013	13,537	6,405	77,356	2,612	577,409
2025	15,104	15,922	18,823	29,067	90,227	360,481	14,170	6,405	77,356	2,806	630,360

Warwick

PRIMARY ENERGY (MWh) - WARWICK											
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	926	1,927	376	168	8,973	0	2,293	79	4,465	87	19,295
2011	1,290	3,743	715	201	10,200	0	2,614	190	10,915	188	30,057
2012	1,665	5,564	1,054	235	11,428	0	2,935	301	17,365	290	40,836
2013	2,051	7,388	1,393	269	12,655	2,272	3,256	411	23,814	393	53,903
2014	2,448	9,216	1,731	302	13,883	4,545	3,577	522	30,264	498	66,987
2015	2,855	11,049	2,070	336	19,361	7,575	3,898	633	36,714	604	85,095
2016	3,468	11,346	2,409	336	19,833	10,605	4,219	823	43,164	712	96,914
2017	4,092	11,648	2,748	336	20,304	13,635	4,540	1,013	49,613	822	108,750
2018	4,727	11,953	3,086	336	20,776	16,664	4,861	1,203	56,063	933	120,602
2019	5,373	12,263	3,425	336	21,248	19,694	5,182	1,393	62,513	1,045	132,471
2020	6,030	12,576	3,764	336	21,719	22,724	5,503	1,583	62,513	1,159	137,906
2021	6,686	12,894	3,764	336	21,719	33,329	5,819	1,583	62,513	1,274	149,916
2022	7,353	13,215	3,764	336	21,719	43,934	6,136	1,583	62,513	1,391	161,942
2023	8,031	13,541	3,764	336	21,719	54,538	6,452	1,583	62,513	1,509	173,985
2024	8,719	13,870	3,764	336	21,719	65,143	6,768	1,583	62,513	1,629	186,044
2025	9,419	14,204	3,764	336	21,719	75,748	7,085	1,583	62,513	1,750	198,119

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	7,368	11,792	4,645	15,687	76,751	0	6,878	507	25,043	695	149,366
2011	10,265	19,876	8,825	18,824	87,291	0	7,841	1,217	61,215	1,494	216,849
2012	13,248	27,993	13,005	21,961	97,832	0	8,804	1,927	97,388	2,305	284,463
2013	16,316	36,142	17,185	25,099	108,372	18,868	9,767	2,637	133,560	3,128	371,074
2014	19,471	44,322	21,365	28,236	118,912	37,735	10,730	3,347	169,733	3,962	457,814
2015	22,711	52,535	25,545	31,374	165,781	62,892	11,693	4,057	205,906	4,808	587,303
2016	27,590	54,901	29,725	31,374	169,874	88,049	12,656	5,274	242,078	5,666	667,189
2017	32,555	57,299	33,905	31,374	173,968	113,206	13,619	6,492	278,251	6,536	747,205
2018	37,606	59,729	38,085	31,374	178,061	138,363	14,582	7,709	314,424	7,418	827,350
2019	42,743	62,190	42,265	31,374	182,154	163,520	15,545	8,926	350,596	8,312	907,625
2020	47,966	64,684	46,445	31,374	186,247	188,677	16,508	10,143	350,596	9,217	951,858
2021	53,186	67,210	46,445	31,374	186,247	276,727	17,457	10,143	350,596	10,134	1,049,519
2022	58,492	69,767	46,445	31,374	186,247	364,776	18,407	10,143	350,596	11,063	1,147,310
2023	63,884	72,357	46,445	31,374	186,247	452,825	19,356	10,143	350,596	12,004	1,245,231
2024	69,362	74,978	46,445	31,374	186,247	540,875	20,305	10,143	350,596	12,957	1,343,281
2025	74,926	77,631	46,445	31,374	186,247	628,924	21,254	10,143	350,596	13,921	1,441,461

BIOMASS ANALYSIS ASSUMPTIONS

Forestry residues

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

Energy Crops

- The E4tech report models 4 case scenarios based on data from the Refuel project, all 4 scenarios consider that land available for energy crops will increase: area of arable land available for energy crops increasing from 605,000 Hectares in 2008 to 963-1334,000 Ha in 2030, and pasture area from 290,000 Ha in 2008 to 1200,000 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.
    - There are many environmental restrictions that make very unlikely the conversion of most pastures to energy crops (potentially significant loss of soil carbon, run-off and biodiversity to name a few).
- Very slow initial uptake is assumed, to account for required specialised machinery and labour, subsidy schemes, and delay of fist harvest (3 years for willow and 5 years for poplar): 10% by 2015, 30% by 2020 and 100% by 2025.

