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Renewable Energy and Planning Research - Update

climatechangesolutions

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Executive Summary

This report has been prepared by Camco for Bath and North East Somerset Council (B&NES). It forms part of the evidence base for B&NES' emerging Core Strategy, specifically addressing the requirements of Planning Policy Statement 1 (PPS1), which expects new development to be planned to make good use of opportunities for decentralised and renewable or low-carbon energy, and also to reflect national polices. It is an update report of the report published in June 2009.

HOUSING GROWTH PLANS FOR B&NES

The Core Strategy makes provision for around 11,000 new homes, with associated commercial and institutional buildings. The new developments will consist of a mixture of rural infill, urban infill (of differing scale), and larger urban developments. 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.

This report assesses the capacity for supplying this new development with low carbon energy for the area's emerging Core Strategy and subsequent Local Development Framework documents. In undertaking this analysis the study:

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

SETTING A LOCAL CARBON STANDARD FOR NEW DEVELOPMENT

Low 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 B&NES Core Strategy, the key question is whether the proposed Building Regulation improvements are considered adequate or whether B&NES 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 renewable energy resource within B&NES indicates that the local renewable energy resource can meet the energy demands of the planned new development. For larger developments this means that zero carbon standards should not be challenging (assuming that the proposed new definition of zero carbon development is adopted which will allow offsite renewable energy to supply zero carbon developments). However there are a limited number of such larger developments (i.e. over 500 units) proposed within B&NES that will be suitable for communal energy systems, which are more capable of achieving low to zero carbon standards than smaller developments. While these developments can technically meet the zero carbon standards there is a cost implication.

Renewable Energy Resource within B&NES

The total practical potential for renewable energy (electricity and thermal energy) within B&NES is estimated to be around 275 MW equivalent installed capacity by 2026. The significant portion of this figure is from decentralised (stand-alone) renewable energy sources. Two specific technologies dominate this renewable energy technical potential – large wind turbines and biomass.

Summary of Practical Potential to 2026

Renewable Energy	2010 Current resource	2020	2026	Percentage reduction in 2026[1]
Capacity - Electricity (MW_e)	0.106	73	110	-
Capacity - Heat (MW_{th})	0.30	89	165	-
Energy - Electricity (MWh_e)	450	102,687	136,992	17%
CO2e abatement from renewable electricity (tCO2 per year)	194	44,155	58,907	9%
Energy - Heat (MWh_{th})	451	150,740	278,892	23%
CO2e abatement from renewable heat (tCO2 per year)	84	27,887	51,595	8%

NB the total percentage reduction in CO_2 emissions in 2026, compared to Business as Usual, accounting for the impact of installing both energy efficiency and renewable energy technologies is 27%.

A Local Standard For Different Areas Or Developments Within B&NES?

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 district. 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. Combined heat & power (CHP) systems, powered by renewable resources, with a district heating network, typically enable the greatest carbon reductions in new developments. In addition, the two key renewable energy resources of biomass and large scale wind do not need to be

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located in the same locality as the development – biomass resources can be transported to where they are needed and wind turbines could potentially, in future, be contractually linked to developments located some distance away[2].

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 an energy strategy for the development they are proposing which demonstrates how they intend to meet carbon targets, in line with tightening Building Regulations and the *Code for Sustainable Homes* carbon standards, explaining why they are using any given solutions.

Carbon Standards For Developments Based on Building Types, Scale and Density

Although this study does not consider individual sites, it might be possible to require tighter carbon standards on a site by site basis, following consideration of local conditions.. Accurate determination of 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 are 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 up to 20% carbon reductions with renewables providing the remaining reductions. Policy and masterplanning must be used to require appropriate energy provision depending on the scale and character of developments.

The evidence indicates that in larger developments i.e. over 500 units communal systems are viable. B&NES could specify that all sites above this threshold carefully examine incorporating a communal system into the development. Work by AECOM for B&NES (District Heating Opportunity Assessment Study, November 2010) has examined in detail the opportunities for heat networks across the district with an options assessment of technologies and costs.

VIABILITY OF DEVELOPMENTS BUILT TO HIGHER CARBON STANDARDS

Illustrative energy supply strategies outline the key technical and financial options for moving towards a zero carbon development through the progressive achievement of CSH and BREEAM levels in line with Building Regulations (BRegs). They demonstrate that although zero carbon requirements would place a significant cost on new developments, they are still viable for the largest developments – there are few developments at this scale proposed for B&NES.

Moving towards a lower carbon development paradigm does impose additional costs on the development. Developers can work in partnership with an Energy Services Company (ESCo) to mitigate some of these costs. Initiative such as the Feed in Tariff (FIT) and the Renewable Heat Incentive (RHI) will further help to mitigate the cost impacts.

[2] *Though this mechanism has yet to be defined to be compliant with the zero carbon definition*

FACILITATING THE DEVELOPMENT OF SHARED INFRASTRUCTURE AND RENEWABLE ENERGY

The Core Strategy should outline that developers should thoroughly explore the opportunities to achieving low carbon standards through for example communal energy infrastructure rather than just opting for the smaller, less complex building integrated renewables to achieve lower carbon standards. Developers should be encouraged not to opt for cheaper strategies in the earlier phases developments which jeopardise the ability of the development to achieve significant carbon savings in the longer term.

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 B&NES, 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. B&NES has an opportunity to directly progress renewable energy installations and decentralized energy generation by taking forward projects on its own buildings and land. The public sector could establish a local ESCo to help implement these low carbon energy projects. There is a particular opportunity to use public buildings as an anchor heat load around which to establish CHP and district heating networks.

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. 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.

KEY RECOMMENDATIONS FOR PROGRESSING LOW CARBON DEVELOPMENT

The following actions will assist the Council in progressing low carbon development:

1. Set a district wide minimum level of renewable electricity and heat generation targets for 2026. The evidence from this study shows how a practical potential can be realised for each technology. It should be noted that the practical potential relates to current costs, market conditions and policy. Should any of these improve the viability of renewables over time might allow for a higher potential to be achieved. The practical potential could therefore be considered to be a base level of capacity to be achieved.
2. Use this study 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 this report and B&NES District Heating Opportunity Study (AECOM November 2010)
3. The resource analysis shows that, when combined with improving energy efficiency measures, there is adequate local resource to achieve the mandatory BRegs carbon

reduction for residential property to progressively move to the achievement of zero carbon by 2016; and for non-residential property by 2019. It should also therefore be possible for developers to achieve the parallel Code for Sustainable Homes from 2013 onwards, up to level 6 by 2016 and BREEAM "Excellent" by 2019.

4. The Core Strategy and subsequent LDDs 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 sites capable of delivering 500 units.
5. Ensure that the master plans for the key growth sites contain comprehensive zero carbon methodologies addressing buildings and low carbon infrastructure. Ensure that developers produce detailed energy strategies for the key development sites, with the onus on them proving why zero carbon standards are not possible if this is the claim.
6. In line with the emerging national mechanism, develop rules to ensure that 'off site' renewables are additional to any commercial renewable energy developments that would occur anyway within the district (and support the development of a delivery mechanism).
7. 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.
8. 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.
9. Investigate the establishment of 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.
10. The public sector should implement renewable energy installations and decentralized energy generation projects on its own buildings and land. This can be realised by public sector buildings providing 'anchor loads' for district heating and low carbon infrastructure networks. Encourage ESCo activity in the district, including the development of a public sector led energy supply project[3]
11. The Council must ensure that there is a sustainable and joined up approach to waste management throughout the sub-region e.g. facilitate the utilisation of biomass waste for regional energy generation and set this requirement into future waste contracts.

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

1 Introduction

1.1 Study Overview

Bath & North East Somerset (B&NES) Council commissioned Camco to undertake an update to the evidence based renewable energy targets and policies report, covering the B&NES district, published in June 2009. These updated targets and policies will inform the Local Development Framework (LDF). The work has been undertaken in response to Planning Policy Supplement 1 relating to Climate Change.

The project has:

- assessed the *technical* potential for renewable energy within B&NES;
- assessed the potential for renewable energy within B&NES and advised on targets;
- calculated the potential for sustainable energy at the proposed new property development across the district – some 11,000 new homes in total plus a non-residential mix of buildings;
- identified policy implications that will assist turning the potential for renewable energy generation into a reality.

1.2 Overview of B&NES

B&NES is characterised by having 48% of its population living in the World Heritage Site of Bath, 37 conservation areas and 6,400 listed buildings. There are two Areas of Outstanding Natural Beauty within B&NES, the Mendip AONB and Cotswolds AONB, and other areas of high landscape value and also important ecological areas. Running through the area are the Rivers Avon and Frome. Geothermal hot springs arise in the centre of Bath. Only 4% of B&NES is wooded, and there are no major sawmills in the area; however, there are over 800 farms and kitchen waste will be collected from 2009 onwards. These characteristics have informed the analysis undertaken in this study.

Currently there are over 74,500 dwellings within B&NES and a non-residential buildings ground floor area of over 2,500,000m^2. By 2026 it is anticipated that B&NES will increase its housing stock by some 11,000 dwellings; an increase of around 15%. With these new homes, additional employment and public buildings will be required.

2 Low Carbon Policy Background

In light of the election of the coalition Government and the likelihood of policy change, this report describes the policy situation currently in place.

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 26 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[4] calls for 15% of the UK's electricity, heat and transport fuel to come from renewable sources by 2020. This comprises a generation target of more than 30% for electricity and a 12% target for heat. The strategy was published in July 2009.

2.3 Planning Policy Statement on Planning and Climate Change Supplement to PPS 1

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[5] PPS 1 requires local planning authorities to develop planning policies for new developments that are based on:

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

The PPS1 supplement also states that:

"alongside any criteria-based policy developed in line with PPS22, consider identifying suitable areas for renewable and low-carbon energy sources, and supporting infrastructure, where this would help

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

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 Regional and Local Planning Policy

Local renewable and low carbon energy planning was until May 2010 to be guided by the Regional Spatial Strategy. However, the Government's intension to abolish Regional Strategies has removed the requirement for Regional Spatial Strategies leaving energy planning to be determined at a local level through the Local Development Framework process. This report informs the development of the Core Strategy in the development of the energy planning and policy development for B&NES. Low carbon planning will be an important part of delivering the Council's aspirations, which are laid out in the Sustainable Community Strategy (SCS) the headline policy for the B&NES Local Strategic Partnership. The SCS sets direction for other Council policy including the LDF. Tackling climate change is a key priority in the SCS and as such the SCS commits the Council and LSP partners to the goal of reducing district-wide CO_2 emissions 45% by 2026.

2.6 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 (BRegs) for new homes.

Figure 1 shows how BRegs are driving down carbon emissions in domestic property up to 2016 when zero carbon development will become the norm. For non-domestic property zero carbon development will be required by 2019.

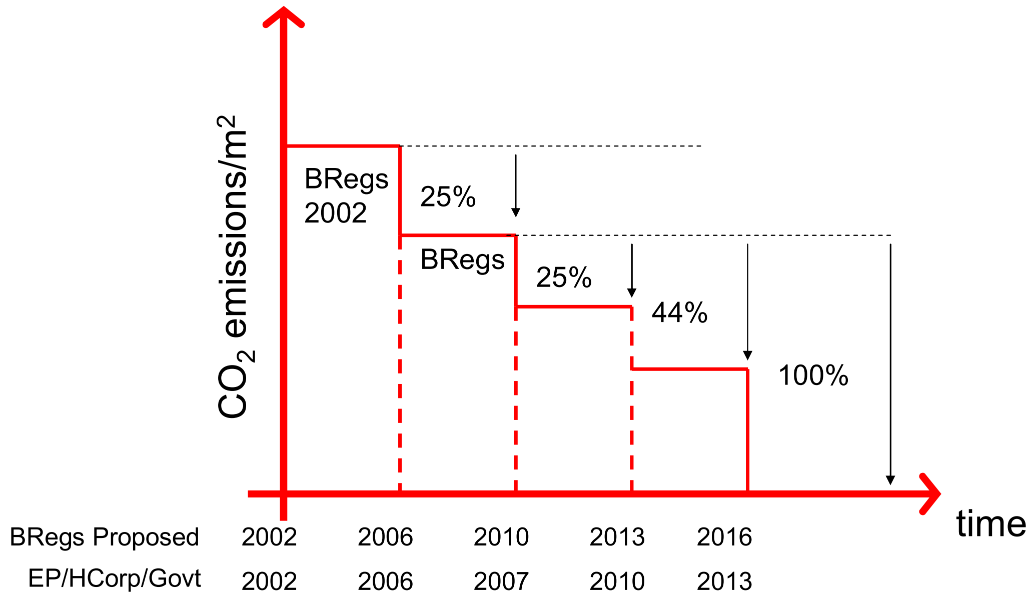


Figure 1 Timeline for the implementation of Zero Carbon Homes through building regulations

The carbon reductions required under BRegs provide the driver for the complementary carbon reductions as assessed through the Code for Sustainable Homes (CSH), for residential property and the Building Research Establishment Environmental Assessment Method, BREEAM, for non-residential property. Both CSH and BREEAM assess construction categories other than carbon eg water, materials, surface water runoff (flooding and flood prevention), waste, pollution, health and well-being, management and ecology, to give an overall assessment of the construction sustainability.

The CSH has been reviewed and updated in November 2010. Figure 2 shows the requirements to achieve specific levels in the CSH – this has not changed the carbon reduction required. The revised CSH has however placed a greater emphasis on the use of energy efficiency measure to reduce CO_2 emissions

Code Level	Minimum Percentage Improvement in Dwelling Emission Rate over Target Emission Rate
Level 1 (★)	0% (Compliance with Part L 2010 only is required)
Level 2 (★★)	0% (Compliance with Part L 2010 only is required)
Level 3 (★★★)	0% (Compliance with Part L 2010 only is required)
Level 4 (★★★★)	25%
Level 5 (★★★★★)	100%
Level 6 (★★★★★★)	Net Zero CO_2 Emissions

Figure 2: Code Levels for Mandatory Minimum Standards in CO2 Emissions[6]

BRegs will require new development in B&NES to meet increasingly stringent mandatory standards, and all housing developments after 2016 will need to be zero carbon. 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 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 2010 – ie 25%, 100% and a 145%[7] 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 show that zero carbon development is possible within the locality and set out the local circumstances that justify this requirement[8].

For non-domestic buildings the aspiration is to achieve zero carbon status by 2019. Non-domestic buildings are usually assessed against BREEAM (BRE Environmental Assessment Method) which is the leading and most widely used environmental assessment method for buildings. It sets the standard for best practice in sustainable design and has become the de facto measure used to describe a building's environmental performance.

2.7 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 inform the 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 considered whether it is practical to expect all types of development to meet all low carbon energy needs from onsite generation, and further

[6] *Code for Sustainable Homes:Technical Guide (November 2010)*
[7] *To comply with zero carbon development will require that developers ensure that both regulated and unregulated emissions are zero carbon. For Code levels up to 5 only regulated emissions are considered.*
[8] *In line with PPS1 paragraphs 31, 33*

determine whether offsite low carbon energy generation[9] or even carbon offsetting should also be allowed to comply with the zero carbon home standard.

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?

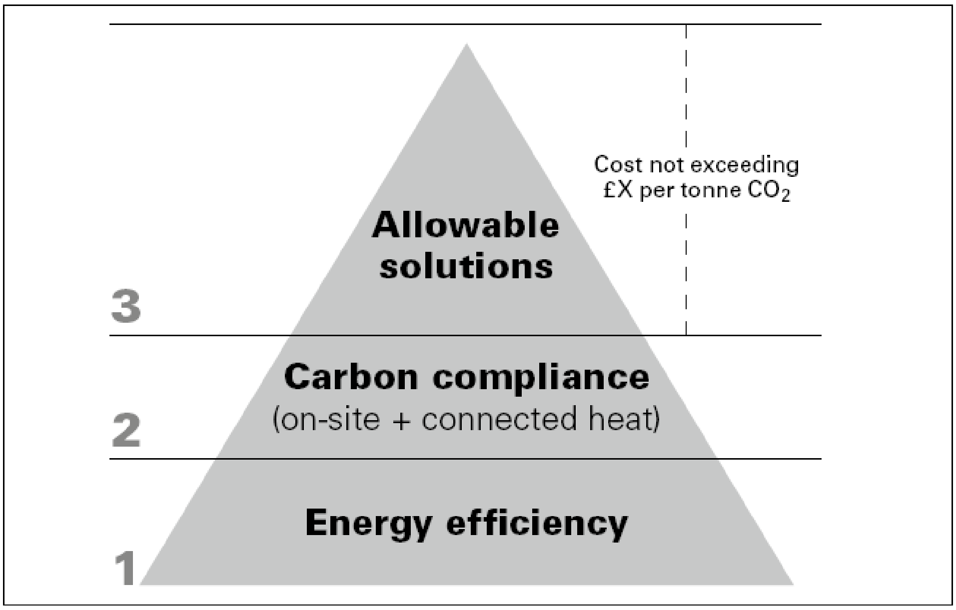


Figure 3: Government's preferred hierarchy for a zero carbon housing development

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 proposed that a minimum of 70% of regulated[10] emissions should be abated through energy efficiency and carbon compliance. This enables 'allowable solutions' to meet the remaining 30% of regulated and 100% of unregulated[11] emissions.

National guidance on allowable solutions is still limited but the consultation on the Definition of Zero Carbon Homes and Non-Domestic Buildings[12] provided some possible examples of allowable solutions in order to deal with the residual emissions. Solutions that commanded broad support included[13]:

[9] So called "allowable solutions"
[10] Regulated emissions arise from space heating, domestic hot water, lighting, fans and pumps.
[11] Unregulated emissions arise from the use of appliances and other electrical items
[12] Definition of Zero Carbon Homes and Non-Domestic Buildings, Consultation. Communities and Local Government (Dec 08)
[13] Sustainable New Homes – The Road to Zero Carbon. Communities and Local Government (Dec 09)

- Further carbon reductions onsite 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;
- 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 B&NES as it is very difficult to meet all the energy needs of new development, of the scale proposed, through onsite generation alone. In particular, the contribution of the local wind resource within B&NES to meeting the low carbon 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, is currently being considered with the involvement of the Zero Carbon Hub and is likely to be resolved by the end of the 2010[14]. The expectation is that offsite allowable solutions will, in general, be less costly than the onsite solutions. Once allowable solutions definition has been resolved, B&NES should consider the types and scale of carbon offsetting that it can, or wishes, to support within the local area. The consultation document for zero carbon homes[15] give a guideline value of £100/tonne CO_2. Clearly the price of carbon is dependent of a number of variables and will therefore change over time. It is expected that when the definition of allowable solutions is published that a clear methodology for the application of carbon pricing will be given.

2.8 Renewable Incentive Schemes

A number of schemes are running which aim to incentivise the generation of renewable energy. The oldest of these schemes is the Renewables Obligation (RO), placed upon electricity suppliers, which allows for the issuing of Renewable Obligation Certificates (ROCs) to support renewable energy generation. 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 a ROC (or multiple of a ROC) is issued for a certain amount of electricity generation. Electricity suppliers then meet their RO by presenting the required number of ROCs. ROCs are tradable commodities and therefore electricity suppliers can meet their RO obligation by generating renewable electricity or purchasing ROCs in the market, or a combination of both.

More recently two renewable energy tariffs have been developed to encourage the uptake of renewable technology on a smaller scale. They reward low carbon energy generators for energy output in the form of renewable electricity (supported by the Feed in Tariff - FIT) and renewable heat generation (supported by the Renewable Heat Incentive - RHI).

The Feed-in-Tariff (FIT) scheme was initialised in April 2010 to attract small-scale renewable electricity generators into the market. It is applicable to generators with a maximum declared

[14] *Housing Minister Grant Shapps speech in Swindon May 2010*
[15] December 2008. Communities and Local Government. Definition of Zero Carbon Homes and Non-Domestic Buildings,

net capacity (DNC) of 5kWp 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 the 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 heat target of 15% by 2020. Its aim is to incentivise the development of renewable heat technologies, including biomass, heat pumps and solar thermal, to ensure that these sources provide heating at a competitive market price.

The Government's Spending Review in October 2010 confirmed that the RHI would be taken forward but the exact details of the scheme are not expected to be released until Spring 2011.

3 Current Energy Consumption and Carbon Emissions

3.1 Energy Demand and CO_2 Emissions in B&NES

3.1.1 Current carbon emissions and energy consumption for the area

The total annual emissions for B&NES, excluding road transport, were 766,434 tonnes of carbon dioxide (tCO_2/yr) in 2007. This represents the most recently available data produced by DECC[16]. The breakdown of fuel use from commercial/industrial and residential dwellings is illustrated in Table 1. As shown, B&NES differs from the national average[17] for residential dwellings with a greater proportion using natural gas and a lower proportion using oil. For Commercial and Industrial consumption B&NES shows the reverse trend to the domestic consumption pattern ie a greater proportion of oil and lower proportion of gas when compared to the national average.

