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Wiltshire Sustainable Energy Planning Study

climatechangesolutions

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Executive Summary

This report has been prepared by Camco for Wiltshire Council. It forms part of the evidence base for Wiltshire's emerging Core Strategy, specifically addressing the requirements of the Planning Policy Statement, PPS 1, which expects new development to be planned to make good use of opportunities for decentralised and renewable or low-carbon energy.

The report assesses the capacity for supplying the new development in Wiltshire with low carbon energy, and considers appropriate 'carbon standards' for the area's emerging Core Strategy and subsequent Local Development Framework documents. In undertaking this analysis the study:

- Assesses the characteristics of the housing growth plans for the area;
- Assesses the resource potential for renewable energy generation within Wiltshire and relates this to the energy demand of the housing growth proposals;
- Provides indicative energy supply strategies that help inform potential carbon standards for the new development;
- Outlines potential carbon standards for new development and the viability of new standards;
- Specifies suitable low carbon solutions and requirements for different development types;
- Outlines the policy options for supporting low to zero carbon development within the county.

HOUSING GROWTH PLANS FOR WILTSHIRE

The county of Wiltshire is scheduled to see considerable development over the next 20 years. 38,347 new homes are proposed for the Wiltshire Council unitary authority area between 2010 and 2026. The proposed new developments will consist of a mixture of rural infill, urban infill, and urban extensions. These developments will benefit from different energy supply solutions depending on their scale, density and mix, and energy resource available, with the larger developments typically finding it easier to achieve low to zero carbon standards.

During the preparation of the study the Draft Regional Spatial Strategy (RSS) for the South West was revoked and a review of housing figures is currently under way by the council. This may result in the proposed housing figures for Wiltshire being amended. It is not anticipated that a change in the housing growth requirements for Wiltshire will materially affect the findings of the report.

RENEWABLE ENERGY RESOURCE WITHIN WILTSHIRE

The total practical potential for renewable energy (electricity and thermal energy) within Wiltshire is estimated to be around 2,000,000 Megawatt hours (MWh)[1] by 2025[2]. This includes microgeneration technologies from existing and new buildings as well as the decentralised energy sources such as biomass, wind and hydro. The significant portion of this figure is from decentralised (stand-alone) renewable energy sources at around 1,663,000 MWh. Two specific technologies dominate this renewable energy technical potential – wind energy and biomass.

The remainder of the estimated renewable energy uptake consists of the renewable energy technologies that could be implemented in new and existing buildings. Our modelling suggests that by 2025, around a total of 160,000 MWh (130,000 MWh thermal, 30,000 MWh electrical) of renewable energy will be generated from the new buildings in Wiltshire and the remainder, 177,000 MWh, from existing buildings.

Of the renewable energy generated in 2020[3] 665,169 MWh will be in the form of electricity. The following table shows the base case target scenario for renewable *electricity* generation by 2020. This base case is calculated using a number of strict assumptions for a variety of social and economic variables.

The UK has a target equivalent to more than 30% electricity generation from renewable energy sources by 2020 and the base case scenario from this report for Wiltshire is just below this level. For the various technologies the relationship between generation and capacity is not uniform and will depend upon the type of electricity generation technique being utilised. The electricity generation value for biomass is calculated using the total resource potential rather than calculating the output of a select number of biomass sites.

Potential Electricity Generation 2020 (Base Scenario)

	Number or Area	Capacity (MW)	Electricity generation (MWh/year)	Percentage of projected electricity consumption	Total carbon savings (tCO_2)[4]
Large Wind	64	160.0	332,880	15.0%	176,094
Biomass		148[5]	267,175	11.7%	141,336
Hydropower turbines	6 - 9	1.2	6,748	0.3%	3,570
Ground mounted PV	0.69km^2	28.6	22,866	1.0%	12,096
Roof mounted Solar PV	0.125km^2	21	15,000	0.7%	7,935
Small Wind	1,400	8	10,500	0.4%	5,555
Total	-	-	655,169	29.1%	346,586

[1] 1 Megawatt hour = 1,000 kWh units of energy
[2] Data for 2025 is shown as this represents the last calendar year in the proposed new build trajectory to 2025/26
[3] Data is provided for this year as 2020 is a key target year for renewable energy, and electricity in particular
[4] Emissions factors used to work out carbon savings are 0.529 kgCO2/kWh for electricity and 0.198 kgCO2/kWh for gas
[5] Biomass resources can be used as fuel for either heating only or CHP, using a variety of technologies. This is an indicative value for thermal capacity based on other studies.

CARBON STANDARDS FOR NEW DEVELOPMENT

Zero Carbon Standards in Advance of National Requirements

The UK Government has set a timetable for tightening carbon standards in the building regulations to achieve zero carbon housing in 2016 and zero carbon non-residential buildings in 2019. When considering carbon requirements within Wiltshire Core Strategy, the key question is whether the proposed Building Regulation improvements are considered adequate or whether Wiltshire would like to set zero carbon requirements, or other site-specific local standards, for its new developments in advance of 2016.

Our analysis of the potential renewable energy resource within Wiltshire has demonstrated that the local renewable energy resource can amply meet the energy demands of the planned new development, and that it should therefore be technically possible for the larger scale developments to achieve zero carbon standards from now onwards (assuming that the proposed new definition of zero carbon development is adopted - this allows offsite renewable energy to supply zero carbon developments – see section below). Around 30% of new housing development within Wiltshire is likely to consist of large scale developments over 500 units that will be suitable for communal energy systems which are more capable of achieving low to zero carbon standards than smaller developments.

Changing Definition of Zero Carbon Development

In 2008-2009 the Government consulted on a new definition of zero carbon homes so as to define the necessary standard for all new homes built from 2016. The proposed new definition consists of a required proportion of on-site generation or connected heat (referred to as 'carbon compliance') in conjunction with an allowed proportion of allowable solutions that will ease the technical and financial challenge of achieving zero carbon status for the remaining emissions. The final definition of what exactly constitutes a zero carbon home will be crucial to the designation of carbon standards within LDFs, as any designation will need to be based upon the national definition of a zero carbon home. This changing policy backdrop to what is meant by a low or zero carbon development has profound implications for the application of the standard in Wiltshire. This report includes consideration of the new elements within the proposed new definition of zero carbon development to inform the potential form of the carbon standard.

Viability of Developments built to Higher Carbon Standards

The illustrative energy supply strategies in section 4 outline the key technical and financial options for achieving a zero carbon development. They demonstrate that although zero carbon requirements would place a significant cost on new developments, they are still viable for larger developments at least when residual land values are taken into account.

The cheapest way of delivering a zero carbon development is to contractually link it with a large scale wind turbine in the local area, and this approach could potentially enable all new development to be zero carbon at a cost as low as £5,000 per dwelling[6]. However, it should be noted that currently very few housing developments in the UK have established a contractual arrangement with a wind turbine in this way.

These costs provide a useful marker with regard to the impact on a development of achieving zero carbon standards. Development costs and land values are changing all the time, and these changes have been particularly severe under recent economic conditions. A specific assessment of the deliverability of a particular development would vary significantly from today to next year to the year after.

Developers can work in partnership with an Energy Services Company (ESCo) to finance, maintain and operate the energy system for a new development and therefore reduce the costs and the level of burden that they face. This may also be possible for PV in low density housing.

There are a number of commercial ESCos in existence which can support developers in designing, installing and operating a communal energy system for a new development. These ESCos may either operate the energy system entirely themselves or enter into an arrangement with the developer and other entities in order to establish a new ESCo - specifically designed to operate the energy infrastructure of the new development. These development-specific ESCos tend to be arranged so that they are part, or wholly, owned by the residents of the development, and are therefore often referred to as 'community ESCos'.

Local Standards for Different Areas or Developments within Wiltshire

Character area definitions, such as 'town centre', 'edge of centre' or 'suburban' can be used to divide up and define key characteristics of certain geographical areas across the county. However, applying general energy solutions to character areas will only provide generic guidance regarding the applicability of communal energy systems versus specific types of individual renewable energy technology, such as solar photovoltaic (PV) or wind.

The ability to set and achieve higher carbon standards is determined by the specific characteristics of a development rather than the general area in which it is located, and whether it can support Combined Heat & Power (CHP) energy systems which can enable better carbon standards to be achieved. CHP systems, powered by renewable resources, with a district heating network, typically enable the greatest carbon reductions in new developments.

It is also worth noting that the two key renewable energy resources of biomass and large scale wind do not need to be located in the same locality as the development. Biomass resources can be transported to where they are needed and wind turbines could in future be contractually linked to developments located some distance away[7].

[6] December 2008 Communities and Local Government. Definition of Zero Carbon Homes and Non-Domestic Buildings
[7] Though this mechanism has yet to be defined to be compliant with the zero carbon definition

All sites will have specific characteristics, and cost effective solutions for each site will vary. Planning policy should include a requirement for developers to produce energy strategies for the developments they are proposing (see section 6.5) which demonstrate how they intend to meet carbon targets, in line with tightening Building Regulations and the *Code for Sustainable Homes* carbon standards, and why they are using any given solutions.

Setting Differential Carbon Standards across Developments Based on Building Types, Scale and Density

The renewable energy evidence base and our assessment of the proposed new developments, does not necessarily support the argument for tighter carbon standards for specific development sites or specific areas within Wiltshire. The main renewable energy resources are wind and biomass, which can potentially supply energy to all the larger developments. Accurate carbon standards, with an understanding of costs, can only be developed for specific developments when detailed information is available about the development, in terms of densities; numbers of units; and breakdown of housing/ building types.

A mixture of energy efficiency measures and renewable energy technologies is used to deliver carbon reductions in new housing. The optimum balance between energy efficiency and renewable energy is specific to a particular development – there is no one-size-fits-all solution, but typically the energy efficiency measures will contribute 10% to 20% carbon reductions with renewable energy providing the remaining reductions. Policy and master planning must be used to require appropriate energy provision depending on the scale and character of developments.

Although density is vitally important in determining the practicality and viability of CHP and district heating, average density thresholds recommendations are indicative only, and other characteristics of specific schemes such as scale and building mix are equally important in determining whether CHP, for example, is a suitable option. The general criteria for a residential communal system are a scale of 500 units and a density of 50 units per hectare – the number of units could be lower if non-domestic buildings are in the development or if appropriate high density (50 units per hectare)existing development is adjacent.

The evidence in section 4 indicates that in larger developments, i.e. over 500 residential units, communal systems are viable. Wiltshire should specify that all sites above this threshold incorporate a communal system.

FACILITATING THE DEVELOPMENT OF SHARED INFRASTRUCTURE AND RENEWABLE ENERGY

In terms of achieving low to zero carbon standards, the Core Strategy should require developers to prepare a Sustainable Energy Strategy which thoroughly explores the opportunities for communal energy infrastructure rather than just opting for the smaller, less complex building integrated renewables to achieve current and near term “lower” carbon standards. This will ensure that developers don’t opt for cheaper strategies in the earlier phases which jeopardise the ability of the development to achieve significant carbon savings in the longer term.

The Council could also establish a ring fenced ‘carbon investment fund’ to provide upfront capital for communal 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.

There are also opportunities to reduce the carbon emissions from existing property in proximity to new development. Existing property can be physically linked to shared renewable energy infrastructure. Financial contributions, from developers to achieve zero carbon standards, could be channelled into retrofit insulation programmes for existing properties. Section 6.5 provides suggested wording for the requirement for developers to prepare energy strategies for their sites.

Potential role of a Local ESCo in stimulating Low Carbon Development

Planning policy alone will not be able to deliver low carbon and renewable energy within Wiltshire, and a range of policy measures covering economic development to council initiated energy projects will also be required. Managing and financing energy infrastructure for long term, phased development projects is extremely challenging. Wiltshire Council has a great opportunity to directly progress renewable energy installations and decentralized energy generation by taking forward projects on its own buildings and land. Wiltshire Council could establish a local Energy Services Company (ESCo) to help implement these low carbon energy projects. There is a particular opportunity in terms of using public buildings as an anchor heat load around which CHP and district heating networks can be established. This also applies to NHS and MoD facilities in the County.

An ESCo or special purpose vehicle led by Wiltshire Council, or another public sector organisation, may help in taking forward low carbon projects that are not being implemented 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 should only 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.

RECOMMENDATIONS FOR PROGRESSING LOW CARBON DEVELOPMENT

Renewable Energy Resource

1. This report provides a very achievable base case of renewable energy generation which is close to the minimum of what the Council should be doing to play its part towards meeting the national target of 30% electricity generation from renewables by 2020. Wiltshire Council should set a target for each technology, in line with the base case scenario, as a practically achievable target for 2020.
2. To help overcome the particular barriers to renewable energy resource uptake in Wiltshire, the Council should play a role in stimulating local community-owned renewable energy and revenue generation, including, wind energy and solar PV.
3. To support the uptake of biomass as a resource, the Council must ensure that there is a sustainable and joined up approach to waste management throughout the county e.g. facilitate the utilisation of biomass waste for regional energy generation and set this requirement into future waste contracts.

Carbon Standards for New Development in Wiltshire

4. The Council should not set a locally specific carbon standard across all new developments in advance of tightening national requirements.
5. Specialist training and continuous professional development should be provided to planners in the different renewable energy systems available and their impacts on developments.
6. The Core Strategy and subsequent LDF documents should indicate the types of low carbon energy systems that the Council expects developments to incorporate and encourage developers to install communal systems, where applicable – with a requirement for these in developments over 500 residential units.
7. Use this report and any subsequent analysis to highlight to developers the key renewable energy sources in the area, and how these relate to the key development sites.
8. Apply heat mapping data in the most densely populated areas and appraise possible heat infrastructure projects linked to major new developments and the existing major heat loads and major heat waste opportunities.
9. Encourage housing developers to work with renewable energy developers e.g. wind and biomass, and with expert ESCos to design, finance and build energy supply systems within their developments.
10. Ensure that the master plans for the key growth sites contain comprehensive zero carbon methodologies addressing buildings and low carbon infrastructure. It should be made compulsory for all developers to produce a detailed sustainable energy strategy for all development sites, with the onus on them proving why zero carbon standards are not possible if this is the claim.

Monitoring and Enforcement

11. Ensure that the new developments include provisions for energy monitoring in their energy strategies that accompany planning applications.
12. Wiltshire Council should prepare CO2 emissions trajectories of what it expects in the Core Strategy based on the phasing of the new housing between now and 2026. This modelled emissions trajectory could be compared with the monitored actual data as it comes in.
13. Capture all low carbon energy installations in the Annual Monitoring Report (AMR). In order to have data available for the AMR, the Council needs to establish a database which is continuously populated with data about new installations.
14. Monitoring is also important for the existing building stock in terms of CO2 emissions for the area as a whole; which should be captured as part of the National Indicator 186 reporting mechanism. It would also be useful to monitor the number and type of renewable energy installations progressed throughout the area to compare with overall CO2 emissions.

Supporting Investment in Low Carbon Infrastructure

15. Establish a ring fenced Carbon Investment Fund to provide the upfront capital needed for financing large scale low carbon infrastructure such as CHP and district heating networks that can supply phased developments. It may be possible to capitalise some of this from a carbon offset fund.
16. To support the national timetable of tightening building regulations establish a 'local carbon offset fund' with distribution mechanisms to enable developers to pay to offset all the residual emissions from their developments. This facility might be needed to support the operation of the 'allowable solutions' proposed in the Government's consultation on the definition of a zero carbon home.
17. In line with the emerging but undefined national mechanism, develop rules to ensure that 'off site' renewables are additional to any commercial renewable energy developments that would occur anyway within the county (and support the development of a delivery mechanism).

Public Sector Leading by Example

18. Wiltshire Council should implement renewable energy installations and decentralized energy generation projects on its own buildings and land. This can be realised by large buildings providing 'anchor loads' for district heating and low carbon infrastructure networks.
19. Encourage ESCo activity in the county, including the development of a public sector led energy supply project.

Glossary

Term	Definition
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.
Anchor Loads	Large buildings with fairly constant heat demand such as leisure centres, hospitals, and hotels that can assist heat network development by providing ‘anchor heat loads’ for heat networks.
APEE	Energy Saving Trust’s Advanced Practice Energy Efficiency Standard.
Base Case	The minimum level of renewable development that the county can achieve.
BERR	UK Department for Business, Enterprise & Regulatory Reform, superseded in June 2009 by the Department of Business, Innovation and Skills.
Biomass	Organic material in either a solid, liquid or gas state that is used as a source of fuel.
BPEE	Energy Saving Trust’s Best Practice Energy Efficiency standard.
Carbon Investment Fund	A source of capital that is used to invest in Carbon-related technologies.
C & D	Construction and Demolition
CHPA	Combined Heat and Power Association
C & I	Commercial and Industrial
CSH	Code for Sustainable Homes; also referred to as the ‘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 1 to 6 star rating system to communicate the overall sustainability performance of a new home.
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.
Discount rates	A rate, usually expressed as a percentage, which reduces the real value of an item over time.

Term	Definition
District Heating	A system of heating that provides residential and commercial heating requirements through a central network.
Elevated Case	A level of renewable development that is achievable within the county with positive planning approval and investment rates.
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 5 to 20 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 for paying the difference.
FIT	Feed-in-Tariff: A UK Government cashback scheme outlined in the Energy Act 2008, effective from 1 April 2010, guaranteeing payment to people who generate small scale low carbon electricity.
GHG	Greenhouse Gas: Any gas that absorbs infra-red radiation in the atmosphere. The current IPCC (Intergovernmental Panel on Climate Change) inventory includes six major greenhouse gases. These are Carbon dioxide (CO_2), Methane (CH_4), Nitrous oxide (N_2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), Sulphur hexafluoride (SF_6).
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 is assumed as being above 1 MW in capacity (tip height typically greater than 100 m). Where appropriate, the default size of large scale

Term	Definition
	wind turbines is 2.5 MW with a tip height of approximately 125 m.
LDF	Local Development Framework
LZC	Low and Zero Carbon
Microgeneration	The generation of renewable energy on a small-scale, usually by a single residential or commercial unit, and mainly used for self-supply.
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 of 5000, and a mean population of 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. There is no direct conversion from MW capacity to MWh as this is dependent upon the type of renewable technology being utilised.
ODT	Oven Dried Ton: An amount of wood that weighs 2,000 pounds at zero percent moisture content. The common conversion unit for solid biomass fuel.
PPS	Planning Policy Statement
Practical Potential	The potential for renewable development depending upon a number of physical constraints as well as other assumptions regarding economic and social issues such as development economics, existing market mechanisms, typical UK planning approval rates, etc. These assumptions vary depending on the technology discussed and act as a guide only for potential development.
ROC	A 'Renewable Obligation Certificate' (ROC) is a green certificate issued to an accredited generator for eligible renewable electricity generated within the United Kingdom and supplied to customers within the United Kingdom by a licensed electricity supplier. One ROC is issued for each megawatt hour (MWh) of eligible renewable output generated.
S106 Contributions	Section 106 (S106) of the Town and Country Planning Act 1990 allows a local planning authority to enter into a legally-binding agreement or planning obligation

Term	Definition
	with a landowner in association with the granting of planning permission.
SHLAA	Strategic Housing Land Allocation Assessment
SHW / STHW	Solar Hot Water; also known as Solar Thermal Hot Water
Small wind	Small scale wind is assumed as being below 500 kW in capacity (tip height typically less than 60 m).
Solar Hot Water	Water that is heated using thermal radiation from the sun.
Solar PV	Solar Photovoltaic
Special Purpose Vehicle (SPV)	A legal entity that is created for a particular financial transaction or series of transactions and to isolate financial risk from a lead organisation.
tCO_2/yr	Tonnes (metric) of CO_2 per year
TCPA	Town and Country Planning Association
Technical Potential	The potential for renewable development depending upon a number of physical constraints but ignoring any financial or planning implications of such developments.
Theoretical Potential	The total potential of renewable generation using all the relevant resources within the county.
TWh	Terra Watt Hours ($1x10^{12}$ Watt Hours or $1x10^{9}$ Kilowatt Hours). A convenient unit of energy consumption for national statistics.
Uptake Curves	The changes in the numbers of renewable developments within the county over time.
Waste Sites	Sites that produce waste which has the potential to be used for energy generation, for example, through the process of Anaerobic Digestion.

Term
Power (*Capacity*) measured in Watts (W) Kilo Watt (kW) = 1000 x W Mega Watt (MW) = 1000,000 x W Giga Watt (GW) = 1000,000,000 x W
Energy (*Load/Demand/Requirement/Consumption*) measured in Watt hours (Wh)
Carbon dioxide emissions (also referred to as carbon emissions in common terminology) measured in kg or tonnes of CO_2 or CO_2e. 1kWh of electricity produces more CO_2 than 1kWh of gas.

1 Introduction

1.1 Study Overview

Wiltshire Council commissioned Camco to undertake a PPS 1 compliant sustainable energy study for Wiltshire to help inform policy development for the area's emerging development strategy and subsequent Local Development Framework documents. This report presents the conclusions of this work. More specifically, the study:

- Assesses the characteristics of the housing growth plans for the area;
- Assesses the resource potential for renewable energy generation within Wiltshire and relates this to the energy demand of the housing growth proposals;
- Provides indicative energy supply strategies that help inform potential carbon standards for the new development;
- Outlines potential carbon standards for new development and the viability of new standards;
- Specifies suitable low carbon solutions and requirements for different development types;
- Outlines the policy options for supporting low to zero carbon development within the county.

In the course of delivering the project we liaised with key local and regional stakeholders including the Ministry of Defence, Community Groups, and RegenSW. We also discussed with the Council a range of supporting planning issues and held two workshops, with council officers; housing developers; and renewable energy project developers, to obtain feedback on the draft results. A list of stakeholders consulted is included in Appendix 3.

1.2 Overview of Wiltshire County

On 1 April 2009, Wiltshire Council formally replaced Wiltshire County Council and the District Councils of Kennet, North Wiltshire, Salisbury and West Wiltshire as the new unitary authority for Wiltshire. The new Wiltshire Council is one of the largest unitary authorities in England with a population of approximately 455,500 covering some 3,255 square kilometres.

Wiltshire is largely a rural area containing many historic features, which make it unique, including more than 16,000 listed buildings and 240 conservation areas, as well as two World Heritage sites and three Areas of Outstanding Natural Beauty.

The county has seen high levels of population growth since 1991 as compared to national averages. This has not been matched by growth in the younger working age population, aged 20-39, which will have implications for the economic base of the county. Currently the area benefits from low unemployment and high economic activity rates, compared to the rest of the UK. Low levels of deprivation are currently observed. However, there are pockets of deprivation at the local level. Areas within both Salisbury and Trowbridge are currently within the 25 per cent most deprived areas in the country.

The Military is the biggest employer in Wiltshire and many jobs within the county are defence dependent. As well as being a major employer, the Military also holds a significant portion of the land in the County, including the training areas on Salisbury Plain.

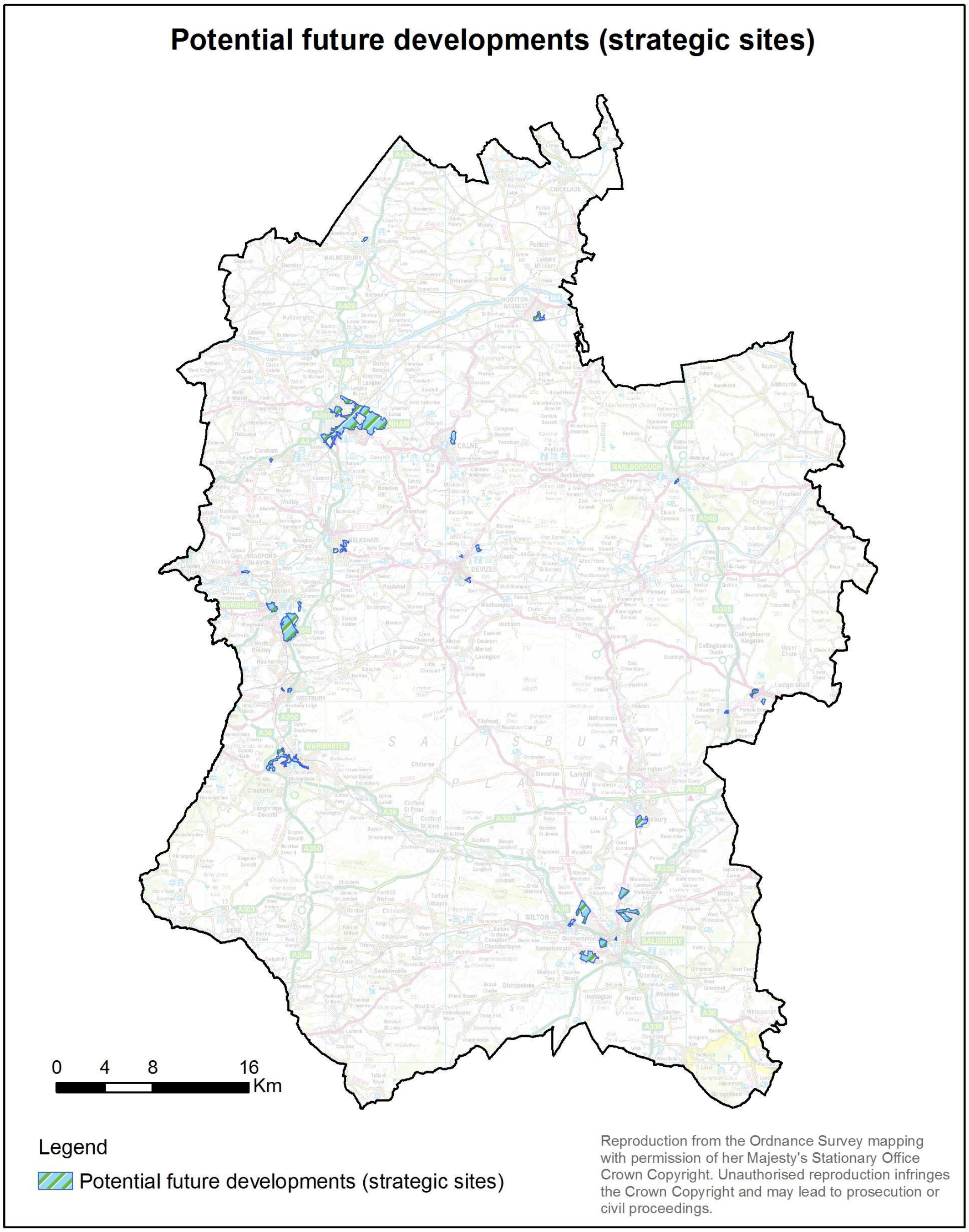


Figure 1: Map of the Core Strategy Area and Potential Development Sites[8]

[8] *The potential strategic development sites have been taken from the 'Wiltshire 2026 – Consultation document to inform the Wiltshire Core Strategy October 2009' and the 'South Wiltshire Core Strategy – Submission Draft, July 2009'. These sites are still under consideration as part of the development plan process and may change.*

2 Low Carbon Policy Background

In light of the new coalition Government and the likelihood of policy change when this report was produced, we have described the policy situation current at the time.

2.1 Climate Change Act

The UK has introduced a long term legally binding framework to reduce greenhouse gas emissions. The Bill was introduced into Parliament on 14 November 2007 and became law on 26th November 2008, putting into statute the UK's targets to reduce carbon dioxide emissions through domestic and international action by at least 80 per cent by 2050 and at least 34 per cent by 2020, against a 1990 baseline. The Committee on Climate Change has been established as a new independent, expert body to advise Government on carbon budgets and cost effective savings. A key part of the Climate Change Act, which has cross-party support, is the establishment of a carbon budgeting system capping emissions over five year periods. The first three carbon budgets will cover five year periods from 2008 until 2022. It is a Government obligation to report to Parliament the policies envisaged to meet the budgets.

2.2 UK Renewable Energy Strategy

The Renewable Energy Strategy[9] calls for 15% of the UK's electricity, heat and transport fuel to come from renewable sources by 2020. This comprises a target of more than 30% for electricity and a 12% target for heat. The strategy was published in July 2009.

2.3 Supplement to PPS1 Planning and Climate Change

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[10] 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".

[9] *http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/renewable/res/res.aspx*
[10] *Refer to paragraph 33*

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".

2.4 Planning Policy Statement on Renewable Energy PPS22

Planning Policy Statement 22 (PPS22) sets out the Government's policies for renewable energy, which planning authorities should have regard to when preparing Local Development Documents and when taking planning decisions.

Local policies should reflect paragraph 8 of PPS22 which says:

> *8. Local planning authorities may include policies in local development documents that require a percentage of the energy to be used in new residential, commercial or industrial developments to come from on-site renewable energy developments. Such policies:*
>
> *(i) should ensure that requirement to generate on-site renewable energy is only applied to developments where the installation of renewable energy generation equipment is viable given the type of development proposed, its location, and design;*
>
> *(ii) should not be framed in such a way as to place an undue burden on developers, for example, by specifying that all energy to be used in a development should come from on-site renewable generation.*
>
> *Further guidance on the framing of such policies, together with good practice examples of the development of on-site renewable energy generation, are included in the companion guide to PPS22.*

2.5 Draft Low Carbon PPS

The draft policy[11] sets out a planning framework for securing enduring progress against the UK's targets to cut greenhouse emissions and use more renewable and low carbon energy, and to plan for climate change. The purpose of the consultation is to get stakeholder views and comments on the new draft planning policy which combines and updates the existing planning policy statements on climate change (PPS1 supplement) and renewable energy (PPS22). The consultation closed in June 2010.

2.6 Regional and Local Planning Policy

The Wiltshire and Swindon Structure Plan 2016[12], published in April 2006, is an alteration to the Wiltshire Structure Plan 2011. The Structure Plan provides a strategic policy framework for land use planning, development and transport across the administrative areas of Wiltshire

[11] *www.communities.gov.uk*
[12] *Wiltshire and Swindon Structure Plan 2016*

(incorporating Wiltshire County and Swindon Borough) up to 2016. This framework is used to inform the more detailed Local Development Frameworks produced by the Borough and County Councils against which decisions on development are made.

The plan was to be replaced by a new Regional Spatial Strategy for the South West. The new coalition Government has though removed the requirement for Regional Spatial Strategies and so any replacement will be at the County level.

The following policy statements are from the Wiltshire and Swindon Structure Plan:

POLICY RE1: Renewable Energy

Policy RE1 states that 'renewable energy schemes will be supported in appropriate locations. In examining proposals, regard should be paid to their impact on the environment and to the potentially cumulative effects of similar development in the locality. Policy RE1 applies to all forms of renewable energy including those identified by REvision 2010. Energy from waste is referred to in Policy W2.

POLICY RE2: Wind Energy

Proposals for wind turbine generators and wind farms, together with any connections to the electricity distribution network, should not detract from the value or interest of areas and features designated for their landscape and natural conservation interest.

Provision of major proposals within the world heritage site, the new forest heritage area and areas of outstanding natural beauty should not be made unless proved to be in the national interest and incapable of being accommodated outside these areas. The principle embodied in Policy RE2 relating to the New Forest Heritage Area should therefore continue to apply to the New Forest National Park.

POLICY W2: Energy from Waste

In order to increase recycling and recovery of resources from waste, proposals for the recycling or the recovery of energy from waste will be favourably considered, subject to their environmental impact.

Wiltshire Council and Swindon Borough Council (the councils) have recently adopted their Waste Core Strategy Development Plan Document (DPD) and Waste Development Control Policies DPD . These documents set out:

- The strategy for meeting forecast demand for new waste facilities;
- The broad strategic locations for new waste management facilities, their relationship with SSCTs (Strategically Significant Cities and Towns) and the settlement pattern of Wiltshire and Swindon; and
- The approach to managing proposals for future waste development.

2.7 Building Regulation Requirements

The previous Government set out its intentions for improving the carbon performance of new developments into the future with its announcement of the tightening of Building Regulations for new homes along the following lines. Reference is made to the Code for Sustainable Homes (CSH) which looks to target sustainability issues regarding a number of categories including energy, water, materials, waste, pollution, health and well-being, ecology, surface water run-off and management.

- 2010: a 25% carbon reduction beyond current (2006) requirements (CSH Level 3);
- 2013: a 44% carbon reduction beyond current (2006) requirements (CSH Level 4); and,
- 2016: a 150% carbon reduction beyond current (2006) requirements (CSH Level 6) in line with the definition of zero carbon from CLG.

