REPORT

Bath & North East Somerset Council - Renewable Energy Research and Planning

climatechangesolutions

Presented to: Bath and North East Somerset Council
Author: Camco Advisory Services
Date: June 2009
Version: Final

report

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Document type:	Report
Client:	Bath and North East Somerset Council
Client contact:	Kaoru Jacques
	Planning Policy
	Trimbridge House, Bath BA1 2DP
	01225-477548

Report Title:	Renewable Energy Research and Planning
Report:	Final
Draft:	June 2009

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Executive Summary

Bath & North East Somerset (B&NES) Council commissioned Camco in June 2008 to assist in the development of evidence based renewable energy targets and policies to cover the B&NES district. These targets and policies will inform the Local Development Framework (LDF) and will further meet the requirements of the Draft South West Regional Spatial Strategy (RSS) of June 2006 and national Planning requirements.

The Draft RSS Proposed Changes were published by the Government in July 2008. Increased growth agenda i.e. housing and employment requirements in the RSS Proposed Changes will have an effect on the renewable energy targets, however, the final details are not confirmed yet. Therefore it was agreed that this research will take the draft RSS as a baseline. Once the RSS requirements are agreed, then an addendum report will be published separately.

The project has:

- assessed the *technical* potential for renewable energy within B&NES;
- taken the assessed potential for renewable energy within B&NES and advised on targets;
- calculated the potential for sustainable energy at the proposed new developments specified in the draft Regional Spatial Strategy for urban extensions to Bristol and Bath, and also brownfield development in urban areas, including Keynsham, Midsomer Norton and Radstock (15,500 new homes in total plus a non-residential mix of buildings);
- recommended policy options that would assist turning the potential for renewable energy generation into a reality.

Context

The UK Government has established challenging targets for carbon dioxide reductions over the next 40 years to address the dangers of climate change. The challenge has currently been set at a reduction of 80% in carbon dioxide emissions (compared to those of 1990) by 2050.

Local authorities are central to the drive required to achieve these targets and are instrumental in developing the policies, strategies and plans to implement carbon reduction at a local level. This will require partnership working and community leadership – working practices that local authority members and officers have always employed as part of the delivery of local action.

There are a number of key drivers that are focusing this agenda around local authority action – these include*, inter alia*:

- National Indicators, in particular NI's 185, 186, 187 and 188
- Carbon Reduction Commitment (CRC)
- Building Regulations and Code for Sustainable Homes
- Display Energy Certificates (DECs)
- Renewable energy targets
- Planning Policy Statement 1 Supplement Planning for Climate Change (PPS1 Supplement).

The current work relates specifically to the last two of the drivers listed. To enable local plans to be drawn up to address these issues will require a body of evidence to be assembled that provides a robust case for action.

PPS 1 Supplement brings the carbon reduction agenda more closely aligned with the land-use planning system than has hitherto been the case. It requires those officers and members responsible for the development of planning policies to develop an understanding of low carbon technologies and the way that they can be integrated into the built environment. Using low carbon technologies can have economic, environmental and social consequences and these need to be assessed, and balanced, in the development of policies to achieve a low carbon society.

Specifically, the PPS1 Supplement enables local authorities to establish how decentralised energy – that is heat and electricity generated on a small to medium scale associated with local energy needs – can be developed, given the existing and proposed pattern of settlements. Ultimately the PPS allows local authorities to develop policies that move ahead of the national targets; identifying where local opportunities for action can be developed and acted upon.

The work reported in this document shows how renewable energy technologies might be brought in across B&NES, after environmental, commercial and social considerations have been taken into account. These targets must be adapted as we go forward as the environmental, commercial and social constraints change.