Table 1: Breakdown of the energy consumption within B&NES in 2007 (source: DECC)

	Energy Consumption (MWh/year)				
	Coal	Petroleum (Oil)	Natural gas	Electricity	Total
Commercial and Industrial - B&NES	7,774	194,543	356,972	408,712	968,001
Residential – B&NES	4,816	133,854	1,075,111	353,835	1,567,617
Commercial and Industrial - GB average	9,430	57,891	883,981	264,503	1,215,805
Residential – GB average	1,347	380,839	502,812	434,816	1,319,813

3.1.2 Future carbon emissions

In line with the B&NES Local Development Framework the construction of around 11,000 dwellings are planned up to 2026. These new homes will add to the area's energy demand. At the same time, national and international impetus is attempting to set a trend for the reduction in CO_2 emissions.

To counter the potential increase in carbon emissions the Council will have to consider policies, across all activities, which support the reduction of carbon emissions. The LDF will specifically need to identify ways that both new and existing buildings can move towards zero carbon.

The government pledged to reduce the UK's total emissions by 26% 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

[16] 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
[17] *The national figures are pro-rated to indicate what the consumption pattern for an area like B&NES would be if it followed the national trend. These figures are only indicative.*

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, two key conclusions can be drawn. Firstly, new buildings must add minimally to the existing energy demands of the area; and, secondly, it is essential that large, renewable, decentralised energy generation technologies are commissioned to help plug this gap.

4 Assessing Potential for a Local Carbon Standard for new development in B&NES

This section looks at the potential for applying carbon standards within B&NES. It begins by describing two main approaches to achieve carbon reductions in new developments and how heat mapping can facilitate this process[18]. It then examines the scale and characteristics of the housing growth plans for B&NES and the low carbon energy strategies that can be employed to address carbon emission reductions. Indicative costs are provided for achieving CSH levels for differing property types in various development types.

4.1 Approaches to Low Carbon Development

4.1.1 Communal energy supply systems

Combined heat & power (CHP) systems, with a district heating network, typically enable the greatest carbon reductions in new developments. However, the viability and effectiveness of CHP is dependent on the scale, density and mix of development. In general, CHP requires large numbers of units at high density with a good mix of building types and a good spread of daily and seasonal energy demand. The 'Community Energy: Urban Planning for a Low Carbon Future' guide produced by the CHPA and TCPA[19] 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.

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

The general threshold criteria for a communal system are at 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 mix or if appropriate existing development is located nearby. Clearly these criteria are sensitive to local conditions, including property mix, the opportunity to link to existing heat loads etc. It might be possible to develop a communal system at a lower development scale, while some larger sites will find it difficult to develop a communal system in a cost effective manner.

For large scale development sites communal renewable CHP systems generally represent the lowest cost energy supply solution to delivering zero carbon development. 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

[18] *See AECOM report District Heating Opportunity Assessment Study, November 2010*
[19] *Community Energy: Urban Planning for a Low Carbon Future, TCPA & CHPA 2008*

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. Note, the mechanics of this kind of linking between property and energy development projects is subject to ongoing work and consultation led by CLG and the Zero Carbon Hub.

The current housing development plans for B&NES are represented by mostly small to medium scale developments. Therefore, the opportunities for heat networks might be limited, however where larger scale developments are planned or adjacent existing buildings might offer additional opportunities, communal heating should be considered as an option. To develop the understanding of the options for heat networks, B&NES has commissioned a parallel report to this analysis, which identifies heat network opportunities for B&NES - District Heating Opportunity Assessment Study (AECOM November 2010).

4.1.2 Microgeneration energy supply systems

Individual building-integrated low carbon technologies such as photovoltaics, solar water heating, ground source heat pumps and improved energy efficiency standards can deliver substantial carbon reductions in new developments, but will struggle to achieve the very low carbon requirements of Code for Sustainable Homes (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.

4.2 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 any given area. The heat map quantifies the areas of greatest heat demand within the district 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 the heating, cooling and power demands are. This builds an existing heat, cooling and power density map which identifies where CHP can provide a carbon reduction solution within the area. The study undertaken by AECOM (District Heating Opportunity Assessment Study, November 2010) has identified specific opportunities for heat networks in B&NES.

Figures 4 and 5 below shows heat maps generated by the AECOM study:

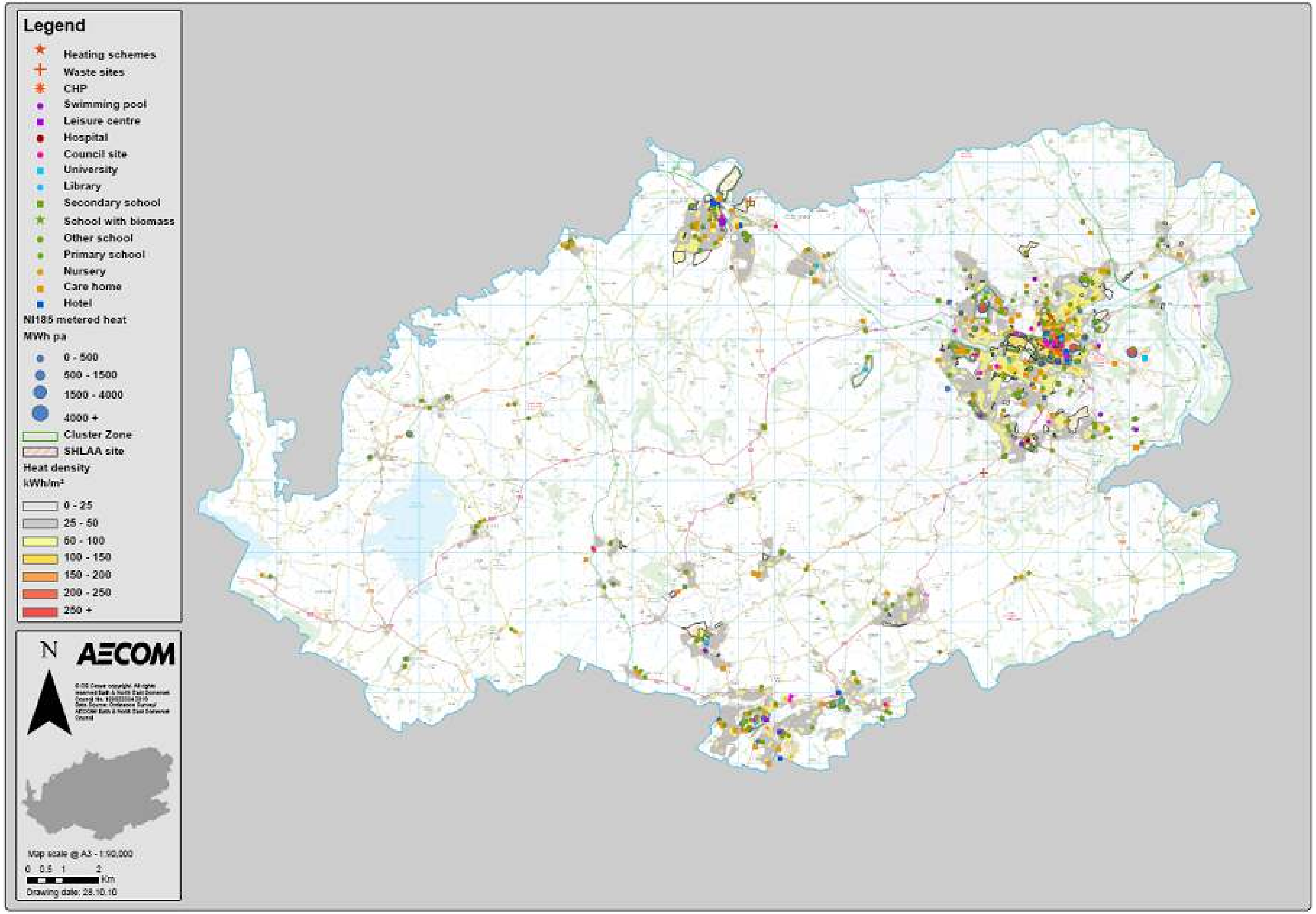


Figure 4 District Heating Opportunity Map for Bath and North East Somerset

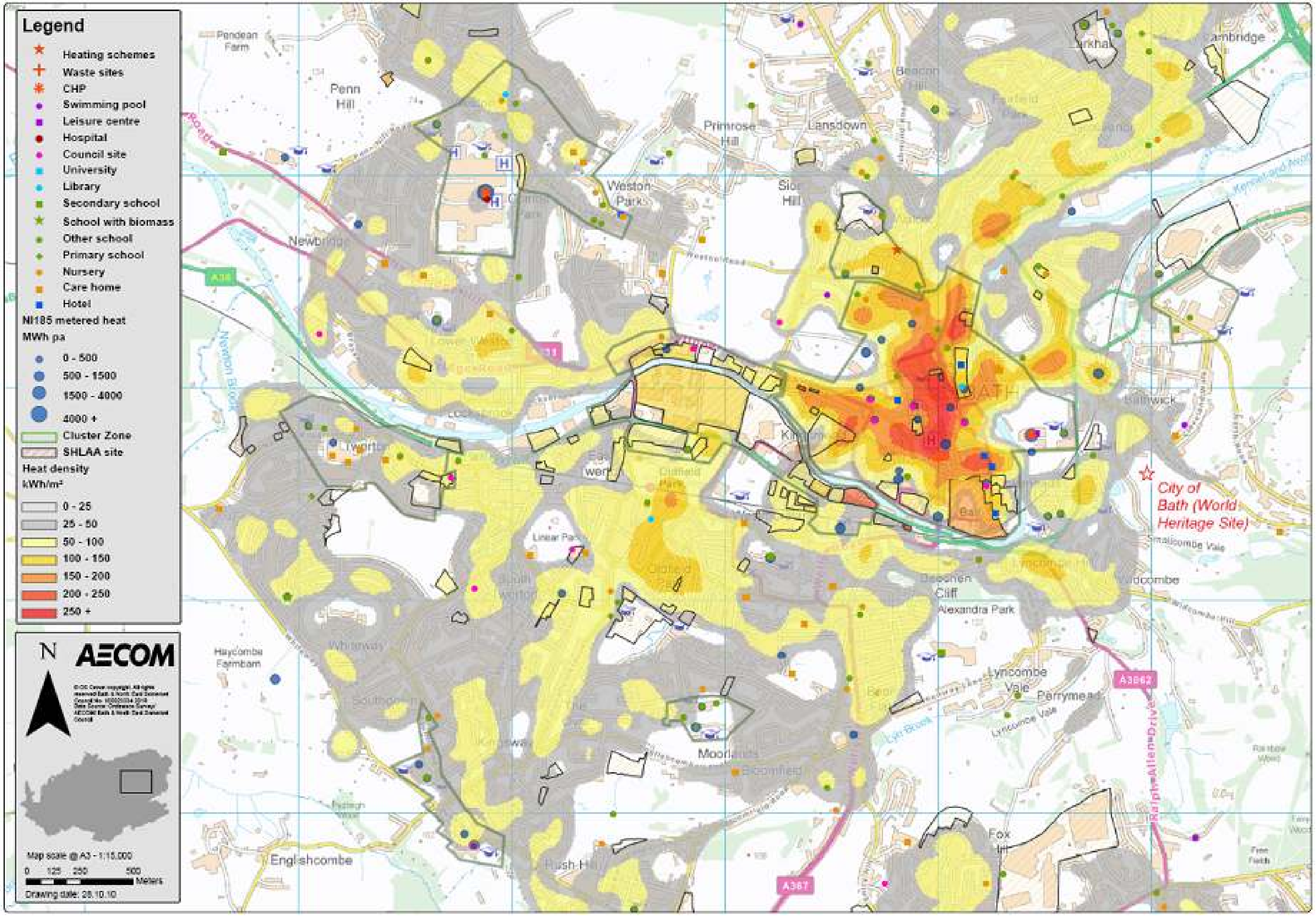


Figure 5 District Heating Opportunity Map for Bath

4.3 Off-Gas Grid Areas

The following map which includes the whole of the (ex-) Avon area, 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 competitive 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 therefore renewable technologies can provide a cost effective alternative.

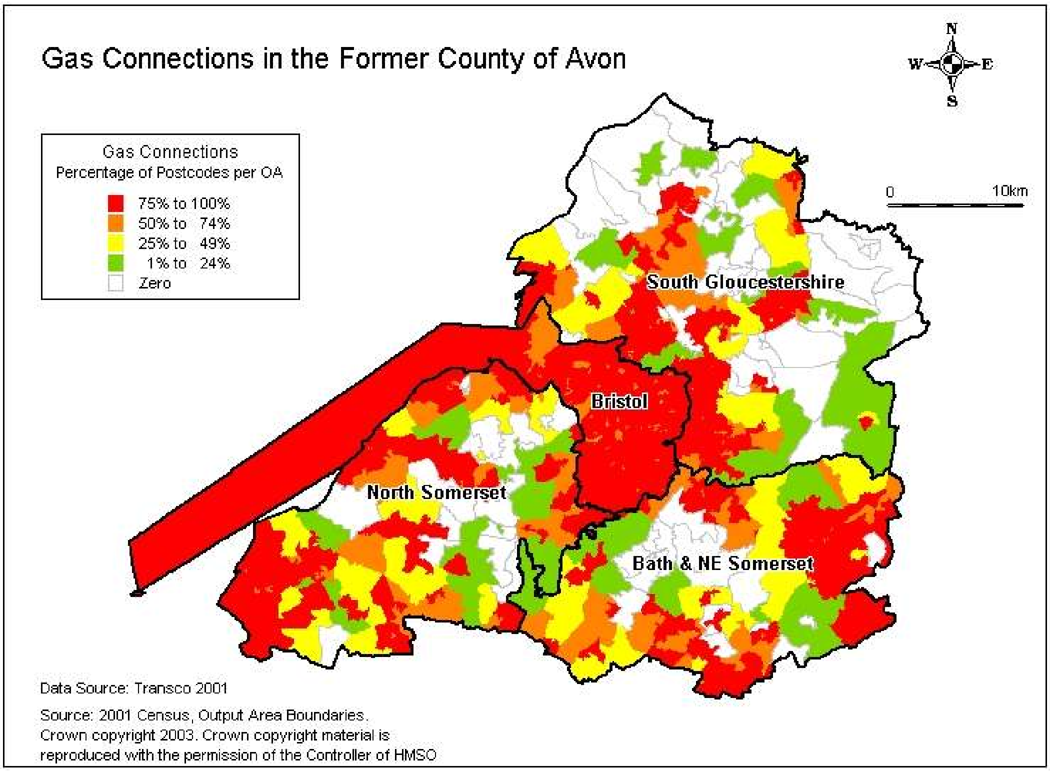


Figure 6: Level of Gas Connections in B&NES

Significant areas of B&NES have low or no connection to the national gas network. These areas should be targeted as priority areas for renewable heat and other microgeneration technologies. Recent modelling of microgeneration scenarios in other regions off the gas network [20], found that using microgeneration provided both greater cost and carbon savings than a full extension of the gas network.

The areas off gas grid are mainly rural and coincide with the potential for renewable energy generation to provide 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 GSHP's, 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.

[20] http://www.energysavingtrust.org.uk/corporate/Corporate-and-media-site/About-us/Strategic-research/Renewables-and-distributed-energy

Fuel poverty is also of concern to local authorities. The figure below shows where poverty exists in B&NES. Areas of fuel poverty, particularly those that coincide with off gas grid areas, can also benefit from renewable technologies that can provide a more cost effective energy supply. Fuel poverty is also often linked to hard to heat housing, so any renewable technologies should be integrated with improved energy efficiency measures.

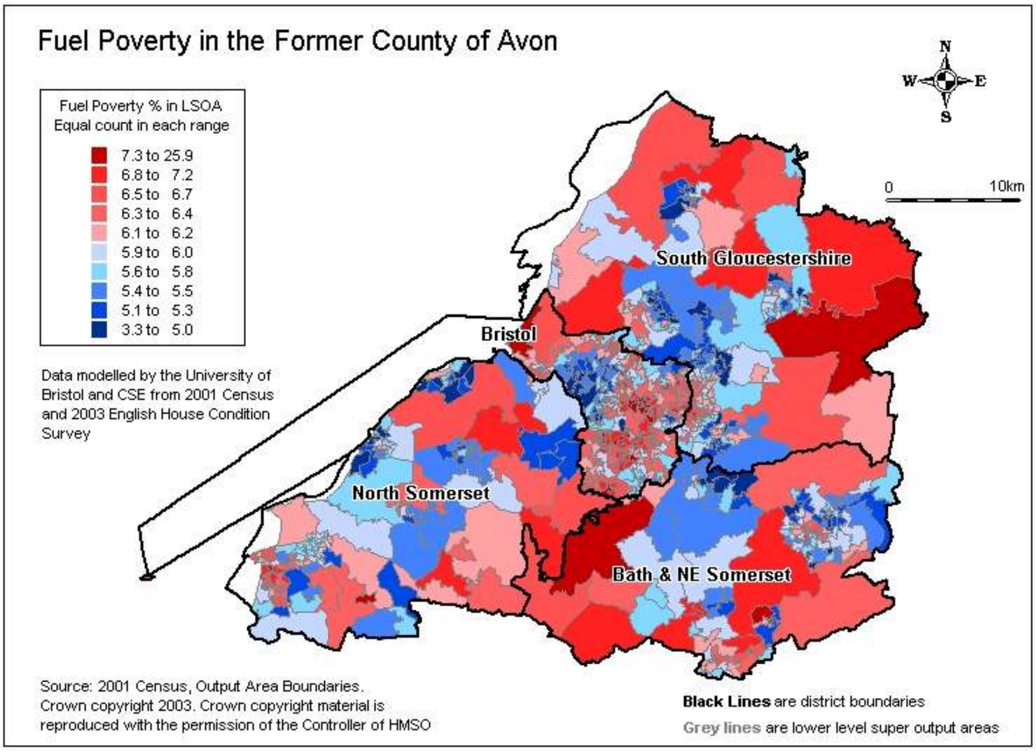


Figure 7: Fuel Poverty in B&NES

4.4 Assessing the Housing Growth Plans for B&NES

4.4.1 Preferred option for housing growth in the Core Strategy

The proposed housing growth numbers provided by B&NES Council amount to some 11,000[21] new housing units between 2006 and 2026. The breakdown of this figure, based on development category, is presented in Table 2. These categorisations are notional to demonstrate the range of development types being proposed and therefore allowing an overview of the likely carbon reduction strategies that might be applied. For any given development an individual assessment of the local conditions, and therefore the optimum carbon reduction strategy, must be applied.

NB. This approach to categorising the proposed housing stock differs from the earlier report where named development areas were identified. Because the large urban extensions will not now be developed, and most of the development will be at a small or medium scale it is not possible to characterise in the same way. The areas identified in the earlier report now have

[21] This includes dwellings with planning permission (either under construction, or not started) those allocated and future expectation of development.

development profiles that show a range of building scales and therefore contain developments with differing carbon reduction profiles.

Table 2: Housing growth plans for the B&NES

Development category	Number of dwellings	Proportion
Urban infill – small scale	3,900	36%
Urban infill – medium scale	4,100	37%
Urban infill – large scale	2,200	20%
Rural infill	800	7%
New settlement[22]	0	0
TOTAL	11,000	100%

4.4.2 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 B&NES, it is necessary to identify the characteristics of the developments and their suitability for installing low to zero carbon technologies. To enable this analysis each main development location has been characterised each one of five development types which are explained in more detail in Table 3. Urban infill –small scale;

- Urban infill – medium scale;
- Urban infill – large scale
- Rural infill;
- New settlement.

The smaller developments that constitute urban and rural infill are typically not appropriate for communal systems and therefore the optimum energy strategy will consist of highly energy efficient buildings with individual building integrated technologies. The large scale urban infill developments are at the larger size and density required to support a communal system in some of the development areas. These will potentially be large enough to 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. It should be noted that the Bath Western Riverside development is expected to go down the route of ESCo development.

These are general rule of thumb categorizations and there will often be overlap between the development types within the characteristics of any specific development site. The specific

[22] NB The category of New Settlement has been included for comparison of potential measures – see Table 4. There are currently no plans to develop at this scale in B&NES.

characteristics of the site will determine the technical and financial suitability of any renewable energy technology options. Therefore the energy strategies presented are indicative only.

Table 4 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. B&NES currently does not have any development planned at this scale.