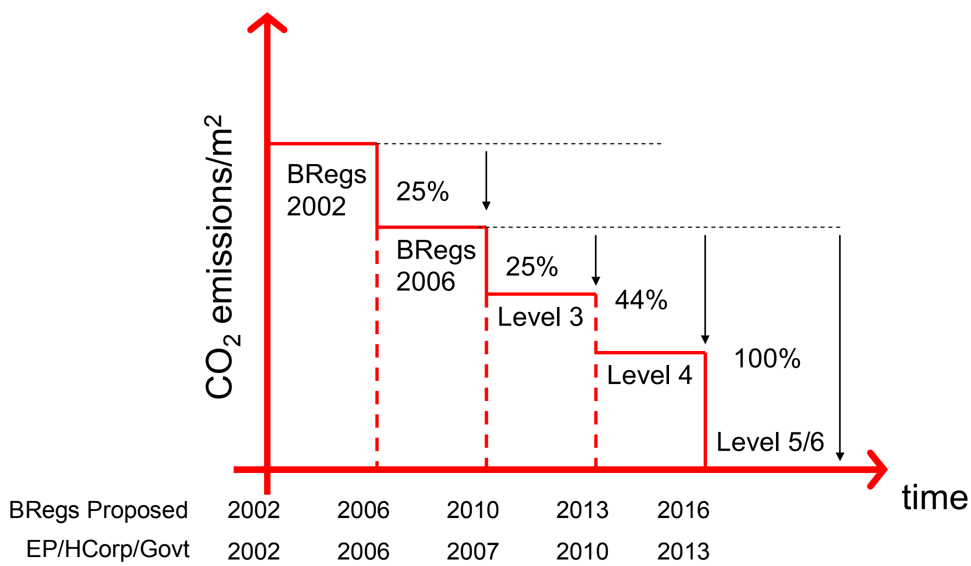


Figure 2: Timeline for the implementation of Zero Carbon Homes through building regulations

Therefore the various phases of development in the county will face stricter and stricter mandatory requirements, and all housing 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 carbon standards outlined above are taken from the Code for Sustainable Homes (CSH) which specifies tightening carbon reduction standards up to Level 6 which corresponds with a zero carbon development. These CSH carbon standards therefore set the benchmark for all new developments, and the evaluation of specific carbon standards for particular developments will need to relate to the CSH carbon standards, ie 25%, 44% and a 150% reduction in carbon emissions beyond Building Regulations. The key question for local authority LDFs is whether to specify carbon standards in advance of those set out above by central Government. If a local planning authority is to require zero carbon standards for new development in advance of 2016 then it needs to illustrate that zero carbon development is possible within the locality and set out the local circumstances that justify this[13].

The intention is also for all non-domestic buildings to be zero carbon by 2019.

2.8 Proposed New Definition of Zero Carbon Homes

The Department of Communities and Local Government consulted in 2008-2009 on the definition of a zero carbon home that will define the necessary standard for all new homes built from 2016. There are a number of challenges involved in the delivery of zero carbon homes and it is both technically and financially difficult to achieve zero carbon status across all types of development. The CLG consultation ran from December 2008 until March 2009, and considered whether it may be too onerous to expect all types of development to meet all energy needs from onsite generation, and if offsite energy generation or even carbon offsetting should also be allowed within the definition of a zero carbon home.

The consultation document proposed that the definition of a zero carbon development follow the preferred hierarchy outlined below with high minimum levels of energy efficiency, minimum levels of onsite energy generation and then the residual carbon emissions offset through offsite generation or investment in other carbon reduction measures. The key question is what minimum standards should be required for energy efficiency and onsite generation?

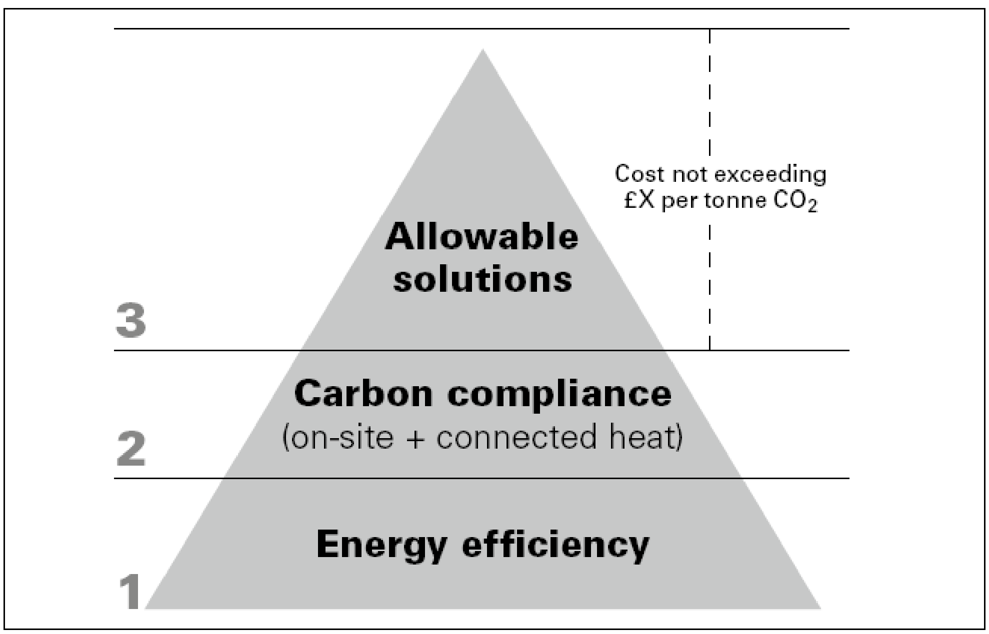


Figure 3: Government's preferred hierarchy for a zero carbon housing development

[13] *In line with PPS1 paragraphs 31, 33*

The definition of what constitutes a zero carbon home will be crucial to the designation of carbon standards within LDFs, as any local carbon standard/ requirement will need to be based upon the national definition of a zero carbon home.

Although the exact definition of a zero carbon home will not be resolved until 2012, it looks very likely that 'flexible mechanisms' will be allowed within the definition, and that some proportion of offsite generation will be acceptable. The consultation document erred towards enforcing a minimum 70% of regulated emissions[14] to be abated through energy efficiency and carbon compliance, including on-site renewables. This enables 'allowable solutions' to meet the remaining 30% of regulated and 100% of unregulated emissions[15].

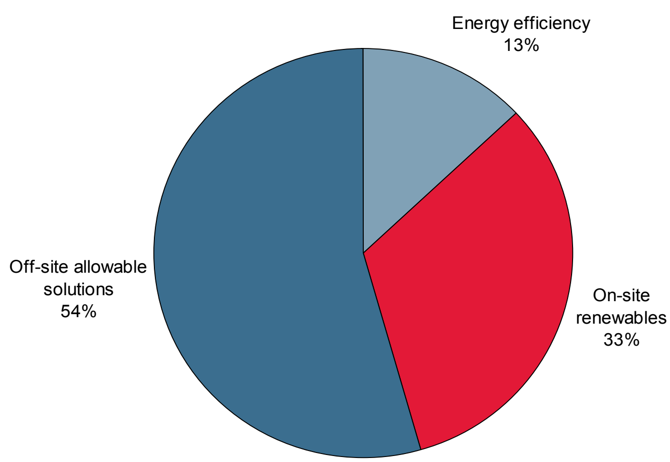


Figure 4: Indicative methods for meeting zero carbon based on the government consultation document - the indicative off-site allowable percentage covers 30% of regulated and 100% of unregulated emissions

National guidance on allowable solutions is still limited but the consultation on the Definition of Zero Carbon Homes and Non-Domestic Buildings[16] provided some possible examples of allowable solutions in order to deal with the residual emissions. Solutions that commanded broad support included[17]:

- Further carbon reductions on site beyond the regulatory standard;
- Energy efficient appliances meeting a high standard which are installed as fittings within the home;
- Advanced forms of building control system which reduce the level of energy use in the home;

[14] 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 and other electrical items are not included, and are known as 'unregulated' emissions sources
[15]Allowable solutions are potentially onsite too though, e.g. low energy appliances
[16] Definition of Zero Carbon Homes and Non-Domestic Buildings, Consultation. Communities and Local Government (Dec 08)
[17] Sustainable New Homes – The Road to Zero Carbon. Communities and Local Government (Dec 09)

- Exports of low carbon or renewable heat from the development to other developments;
- Investments in low and zero carbon community heat infrastructure.

Other allowable solutions remain under consideration.

The use of offsite renewable energy will be essential to the achievement of zero carbon development in Wiltshire as it is very difficult to meet all the energy needs of new development through onsite generation only. In particular, the contribution of the local wind resource within Wiltshire to meeting the energy needs of the new development requires the eligibility of offsite local renewables to the definition of zero carbon development. The likely cost, or the minimum cost of carbon reductions from these measures that Government will deem acceptable, is currently being considered with the involvement of the Zero Carbon Hub and is likely to be resolved by the end of the year[18], but it will be cheaper than the onsite solutions. Once this has been resolved, Wiltshire Council should consider the types and scale of carbon offsetting that it can or wishes to support within the local area.

2.9 Renewable Incentive Schemes

A number of schemes are running which aim to incentivise the generation of renewable energy. The oldest of these schemes involves Renewable Obligation Certificates (ROC's) which act to support the Renewables Obligation (RO). These are issued to an accredited energy generator who supplies renewable electricity within the UK via a registered supplier. Depending upon the type of renewable source one ROC is issued for a certain amount of electricity generation. Electricity suppliers then meet their RO by presenting a sufficient amount of ROC's.

More recently two renewable energy tariffs have been developed to encourage the uptake of renewable technology on a smaller scale. They generously reward energy users for useful energy output in the form of renewable electricity (FIT) and renewable heat generation (RHI).

The Feed-in-Tariff (FIT) scheme was initialised in April 2010 to attract small-scale electricity generators into the market. It is applicable to generators with a maximum declared net capacity (DNC) of 5MWp offering a fixed subsidy per kWh of renewable electricity generated. Unlike ROC's they are not susceptible to market fluctuations and so offer a stable income to the electricity generator. However, renewable generators are still able to choose between the FIT or RO scheme but are unable to participate in both.

Currently at the proposal stage, the Renewable Heat Incentive (RHI) looks to help meet the renewable energy target of 15% by 2020. Its aim is to incentivise the development of renewable heat technologies, such as CHP, to ensure that these sources provide heating at a competitive market price. The Department of Energy and Climate Change (DECC) aims to begin this scheme in April 2011.

[18] *Housing Minister Grant Shapps speech in Swindon May 2010*

3 Current Energy Consumption and Carbon Emissions

3.1 Wiltshire's Energy Demand and CO_2 Emissions

3.1.1 Current carbon emissions and energy consumption of the area

The total annual emissions for Wiltshire, including road transport, were 6,001,000 tonnes of carbon dioxide (tCO_2/yr) in 2007. This represents the most recently available data produced by DECC[19]. The breakdown of fuel use from commercial/industrial and residential dwellings is illustrated in Figure 5. Accompanying the graph is a table representing the respective energy consumption of each fuel type in the Wiltshire area (Table 1). As shown, Wiltshire differs from the national average for residential dwellings with a greater proportion using Petroleum (Oil) and a lower proportion using natural gas. On a Commercial and Industrial basis Wiltshire uses a larger amount of coal sourced energy.

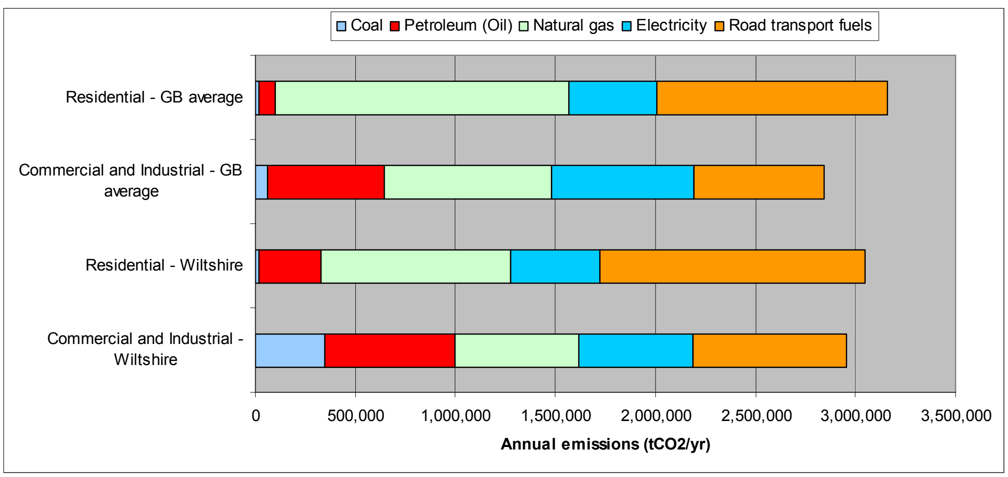


Figure 5: Breakdown of Wiltshire's carbon dioxide emissions for 2007 (source: DECC)

Table 1: Breakdown of the energy consumption within Wiltshire in 2007 (source: DECC)

	Energy Consumption (MWh/year)					
	Coal	Petroleum (Oil)	Natural gas	Electricity	Road transport fuels	Total
Commercial and Industrial - Wiltshire	803,000	1,514,000	1,438,000	1,337,000	1,777,000	6,869,000
Residential – Wiltshire	39,000	730,000	2,199,000	1,043,000	3,077,000	7,087,000
Commercial and Industrial - GB average	145,000	1,358,000	1,941,000	1,655,000	1,514,000	6,612,000
Residential – GB average	42,000	192,000	3,410,000	1,020,000	2,680,000	7,344,000

[19] http://www.decc.gov.uk/en/content/cms/statistics/regional/total_final/total_final.aspx
http://www.decc.gov.uk/en/content/cms/statistics/regional/road_transport/road_transport.aspx

3.1.2 Future carbon emissions forecast

Wiltshire's Core Strategy will need to plan for the delivery of significant levels of new housing growth over the period 2006 to 2026. These new homes will add to the county's energy demand. At the same time, national and international impetus is attempting to set a trend for the reduction in CO_2 emissions.

Figure 6 shows a prediction of the future emissions for Wiltshire based on the proposed changes to the original figures from the draft RSS. A review of housing figures is currently under way by the council, and although a change in housing requirements will impact on the figures shown below, it will not alter the conclusions of this section.

The blue area in Figure 6 shows the 2006[20] baseline emissions of circa 2.7 $MtCO_2$/yr. The red area indicates the emissions that would take place if the current Building Regulations were to continue, instead of the advancing standards. This would see a 5% rise in the annual emissions arising from the built environment. .Taking into consideration the current road map for advancing Building Regulations[21], the blue area shows predicted emissions. Due to all domestic buildings being zero carbon by 2016 and all non-domestic buildings by 2019, the increase in emissions slows down after 2016 and stops after 2019.

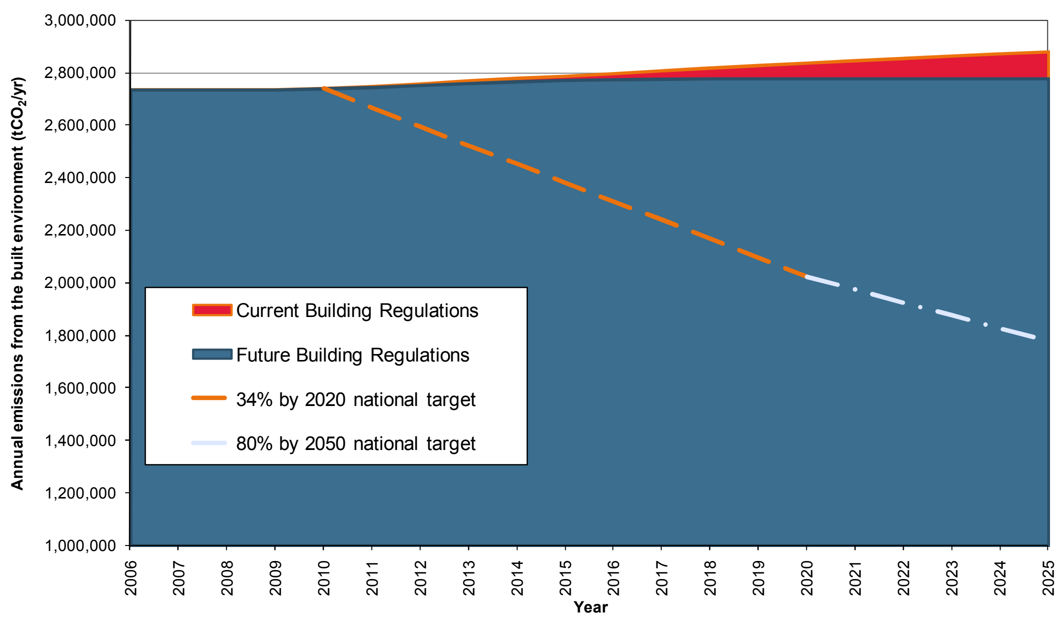


Figure 6: Emissions projection for Wiltshire resulting from the proposed residential developments on top of all current residential and commercial emissions

[20] 2006 is the baseline emissions year in this chart based on the Building Regulations Part L: 2006

[21] At present, Building Regulations will require Code for Sustainable Homes level 3 for all residential dwellings by 2010, which stipulates a 25% reduction in regulated emissions compared to Part L 2006. In 2013, CSH level 4 (44%) will be required, followed by CSH level 6 (true zero carbon homes) as of 2013.

To put the projected increase in emissions into context, recently adopted national targets are included. The government pledged to reduce the UK's total emissions by 34% in 2020. This target includes transport, which is outside the scope of this analysis, and a proportion of the emissions reductions are expected to come from cleaner grid electricity. None the less, there is an onus upon local government to assist in reaching this target, as well as the equivalent 80% by 2050.

The gap between the 2020 target and the projected emissions for that year is over 750,000 tCO_2, and is 28 % of the 2006 baseline. Hence, three key conclusions can be drawn:

- Firstly, it is essential that new buildings should add minimally to the existing energy demands of the county;
- Secondly, it is essential that large, renewable, decentralised energy generation technologies are commissioned to help plug this gap; and
- Thirdly, it is vital to look at the existing building stock and to consider where carbon savings can be made, thus helping to reach the 2020 target.

Table 2: Projected Energy Demand for Wiltshire (source: DECC)

	Year			
	2010	2015	2020	2025
Thermal energy demand (MWh)	6,108,903	5,559,361	4,872,069	4,990,025
Electrical energy demand (MWh)	2,207,978	2,234,089	2,286,641	2,394,573
Total energy demand (MWh)	8,316,881	7,793,450	7,158,710	7,384,598

4 Carbon Standards for New Developments in Wiltshire

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

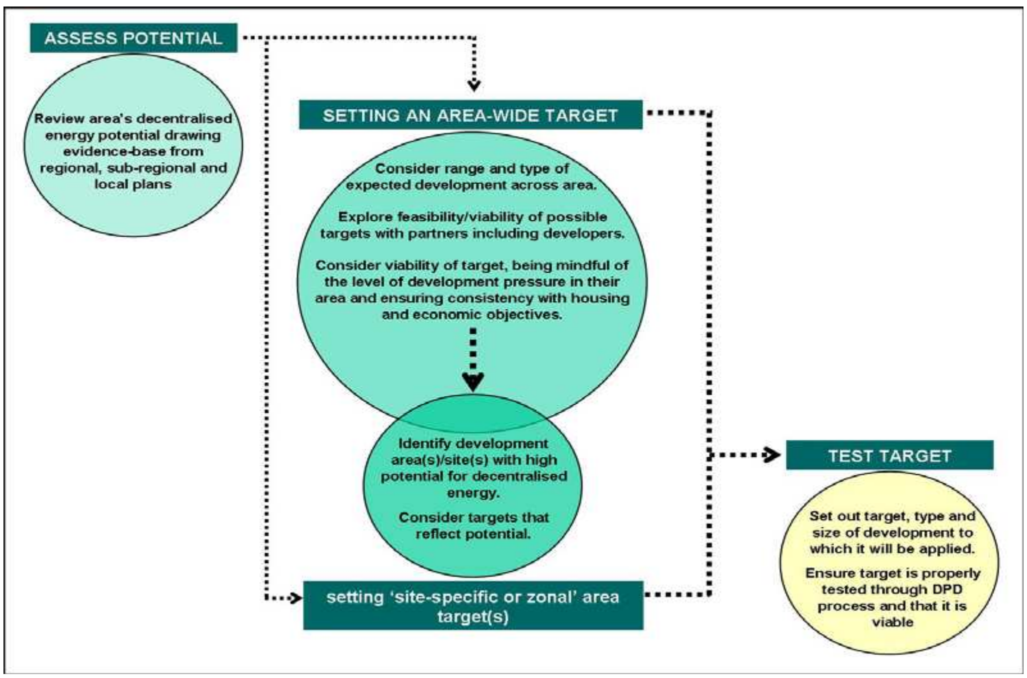


Figure 7: Approach to setting low carbon targets for new developments[22]

This section looks at the potential for applying carbon standards within Wiltshire. It begins by describing three main approaches to achieve carbon reductions in new developments: energy efficiency; microgeneration; and communal energy networks, consider off-grid areas in the county, and how heat mapping and ESCos can help facilitate the realisation of significant carbon reductions in energy infrastructure. It then examines the scale and characteristics of the housing growth plans for the county and alternative low carbon energy strategies to address these. Finally, indicative costs are provided for the strategies and an assessment made of financial viability using an example site: Fugglestone Red in Salisbury, South Wiltshire.

[22] *From Working Draft of Practice Guidance to support the Planning Policy Statement: Planning and Climate Change, CLG (ERM & Faber Maunsell) March 2008*

4.1 Approaches to Low Carbon Development

4.1.1 Energy efficiency levels

Making a building more energy efficient is in line with the first step of the energy hierarchy set out in the consultation for the definition of zero-carbon homes, and should always be considered before looking to introduce renewable or low carbon energy sources. There comes a point, however, where energy efficiency becomes a more expensive option than renewables, particularly for more advanced low carbon construction. Figure 8 illustrates an example of a marginal abatement cost curve, which looks to establish the most cost effective method for achieving a 44% reduction in emissions (Code for Sustainable Homes level 4). This demonstrates that the lowest cost option is for 18% by energy efficiency, and hence the remaining 26% by renewable energy. The optimum balance between energy efficiency and renewable energy is specific to a single dwelling. There is no one-size-fits-all solution.

However, for this analysis, the following energy efficiency levels have been applied, which currently represent the most cost effective solution for a standard semi-detached dwelling (Table 3).

Table 3: The level of energy efficiency for relevant building regulations

Code Level	Energy efficiency as proportion of regulated emissions
3	15%
4	18%
6 (zero carbon)	20%

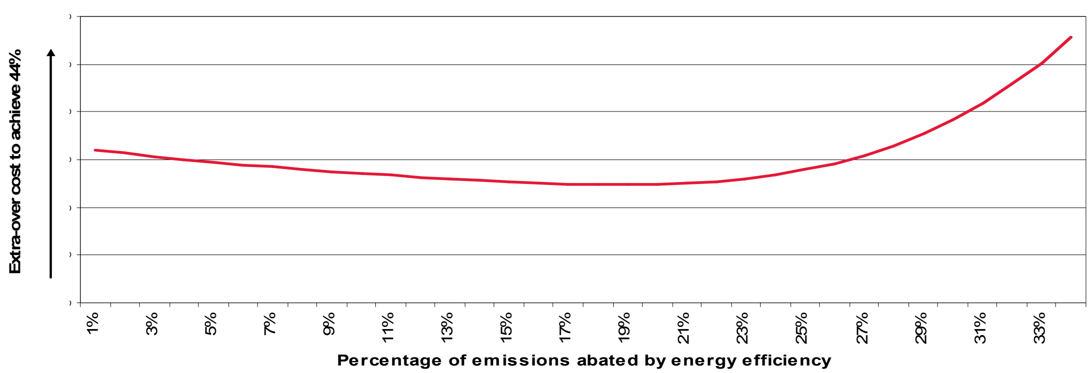


Figure 8: An example of finding a cost effective scenario for achieving emissions targets such as the Code for Sustainable Homes (illustrative purposes only)

4.1.2 Microgeneration energy supply systems

Microgeneration, or building-integrated low carbon technologies, such as photovoltaics, solar water heating, and ground source heat pumps can also deliver substantial carbon reductions in new developments.

This report considers the following microgeneration technologies:

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 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.

Ground source heat pumps (GSHP) make use of the constant temperature that the earth 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.

Similarly, **air source heat pumps** (ASHP) extract the heat in the air to provide space and water heating. As the outside air temperature is less stable than the ground temperature, the carbon efficiency and the energy produced by these systems are lower than GSHP. However ASHPs have lower space requirements and therefore can be more suitable than GSHPs in some cases.

Individual building-integrated low carbon technologies and improved energy efficiency standards can deliver substantial carbon reductions, but will struggle to achieve the very low carbon requirements of Code for Sustainable Homes (CSH) Levels 5 and 6. Individual systems can achieve the 44% carbon reduction under CSH Level 4, but would constitute a very capital intensive approach, particularly if rolled out over a large number of units.

Taking into account current proven technologies, an individual system approach would not achieve zero carbon status for higher density new developments due to the roof space limitations and extensive renewable energy installations that would be needed on each and every building.

4.1.3 Communal energy supply systems

Communal energy supply systems provide residential and commercial heating and power requirements through a central network. The use of CHP and biomass heating is generally dependent upon district heating networks in order to distribute the heating to housing and other buildings. For large scale development sites communal renewable CHP systems generally represent the lowest cost energy supply solution to delivering zero carbon development.

The viability and effectiveness of CHP is dependent on the scale, density and mix of development. In general, CHP requires large numbers of units at high density with a good mix of building types and a good spread of daily and seasonal energy demand. The 'Community Energy: Urban Planning for a Low Carbon Future' guide produced by the Combined Heat and Power Association (CHPA) and the Town and Country Planning Association (TCPA)[23] 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 onsite approach tends to require a communal energy system as the basis of the energy strategy.

District heating networks account for the majority of the capital costs of delivering biomass heating and CHP systems. However the costs vary according to the density and layout of the development; and the specific conditions of a development determine the economics of the communal energy and CHP system. The density of the development is the key determining factor in terms of the economics of a communal system.

The CHPA/TCPA report provides indicative costs of district heating systems calculated per dwelling, and illustrates that the cost of communal systems increase substantially in lower density development. However, these unit costs for communal systems in low density development may still be a lower cost approach to delivering zero or very low carbon housing than through individual building integrated renewable energy systems.

Table 4: Indicative costs of district heating systems based on different density levels [24]

	Medium Rise Apartment Block	Perimeter Block Of Flats & Townhouses	Terraced Housing	Detached/ Semi-Detached Housing
Form	Corridor access, 5-6 storeys	Stairwell or street level access, 3-4 storeys	Street level access, 2-3 storeys	Street level access, compact layout
Net Density	120 units/ha	80 units/ha	80 units/ha	40 units/ha
Pipe Length	8m	11m	13m	19-24m
Cost Per Dwelling	£2,800	£4,100	£5,300	£7,700 - £9,550

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

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

The number of dwellings is important to the economic viability of CHP and although it is possible to install small CHP systems, they tend to be expensive and larger developments are needed in order to install commercial CHP systems. In general, 500 dwellings is a minimum number for a CHP system (although it can be smaller for ideal applications such as sheltered housing or mixed loads, if non-domestic buildings are in the mix or if appropriate existing development is located nearby). Above 1,000 dwellings (and at the appropriate density), CHP and communal heating schemes tend to have excellent commercial prospects as an investment in their own right for ESCos, and may not even require additional investment contributions from a housing developer.

Based on the levels of growth within the draft RSS and draft proposals to meet this, around 30% of new housing development in Wiltshire will consist of large scale developments over 500 units that will be suitable for communal energy systems. CHP and district heating suffer a general lack of support policy though and are not favoured by the UK's energy market place. The challenge of realising the carbon savings from CHP and biomass heating within the existing built environment is generally wrapped up within the challenge of developing district heating networks which require high capital investment and long payback periods. CHP and district heating require support from both planning policy and financing mechanisms.

Linking CHP and district heating with existing communities

CHP and district heating could potentially deliver significant carbon reductions in existing buildings, which are more energy inefficient than new developments and are therefore responsible for greater carbon emissions. The more energy efficient a building is though, then the lower its heating demand and the less significant the carbon savings from a CHP plant.

The establishment of CHP and heat networks within existing communities is very difficult however, due to the competition provided by the incumbent heating system. New policy mechanisms would be required in order to capitalize on the low carbon infrastructure for new communities, and develop this into existing communities. Measures would be needed to encourage and enable the roll out of district heating, through planning policy and enforcement, through connecting public sector buildings and through establishing a financing mechanism to help reduce the level of risk and help integrated networks get started.

Linking large scale wind to development sites

Large scale wind turbines also represent a typically lower cost means of achieving a very low to zero carbon development, and will be a key ingredient of a lower cost zero carbon supply strategy. Large scale wind can potentially be linked to larger development sites where the overall electricity demand can support a supply contract with a wind developer, whereas a smaller development will not have a large enough energy demand to support a large turbine.

With the quoted load factor and availability assumptions given in section 5.1.1, a 2.5 MW turbine would be expected to produce approximately 5,200MWh/yr, equivalent to the current typical annual consumption of approximately 1,250 households.

Note, the mechanics of this kind of linking between property and energy development projects is subject to ongoing work and consultation led by Communities and Local Government (CLG), and the Zero Carbon Hub, which is a public/private partnership co-ordinating delivery of low and zero carbon new homes.

4.1.4 Off-Gas Grid Areas

The following map (Figure 9), which includes the borough of Swindon, shows the level of connections to the gas grid across the County in 2001. This gives one indication of priority areas to target with renewable heat technologies. The use of renewable technologies, such as biomass, is generally more financially viable in off-grid areas. Fossil fuels, such as oil, used for heat generation in off-grid areas, are more expensive than natural gas supplied in on-grid areas and have higher levels of carbon emissions per unit of energy generated.

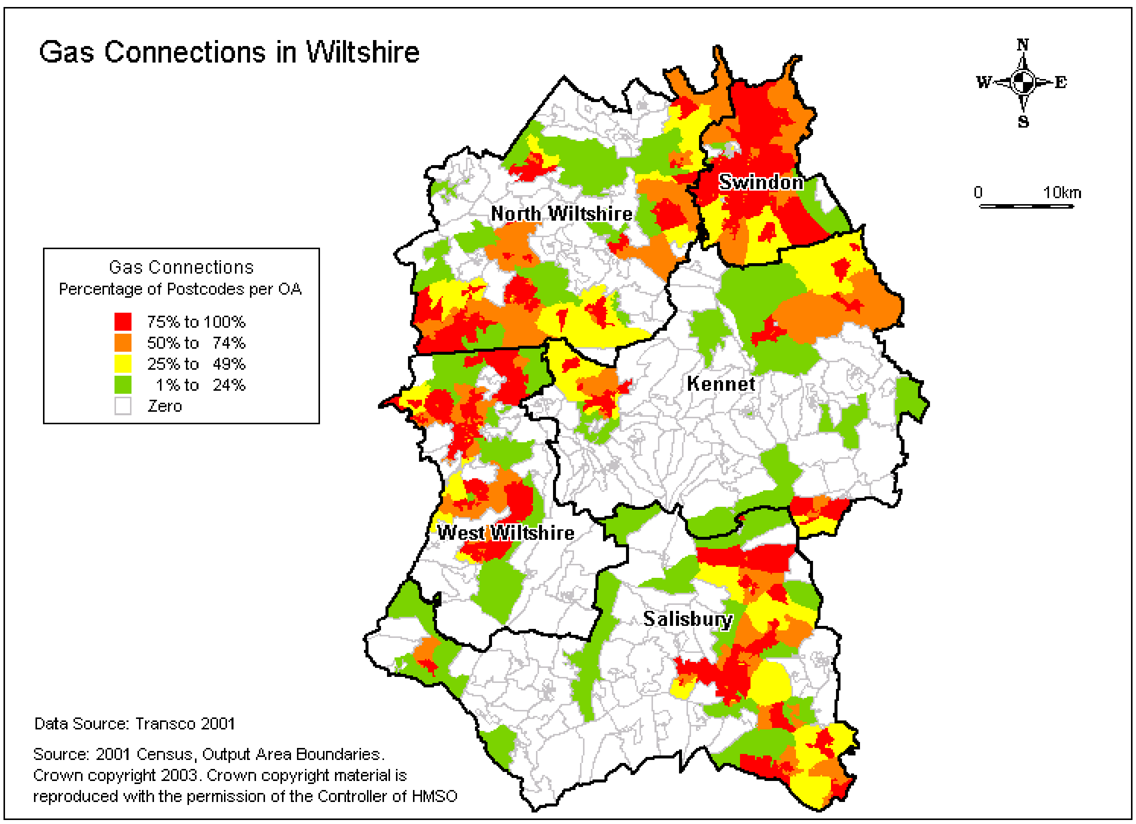


Figure 9: Level of Gas Connections in Wiltshire

Large areas of Wiltshire are not connected to the national gas network. These areas should be targeted as priority areas for renewable heat and other microgeneration technologies such as biomass boilers. Recent modelling of microgeneration scenarios in other regions off the gas network [25], found that using microgeneration provided both greater cost and carbon savings than a full extension of the gas network.

Analysis in section 5 shows that a number of the areas with no gas connections (white in Figure 9) co-exist with areas that could provide renewable electricity for heating via either hydropower or wind sources. However, a more sustainable approach to heating would be to encourage and incentivise the development of microgeneration technologies such as Ground Source Heat Pumps (GSHP's), Air Source Heat Pumps (ASHP's) and Solar Thermal (for hot water). Further heating could potentially be generated from biomass material at waste and food processing sites that lie within or adjacent to areas that include no gas connection.

4.1.5 Heat Mapping

It is possible to quantify the potential for district heating, and the associated carbon savings of connecting existing buildings to a heat network, through producing a 'heat map' for the area. The heat map quantifies the areas of greatest heat demand within the county and thereby highlights where CHP and district heating networks would be most effective. The data collected includes what building types and floor areas are present and what their, heating, cooling and power demands are. This helps to build up an existing heat, cooling and power density map which identifies where CHP can provide an excellent carbon reduction solution within the area. The figures below show a heat map for Wiltshire[26] (Figure 10) and, as an example, a heat map for Chippenham (Figure 11) and its potential development areas.

The general criteria for a communal system are a scale of 500 units and a density of 50 units per hectare – the number of units could be lower if non-domestic buildings are in the development or if appropriate high density existing development is adjacent. The example heat maps show where developments are adjacent to potential heat load areas and potential anchor points are identified in the 'energy opportunity' map shown in section 5.3.