It is important to note that the main focus of the PPS1 Supplement is on new developments, at all scales, and not existing property. This does not mean that any action relating to renewable energy and low carbon technologies in general will not have an impact on existing property. Action on existing property, domestic, commercial and institutional, will also require concerted action where retrofitting of low carbon measures (both energy generating and energy saving) will be vital to achieve overall carbon emission reductions. The need for action on existing property is demonstrated by the fact that carbon dioxide emissions relating to existing buildings far outweighs any potential carbon emissions that might occur from proposed new developments. For example current carbon dioxide emissions from existing buildings across B&NES is some 668,900 tonnes per year, by 2026 if the proposed new developments are completed and built to the new building regulations (and the Code for Sustainable Homes) and existing property takes advantage of renewable energy sources and energy efficiency, then this level will reduce to some 496,379 tonnes per year. The existing property will account for some 98% of the reduced emission figure. This clearly demonstrates that continuing action around the existing building stock will be vital to achieve wider scale and deep cuts in carbon emissions.

Renewable Energy

The UK has established targets for renewable energy generation which derive from European Union Directives. These targets have been further tiered down to regions (in the south west through work undertaken by GOSW, the Regional Assembly, SWRDA and Regen SW). Regional targets have been based on a broad analysis of the renewable energy potential for the south west, giving an indicative target at the County level. For local authorities wishing to act within the PPS1 supplement then, a further, more locally based analysis of the opportunity for renewable energy is required. This report shows the potential for renewable energy and how that might be developed into realistic targets.

We have considered renewable energy technologies that generate heat and/or electricity. Renewable energy technologies are not a homogenous group, they all have their individual technical, economic, environmental and social issues. This means that each technology must be assessed against a specific set of criteria to develop an understanding of the overall potential for development.

The technologies considered are:

- Wind turbines – both large and small scale
- Biomass – ranging from wood grown as a fuel through to biomass recovered from the waste stream
- Hydro
- Solar Photovoltaic (PV) - electricity generated directly from the sun
- Solar thermal hot water
- Ground Source Heat Pumps (GSHP) – heat generated by exploiting the local differences in temperature between the air and the ground.

- Geothermal heat – the use of deep rock heat, either through deep drilling or by using the consequence of that heat where water reaches the surface at an elevated temperature e.g. the hot springs in Bath.

The renewable energy potential has been assessed on two levels; firstly, on the basis of the Technical potential; and secondly, on the basis of a Target potential.

The Technical potential relates to the maximum renewable energy that would be possible for B&NES. This is the sum of the maximum potential for each of the individual technologies considered. This allows for the maximum possible energy generation when considering the technology available (and an assessment of credible advances in technology for future targets i.e. this excludes major technological advances that are not currently foreseen), the nature of the geography and the built settlements that exist and those that are proposed. This gives a current upper limit on the likely renewable energy potential for B&NES.

The Target potential is the renewable energy potential that remains after a number of constraints have been applied to the Technical potential. These include constraints such as landscape and environmental issues, commercial likelihood of the technology being developed, technical integration within the area amongst others. Having applied these constraints each technology will have, for a number of dates into the future, a level of potential that is realistic, but often at the same time challenging.

An analysis of the Target potential gives the following results. These include those renewable energy sources integrated into buildings and those that are “free standing”.

	B&NES Potential Target Capacity (MW)	**B&NES Potential Renewable Energy Generation Target (MWh)**
Electricity 2010 Target Capacity	0.38 MWe	1,000
Electricity 2020 Target Capacity	56 MWe	70,000
Electricity 2026 Target Capacity	80 MWe	110,000
Heat 2010 Target Capacity	2.0 MWth	3,500
Heat 2020 Target Capacity	101 MWth	160,000
Heat 2026 Target Capacity	186 MWth	300,000

Carbon Dioxide Abatement

The purpose of assessing the renewable energy potential for B&NES is to assess how such developments can contribute to the reduction in carbon dioxide emissions. If climate change was not such a danger to the way we are able to function as a society, then, arguably, the need for renewable energy technologies would be diminished – although an argument around the reduction in the availability of fossil fuels provides an alternative imperative. Because of the need to reduce carbon dioxide emissions, there is a clear requirement to maximise the amount of energy that can be generated through renewable sources. It is clear that if there is a drive to maximise the amount of renewable energy generated then there are economic, environmental and social consequences of using these technologies and that difficult and complex decisions will be required from the local authority in partnership with the whole community. These decisions need not cause negative impacts – benefits through increased employment, local ownership of energy generation plant (maintaining profits in the community), reductions in fuel poverty etc can be maximised at the same time.