Sawmill residues

- The competing uses are the panel board industry, paper and pulp, exports and fencing. Currently, 12% of co-products are sold for bio-energy (Forestry Commission statistics 2009[52]). 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[53]).

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[52] *Forestry Commission statistics. 2009. http://www.forestry.gov.uk/website/forstats2009.nsf/TopContents?Open&ctx=92B74B2CCD24A56C8025731B0053FB26*

[53] *New forecast of softwood availability (Forestry Commission 2006). http://www.forestry.gov.uk/website/ForestStats2006.nsf/byunique/ukgrown.html*

  - Increasing recycling rates of waste wood from the construction and other industries will supply part of panel board industry and therefore release part of the sawmill resource

- Immediate uptake achievable as soon as the resource is made available
- Output of the sawmills in the study area remain constant.

Crop residues - Straw

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

Agricultural animal waste

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

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

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

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

  - 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[54]

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

Waste currently land-filled

- For this study, slow growth of waste arisings (0.75% annually over current levels) has been assumed. It is acknowledged by a number of sources (Waste Strategy for England 2007[55], ERM[56] and E4Tech reports) that there is great uncertainty regarding future arisings. E4tech assumes static, waste strategy suggests four scenarios (one of them no growth, 3 of them little growth with maximum of 2% a year).
- For paper and card recycling is supplied first. Overall recycling targets in the waste strategy for household waste assumed to be applicable to individual waste components. This is supported by EU directive that sets specific recycling targets for 2020 of 50% for glass, plastic, paper and metals.
- Maximum recovery levels are set based on best performance across Europe, under the basis that if it has been achieved elsewhere in Europe, it can theoretically be achieved in the study area. These are taken from Table B1.2 of the ERM report.
- Separability of waste will increase linearly to reach maximum recovery levels in 2025/26.
- Initial recovery potential = 5% over recycling rate.
- Alternative disposal routes for kitchen waste and green waste e.g. composting are not considered as competing demand.
- The Waste Strategy for England 2007 sets actions to stimulate energy recovery of wood waste rather than recycling. Therefore, all collectable wood waste over current recycling rates assumed to be available for energy. From the waste strategy it is clear that wood has relatively low embodied energy (energy consumed in extraction) but high calorific value. Though for some kinds of wood waste re-use or recycling are better options, use as a fuel generally conveys a greater greenhouse gas benefit than recovering the material as a resource (and avoiding primary production).

Green waste currently diverted

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

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[54] *•Biomass energy centre http://www.biomassenergycentre.org.uk/portal/page?_pageid=75,17976&_dad=portal&_schema=PORTAL*

[55] *Waste strategy for England 2007. http://www.defra.gov.uk/environment/waste/strategy/strategy07/index.htm*

[56] *Carbon Balances and Energy Impacts of the Management of UK Wastes (ERM 2006). http://randd.defra.gov.uk/Document.aspx?Document=WR0602_4746_FRA.pdf*

PROJECTED BIOMASS CHP FACILITY

Operational hours	8000 hours/yr
Capacity installed	2.5 MWe
Electrical efficiency	30%
Primary energy required	66,667 MWh
Feedstock used	Dry clean biomass

LA	Total clean biomass potential - primary energy MWh -2015	Contribution to project
Nuneaton	18,687	3,586
North Warwickshire	39,916	7,660
Rugby	52,533	10,082
Stratford	151,721	29,117
Warwick	49,824	9,562
Solihull	34,697	6,659
Total	**347,377**	**66,667**