[25] *http://www.energysavingtrust.org.uk/corporate/Corporate-and-media-site/About-us/Strategic-research/Renewables-and-distributed-energy*
[26] *Source: www.regensw.co.uk*

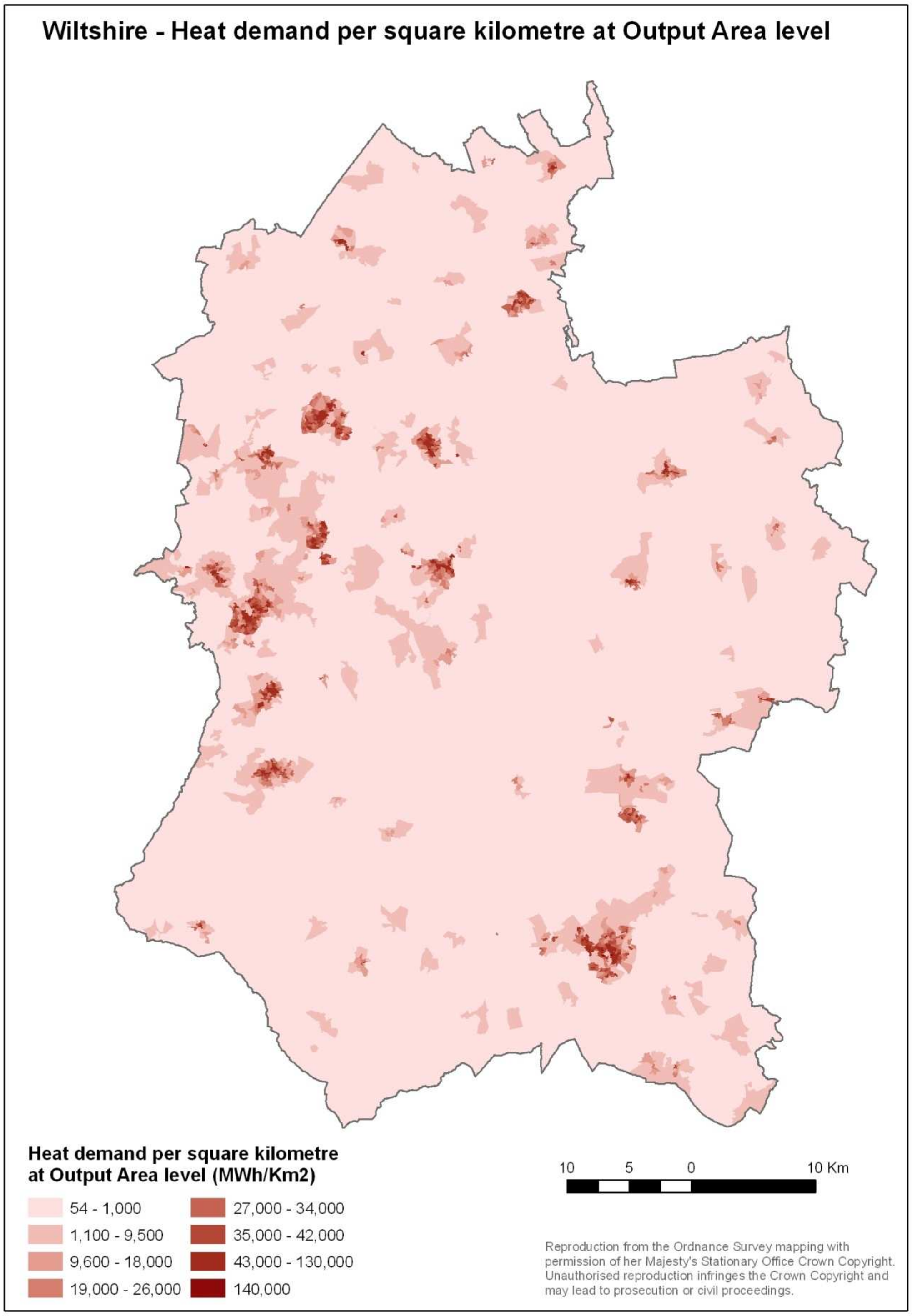


Figure 10: Wiltshire heat demand per square kilometre at Output Area level

Chippenham - Heat demand per square kilometre at Output Area level

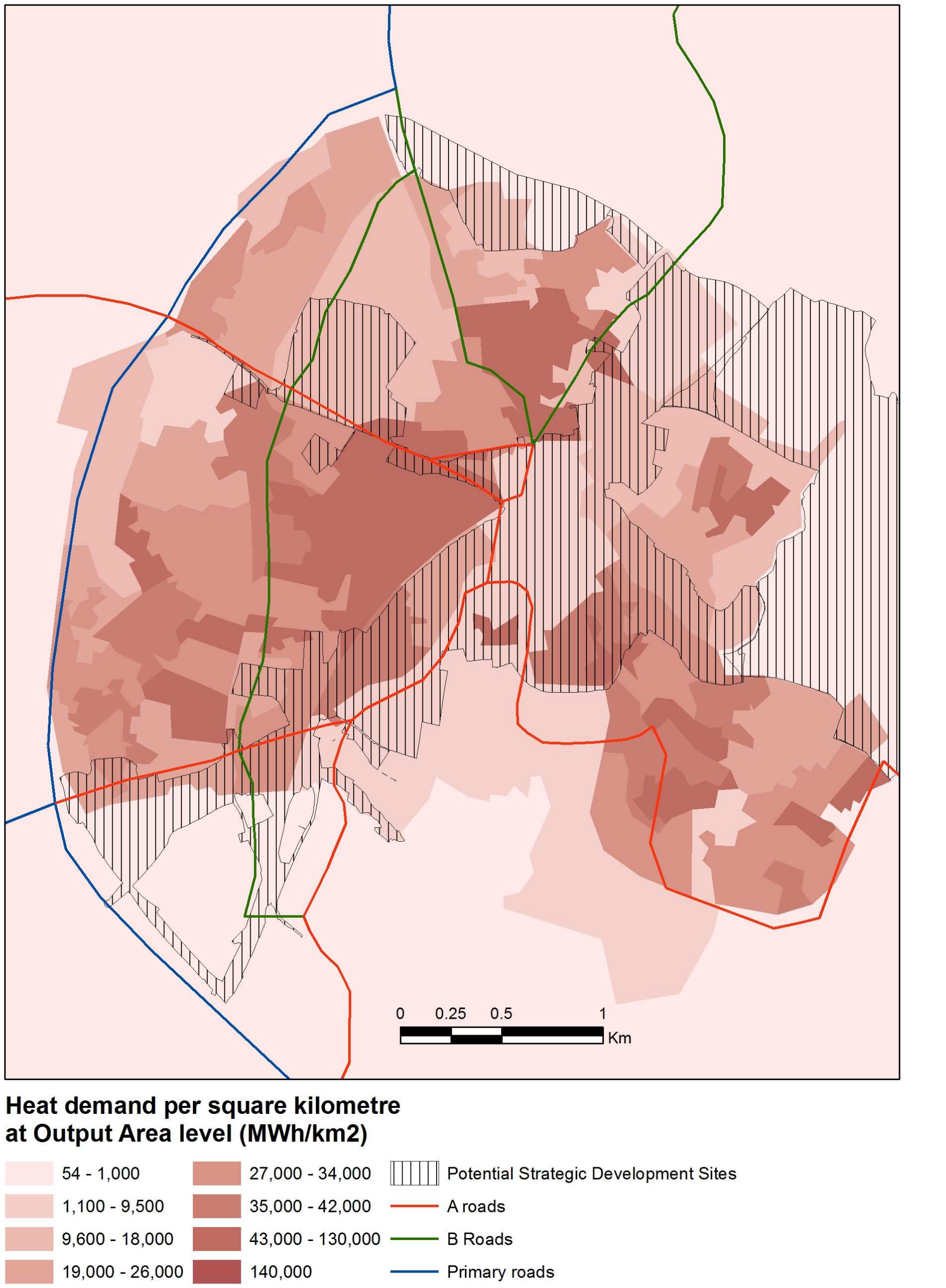


Figure 11: Chippenham heat demand per square kilometre at Output Area level

4.1.6 Energy Services Companies

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

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

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

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

There are essentially three different types of ESCo:

1. Public sector driven
2. Private sector driven
3. Community driven.

For an ESCo to progress an energy system within a new development it will generally be given a long lease for the energy centre building and plant and distribution systems - with the responsibility to operate, maintain, and replace as necessary. Implementing a full ESCo project is a long and complex process which relies upon expert business, procurement, legal and technical advice. Contracts bring together the procurement, finance and management arrangements for an ESCo. The particular procurement strategy that is followed for any given ESCo will differ from case to case, but will follow the basic contract structure of a relationship between a technical energy expert company and the entity that requires its services.

Contract Management will be an important element of the long term monitoring of the successful delivery of the output specification and the successful relationship with the expert energy services partner. Good partnership working is essential to the viable and successful operation of a CHP and decentralised generation scheme.

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

Typical features include:

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

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

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

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

4.2 Assessing the Housing Growth Plans for Wiltshire

4.2.1 Preferred option for housing growth in the Core Strategy

In order to meet the levels of housing growth proposed in the now revoked RSS, Wiltshire would need to build 38,347 new housing units between now and 2026. The breakdown of this figure, based on development category, is presented in Table 5.

As stated in section 3.1.2, a review of housing figures is currently under way by the council.

Table 5: Housing growth plans for the Wiltshire

Development category	Number of dwellings	Proportion
Urban infill	13,120	34%
Rural infill	1,027	3%
Settlement extension	13,715	36%
Urban extension	10,264	27%
New settlement	221	1%
TOTAL	38,347	100%

4.2.2 Characterising the main developments and modelling indicative energy supply strategies

The precise nature of the technical solution for a specific development will vary depending on the scale, density and mix of the development. However, in order to assess the potential carbon standards that could be appropriate for the proposed new developments in Wiltshire, it is necessary to identify the characteristics of the developments and their suitability for installing low to zero carbon technologies. To enable this analysis we have characterised each of the main development locations into one of five development types which are explained in more detail in Table 6:

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

The smaller developments that constitute urban and rural infill are typically not appropriate for communal systems and therefore the optimum energy strategy will consist of highly energy efficient buildings with individual building integrated technologies[27]. The urban extensions are at the larger size and density necessary to support a communal system in some or all of their development areas. These will be large enough to potentially establish a long term power purchase agreement with a renewable energy developer or justify the creation of a local community owned ESCo on behalf of the future development.

[27] *This is not always the case as the presence of good existing anchor loads for district heating systems may sometimes make them viable even at smaller scale*

These are general rule of thumb categorizations only. It is the specific characteristics of a site that will determine the technical and financial suitability of any renewable energy technology options. There will often be overlap within individual sites between the different development-types described in this section. Thus the energy strategies presented in Table 6 are indicative only.

Table 6 outlines the general principles regarding the most appropriate energy supply strategies for different development types. New settlements are the most suitable type of development for district heating systems, due to their size and density. Wiltshire only has 221 dwellings[28] that were categorised in Table 5 as 'new settlement'. This does not create sufficient volume to make a district heating system suitable. Therefore, these developments have been modelled below with biomass heating systems.

4.2.3 Indicative energy supply strategies for the key development locations

In identifying appropriate technical solutions for delivering zero carbon standards in new developments, there are two fundamental variables:

1. Appropriate scale of renewables installed – this is fundamentally the choice between individual microgeneration systems and communal systems; and
2. Whether the solutions should be exclusively on-site, or whether a proportion of off-site emissions abatement should be permitted (following the discussions outlined in section 2.8).

The typical methodology for identifying the supply options is then as follows:

- Estimations of the annual electrical and thermal energy demands for each dwelling using benchmarks;
- Conversion of these benchmarks into carbon dioxide emissions, enabling emissions abatement targets to be established;
- Break-down of targets into three parts: energy efficiency, on-site technologies, and off-site 'allowable solutions';
- Assessing a range of low- and zero-carbon technologies, including indicative costs, to establish their ability to achieve the CO_2 reduction targets;
- Considering both the category and scale of development (refer to Table 6), to choose the most appropriate mix of technologies for each site.

For the development scenarios described in Table 6, illustrative energy strategies have been applied according to the development category and the scale of the development (number of dwellings). Note that both the development scenarios and the illustrative energy strategies are for demonstration purposes only, intended to inform broad conclusions rather than prescriptive site strategies. The following sections explain the strategies chosen for different development categories and the reasoning behind it.

[28] *Royal Arthur, Corsham & Box*

Table 6: Table of typical low carbon energy strategies for different development types in Wiltshire

Development Category	General Development Characteristics	Time frame built	Renewable Energy Strategy
Urban infill	Small numbers of typically around 10-100 housing units integrated into existing urban environment/settlement framework - few other building types. High density (50 dwellings/ha).	2010-2013	PV + Solar thermal
		2013-2016	PV + Solar thermal
		2016-	Individual biomass heating + allowable solutions
Rural infill	Small numbers of housing units situated within existing settlement framework - ranging from 1 to 100 Medium density (30 - 40 dwellings/ha).	2010-2013	PV + Solar thermal
		2013-2016	GSHP + PV
		2016-	Individual biomass heating + allowable solutions
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).	2010-2013	Small wind
		2013-2016	Small wind + GSHP
		2016-	Small wind + GSHP +allowable solutions
Urban extension	Over 1,000 housing units adjoined to existing town and mix of other building types. Medium density (40 dwellings/ha).	2010-2013	PV
		2013-2016	Communal biomass heating + PV
		2016-	CHP (biomass, AD or EfW) + biomass boilers + allowable solutions
New Settlement	Large number of housing units adjoined to existing town - up to 4,000 dwellings - and good mix of other building types. High density (50 dwellings/ha).	2010-2013	PV + Solar thermal
		2013-2016	Communal biomass heating + PV
		2016-	Communal biomass heating + PV + allowable solutions

Microgeneration

In section 4.1.2, it was stated that microgeneration technologies would struggle to achieve carbon reductions higher than those required by Code Level 4. This was due to technical issues (such as insufficient roof space to mount sufficient photovoltaic panels, or limits to the technology's effectiveness) and the high cost of technologies at the scale required. The rationale for the choice of technologies is demonstrated in Table 7 and for illustration purposes it is assumed that the developments provide sufficient space to enable microgeneration to abate all of the emissions relating to a zero carbon dwelling.

Recent modelling carried out by Camco suggests that PV and solar water heating (SWH) in low density housing costs less that than biomass CHP in high density housing once the Feed in Tariff (FIT) and the proposed Renewable Heat Incentive (RHI) have been taken into account. This is because biomass CHP does not qualify for the Feed in Tariff, but can claim Renewable Obligation Certificates (ROCs) and could qualify for the Renewable Heat Incentive if this is implemented by Government. However, ROCs are incompatible with the requirements of the Code for Sustainable Homes and must be retired as homes are connected to the CHP network.

Table 7: Outline rationale for the choice of microgeneration technologies

Technologies	Rationale
Photovoltaics (PV)	A large array of PV panels will provide all, or part of, the energy required to heat and power the dwelling. Surplus electricity exported to the grid will equal the electricity drawn from the grid. Suitable for achieving up to Code Level 4 due to area limitations and more appropriate for developments with considerable roof areas.
Ground source heat pumps (GSHP) + PV	PV powers GSHP, which provides a significant proportion of space heating and/or cooling. Hot water is heated electrically. This mix of technology is suitable for medium to high density developments due to economies of scale for piping work.
Ground source heat pumps (GSHP) + small wind	Same rationale as GSHP + PV except that small wind powers the system.
Biomass boiler + PV	Biomass boiler provides all heating and hot water demand. Smaller PV array provides electricity.
Solar thermal + PV	Solar thermal panels provide a proportion of the hot water demand. Remaining hot water and space heating is electrical which is partly provided by the PVs. This mix is suitable for achieving up to Code Level 4 due to area limitations and is more appropriate for developments with considerable roof areas.

Communal energy

Communal systems (supplemented by microgeneration) should be used where this is practicable. Section 4.1.1 highlights the key factors which dictate the viability of a communal system. In brief, communal energy strategies are most suitable for a development that is large, dense, and has a good mix of residential and non-residential. The rationale for the choice of technologies is demonstrated in Table 8.

Table 8: Outline rationale for the choice of communal technologies

Technologies	Rationale
Renewable CHP + biomass boilers	The CHP is sized to meet the base load and provide a proportion of the electricity demand. Biomass heating supports the CHP system for additional heat demand. This mix requires large, high density developments.
Communal biomass boilers	Communal biomass boilers provide the energy required for space and water heating. Again, this technology generally requires large and high density developments, though a good anchor load can improve viability for smaller clusters of buildings.

Off-site abatement

Section 2.8 refers to the likely change in definition of zero carbon homes[29]. It is expected that the future definition will enable off-site solutions to be allowed as part of a zero carbon solution. The current consultation documents appear to suggest that a minimum 70% of regulated emissions must be abated on-site. The remaining emissions may be abated through a suite of on and off-site 'allowable solutions', including energy efficiency projects. It is envisaged that these allowable solutions will offer a significantly lower cost compared to on-site measures. We have used £100/tonne CO_2 based on the guideline figure provided in the consultation document for zero carbon homes.[30]

4.2.4 Indicative Costs of Compliance with Future Building Regulations in New Developments

We have analysed the financial costs for achieving low to zero carbon developments. These refer to the additional costs associated with going beyond the 2006 Building Regulation energy requirements. For illustrative purposes, Table 9 shows the costs associated with achieving different levels of carbon reduction for different types of dwellings located in various development types. The data was sourced from the Zero Carbon Consultation held by Communities and Local Government in December 2008. The table shows the overall level of carbon reduction that is achieved relative to Part L 2006 requirements, and the capital cost associated with the package. The figures suggest that in order to achieve carbon reductions of up to 44%, PV is a cheaper technology compared with the rest of the technologies assessed. Biomass CHP replaces PV as the cheapest option when further carbon reductions are considered except for small scale developments where the size and density of the development does not financially justify the implementation of a CHP system. **Please note that these costs, as provided by CLG, only consider the costs of meeting on-site carbon reduction requirements** and do not include the costs of allowable solutions

[29] *Reference status of zero carbon non-domestic buildings policy. Potential on-site rich, off-site rich and balanced scenarios.*
[30] *December 2008. Communities and Local Government. Definition of Zero Carbon Homes and Non-Domestic Buildings,*

Table 9: Costs of achieving Zero Carbon Developments. Abbreviations can be found in the glossary.

Technology Combination	City infill – flat		Small scale - mid terrace		Market town - mid terrace		Market town - detached		Urban regeneration - flat		Urban regeneration - mid terrace	
	Carbon reduction (vs. Part L 2006)	Capital cost premium[31]	Carbon reduction (vs. Part L 2006)	Capital cost premium	Carbon reduction (vs. Part L 2006)	Capital cost premium	Carbon reduction (vs. Part L 2006)	Capital cost premium	Carbon reduction (vs. Part L 2006)	Capital cost premium	Carbon reduction (vs. Part L 2006)	Capital cost premium
BPEE alone	14%	£1,065	15%	£2,093	15%	£2,093	16%	£2,381	14%	£1,065	15%	£2,093
APEE alone	28%	£5,984	28%	£5,738	28%	£5,738	35%	£8,934	28%	£5,984	28%	£5,738
SHW + BPEE	29%	£4,118	29%	£5,364	29%	£5,364	26%	£5,985	29%	£4,118	29%	£5,364
PV + BPEE	27%	£3,392	26%	£4,977	26%	£4,977	25%	£5,964	27%	£3,392	26%	£4,977
GSHP +BPEE	39%	£11,461	29%	£11,457	29%	£11,457	31%	£16,510	39%	£7,456	39%	£8,976
Gas CHP (80%) with BPEE	31%	£10,811	31%	£23,774	40%	£7,892	41%	£11,675	44%	£5,583	44%	£6,959
PV + BPEE	44%	£5,673	44%	£7,346	44%	£7,346	44%	£10,180	44%	£5,673	44%	£7,346
PV + APEE	44%	£8,418	44%	£9,112	44%	£9,112	44%	£11,861	44%	£8,418	44%	£9,112
SHW + APEE	41%	£8,827	43%	£8,789	43%	£8,789	45%	£12,271	41%	£8,827	43%	£8,789
Biomass heating (80%) + BPEE	68%	£9,895	67%	£13,593	67%	£7,098	68%	£10,402	68%	£4,938	67%	£6,264
Biomass heating (80%) + APEE	69%	£14,755	67%	£17,181	67%	£10,686	71%	£16,867	69%	£9,798	67%	£9,852
GSHP +APEE	47%	£15,972	46%	£16,501	36%	£14,730	44%	£22,500	47%	£12,102	46%	£12,333

[31] *Capital cost premium is the additional investment cost require to include the technology in the development.*

Technology Combination	City infill – flat		Small scale - mid terrace		Market town - mid terrace		Market town - detached		Urban regeneration - flat		Urban regeneration - mid terrace	
	Carbon reduction (vs. Part L 2006)	Capital cost premium[31]	Carbon reduction (vs. Part L 2006)	Capital cost premium	Carbon reduction (vs. Part L 2006)	Capital cost premium	Carbon reduction (vs. Part L 2006)	Capital cost premium	Carbon reduction (vs. Part L 2006)	Capital cost premium	Carbon reduction (vs. Part L 2006)	Capital cost premium
PV + BPEE	48%	£5,715	70%	£10,786	70%	£10,786	70%	£15,476	48%	£5,715	70%	£10,786
PV + APEE	62%	£10,530	70%	£12,264	70%	£12,264	70%	£17,264	62%	£10,530	70%	£12,264
GSHP + PV + BPEE	70%	£14,969	70%	£17,346	70%	£17,346	70%	£24,840	70%	£11,228	70%	£13,411
Biomass heating (80%) + PV + BPEE	81%	£11,425	79%	£15,475	79%	£9,144	76%	£12,372	81%	£6,592	79%	£8,330
Biomass heating (80%) + PV + APEE	82%	£16,240	79%	£19,019	79%	£12,688	71%	£16,597	82%	£11,407	79%	£11,874
Biomass CHP (80%) + BPEE	75%	£8,508			116%	£10,265	118%	£15,477	118%	£7,916	116%	£9,471
Biomass CHP (80%) + APEE	74%	£13,323			103%	£13,809	105%	£21,873	106%	£12,731	103%	£13,015
Gas CHP (80%)+ PV + BPEE	65%	£15,187	70%	£29,343	70%	£12,397	70%	£18,454	70%	£8,954	70%	£10,928
PV + BPEE	48%	£5,715	74%	£11,439	74%	£11,439	74%	£16,508	48%	£5,715	74%	£11,439
PV + APEE	62%	£10,530	87%	£14,983	87%	£14,983	93%	£22,904	62%	£10,530	87%	£14,983
GSHP + PV + BPEE	73%	£15,427	88%	£20,187	88%	£20,187	90%	£29,708	73%	£11,686	98%	£17,870
Biomass heating (80%) + PV + BPEE	100%	£14,003	100%	£18,444	100%	£12,113	100%	£17,845	100%	£9,170	100%	£11,299
Biomass heating (80%) + PV + APEE	100%	£18,729	100%	£22,031	100%	£15,699	100%	£23,576	100%	£13,896	100%	£14,886
Biomass CHP (80%) + BPEE	75%	£8,508			116%	£10,265	118%	£15,477	118%	£7,916	116%	£9,471

Technology Combination	City infill – flat		Small scale - mid terrace		Market town - mid terrace		Market town - detached		Urban regeneration - flat		Urban regeneration - mid terrace	
	Carbon reduction (vs. Part L 2006)	Capital cost premium[31]	Carbon reduction (vs. Part L 2006)	Capital cost premium	Carbon reduction (vs. Part L 2006)	Capital cost premium	Carbon reduction (vs. Part L 2006)	Capital cost premium	Carbon reduction (vs. Part L 2006)	Capital cost premium	Carbon reduction (vs. Part L 2006)	Capital cost premium
Biomass CHP (80%) + APEE	74%	£13,323			103%	£13,809	105%	£21,873	106%	£12,731	103%	£13,015
Gas CHP (80%)+ PV + BPEE	65%	£15,187	90%	£32,510	100%	£17,075	99%	£25,540	78%	£10,106	100%	£15,637
Biomass heating (80%) + PV + BPEE	102%	£14,324	127%	£22,651	127%	£16,319	127%	£24,328	102%	£9,491	127%	£15,505
Biomass heating (80%) + PV + APEE	103%	£19,138	127%	£26,195	127%	£19,863	130%	£30,724	103%	£14,305	127%	£19,049
Biomass CHP (80%) + PV + BPEE	109%	£13,158			173%	£19,292	155%	£24,402	152%	£12,566	173%	£18,499
Biomass CHP (80%) + PV + APEE	108%	£17,973			162%	£23,155	155%	£33,838	140%	£17,381	162%	£22,361
Gas CHP (80%)+ PV + BPEE	65%	£15,187	90%	£32,510	100%	£17,075	99%	£25,540	78%	£10,106	103%	£16,168

Based on the costs presented in Table 9, Figure 12 illustrates the trend lines in costs of compliance with future building regulations for different development categories. The figure suggests as expected that the costs of compliance will be lower for large scale and high density development types (e.g. urban regeneration – flats). The costs of compliance increases as the scale and density of the development decreases (e.g. small scale - mid terrace and market town – detached).

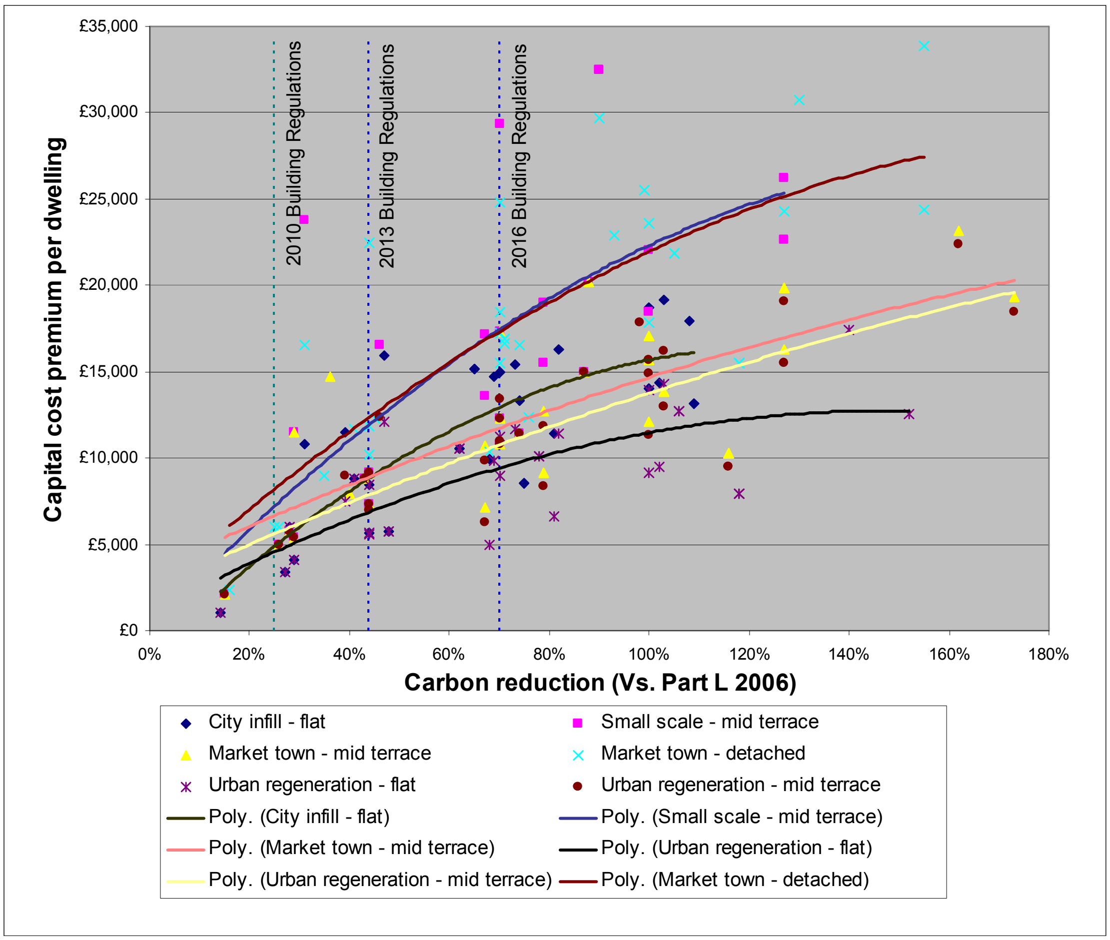


Figure 12: Costs of complying with Future Building Regulations[32]

4.2.5 Impacts on Residual Land Values and Viability of Development in Wiltshire Sites

4.2.5.1 Methodology

The viability of the sustainability policies on residential developments has been assessed through building on the residual land values (RLV)[33] calculated for a range of South Wiltshire sites in the 'Strategic Sites – Viability Overview Assessment' published by Adams Integra in December 2009. The viability in this report is assessed based on five different criteria, where

[32] *Poly. refers to the polynomial trend line*
[33] *Residual land value is defined as the value of the site after taking out the costs of development and developer's profit from the likely income from sales and/or rents.*

RLV should either be greater than zero or exceed a certain value which will be discussed below.

The RLVs are derived based on CSH Level 3 costs and a 40% affordable housing scenario. For the purpose of this report, Camco has used these RLVs and included the additional costs of achieving 4 different levels of carbon reductions to derive a new RLV that would reflect the costs of complying with future Building Regulations.

Out of the nine sites that were assessed in the Adams Integra study, Fugglestone Red was chosen to illustrate the impacts of higher carbon reductions on RLVs and development viability. It was assumed that this would constitute a good example given that this site is a strategic large development consisting of 1,250 units and categorised as an urban extension which forms a significant portion of the development types included in Wiltshire's trajectory of new developments.

The costs of renewable technologies were taken from the zero carbon consultation[34]. The technology mix chosen from Annex E of the consultation was in line with the technologies we allocated to urban extension sites in Section 4.2.3 for the purpose of estimating the renewable energy uptake in Wiltshire. Based on the categorisation of developments in the consultation, 'market town' was the most appropriate match for Fugglestone Red based on the characteristics defined by the zero carbon consultation regarding density, site area and dwelling types. The density and therefore costs relating to this type of development were used in our viability testing. In addition, for the sake of simplicity and in the absence of data regarding the type of development, we sourced costs for mid-terrace dwellings given that the slight variance in costs would not have a significant impact on the viability analysis. Table 10 presents the technologies chosen for different carbon reduction scenarios and the costs associated with them.

[34] *Definition of Zero Carbon Homes and Non-domestic Buildings: Consultation – Communities and Local Government (2008)*

Table 10: Costs associated with carbon reductions (Source: Definition of Zero Carbon Homes and Non-domestic Buildings – Communities and Local Government (2008)

Reduction level	Energy strategy	Capital cost premium (£/dwelling)	Carbon reduction (vs. Part L 2006)	Allowable solutions[35] cost (£/dwelling)	Total cost / dwelling (£/dwelling)
25% on-site carbon reduction	PV + BPEE	4,977	26%	0	**4,977**
44% on-site carbon reduction	Biomass heating + BPEE	7,098	67%	0	**7,098**
70% on-site carbon reduction + allowable solutions for the remaining regulated emissions	Biomass CHP + BPEE	10,265	116%	0	**10,265**
70% on-site carbon reduction + allowable solutions for the remaining regulated and unregulated emissions	Biomass CHP + BPEE	10,265	116%	2,605	**12,870**

Currently, the portion of the reductions for zero carbon homes to be met by allowable solutions is under consultation and the following options are being considered:

- Carbon compliance level of 44% on-site and allowable solutions
- Carbon compliance level of 70% on-site and allowable solutions
- Carbon compliance level of 100% on-site and allowable solutions

In our modelling, we have used the second option where 70% of the carbon reductions are realised on-site with the remainder of the emissions being covered by the allowable solutions. We believe that this is the option most likely to be imposed by the government as it is an ambitious but a realistic target, and one which would bring momentum to onsite renewable solutions in new developments without putting an unrealistic burden on the developers. This was also supported by a ministerial statement made during summer 2009.

Another key issue in estimating the costs for achieving zero carbon homes standards was the costs associated with any allowable solutions. As it is not possible to predict with certainty the relative amounts of the different types of allowable solutions that will be taken up from 2016, 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 Consultation where the price of allowable solutions is capped at £100/tonne of CO_2 over 30 years.

[35] The government is proposing to introduce a more flexible definition of 'zero carbon' to guide building policy where 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 costs sourced from the Zero Carbon Homes consultation were additional to Building Regulations and the residual values derived by the Adams Integra study included costs of CSH Level 3 and renewable energy requirements (assumed to be £50/m^2 and £25/m^2). Therefore, before subtracting the renewable energy costs from the residual land values, these costs included by the Adams Integra study (a total of £75/m^2) were added back on to the RLVs to avoid double counting and reflect values that were based on buildings built to building regulations requirements.

Once new RLVs were derived from including the costs of the technologies implemented for different levels of carbon reductions, these were then compared with the threshold values identified by the Adams Integra study to understand whether the RLVs would be able to absorb the additional costs of higher carbon reduction requirements in Wiltshire.

A positive RLV is usually not considered as a sufficient requirement to lead on to a viability conclusion. The RLV should be above a certain level in order to provide the incentives for the landowner to release the site for residential development. In order to take this into account, the viability study has considered five threshold values or 'filters' against which viability is assessed (Table 11).