Defining the appropriate renewable energy mix

This report concentrates on the new developments proposed for B&NES until 2026. The scale and type of development is identified through the Regional Spatial Strategy. Because renewable energy technologies are all different and apply at different scales and generate through different means, it is not always immediately obvious which technologies should be developed in which cases.

For example, for a large new development, there may be a number of ways of providing renewable energy using different technologies in differing configurations. The consequences of using any particular mix might have different economic, environmental or social impacts when compared to any other technology mix. The development might be able to achieve the same levels of carbon dioxide reduction (against current building standards) by using either a biomass combined heat and power generation plant with a district heating system as its major component, or it might use large wind turbines combined with small scale heat technologies. For such a development it is possible that the biomass option might be more expensive for the property developer to build but the wind option has landscape impacts that some might find difficult to accept. There will always be difficult decisions to be made – something the land use planning system in the UK has been developed to address.

Realising Technical Potential

Identifying the renewable energy potential for the community is only the first step on the ladder to delivery. There are a wide range of issues that have to be addressed to ensure that the potential identified is realised. These can range from the individual resident – ensuring that there is support for homeowners and business people to understand and use the renewable technologies - through to new commercial structures to own the generation plant – Bath has been at the forefront of this issue with the development of an Energy Service Company (ESCo) that will own the generation equipment at the Bath Western Riverside development, providing energy for the those who will live there. These are not tasks that the local authority can deliver alone. However, with a partnership approach it will be possible to maximise the carbon reduction opportunities thus benefiting the whole community.

The table below shows, in summary form, some of the implications for the scale of development being proposed by the Target potential shown above. It indicates the type of actions that will help to achieve the proposed targets.

Technology	2020 target implications	Recommendations to help turn target into reality
Wind turbines – large scale	Up to 9-10 large turbines	Ensure potential wind turbine sites close to new developments are considered when allocating land. Ensure B&NES has the resources for quick turnaround of wind energy applications.
Wind turbines – small scale	Up to 10 smaller turbines	Encourage farm awareness and have clear planning guidelines for smaller wind turbines. Consult with Highways Department and agree if they are acceptable to be placed at blade distance from roads rather than maximum height to tip.
Biomass	Would require 250,000MWh of biomass resource for potential demand from new and existing build by 2026. B&NES current biomass resource is 98,200MWh. In other words to supply the demand within B&NES the resource would	It is recommended that a wood-fuel group is set up to enable the establishment and promotion of a wood-fuel supply chain for the local authority, and that the farming industry is engaged with to facilitate the growth of energy crops and the promotion of agri-forestry systems which allow for food and wood production on the same land.

Technology	2020 target implications	Recommendations to help turn target into reality
	need to double. There will be a 5% biomass heating uptake on existing stock; the remainder will come from new development demand.	
Waste	All organic kitchen, garden, supermarket and farm wastes should be processed in Anaerobic Digesters (AD) in order to produce biogas and fertilizer.	Liaison and integration with the waste strategy is vital.
Hydro	Approximately 3 hydro sites would need to be developed along the Avon	B&NES may be in a position to progress some sites, such as the Pultney Weir site, in partnership with private developers.
Solar PV	13.5% uptake on existing stock, uptake on new build will vary according to the development configuration and location	Clear definition of what could be acceptable on listed buildings - some products might be more acceptable e.g. PV roof tiles or roof integrated panels rather than bolt on, or if they are not seen from a main highway. Consultation and education of planning officers.
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)	Like PV, STHW is now a permitted development on roof tops in the World Heritage Site and Conservation Areas, but not on listed buildings. Investigate the possibility of planning officers being more tolerant if the STHW collectors are not visible from a main highway.
GSHP	5% uptake on existing stock, uptake on new build will vary according to the development configuration and location	Ensure that local regulations e.g. the Avon Act do not overly reduce the opportunity for this technology
Geothermal heat	Heat from the hot spring discharge used e.g. for heating local buildings.	Encouragement of officers already looking into this possibility.