Table 3: Table of typical low carbon energy strategies for different development types in B&NES

Development Category	General Development Characteristics	Time frame built	Renewable Energy Strategy
Urban infill – small scale	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 + GSHP
		2016-	Individual biomass heating + allowable solutions
Urban infill – medium scale	Up to 1,000 dwellings within or adjoined to existing town or village with limited mix of other building types. Medium density (40 dwellings/ha).	2010-2013	PV + Solar thermal
		2013-2016	Small wind + GSHP
		2016-	Small wind + GSHP +allowable solutions
Urban infill – large scale	Over 1,000 housing units within or 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 + wind + 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

Development Category	General Development Characteristics	Time frame built	Renewable Energy Strategy
New Settlement *(For comparison only - currently no developments of this scale are planned for B&NES)*	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/district heating + PV
		2016-	Communal biomass heating/district heating + PV +wind + allowable solutions

Table 4 Summary of carbon strategies

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

Development types and typical low carbon energy strategies
New Settlement: Large number of housing units adjoined to existing towns – up to 4,000 dwellings – good mix of other building types. High density (greater than 50 dwellings/ha). • As for Urban extension/ major regeneration site: above. Good potential to achieve very low carbon developments.

4.5 Indicative Energy Supply Strategies for New Development

4.5.1 Energy supply options

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.
2. Whether the solutions should be exclusively on-site, or whether a proportion of off-site emissions abatement should be permitted

The typical methodology for identifying the supply options is:

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

4.5.2 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).

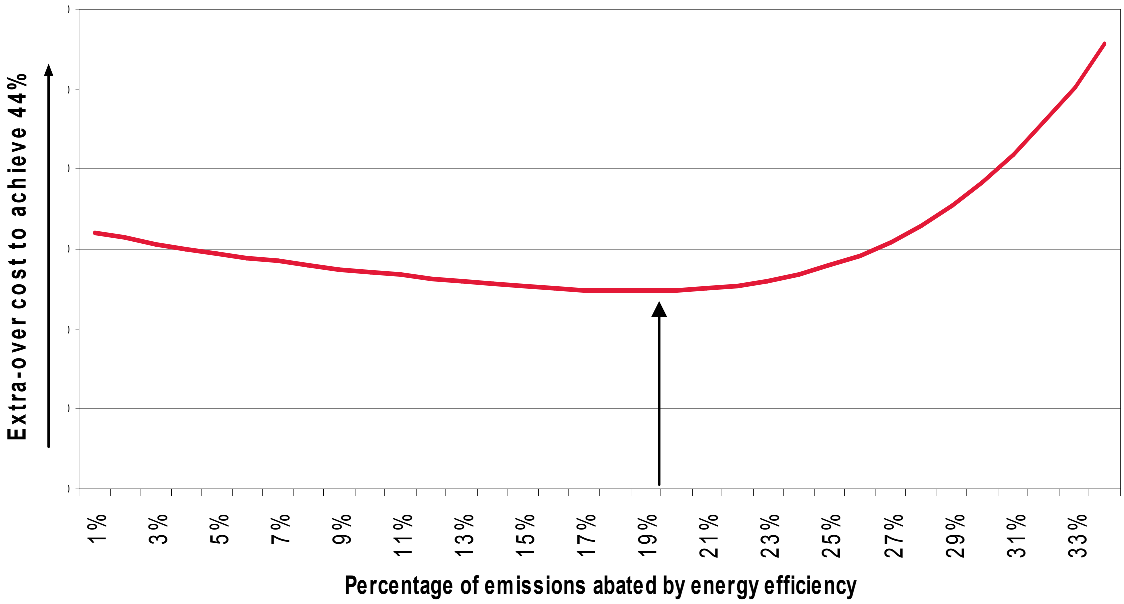


Figure 8: An example of finding a cost effective scenario for achieving emissions targets such as the Code for Sustainable Homes (illustrative purposes only)

This demonstrates that the lowest cost option is for 20%[23] by energy efficiency, and hence the remaining 24% by renewable energy. The optimum balance between energy efficiency and renewable energy is specific to each dwelling type – there is no one-size-fits-all solution.

4.5.3 Indicative energy supply strategies for the key development locations

After energy efficiency is taken into consideration, low- and zero-carbon technologies must be installed to achieve the required emissions reduction target.

For the development scenarios described in Table 5 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.

Microgeneration

Microgeneration technologies alone will struggle to achieve carbon reductions higher than those required by Code Level 4. This is due to technical issues (such as insufficient roof space to mount sufficient photovoltaic panels, or limits to the technology's effectiveness) and the

[23] 20% reduction in heat is due to improved building fabric U-values and air tightness and based on Standard Assessment Procedure [SAP] calculations) and 20% reduction in electricity is based on improved lighting, energy efficient appliances and rising costs of electricity influencing consumer behaviour. It is expected that the impact of energy efficiency will increase as technology costs reduce.

high cost of technologies at the scale required. The rationale for the choice of technologies is demonstrated in Table 5 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.

Table 5: 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.
Heat pumps (GSHP/ASHP) + PV	PV powers heat pumps, 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
Heat pumps (GSHP/ASHP) + small wind	Same rationale as heat pumps + 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. We have shown earlier that 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 6.

Table 6: 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 requires large and high density developments.

4.5.4 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, Appendix 4 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. A more detailed analysis demonstrating the viability of meeting CSH levels 3 and 4 in addition to affordable housing provision and develop contributions has been commissioned by B&NES - Bath and North East Somerset Viability Study, Three Dragons June 2010.

Based on the costs presented in Appendix 4, Figure 9 illustrates the trend in costs of compliance with future building regulations for different development categories. The figure suggests, as might be 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).

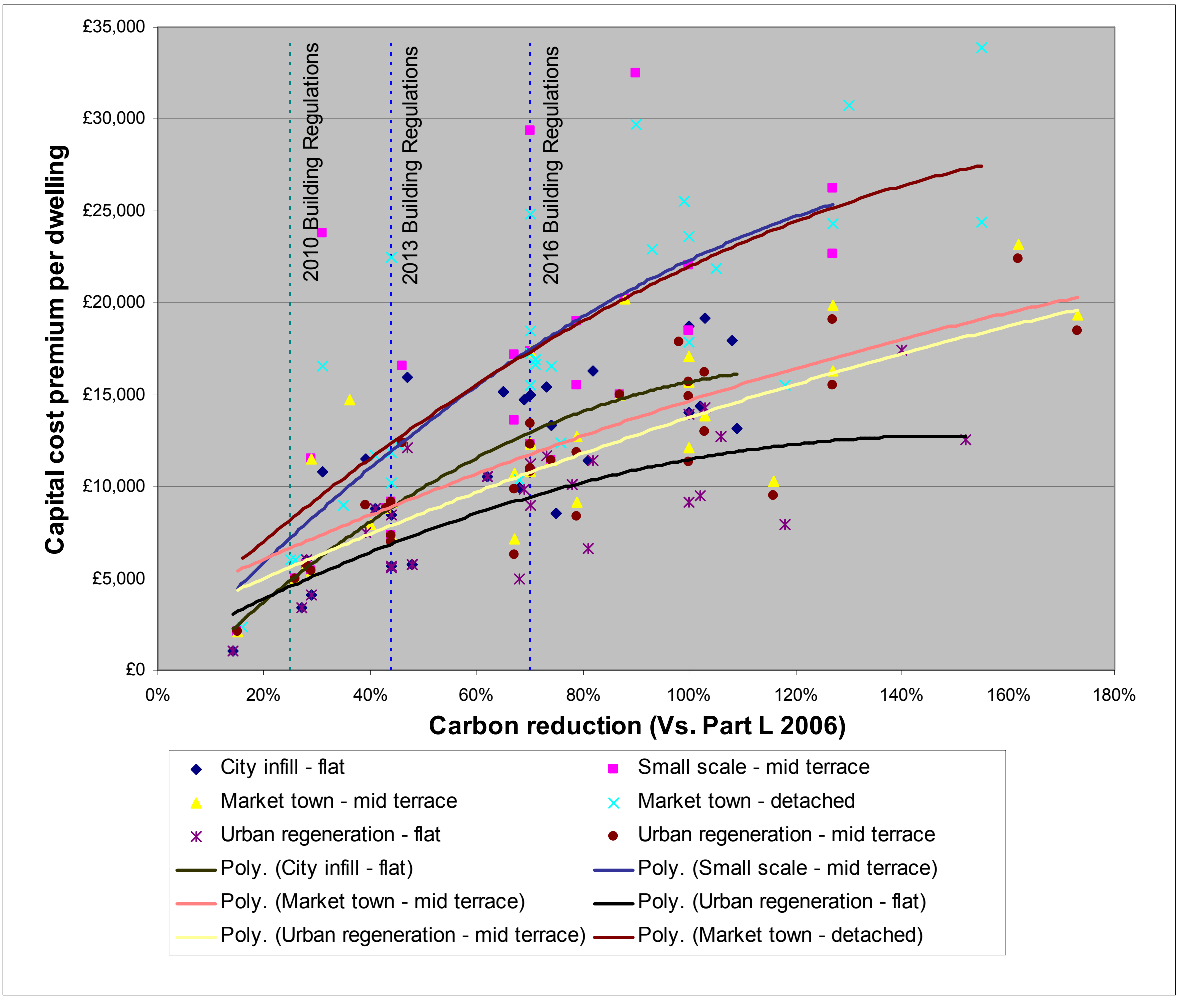


Figure 9: Costs of complying with Future Building Regulations

5 Assessing the Renewable Energy Resource within B&NES

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[24]. 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.

To refine the analysis produced by the DECC methodology B&NES have commissioned work to assess the landscape sensitivity to the development of wind turbines across the district. The study, Landscape Sensitivity Analysis for Wind Energy Development in Bath and North East Somerset by Land Use Consultants (2010), identifies the categories of land sensitivity to turbines of small, medium and large scale. These sensitivity categories have been used in the GIS analysis of areas of opportunity for wind in B&NES. This is described in the sections relating to the wind resource below.

There is currently very little renewable energy generation within B&NES (Tables 7 and 8)[25] but as discussed in the following section there is significant potential.

Table 7: Existing renewable electricity generation within B&NES (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)
19	0.01	0	0	0	0	0.05	0.06

Source *Regensw 2010 annual survey: Renwable electricity and heat projects in south west England*

Table 8: Existing renewable heat generation within B&NES (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)
28	0.19	0.09	0	0	0.07	0.35

Source *Regensw 2010 annual survey: Renwable electricity and heat projects in south west England*

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

5.1 Stand-alone generation potential

This section of the report sets out the potential for stand-alone renewable energy generation projects. The 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.

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[26]. 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[27].The generation potential is based on an assumed load factor of 25%, and a 95% turbine availability factor[28]. The load factor is a measure of the time that a wind turbine is actively generating electricity – this can vary significantly depending on the geographical position of the turbine and the local topography of the landscape. The availability factor is a measure of the time that the wind turbine is available in a year to generate electricity, accounting for periods of maintenance.

Assessment of practical potential

The 'practical potential' is an estimate of the wind capacity that could realistically be developed. The assumptions made in this study 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.

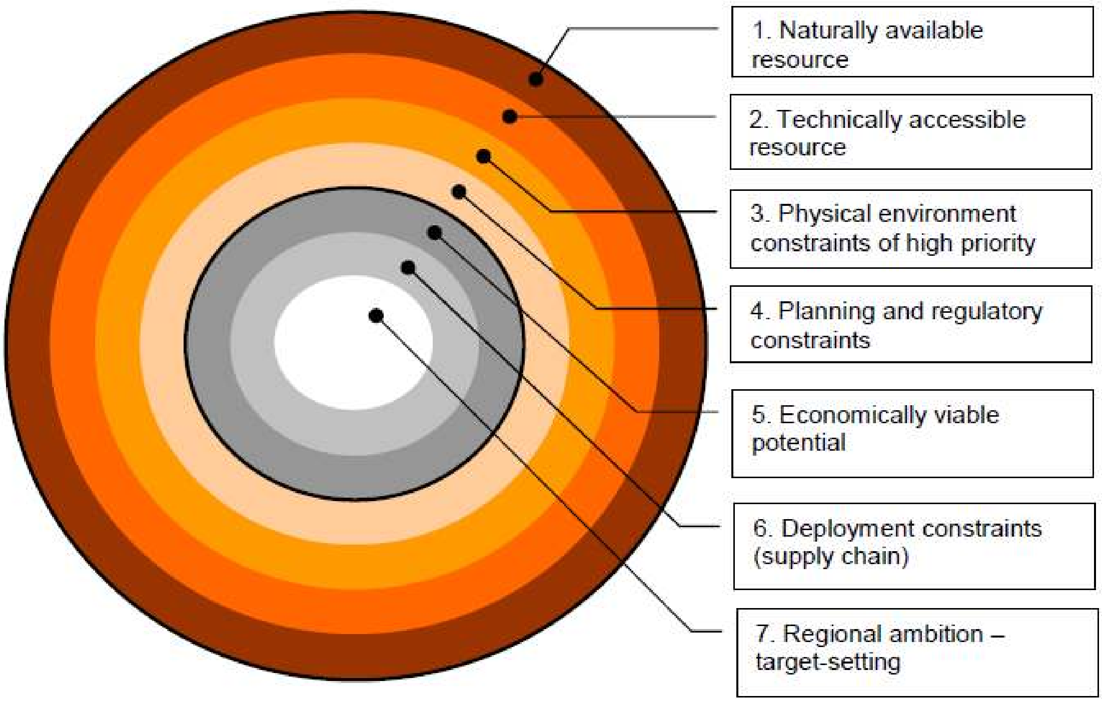
5.1.1.2 Identifying potential wind locations - GIS Mapping

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.

[26] Wardell Amstrong 2010. Wind Resource Assessment for the South West Following SQWenergy Methodology.
[27] 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 produce approximately 5,200MWh/yr, equivalent to the current typical annual consumption of approximately 1,250 households.
[28] Annual generation (MWh/yr) = Capacity (MWe) x Load Factor (%) x availability (%) x Hours in year (hrs)

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 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 the study area. It should be noted that this analysis uses wind speed data at a scale of 1km blocks. Therefore, the areas which appear to have good potential may, within that 1km square, have varied topography or local conditions which would affect the suitability of the sites for wind turbines.

Figure 10 below shows the seven key stages recommended by the Methodology to develop a comprehensive evidence base for renewable energy potential. 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.



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

Figure 10 Calculating renewable targets from the naturally available resource

Table 9 Technical.potential - absolute constraints to commercial-scale wind development

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)	-	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

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

Figure 11 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 9. The area shown in this map adds up to 87.8 km2, with potential to accommodate a total installed capacity of 878 MW. This potential has been further reduced to take account of other factors not included in Table 9 but that will in reality limit the development of large-scale wind. This is further discussed below.

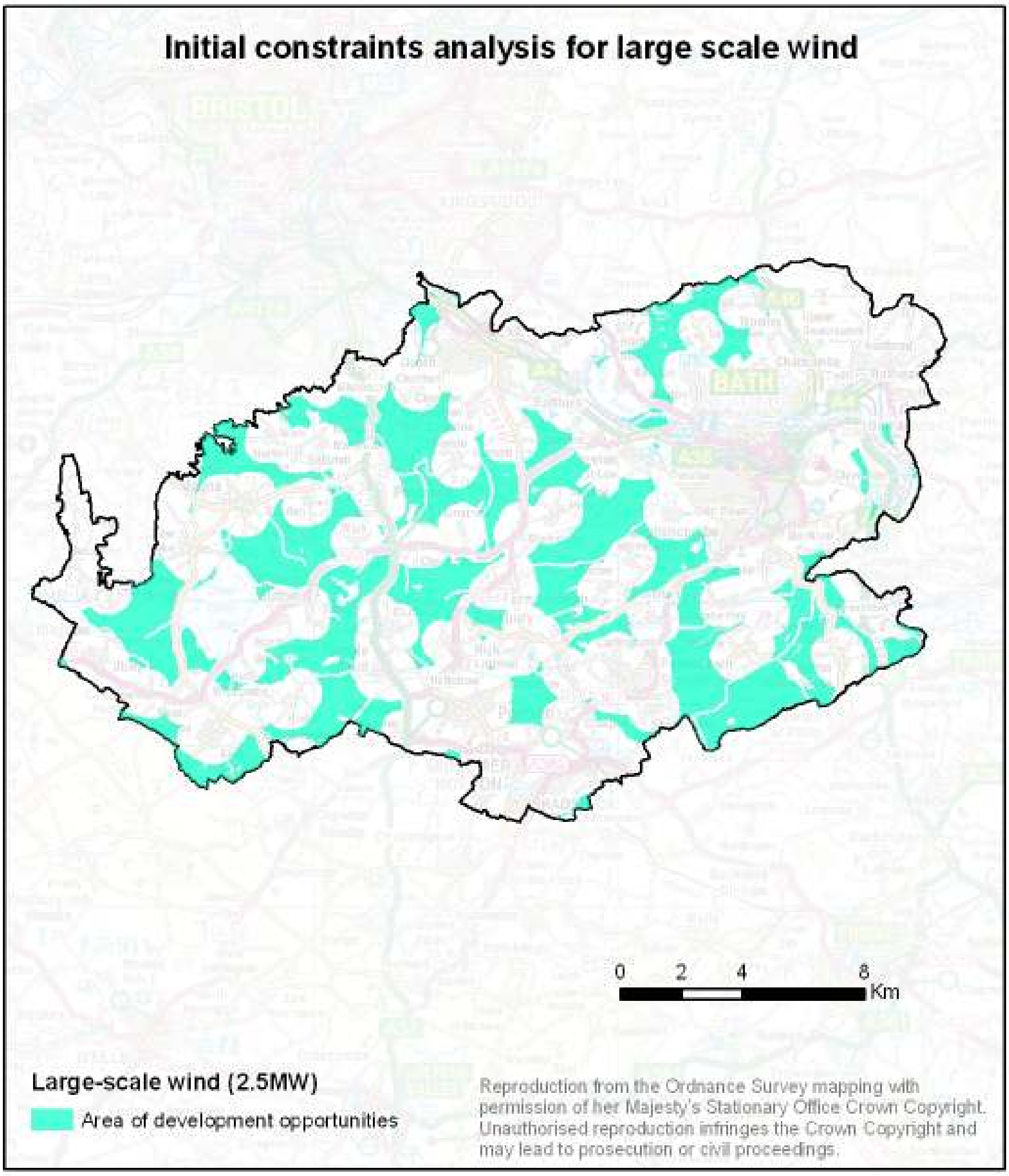


Figure 11. Area of large-scale wind development opportunities - including sites in designated areas

National designated landscapes and international and national nature conservation areas

Whilst the DECC methodology recognises sensitivity around these protected areas (see Table 10), 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 10 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

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

The REvision 2020 report[29] regional wind resource analysis was based on the recommendations of a landscape sensitivity analysis carried out by Land Use Consultants which considered designated areas within the South West Region as constrained for large-scale wind turbines. The same approach has been taken in this study, though 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. Figure 12 shows the area of development opportunities once the sites within designated areas have been excluded. The total area suitable for development is reduced to 64.4 km^2 with a potential maximum installed capacity of 644MW.