Table 11: Filters for Viability Assessment of Wiltshire Sites

Filter	Filter value	Filter Description
Filter 1	£ 0/Ha	RLV is positive given that with a negative RLV, a site is not likely to proceed.
Filter 2	£ 20,000/Ha	RLV exceeds agricultural land value. This is usually a very low threshold not necessarily creating the incentives for landowners to release the site for development.
Filter 3	£ 500,000/Ha	RLV exceeds the 'hope value' which is the likely minimum value to encourage the land owner to sell the site.
Filter 4	£ 1,000,000/Ha	RLV exceeds the alternative use value.
Filter 5	£ 1,800,000/Ha	RLV matches market price expectations for residential development land.

The residual land values used in our viability testing were based on 'Appraisal 3' scenario of the Adams Integra study which assumed £2,950/m^2 for the property values and included allowance for planning infrastructure requirements. Please see Section 2 of the study for more detail on the assumptions.

Results

Based on the methodology presented above, the viability results are presented in Table 12. The base case scenario shows the residual land values with the £75/m^2 added on to the RLVs derived by the Adams Integra study and reflects the values with Part L 2006 regulations.

Table 12: Viability of various carbon reduction levels[36]

Site & Carbon Reduction Level	Number of units	Approx RLV (£)	Approx RLV (£ / Ha)	INDICATIVE FILTER (£ RLV / Ha)				
		Density	Developable area (Ha)	RLV>£0	RLV>£20,000	RLV>£500,000	RLV>£1m	RLV>£1.8m
Fugglestone Red	Units	40 dph	31.25	Filter 1	Filter 2	Filter 3	Filter 4	Filter 5
Base case (withPart L 2006)	1250	£36,137,500	£1,156,400	Y	Y	Y	N/A	N
25% on-site carbon reduction		£29,916,250	£957,320	Y	Y	Y		N
44% on-site carbon reduction		£27,265,000	£872,480	Y	Y	Y		N
70% on-site reduction + allowable solutions for the remaining regulated emissions		£23,306,250	£745,800	Y	Y	Y		N
70% on-site reduction + allowable solutions for the remaining regulated and unregulated emissions		£20,049,750	£641,592	Y	Y	Y		N

The results indicate that viability remains healthy even with a zero carbon development where 70% reduction of the regulated emissions is achieved on-site with the remainder of the regulated and unregulated emissions offset by allowable solutions. As expected however, the residual land values gradually decreased with the introduction of tighter carbon reduction targets. For the zero carbon development, the RLV still exceeded the £500,000 threshold which was considered as the assumed minimum point at which an owner would sell a Greenfield site for housing development.

[36] *N/A = the data was unavailable because the filter level was not applicable in the original Adams Integra Study*

5 Assessing the Renewable Energy Resource within Wiltshire

The Department for Energy and Climate Change (DECC) has recently published the Renewable and Low-Carbon Energy Capacity Methodology for the English Regions, referred to as "DECC Methodology" in this report[37]. The methodology intends to standardise assessments for the potential of renewable energy on a regional basis.

Although these are voluntary guidelines and not intended for sub-regional studies, the assessment of potential for all the technologies considered has been initially carried out in accordance with the DECC Methodology for consistency with regional studies currently being conducted. Where appropriate, the approach proposed by the standard DECC Methodology has been complemented by conducting additional opportunities and constraints analysis in order to define a more realistic practical potential and provide a robust evidence base for target setting.

There is currently very little renewable energy generation within Wiltshire (Table 13 - Table 14)[38] but as discussed in the following section there is significant potential.

Table 13: Existing renewable electricity generation within Wiltshire (Jan 2010)

Number of projects	Wind (MW)	Hydro (MW)	Landfill gas (MW)	Sewage gas (MW)	Advanced treatment of waste (MW)	Solar PV (MW)	Installed renewable capacity (MW)
47	0.01	0.08	10.02	0.17	0	0.12	10.39

Table 14: Existing renewable heat generation within Wiltshire (Jan 2010)

Number of projects	Biomass (MW)	Heat pumps (MW)	Sewage gas (MW)	Advanced treatment of waste (MW)	Solar thermal (MW)	Installed renewable capacity (MW)
154	1.18	0.46	0.20	0	0.41	2.25

5.1 Stand-alone generation potential

This section of the report sets out the potential for stand-alone renewable energy generation projects. The principal technologies considered are large-scale wind, biomass and hydro power. Non stand-alone technologies i.e. building integrated renewables (small wind, solar PV, solar hot water, heat pumps) are covered in subsequent sections. However, ground mounted solar PV is also considered in this section as a potential stand-alone generation source.

[37] *SQWenergy 2010. Renewable and Low-carbon Energy Capacity Methodology.*
[38] *Regensw 2010 annual survey: Renwable electricity and heat projects in south west England*

5.1.1 Large-scale wind energy
5.1.1.1 Overview of approach

GIS Mapping

Wind energy resources and constraints in the South West Region have been mapped by Wardell Amstrong as part of a study commissioned by Regen SW[39]. Layers of constraint have been overlaid to identify areas of development opportunity where at least one large wind turbine could be installed.

Assessment of technical potential

The technical potential is defined as the wind generation that could be delivered if all available sites identified by the GIS mapping are developed.

The maximum number of wind turbines that could be installed at each site is determined by the separation distance between turbines required to prevent air stream interference and any associated operational detriment to the turbines. In line with DECC Methodology, we have assumed a separation distance equivalent to five rotor diameters.

In line with DECC methodology, we have assumed a wind turbine capacity of 2.5MWe to provide an upper estimate of the potential[40].The generation potential is based on an assumed load factor of 25%, and a 95% turbine availability factor[41].

Assessment of practical potential

The 'practical potential' is an estimate of the maximum wind capacity that could realistically be developed. The assumptions made in this report are considered to be broadly representative of the current situation taking into account development economics, existing market mechanisms, typical UK planning approval rates, etc. The practical potential is calculated from the technical potential under two scenarios. **Note that further research is required into the individual opportunity areas identified, so they should only be seen as indicative at this stage.** For example, the MOD is examining potential opportunity areas on its land which may rule out (or indeed rule in due to changing usage patterns) some of the areas presented in this study.

5.1.1.2 Identifying potential wind locations - GIS Mapping

The GIS constraints analysis undertaken by Wardell Amstrong identified sites suitable for the deployment of large-scale wind turbines, where 'large' refers to 2.5MW turbines.

The analysis has been carried out in line with the methodological principles and criteria provided by DECC methodology, applying layers of analysis to progressively reduce the

[39] Wardell Amstrong 2010. Wind Resource Assessment for the South West Following SQWenergy Methodology.
[40] The typical dimensions of a 2.5MWe wind turbine are: height to the tip of the blade at the top of its swept area of approximately 135 m, and rotor diameter of 100m. With the quoted load factor and availability assumptions such turbines would be expected to produce approximately 5,200MWh/yr, equivalent to the current typical annual consumption of approximately 1,250 households.
[41] Annual generation (MWh/yr) = Capacity (MWe) x Load Factor (%) x availability (%) x Hours in year (hrs)

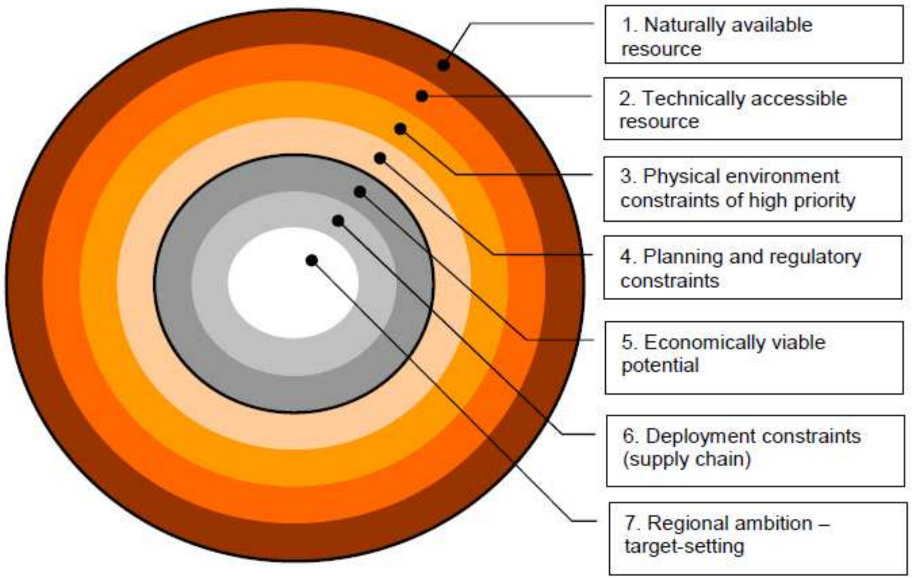
theoretical opportunity to what is technically viable. The analysis takes account of a range of wind resource, physical, environmental, regulatory and planning constraints. Camco has refined the results of the analysis carried out by Wardell Amstrong to take account of all Sites of Historic Interest within Wiltshire.

There are seven key stages recommended by the DECC methodology to develop a comprehensive evidence base for renewable energy potential (Figure 13). The methodology, however, only covers the initial stages (1 to 4) and does not provide any guidance or criteria to address economic and supply chain constraints (stages 5 to 7) which can significantly limit the actual access to the resource and the realistic potential for deployment of commercial scale technologies.

Table 15: Technical potential - absolute constraints to commercial-scale wind development (GIS layers and buffer distances)

Assessment stage	GIS Layers - Large-scale turbines (~ 2.5MW)		
	Layer	Buffer	Dataset source
Stage 1: Naturally available resource	Wind speed at 45m above ground level	-	NOABLE database
Stage 2: Technically accessible resource	Average wind speed @ 45m above ground level < 5m/s	-	Derived from NOABLE database
Stage 3: Non accessible areas due to physical environment constraints	Roads (A, B, and motorways)[42]	-	OS Strategi
	Railways	-	OS Strategi
	Inland waters	-	OS Strategi
	Built-up areas (settlement polygons)	-	OS Strategi
	Airports and airfields	-	RESTATS
	MoD training sites	-	MoD
Stage 4: Areas where wind developments are unlikely to be permitted	Ancient woodland	-	Natural England
	Roads (A, B, and motorways) and Railways	150m	Derived from OS Strategi
	Built-up areas (settlement polygons)	600m	OS Strategi
	Civil airports	5km	RESTATS
	MoD airbases	5km	MoD
	Civil airfields	5km	RESTATS
	Sites of historic interest (Scheduled Ancient Monuments, Listed Buildings, Conservation Areas, Registered Historic Battlefields and Registered Parks and Gardens, World Heritage Sites)	-	English Heritage

[42] The constraints at this stage represent the physical road and rail infrastructure itself whereas the constraints in stage 4 represent buffer areas of 150m around this transport infrastructure



Source: ***DECC/SQW Energy***

Figure 13: Calculating renewable targets from the naturally available resource

Figure 14 presents the results of the initial constraints analysis, showing areas where development of large-scale wind is not limited by the constraints listed in Table 15. The area shown in this map adds up to 959 km^2, with potential to accommodate a total installed capacity of 9,590 MW. This potential has been further reduced to take account of other factors not included in Table 15 but that will in reality limit the development of large-scale wind. This is further discussed below.

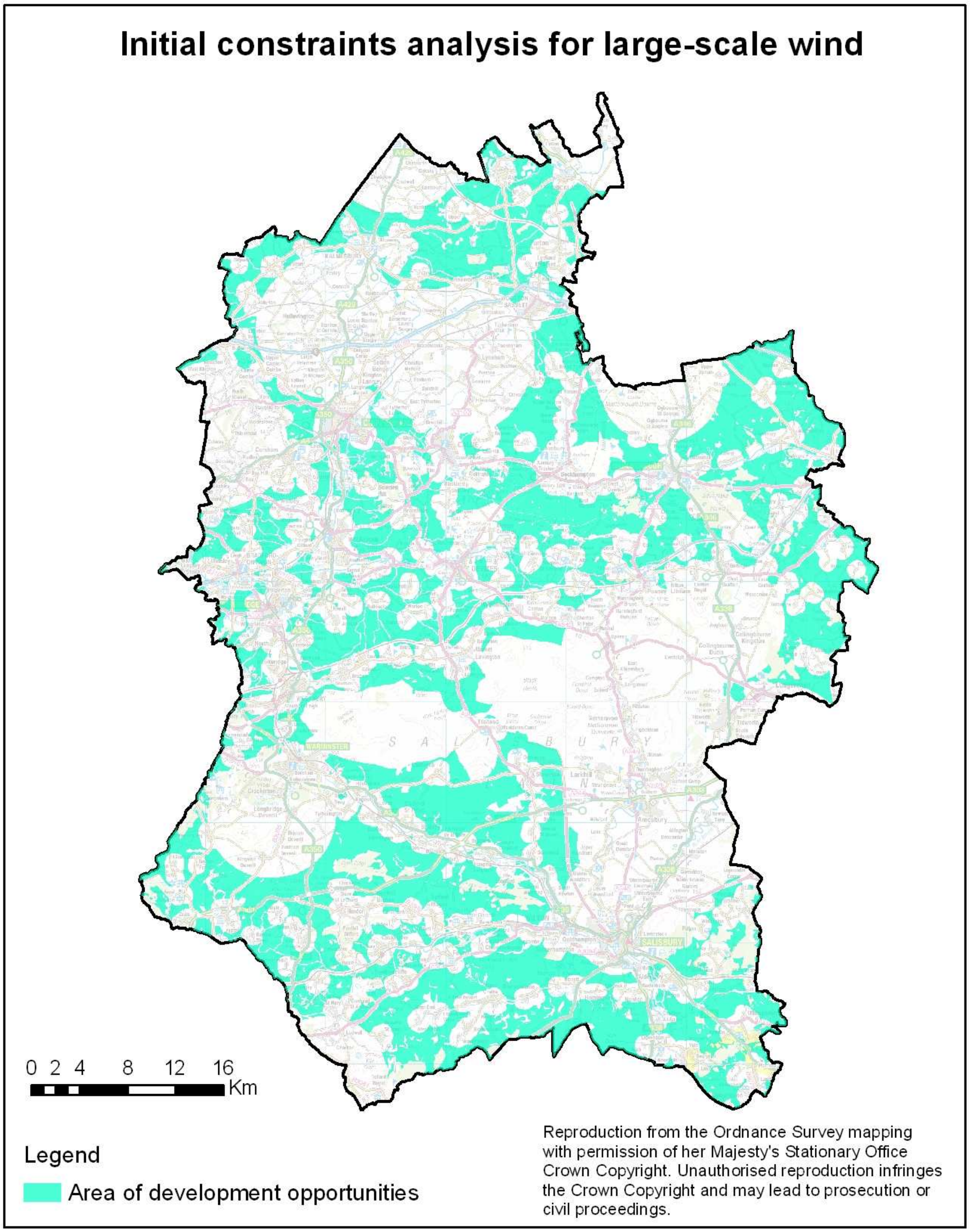


Figure 14: Area of large-scale wind development opportunities - including sites in designated areas

National designated landscapes and international and national nature conservation areas

Whilst the DECC methodology recognises sensitivity around these protected areas (Table 15), it states that these designations should not be automatically considered as a constraint to wind development. The methodology recommends that, in the absence of local studies to draw upon, high level assessments are carried out to identify the type and level of renewable energy infrastructure that could be accommodated within areas protected under these designations.

Table 16: Internationally and nationally designated areas

Designation category	Layer	Dataset source
International and national designations for landscape	Areas of Outstanding Natural Beauty	Natural England
	National Parks	Natural England
	Heritage Coast	Natural England
International and national nature conservation designations	Sites of Special Scientific Interest	Natural England
	Special Areas of Conservation	Natural England
	Special Protection Areas	Natural England
	National Nature reserve	Natural England
	Ramsar Sites	Natural England

Based on the recommendations of a landscape sensitivity analysis carried out by Land Use Consultants (LUC), the REvision 2020 report[43] considered designated areas within the South West Region as constrained for large-scale wind turbines. The same approach has been taken in this report, although, in line with Government guidance this does not necessarily preclude the siting of wind turbines within these areas based on the merits of individual planning applications. The total area suitable for development is reduced to 409 km^2 with a potential maximum installed capacity of 4,090MW when development sites are excluded (Figure 15).

[43] *REvision 2020. South West Renewable Electricity, Heat and On-Site Generation Targets for 2020* *http://www.oursouthwest.com/revision2020/*

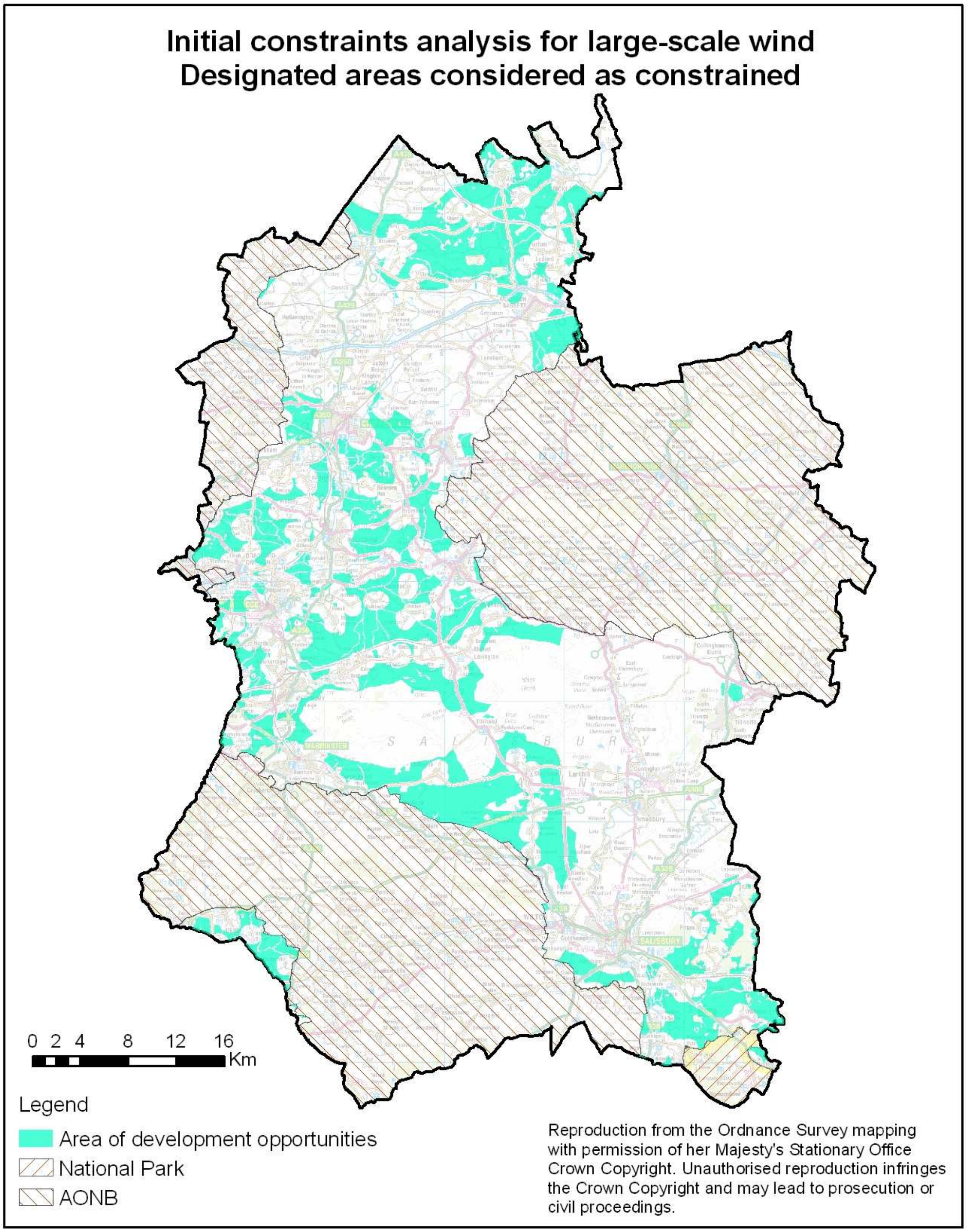


Figure 15: Area of large-scale wind development opportunities - excluding sites within designated areas

Proximity to buildings / settlements

Residents of dwellings in close proximity to wind turbines may potentially be affected by mechanical and aerodynamic noise and shadow flicker from wind turbines. An interim draft of the DECC Methodology discussed different approaches to take account of proximity to buildings, particularly housing, stating that 600m should be the distance applied for larger turbines (circa 2.5MW). The final version of DECC methodology, however, prescribes that the buffer should be applied to “built-up areas[44]” rather than to individual buildings. Although the latter significantly limits the land identified as suitable for wind energy, it merely reflects the fact that owners of all properties, even isolated rural properties, can raise objections and there is reasonable likelihood that if a development is closer than a stated ‘rule of thumb’ (600m in this case) it will not achieve planning permission.

Given the rural environment of a large part of Wiltshire, there is a significant number of isolated properties and small clusters of properties that are not captured as built-up areas by OS Strategi data. It has been therefore considered appropriate to apply a buffer around individual properties (as defined by OS Address Point) as an additional layer of constraint in order to avoid a large overestimation of potential.

Taking account of potential impact on individual properties, the area with opportunity for large wind development is reduced to 141 km^2 with a potential maximum installed capacity of 1,832MW (Figure 16). It should be noted, however, that this approach ignores the fact that large-scale wind economics might allow in some cases a negotiated settlement between the developer and property owner.

[44] *In the context of DECC methodology, “built-up areas” are equivalent to settlement polygons as represented in OS Strategi data.*

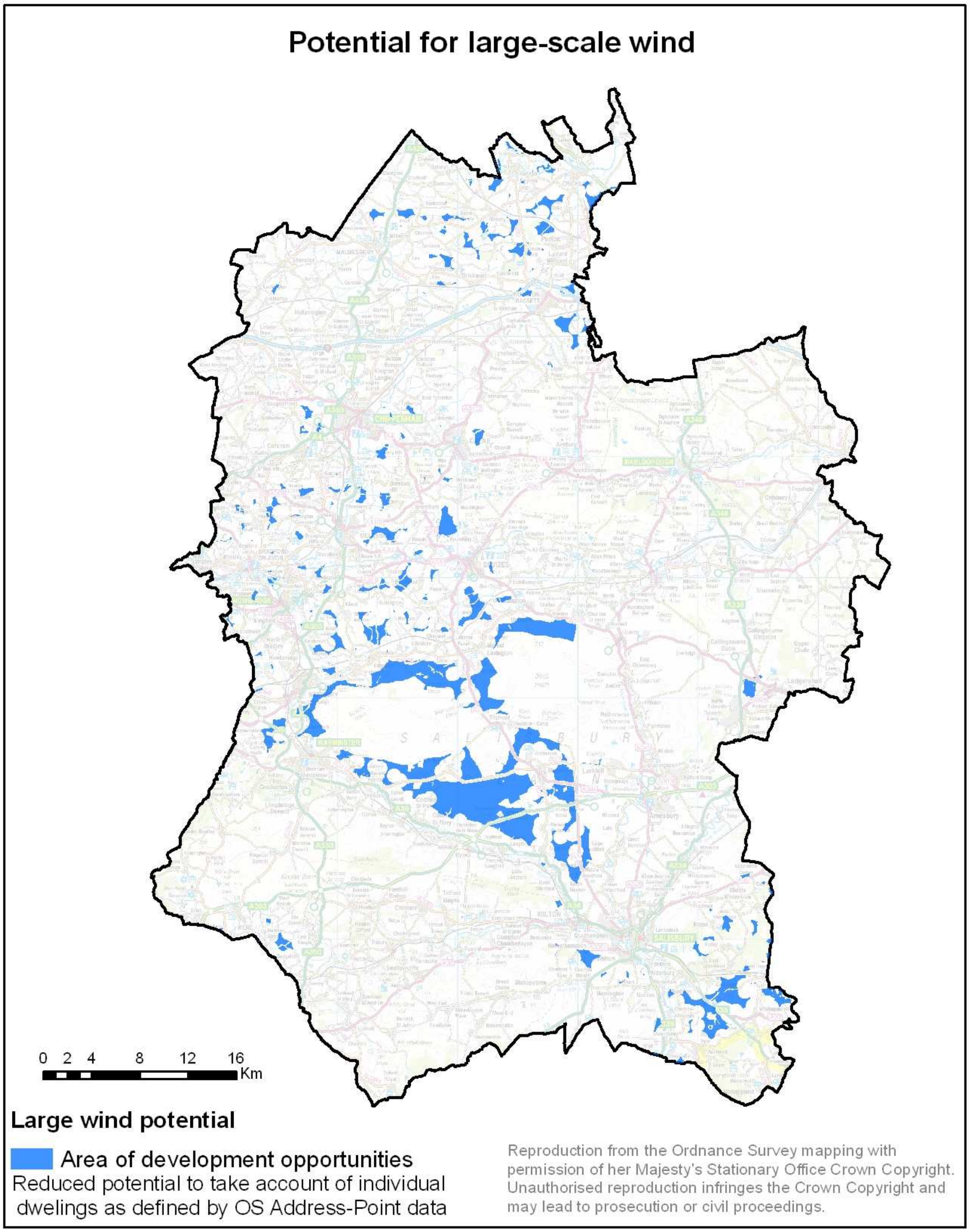


Figure 16: Large-scale wind: Reduced potential to take account of individual dwellings

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

The study identifies the key constraints that are likely to rule out wind turbine developments; however, there are a number of additional local issues and preferences that could constrain any specific wind turbine location. These include ease of grid connection, local/regional designations, site access (for construction), contamination and private airstrips. There may also be objections to wind turbine developments due to potential radar interference though it may be possible to mitigate these potential impacts. Appendix 8 includes 2 maps which show where there may be an impact on civilian and MoD air traffic control and/or air defence radar for large wind turbines with blade tip heights of 100m and 140m respectively.

The study does not take account of landscape / visual amenity constraints (other than by excluding internationally and nationally designated areas of land) which would need to be considered on a project-by-project basis against the local landscape character assessments to ascertain their potential impact.

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

5.1.1.3 Practical potential

5.1.1.3.1 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.

Development has been deemed viable for all sites with 3 or more wind turbines, 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’[45] projects; which will either require lower rates of return or benefit from direct electricity sales to an on-site user. Examples of this type of smaller scale of development are the

[45] *The term Merchant wind power refers to the development of wind turbine(s) to power a dedicated on-site energy demand.*

community project in Swaffham (Norfolk)[46] 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.

5.1.1.3.2 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.

5.1.1.3.3 Uptake 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 single large sites that could technically accommodate a greater number of turbines. This threshold has been derived by assessing British Wind Energy Association (BWEA) data of operational UK wind farms[47]. 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 for 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 for 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 rate therefore reflects the highest known approval rates which is used as an upper limit. This then reflects a future scenario of increased acceptance at a local level and supportive decision-making by officers and elected members and/or better constructed planning.

[46] *www.ecotricity.com*

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

Table 17: Large-scale wind: practical potential.

		Practical potential - 2020	
	Technical potential	Base case	Elevated case
Number of turbines	733	64	192
Capacity (MW)	1832.5	160	480
Electricity generation (MWh/year)	6,421,080	332,880	665,760
% of electricity consumption	281%	15%	29%

5.1.1.4 Large-scale versus small-scale wind

There is a significant difference in terms of electricity output based on the height and capacity of a turbine, and small scale turbines have a far lower output than large turbines (Figure 17). Hence, small scale wind offers significantly less energy generation potential compared to large scale installations, though it may offer other advantages, such as potential for location in closer proximity to dwellings.

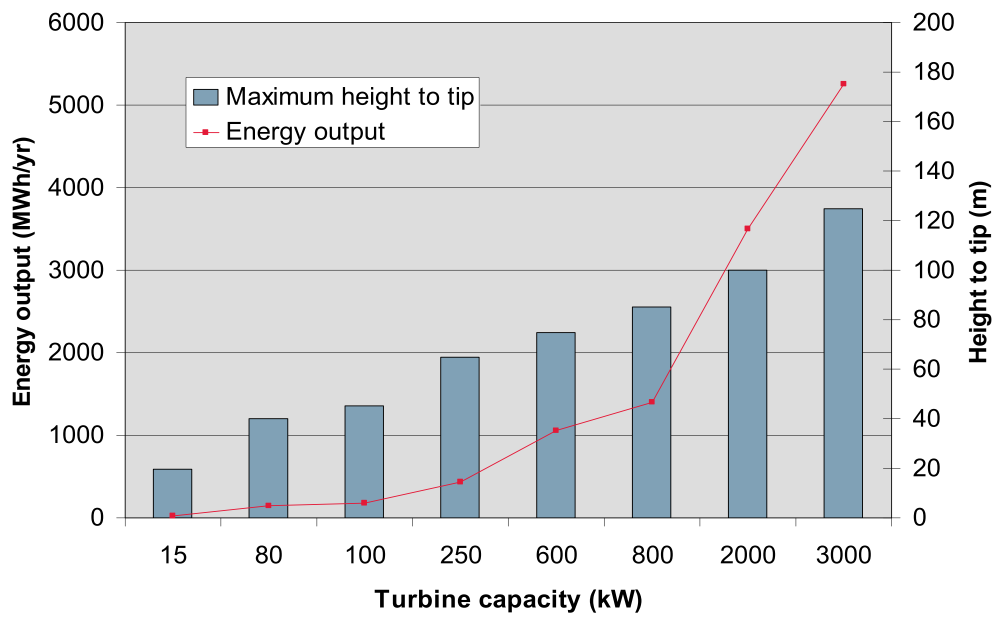


Figure 17: Turbine height compared to turbine output in MWh

Small scale wind turbines tend to be located within immediate proximity to the energy user, as insufficient economies of scale are generated to justify long cabling lengths. This factor more often overrides the constraints within the GIS analysis for large wind. Hence, the same GIS constraints are not applied in the estimations for small wind. The potential for small-scale wind is examined in section 5.2.

5.1.1.5 Wind economics

The economic feasibility of wind turbines depends primarily on wind speed, which tends to increase with turbine height. Generally the greater the wind speed, the more electricity will be generated and the faster the investment will pay back. The cost effectiveness of a turbine installation is usually measured by the payback period i.e. how long it takes for the value of energy produced to exceed the capital and running costs of the turbine.

Cost per kWh produced and payback time are dependent on factors which can vary from project to project, but include the length of cabling required to connect the turbine to the grid, and servicing and maintenance. The rates of revenue that generators receive under the Feed in Tariff have been set by DECC[48] and vary from 34.5 p/kWh for turbines under 15 kW capacity, to 4.5 p/kWh for turbines in the 1.5MW to 5 MW capacity range. Tariffs are increased annually in line with inflation.

5.1.2 Biomass energy

5.1.2.1 Overview of approach

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

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

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 and waste data provided by the council waste management team and data specific to the study area collated from Defra and a range of other cited sources. The analysis follows through a number of stages in order to arrive at a reasonable estimate of the available potential resource:

    1.1. Estimate theoretical potential i.e. the total quantity of feedstock generated in the study area.

    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

[48] *www.decc.gov.uk*

quantity of straw that can be extracted from the field using technology currently available.

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

- for sawmill co-products, the wood processing industry's needs are supplied first
- for crop residues, feed and bedding needs are supplied first
- for wastes, recycling is supplied first. Composting is not treated as competing demand[49].
- 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 firstly 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[50], 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[51].

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

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

The methodological principles and criteria used to quantify the biomass resource available for energy generation are broadly in line with those provided by the DECC methodology; as mentioned above in *Section 5.1.1*, the DECC methodology does not provide any guidance on how to identify uptake over a period of time. Specific assumptions are used to assess the resource potential for particular fuel types and any discrepancies with DECC methodology are described in Appendix 5.

[49] See Appendix 5 for reasoning.
[50] To inform the government's Renewable Energy strategy, the Department of Energy and Climate Change (DECC) [50] 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
[51] 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.

5.1.2.2 Local biomass resource and potential useful energy generation

Table 18 below shows the total quantity of each feedstock considered currently generated in Wiltshire (i.e. the total theoretical resource) expressed in oven dried tonnes and energy content[52].

Table 18: Theoretical potential of biomass sources

Waste stream		Theoretical resource - Wiltshire	
		ODT*	MWh
Municipal solid waste currently landfilled	Paper and card	29,936	91,470
	Green waste	7,140	15,942
	Food waste	3,839	18,675
	Wood waste	4,736	22,099
Household wood waste currently sent for energy recovery		2,756	12,862
Green waste currently diverted		6,386	14,258
Wood waste (C&I* and C&D*)		21,905	102,222
Food waste (Commercial)		2,203	10,715
Animal manure	Wet	103,348	138,590
	Dry	23,052	100,530
Straw		222,356	1,317,124
Energy crops		-	-
Sawmill residues		7,217	0
Forestry residues		21,654	100,453

*definitions provided in glossary

5.1.2.3 Practical potential

Figure 18 show potential useful energy generation over the study period, based on the fraction of the theoretical resource that is technically accessible and available for bio energy. Market uptake curves and efficiency of the relevant conversion technologies, as outlined in *Section 5.1.2.1 and detailed in Appendix 5,* are also considered. As shown in

[52] *Municipal waste data provided by Wiltshire Council Waste Management Team 3/2010*

Table 19 there is good potential for biomass development in Wiltshire with approximately 8% of current energy needs potentially met by 2020. This is equivalent to over 267,000 MWh/yr of power generation and 308,000 MWh/yr of heat generation from biomass boilers.

These figures do not take account of existing waste contracts that the Council has in place, which divert some of the potential biomass resource out of the county. This resource should eventually be made available to the county, but these contracts will limit availability in the coming years.