Financial Implications

The use of renewable energy technologies and energy efficiency measures will inevitably increase the cost of developing domestic, commercial and institutional property – the additional cost per dwelling might be up to £20,000, depending on the technology mix and the scale of the development (NB other studies that have assessed the additional cost of using micro-generation technologies alone suggest an additional cost per dwelling of over £30,000 might be needed). For many developments over the next 10-20 years new regulations will require that elevated targets for the reduction of carbon will require developers to implement these low carbon technologies. They will seek to do this at the lowest cost. This means that policy should not be prescriptive about which technologies should be used as long as the carbon reductions are achieved and that no other detrimental impacts occur.

The choice of technologies (or combinations of technologies) made might have wider impacts on the community. For example while a biomass combined heat and power generating plant might be seen as the most acceptable solution for any given development, it might also be true that the use of wind turbines in combination with small scale heat generating technologies might give the most cost effective solution.

The inevitable costs can be mitigated from the developers' perspective by using a commercial financing vehicle such as an Energy Services Company (ESCo). These companies will contract to build, own and operate the technologies proposed, thereby taking the risk away from the property develop. The developer of the ESCo will recoup their investment over the long term (25 years plus) through the sale of energy to the residents of the property.

Policy Implications

The analysis undertaken for this report has identified a need for planning policies in B&NES to incorporate the results of this work to ensure carbon reduction targets for, in particular, new build, can be achieved. This will require Councillors and officers to engage with the wider community to ensure that the difficult decisions needed are tested against local opinion in an informed manner.

There are a number of specific actions that will help to bring forward the development of individual technologies as well as the wider developments of mixed technologies. These include:

- The development of a biomass fuel supply chain. Good examples of local authority intervention exist and show how the development of the fuel supply chain can accelerate the implementation of biomass technologies.
- The Council can reinforce its Community Leadership status by ensuring that for Council property, low carbon energy generation technologies are used. For example many local authorities have implemented a biomass boiler replacement programme for schools.
- Where new developments are making use of larger scale renewable technologies e.g. biomass combined heat and power, then consideration should be given to the potential for using some of the energy generated for existing buildings. This is particularly relevant to the case of district heating schemes that can be extended to service existing property.
- Ensuring that the new status of permitted development for microgeneration within conservation areas (including the World Heritage Site) is understood and implemented. Further consideration of a similar approach for listed buildings would be advantageous in achieving carbon reduction targets e.g. the acceptance of solar technologies on the roofs of buildings that are not immediately visible from major roads.
- The potential for public/private Energy Service Companies (ESCo) to develop, build and operate the larger scale technologies should be considered. There are a number of local authorities who have established these arrangements and have benefited from the resulting low carbon energy.

Sustainable Construction Policy, to ensure that an effective holistic approach to new build is taken. The analysis undertaken suggests that the following carbon reductions can be achieved in the context of the Code for Sustainable Homes.

Development	Sustainable Construction Recommended Targets
Urban Brownfield (less than 500 dwellings and non-residential under 1000m^2)	2008 – 2010: CSH Level 3 energy requirements and 25% reduction in regulated CO_2 emissions for non-residential buildings. 2010 – 2012: CSH Level 3 energy requirements and 25% reduction in regulated CO_2 emissions for non-residential buildings. 2013 – 2016: CSH Level 4 energy requirements as per Building Regulations and 44% reduction in regulated CO_2 emissions for non-residential buildings. From 2016: CSH Level 6 energy requirements as per Building