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

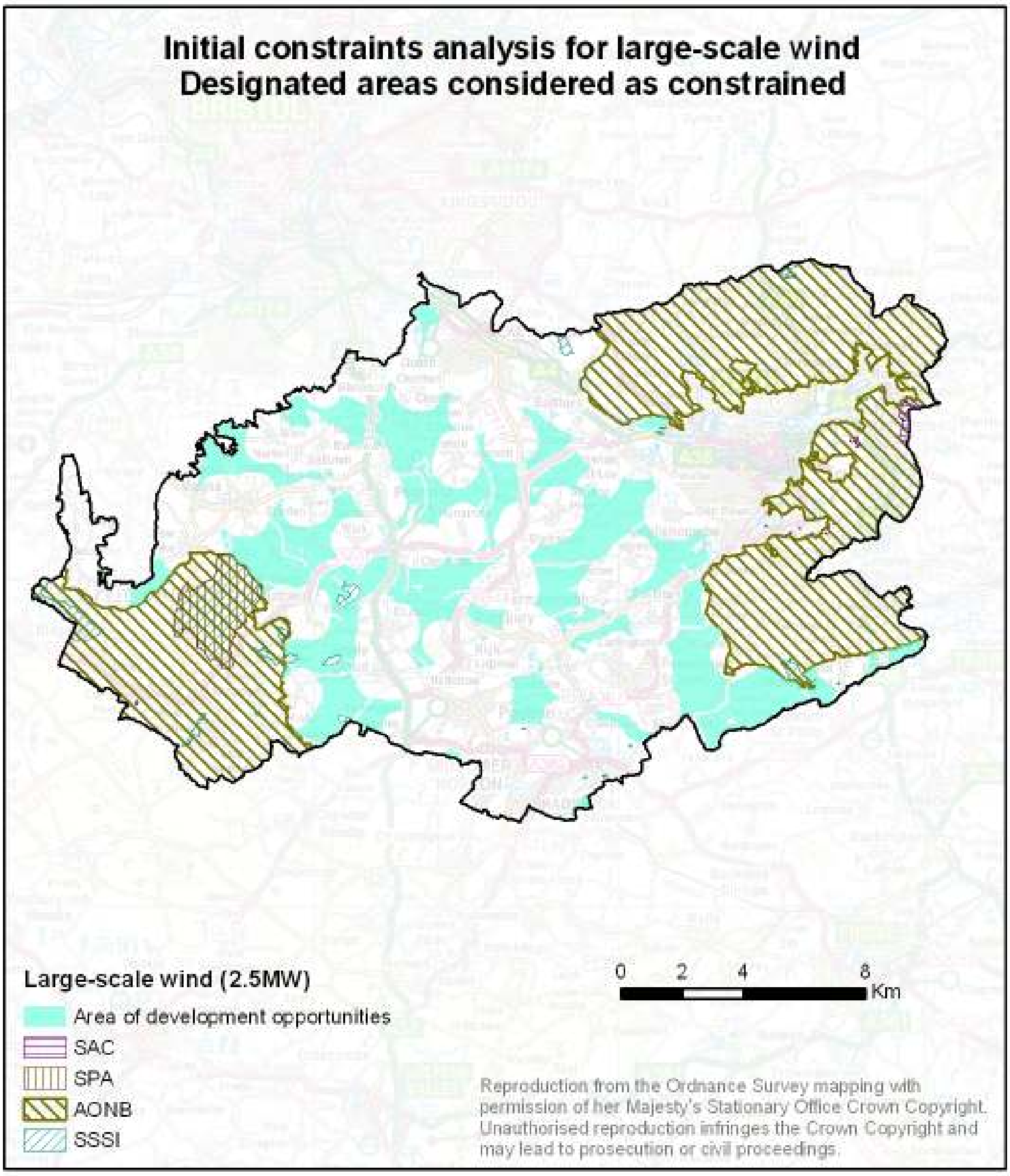


Figure 12. Area of large-scale wind development opportunities - excluding sites within designated areas

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[30]" rather than to individual buildings. Although the

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

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.

Taking account of potential impact on individual properties, the area with opportunity for large wind development is reduced to 11.9 km^2 with a potential maximum installed capacity of 119MW with 48 turbines (see Figure 13). 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.

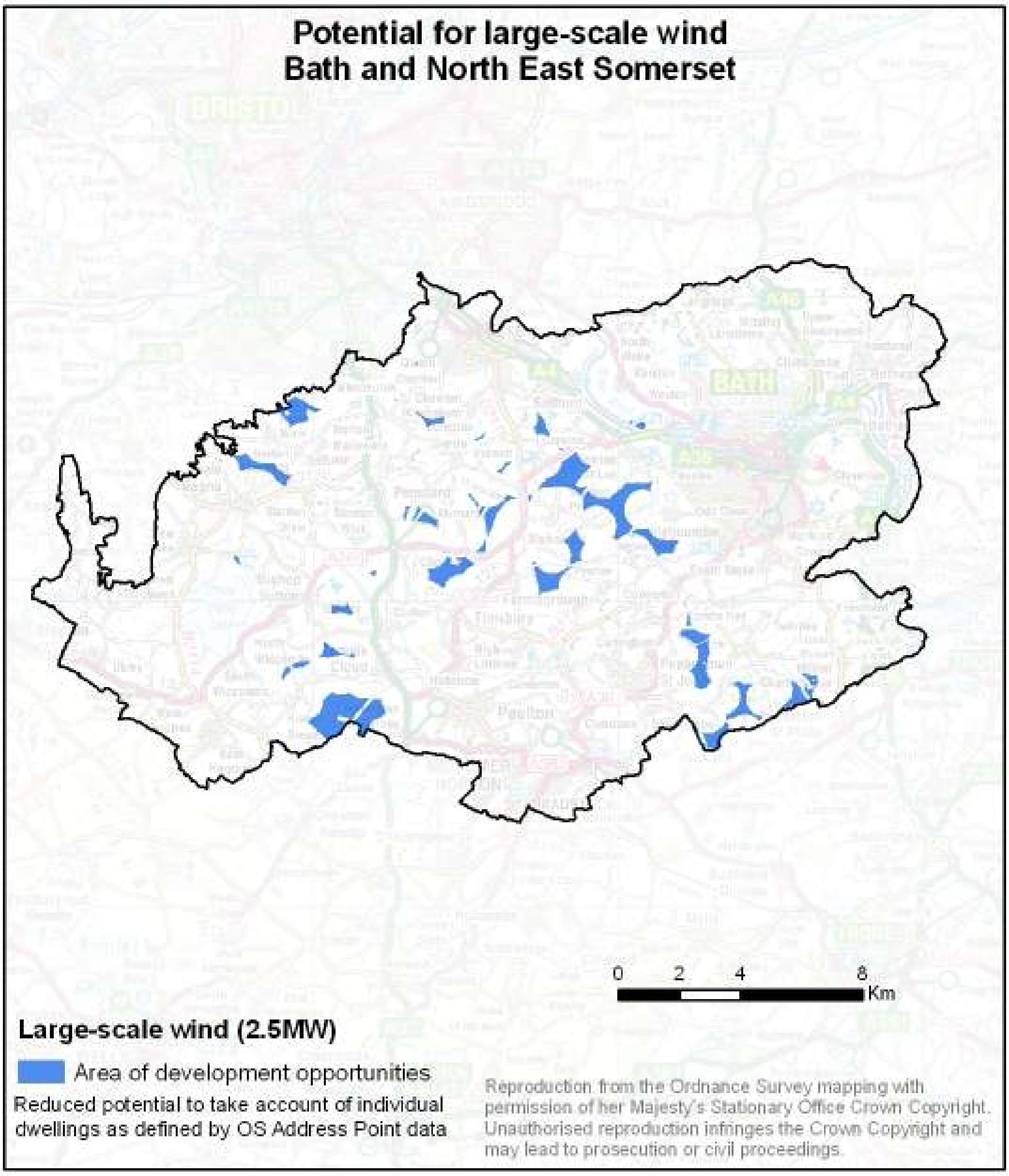


Figure 13. Large-scale wind: Reduced potential to take account of individual dwellings

Because the AONB is not an absolute barrier to development Figure 14 shows the resource as reduced by taking account of individual dwellings but including that resource that the AONB constraint excludes in the DECC methodology. This figure is for information only and is not used to generate the practical potential for wind.

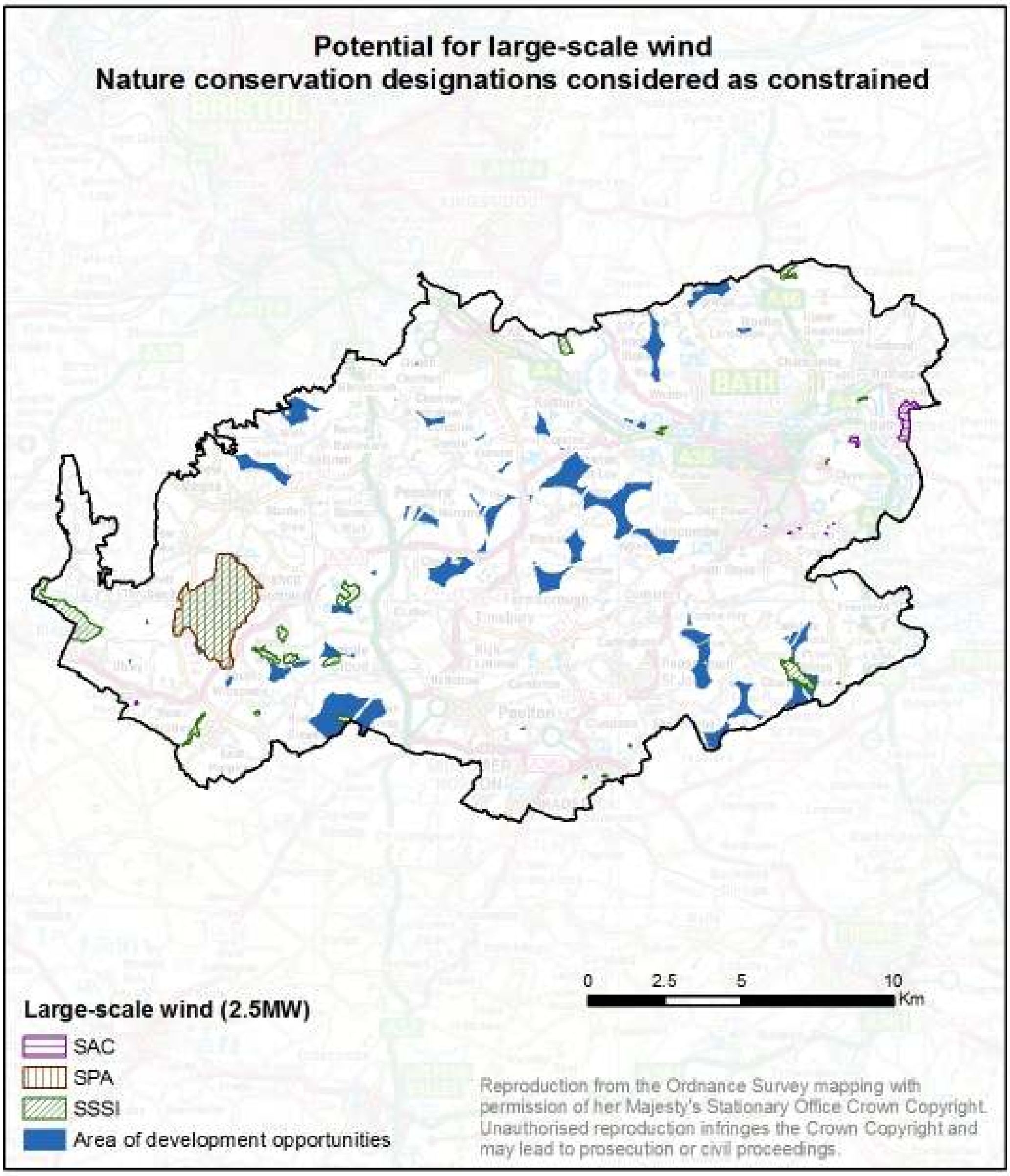


Figure 14 Large-scale wind: Reduced potential to take account of individual dwellings, but including the resource covered by the AONBs

Other parameters <u>not</u> accounted for in the DECC methodology

The DECC methodology 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.

The DECC methodology does not take account of landscape / visual constraints (other than by excluding internationally and nationally designated areas of land) which would need to be considered on a project-by-project basis 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. 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.

To address the issue relating to the impact of landscape B&NES commissioned Land Use Consultants Ltd to undertake a study characterising the landscape sensitivity to the deployment of wind turbine. Landscape Sensitivity Analysis for Wind Energy Development in Bath and North East Somerset by Land Use Consultants (2010), For the large scale wind turbines a notional turbine rating of 2.5 MW was used equivalent to a turbine of 95-130m to blade tip, with typical rotor diameters up to 94m The study assessed the relative landscape sensitivity to three scales of wind turbine for each of the rural landscape character areas including in the Rural Landscapes of Bath and North East Somerset – A Landscape Character Assessment April 2003.

The definitions of sensitivity used in the LUC study are shown below:

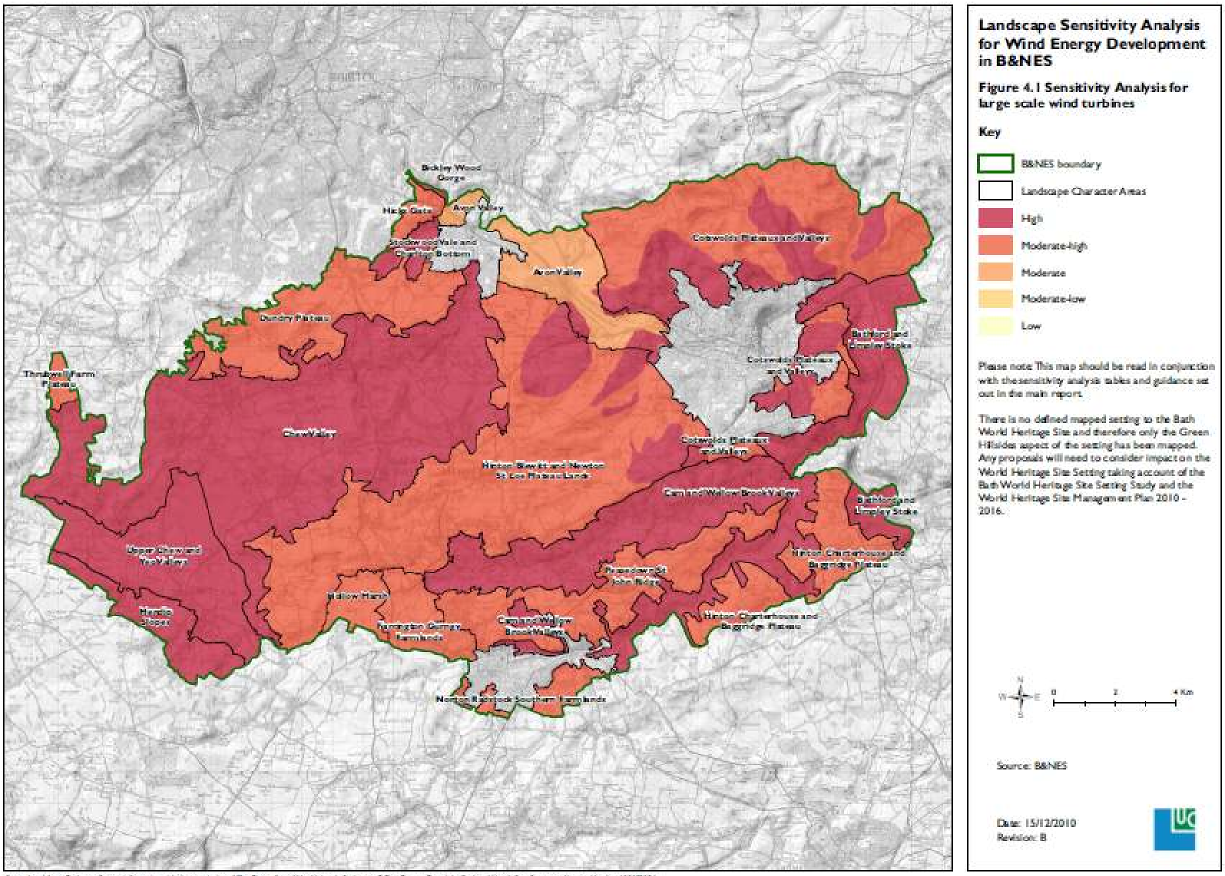


Figure 15 Sensitivity Analysis for Large Scale Wind Turbines - , Landscape Sensitivity Analysis for Wind Energy Development in Bath and North East Somerset by Land Use Consultants (2010)

The GIS analysis undertaken for this study has followed the DECC recommended methodology to ensure it is compatible with similar analysis elsewhere. However to take account of the additional analysis undertaken on landscape sensitivity we show below in Figure 16 the proportion of the large scale wind resource that falls into the identified landscape sensitivity categories. Figure 16 shows that the greatest proportion of the total area of technical potential for large turbines falls within landscape character area moderate-high landscape sensitivity to these turbines.

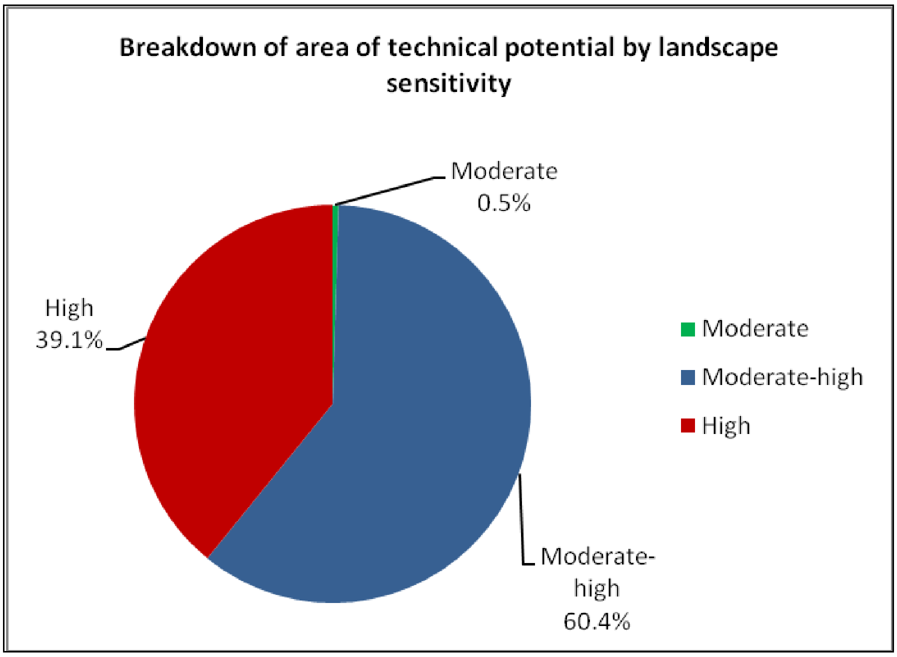


Figure 16 Breakdown of area of technical potential by landscape sensitivity - Large scale turbines

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'[31] 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 community project in Swaffham (Norfolk)[32] 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 based upon the long term average for approval rates.

[31] The term Merchant wind power refers to the development of wind turbine(s) to power a dedicated on-site energy demand.
[32] www.ecotricity.com

5.1.1.3.3 Uptake

Modelling has been carried out to assess the large wind potential using the following criteria:

- 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[33]. 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 50%. This is based upon the, long term average, proportion of positive local planning decisions. This average is for all wind developments across the UK. It may therefore not be totally applicable to every area of the UK which will differ greatly in wind speed and landscape sensitivity for example.

The estimated potential under these criteria is presented below in. Table 11

Table 11. Large-scale wind: potential.

	Technical potential	Practical potential - 2026
Number of turbines	62	17
Capacity (MW)	155	42.9
Electricity generation (MWh/year)	322,478	89,243

Large-scale versus small-scale wind

There is a significant difference in electricity output based on the height and capacity of a turbine, with small scale turbines having a far lower proportional output than large turbines. The figure below illustrates that the energy output per MW installed grows exponentially with increasing turbine height. Hence, small scale wind offers significantly less energy generation potential compared to large scale installations.

[33] 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.

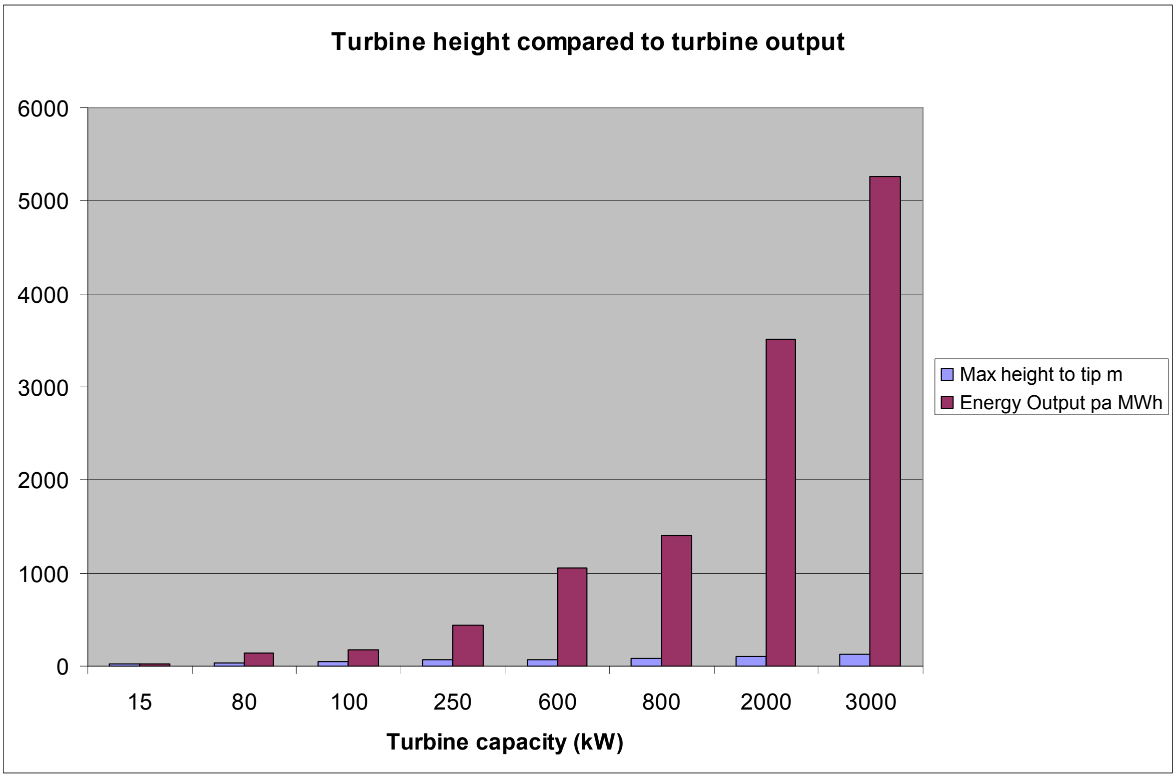


Figure 17: Turbine height compared to turbine output in MWh

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.