Table 19: Biomass practical potential (MWh/yr)

		Practical potential -2020
Energy generated (MWh/yr)	Thermal	308,545
	Electrical	267,175
	Total	575,720
Proportion of demand	Thermal	6.33%
	Electrical	11.68%
	Total	8.04%

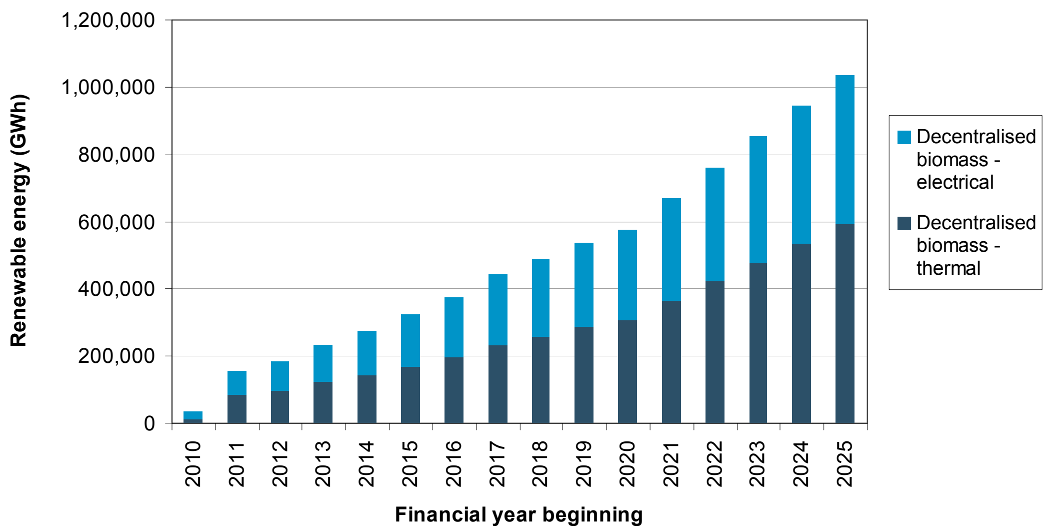


Figure 18: Biomass practical potential (MWh/yr).

The analysis assumes that:

- All available local biomass resource (i.e. generated within Wiltshire) is used according to the market uptake curves. It is assumed that this increase in use of biomass resources also reflects: an increase in planning approval rates for biomass power and CHP projects; maturing of the supply chain; and reduction / management of development and planning risk.
- No net import of biomass fuels from beyond the study area.

5.1.2.4 Delivering biomass energy

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

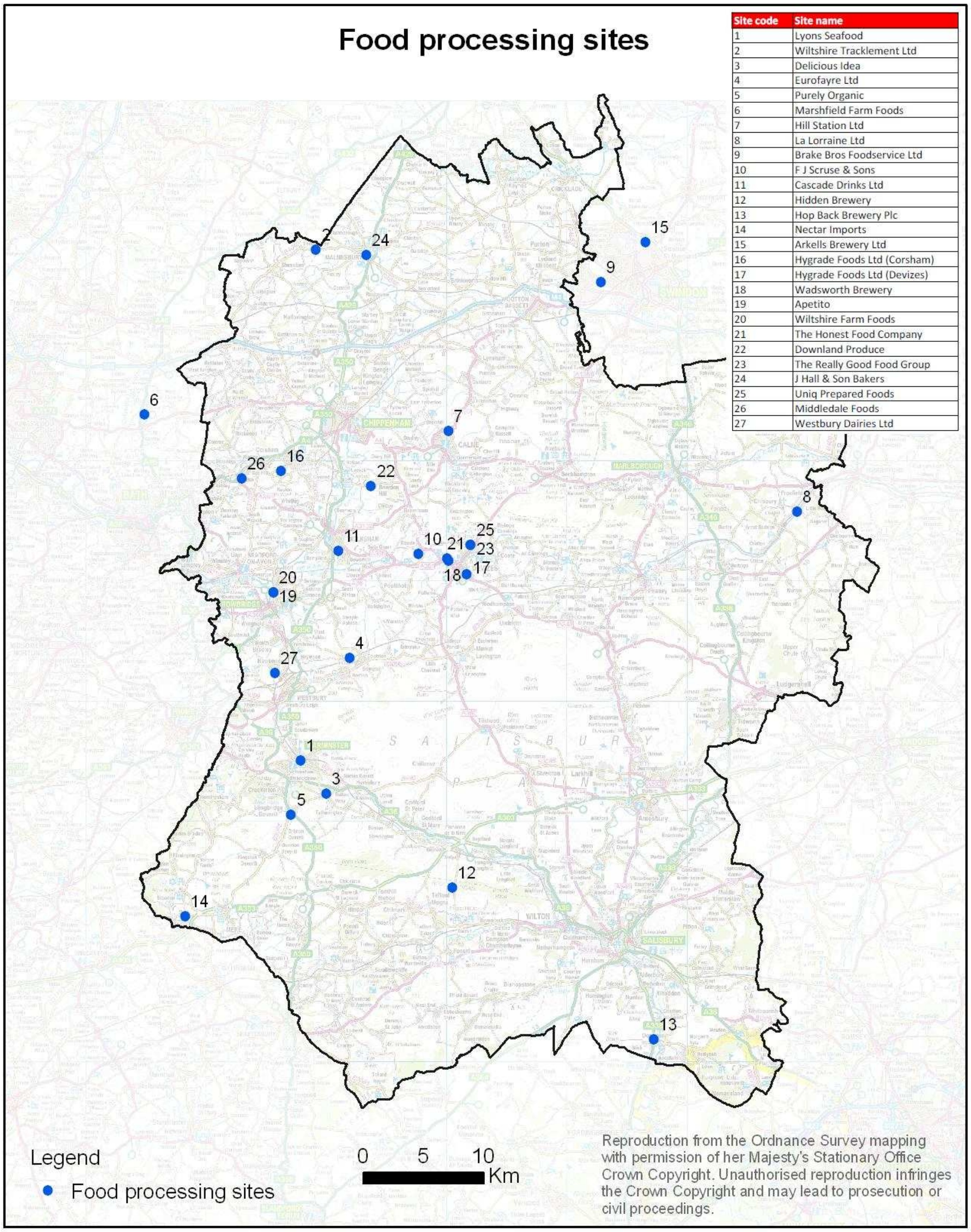
One possible source of fuel supply within Wiltshire is from food processing sites. Using anaerobic digestion (AD) technology, food waste, along with farm slurry, can be converted by digestive processes into biogas (which is used to create heat and energy) and a fertiliser known as digestate. An example is the redevelopment of the Bore Hill Farm site, in Warminster, which is expected to annually produce 680kWh of energy from around 12,000 tonnes of food waste and 5,000 tonnes of farm slurry. By looking at the locations of major food processing sites (Figure 19) future AD developments can be set up in conjunction with such sites to provide decentralised sources of energy supply to both new and existing developments.

The first key policy measure that the Council should undertake is to ensure that there is a sustainable and joined up approach to waste management throughout the county e.g. facilitate the utilisation of biomass waste for energy generation and set this requirement into future waste contracts

Other measures to help implement the potential of biomass in the county include:

- Incentive schemes for farmers to provide farm wastes for biomass energy generation
- Incentive schemes from land owners, such as the Defence Estates (though there are currently limited wooded areas/coppices on MoD land), to encourage woods and forests to become managed for woodchip supply
- Bring more woodland into management and manage as commercial forestry for woodchip production
- Establish a biomass fuel group to help set-up a wood-fuel supply chain for Wiltshire. This could build on the work of Regen SW's Bioheat programme[53] which stimulated demand for biomass in the south west by supporting boiler installations.
- Exporting biogas from sewage works, for example, into the gas network in larger towns such as Trowbridge which have with suitable gas pressure tiers

[53] *http://www.regensw.co.uk/projects/biomass*



Site code	Site name
1	Lyons Seafood
2	Wiltshire Tracklement Ltd
3	Delicious Idea
4	Eurofayre Ltd
5	Purely Organic
6	Marshfield Farm Foods
7	Hill Station Ltd
8	La Lorraine Ltd
9	Brake Bros Foodservice Ltd
10	F J Scruse & Sons
11	Cascade Drinks Ltd
12	Hidden Brewery
13	Hop Back Brewery Plc
14	Nectar Imports
15	Arkells Brewery Ltd
16	Hygrade Foods Ltd (Corsham)
17	Hygrade Foods Ltd (Devizes)
18	Wadsworth Brewery
19	Apetito
20	Wiltshire Farm Foods
21	The Honest Food Company
22	Downland Produce
23	The Really Good Food Group
24	J Hall & Son Bakers
25	Uniq Prepared Foods
26	Middledale Foods
27	Westbury Dairies Ltd

Figure 19: Food processing sites in the Wiltshire area

5.1.3 Hydropower

The results presented in this section have been derived from the findings of a study commissioned by the Environment Agency [54] (EA study) to identify the hydropower opportunities in England and Wales.

5.1.3.1 Overall resource

The study identified 356 sites within rivers in Wiltshire where small-scale hydropower schemes could theoretically be implemented (Figure 20). If all these sites were used for hydropower, the total theoretical potential would add up to 5.8 MW of power installed capacity. Assuming an availability factor of 95%, these sites could generate approximately 48,013 MWh/year. In reality, only some of these sites could be exploited due to environmental sensitivities, particularly the impact on migratory fish populations such as salmon and eels, as well as practical/economic constraints including access for construction and connection to the electricity network.

5.1.3.2 Hydropower opportunity categorisation

The EA study categorized the barriers (hydropower systems) in accordance to the estimated potential generating capacity of the turbine that could theoretically be installed (power category), as a function of the turbine discharge flow (the volume of water passing through the turbine at any given time, which will change depending on the time of year) and available head (the vertical distance between the point where the water is highest and the turbine).

Where data was available, the sites were also classified with regards to the environmental sensitivity of the barrier being converted to a hydropower scheme (Figure 21). Opportunities were classified as low, medium or high environmental sensitivity based on the fish species likely to be present and whether the site is in a designated area. This is a basic assessment that does not consider the full suite of environmental impacts, and is therefore indicative only.

[54] *Environment Agency. 2009. 'Mapping Hydropower Opportunities in England and Wales'.*

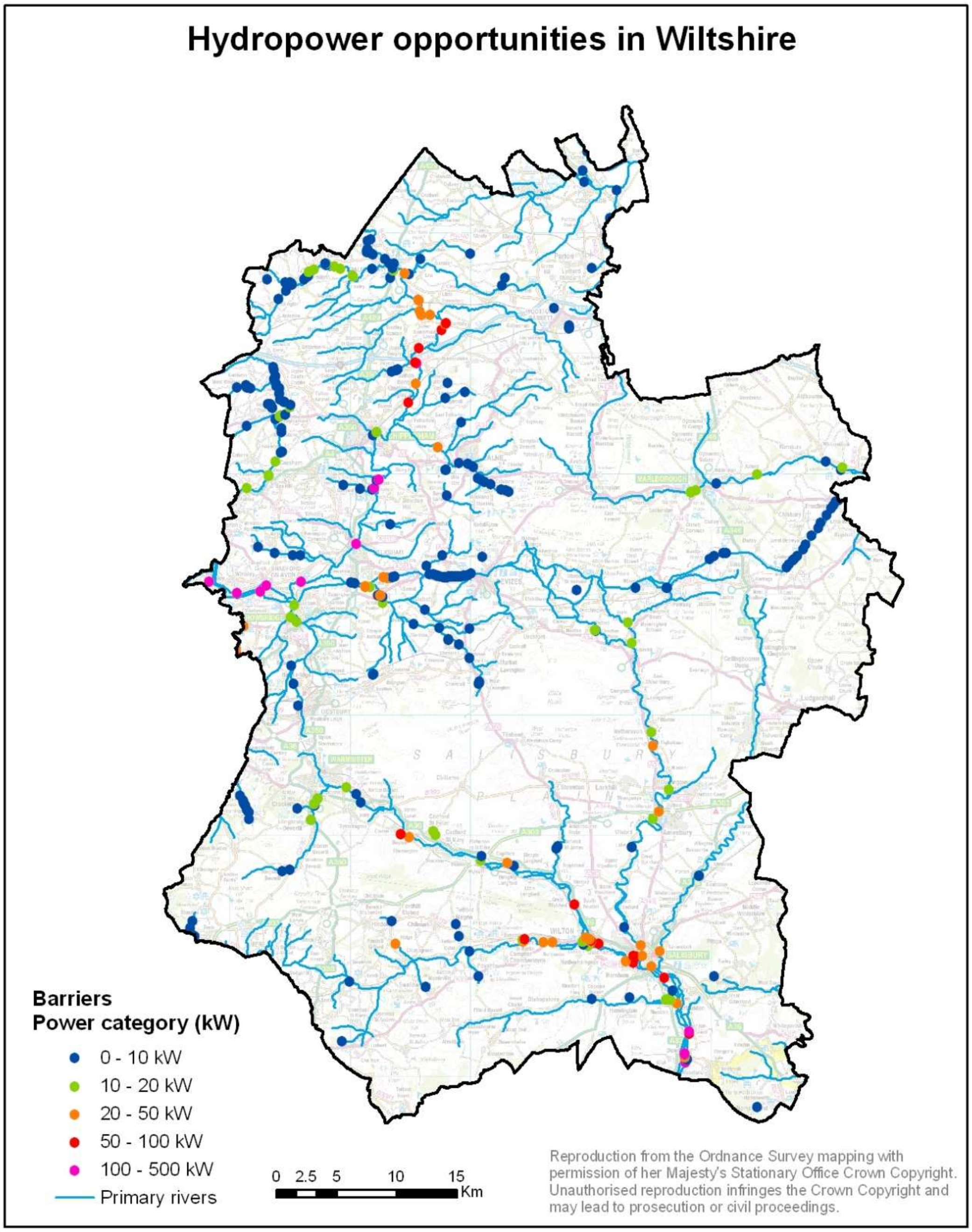


Figure 20: Hydropower Opportunities in Wiltshire defined by their power capacity

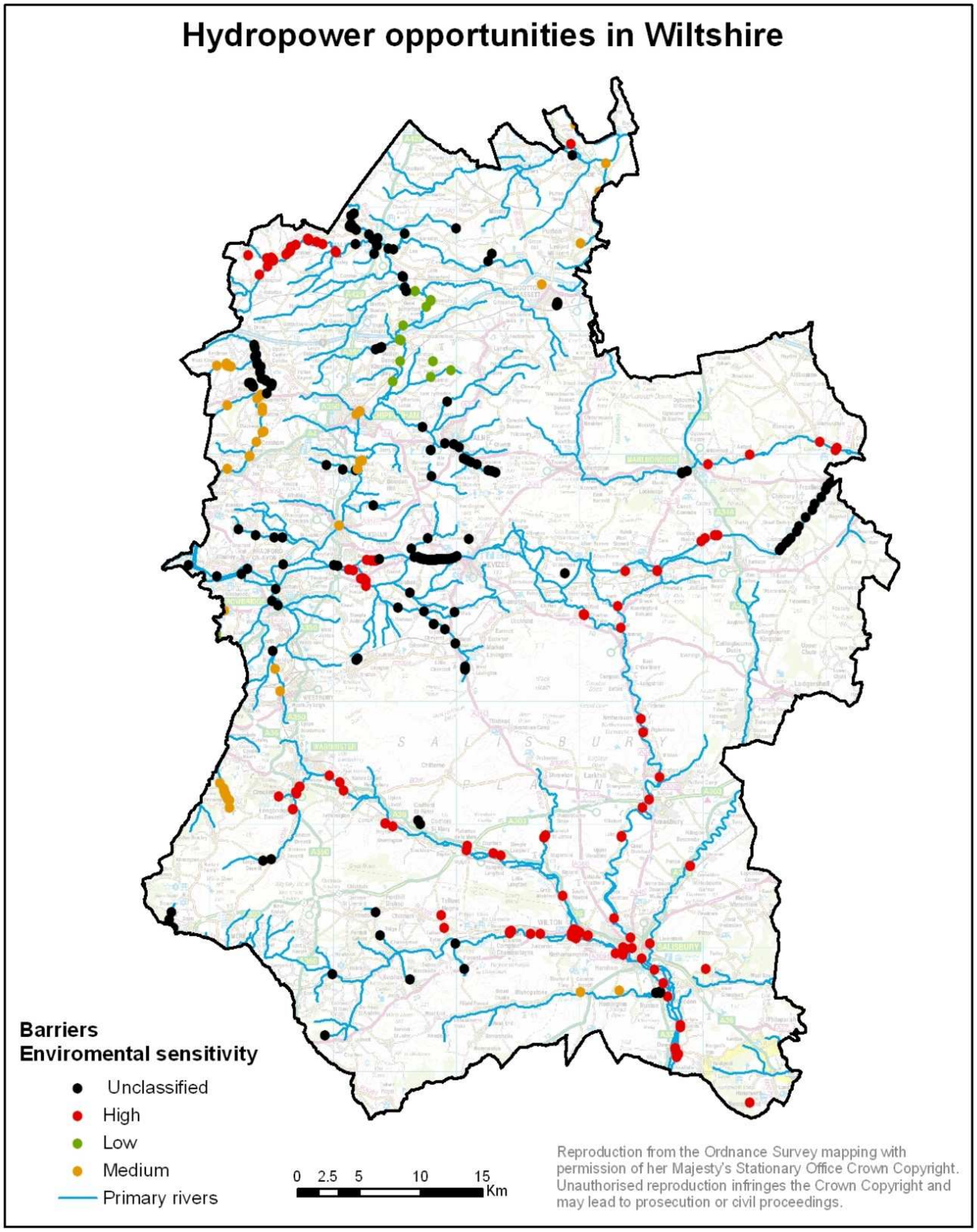


Figure 21: Hydropower Opportunities in Wiltshire defined by their environmental sensitivity

The Environment Agency's report presents an "overall opportunity matrix" for each of the regions based on the power potential and sensitivity categorisation of the barriers (Figure 22). The best opportunities exist at locations where there is a high hydropower potential and a low sensitivity categorisation, whilst the least attractive opportunities are those with low hydropower potential and high sensitivity. Using the technique employed by the Environment Agency an opportunity matrix replicated for the barriers identified within Wiltshire, with each of the barriers located into twenty matrix locations that have been further summarised into five final generalised categories (Figure 23).

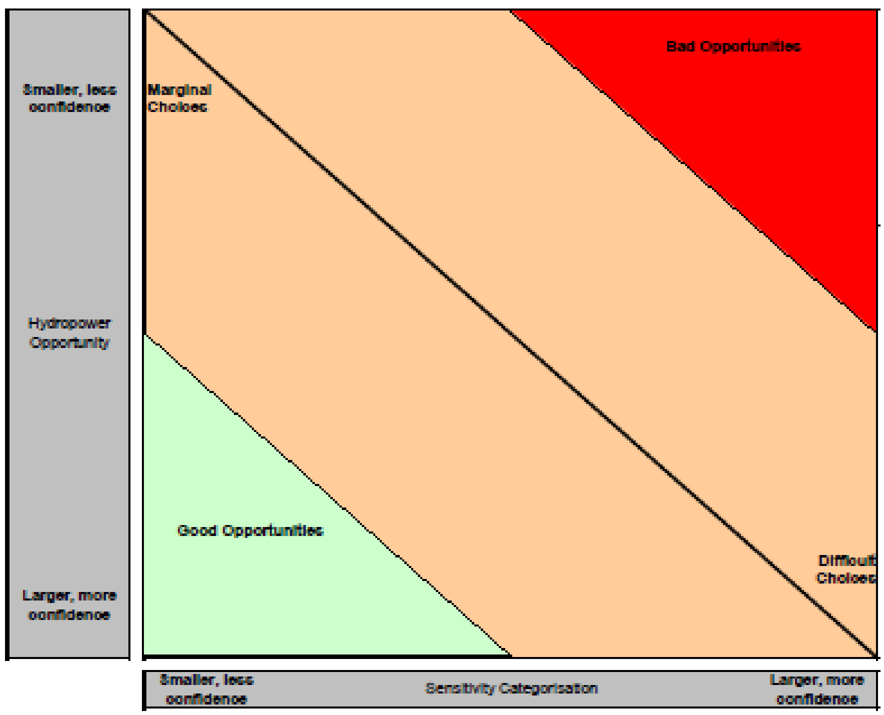


Figure 22: Opportunity categorisation matrix for hydropower sites

Source: Environment Agency (2009)

camco

		Sensitivity category			
		No sensitiv data	Low	Med.	High
Power category	0 - 10 kW	148	3	34	54
	10 - 20 kW	13		7	28
	20 - 50 kW	7	4	1	29
	50 - 100 kW		6		10
	100 - 500 kW	5	1	3	3

Number of barriers

		Sensitivity category			
		No sensitiv data	Low	Med.	High
Power category	0 - 10 kW				54
	10 - 20 kW	209		8	
	20 - 50 kW				
	50 - 100 kW	12		73	
	100 - 500 kW				

Number of barriers

		Sensitivity category			
		No sensitiv data	Low	Med.	High
Power category	0 - 10 kW	361	4	100	172
	10 - 20 kW	191		110	392
	20 - 50 kW	221	167	25	865
	50 - 100 kW		420		668
	100 - 500 kW	1,010	101	399	563

Maximum power potential (kW)

		Sensitivity category			
		No sensitiv data	Low	Med.	High
Power category	0 - 10 kW				172
	10 - 20 kW	1,045		136	
	20 - 50 kW				
	50 - 100 kW	1,531		2,887	
	100 - 500 kW				

Maximum power potential (kW)

- Good opportunities
- Moderate oportunities
- Bad opportunities
- Marginal choices
- Difficult choices

Figure 23: Wiltshire - Hydropower Opportunity Categorisation Matrix

Although, within the final categories only 20 barriers (5% of the total) fall within the good and moderate opportunities, this small percentage represents a potential power installed capacity of approximately 1,666kW or 30% per cent of the total maximum power potential for all the barriers (Figure 24). If a hydropower scheme was built on each of these 20 barriers, they could generate approximately 13,866 MWh, assuming 95% availability factor.

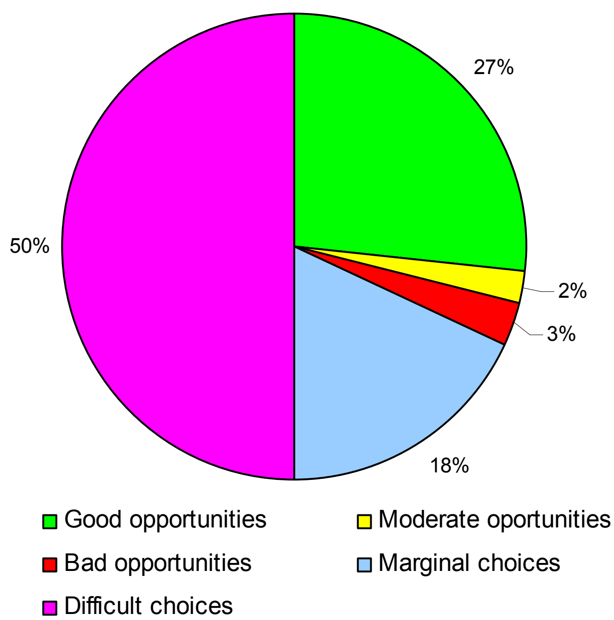


Figure 24: Wiltshire - Percentage of Total Maximum Power Potential per Category

5.1.3.3 Heavily modified water bodies and win-win opportunities

The Environment Agency study defines win-wins as an opportunity of medium to high power potential that is within one of the 2,708 heavily modified water bodies in England and Wales.

Within the Water Framework Directive, heavily modified water bodies are those water bodies which have been identified as being at significant risk of failing to achieve good ecological status because of modifications to their hydromorphological characteristics resulting from past engineering works. The study considers that, due to the characteristics of heavily modified water bodies, there is potential for the creation of a hydropower barrier to be beneficial to the passage of fish upstream. These locations are therefore considered “win-win” opportunities which could result in the delivery of good hydropower potential and improve the ecological status of a river.

Of the total 356 barriers identified in Wiltshire, 91 barriers are within heavily modified water bodies, of which 60 barriers have a power potential above 10kW. If a hydro scheme was built at each of these 60 barriers, the total installed capacity would add up to 3,902kW with the potential to generate 32,477MWh.

The EA recognises that win-win opportunities will not only exist in heavily modified water bodies, and it plans further work to identify such opportunities at the individual level through linking this work with work on prioritisation of fish passes for removal. The representation of win-win opportunities based on river status here is therefore used as a demonstration of the potential scale of win-wins available.

5.1.3.4 Practical potential: Uptake scenarios

The Environment Agency study did not carry out detailed research into each potential site. The site categorisations should therefore be seen as indicative only and simple working assumptions have been applied to estimate the practical potential for the following base case and elevated case scenarios.

Base case
It is assumed, as a working assumption, that 75% of "good opportunities" and 50% of "moderate opportunities", as defined in Section 5.1.3.2, will be developed. These proportions have been deducted to reflect sites where development would be largely uneconomic (e.g. due to poor access to the site, high grid connection costs) or the associated environmental impact would not be justified.

Elevated case
It is assumed, as a working assumption, that 75% of "win-win" potential opportunities (opportunities of medium to high power in heavily modified water bodies) will be developed.[55] As for the base case, a proportion of the win-wins identified have been deducted to reflect sites where development would be largely uneconomic or the associated environmental impact would not be justified. The capacity that could potentially be deployed by 2020 under both scenarios is shown below (Table 20).

Table 20: Hydropower: practical potential.

		Practical potential - 2020	
	Technical potential	Base case	Elevated case
Number of turbines	356	6-9	25-52
Capacity (MW)	5.8	1.2	2.9
Electricity generation (MWh/year)	48,010	6,748	16,236
% of electricity consumption	2%	0.3%	0.7%

[55] Note that the elevated case does not use the base case as its starting point, and reduce the percentages down from the assumptions made there. Instead it usesall the EA study's win-win opportunities as its starting point and arrives at a potential uptake figure from these based on the working assumption described.

5.1.4 Solar arrays

Roof top potential for solar PV is provided in the building integrated renewables section although PV on facades and PV fields may become more viable in the future as prices drop.

Optimising the actual energy output from a given PV system depends on a large number of factors. Two of the most important factors are (i) to select a site that is free from either natural or anthropogenic shadow casting and (ii) the amount and type of solar radiation that arrives at the surface of the PV panel.

In spite of the ability of flat plate PV panels to generate electricity from diffuse solar radiation as well (i.e. light that is scattered off of the clouds, ground and surroundings), it is clear that exposure to more hours of direct sunlight increases the energy output of a PV module. This is optimised by installing PV panels on a 30° incline facing due south. A sensible goal is therefore to select a site with maximum average annual sunshine duration.

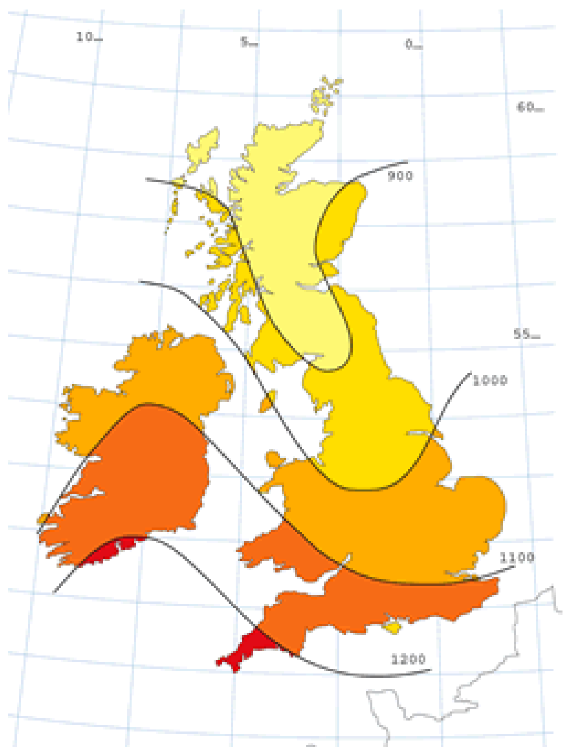


Figure 25: Map showing average solar radiation in the UK on a 30° incline facing due south

Source: Solar Trade Association[56] ©2010 Solar Trade Association

[56] *www.solar-trade.org.uk*

As Figure 26 shows, the highest levels of annual average sunshine duration in the South of England are at coastal areas. The highest levels of sunshine in Wiltshire on this map are in the south east of the county.

Choosing a site in close proximity to an existing high voltage substation will minimise potential capital expenditure (e.g. cost of cabling and potential grid reinforcement) to get the project connected to the grid. Sites should also ideally be close enough to electricity users to sell electricity directly to the consumer. Other possible considerations for PV developments include site security and land costs.

If ground-mounted, the land should preferably be of low value, i.e. former landfill sites, brownfield land, or low quality farmland. The site would also need to minimise the risk of vandalism or theft.

The areas of land needed to supply 1, 2, 3, 4 and 5 per cent respectively of the projected electricity demand for the Wiltshire area have been calculated below (Table 21). This is based upon the size of a 2MWp solar PV plant being around 220m x 220m with an output of 800mWh/mWp [57]. It should be noted that these are conservative values as the performance will depend on local conditions and on the technology utilised. As can be seen on the chart, to supply 5% of the projected electricity demand in Wiltshire by 2025 a total area of over 3.6km^2 would be needed. This is equivalent to 0.11% of the total area of the county.

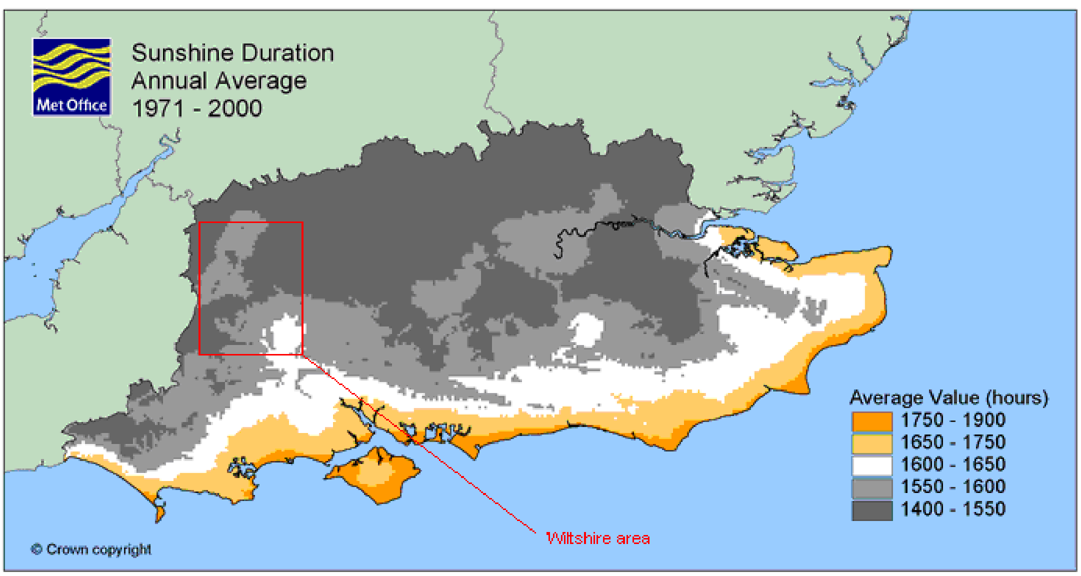


Figure 26: Annual average sunshine duration in the South of England 1971 – 2000
Source: Met Office[58]

A base case scenario has been assumed of ground-mounted solar PV supplying 1% of the total energy demand. This is equivalent to a total capacity of 28.6MWp and is similar to the output from two to three small to medium sized solar PV plants. Comparisons have been

[57] *Camco internal report on Solar PV*
[58] *http://www.metoffice.gov.uk/climate/uk/averages/regmapavge.html#*

made to solar parks in Bavaria, Germany, where Feed-in-Tariff's have helped establish a number of Solar PV plants. An example is the Erlasse Solar Park which has a capacity of 12MWp.

An elevated scenario is projected to be where 3% of Wiltshire's energy needs are supplied by ground-mounted Solar PV. This equates to a capacity of 85.7MWp. This would include the development of a larger plant similar to the Straßkirchen Solar Park, which has a capacity of 54MWp, and a number of smaller plants such as the Erlasse Park described above.

Table 21: Area needed for ground mounted solar PV to supply electricity to the Wiltshire area

	Year/Total area needed (km^2)			
Percentage of projected electricity demand	**2010**	**2015**	**2020**	**2025**
1%	0.67	0.68	0.69	0.72
2%	1.34	1.35	1.38	1.45
3%	2.00	2.03	2.08	2.17
4%	2.67	2.70	2.77	2.90
5%	3.34	3.38	3.46	3.61

Table 22: Ground-mounted solar PV: indicative generation potential

Scenario	Area (km^2)	Capacity (MW)	Electricity generation (MWh/year)	Percentage of projected electricity consumption
Base case	0.69	28.6	22,866	1.0%
Elevated case	2.08	85.7	68,560	3.0%

5.2 Building-integrated renewable energy potential

5.2.1 Technical potential

The methodological principles and parameters provided by DECC methodology[59] have been used to estimate the technical potential of building integrated technologies within Wiltshire (including small-scale wind).

5.2.1.1 Photovoltaics

The calculation considered all existing domestic and non-domestic developments consisting of 183,753 and 11,049 units respectively. The potential capacity from the new developments was also included in the calculations to reflect the overall capacity in the future.