Development	Sustainable Construction Recommended Targets
	Regulations and 70% reduction in regulated CO_2 emissions compared to Building Regulation 2006 standards. .
Urban brownfield (over 500 dwellings and non-residential over 1000m^2)	2008 – 2010 CSH Level 3 energy requirements and 25% reduction in regulated CO_2 emissions for non-residential buildings. 2010 – 2012 CSH Level 4 energy requirements and 25% reduction in regulated CO_2 emissions for non-residential buildings. 2013 – 2016 Dwellings - CSH Level 4 energy requirements plus a requirement for communal heat network for densities over 50 dwellings per ha, unless it can be proven that zero carbon is possible for the development as a whole without one. Non-residential buildings - 44% reduction in regulated CO_2 emissions compared to Building Regulation 2006 standards. 2016 -2019: Dwellings - CSH Level 6 energy requirements as per Building Regulations Non-residential buildings - 70% reduction in regulated CO_2 emissions compared to Building Regulation 2006 standards. 2019 onwards: Zero carbon for all buildings.
Urban Extensions	2008 – 2010 CSH Level 3 energy requirements 2010 – 2012: Dwellings - CSH Level 4 energy requirements Non-residential buildings - 25% reduction in regulated CO_2 emissions compared to Building Regulation 2006 standards. 2013 – 2016: Dwellings - CSH Level 5 energy requirements plus a requirement for communal heat network for densities over 50 dwellings per ha, unless it can be proven that zero carbon is possible for the development as a whole without one. Non-residential buildings - 44% reduction in non-residential regulated CO_2 emissions compared to Building Regulation 2006 standards. 2016 – 2019: Dwellings - CSH Level 6 as per Building Regulations Non-residential buildings - 100% reduction in non-residential regulated CO_2 emissions compared to Building Regulation 2006 standards. It is recommended that all urban extensions in B&NES are set the same standard so there is a level playing field.

NB The onus must be on the developer to prove they *cannot* reach the targets with a proper consideration of more detailed development costs and an update of energy systems costs, market sales prices, number of affordable homes, and land value at that time.

The analysis demonstrates local circumstances that warrant higher than national standards, particularly for those developments that are able to have a communal heat network and/or wind energy from large turbines. Hence the recommendations for smaller scale urban brownfield developments are less stringent as they are less likely to be feasible. However, CSH level 3 should be feasible for smaller scale urban brownfield developments prior to 2013.

Urban brownfield developments, where the recommended targets are less stringent than for the urban extensions, could be set a carbon neutral target for *regulated* emissions 2013 – 2016. This would mean that whilst they would be required to meet CSH Level 4 and 44% reduction in regulated CO_2 emissions for non-residential buildings on-site, it would mean that they could meet 100% reduction in regulated emissions either on-site or by paying into a fund so that the amount of CO_2 reductions could be met with projects elsewhere e.g. cavity wall insulation of existing buildings.

- *RSS Policy RE 5*

The analysis suggests that the following elevated target could be achieved above that identified in RE5 of the RSS: This would be an interim target before the Building Regulation and Code for Sustainable Homes (CSH) requirements come into effect in 2013 and 2016. This Policy will be superseded in 2013 when a 44% reduction in regulated emissions should be achieved. The 20% reduction can be achieved by a combination of energy efficiency measures and the deployment of renewable energy technologies.

> Larger scale developments [over 10 dwellings or 1000m^2 of non-residential use] will be expected to provide, as a minimum, sufficient on-site renewable energy to reduce emissions from energy use by users of the buildings constructed on site by the equivalent of 20% of regulated emissions. Developers will be expected to demonstrate that they have explored all renewable energy options, and have designed their developments to incorporate any renewable energy requirements.

This would provide a clear indication to the renewables industry that there is a clear commitment to carbon reductions in the B&NES area.

1 Introduction

Bath & North East Somerset (B&NES) Council commissioned Camco in June 2008 to assist in the development of evidence based renewable energy targets and policies to cover the B&NES district. These targets and policies will inform the Local Development Framework (LDF) and will further meet the requirements of the Draft South West Regional Spatial Strategy (RSS) in June 2006 and national Planning requirements.