5.1.2 Technical potential of medium and small scale wind turbines

Spatial analysis using GIS has been conducted to identify sites technically suitable for the deployment of medium and small wind turbines. The scales of turbines assessed in this study are consistent with those considered by the Landscape Sensitivity Analysis carried out by LUC[34]. Table 12 below shows the dimension and estimated generation capacity of these turbines.

Table 12: Wind turbine scales

Scale	Power rating	Energy yield[35]	Hub height	Rotor diameter
Medium	~ 600 kW	~ 1,000 MWh/yr	40m	42m
Small	~ 15 kW	~ 20 MWh/yr	19m	12m

[34] *LUC. 2010. Draft report: Landscape Sensitivity Analysis for Wind Energy Development in Bath and North East Somerset. Land Use Consultants. May 2010.*
[35] *Energy yields have been estimated based on the power curves of Vestas V42-600kW and Proven 35-2 and average wind speeds at 40 and 20 metres above ground level.*

Table 13 below shows the GIS layers and buffer distances applied (where appropriate) to identify sites where the deployment of medium and small scale turbines would not be restricted by physical environment or high priority planning/regulatory constraints. Based on these absolute constraints, the areas with technical potential for large and medium scale wind turbines are shown in Figure 18 and Figure 19 respectively. The maps also show the international and national designations listed in Table 10.

For comparison Figures 20 and 21 show the resource for both small and medium wind turbines unconstrained by the exclusion of AONB areas.

Table 13: Parameters for assessing technical potential - absolute constraints to commercial-scale wind development

	Medium-scale turbines (~ 600 kW)		Small-scale turbines (~15 kW)	
Assessment stage	**Layer**	**Buffer**	**Layer**	**Buffer**
Stage 1: Naturally available resource	Wind speed at 60 m agl	-	Wind speed at 25 m agl	-
Stage 2: Technically accessible resource	Exclude areas with wind speed @ 60m above ground level < 5m/s	-	Exclude areas with wind speed @ 25m above ground level < 5m/s	-
Stage 3: Non accessible areas due to physical environment constraints	Roads (A, B, and motorways)	-	Roads (A, B, and motorways)	-
	Railways	-	Railways	-
	Inland waters	-	Inland waters	-
	Residential properties	-	Residential properties	-
	Commercial buildings	-	Commercial buildings	-
	Airports and airfields	-	Airports and airfields	-
	MoD training sites	-	MoD training sites	-
Stage 4: Areas where wind developments are unlikely to be permitted	All woodland area	-	All woodland area	-
	Roads (A, B, and motorways) and Railways	70m	Roads (A, B, and motorways) and Railways	30m
	Residential properties	350m	Residential properties	100m
	Commercial buildings	50m	Commercial buildings	50m
	Civil airports	5km	Civil airports	5km
	MoD airbases	5km	MoD airbases	5km
	Civil airfields	5km	Civil airfields	5km
	Sites of historic interest*	-	Sites of historic interest*	-

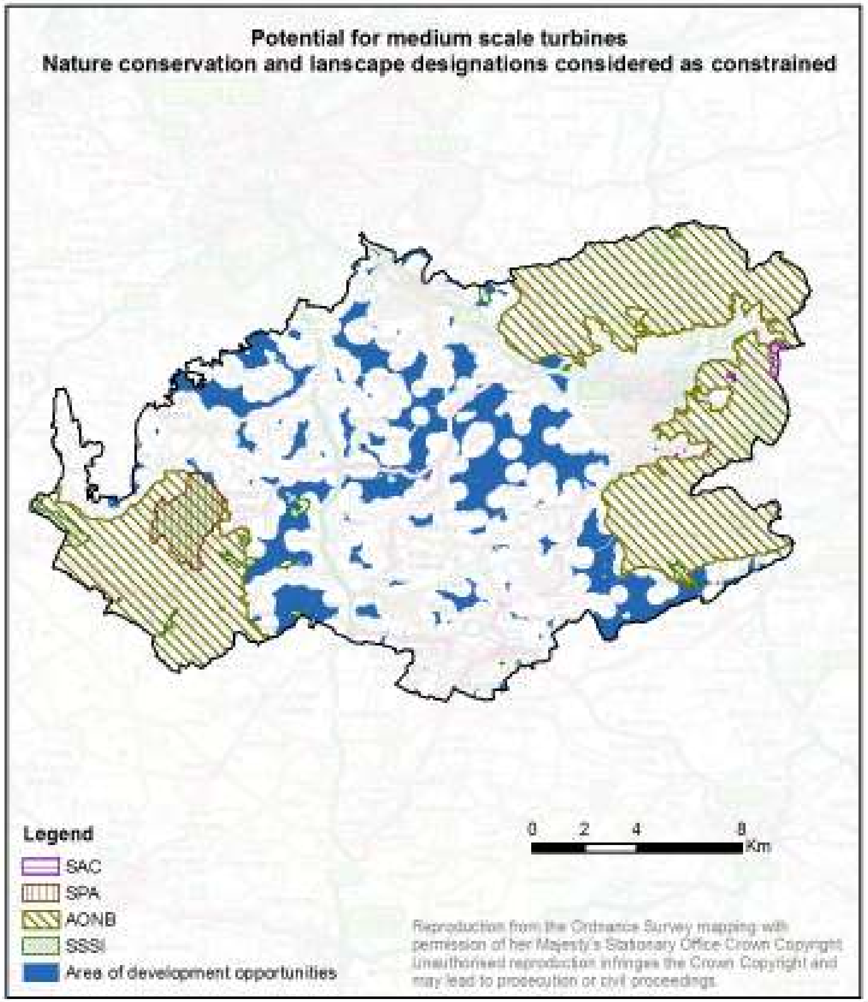


Figure 18. Area of technical potential for medium scale turbines.

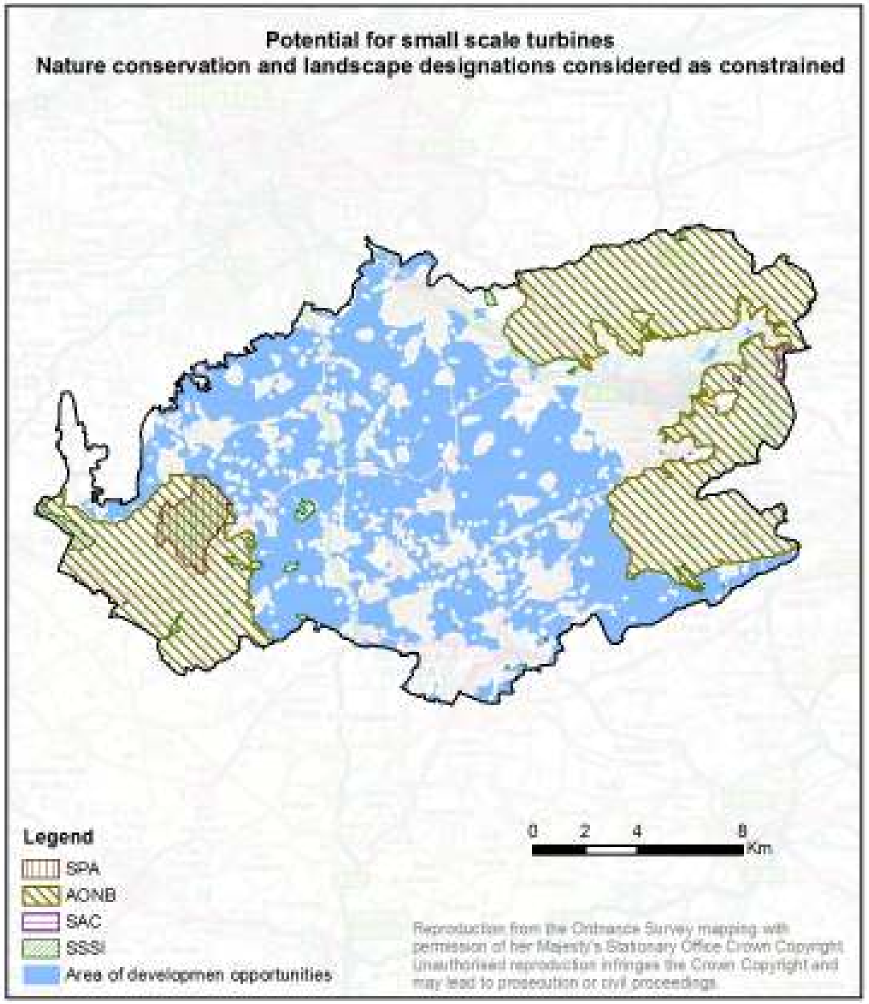


Figure 19. Area of technical potential for small scale turbines.

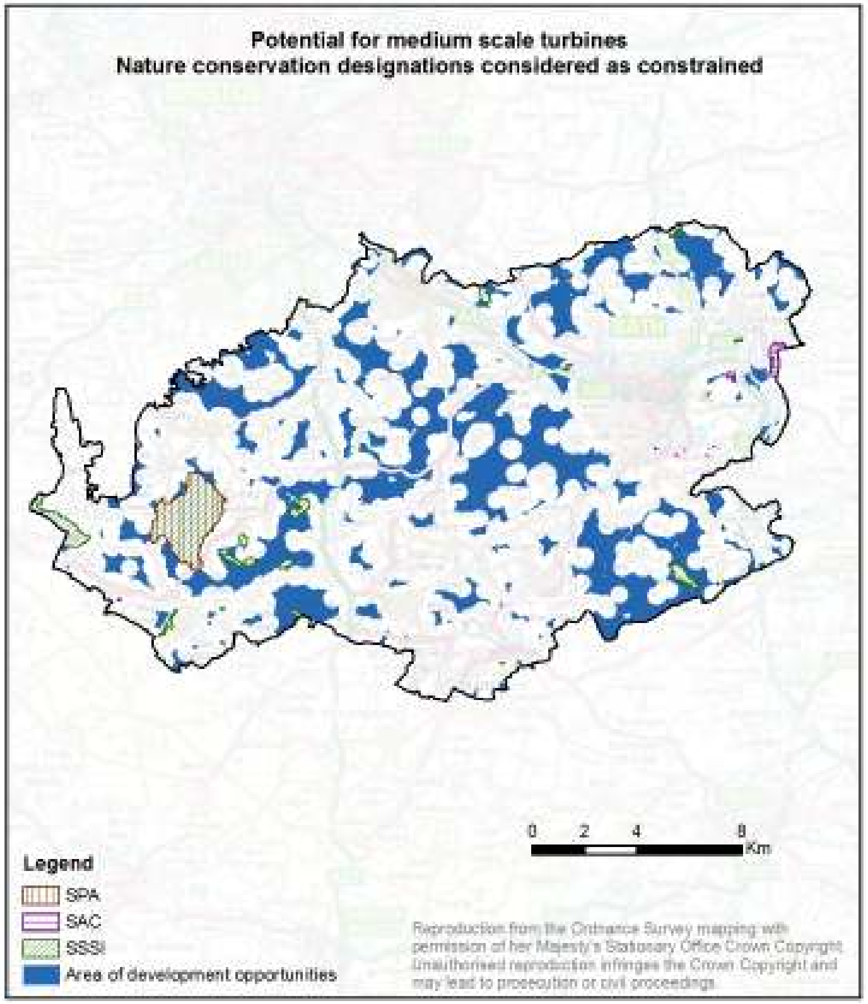


Figure 20 Area of technical potential for medium scale turbines including the resource in ANOBs

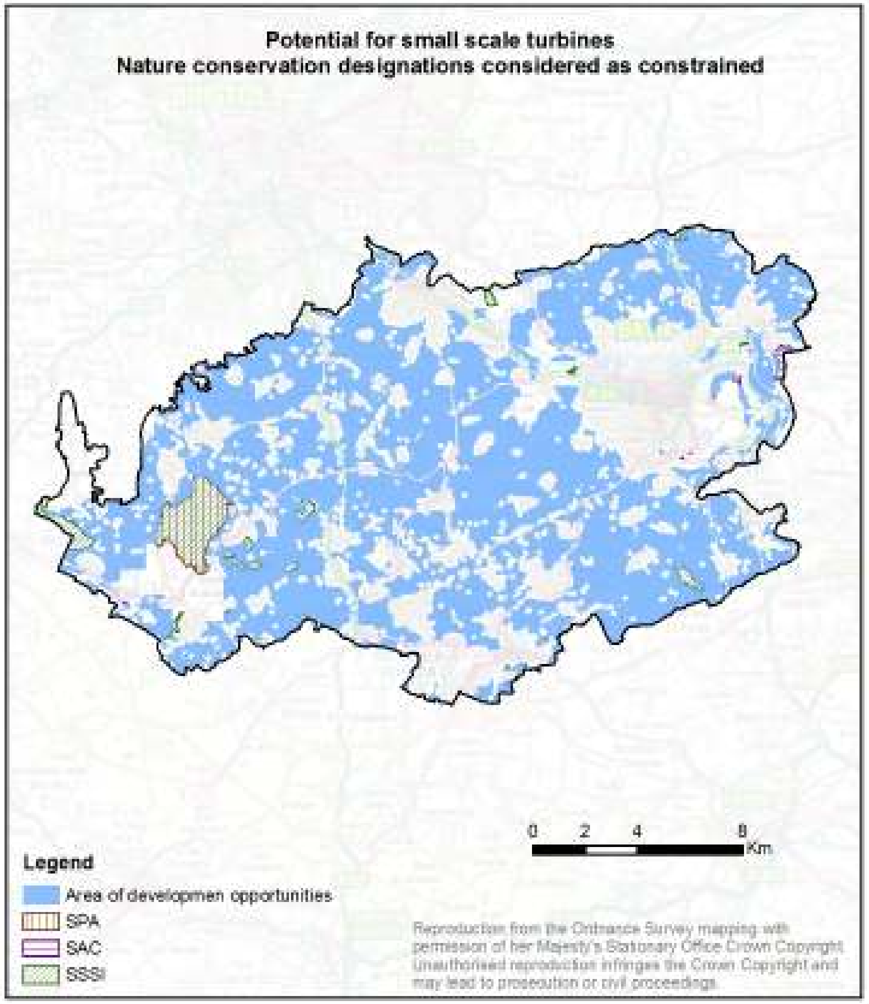


Figure 21 Area of technical potential for small scale turbines including the resource in ANOBs

The GIS constraints analysis suggests that there is good technical potential for medium and small turbines in Bath and North East Somerset. As shown in Table 14, the total area of development opportunity for medium scale turbines extends to approximately 64 km^2, equivalent to a potential installed capacity of 914 MW. If international and national landscape and nature conservation designations are considered as constraints, the area of opportunity for medium turbines is reduced to 46 km^2, with a potential maximum installed capacity of 643 MW. Despite the analysis identifying a greater potential for small turbines in terms of installed capacity, a greater energy yield could be expected from the lower installed capacity of medium scale turbines. This is due to the larger capacity factor estimated for medium turbines, mainly due to the higher wind speeds at 40 above ground level. The table also shows the impact of considering international and national designations as constrained areas for small scale turbines.

Scale of wind turbines	Wind potential including sites within designations			Wind potential excluding sites within nature conservation designations			Wind potential excluding sites within nature conservation and lanscape designations		
	Area (ha)	No. of turbines	Generation (MWh/year)	Area (ha)	No. of turbines	Generation (MWh/year)	Area (ha)	No. of turbines	Generation (MWh/year)
Medium	6,432	1,523	1,520,929	6,300	1,461	1,459,013	4,586	1,071	1,069,543
Small	17,286	69,134	1,294,500	17,099	68,386	1,280,494	12,784	51,114	957,084

Table 14. Technical potential for medium and small scale wind turbines.

It is worth reiterating that the results presented in Table 14 refer to the area where wind energy developments are not restricted by absolute constraints. This 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), radar interference, landscape sensitivity and visual impact. The level of constraint imposed by these factors needs to be assessed on a site-by-site basis, since the impact and the possibilities for mitigation may be lower or higher for differing sites and different scales of development.

As for large turbines, cumulative landscape impact of multiple turbines is an important issue and one that is of critical concern for more rural districts, particularly in sensitive areas where there are no major landscape designation constraints.

The LUC landscape sensitivity study assessed the landscape character for its ability to accommodate both small and medium scale wind turbines, these sensitivity category areas are shown in Figures 22 and 23.

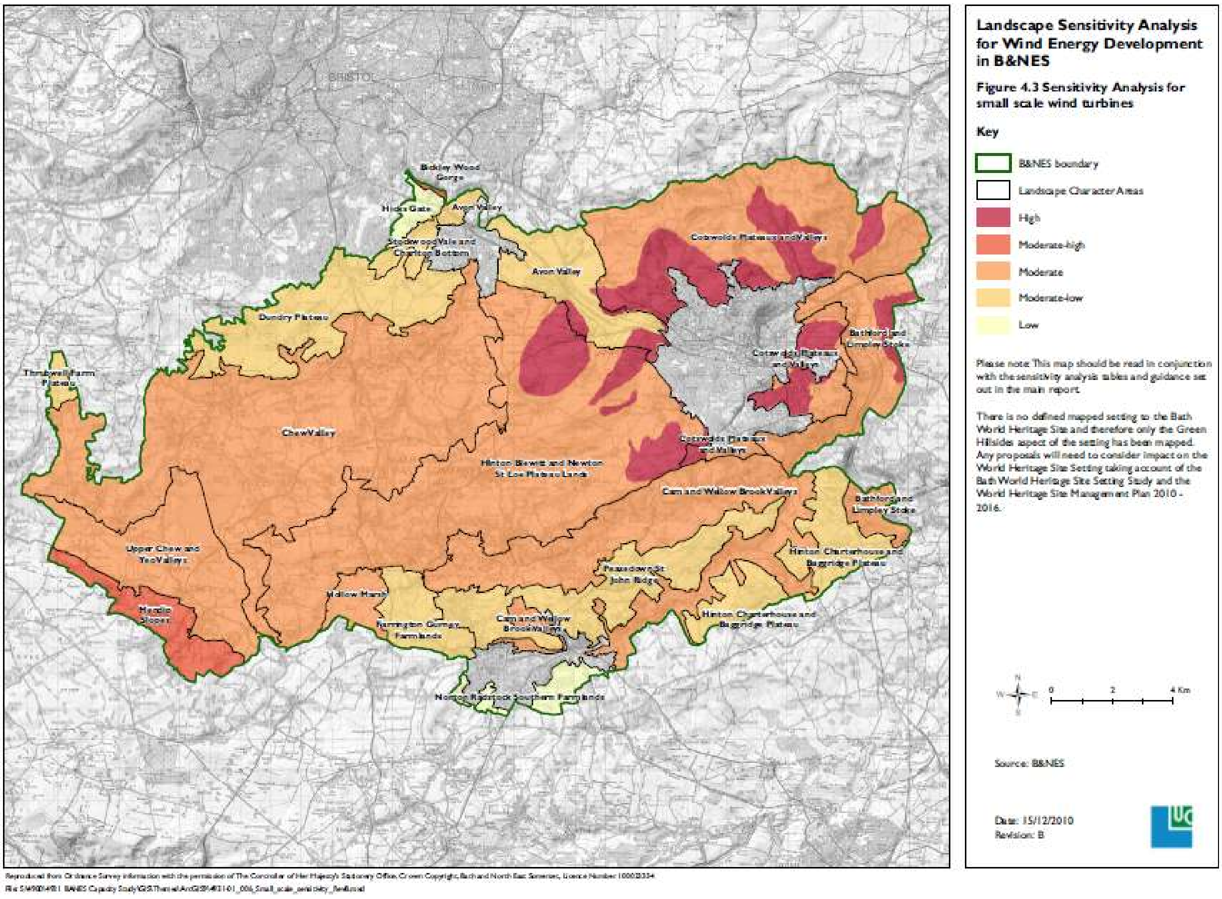


Figure 22 Sensitivity Analysis for Small Scale Wind Turbines - , Landscape Sensitivity Analysis for Wind Energy Development in Bath and North East Somerset by Land Use Consultants (2010)