In line with DECC methodology, the number of roofs suitable for domestic PV installations was assumed to be equivalent to 25% of the total number of domestic properties (including flats). For non-domestic installations, the number of suitable roofs was estimated to be equivalent to 60% of the total number of non-residential properties[60]. Finally, the capacity of the systems was assumed to be 2 kWp for domestic properties and 5 kWp for non-domestic properties.

As identified in Section 4, PV is prescribed as a viable solution for some new build residential developments. To meet the zero carbon needs of these future developments and in line with DECC Methodology, it was assumed that PV panels would be installed in 50% of the roof spaces which is in line with DECC's methodology.

The technical potential for photovoltaics is over 165 MW_p, contributing 5% of the existing baseline electricity demand in the county. This requires the installation of over 1 million m^2 of PV panels.

5.2.1.2 Solar Thermal

As identified in Section 4, solar thermal is prescribed as a viable solution for some new build residential developments. To meet the zero carbon needs of these future developments, panels would also be installed in new domestic properties given that SWH systems are most suitable for domestic buildings. Based on the methodology advised by the government, the same assumptions were made for SWH as for photovoltaics as described in the preceding section.

The technical potential for solar thermal is over 60,000 installations producing over 127 MW_p.

5.2.1.3 Heat Pumps

In line with DECC methodology, it was assumed that 75% of detached and semi-detached houses, 50% of terraced houses, 25% of flats and 50% of all new build domestic properties would be suitable for heat pumps. In the absence of clear guidance for non-domestic

[59] Renewable and Low-carbon Energy Capacity Methodology: Methodology for the English Regions. SQW Energy, January 2010.
[60] DECC methodology suggest that the number of suitable roofs is estimated separately for industrial and commercial properties: 40% for commercial properties and 80% for industrial buildings. In the absence of a breakdown of the number of commercial and industrial properties, the average of 60% as been applied to the total number of non-residential buildings as a whole.

buildings, Camco assumed 50% of non-domestic buildings would be suitable for heat pumps. The capacities of the heat pump systems were assumed to be 5 kW and 100 kW for domestic and non-domestic properties respectively.

Given that heat pumps were identified as another viable solution for the new builds, the technical potential for heat pumps was estimated taking into account all the existing and predicted new build properties in Wiltshire by 2025.[61]

The technical potential for heat pumps is for 1,348 MWt_h to be installed in all suitable dwellings and businesses.

5.2.1.4 Small-scale wind

As part of the study commissioned by Regen SW mentioned above, Wardell Amstrong assessed the technical potential of small-scale wind within the South West Region. In line with DECC Methodology, the number of small wind installations has been calculated as a function of the number of buildings, sequentially applying the parameters detailed below:

- **Determine the Natural and Technically accessible resource.** Consider all address points with wind speed at and above 4.5m/s at 10m above ground level (agl) derived from NOABLE wind speed database. Apply standard average turbine size of 6 kW installed capacity per address point.

Figure 27: 6 kW Turbine Source: www.ampair.com

- **Constraints assessment.** Categorise the built-up areas as urban, sub-urban and rural at ward level, and apply a wind speed scaling factor to each category (urban: 56%; suburban: 67%; rural: 100%). Exclude all address points where the resulting average wind speed is less than 4.5 m/s at 10m above ground level (agl).

The technical potential for small scale wind is over 51,000 installations with an overall generating capacity of approximately 308 MW_p

Small scale wind turbines, including larger capacity turbines such as 100 kW and 50 kW, could be particularly suited for out-of-town retail and industrial parks, as well as farms (there are around 1800 farms in Wiltshire), schools, and colleges. See appendices 1 and 2.

[61] *Any increase in use of heat pumps as plant for heating will also lead to a proportionate increase in demand for electricity to power the pumps.*

5.2.1.5 Summary of Technical Potential

The following table provides a summary of the technical potential for building integrated technologies in existing and predicted new build properties in Wiltshire by 2025.

Technical Potential	Number or Area	Capacity (MW)
Solar PV	1 million m^2	165.
Solar Thermal	60,000	127
Heat Pumps		1,348
Small Wind	51,000	308
Total		1948

Table 23: Technical potential for building integrated technologies within Wiltshire by 2025

5.2.2 Practical potential

The assessment of the technical potential presented above provides an indication of the total maximum generating capacity of each technology that could be installed within existing stock and future developments. However, it does not take account of a large number of technical, economic and supply chain constraints that will significantly limit microgeneration uptake. This section estimates the practical potential uptake of microgeneration as a whole, and separately for the existing stock and future developments.

5.2.2.1 New buildings

The renewable energy that will be generated from new developments has been modelled based on the renewable energy strategies chosen for residential and non-residential buildings in these future developments (Table 24). As shown in Table 24, it has been estimated that, by 2020, a total of 92,800 MWh (76,300 MWh thermal, 16,500 MWh electrical) of renewable energy will be generated from the new buildings in Wiltshire (Figure 28).

A similar approach to the viability testing in section 4.2 was taken while choosing the energy strategies for the different sites in order to predict the renewable energy that will be generated from new buildings within Wiltshire. The smaller developments that constitute urban and rural infill are typically not appropriate for communal systems and therefore the optimum energy strategy will consist of highly energy efficient buildings with individual building integrated technologies.

The urban extensions are at the larger size and density necessary to support a communal system in some or all of their development areas, and are large enough to potentially establish a long term power purchase agreement with a wind turbine developer or justify the creation of a local community owned ESCo on behalf of the future development.

Future building regulations for non-residential buildings are not yet set, besides the intention to make all such buildings zero carbon as of 2019. Therefore it was assumed that there would be a 25% target set on emissions reductions between 2013 and 2016 and a 44% reduction target between 2016 and 2019. All new non-residential developments were assumed to be zero carbon after 2019.

The energy strategies allocated to sites were all rule of thumb categorizations and there will often be an overlap between these development types within the characteristics of any specific development site. The specific characteristics of the site will also determine the technical and financial suitability of CHP and district heating systems. Therefore the energy strategies allocated for the purpose of estimating the renewable energy potential from new buildings are indicative only.

Table 24: Projected renewable energy generated from new developments within Wiltshire

Year/Carbon savings		Practical potential 2020	Carbon savings (tonnes of CO_2)	Practical Potential 2025	Carbon savings (tonnes of CO_2)[62]
Microgeneration energy generated (MWh)	Thermal	76,300	15,107	131,100	25,958
	Electrical	16,500	8,729	27,600	14,600
	Total[1]	**92,800**	**23,836**	**158,700**	**40,558**
Proportion of projected demand	Thermal	1.57%	-	2.63%	-
	Electrical	0.72%	-	1.15%	-
	Total	1.30%	-	2.15%	-

Based on the figures above, the carbon savings resulting from renewable energy installations in the new buildings would be equivalent to a total 23,836 tonnes of CO2 in 2020 and 40,558 tonnes of CO_2 in 2025[63].

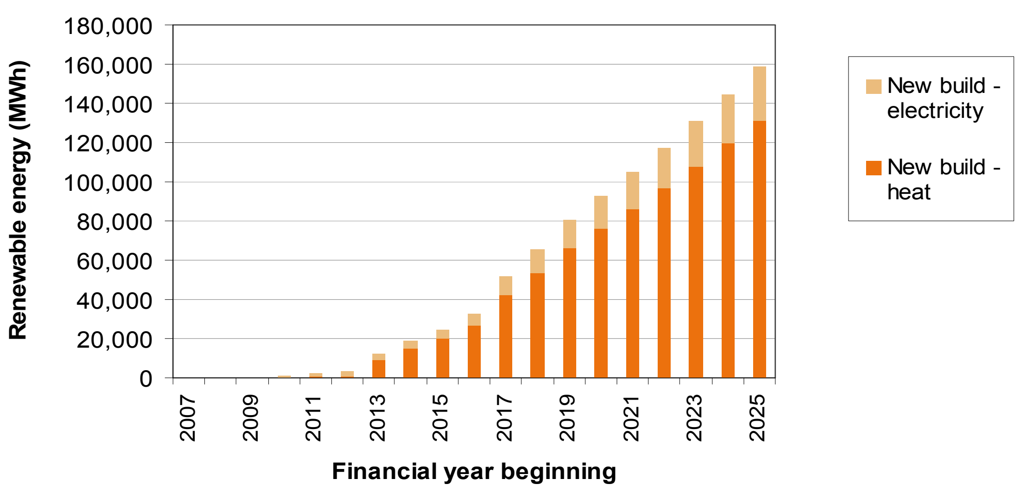


Figure 28: Projected renewable energy generated from proposed new developments within Wiltshire

[62] *Based on SAP 2009 guidance emissions factors used to work out carbon savings are 0.529 kgCO2/kWh for electricity and 0.198 kgCO2/kWh for gas*

[63] *Estimates are given up to 2025 as this is the last full year for which the proposed new build plan was provided.*

5.2.2.2 Existing Buildings

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[64]. This provides scenarios for the energy delivered by renewable sources for Great Britain as a whole, and a number of individual regions. The report 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. The scenario models uptake of microgeneration based upon technologies receiving 2p/kWh for heat and 40p/kWh[65] 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[66]. It is considered that this is the closest match to the current feed-in tariff for electricity, and the proposed Renewable Heat Incentive for thermal systems, which is under consultation.

The study provides overall energy generation for Great Britain. These figures have been scaled down for Wiltshire using the number of dwellings as a scaling factor (Table 25).

Table 25: Microgeneration scaling factor by number of dwellings.

Scaling factors by number of dwellings		
	Number of dwellings[67]	Proportion
UK (excl. NI)	24,730,887	100%
Wiltshire	183,753	0.74%

The study's results include new build uptake of microgeneration technologies. It is not possible to disaggregate the existing build component from the results, hence a working assumption has been made that 2/3^rds^ of the delivered energy is generated on/in existing buildings[68]. The remaining 1/3^rd^ is ignored to avoid double counting with the new build analysis.

[64] Element Energy, 2008, The growth potential for microgeneration in England, Scotland and Wales
[65] Our modelled tariff figures are very similar to current tariffs and based on the Element Energy study scenarios so have not been remodelled based on the actual current FIT.
[66] The annual payment is set for 20 years but the value reduces depending on the year of commencement of the project
[67] Wales, England and Wiltshire figures: National Statistics, 2009, ONS Neighbourhood Statistics, Housing, Accommodation Type - Household Spaces (UV56), data from most recent census in 2001; Scotland figures: Scottish Neighbourhood Statistics, Housing, Total number of households
[68] This is a judgement made by Camco based on a review of the Element Energy study assumptions and is used to form a potential scenario. The actual breakdown will be for the market to determine.

The estimated uptake scenario of the renewable energy potential in existing buildings within Wiltshire is 1.21% of the projected energy demand[69] in 2020 (Table 26). This equates to a renewable energy potential of 86,700 MWh/year for existing buildings (Figure 29).

Table 26: Existing buildings uptake scenario

Year		Practical potential 2020	Carbon savings (tCO_2) [70]
Microgeneration energy generated (MWh)	Thermal	77,800	15,404
	Electrical	9,000	4,761
	Total[71]	**86,700**	**20,165**
Proportion of projected demand	Thermal*	1.60%	-
	Electrical	0.39%	-
	Total	1.21%	-

Based on the figures above, the total carbon savings resulting from the renewable energy installations in existing buildings would equate to 20,165 tonnes of CO_2 by 2020.

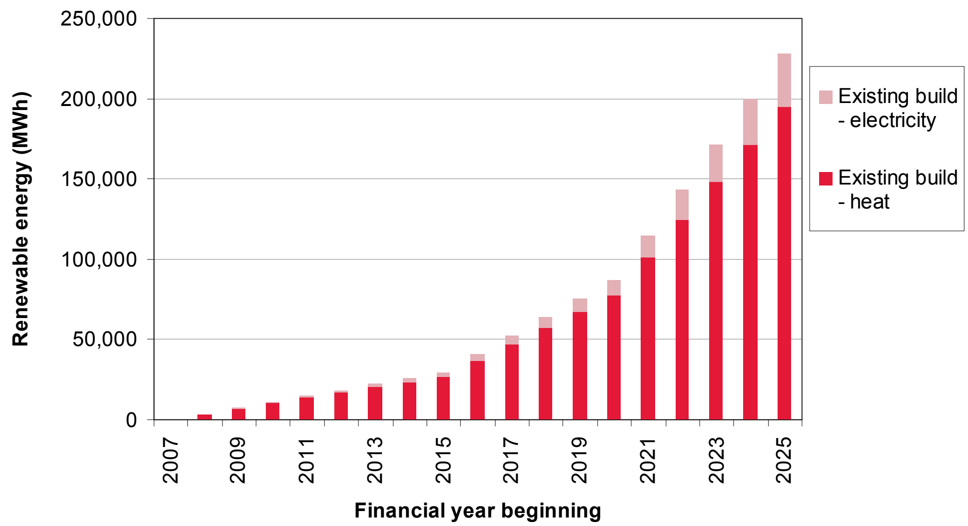


Figure 29: Existing buildings uptake scenario

[69] *Estimated growth in energy demand is based on 'Energy projections for the UK, DTI'*
[70] *Based on SAP 2009 guidance emissions factors used to work out carbon savings are 0.529 kgCO2/kWh for electricity and 0.198 kgCO2/kWh for gas*
[71] *Rounding applies*

5.2.2.3 Summary of Practical Potential for Building Integrated Technology

The following table provides an indicative breakdown of practical potential to the year 2020.

Practical Potential	Number or Area	Capacity (MW)	Energy Generated – Electrical (MWh)	Percentage of projected electricity consumption	Energy Generated - Thermal (MWh)	Percentage of projected thermal consumption
Solar PV	125,000 m^2	21	15,000	0.7%	-	
Solar Thermal	13,500	29	-		19,000	0.4%
Heat Pumps	12,000	67	-		135,000*	2.8%
Small Wind	1,400	8	10,500	0.4%	-	
Total	-	-	25,500		154,000	

Table 27: Breakdown of potential for building integrated technologies within Wiltshire by 2020

The table is based on a number of uptake assumptions for the different technologies.

Solar PV: 12.5% uptake on technical potential. This is a fairly ambitious target but achievable if PV prices drop and will depend on the FIT being maintained at favourable rates.

Solar Thermal: 22% uptake on technical potential. This assumes a high uptake on new buildings and some uptake on existing properties.

Heat Pumps: 5% uptake on existing stock and a similar level of uptake in new developments. *Around 38,500 MWh of electricity will be required to generate this much of thermal energy from heat pumps.

Small Wind: 3% uptake on technical potential. This assumes high uptake on farms and public sector owned properties such as schools.

5.2.2.4 Prediction of Renewable Energy Generation in Wiltshire

We have modelled the renewable energy generation associated with the growth plans for residential and non-residential development[72] over the next 15 years. It should be noted that technologies integrated within both existing buildings and proposed developments will play a significant role in the future renewable energy generation. Our modelling suggests that by 2025, around a total of 160,000MWh (130,000 MWh thermal, 30,000 MWh electrical) of renewable energy will be generated from the proposed new buildings in Wiltshire.

Figure 30 illustrates the total of renewable energy uptake in Wiltshire which is estimated to be around 2,000,000 MWh by 2025. The figure also demonstrates that a significant portion of this figure could potentially come from decentralised renewable energy sources, which can offer a large potential of around 1,663,000 MWh. The remainder of the estimated renewable energy uptake consists of the renewable energy technologies implemented in new and existing buildings. The annual breakdown of this model is provided in Appendix 9. Please note that these figures are indicative only.

[72] *The timetable for zero carbon non-domestic buildings lags slightly behind the housing timetable with all non-domestic development set to be zero carbon from 2019. In our modelling, we have assumed that by 2013, all non-domestic developments would be required to achieve 25% reductions in total emissions, followed by 44% by 2016 and become zero-carbon by 2019.*

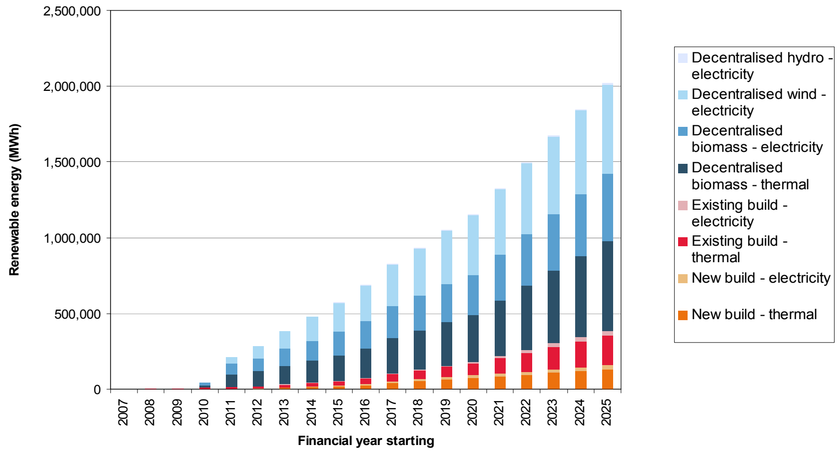


Figure 30: Summary of Renewable Energy Uptake in Wiltshire

The following table provides a summary of indicative practical potential to the year 2020, across all technologies.

Practical Potential	Number or Area	Capacity (MW)	Energy Generated – Electrical (MWh)	Percentage of projected electricity consumption	Energy Generated – Thermal (MWh)	Percentage of projected thermal consumption	Total carbon savings (tCO_2) [73]
Large Wind	64	160	332,880	15%	-	-	176,094
Biomas	-	148[74]	267,175	11.7%	308,545	6.3%	202,428
Hydro	6 - 9	1.2	6,748	0.3%	-	-	3,570
Ground mounted PV	0.69km^2	28.6	22,866	1.0%	-	-	12,096
Roof mounted Solar PV	0.125km^2	21	15,000	0.7%	-	-	7,935
Solar Thermal	13,500	29	-	-	19,000	0.4%	3,762
Heat Pumps	12,000	67	-	-	135,000[75]	2.8%	6,364
Small Wind	1,400	8	10,500	0.4%	-	-	5,555
Total	-	-	655,169	29.1%	462,545	9.5%	417,804

Table 28: Summary of indicative practical potential to the year 2020

[73] Emissions factors used to work out carbon savings are 0.529 kgCO2/kWh for electricity and 0.198 kgCO2/kWh for gas
[74] Biomass resources can be used as fuel for either heating only or CHP, using a variety of technologies. This is an indicative value for thermal capacity based on other studies.
*[75] *Around 38,500 MWh of electricity will be required to generate this much of thermal energy from heat pumps so the equivalent amount of carbon emitted is subtracted from the total carbon savings for this technology.*

5.3 Energy opportunity maps

Energy opportunity maps have been created for nine of the main towns in Wiltshire and the city of Salisbury (Appendix 6). These show the relative locations of potential sources of renewable energy and proposed future developments. Example maps for Salisbury and Chippenham can be found below. The potential renewable energy sites highlighted in the text are only indicative and would require individual viability assessments.

5.3.1 Chippenham Energy Opportunity Map

The energy opportunity map for Chippenham (Figure 31) identifies a number of renewable energy sources. Possible large-scale wind sites to the south of Chippenham could provide electricity to the large-scale proposed developments to the south and east of the town. Further electricity could be delivered via a hydropower source to the northeast.

Potential waste sites on the Bumpers Farm industrial estate to the northwest provide another possible renewable source via biomass feedstock and plant, providing electricity and heat either for the estate itself or the proposed new developments.

Energy Opportunity Map - Chippenham

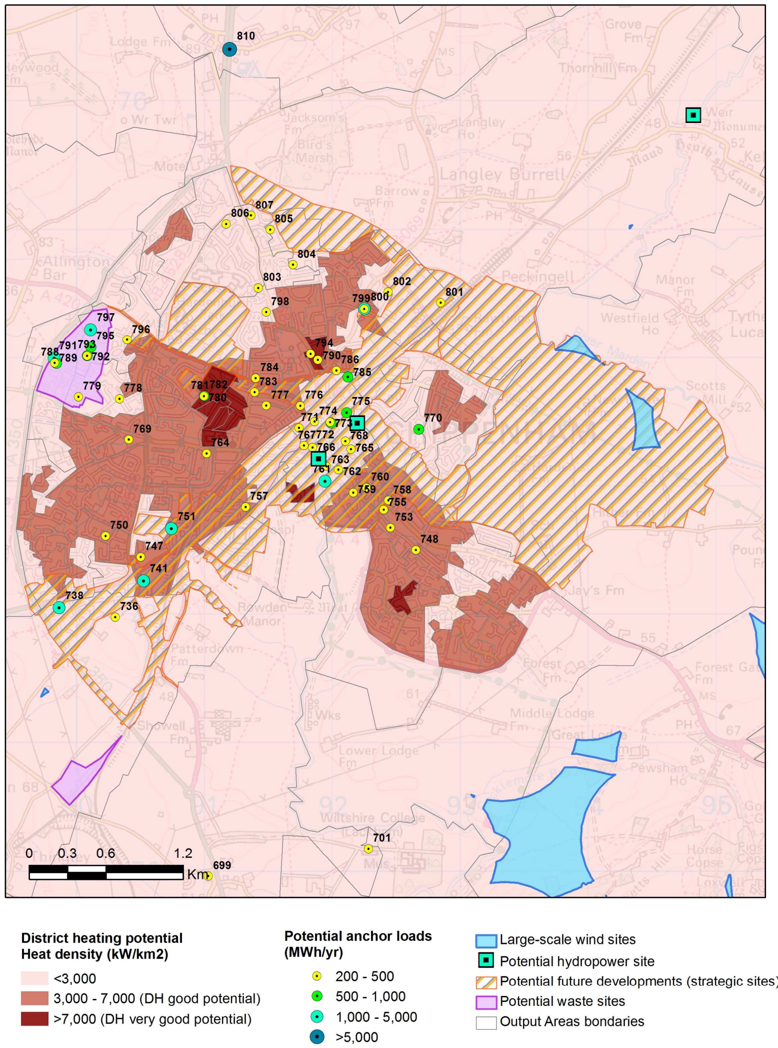


Figure 31: Energy Opportunity Map for Chippenham

5.3.2 Salisbury Energy Opportunity Map

The energy opportunity map for Salisbury (Figure 33) identifies a number of renewable energy sources and provides examples of how energy sources could be allocated to proposed new developments (Figure 32).

There is potential for a biomass plant to be developed for the *South of Netherhampton Road* site to work in conjunction with an adjacent waste site. A number of possible large-scale wind sites are also identified to the south of Salisbury which could provide electricity to proposed development sites in the south of the city such as the *South of Netherhampton Road*, *Churchfields and Engine Shed* sites.

A further potential waste site to the northeast of the Salisbury could be a potential source of biomass renewable energy and heat to the *Hampton Park* housing site.

The hydropower sites that have been identified are subject to high environmental sensitivity but a number of these sites do provide the opportunity for large-scale hydropower. Possible locations include the Bishops Mill on the Avon and the Old Mill on the Nadder, both of which have been previously identified by Salisbury District Council as potential sites[76].

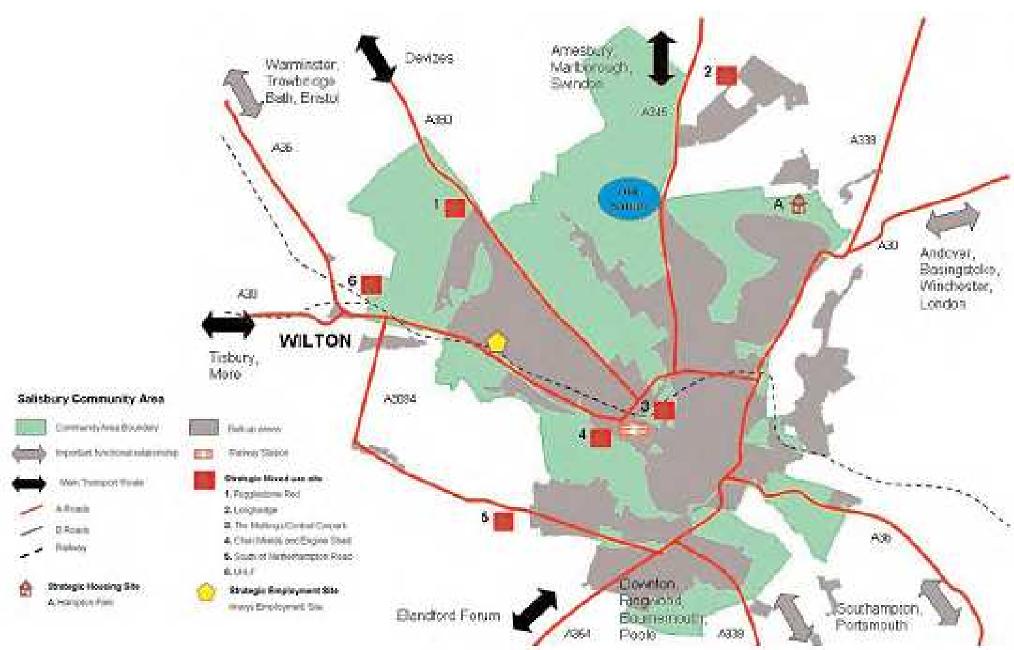


Figure 32: A spatial strategy for the development of Salisbury.
Source: South Wiltshire Core Strategy – Submission Draft (July 2009)

[76] *http://documents.salisbury.gov.uk/council/committees/Cabinet/2009-03-25/R06-2009-03-25.pdf*

Energy Opportunity Map - Salisbury

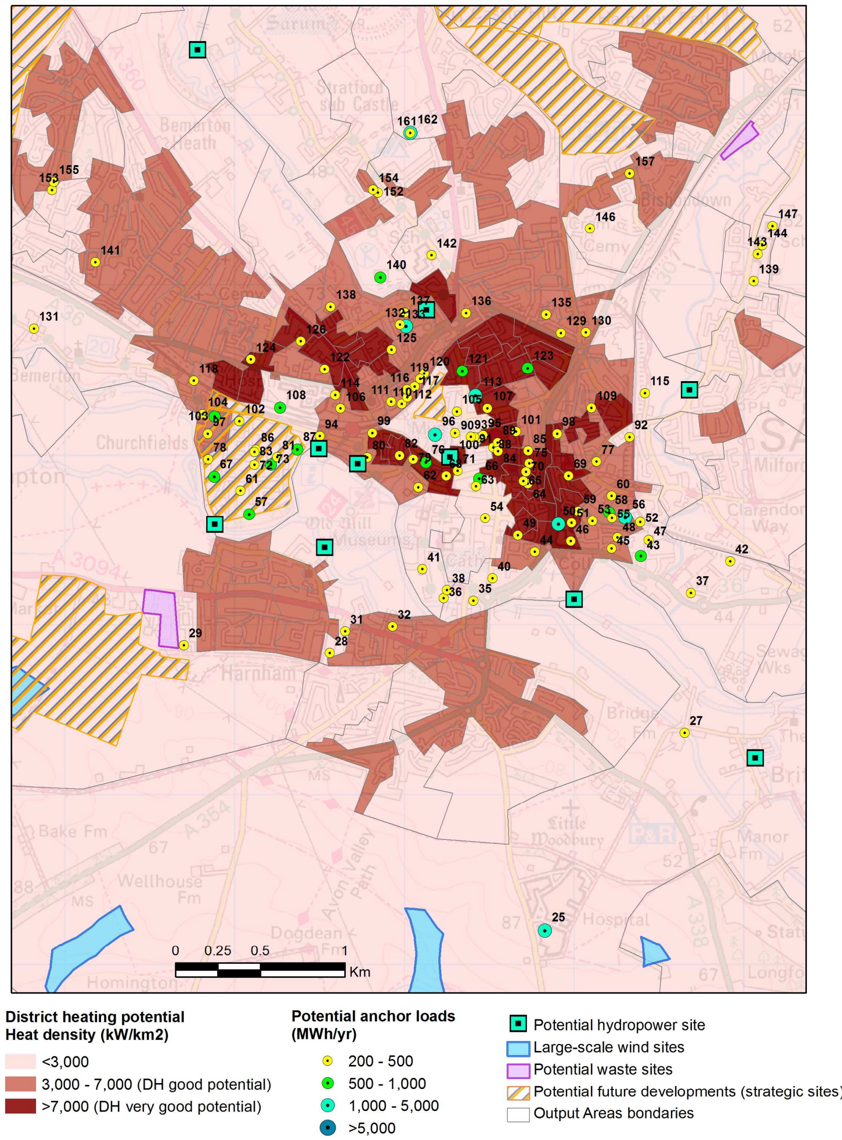


Figure 33: Energy Opportunity Map for Salisbury

6 Conclusions

6.1 Renewable Energy Assessment

Our analysis, in section 5, of the potential renewable energy resource within Wiltshire, has demonstrated that the local renewable energy resource can amply meet the energy demands of the planned new development and supply a far greater proportion of energy consumption for existing buildings.

The total practical potential for renewable energy (electricity and thermal energy) within Wiltshire is estimated to be around 2,000,000 Megawatt hours (MWh)[77] by 2025[78]. This includes microgeneration technologies from existing and new buildings, as well as decentralised energy sources such as biomass, wind and hydro.

The following table shows the base case target scenario for renewable electricity generation by 2020 (a national target year for emissions reductions). This base case is calculated using a number of strict assumptions for a variety of social and economic variables.

Potential Electricity Generation 2020 (Base Scenario)

	Number or Area	Capacity (MW)	Electricity generation (MWh/year)	Percentage of projected electricity consumption	Total carbon savings (tCO_2)[79]
Large Wind	64	160.0	332,880	15.0%	176,094
Biomass		148[80]	267,175	11.7%	141,336
Hydropower turbines	6 - 9	1.2	6,748	0.3%	3,570
Ground mounted PV	0.69km^2	28.6	22,866	1.0%	12,096
Roof mounted Solar PV	0.125km^2	21	15,000	0.7%	7,935
Small Wind	1,400	8	10,500	0.4%	5,555
Total	-	-	655,169	29.1%	346,586

Recommendation 1

This report provides a very achievable base case of renewable energy generation which is close to the minimum of what the Council should be doing to play its part towards meeting the national target of 30% electricity generation from renewables by 2020. An elevated case also provides an achievable target for renewable energy generation if developments are supported by positive investment rates and planning policies. However, considering the current lack of renewable energy generation in Wiltshire this target would be very challenging. Thus Wiltshire Council should set a target for each technology, in line with the base case scenario, as a practically achievable target for 2020.

[77] 1 Megawatt hour = 1,000 kWh units of energy
[78] Data for 2025 is shown as this represents the last calendar year in the proposed new build trajectory to 2025/26
[79] Emissions factors used to work out carbon savings are 0.529 kgCO2/kWh for electricity and 0.198 kgCO2/kWh for gas
[80] Biomass resources can be used as fuel for either heating only or CHP, using a variety of technologies. This is an indicative value for thermal capacity based on other studies.

Recommendation 2

To help overcome the particular barriers there have been to renewable energy resource uptake in Wiltshire, the Council should play a role in stimulating local community-owned renewable energy and revenue generation, including, wind energy and solar PV.

Recommendation 3

To support the uptake of biomass as a resource, the Council must ensure that there is a sustainable and joined up approach to waste management throughout the county e.g. facilitate the utilisation of biomass waste for regional energy generation and set this requirement into future waste contracts.

6.2 Carbon Standards for New Development in Wiltshire

When considering carbon requirements within the core strategy the key question is whether the proposed Building Regulation improvements are adequate or whether Wiltshire Council would like to set stricter requirements. Tighter requirements could be set for all new development in the county or site specific policy could be set for specific developments.

Of the remaining 38,347 dwellings required to meet the target set in the proposed changes to the draft RSS[81] by 2026, 48 % have been identified as being deliverable between 2009 and 2016. This means that any locally specific carbon standards for new development will only impact on these 18,000 dwellings. This is because national legislation will require all new housing to be zero carbon from 2016 onwards regardless of local policy. Any amendment to this figure will inevitably impact upon the delivery of the identified sites, and this could result in the delivery to 2016 being reduced from the figure above. This would have a smaller corresponding impact on carbon emissions.

This report does not support bringing forward tighter carbon standards in advance of national requirements, which are already challenging for developers in their own right.

Recommendation 4

The Council should not set a locally specific carbon standard across all new developments in advance of tightening national requirements.

Nonetheless, if the first phases of the larger scale developments come forward before 2016, and these first phases install energy solutions that only achieve relatively small carbon savings, then they might miss the opportunity for putting in place zero carbon infrastructure across the whole of the development.

It is important that developers do not opt for cheaper strategies in the earlier phases which jeopardise the ability of the development to achieve significant carbon savings in the longer term (post 2013/ 16). In particular, developers need to plan for a communal system from the outset so as to ensure that greater carbon reductions are achievable. If developers concentrate on individual building systems for the earlier phases in the period pre-2016, then it will be difficult to introduce successful communal systems in the later periods.

The options outlined in Section 4 provide a useful guide to the energy strategies that developers will need to install in order to achieve very high carbon standards.

[81] During the preparation of the study the Draft RSS for the South West has been revoked and a review of housing figures is currently under way by the council. This may result in the proposed housing figures for Wiltshire being amended.

A detailed understanding of the technical requirements for different development types will also enable the Council's planners to outline in detail what they expect from developers - which will aid planning negotiations. It will also help ensure that energy strategies for phased developments are future-proofed so that they do not opt for individual building solutions in the early phases which jeopardise the viability of a development-wide CHP and district heating scheme.

Recommendation 5

Specialist training and continuous professional development should be provided to planners in the different renewable energy systems available and their impacts on developments.