Proportion diverted to proposed biogas plant	19%

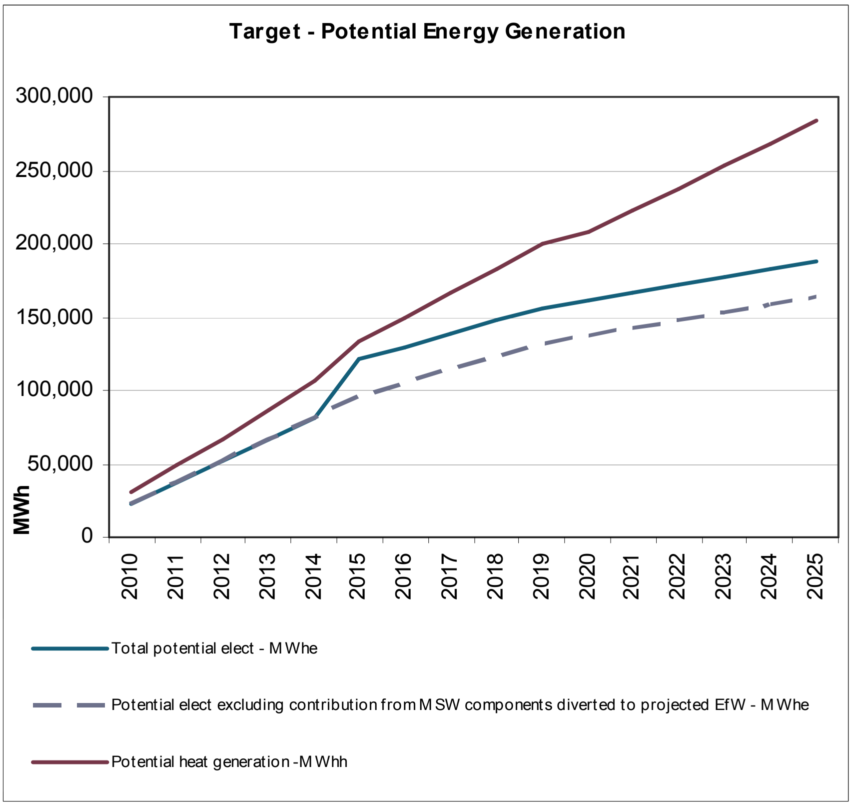
PROJECTED BIOGAS PLANT

Operational hours	8000 hours/yr
Capacity installed	2 MWe
Electrical efficiency	30%
Primary energy required	53,333 MWh

LA	Total AD potential - primary energy MWh -2015	
Nuneaton	44,077	9,098
North Warwickshire	30,773	6,352
Rugby	46,359	9,569
Stratford	58,381	12,050
Warwick	49,119	10,139
Solihull	29,678	6,126
Total	**258,388**	**53,333**

Proportion diverted to proposed biogas plant	21%

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



Appendix IX: Small wind

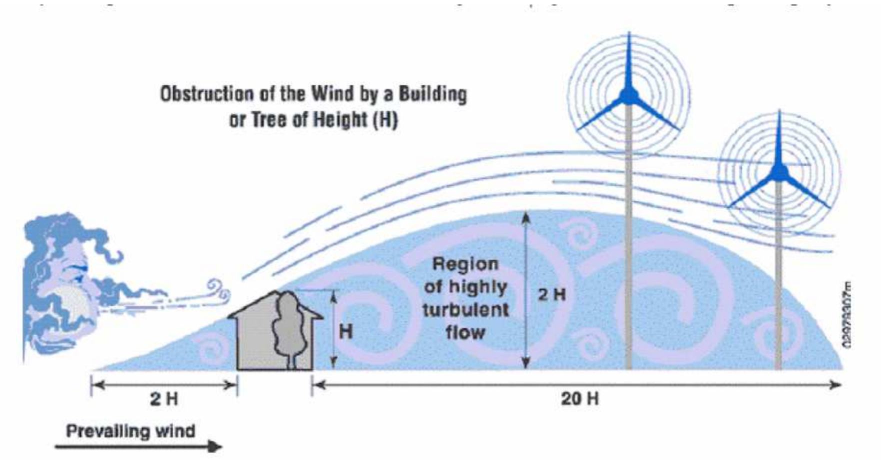
Small wind has not been explicitly reviewed in terms of generation potential within this study since the overall potential is limited. The following provides guidance on the key issues associated with small wind energy development. Key opportunities for small wind energy development include:

- Farms
- Public sector sites such schools
- Industrial parks and retail parks

When considering the potential for small wind energy schemes, which can 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.