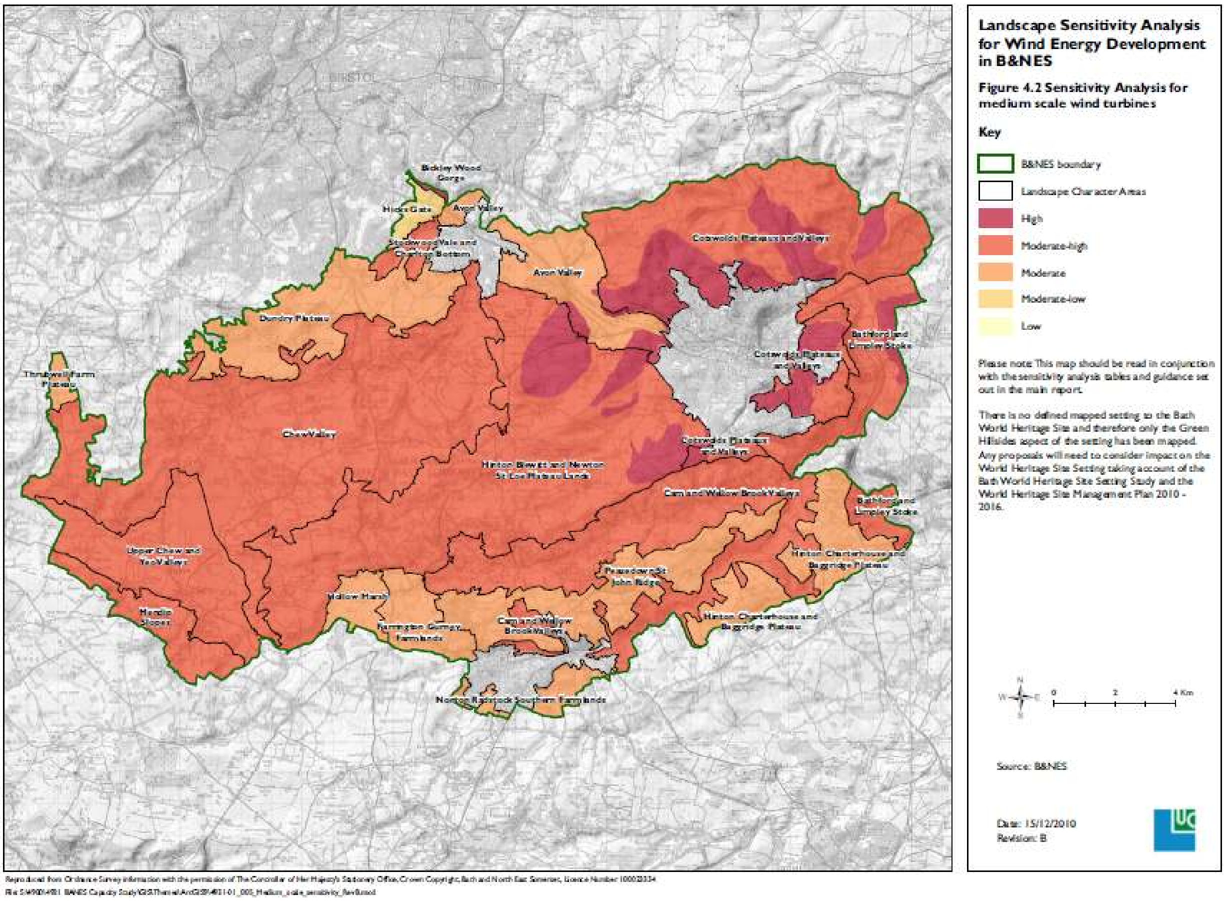


Figure 23 Sensitivity Analysis for Medium Scale Wind Turbines - Landscape Sensitivity Analysis for Wind Energy Development in Bath and North East Somerset by Land Use Consultants (2010)

The GIS outputs of the landscape sensitivity analyses, see Figures 22 and 23, were overlaid the results of the GIS constraints analysis conducted in this study. As shown in Figure 24, a significant proportion of the total area of technical potential for medium turbines falls within landscape character areas of high or moderate-high landscape sensitivity to these turbines. However, as shown in Figure 25, the majority of the area of technical potential for small turbines presents moderate or moderate-low sensitivity to this scale of wind turbines.

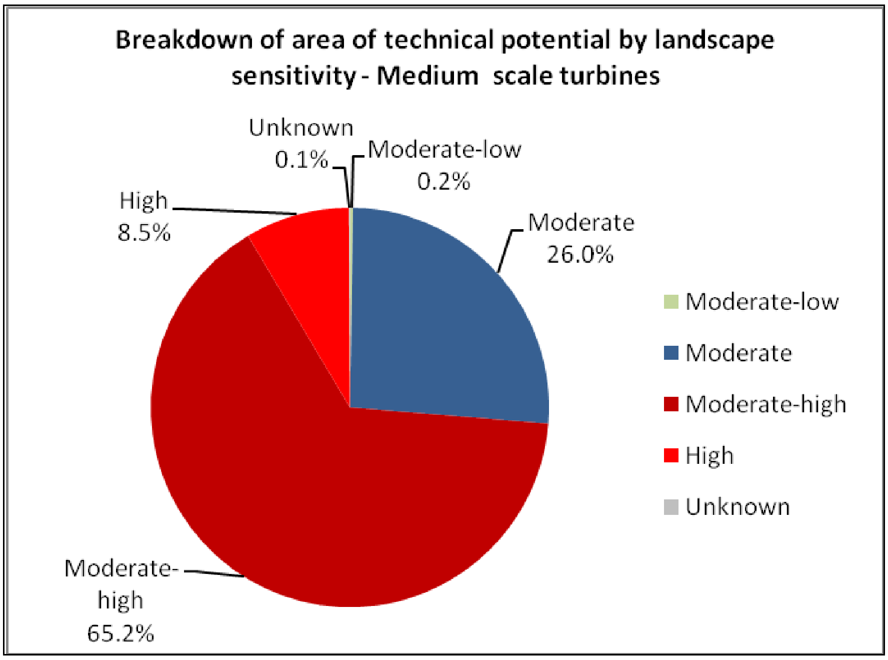


Figure 24. Breakdown of area of technical potential by landscape sensitivity - Medium scale turbines.

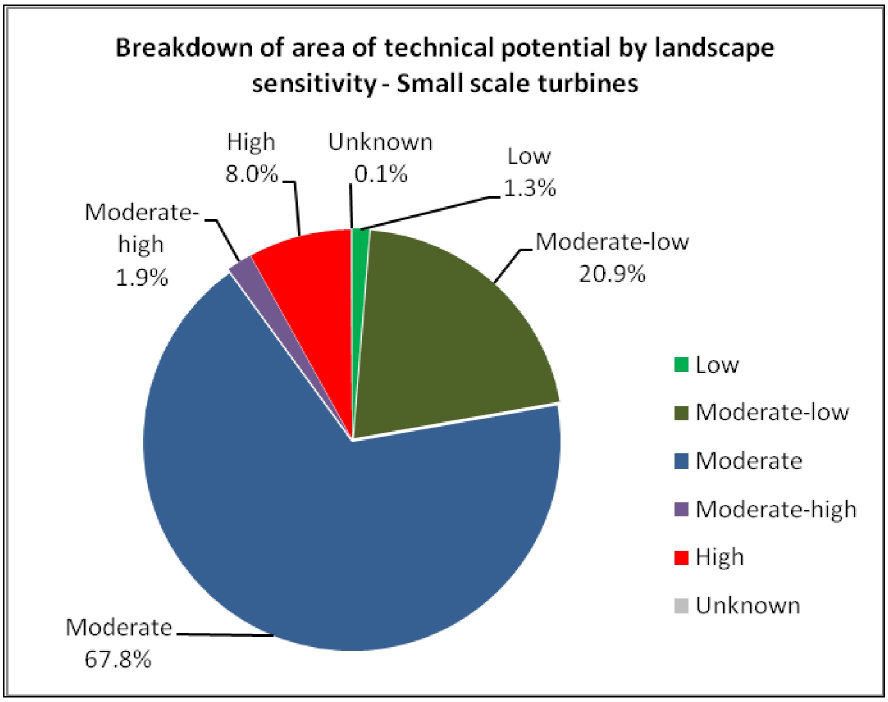


Figure 25. Breakdown of area of technical potential by landscape sensitivity - Small scale turbines.

Table 14 shows there is large technical potential for both medium and small scale turbines. However, the DECC methodology does not provide a recognised methodology for calculating a practical potential from the technical potential for small and medium scale turbines.

To provide an indication of the possible practical potential for small and medium scale wind turbines the following assumptions have been made:

- priority given to larger turbines as they will produce far greater CO2 reductions
- a large number of 50kW and 100kW turbines would be less acceptable visually than a small number of larger turbines.
- only a small proportion of farmers and small businesses would be prepared to pay upfront for a payback of over 3 years ("The Growth Potential for Microgeneration in England, Wales and Scotland" June 2008, Element Energy and TNS sponsored by BERR, EST et al.)

Therefore, overall it is assumed that by 2026 the uptake of small and medium scale wind turbines is limited to 1.4% of the technical resource. This is the equivalent of some 17 turbines by 2026. Because of the large technical potential for small and medium scale wind turbines, it is possible, that with suitable encouragement, the number of turbines could considerably exceed this figure.

5.1.3 Biomass energy

5.1.3.1 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 B&NES 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:
   a. Estimate theoretical potential i.e. the total quantity of feedstock generated in the study area.

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

c. 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 ie wastes are used for recycling first, and only then are wastes considered for composting.
- for energy crops, arable land required for food production is excluded ie energy crops are not grown on land that has a primary use for food production.

2. Define uptake curves for each feedstock considered. The fraction of the available resource that can be realistically extracted now is estimated based on current capabilities and practices. This is then increased gradually over time up to the full available resource, taking into consideration the rate at which each sector could develop. The principles upon which the uptake curves have been defined are drawn from a recent study commissioned by DECC[36], 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[37].

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

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

The methodological principles and criteria used in this study to quantify the biomass resource available for energy generation are broadly in line with those provided by the DECC methodology; as stated earlier, the DECC methodology does not provide any guidance on how to identify uptake over a period of time.

[36] To inform the government's Renewable Energy strategy, the Department of Energy and Climate Change (DECC) [36] 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

[37] 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.

5.1.3.2 Local biomass resource and potential useful energy generation

Table 15 below shows the total quantity of each feedstock considered currently generated in B&NES (i.e. the total theoretical resource) expressed in oven dried tonnes and energy content.

Table 15: Theoretical potential of biomass sources

Market	System size	Resource (ODT equivalent)	Sources considered
Pellet	2kW+	56	Joinery wastes
Dry Chip	10kW+	8,542	A portion of crop/bare fallow and set-aside land for energy crops. Thinnings from local non-ancient forestry. Recycling centres clean waste wood.
Wet Chip	500kWe	836	Council parks woodchip, private tree surgeons waste, council forestry/woodland residues and thinnings.
Off cuts	100kWe+	204	Joinery off cuts
Straw	2MWe+	782	A portion of straw from cereals
AD Plant	500kWe+	6,701	Cattle waste, organic portion of the municipal waste stream, council park green waste, recycling centre green waste.
MSW plant	5MWe+	2,526	A portion of waste going to Landfill, recycling centre contaminated waste wood.
Total		**19,646**	

Because each of the biomass resources can be used as fuel for either heating only or CHP, using a variety of technologies, it is not appropriate to give capacity figures for each biomass resource individually. The analysis for the practical potential, see below ascribes the biomass sources to CHP or heating and therefore allows capacity and output figures to be determined.

5.1.3.3 Practical potential

Table 16 shows there is reasonable potential for biomass development in B&NES, equivalent to over 8,158 MWh/yr of electricity generation from CHP and 152,062 MWh/yr of heat generation from biomass boilers and CHP. However because there are no large scale urban extensions or new settlements proposed for B&NES, the opportunity for biomass CHP development is currently limited. Biomass heating shows good potential for the lower scale developments.

Table 16: Biomass practical potential (MWh/yr)

		Practical potential -2026
Energy generated (MWh/yr)	Thermal	152,062
	Electrical	8,158
	Total	160,220
CO_2 Reduction per year in Tonnes	CHP	5,044
	Biomass heating	25,717
	Total	30,761

The analysis assumes that:

- All available local biomass resource (i.e. generated within B&NES) 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.

5.1.3.4 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.

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

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

- Incentive schemes for farmers to provide farm wastes for biomass energy generation
- Incentive schemes from land owners, 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 B&NES. This could build on the work of Regen SW's Bioheat programme[38] 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 settlements which have suitable gas pressure to accommodate the biogas.

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

5.1.4 Hydropower

The results presented in this section have been derived from the findings of a study commissioned by the Environment Agency [39] (EA study) to identify the hydropower opportunities in England and Wales.

5.1.4.1 Overall resource

The study identified 131 sites within rivers in B&NES where small-scale hydropower schemes could theoretically be implemented. If all these sites were used for hydropower, the total theoretical potential would add up to approximately 5MW of power installed capacity. Assuming an availability factor of 95%, these sites could generate approximately 41,384 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.

5.1.4.2 Hydropower opportunity categorisation

The EA study categorized the barriers 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. 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. The EA study used existing environment sensitivity analyses. Some hydro opportunities have not been included in any of the existing sensitivity analyses and are therefore categorised as "unclassified" for the purposes of the EA study.

Figure 26 shows the barriers identified in Bath & North East Somerset and the power category in which each of them fall. Figure 27 shows these barriers categorized based on their environmental sensitivity.

[39] Environment Agency. 2010. '*Mapping Hydropower Opportunities and Sensitivities in England and Wales*'.

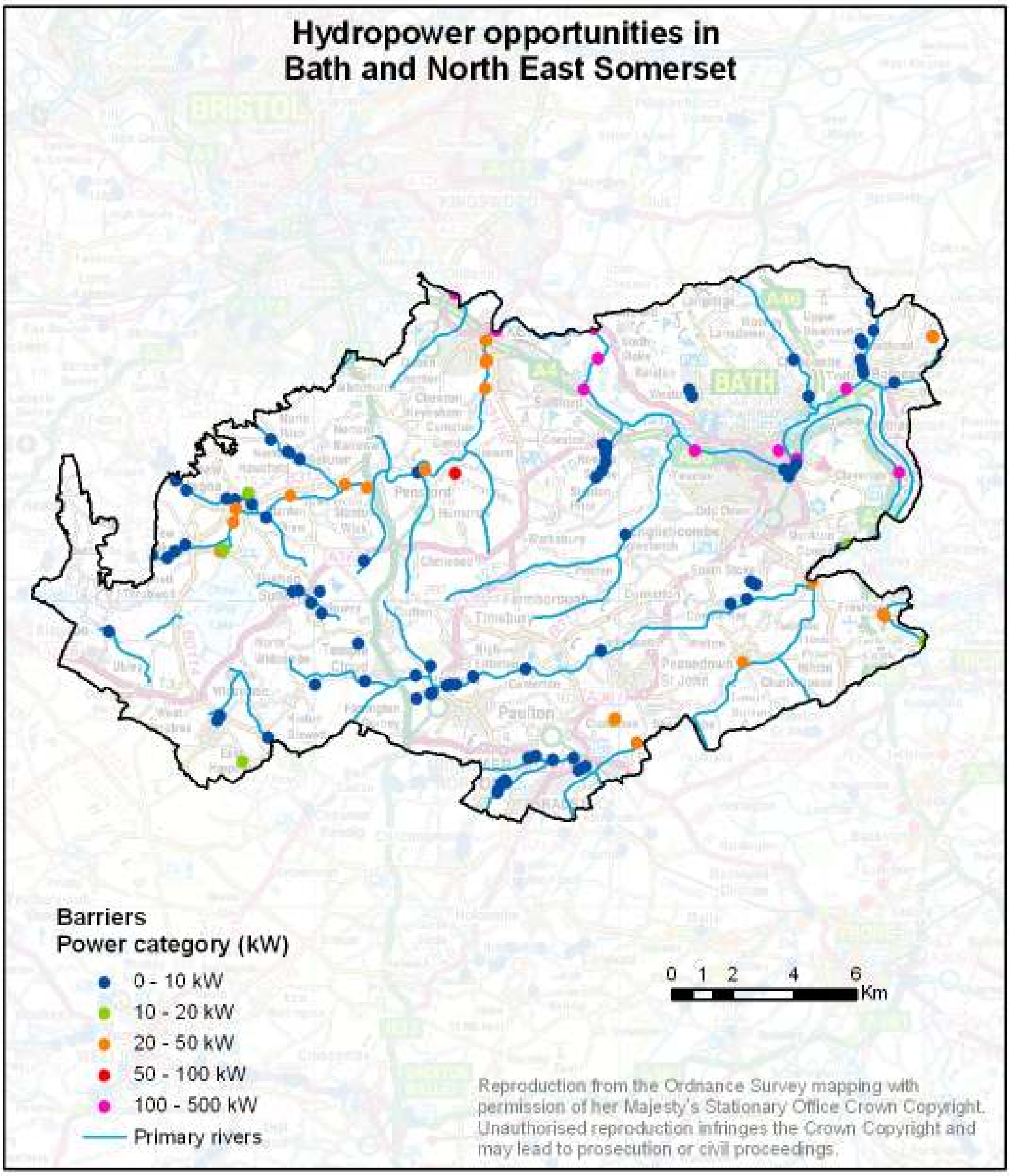


Figure 26. Hydropower Opportunities in Bath & North East Somerset - Power category. Mapping Hydropower Opportunities and Sensitivities in England and Wales, Environment Agency (February 2010)

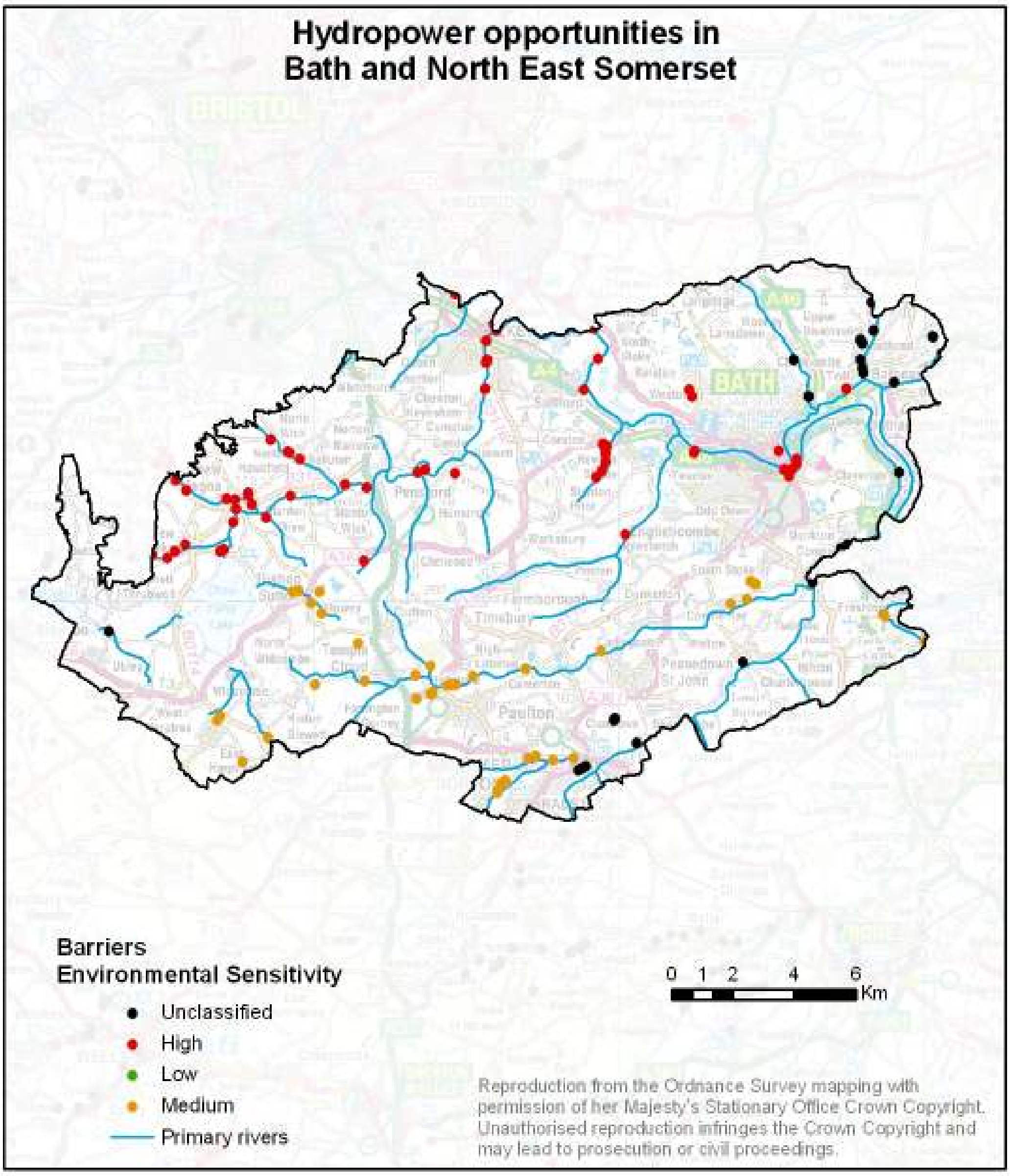


Figure 27. Hydropower Opportunities in Bath & North East Somerset - Environmental sensitivity - Mapping Hydropower Opportunities and Sensitivities in England and Wales, Environment Agency (February 2010)

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. 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. This is represented schematically in Figure 28 (taken from the Environment Agency's study).