6.3 Potential Low Carbon Policy for the Core Strategy

The tightening carbon requirements in the Building Regulations over the next six years until zero carbon requirements by 2016 will allow developers flexibility in terms of their choice of technology and approach to meeting carbon targets. The Council needs to determine how to embed these carbon requirements within the core strategy and subsequent LDFs, and to shape the interpretation of the Building Regulation requirements within the area. This situation is made even more complex by the Government's changing definition of what constitutes a zero carbon home.

The two key variables in terms of crafting planning policies for new developments are the level of carbon reductions required and the flexibility allowed in meeting these requirements. If planning policy is only prescriptive over carbon targets and is not able to exercise some degree of control over the choice of technology, then developments may opt for technologies that may be inappropriate for the particular location or 'sterilise' the ability of the development to achieve very low to zero carbon status in the long term. As outlined in Section 4, the type of development and the scale of the development all determine the most appropriate technical approach to energy supply and the level of carbon reductions that are achievable. In general, larger developments are able to achieve significant carbon reductions more cost effectively than small developments.

If the Government's proposed new definition of zero carbon housing is followed, then the developments can achieve zero carbon standard status through a combination of microgeneration and communal energy supply systems.

The analysis also demonstrates that 30% of the new development will be large scale, suitable for communal energy supply systems, which are more capable of achieving low to zero carbon standards through on, or near-site, energy supply.

Recommendation 6

The Core Strategy and subsequent LDF documents should indicate the types of low carbon energy systems that the Council expects developments to incorporate and encourage developers to install communal systems, where applicable – with a requirement for these in developments over 500 residential units.

6.4 Viability of Higher Carbon Standards for New Development

It is very difficult with current technology for the average small scale urban or rural infill to achieve very substantial carbon reductions unless the development can share energy systems with existing neighbours. This is mainly due to the fact that PV will be relied on to generate electricity and with limited space to integrate PV in dense urban infill it may not be technically feasible.

For larger urban extension developments of over 1000 dwellings, the chances of achieving zero carbon status are greater if biomass or gas CHP can be used to generate renewable electricity. The large developments, such as urban extensions, are more easily able to achieve zero carbon status using a range of renewable technologies and communal heat networks, with the majority of electricity provided by wind energy, biomass/gas CHP and PV.

If larger developments in Wiltshire can be built in conjunction with large wind turbines then they have a much better chance of achieving zero carbon energy supply. Large wind turbines can provide substantial amounts of zero carbon electricity. New developments could establish a contractual relationship with wind turbine installations located away from the site.

The inclusion of a large wind turbine, for example, can be an important element of a low carbon strategy, but in order to progress this option the developer will need to arrange a contract with a wind turbine developer and a land-owner. This presents additional challenges for the developer and the Council may need to assist the developer in forming relationships with adjacent land-owners and in encouraging land-owners to opt for installing turbines on their land. The Council could play a role in stimulating and sanctioning such relationships between housing developers and commercial wind developers or between developers and a local community owned wind farm.

It is unlikely that a large wind turbine can be located on the actual development site as it would be too close to housing, and it will therefore need to be located on land close to the site. This will require the LDF to specifically allow for 'offsite' renewable energy in supplying energy to new developments, so that developers can generation capacity using a wind turbine, for example, located on land nearby to provide power for the development. There are additional issues that will need careful consideration for each development.

The Council should therefore consider allocating sites for renewable energy generation that can supply the major new developments. The 'energy opportunity' maps shown in Appendix 5 indicate potential sites for some of the main town developments, though individual sites would need viability assessments.

Recommendation 7

Use this report and any subsequent analysis to highlight to developers the key renewable energy sources in the area, and how these relate to the key development sites. In order to help meet the targets recommended above, new developments need to start exploiting the renewable energy resources identified in the maps shown in Appendix 5.

Recommendation 8

Apply heat mapping data in the most densely populated areas and appraise possible heat infrastructure projects linked to major new developments and the existing major heat loads and major heat waste opportunities.

Recommendation 9

Encourage housing developers to work with renewable energy developers e.g. wind and biomass, and with expert ESCos to design, finance and build energy supply systems within their developments.

6.5 Sustainable Energy Strategies for Development Sites

Section 4 considered the costs of delivering further carbon reductions in new developments as progress is made towards CSH 6 and achieving a zero carbon development. Developers can work in partnership with an Energy Services Company (ESCo) to finance, maintain and operate the energy system for a new development and therefore reduce the costs and the level of burden that they face.

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

Planning policy content

Planning policies should require evidence from developers as to how they intend to meet carbon reduction targets, identifying how they could achieve maximum targets where lower cost solutions are viable (such as CHP, existence of communal heating infrastructure, access to surplus heat or biomass heating). 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 targets
- 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 authority and wider area
- Exploration of opportunities to support the development of low zero carbon infrastructure serving existing developments
- Exploring additional income through ESCo and/or capitalisation of renewable energy tariffs

Wiltshire Council 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 Service Companies
- Impact on overall viability of the development using an assessment method such as the Home and Communities Economic Viability model that will examine factors such as land value, sale value, construction costs and other s106 contributions.

Recommendation 10

Ensure that the master plans for the key growth sites contain comprehensive zero carbon methodologies addressing buildings and low carbon infrastructure. It should be made compulsory for all developers to produce a detailed sustainable energy strategy for all development sites, with the onus on them proving why zero carbon standards are not possible if this is the claim.

6.6 Monitoring and Enforcement

Effective measurement and management is essential to ensure that the Council's requirements are met. To develop effective monitoring and compliance processes we make the following recommendations:

Recommendation 11

Ensure that the new developments include provisions for energy monitoring in their energy strategies that accompany planning applications. The monitoring programmes should be able to provide annual figures on CO_2 emissions for dwellings and non-residential buildings, and preferably non-residential buildings split into office, retail and industrial. It would also be useful to obtain figures for the amount of energy generated by different renewable energy technologies to compare with the original energy strategies in order that lessons can be learnt if any of the systems are under performing.

Recommendation 12

Wiltshire Council should prepare CO_2 emissions trajectories of what they expect in the Core Strategy based on the phasing of the new housing between now and 2026. This modelled emissions trajectory could be compared with the monitored actual data as it comes in, and in this way the LDF carbon targets can be checked.

Recommendation 13

All low carbon energy installations need to be captured in the Annual Monitoring Report (AMR). In order to have data available for the AMR, the Council needs to establish a database which is continuously populated with data about new installations. Processes can be created to ensure that data can be provided for new developments when they are completed but it is likely to be more difficult to capture data about small scale renewables that are installed on existing buildings, as many forms of microgeneration no longer require planning permission.

Recommendation 14

Monitoring is also important for the existing building stock in terms of CO_2 emissions for the area as a whole; which should be captured as part of the National Indicator 186 reporting mechanism. It would also be useful to monitor the number and type of renewable energy installations progressed throughout the area to compare with overall CO_2 emissions.

6.7 Coordinating the development of low carbon infrastructure

As outlined in Section 4, shared low carbon infrastructure has an essential role to play in enabling carbon reductions in the built environment and in facilitating the exploitation of renewable energy. Planning policy needs to be proactive in encouraging these networks and in encouraging buildings to connect to these networks. The approach can vary from prescriptive requirements to more general policies of encouragement.

Planning policy alone will not be able to deliver low carbon and renewable energy within Wiltshire, and a range of policy measures covering economic development, to council initiated energy projects will also be required. Managing and financing energy infrastructure for long term, phased development projects is extremely challenging. Large combined heat and power systems are a very cost effective low carbon strategy but they are difficult to establish in phased development. The Council needs to encourage developers to engage with expert organisations 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.

The Council should play a key role in working with communities to address any concerns about low carbon and renewable infrastructure as well as highlighting benefits. Keeping facilities under community ownership could also keep the revenues from energy production in the local economy. If the public sector were to establish an ESCo to supply energy to the new developments then it could collate the energy demands and risks of the smaller scale developments so as to set-up a contract with a wind turbine developer, for example, or even install wind turbines and solar PV arrays itself.

6.7.1 Local ESCos to develop low carbon energy projects

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.

Appendix 6 provides examples of recent ESCo's that have been set-up.

6.8 Supporting Investment in Low Carbon Infrastructure

Zero carbon developments[82] are possible within Wiltshire for the larger developments, but zero carbon compliance will put a significant extra cost on the development.

Key actions to overcome potential investment shortages include:

- A ring fenced carbon investment fund 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 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 channelled towards shared offsite renewable developments and carbon investment fund could manage this role;
- Additional measures to mitigate early stage infrastructure development risk;
- Increased support for renewable energy development with mechanisms to contractually link offsite renewable energy infrastructure to new developments.

The installation of low carbon infrastructure, such as PV arrays and heat networks for large developments, requires considerable financial investment, and yet due to the long term phased construction of the development the returns on this investment will not be received until many years into the future. For this reason a support mechanism may be required to provide infrastructure funding for systems under current market conditions.

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

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

This public sector 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

[82] *Following the Government's current definition of zero carbon housing*

be reimbursed through payments from private sector developers as their developments are rolled out.

Recommendation 15

Establish a ring fenced Carbon Investment Fund to provide the upfront capital needed for financing large scale low carbon infrastructure such as CHP and district heating networks that can supply phased developments. It may be possible to capitalise some of this from a carbon offset fund.

6.9 Diverting finance to more cost effective measures

The proposed new definition of zero carbon housing considers whether it is more appropriate to divert finance to more cost effective offsite carbon reduction measures rather than eek out continually more expensive carbon reductions to achieve a zero carbon development. In the same way, the Council may consider that developer payments to carbon offset schemes might be a more practical solution for carbon neutral developments.

The Core Strategy could require developers to pay to offset all the residual emissions from their developments following the approach taken by Milton Keynes Council. For example, if the Council sets a policy requiring developers to achieve CSH Level 4, rather than 5 or 6, then it could also require all developers to pay money into the offset fund to offset the residual emissions – note that the difference in cost between CSH 4 and 6 in the cost analysis of the CSH can be up to £30,000 per dwelling, whereas similar reductions in carbon emissions within existing houses can be delivered at a far smaller cost.

The Council would need to establish a ‘carbon offset fund’ into which these payments are deposited, and then distributed to energy saving schemes within the county, such as insulation, renewable energy projects or district heating infrastructure. Milton Keynes Council has set a cost per tonne of carbon that it requires developers to pay which is based on the cost of delivering carbon savings through loft and cavity wall insulation in existing homes. If this money is invested in loft and cavity wall insulation then it will exactly offset the carbon emissions from the new build, which could then be viewed as a ‘carbon neutral’ development. However, in order to claim that the new developments are carbon neutral, it is essential that these carbon reductions in existing housing are ‘additional’ savings – i.e. that they wouldn’t have happened unless they were financed by the carbon offset fund.

The carbon offset fund could nonetheless be a very effective mechanism in the years up to 2016 if a planning authority feels that it is too expensive a demand to expect developers to deliver zero carbon developments. They could require the developers to provide carbon neutral developments by covering the costs of their residual carbon emissions based on an agreed market price per tonne of carbon. The definition of a ‘zero carbon development’ adopted here is that of all heating and power needs being supplied from on-site renewable energy, whereas a ‘carbon neutral development’ is one which offsets its (remaining) carbon emissions through investment in external carbon saving measures.

Recommendation 16

To support the national timetable of tightening building regulations establish a ‘local carbon offset fund’ with distribution mechanisms to enable developers to pay to offset all the residual emissions from their developments. This facility might be needed to support the operation of the ‘allowable solutions’ proposed in the Government’s consultation on the definition of a zero carbon home. It will be important to consider the cost (per tonne) of the offsets and establish clear rules to determine additionality.

Recommendation 17

In line with the emerging but undefined national mechanism, develop rules to ensure that 'off site' renewables are additional to any commercial renewable energy developments that would occur anyway within the county (and support the development of a delivery mechanism).

6.10 Public sector leading by example

Wiltshire Council has a real opportunity to directly progress renewable energy installations and decentralised energy generation by taking forward projects on their own buildings and land. These can include solar PV, solar water heating, small to medium sized wind turbines; and replacing fossil fuel boilers with biomass boilers;

As outlined above, the Council could establish a local ESCo to help implement these low carbon energy projects.

The public sector can further assist heat network development by using its buildings as 'anchor heat loads' to form the basis of heat network development. Large buildings with fairly constant heat demand such as leisure centres, hospitals, prisons and hotels are all effective anchor loads. As an example it is understood that proposals are being prepared for a new leisure centre in the town of Trowbridge, to be located close to the existing Trowbridge County Hall. Given that there will be a major refurbishment of County Hall starting next year, and that the council is undertaking a master planning process of Trowbridge, this would provide a good opportunity for establishing an energy/ heat network in the town.

Market demand and political will are essential for renewable supply chains to develop. The access to revenue from schemes such as the Feed in Tariff should now be accelerating renewable energy development around the UK.

Recommendation 18

The Council should implement renewable energy installations and decentralized energy generation projects on its own buildings and land. This can be realised by large public sector buildings providing 'anchor loads' for district heating and low carbon infrastructure networks.

Recommendation 19

Encourage ESCo activity in the county, including the development of a public sector led energy supply project[83].

[83] *New legislation was tabled in the May 2010 Queen's Speech to address current restrictions on Local Authorities selling electricity.*

Appendix 1: Industrial Parks in Wiltshire

The following sites are listed as 'employment zones' in the Wiltshire and Swindon Employment Land and Floorspace Report (April 2007). Four of the sites are close to the town centre, as marked below.

Settlement	Employment zone
Amesbury	Boscombe Down Business Park
Bradford on Avon	Treenwood Estate
Calne	Beversbrook
	Portemarsh
Chippenham	Bumpers Farm
	Greenways
	Littlefields
	Methuen Park
	Parsonage Way
Corsham	Fiveways Industrial Estate
	Leafield Trading Estate
Cricklade	Chelworth Estate
Devizes	Garden Trading Estate
	Hopton Barracks
	Hopton Park
	Le Marchant Barracks
	Nursteed Road
Downton	Salisbury Road
Malmesbury	Malmesbury Industrial Park
Market Lavington	Broadway Farm
Melksham	Bowerhill (& Hampton Park)
Purton	Purton Brickworks

Salisbury	Churchfields (near centre)
	Old Sarum Airfield
	Southampton Road (near centre)
	Harnham Trading Estate
Trowbridge	Bryer Ash Business Park (near centre)
	Canal Road
	White Horse Business Park
Warminster	Crusader Park
	Furnax Lane/Gas House Farm
	Woodcock Industrial Estate (near centre)
Westbury	Brook Lane
	West Wilts Trading Estate
Wilton	Kingsway
Wootton Bassett	Interface
	Templars Way
	Whitehill Lane

Appendix 2: Out-of-town retail parks in Wiltshire

Details of out-of-town retail parks are provided in the table below.

Table 1: Out-of-town retail parks in Wiltshire

Settlement	**Out-of-town retail area**	**Information source**
Chippenham	Hathaway Retail Park	North Wiltshire Retail Needs Assessment Study (2007)
Trowbridge	Spitfire Retail Park, Bradley Road	West Wiltshire Retail Needs Study (April 2007)
Salisbury	Dolphin Retail Park, on the north side of Southampton Road	Salisbury District Council Retail and Leisure Needs Study (October 2006)
	Bourne Retail Park (located to the east of the Dolphin Retail Park and adjacent to Salisbury Business Park)	
	Wilton Shopping Village (located 3 miles west of Salisbury at the junction of the A36 and A30).	

Planning permission has also been granted for a new 8-unit retail park to be located on London Road (‘Salisbury Retail Park’; application number S/2007/1460).

There are also a number of freestanding supermarkets and other large stores in out-of-centre (or edge-of centre) locations in Wiltshire. These stores are listed in the table below.

Please note that this table may not include every single store, but gives an indication as to the level of out-of-centre provision.

Settlement	Supermarkets and other freestanding large stores	Location
Chippenham	Morrisons	Cepen Park North
	Sainsbury's	Cepen Park South
	B&Q and Currys	Bath Road
Malmesbury	Somerfield	Gloucester Road
Trowbridge	Tesco	County Way
	Aldi	Bradley Road
	Lidl	Canal Road
	B&Q and Halfords	Adjacent to the Spitfire Retail Park
	Wickes DIY store	Kennet Way
Melksham	Aldi	Beanacre Road
	Co-op	Blackmore Road
	Sainsbury's	Bath Road
	Lidl	Bath Road
	Leekes	Beanacre Road
	Bedland	Lancaster Road
	Countrywide	Western Way
Westbury	Co-op	Bitham Park
Warminster	Lidl	Fairfield Road
	Morrisons	Weymouth Street
Bradford on Avon	Sainsbury's	Rowden Lane
Salisbury	Tesco	Southampton Road
	Waitrose Food and Home	Churchill Way West
	Majestic Wine	Southampton Road

	Spar	Gainsborough Close, Bemerton
	B&Q and Matalan stand alone units	South side of Southampton Road.
	JJB Sports and Comet plus another retail unit	Churchill Way, adjacent to the Waitrose Food and Home store.
	A number of freestanding retail warehouse operators	Bourne Way, close to Tesco
	Further provision	Hatches Lane
Amesbury	Spar	Boscombe Road
	Lidl	London Road
Devizes	Lidl	London Road
	Morrisons	Estcourt Street

Appendix 3: Study Contacts

In the course of delivering the project we liaised with key local and regional stakeholders. We also discussed with the Council, a range of supporting planning issues and the appropriate policy options in support of delivering carbon reduction.

A workshop was held at the start of the project, on January 22nd 2010, to introduce the study and obtain feedback from Council Officers. A briefing about the study was also provided to Council Members on March 24th 2010.

Workshops were also held on July 2nd and July 6th 2010 to present and discuss the draft findings. The first workshop was for Council Officers and the second was attended by a range of representatives and regional stakeholders including regional housing developers and renewable energy project developers. A list of attendees at the workshops is available separately.

Representatives from the following organisations were also consulted separately during the study and we are grateful for their assistance.

Regen SW Wiltshire Council: Spatial Planning; Climate Change; Home Energy; Planning; Waste Services; Minerals & Waste; LDF Monitoring; Regeneration; Urban Design; Rural Estates, Wiltshire Area Boards. Ministry of Defence civilian integration programme 43 (Wessex) Brigade Defence Estates Defence Training Estates Landmarc GL Hearn	Cranbourne Chase & West Wiltshire Downs Area of Outstanding Natural Beauty Low Carbon Bradford on Avon CIC Climate Friendly Bradford on Avon Corsham Transition Town TransCoCo SWA21 Redhone Community Trust Wiltshire Community Wind Energy Trowbridge Community Planning Partnership (TCAF) Avon and Wiltshire Mental Health Trust

Appendix 4: Biomass Analysis Assumptions

Biomass uptake curves are referenced in this analysis, which were produced by E4tech as part of the UK Renewable Energy Strategy in 2009. These can be viewed at http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/renewable/res/res.aspx.

Forestry residues

The Forestry Commission Research tool, suggested by DECC methodology as a data source, only provides data at regional level. In this report, total area of coniferous and broadleaf woodlands in Wiltshire have been taken from the National Inventory of Woodlands and Trees[84] and the following assumptions have been used to assess potential from 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 years for Scots pine and 60 years for Birch. Total volume of residues generated from thinnings over rotation and final harvest is divided by rotation to derive annual oven-dried tonnes (ODT/year). Therefore, it is assumed that all forestry age classes are represented equally.
- Slow initial uptake is assumed, to account for machinery and labour required and incorporation of residues extraction in forest management plans: 5% by 2010; 40% by 2015; and 100% by 2020.

Energy Crops

- The E4tech report models 4 case scenarios based on data from the Refuel project, all 4 scenarios consider that land available for energy crops in the UK will increase: area of arable land available for energy crops increasing from 605,000 Ha in 2008 to 963-1334,000 Ha in 2030, and pasture area from 290,000 Ha in 2008 to 1,200,000 Ha in 2030. However, for this report 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)

[84] *Forestry Commission 2002, National Inventory of Woodlands and Trees. County report for Wiltshire. http://www.forestry.gov.uk/pdf/wiltshire.pdf/$FILE/wiltshire.pdf*

- 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 first harvest (3 years for willow and 5 years for poplar): 10% by 2015, 30% by 2020 and 100% by 2025.

The scenario defined to estimate the potential contribution of energy crops matches the "Medium scenario" suggested by the DECC methodology. The principle to calculate the technically available resource under the "Medium scenario" is to assume that energy crops are planted in all abandoned arable land and pasture. However, the methodology indicates that permanent pasture/grassland needs to be excluded from the assessment in order to estimate the physically accessible and practically viable resource.

Sawmill residues

The DECC methodology suggests that data from the Forestry Commission Research tool is used to estimate the availability of sawmill residues. As mentioned above, the tool only provides data at regional level. The potential from sawmill residues has been estimated making the following assumptions:

- The output of residues at each sawmill in the study area is assumed to be equivalent to the average output in England, derived from total volume of residues and total number of sawmills in England as per Forestry Commission's Sawmill Survey 2008[85].
- 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[86]). 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[87]).
    - Increasing recycling rates of waste wood from the construction and other industries will supply part of the panel board industry and therefore release part of the sawmill resource
- Immediate uptake achievable as soon as the resource is made available
- Output of the sawmills in the study area remains constant.

[85] Forestry Commission Sawmill Survey 2008. http://www.frcc.forestry.gov.uk/website/forstats2009.nsf/0/6322930083F37DA88025731E0047F672
[86] Forestry Commission statistics. 2009. http://www.forestry.gov.uk/website/forstats2009.nsf/TopContents?Open&ctx=92B74B2CCD24A56C8025731B0053FB26
[87] New forecast of softwood availability (Forestry Commission 2006). http://www.forestry.gov.uk/website/ForestStats2006.nsf/byunique/ukgrown.html

Crop residues - Straw

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

The DECC methodology suggest an availability factor of 50% but does not reduce the potential further to account for the fraction of straw that cannot be recovered from the field. Therefore, final estimates applying the DECC methodology could be expected to be fairly similar to the results presented in this report. The assumptions above are in-line with national biomass strategy assumptions.

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[88]

- It is assumed that number of livestock will remain constant over time.

DECC methodology prescribes that only 50% of the total resource should be considered as available for bioenergy due to competing demands (fertiliser, compost). As implied by the assumptions outlined above the use of manure as fertiliser has not been considered as a competing demand. It should also be noted that DECC methodology does not propose to discount the technical resource to account for technical limitations of manure collection and handling losses.

Municipal Solid Waste (MSW) currently land-filled

DECC methodology considers incineration as the conversion technology for all components of MSW, providing a benchmark of 10 kilo tonnes of MSW per annum required for 1MW of installed capacity. The approach taken has considered the different components of MSW individually, assuming that paper/card and wood waste will be incinerated, and kitchen/food waste and green waste will be sent to anaerobic digestion plants. Other assumptions made are outlined below.

- A 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[89], ERM[90] 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.

[88] •Biomass energy centre
http://www.biomassenergycentre.org.uk/portal/page?_pageid=75,17976&_dad=portal&_schema=PORTAL
[89] *Waste strategy for England 2007. http://www.defra.gov.uk/environment/waste/strategy/strategy07/index.htm*
[90] *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*

- Separability of waste will increase linearly to reach maximum recovery levels in 2025/26.
- Initial recovery potential = 5% over recycling rate.
- 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 is 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. Its use as a fuel generally conveys a greater greenhouse gas benefit than recovering the material as a resource (and avoiding primary production).

Kitchen waste and green waste currently diverted

This biomass stream is not considered in DECC methodology. Composting is not considered a competing demand. It is assumed that the Wiltshire waste figures provided exclude the proportion of material that is used for home composting. The full resource is therefore considered to be available for energy generation. However, an uptake period of 5 years is assumed.

Appendix 5: Energy Opportunity Maps for various towns in Wiltshire

The Energy Opportunity Maps are published on the Wiltshire Council website alongside this report.

Key for potential anchor loads[91]

Calne

Key	Name	POSTCODE
700	HOLY TRINITY CE JUNIOR SCHOOL	SN11 0AR
715	AGRICENTRE	SN11 0HB
721	THE WHARF	SN11 0DH
722	CHAVEYWELL COURT	SN11 0DX
723	CARNEGIE MEWS	SN11 0SQ
724	SOMERFIELD	SN11 8DP
725	MARDEN COURT	SN11 0EE
726	ST MARYS SCHOOL	SN11 0DF
731	SAVOY COURT	SN11 9RQ
733	CHARLOTTE COURT	SN11 9RG
734	GLOBE COURT	SN11 9RQ
735		SN11 9PS
739	FYNAMORE PRIMARY SCHOOL	SN11 9UG
742		SN11 9PT
743	CALNE BUSINESS CENTRE	SN11 9PT
744		SN11 8RT
745	PORTE MARSH ENTERPRISE PARK	SN11 9PU
746		SN11 9PU
749	FOUR BROOKS BUSINESS PARK	SN11 9PP
752	BEVERSBROOK CENTRE	SN11 9PR
754	REDMAN BUSINESS CENTRE	SN11 9PL
756	PENN COURT	SN11 8BJ

Chippenham

Key	Name	POSTCODE
699	NOTTON SCHOOL HOUSE	SN15 2NF
701	WILTSHIRE COLLEGE LACKHAM	SN15 2NY
736	THINGLEY CARAVAN SITE	SN14 0RW
738	METHUEN PARK	SN14 0UL
741	LITTLEFIELDS	SN14 0AT

[91] *Please note that not all locations have a description and that some site uses may have changed since the data was produced.*

747	CROFT COURT	SN14 0LS
748	CHARTER COUNTY PRIMARY SCHOOL	SN15 3EA
750	TRENCHARD CLOSE	SN14 0PZ
751	BATH ROAD INDUSTRIAL ESTATE	SN14 0AB
753	WESTMEAD TERRACE	SN15 3DU
755	CYPPA COURT	SN15 3LH
757	ST MARYS SCHOOL	SN15 2AH
758	QUEENSQUARE	SN15 3BL
759	DIVISIONAL POLICE HEADQUARTERS	SN15 3DH
760		SN15 3DA
761	HYGRADE FOODS LTD	SN15 3HZ
762		SN15 3BW
763	AVONSIDE	SN15 3HY
764		SN14 0BU
765		SN15 3HU
766	AVONBRIDGE HOUSE	SN15 2BB
767	THE BRIDGE CENTRE	SN15 2AA
768		SN15 3ET
769	FROGWELL PRIMARY SCHOOL	SN14 0DG
770	MONKTON PARK SCHOOL	SN15 3PN
771	PROVIDENCE TERRACE	SN15 1HD
772	AVON REACH	SN15 1EE
773		SN15 1EE
774		SN15 1ES
775	NORTH WILTSHIRE DISTRICT COUNCIL	SN15 1ER
776	BEWLEY HOUSE	SN15 1JN
777	FIRE STATION	SN15 1LE
778	ST PETERS SCHOOL	SN14 0LL
779	LANSDOWNE COURT	SN14 6RZ
780	METHUEN PARK	SN14 0GF
781	METHUEN PARK	SN14 0GX
782	METHUEN PARK	SN14 0WT
783	HARDBROOK COURT	SN14 0QZ
784	ST PAULS HOUSE	SN15 1LA

camco

785	HATHAWAY RETAIL PARK	SN15 1JG
786	THE OLD FOUNDRY	SN15 1JB
788	ENTERPRISE CENTRE	SN14 6QA
789	ENTERPRISE CENTRE	SN14 6QA
790	HILL GREEN	SN15 1FE
791	UNIT 4	SN14 6NQ
792	TYAK BUSINESS CENTRE	SN14 6NQ
793	THE BEAUFORT BUILDING	SN14 6NQ
794	PARKLANDS	SN15 1PP
795	CORNBRASH PARK	SN14 6RA
796	ALLINGTON SPECIAL SCHOOL	SN14 0JS
797	AVON CLEVITE	SN14 6NF
798	ST NICHOLAS SCHOOL	SN15 1QD
799	LANGLEY PARK WAY	SN15 1GE
800	CONNECT 17	SN15 1GG
801	LEIGH DELAMERE SERVICE STATION	SN15 5PT
802	PEW HILL HOUSE	SN15 1DN
803	ST NICHOLAS SCHOOL	SN15 1PL
804	ST PAULS PRIMARY SCHOOL	SN15 1DU
805	GREENWAYS BUSINESS PARK	SN15 1BN
806	SHELDON COMPREHENSIVE SCHOOL	SN14 6HS
807		SN15 5LN
810	WAVIN PLASTICS LTD	SN15 5PT

Devizes

Key	Name	POSTCODE
473	BOWES COURT	SN10 5FQ
475	WYATT COURT	SN10 5FF
476	THURNHAM COURT	SN10 5FL
484	THE MEWS	SN10 5LU
487		SN10 5BS
489	NURSTEED ROAD TRADING ESTATE	SN10 3EW
491	BANDA TRADING ESTATE	SN10 3DY
492	NURSTEED MEADOWS	SN10 3HL

498	SOUTHBROOM C OF E JUNIOR SCHOOL	SN10 3AF
502	SOUTHGATE HOUSE	SN10 5EQ
505		SN10 1NW
506	SOUTHBROOM COUNTY INFANTS SCHOOL	SN10 5AA
507	DEVIZES LEISURE CENTRE	SN10 5AB
509	DEVIZES COMPREHENSIVE SCHOOL	SN10 5AA
510	OFFERS COURT	SN10 1LJ
512	SEYMOUR COURT	SN8 3TW
516	BATH ROAD BUSINESS CENTRE	SN10 1XA
517	STANFORD COURT	SN10 1EW
518	TERRITORIAL ARMY CENTRE	SN10 3AA
519	OLD SWAN YARD	SN10 1AT
520		SN10 1AG
521	ELIZABETH HOUSE	SN10 1BZ
523	CORN EXCHANGE	SN10 1HS
524	CRAMMER COURT	SN10 3AW
526		SN10 1DW
529	CHANTRY COURT	SN10 1BH
530	TOWNSENDS GARDEN CENTRE	SN10 2BB
532	THE CROFT	SN10 3BJ
536	ROSELAND	SN10 2BB
537	SUDWEEKS COURT	SN10 1DX
542	KENNET HOUSE	SN10 1JT
544	HEWITT COURT	SN10 1FE
545	POLICE STATION	SN10 1DZ
547	GIRVIN IRON WORKS	SN10 1JP
550	BROWFORT	SN10 2AT
551	THE BEECHES	SN10 2AL
588	HOPTON PARK	SN10 2EY
592	GARDEN TRADING ESTATE	SN10 2HJ
596	ROWDE PRIMARY SCHOOL	SN10 2ND
599	SIR RALPH TRADE CENTRE	SN10 2FD
600	OPTIONS HOUSE	SN10 2EU
601	SARSEN COURT	SN10 2AZ

602	HOPTON INDUSTRIAL ESTATE	SN10 2EU
603	HAYDENS BAKERIES	SN10 2EU
606	STORAGE DEPOT	SN10 2JW
608	HOPTON COURT	SN10 2EU
615	ROUNDWAY HILL BUSINESS CENTRE	SN10 2LT
617	BEACON BUSINESS CENTRE	SN10 2EY
620	DEVIZES TRADE CENTRE	SN10 2EH

Ludgershall

Key	Name	POSTCODE
274	GRANBY GARDENS	SP11 9RG
275	SPRINGFIELDS	SP11 9BW
280	BASE VEHICLE DEPOT	SP11 9TU
281	FITZ GILBERT COURT	SP11 9FA
283	PRINCE OF WALES HOUSE	SP11 9LZ
290	CASTLE MEWS	SP11 9TL
291	COLLIS TERRACE	SP11 9QZ

Melksham

Key	Name	POSTCODE
528		SN12 6GX
531		SN12 6XP
534		SN12 6XR
535		SN12 6XW
538	AVON TECHNICAL PRODUCTS	SN12 6NB
539	CEREAL PARTNERS UK	SN12 6FL
540		SN12 6XS
541		SN12 6XN
543	DIVISIONAL POLICE HEADQUARTERS	SN12 6QQ
546		SN12 6TS
548		SN12 6TS
549		SN12 6WB
552		SN12 6TS
553		SN12 6WG

camco

554	ASHVILLE CENTRE	SN12 6ZE
555		SN12 6QY
556		SN12 6QS
557		SN12 6FA
558		SN12 6FF
561		SN12 6TR
562		SN12 6SS
563		SN12 6TR
564	BOWERHILL PRIMARY SCHOOL	SN12 6YH
565	WILTSHIRE SCHOOL OF GYMNASTICS	SN12 6SP
566		SN12 6SS
567		SN12 6FD
568	HOLT PRIMARY SCHOOL	BA14 6RA
569		SN12 6FQ
570		SN12 6SS
571		SN12 6QF
572	INDUS ACRE	SN12 6TP
573	AVRO BUSINESS CENTRE	SN12 6TP
574		SN12 6FJ
576		SN12 6AQ
577		SN12 6EY
579		SN12 6FH
582		SN12 6XY
583		SN12 6BY
585		SN12 6XX
586		SN12 6AH
587		SN12 6AJ
589	LANCASTER PARK INDUSTRIAL ESTATE	SN12 6TT
590		SN12 6XU
591		SN12 6SS
593		SN12 6SS
594		SN12 6TJ
595		SN12 6TJ
604		SN12 7TE