The Draft RSS Proposed Changes were published by the Government in July 2008. Increased growth agenda i.e. housing and employment requirements in the RSS Proposed Changes will have an effect on the renewable energy targets, however, the final number is not confirmed yet. Therefore it was agreed that this research is taking the draft RSS as a baseline. Once the RSS requirements are agreed, then an addendum report will be published separately.

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- recommended policy options that would assist turning the potential for renewable energy generation into a reality.

2 The B&NES Context

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 the South West Draft RSS expects B&NES to increase its housing stock by 15,500 dwellings; an increase of 21%. With this, additional employment and public buildings will be required.

3 B&NES Energy Demand and CO_2 Emissions

In 2005, the total energy demand from both domestic and non-domestic buildings within B&NES[1] and the associated annual CO_2 emissions were:

- 787,600MWh of electricity
- 1,907,300MWh of heating (from gas, oil and coal)
- 668,900 tonnes of CO_2[2]

If the South West Draft RSS's requirement for 15,500 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[3] to be:

- 95,000MWh of electricity
- 153,000MWh of heating
- 77,500 tonnes CO_2 per year

[1] *BERR (June 2008): total final energy consumption at regional and local authority level 2005, URN 08/p1c*
[2] *Based on DEFRA's carbon emission factors of 0.43 tonnes CO_2 per MWh for electricity (long term marginal factor) and 0.185 for gas*
[3] *This is based upon a collection of benchmark's from CIBSE, Carbon Trust, London Renewable's Toolkit and The Energy Savings Trust.*

4 Renewable Energy Policies and Targets

4.1 UK Policy

4.1.1.1 Climate Change Act 2008

The UK is introducing a long term legally binding framework to reduce greenhouse gas emissions. The Act which came into effect in 2008, puts into statute the framework to set 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.

This target will be reviewed, based on a report from the new independent Committee on Climate Change, that will determine if the targets should be strengthened further. The Committee on Climate Change presented its initial findings in December 2008.

4.1.1.2 Energy White Paper 2003

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

4.1.1.3 Renewable Energy Strategy (in consultation)

Currently in consultation, the Renewable Energy Strategy is likely to call for 15% of the UK's electricity, heat and transport fuel to come from renewable sources by 2020. This is likely to comprise of a 35% target for electricity and a 14% target for heat.

4.1.1.4 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.*

4.1.1.5 Planning Policy Statement on Planning and Climate Change Supplement to PPS1

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

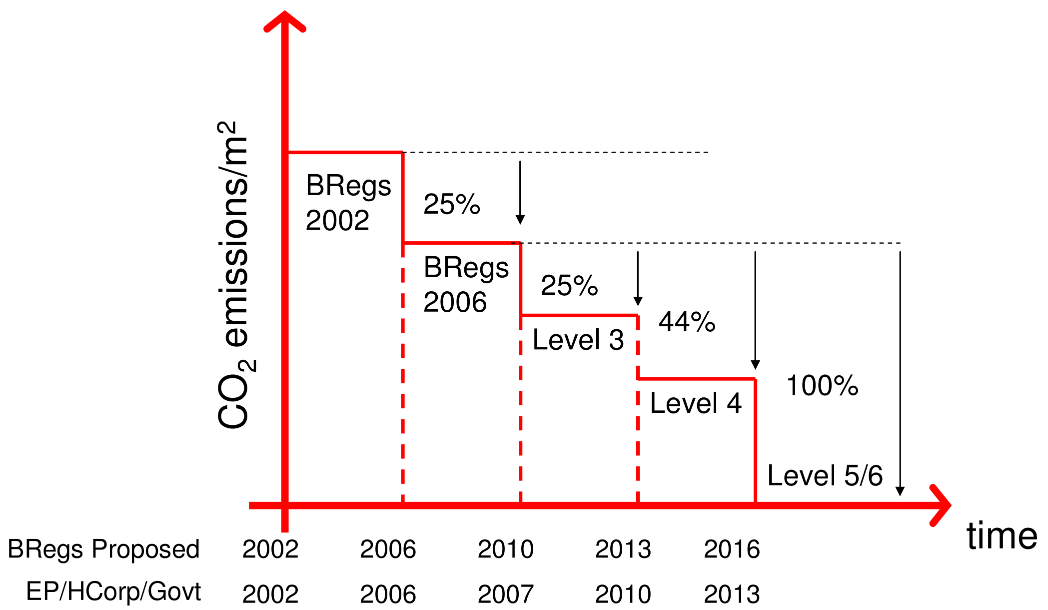
- there are clear opportunities for significant use of decentralised and renewable or low carbon-energy; or