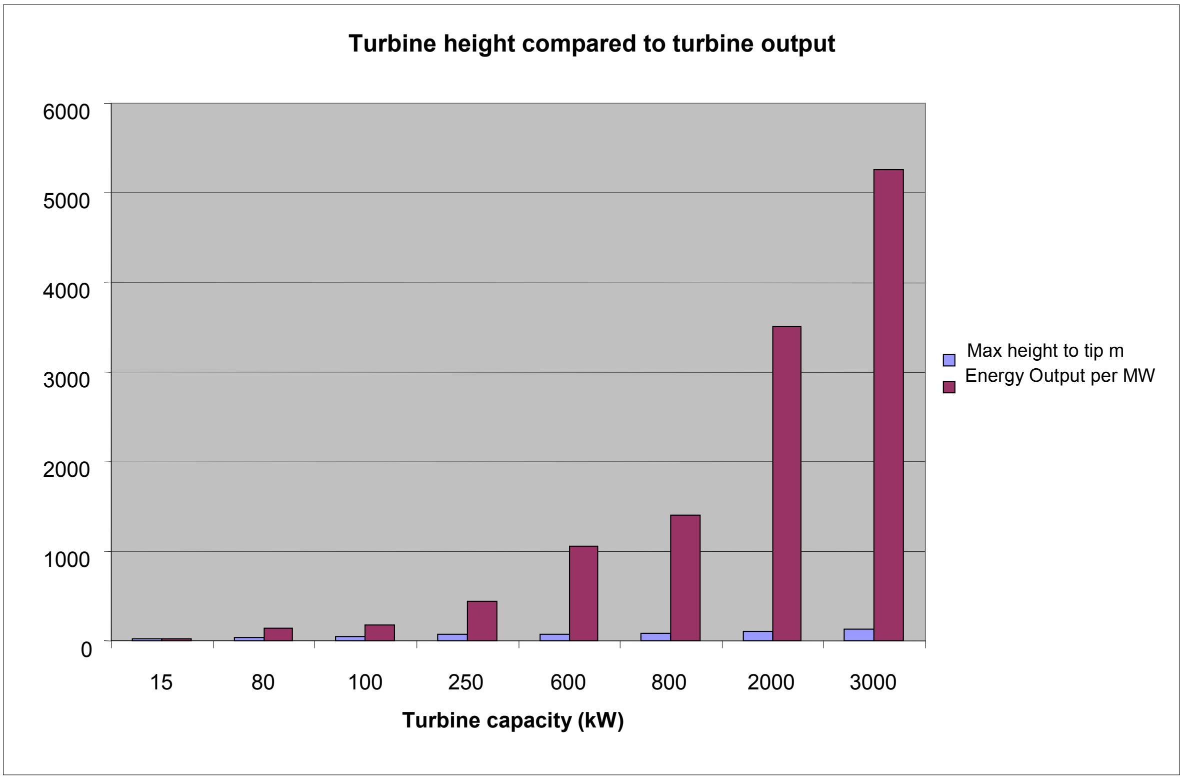
Figure92: Effects of wind shadowing (Source: www.awea.com)



- 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 taken when planning installations.
- It is much easier to install a wind turbine on a new building instead of retrofitting it to an existing building (structural engineers must be consulted in both cases).
- Access for inspection and maintenance is important for building-mounted wind turbines.
- The electricity for small scale turbines can either link to the grid or charge batteries, the former being more cost effective.

- The availability of grants (such as through the Low Carbon Buildings Programme[57]) for the installation of microgeneration technologies, can increase the affordability of the development of small wind schemes for potential target groups, such as community groups, schools, supermarkets, council buildings, industrial estates or other large commercial customers.
- At present national planning legislation requires that planning permission is obtained for domestic wind turbines and similar small wind energy installations, which do not benefit from Permitted Development Rights: different conditions and limitations apply depending on whether a small-scale turbine is fixed to a house, on a wall, to the roof or whether it is a free standing turbine. The main criteria that Local Authorities would take into consideration include turbine height; location, age and impact on the host building; shadow flicker; noise; interference with electromagnetic interference; highway safety; visual impact; environmental considerations and site access[58].
- With respect to potential sites for small-scale wind, the technology is particularly suitable for farms, but also for municipal buildings such as community centres or schools (above all in rural areas where the effects of wind shadowing would be smaller than in urban areas and where schools usually have more land to place the turbine on). An additional advantage of these “community” sites would support education.
- There is a significant difference in terms of electricity output based on the height and capacity of a turbine. The figure below illustrates that the energy output per MW installed grows exponentially with increasing turbine height.