605		SN12 7SJ
607		SN12 7SW
609		SN12 7SH
610		SN12 7SL
611	KENILWORTH COURT	SN12 6AE
613		SN12 6FW
614		SN12 6RP
616		SN12 6FU
618	WEST END HOUSE	SN12 6DA
619		SN12 6FS
621		SN12 6FR
622		SN12 6FT
623		SN12 6FZ
624		SN12 6FY
625	LEGION HOUSE	SN12 6HE
626		SN12 6GD
627		SN12 6GB
628	CROWN HOUSE	SN12 6ES
630		SN12 6GY
631	QUEENSWAY CHAPEL PRE-SCHOOL PLAYGROUP	SN12 7LQ
632	MANOR PRIMARY SCHOOL	SN12 7LQ
633	GIFFORDS COURT	SN12 7DY
634		SN12 6LE
635	THE MANOR PRIMARY SCHOOL	SN12 7NG
636	LITTLEBROOK CENTRE	SN12 6LP
637		SN12 8BT
638		SN12 8BW
639	HIGHFIELD HOUSE	SN12 7ED
640		SN12 8BP
641	KINGS PARK PRIMARY SCHOOL	SN12 7ED
642		SN12 8FD
643		SN12 8FE
644		SN12 8FB
645	GEORGE WARD SCHOOL	SN12 8DQ

Salisbury

Key	Name	POSTCODE
25	SALISBURY DISTRICT HOSPITAL	SP2 8BJ
27	BRIDGE FARM	SP5 4DY
28	PUDDLEDUCKS COMMUNITY PLAYGROUP	SP2 8JZ
29	ARMSTRONG HOUSE	SP2 8PE
31	HARNHAM JUNIOR SCHOOL	SP2 8JZ
32	HARNLEIGH GREEN	SP2 8JN
35	ST NICHOLAS HOSPITAL	SP1 2SW
36	SPORTSGROUND	SP1 2ES
37	THE CLARENDON CENTRE	SP1 2TJ
38	HALL	SP1 2ES
40	ST OSMUNDS ROMAN CATHOLIC SCHOOL	SP1 2SG
41	LEADEN HALL SCHOOL	SP1 2EP
42	BOURNE RETAIL PARK	SP1 2NZ
43	HOMEBASE LTD	SP1 2LB
44	TINTERN COURT	SP1 2HS
45	MERCEDES BENZ OF SALISBURY	SP1 2JS
46	SALISBURY COLLEGE OF TECHNOLOGY	SP1 2LW
47	NAIM AUDIO LTD	SP1 2LN
48	WELLINGTON MEWS	SP1 2JL
49	FOUNTAINS HOUSE	SP1 2HE
50	ST MARYS HOUSE HALLS OF RESIDENCE	SP1 2AB
51	SCHOOL OF ENGLISH	SP1 2HY
52	VOLPOINT HOUSE	SP1 2JG
53		SP1 2JJ
54		SP1 2ED
55	BARNACK BUSINESS CENTRE	SP1 2LP
56	MILFORD INDUSTRIAL ESTATE	SP1 2JG
57	UNIT 28	SP2 7GL
58		SP1 2JG
59	WYLD HOUSE	SP1 2JD
60	ST MARTINS C OF E JUNIOR SCHOOL	SP1 2RE
61	STANLEY COURT	SP2 7GL

camco

62	CRANE LODGE	SP2 7TQ
63		SP1 2AG
64	MAGDALENE COURT	SP1 2DL
65	CHARTER COURT	SP1 2LH
66		SP1 2AA
67	BRUNEL HOUSE	SP2 7PU
68		SP1 2NS
69	METHUEN HOUSE	SP1 2QH
70	ROLFES COURT	SP1 2BU
71		SP1 2NH
72		SP2 7NU
73	UNITS 3 AND 4	SP2 7NU
75	MILFORD HOUSE	SP1 2BP
76	PEMBROKE HOUSE	SP2 7SX
77	GODOLPHIN SCHOOL	SP1 2RA
78	SUSSEX HOUSE	SP2 7QA
79	ELIZABETH COURT	SP2 7UX
80	HARDY HOUSE	SP2 7SD
81		SP2 7NU
82	HOLLY HOUSE	SP2 7SA
83		SP2 7NU
84	CROSS KEYS CHEQUER	SP1 1EL
85		SP1 1HL
86	FARM LANE BUSINESS CENTRE	SP2 7NG
87	UNIT A AND C	SP2 7NQ
88	CROSS KEYS HOUSE	SP1 1EY
89		SP1 1HB
90		SP1 1DE
91		SP1 1DA
92	GODOLPHIN PREP SCHOOL	SP1 2RB
93		SP1 1DA
94		SP2 7NH
95	DENIS HOUSE	SP1 1DZ
96		SP1 1BD

97	NORTON ENTERPRISE PARK	SP2 7YS
98	ELM COURT	SP1 1JN
100	RIVERSIDE HOUSE	SP1 3SW
101	ST EDMUNDS GATE	SP1 1EF
103		SP2 7QD
104	ENTERPRISE HOUSE	SP2 7LD
105		SP1 3SU
106	RAILWAY COURT	SP2 7AR
107	ENDLE COURT	SP1 3RE
108	ASHFIELD TRADING ESTATE	SP2 7HL
109	CLEVELAND FLATS	SP1 1JY
110	BARTHOLOMEW COURT	SP2 7GB
111	AUGUSTINE COURT	SP2 7GA
112	FRANCIS COURT	SP2 7GE
113	UNITED KINGDOM HOUSE	SP1 3SH
114	HOME SARUM HOUSE	SP2 7HS
115	LAVERSTOCK NURSERY	SP1 2SR
116	GREGORY COURT	SP2 7GF
117	JOSEPH COURT	SP2 7GG
118	THE CROFT	SP2 9NE
119	JULIUS COURT	SP2 7GJ
120	NICHOLAS COURT	SP2 7GN
121		SP1 3TB
122	LLANGARREN HOUSE	SP2 7EJ
123	SALISBURY SWIMMING BATHS	SP1 3AL
124	SALISBURY POLICE STATION	SP2 7HR
125	AVON REACH	SP2 7AY
126	RAGLAN COURT	SP2 7NE
129	THAXTED	SP1 3BG
130	ST MARKS HOUSE	SP1 3DL
131	BEMERTON FARM	SP2 9NA
132	WAITROSE SUPERSTORE	SP2 7TS
133	UNIT 3	SP2 7TS
135	LA RETRAITE SCHOOL	SP1 3BQ

136	OSBORNE HOUSE	SP1 3NQ
137	FIRE STATION	SP2 7TN
138	SARUM ST PAULS C OF E SCHOOL	SP2 7DG
139	ST ANDEWS SCHOOL	SP1 1QX
140	FIVE RIVERS LEISURE CENTRE	SP1 3NR
141	CARNIVAL HOUSE	SP2 9ER
142	SOUTH WILTS GRAMMAR SCHOOL FOR GIRLS	SP1 3JJ
143	WYVERN COLLEGE	SP1 1RE
144	ST EDMUNDS GIRLS SCHOOL	SP1 1RD
146	REINDORP LODGE	SP1 3EP
147	ST JOSEPHS R C SCHOOL	SP1 1QY
152	GLOUCESTER HOUSE	SP1 3ZT
153	WOODLANDS COUNTY FIRST SCHOOL	SP2 9DY
154	STEVE BIDDLE HOUSE	SP1 3ZT
155	TREETOPS NURSERY	SP2 9EA
157	BISHOPS COURT	SP1 3DT
161	JANSPEED ENGINEERING LTD	SP1 3RX
162	OLD SARUM WORKS	SP1 3SA

Tidworth

Key	Name	POSTCODE
247	HAMPSHIRE CROSS	SP9 7SG
248	ASPIRE BUSINESS CENTRE	SP9 7QD
249	ENTERPRISE UNIT	SP9 7QF
250	CLARENDON COUNTY INFANTS SCHOOL	SP9 7QD
251	CLARENDON COUNTY JUNIOR SCHOOL	SP9 7QD
252	JUNIPER COURT	SP9 7PA
253	TRINITY HOUSE	SP9 7HJ
254	FOREST COURT	SP9 7PB

Trowbridge

Key	Name	POSTCODE
353	THE EPSOM CENTRE	BA14 0XG
354	DERBY COURT	BA14 0XG

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355	EPSOM COURT	BA14 0XF
356	ASCOT COURT	BA14 0XA
357		BA14 0XD
358		BA14 0XD
359	CROMWELL PRESS LTD	BA14 0XB
360	TROWBRIDGE RETAIL PARK	BA14 0RQ
361	THE SPITFIRE RETAIL PARK	BA14 0AZ
362		BA14 0RQ
363		BA14 0AF
364	WILTSHIRE COUNCIL	BA14 0RD
365	HOLBROOK PRIMARY SCHOOL	BA14 0PS
366	WILTSHIRE COLLEGE	BA14 0ES
367		BA14 9EY
368	TROWBRIDGE GARDEN CENTRE	BA14 0DT
370	GROVE COURT	BA14 0EW
371	THE MANOR	BA14 0DT
372		BA14 9BW
373	MANOR COURT	BA14 9HU
374		BA14 9GD
377		BA14 9GB
378		BA14 0QP
379	LONG MEADOW PRIMARY SCHOOL	BA14 7ST
380	BATHWICK TYRES LTD	BA14 0QJ
381		BA14 0QL
382		BA14 0FD
383		BA14 0ND
384		BA14 0NB
385		BA14 0NE
386		BA14 6FJ
387		BA14 6FL
388		BA14 6FP
389		BA14 9GG
390		BA14 6FG
392	WESLEY ROAD CLUB	BA14 0AX

393	ASHTON MILLS	BA14 7BA
395	ANDIL HOUSE	BA14 8BR
396	KESTREL HOUSE	BA14 8BE
397	ASDA STORES	BA14 8AT
398	MEADOW WORKS	BA14 8BR
399	CASTLE PLACE SHOPPING CENTRE	BA14 8AL
400	STONE MILLS	BA14 8BU
401		BA14 7TS
402		BA14 7TR
403		BA14 7TR
404		BA14 8HP
405	ST GEORGES WORKS	BA14 8AA
406		BA14 7TS
407		BA14 8EW
410	BOWYERS (WILTSHIRE) LTD	BA14 8HH
411		BA14 7TJ
412		BA14 7TT
413		BA14 7TU
414		BA14 7UD
415	TEAZLE GROUND COURT	BA14 7JY
416		BA14 8DF
417	HILL STREET COURT	BA14 8LB
418	ST JAMES COURT	BA14 8DW
419	MANVERS HOUSE	BA14 8YX
420		BA14 7GT
421		BA14 7UF
422		BA14 7UL
423	LARKRISE SCHOOL	BA14 7EB
424		BA14 7HY
425	PAXCROFT PRIMARY SCHOOL	BA14 7EB
426		BA14 7UE
427	KIDDIWINKS PRE SCHOOL	BA14 7EB
428		BA14 7GP
429		BA14 7GR

430	BELLEFIELD HOUSE	BA14 7FP
431		BA14 8RY
432		BA14 7GW
433		BA14 7HX
434		BA14 7FN
435		BA14 7FN
436		BA14 7HZ
437		BA14 7HY
439		BA14 7HZ
440	MARGARET STANCOMB INFANT SCHOOL	BA14 8PB
441		BA14 7QN
442		BA14 7FL
443		BA14 7EN
444	DARLINGTONS	BA14 8QA
445	THE MEAD COMMUNITY PRIMARY SCHOOL	BA14 7GN
446		BA14 7QE
447		BA14 7QF
448		BA14 7QW
449		BA14 7RF
457		BA14 7NQ
462	DORIC BUSINESS CENTRE	BA14 8FW
463	HARCOURT BUSINESS PARK	BA14 8RL
464	HILPERTON PRIMARY SCHOOL	BA14 7SB
466		BA14 8RN
468	WILLOWSIDE PARK	BA14 8RH
471		BA14 8WD
474		BA14 8UP
478		BA14 8TT
482	MARSH FARM	BA14 7PJ
483		BA14 8AB

Warminster

Key	Name	POSTCODE
211		BA12 8FD

214	FOREMINSTER COURT	BA12 8DA
215		BA12 9QY
217	CHURCH OF ENGLAND PRIMARY SCHOOL	BA12 8LF
219	WARMINSTER SPORTS CENTRE	BA12 9DQ
220	THE OLD SILKWORKS	BA12 8LX
225	COBBETT HOUSE	BA12 8NX
227	WOODCOCK HOUSE	BA12 9DG
228		BA12 9AN
229	NEW CLOSE COUNTY PRIMARY SCHOOL	BA12 9JJ
230	CHINNS COURT	BA12 9AN
231	CHATHAM COURT	BA12 9LS
232	THE MINSTER CHURCH OF ENGLAND PRIMARY SCHOOL	BA12 8JA
233		BA12 9DA
234	WARMINSTER UNITED SERVICES CLUB	BA12 9DD
235	WARMINSTER SCHOOL	BA12 8JG
236		BA12 9AY
237	POLICE STATION	BA12 9BR
238		BA12 8SD
239	WARMINSTER LIBRARY	BA12 9BT
241	WARMINSTER SCHOOL	BA12 8PJ
242	HOMEMINSTER HOUSE	BA12 9BP
243		BA12 9BL
244	FIRE STATION	BA12 8QE
245	MEDLICOTT HOUSE	BA12 8QN

Westbury

Key	Name	POSTCODE
255	LYES GROVE	BA13 4BT
256		BA13 3AZ
257		BA13 4JH
258		BA13 3FD
259		BA13 3UW
260		BA13 3UN
261		BA13 3UT

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262		BA13 3GY
263	BECKS MILL	BA13 3GP
264		BA13 3GZ
265		BA13 3UP
266		BA13 3GS
267		BA13 3WQ
268	FAIRWOOD TRADING ESTATE	BA13 3SW
269		BA13 3GB
270		BA13 3GR
271	LEIGHTON HOME FARM COURT	BA13 3PT
272		BA13 3SD
273		BA13 3FP
276		BA13 3GF
277		BA13 3GA
278		BA13 2GG
279		BA13 3GE
282		BA13 2GN
284		BA13 3GH
285		BA13 2GH
286		BA13 2GJ
287	WILLIAM HOUSE COURT	BA13 3QX
288		BA13 2GP
289		BA13 2GA
293		BA13 2GE
294	WOODLAND INDUSTRIAL ESTATE	BA13 3QS
295		BA13 2GF
296		BA13 2GE
297		BA13 2GF
298	SWIMMING BATHS	BA13 3BY
299	WESTBURY C OF E JUNIOR SCHOOL	BA13 3NY
300	WESTBURY INFANTS SCHOOL	BA13 3NY
301		BA13 3NZ
302	LOTZ ABBOTT WORKS	BA13 3DY
303	WESSEX HOUSE	BA13 3JH

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304		BA13 3UD
305		BA13 3UF
306	ABSOLUTE SOLVENTS	BA13 4EN
308	BITHAM BROOK COUNTY PRIMARY SCHOOL	BA13 3UA
309		BA13 3XN
310	FROGMORE HOUSE	BA13 3AT
311		BA13 3UE
313		BA13 3UA
314		BA13 3UB
315		BA13 4QZ
316	BROOK LANE INDUSTRIAL ESTATE	BA13 4EN
317	WESTBURY INDUSTRIAL ESTATE	BA13 4HR
318		BA13 4WF
319	CURTIS CENTRE	BA13 4EW
321	THERAPOSTURE LTD	BA13 4WE
322		BA13 4WE
323	WEST WILTSHIRE CRAFT CENTRE	BA13 4HU
324		BA13 4JR
325		BA13 4JR
326	ASPACE	BA13 4GZ
327		BA13 4JR
328		BA13 4JP
329	WHITE HAYS SOUTH	BA13 4JT
330		BA13 4JN
331	WHITE HAYS NORTH	BA13 4JT
332		BA13 4JA
333	COMMERCE BUSINESS CENTRE	BA13 4LS
334		BA13 4JX
335		BA13 4JB

Appendix 6: Example ESCo sites

The following are examples of sustainable developments that have included investigation into, and the establishment of an ESCo:

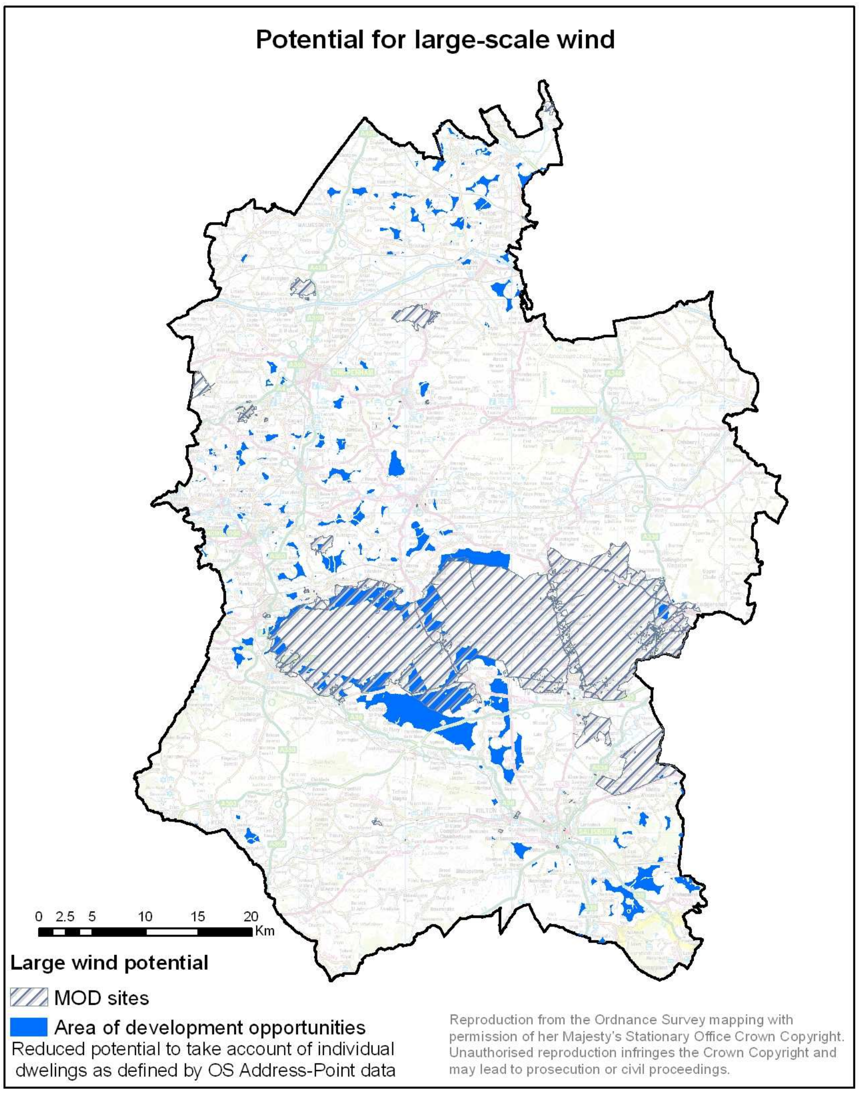
- One Brighton is a development of 172 apartments plus office and community space in the centre of Brighton. A biomass boiler and PV system is run by One Brighton Energy Services, set up as an ESCo to monitor, maintain and upgrade the renewable energy system.
- One Gallions is a flagship Zero Carbon development in east London containing 260 apartments. There will be an onsite woodchip powered Biomass CHP unit run by a community ESCo to provide sustainable living.
- Middlehaven is a planned development in Middlesbrough that will contain approximately 750 new homes, in excess of 200,000 ft^2 of new office and leisure space, and 25,000ft^2 of shops. Negotiations took place with adjacent land owners to progress investigations into the establishment of a large wind turbine to power the site.
- Wembley City is a £2b redevelopment project surrounding the new Wembley stadium containing residential, office and retail areas. This site has the potential to be the largest commercial-led CHP project within London.
- Bath Western Riverside is a proposed development of 2000 new homes in the centre of Bath. An onsite energy generation unit using natural gas and renewable energy fuel sources is proposed.
- Poundbury is a development site on the Duchy of Cornwall estate in Dorset which will contain 2,500 units by 2025. A sustainable energy system based on multi-fuel CHP was developed and an ESCo set up by the Duchy to bringing together partners willing to invest in sustainable technology.
- Grahame Park is a £450 million redevelopment of 3,400 homes and associated community and leisure facilities in North London. The development contains a CHP system and *Choices for Grahame Park*, a subsidiary of the Genesis Housing Group, was working with the council to develop a partnership with an energy service provider to form an ESCo.
- The Titanic Mill project near Huddersfield was the renovation of a previously derelict textile mill into a combination of domestic and commercial properties. The building contains a 48.5 kWp PV system and a CHP boiler system. A resident-owned not-for-profit ESCo was set up which looked to provide the residents with the collective ability to guarantee low cost energy supply in the future.
- Birmingham City Council installed its first CHP in October 2007 which provided energy and heat to several Council buildings in the city centre. The CHP scheme is being delivered by Birmingham City Council in partnership with Utilicom Ltd, through the formation of an ESCo saving 5% on annual energy costs.
- The Millbrook CHP and district heating scheme in Southampton reduces heat and hot water bills. An ESCo, limited by guarantee has been set up to deliver the scheme with council participation at member and director level maintained at 20% to ensure no council influence. Heat is supplied to the council who then supply it on to tenants and other council owned properties.

Appendix 7: Example "Community-owned" energy projects

- Westmill Wind Farm Co-op was one of a number of co-operatives set up by Energy4all. This is an onshore wind farm in Oxfordshire containing five turbines. It produces electricity to power over 2,500 homes whilst avoiding annual emissions of at least 5000 tonnes of CO_2.
- Reeves Hill Wind Farm in Herefordshire contains four wind turbines of which one will be community-owned.
- The Baywind Energy Co-op owns six wind turbines over two sites known as Harlock Hill and Haverick II in Cumbria. It has raised over £2 million through share offers and contains 3,000 members.
- Fenland Green Co-op was an initiative set up by Wind Prospect Ltd to give local people in the fen the opportunity to invest in wind energy. A share prospectus in 2007 raised over £2.6 million to purchase two operational turbines.
- Boyndie Wind Farm Co-op purchased a stake in former World War II airfield from owners Falck Renewables in 2006 after raising £750.000. The 716 members each own a shareholding ranging from £250 to £20,000 and receive annual interest on their shares. The wind farm has 7 turbines and when it's operating fully it generates 14 MW of electricity, enough energy to supply around 8,500 homes.
- The Great Glen Energy Co-op purchased a stake in the Millennium wind farm in 2008 after raising £1.3million. The 677 members, each with a shareholding ranging from £250 to £20,000, receive annual interest on their shares in the co-op.
- The Torrs-Hydro is a community owned small scale hydro electric plant on the River Goyt in Derbyshire. The development of this hydro plant was in conjunction with h2oPE (Water Power Enterprises) providing 70kW of electricity, some 260,000 kilowatt hours annually.
- A 50kW Archimedean screw hydro facility at Settle Weir in Yorkshire generates approximately 165,000 kWh (units) of electricity per year – enough for around 50 average houses, saving 80 tonnes of carbon per year.

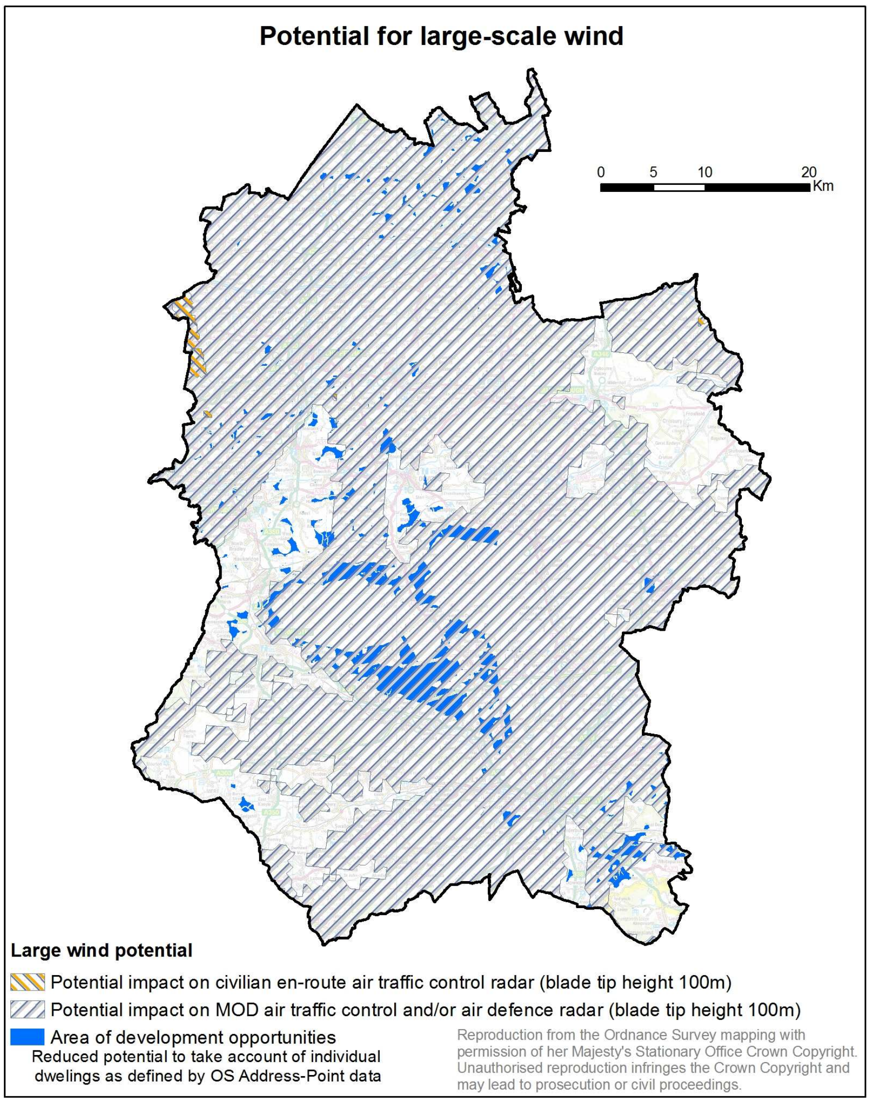
Appendix 8: Ministry of Defence and Large Wind Potential Sites

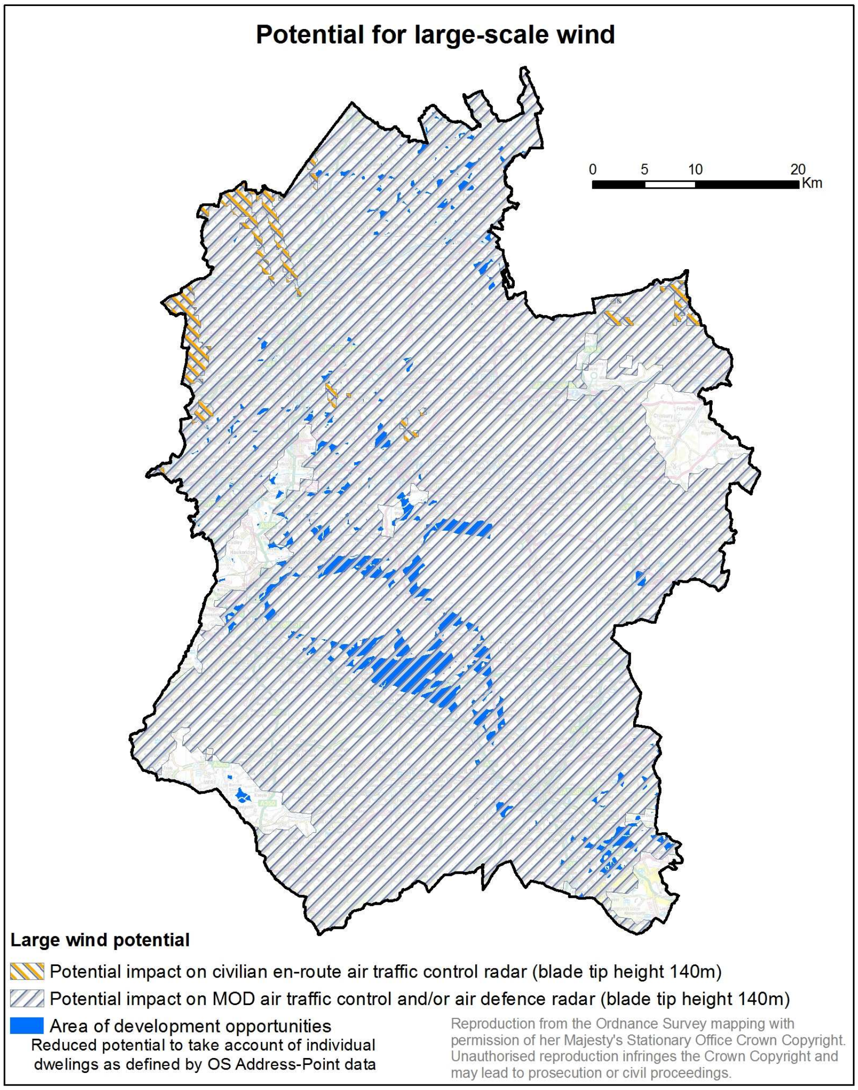
The map below shows the position of MoD owned land relative to possible areas of opportunity for large-scale wind development. The large area in the middle is Salisbury Plain with a number of adjacent barracks and airfield. The area to the north of Salisbury Plain is Keevil airfield which lies within a number of possible potential areas for large-scale wind development. The areas to the north of Wiltshire are RAF Hullavington and RAF Lyneham. RAF Lyneham is scheduled to stop operating as an airfield by the end of 2012 but the future use of the site is still uncertain. The area to the south of the plain, around Deptford Airstrip, is unlikely to be developed for large wind energy due to continuing use for flying activity.



The following two maps show where there may be an impact on civilian and MoD air traffic control and/or air defence radar for wind turbines with blade tip heights of 100m and 140m respectively. It may be possible to mitigate these potential impacts, but it is likely that the MOD will raise planning objections to larger turbines in these areas.

Of the 141 km^2 of technical potential described in section 5.1.1.2, and shown in Figure 16, 123 km^2 would be within the area of potential impact on radar at 100m agl and 136 km^2 within the area of potential impact at 140m. Prospective developers of wind power would need to consult with the MoD to address potential impacts on radar and may need to plan for turbines of lower height in these areas.




Potential for large-scale wind
0 5 10 20
Km
Large wind potential
Potential impact on civilian en-route air traffic control radar (blade tip height 140m)
Potential impact on MOD air traffic control and/or air defence radar (blade tip height 140m)
Area of development opportunities
Reduced potential to take account of individual dwellings as defined by OS Address-Point data
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Appendix 9: Summary table of renewable generation within Wiltshire[92]

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016
Renewable Energy Uptake - Existing Buildings (Cumulative GWh)									
Thermal energy	3.34	6.69	10.03	13.37	16.72	20.06	23.40	26.75	36.95
Electrical energy	0.35	0.70	1.04	1.39	1.74	2.09	2.44	2.78	4.02
Renewable Energy Uptake - New Builds (Cumulative GWh)									
Thermal energy	0	0	0.26	0.49	0.83	8.97	15.04	19.80	26.66
Electrical energy	0	0	0.84	1.58	2.67	3.37	3.94	4.41	6.15
Summary of Renewable Uptake (GWh)									
New build – thermal	0	0	0.26	0.49	0.83	8.97	15.04	19.80	26.66
New build – electricity	0	0	0.84	1.58	2.67	3.37	3.94	4.41	6.15
Existing build - thermal	3.34	6.69	10.03	13.37	16.72	20.06	23.40	26.75	36.95
Existing build - electricity	0.35	0.70	1.04	1.39	1.74	2.09	2.44	2.78	4.02
Decentralised biomass - thermal	0	0	12.22	82.93	95.97	122.08	143.77	169.21	198.01
Decentralised biomass - electricity	0	0	21.93	71.81	87.89	112.11	132.46	155.01	178.23
Decentralised wind - electricity	0	0	0	31.21	62.42	98.82	130.03	166.44	197.65
Decentralised hydro - electricity	0	0	0	0.67	1.35	2.02	2.70	3.37	4.05

[92] *See section 5.2.2.3*

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025
Renewable Energy Uptake - Existing Buildings (Cumulative GWh)									
Thermal energy	47.16	57.36	67.56	77.77	101.15	124.53	147.91	171.29	194.67
Electrical energy	5.26	6.49	7.73	8.97	13.84	18.71	23.59	28.46	33.34
Renewable Energy Uptake - New Builds (Cumulative GWh)									
Thermal energy	42.31	53.47	66.16	76.25	86.35	96.44	107.92	119.42	131.07
Electrical energy	9.43	11.92	14.44	16.50	18.57	20.64	22.95	25.26	27.60
Summary of Renewable Uptake (GWh)									
New build – thermal	42.31	53.47	66.16	76.25	86.35	96.44	107.92	119.42	131.07
New build – electricity	9.43	11.92	14.44	16.50	18.57	20.64	22.95	25.26	27.60
Existing build - thermal	47.16	57.36	67.56	77.77	101.15	124.53	147.91	171.29	194.67
Existing build - electricity	5.26	6.49	7.73	8.97	13.84	18.71	23.59	28.46	33.34
Decentralised biomass - thermal	234.35	259.36	287.20	308.55	365.66	422.79	479.93	534.52	591.27
Decentralised biomass - electricity	208.07	228.00	250.43	267.18	302.97	338.79	374.64	408.56	443.83
Decentralised wind – electricity	228.86	265.26	296.47	332.88	364.09	400.50	431.70	462.91	499.32
Decentralised hydro – electricity	4.72	5.40	6.07	6.75	7.42	8.10	8.77	9.45	10.12

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