- without the requirement, for example on water efficiency, the envisaged development would be unacceptable for its proposed location.

4.1.1.6 Building Regulations

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

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



The diagramme above shows how building regulations and now the Code for Sustainable Homes are being used to drive down carbon dioxide emissions from new buildings. It shows how, by 2016, all domestic new build must be effectively “carbon neutral” for all energy use (this excludes transport emissions). It also shows that the public sector must reach this target by 2013 – this imposes a challenging target that will need coordinated action to achieve.

In the March 2008 budget the Government announced its intention that all non-domestic buildings should be zero carbon by 2019. Therefore, the various phases of development within B&NES will face increasing levels of CO2 reduction requirements, and the majority of development after 2016 is likely to need to be zero carbon. However, the aspiration for zero carbon development by 2016 is very challenging and will require innovative approaches from both the public sector as well as the development industry.

4.2 South West – Draft RSS

Arising from the Secretary of State’s Proposed Changes to the South West Draft RSS, 22 July 2008, the policies pertaining to renewable energy are currently as follows:

4.2.1.1 RE1: Renewable Electricity Targets: 2010 and 2020

Local Development Documents will include positive policies to enable the achievement of the following targets:

By 2010 a minimum target of 509 to 611 MWe installed capacity, from a range of onshore renewable electricity technologies in the following broad distribution:

Sub-region Installed Electricity Capacity (MWe)

Former Avon	35-52
Gloucestershire	40-50
Wiltshire	65-85
Somerset	61-81
Devon	151
Dorset	64-84
Cornwall	93-108
Total	509-611

By 2020 a minimum cumulative target of 850MW_e installed capacity from a range of onshore renewable electricity technologies.

4.2.1.2 RE3: Renewable Heat Targets: 2010 and 2020

Local Development Documents will include positive policies to enable the achievement of the following targets by the use of appropriate resources and technologies:

Timescale Installed Thermal Capacity (MWth)

2010:	100
2020:	500

4.2.1.3 RE4: Meeting the Targets Through Development of New Resources

When considering individual applications for development of renewable energy facilities, local planning authorities will take into account the wider environmental, community and economic benefits of proposals, whatever their scale, and should be mindful that schemes should not have a cumulative negative impact. Proposals in protected areas should be of an appropriate scale and not compromise the objectives of designation.

4.2.1.4 RE5: Decentralised Energy to Supply New Development

Local planning authorities should set targets in their DPDs for the energy to be used in new development to come from decentralised and renewable or low-carbon energy sources where it is feasible and viable, and the development thresholds to which such targets would apply. In the interim, before targets are set in DPDs, at least 10% of the energy to be used in new development of more than 10 dwellings or 1000m^2 of non-residential floor space should come from decentralised and renewable or low-carbon sources, unless, having regard to the type of development involved and its design, this is not feasible or viable.

4.2.1.5 Development Policy G: Sustainable Construction

Local Planning Authorities should promote best practice in sustainable construction and help to achieve the national timetable for reducing carbon emissions from residential and non-residential buildings. This will include:

- consideration of how all aspects of development form can contribute to securing high standards of energy and water efficiency
- the use of sustainable drainage systems to minimise flood risk, manage surface water and

encourage natural drainage and ground water recharge where appropriate

- designing for flexible use and adaptation to reflect changing lifestyles and needs and the principle of 'whole life costing'.