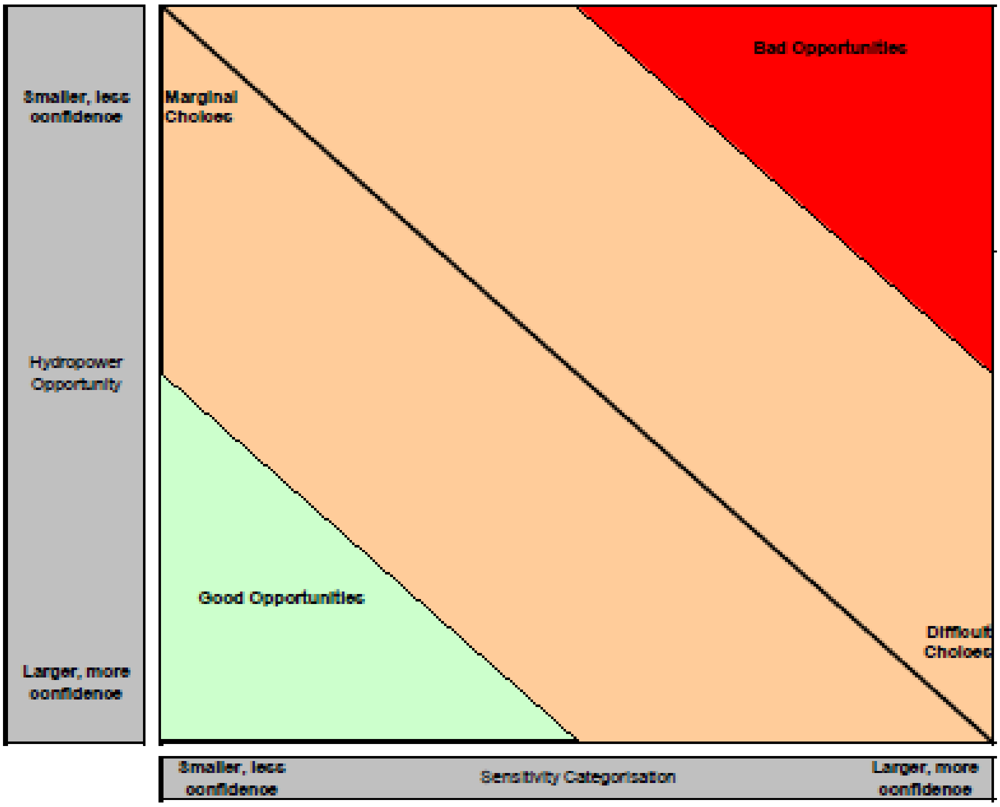


Figure 28. Opportunity categorisation matrix

Source: Environment Agency (2009)

Figure 29 presents the overall opportunity matrix replicated for the barriers identified within Bath & North East Somerset, with each of the barriers located into twenty eight matrix locations that have been further summarised into five final generalised categories.

Power category	Sensitivity category: No sensitiv data	Low	Med.	High
0 - 10 kW	18		39	35
10 - 20 kW	2		2	2
20 - 50 kW	6		2	11
50 - 100 kW	1			1
100 - 500 kW	1			10
500 - 1,500 kW				1
> 1,500 kW				

Number of barriers

Power category	Sensitivity category: No sensitiv data	Low	Med.	High
0 - 10 kW				35
10 - 20 kW	65		4	
20 - 50 kW				
50 - 100 kW				
100 - 500 kW	2			25
500 - 1,500 kW				
> 1,500 kW				

Number of barriers

Power category	Sensitivity category: No sensitiv data	Low	Med.	High
0 - 10 kW	34		176	133
10 - 20 kW	25		29	22
20 - 50 kW	186		74	364
50 - 100 kW	59			55
100 - 500 kW	338			2,919
500 - 1,500 kW				558
> 1,500 kW				

Maximum power potential (kW)

Power category	Sensitivity category: No sensitiv data	Low	Med.	High
0 - 10 kW				133
10 - 20 kW	422		103	
20 - 50 kW				
50 - 100 kW				
100 - 500 kW	397			3,918
500 - 1,500 kW				
> 1,500 kW				

Maximum power potential (kW)

- Good opportunities (green)
- Marginal choices (blue)
- Moderate oportunities (yellow)
- Difficult choices (magenta)
- Bad opportunities (red)

Figure 29. Bath & North East Somerset - Hydropower Opportunity Categorisation Matrix

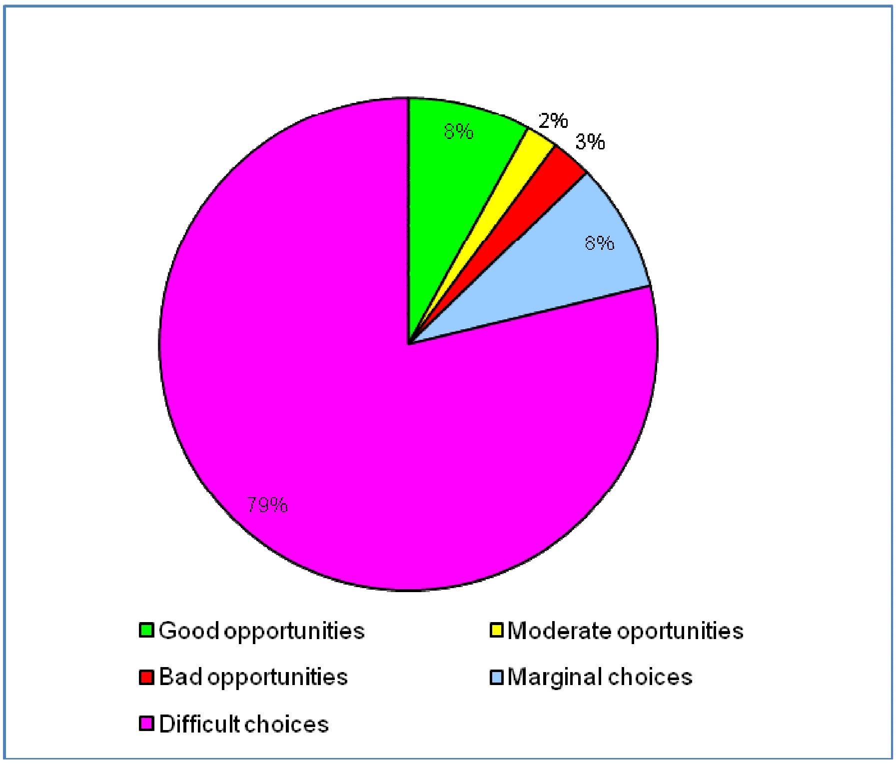


Figure 30. Bath & North East Somerset - Percentage of Total Maximum Power Potential per Category

5.1.4.3 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 a good hydropower potential and improve the ecological status of a river.

Of the total 131 barriers identified in B&NES, 37 barriers are within heavily modified water bodies, of which 9 barriers have a power potential above 10kW. If a hydro scheme was built at each of these 9 barriers, the total installed capacity would add up to 1,182kW with the potential to generate 9,837MWh.

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.

5.1.4.4 Practical potential: Uptake

It is assumed that 60% of the potential in each of the “good opportunities” and “moderate opportunities” categories will be developed. This development percentage has been applied to exclude 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.

The capacity that could be potentially be deployed by 2026 under both scenarios is shown below in Table 17.

Table 17. Hydropower: practical potential.

	Technical potential	Practical potential - 2026
Capacity (MW)	5.0	0.3
Electricity generation (MWh/year)	41,384	2,498

5.2 Building integrated renewables potential

5.2.1 Technical potential

The methodological principles and parameters provided by DECC methodology[40] have been used in this study to estimate the technical potential of building integrated technologies within B&NES (including small-scale wind).

5.2.1.1 Photovoltaics

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

The calculation considered all existing domestic and non-domestic developments. 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[41]. Finally, the capacity of the systems was assumed to be 2 kWp for domestic properties and 5 kWp for non-domestic properties.

PV is essential to achieve 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 169.0MW$_p$, by 2026.

5.2.1.2 Solar Thermal

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.

Solar thermal is required 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.

[40] Renewable and Low-carbon Energy Capacity Methodology: Methodology for the English Regions. SQW Energy, January 2010.
[41] 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.

Based on the methodology advised by the government, the same assumptions were made for SWH as for photovoltaics.

Deployment of either solar technology in practice is subject to available suitable space for installation. A building may have either or both technologies installed, however the total capacity of the system(s) will not vary considerably, i.e. a large system of either technology or two systems, one of each technology. Therefore, the assessment uses a single set of parameters for both categories to avoid double counting.

The technical potential for solar thermal is 82.9 MW_{th} by 2026

5.2.1.3 Heat Pumps

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

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 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.

The technical potential for heat pumps is for 377 MW_{th} to be installed in all suitable dwellings and businesses by 2026

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, 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. These are based on the appropriate scenario for the scale of development

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 of renewable technologies in existing buildings, 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[42]. This provides scenarios for the energy delivered by renewable sources for Great Britain as a whole, and a number of individual regions. This study presents a range of uptake scenarios and we contend that the scenario that best fits current policy for renewable energy generation is that which considered the implementation of the renewable power and heat tariffs. The scenario models uptake of microgeneration based upon technologies receiving 2p/kWh for heat and 40p/kWh for electricity. Support is assumed to run for 10 years at a 3.5% discount rate, with the level of support for future installations being decreased[43]. 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 total for building integrated renewable energy technologies is shown below:

Table 18. Projected renewable energy generated from new developments within B&NES

Year		Practical potential 2020	Practical Potential 2026
Microgeneration energy generated (GWh)	Thermal	125	169
	Electrical	74	125
	Total[44]	198	279

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

6 Renewable Energy Summary

6.1 Technical Potential

Definition of Technical Potential

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

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

The technical potential does not consider the likely uptake of the technologies and how the market, economics, and technology and in the case of biomass, the resource, may change over time: potential scenarios for these are considered for deriving suggested targets.

The renewable energy and low carbon technologies assessed are:

- wind energy – large scale and smaller scale turbines;
- energy from biomass and waste - both combine heat and power (CHP) and heat only;
- hydro energy – from the River's Avon and Frome;
- solar photovoltaic electricity (PV) – roof top potential only although PV on facades and PV fields may become more viable in future if prices drop;
- solar thermal hot water (STHW) – roof top potential;
- heat pumps, ground source heat pumps and air source heat pumps – for ground source heat pumps, excluding central Bath in order to protect the hot springs (Zone B delineated in the County of Avon Act 1982);
- geothermal heat – derived from the hot springs.

6.1.1 Summary of Technical Potential

The updated analysis includes; a review of the assumptions made in the original report; information from recent resource studies; and changes to housing numbers expected to be developed in B&NES. The assessments made have followed the DECC methodology published in Jan 2010 where ever appropriate.

Table 19: Technical Potential

Technology	Technical Capacity		Potential Energy Generation		Potential CO_2 reductions
	Electricity (MW_e)	*Heat (MW_{th})*	*Electricity (MWh)*	*Heat (MWh)*	*tCO_2/yr*
Large Scale Wind Turbines (2.5 MWe)	155		322,478		138,666
Smaller Scale Wind Turbines(50-100 kW)[45]					
PV	169.0		122,77		52,793
Hydro	5.0		39,420		16,951
Biomass	0.002	26.8	12,765	58,158	14,794
Solar Thermal Hot Water		82.9		56,085	10,376
Geothermal heat		0.05		150	28
Heat Pumps (GSHP/ASHP)	-107.7	376.9	-215,391	753,868	46,847
Totals	251.7	486.7	336,599	868,260	303,912

6.2 Practical Potential

Definition of Practical Potential

For the purpose of this project, Practical Potential means the amount of renewable energy that can be generated once market conditions, landscape and visual considerations have been taken into consideration – these will differ from technology to technology. , and applied to the technical potential. Market conditions could be defined by policy and political will, economics, technological advancement and consumer behaviour; hence it is difficult to predict exactly how these may change over time. Likewise, people's perception of landscape considerations can vary. The accepted methodologies for assessing landscape and visual impact cannot be totally objective and the local value ascribed to the landscape can change over time.

[45] Because the technical resource for the small and medium wind categories is so large – but the likely practical potential is significantly smaller – the technical potential has been exclude from the summary table so that it does not skew the technical resource assessment. See Table 14 for details of the technical resource for small and medium turbines.

Table 20: Practical Potential

	2010 Current resource	2020	2026
Wind power (all sizes)			
Capacity - Electricity (MW_e)	0.1	37.4	44.9
Energy - Electricity (MWh_e)	0	80,104	97,519
CO_2e abatement (tCO_2 per year)	0	34,445	41,933
Solar PV			
Capacity - Electricity (MW_e)	0.012	41.6	76.6
Energy - Electricity (MWh_e)	8.5	30,247	55,681
CO_2e abatement (tCO_2 per year)	3.7	13,006	23,943
Hydro power			
Capacity - Electricity (MW_e)	0.1	0.3	0.3
Energy - Electricity (MWh_e)	499	2,365	2,365
CO_2e abatement (tCO_2 per year)	215	1,017	1,017
Biomass CHP			
Capacity - Electricity (MW_e)	0.0	0.9	1.6
Capacity - Heat (MW_{th})	0.0	1.4	3
Energy - Electricity (MWh_e)	0	4,405	8,158
Energy - Heat Actual (MWh_{th})	0	7,049	13,053
CO_2e abatement (tCO_2 per year)	561	2,724	5,044
Biomass Heating			
Capacity - Heat (MW_{th})	0.0	36.1	67
Energy - Heat (MWh_{th})	0.0	75,065	139,009
CO_2e abatement (tCO_2 per year)	0.0	13,887	25,717
Solar thermal hot water			
Capacity - Heat (MW_{th})	0.2	26.5	49.0
Energy - Heat (MWh_{th})	101.5	17,806	32,974
CO_2e abatement (tCO_2 per year)	19	3,294	6,100
Geothermal heat			
Capacity - Heat (MW_{th})	0.05	0.10	0.10
Energy - Heat (MWh_{th})	150	300	300
CO_2e abatement (tCO_2 per year)	28	56	56
Heat Pumps (GSHP/ASHP)			
Capacity - Electricity (MW_e)	0.0	-7.2	-13

	2010 Current resource	2020	2026
Capacity - Heat (MW_{th})	0.1	25.3	47
Energy - Electricity (MWh_e)	-57.1	-14,434	-26,730
Energy - Heat (MWh_{th})	200.0	50,521	93,557
CO_2e abatement (tCO_2 per year)	12.4	3,139	5,814
Total Renewable Energy			
Capacity - Electricity (MW_e)	0.106	73	110
Capacity - Heat (MW_{th})	0.30	89	165
Energy - Electricity (MWh_e)	450	102,687	136,992
CO2e abatement from renewable electricity (tCO2 per year)	194	44,155	58,907
Energy - Heat (MWh_{th})	451	150,740	278,892
CO2e abatement from renewable heat (tCO2 per year)	84	27,887	51,595

In 2026, if all the renewable energy technologies identified are installed, then, the energy from these renewable sources would represent 21% of the total electricity and heat demand in B&NES.

Table 21: Summary of Practical Potential to 2026

	Practical Potential
Electricity 2010 (current)	0.1 MWe
Electricity 2020	73 MWe
Electricity 2026	110 MWe
Heat 2010 (current)	0.3 MWth
Heat 2020	89 MWth
Heat 2026	165 MWth

Below is a series of tables which identifies the type of developments for renewable energy technologies to deliver the Practical Potential identified above. NB Table 22 shows the current position for renewable technologies in B&NES according to the Regen SW survey 2010.

Table 22: What would the suggested Practical Potential require in B&NES for 2010

Technology	2010
Wind turbines – large scale	No large turbines as they can take a significant time to develop (often over three years).
Wind turbines – small scale	No/few small scale turbines in place
Biomass	Very low level take up of small scale applications
Hydro	No hydro projects generating
Solar PV	Based on the Government grant programme, a pro-rated uptake for B&NES could be 12kW (approximately 6 – 12 roof top systems). This is a low target for 2010, but it is hoped that if the anticipated PV price drop occurs, uptake should start increasing more rapidly between 2010 and 2020. Unchanged - FIT will provide a supply push
Solar thermal hot water	Assumes a 0.2% uptake on building stock roof tops. This is 248 systems equalling 0.2MW. This is a more ambitious target than PV due to the fact that it currently has a much shorter payback period. The new General Permitted Development Order for microgeneration should facilitate the uptake of STHW in the World Heritage Site. Community organizations such as Transition Bath may also help increase the number of solar thermal installations on existing stock, as may the new Energy Saving Trust programme targeting owner-occupiers. Take up assumption reduced
Heat Pumps (GSHP/ASHP)	Assumes an uptake of 50 x 5kW systems. Bath's first GSHP has recently received permission to progress after consulting B&NES council with regard to the Avon Act. The Renewable Heat Incentive will increase take up
Geothermal heat	Assumes no further take up above that for the heating systems in the Pump Rooms and Thermae Spa (partial)

Table 23: What would the suggested Practical Potential require in B&NES for 2020

Technology	2020
Wind turbines – large scale	Up to 15 turbines using the DECC methodology
Wind turbines – small scale	Up to 10 smaller turbines
Biomass	Would require 82,000MWh of biomass resource for potential demand from new and existing build. B&NES current biomass resource is 98,200MWh. Therefore in 2020 B&NES has enough technical biomass fuel resource (if it is developed) to supply its needs. However by 2026 the requirement could reach 152000, MWh, when additional fuel supply from outside B&NES would be required. 5% biomass heating uptake on existing stock. Remainder from new development demand.
Hydro	Assume that 60% of the sites which are characterized as "Good" or "Moderate" opportunities are developed. It is not likely that all the technical potential will be turned into reality due to detailed site constraints, such as ecology and civil engineering constraints, and land owner decisions. However, hydro sites can have good financial returns and so a high proportion may be implemented.
Solar PV	13.5% uptake on existing stock, some uptake on new build (particularly smaller scale urban brownfield developments). This is a fairly ambitious target but achievable if PV prices drop with the recent introduction of third generation PV technology. The achievement of the target will depend on the FIT being maintained at favourable rates.
Solar thermal hot water	19% uptake on existing building stock. Approx 30-40% uptake on new buildings (majority of their heating will come from other sources). The suggested percentage is higher than for PV due to the fact that currently STHW is cheaper to install with a quicker payback period.
Heat Pumps (GSHP/ASHP)	5% uptake on existing stock and a similar level of uptake in the new developments. The target suggested for GSHP is fairly low as: • existing buildings would need to change from existing heat distribution systems to either larger radiators or underground heating • it is competing with biomass heating • it requires electricity to operate. If the electricity is from a non renewable source then the overall CO_2 benefits will be reduced
Geothermal heat	Assumes all technical resource will be realised. That is, in addition to the heating systems in the Pump Rooms and Thermae Spa (partial), the heat from the hot spring discharge will also be used e.g. for heating the Abbey. Unchanged from original assessment

Table 24: What would the suggested Practical Potential require in B&NES for 2026

Technology	2026
Wind turbines – large scale	Up to 17 turbines using the DECC methodology
Wind turbines – small scale	Up to 17 smaller turbines–
Biomass	B&NES would need to improve fuel supply chain within the district (or source biomass fuel from outside the district to service the energy generation likely by 2026. 8% biomass heating uptake on existing stock. Remainder from new development demand.
Hydro	Assumes that 60% of the sites which are characterized as “Good” or “Moderate” opportunities are developed. It is not likely that all the technical potential will be turned into reality due to detailed site constraints, such as ecology and civil engineering constraints, and land owner decisions. However, hydro sites can have good financial returns and so a high proportion may be implemented. It is assumed that the modest capacity for the hydro resource will be achieved by 2020
Solar PV	25% uptake on existing stock and uptake on new build (particularly smaller scale urban brownfield developments). This is a fairly ambitious target but achievable if PV prices drop with the recent introduction of third generation PV technology. The achievement of the target will depend on the FIT being maintained at favourable rates.
Solar thermal hot water	35% uptake on existing building stock. Approx 30-40% uptake on new buildings (majority of their heating will come from other sources). The suggested percentage is higher than for PV due to the fact that currently STHW is cheaper to install with a quicker payback period.
Heat Pumps (GSHP/ASHP)	10% uptake on existing stock and a similar level of uptake in the new developments (with. uptake in “off gas” areas likely to be higher for existing buildings) The target suggested for GSHP is fairly low as: • existing buildings would need to change for existing heat distribution systems to either larger radiators or underfloor heating • it is competing with biomass heating • it requires electricity to operate. If the electricity is from a non renewable source then the overall CO_2 benefits will be reduced
Geothermal heat	Assumes all technical resource will be realized by 2020. That is, in addition to the heating systems in the Pump Rooms and Thermae Spa (partial), the heat from the hot spring discharge will also be used e.g. for heating the Abbey. Unchanged from original assessment.