Figure93: Turbine height compared to turbine output



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[57] *http://www.lowcarbonbuildings.org.uk/home/*
[58] *http://www2.valeroyal.gov.uk/internet/vr.nsf/AllByUniqueIdentifier/DOCC3B2E8B8DEF3AD2380257260005AB960*

Appendix X: 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[59].

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.

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

Appendix XI: 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.

Appendix XII: Ground source heat pumps

According to the Energy Saving Trust[60], 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.

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

Appendix XIII: Hydro power

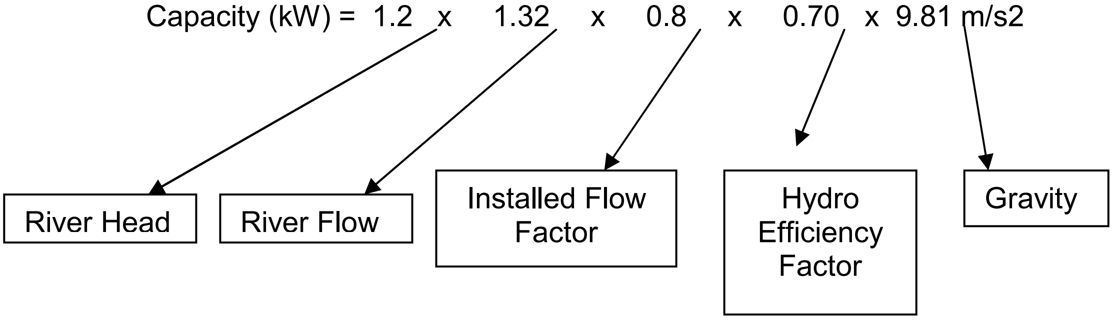
Study area potential

There are numerous weirs within the study area but these are assumed to have heads less than 2 metres as they were not included with a key reference report that reviewed the UK potential for small hydro in 1989[61]. Many weirs sites were identified within the report but discounted principally because of they had a 'head' height of less than 2 metres. Since this report there has been improvements in Hydro technology and so many recent hydro power studies have included sites with a 'head' height less than 2 metres, for example a recent report for Sheffield[62] used a minimum head for potential hydro developments as 1.2 metres.

The assessment of hydro energy potential sites in the study area was restricted to 3 sources of data: Volume 2 (Assessed Sites) and Volume 3 (Rejected sites) of the report above and the Small Hydro website[63].

In total 12 sites were reassessed which were all located either on the River Stour or River Avon. All these sites had heads less than 2 metres and for the purpose of this study a minimum head was assumed to be 1.2 metres and a maximum head of 2 metres. River flow data for The Avon and Stour was taken from the National River Flow Archive[64] and the formula below was used to generate potential capacities for each assessed site (based on basic hydro calculation[65]). From this hydro capacity factors were converted to annual generation (MWh).

Capacity (kW) = 1.2 x 1.32 x 0.8 x 0.70 x 9.81 m/s2



The results are summarised in the table below.

Warwickshire Potential Small Hydro Capacity (kW) and Annual MWh

Local Authority	Number of Sites	Estimated Minimum Capacity (kW)	Estimated Maximum Capacity (kW)	Estimated Minimum Annual (MWh)	Estimated Maximum Annual (MWh)
North Warwickshire	0	0	0	0	0
Nuneaton and Bedworth	0	0	0	0	0
Rugby	2	21	34	171	284
Solihull	0	0	0	0	0
Stratford	4	134	224	1118	1863
Warwick	6	283	472	2358	3931
TOTAL	**12**	**438**	**730**	**3647**	**6079**

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[61] *Small scale hydroelectric generation potential in the UK, Vol3, Department of Energy, 1989*

[62] *Sheffield City Council Renewable Energy Scoping and Feasibility Studyhttp://www.sheffield.gov.uk/planning-and-city-development/planning-documents/background-reports/renewable-energy-study*

[63] *http://www.small-hydro.com/*

[64] *The National River Flow Archive http://www.ceh.ac.uk/data/nrfa/index.html*

[65] *Renewable Energy UK: Calculation of Hydro Power http://www.reuk.co.uk/Calculation-of-Hydro-Power.htm*

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.