In 2005, the total energy demand from both domestic and non-domestic buildings within B&NES[46] and the associated CO_2 emissions were:

Table 25: Energy consumption and CO_2 in 2005

Energy Demand/CO_2 Emissions	
Electricity MWh	787,600
Heating MWh (gas, oil and coal	1,907,300
CO_2 in Tonnes	668,900

If the new homes and associated mixed use non-residential development within B&NES were to be built to today's standards (i.e. Building Regulations 2006) the energy requirement and resulting CO_2 emissions are calculated[47] to be:

Table 26: Potential energy consumption and CO_2 increase from new build

Energy Demand/CO_2 Emissions	
Electricity MWh	41,856
Heating MWh (gas, oil and coal	63,791
CO_2 in Tonnes	33,319

[46] BERR (June 2008): total final energy consumption at regional and local authority level 2005, URN 08/p1c
[47] This is based upon applying benchmark's from CIBSE, Carbon Trust, London Renewable's Toolkit and The Energy Savings Trust.

7 Recommendations for Core Strategy and LDF Documents

7.1 Indicative Energy Strategies and Renewables Assessment

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

The analysis shows that there are a low number of developments of a large enough scale to be suitable for communal energy supply systems. Those that can use communal heating networks are more capable of achieving low to zero carbon standards through on, or near-site, energy supply.

7.2 Renewable Energy Resource within B&NES

The total practical potential for renewable energy (electricity and thermal energy) within B&NES is estimated to be around 275 MW equivalent installed capacity by 2026. The significant portion of this figure is from decentralised (stand-alone) renewable energy sources. Two specific technologies dominate this renewable energy technical potential – large wind turbines and biomass.

Summary of Practical Potential to 2026

Renewable Energy	2010 Current resource	2020	2026	Percentage reduction in 2026[48]
Capacity - Electricity (MW_e)	0.106	73	110	-
Capacity - Heat (MW_{th})	0.30	89	165	-
Energy - Electricity (MWh_e)	450	102,687	136,992	17%
CO2e abatement from renewable electricity (tCO2 per year)	194	44,155	58,907	9%
Energy - Heat (MWh_{th})	451	150,740	278,892	23%
CO2e abatement from renewable heat (tCO2 per year)	84	27,887	51,595	8%

NB the total percentage reduction in CO_2 emissions in 2026, compared to Business as Usual, accounting for the impact of installing both energy efficiency and renewable energy technologies is 27%.

It is recommended that B&NES set a district wide minimum level of renewable electricity and heat generation targets for 2026. The evidence from this study, shown in summary form above, indicates how a practical potential can be realised for each technology. It should be noted that the practical potential relates to current costs, market conditions and policy. Should any of these improve the viability of renewables over time might allow for a higher potential to

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be achieved. The practical potential could therefore be considered to be a base level of capacity to be achieved.

7.3 Potential Low Carbon Policy for the Core Strategy

7.3.1 Setting carbon standards for new development

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.

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

The Government has set out its intentions for improving the carbon performance of new developments into the future with its announcement of the tightening of Building Regulations for new homes along the following lines, as compared to BRegs 2010:

2013 – 25% carbon reduction beyond current requirements; and,

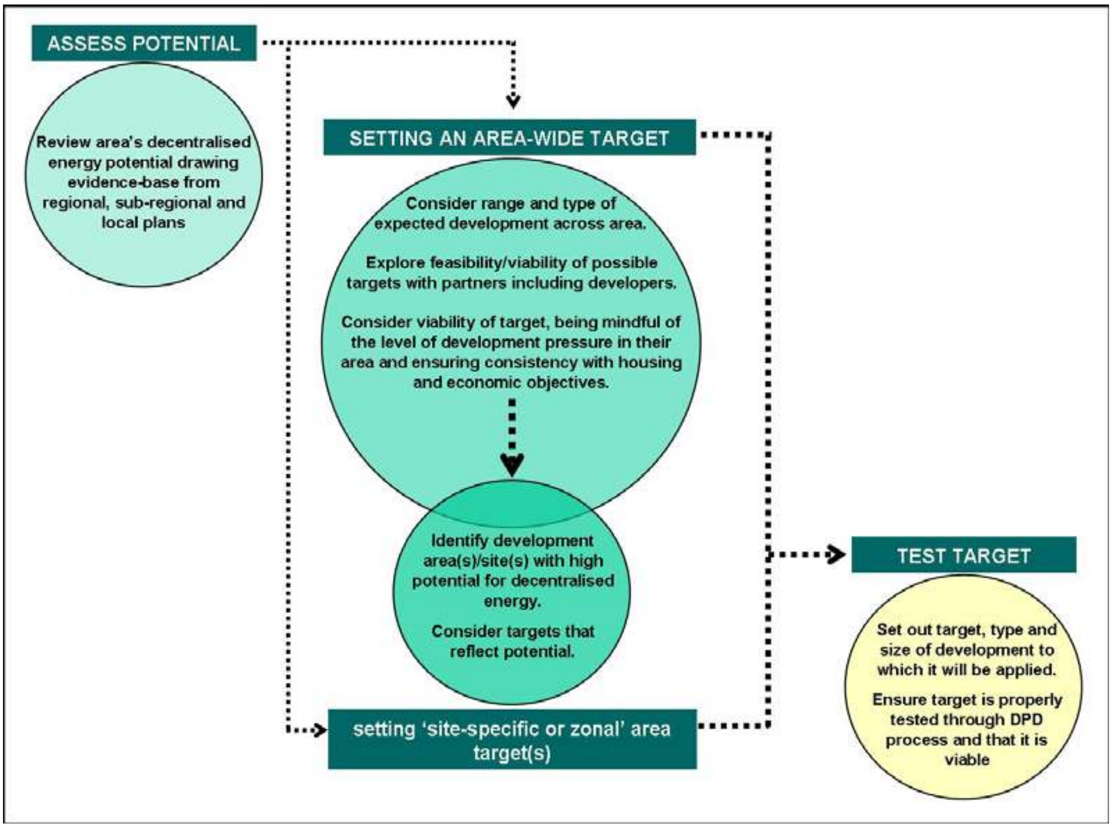
2016 – 100% carbon reduction beyond current requirements.

National legislation will require that all new housing has to be zero carbon from 2016 onwards regardless of local policy. Under the current economic conditions, the pace of housing development within the UK has slowed down, and therefore it is very likely that the housing projection figures will fall back a few years. In which case, the proportion of housing units which will be built after 2016 will be greater and the effect of tighter carbon requirements, and carbon standards that are in advance of national policy, will have a smaller corresponding impact on carbon emissions.

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 large scale development.

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

Figure 31: Approach to setting low carbon targets for new developments[49]



B&NES should require developers to demonstrate how they will firstly comply with the BRegs requirements for carbon reduction, and secondly how they will achieve the appropriate CSH and BREEAM levels by addressing wider sustainability issues. For larger developments, developers should be encouraged to achieve CSH and BREEAM levels ahead of the recommended time points. This might be best demonstrated by the development of an energy strategy for the larger developments.

7.3.2 Suitability criteria for communal energy systems and CHP

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

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

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 number of dwellings is also 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). 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.

The AECOM study for B&NES (District Heating Opportunity Assessment Study, November 2010) has quantified in detail the heat demand within B&NES which could potentially be served by district heating networks. The study was technology neutral and does not make recommendations as to the fuel source, however it does provide an options analysis of the most promising opportunities.

7.4 Assessment of the Viability of Higher Carbon Standards for New Development

B&NES will need to decide what carbon standard it adopts for new development. If the Council is keen to encourage zero carbon developments before 2016, then PPS 1 requires an evidence base demonstrating that local circumstances can enable zero carbon status to be achieved. Zero carbon developments[50] will be difficult to achieve in B&NES ahead of the 2016 requirement. Zero carbon compliance is possible but will put a significant extra cost on the development. This study does not, therefore, support bringing forward tighter carbon standards in advance of national requirements based on the current technology and the expected type and scale of new developments across the district.

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.

The Council could play a key role facilitating community owned wind farms, thus reducing opposition to renewable energy development among residents. Keeping the facility 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, or even install turbines itself.

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

7.5 Consideration of Undue Burden for Developers

7.5.1 Impact on development costs

The report has considered the costs of delivering increasing carbon reductions in new developments as you progress towards zero carbon developments. Developers can work in partnership with an Energy Services Company (ESCo) to finance, maintain and operate the energy system for larger new developments and therefore reduce the costs and the level of burden that they face.

In evaluating the impact of the carbon costs on the viability of a development, developers will need to consider overall development costs in the light of the market sales prices and land value at the time of development. Interpreting the results will require an assessment to be made of how the additional technology costs will be apportioned between 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 any given time of selling.

The impact on developers isn't only that of cost. There is the technical challenge, for developers, of installing energy infrastructure, understanding the energy supply business and working with ESCos. Until recently the low level of knowledge amongst developers has resulted in a view that low carbon developments are a considerable burden. However, the knowledge of the development industry is advancing quickly leading to a reduced knowledge barrier to developing to low carbon requirements.

7.5.2 Diverting finance to more cost effective local carbon reduction measures

The proposed new definition of zero carbon housing – currently under consultation - considers whether it is more appropriate to divert finance to more cost effective offsite carbon reduction measures rather than seek 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. 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 district, 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 achieving the required BReg level. 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 low carbon 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 local renewable energy, whereas a 'carbon neutral development' is one which offsets its (remaining) carbon emissions through investment in external carbon saving measures.

7.6 Planning policy to support developers in achieving low carbon standards

7.6.1 Need to support low carbon infrastructure

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

The 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. 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, in the few cases where this is a realistic opportunity.

The inclusion of wind turbines, 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. 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 use a wind turbine, for example, located on land nearby to provide power for the development. There are additionality issues that will need careful consideration for each development.

7.6.2 Planning policy content

Planning policies should require evidence from developers as to how they intend to meet targets, identifying how they could achieve maximum targets where lower cost solutions are viable (such as CHP, existence of communal heating infrastructure, access surplus heat or biomass heating). 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

B&NES Council should require evidence of a viability assessment, effectively an Energy Strategy for the development, 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.

7.6.3 Characteristics of communal 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, where scale and development type permit. District heating networks are particularly important in terms of enabling the efficient use of biomass fuel through combined heat and power (CHP) systems or enabling advanced technology energy-from-waste CHP plants to provide heat and power to communities. Planning policy needs to be proactive in encouraging these networks, and in encouraging buildings to connect to these networks – and the approach can vary from prescriptive requirements to more general policies of encouragement.

Combined heat and power and biomass heating are vitally important low carbon technologies, and yet their use is generally dependent upon district heating networks in order to distribute the heating to housing and other buildings. CHP and district heating suffer a general lack of support policy and are not favoured by the UK's energy market place. The challenge of realising the carbon savings from CHP and biomass heating within the existing built environment is generally wrapped up within the challenge of developing district heating networks which require high capital investment and long payback periods. CHP and district heating require support from both planning policy and financing mechanisms.

The public sector can further assist heat network development by using their buildings as 'anchor heat loads' to form the basis of heat network development. Large buildings with fairly constant heat demand such as leisure centres, hospitals, prisons and hotels are all effective anchor loads. The separate report being undertaken by AECOM has identified district heating opportunities that might be fuelled by renewable sources if cost effective.

7.6.4 Linking existing communities to emerging heat networks

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.

The study undertaken by AECOM (District Heating Opportunity Assessment Study, November 2010) has identified specific opportunities for heat networks in B&NES. This provides a detailed analysis of the most promising heat network opportunities across the district, showing fuel options and costings as well as how heat networks can bridge between new and existing developments. The report demonstrates that heat networks can be a viable method of delivering low carbon development in B&NES.

The AECOM report provides the opportunity for the Core Strategy to include a recommendation that developers assess the opportunity for heat networks where the development scale and/or proximity of existing heat demand indicates a cost effective outcome.

7.6.5 Overcoming project risk and enabling commercial delivery

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 (see Non-Planning Policy section below).

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

7.6.6 Need for specialist training and planners

There is a need for specialist training and continuous professional development for planners in the different renewable energy systems available and the implications on developments.

7.7 Monitoring and Enforcement

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

- 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 should split into office, retail and industrial. It would also be useful to obtain figures for the amount of energy generated by different renewable energy technologies to compare with the original energy strategies in order that lessons can be learnt if any of the systems are under performing.
- B&NES could 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.
- All low carbon energy installations need to be captured in a Monitoring Report. The Council will need 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.
- Monitoring the CO_2 emissions from the existing building stock across the district is also important. This can be captured as part of monitoring systems set up to measure progress towards the goals in the SCS. 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.

8 Non-Planning Delivery Mechanisms for Enabling Low Carbon Development

8.1 Coordinating the Development of Low Carbon infrastructure

8.1.1 Coordinating the development of low carbon infrastructure

Planning policy alone will not be able to deliver low carbon and renewable energy within B&NES, 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.

8.1.2 Local ESCos to develop low carbon energy project?

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

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

- Low carbon energy supply for a new development
- District heating or CHP scheme for social housing and / or other community and private sector customers
- Community renewables projects

- Retrofitting energy efficiency measures into buildings or energy management in buildings
- Pre-commercial energy development/ projects and small bespoke projects.

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 the 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 their services.

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

Public 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 they identify 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.

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

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

8.2 Financing low carbon infrastructure

8.2.1 Addressing investment challenge for communal infrastructure

A ‘carbon investment fund’ could help overcome the high upfront costs of energy infrastructure with the public sector providing the initial lump sum which is then repaid through developer’s energy contributions. 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 and PV arrays that can supply phased developments. The carbon investment fund would bring forward the value of staged developer contributions to early stage investment and would be reimbursed through payments from private sector developers as their developments are rolled out.

Key actions to overcome potential investment shortages include:

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

8.2.2 Managing contractual complexities & project uncertainties

Key actions to mitigate risk include:

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

8.2.3 Public sector leading by example

B&NES has a real opportunity to directly progress renewable energy installations and decentralised energy generation by taking forward projects on their own buildings and land. As outlined above, the public sector could establish a local ESCo to help implement these low carbon energy projects.

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

- Public sector buildings to provide ‘anchor loads’ for district heating and low carbon infrastructure networks so as to lead the way in installing CHP and developing heat networks;
- Renewable energy installations on Council property, including PV, solar water heating and small to medium wind turbines; replacing fossil fuel boilers with biomass boilers;
- Develop an action plan for implementing some of these as demonstration projects;
- Make renewable resource maps available to developers and the public.

Appendix 1: Important Terminology

GLOSSARY	
AD	Anaerobic Digestion; process in which organic materials are broken down in the absence of oxygen producing biogas which can be burnt to produce electricity and/or heat
AMR	Annual Monitoring Report: One of a number of documents required to be included in the Local Development Framework Development Plan Documents, submitted to Government via the Regional Government office by a Local Planning Authority at the end of December each year to assess the progress and the effectiveness of a Local Development Framework
APEE	Energy Saving Trust's Advanced Practice Energy Efficiency Standard.
ASHP	Air source heat pump
BERR	UK Department for Business, Enterprise & Regulatory Reform, superseded in June 2009 by the Department of Business, Innovation and Skills
BPEE	Energy Saving Trust's Best Practice Energy Efficiency standard
CHPA	Combined Heat and Power Association
CSH	Code for Sustainable Homes; also referred to as 'Code': The Code is the national standard in England for the sustainable design and construction of new homes. The Code aims to reduce carbon emissions and create homes that are more sustainable by measuring the sustainability of a new home against nine categories of sustainable design, rating the 'whole home' as a complete package. The Code uses a one to six star rating system to communicate the overall sustainability performance of a new home. From 1 May 2008 it is mandatory for all new homes to be rated against the Code and include a Code or nil-rated certificate within the Home Information Pack.
DECC	Department for Energy and Climate Change: Government department created in October 2008. It is responsible for all aspects of UK energy policy, and for tackling global climate change on behalf of the UK.
ESCo	Energy Service Company; This is a professional business providing a broad range of comprehensive energy solutions including designs and implementation of energy savings projects, energy conservation, energy infrastructure outsourcing, power generation and energy supply, and risk management. The ESCo performs an in-depth analysis of the property, designs an energy efficient solution, installs the required elements, and maintains the system to ensure energy savings during the payback period The savings in energy costs is often used to pay back the capital investment of the project over a five- to twenty-year period, or reinvested into the building to allow for capital upgrades that may otherwise be unfeasible. If the project does not provide returns on the investment, the ESCo is often responsible to pay the difference.
FIT	Feed-in-Tariff: A UK Government cashback scheme outlined in the Energy Act 2008 effective from 1 April 2010 guaranteeing payment to people who generate small scale low carbon

GLOSSARY	
	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, for this study this is assumed as being above 1 MW in capacity (tip height typically greater than 100 m). Where appropriate, the default size of large scale wind turbines in 2.5 MW with a tip height of approximately 125 m.
LDF	Local Development Framework
LZC	Low and Zero Carbon
MLSOA	Middle Layer Super Output Area; Super Output Areas are a unit of geography used in the UK for statistical analysis. They are developed and released by Neighbourhood Statistics. Middle Layer SOAs have a minimum population 5000, and a mean population 7200. Built from Lower Layer SOAs. There are 7,193 MLSOAs in England and Wales
MOD	Ministry of Defence
MSW	Municipal Solid Waste: Waste type that includes predominantly household waste (domestic waste) with sometimes the addition of commercial wastes collected by a municipality within a given area.
$MTCO_2e$	Million Tonnes of Carbon Dioxide Equivalent
MW	Megawatts. The productive capacity of electrical generation plant is often measured in MWe.
MW_e	Megawatts of electrical capacity.

GLOSSARY	
MW_{th}	Megawatts of thermal capacity.
MWh	Megawatt-hour, equal to 1,000 kWh.
ODT	Oven Dried Ton; an amount of wood that weighs 2,000 pounds at zero percent moisture content, common conversion unit for solid biomass fuel
PPS	Planning Policy Statement
ROC	A Renewables 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.
SHLAA	Strategic Housing Land Allocation Assessment
SHW / STHW	Solar Hot Water; also known as Solar Thermal Hot Water
Small wind	Small scale wind, for this study this is assumed as being below 500 kW in capacity (tip height typically less than 60 m)
Solar PV	Solar Photovoltaic
SPV	Special Purpose Vehicle; a legal entity set up for a specific purpose: to isolate financial risk from a lead organisation.
tCO_2/yr	Tonnes (metric) of CO_2 per year
TCPA	Town and Country Planning Association
TWh	Terra Watt Hours ($1x10^{12}$ Watt Hours or $1x10^{9}$ Kilowatt Hours). A convenient unit of energy consumption for national statistics.

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)

Mega Watt is used to demonstrate the potential a energy generating plant has. Large scale centralised power stations eg Didcot, Drax etc have a potential measured in the 1000's of Mega Watts.

Mega Watt hrs is a measure of the actual energy delivered by a energy generating plant. A 2.5MW wind turbine might produce some 5,000 MWh or 5,000,000 kWh in a year. A typical home in the UK will consume 4,000 kWhs in a year. Therefore, a 2.5 wind turbine will produce enough electricity for some 1,250 typical homes.

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.

Appendix 2: 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. Camco supported an ESCo procurement process and negotiated 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, and Camco has helped market test the delivery of such an infrastructure through an ESCo.
- Bath Western Riverside is 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 and Camco has acted as a technical advisor alongside Crest Nicholson for ESCo negotiations.
- 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, is now 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 protect and guarantee their carbon neutral, 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 3: 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 £1,288,270. 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 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 4: Costs of achieving Zero Carbon Developments.

Costs of achieving Zero Carbon Developments. Abbreviations can be found in the Appendix 1.

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	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
PV + BPEE	48%	£5,715	70%	£10,786	70%	£10,786	70%	£15,476	48%	£5,715	70%	£10,786

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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	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 + 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
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

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	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 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