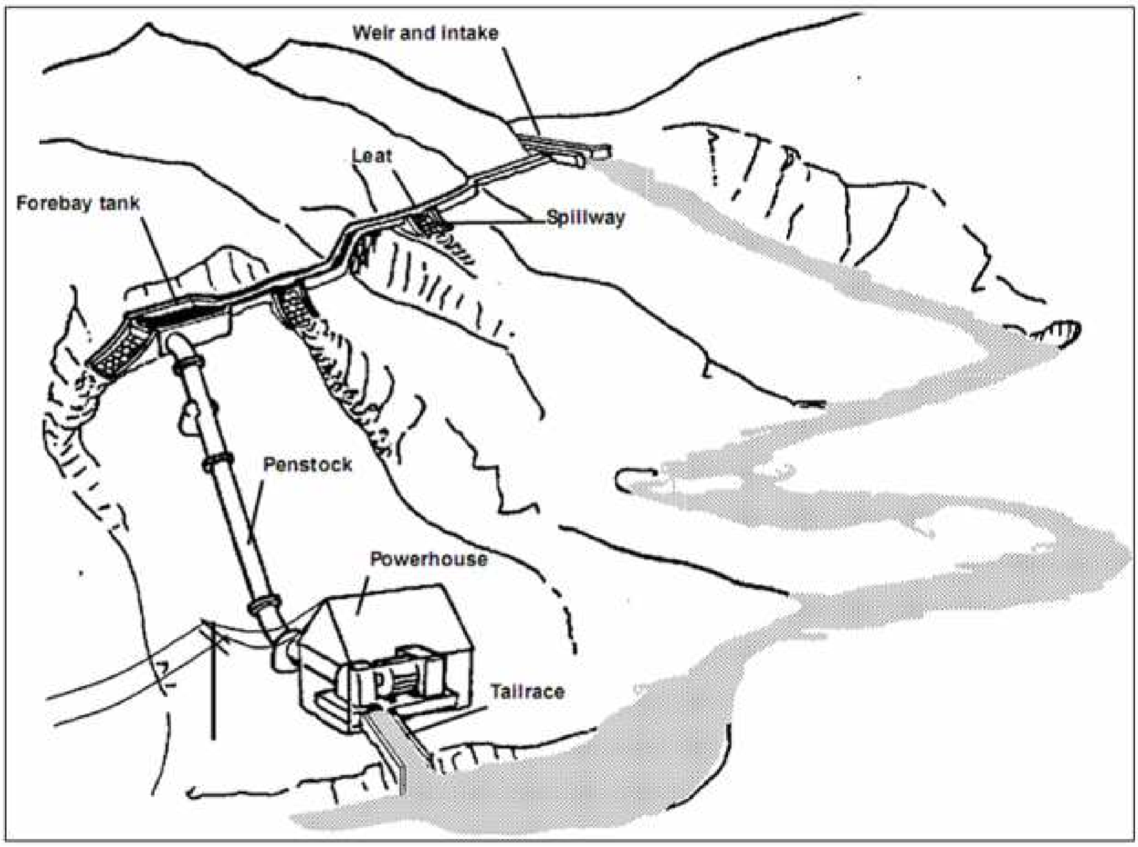
Figure94: Hydropower – Head and Flow (Source: British Hydropower Association – UK Mini Hydro Guide)

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:

Figure95: Components of a hydro scheme (Source: British Hydropower Association – Guide to UK Mini-Hydro Developments)



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

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

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

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

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

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

Appendix XIV: Gas-fired Combined Heat and Power (CHP)

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

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

1. Scale of development. As a rule of thumb, community heating systems require a development of at least 300 dwellings, with improving economics as the scale of development increases.
2. Density of development. The suitability of community heating increases with the number of dwellings per hectare.
3. Mix of development. A good mix of residential, commercial and industrial building types is beneficial. Residential peak energy demand is early morning and evening. Commercial peaks tend to be during daytime hours. Adding the building uses together helps to provide a more even energy demand, which suits CHP.

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

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

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

Appendix XV: 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%

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www.camcoglobal.com

Camco Advisory Services Ltd
The Workstation, 15 Paternoster Row, Sheffield, South Yorkshire, S1 2BX
t +44 (0)114 225 7481   f +44 (0)114 225 7483