There will be situations where it could be appropriate for local planning authorities to anticipate higher levels of building sustainability in advance of those set out nationally, for identified development area or site-specific opportunities. When proposing any local requirements for sustainable buildings, local planning authorities must be able to demonstrate clearly the local circumstances that warrant and allow this and set them out in Development Plan Documents

5 Renewable Energy Targets for B&NES

5.1 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, technology and in the case of biomass, the resource, may change over time: potential scenarios for these are considered for deriving suggested targets.

*Note that for wind energy the technical potential does not include the constraints imposed by what might be considered acceptable on landscape and visual grounds. This important criterion has been considered for the proposed targets (for further information please see wind energy methodology in Appendix 1).

The renewable energy and low carbon technologies assessed were:

- 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;
- ground source heat pumps (GSHP) – 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.

5.1.1 Summary of Technical Potential

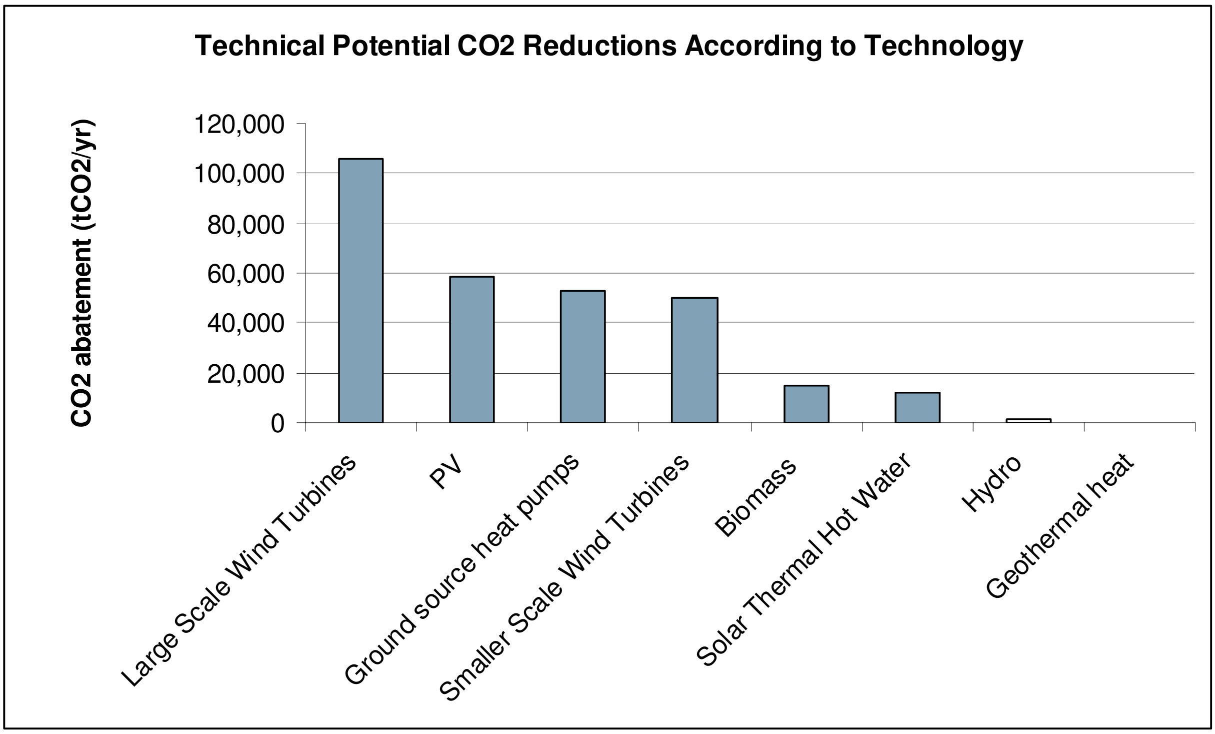
The methodology for calculating the technical potential for each of the above is provided in Appendix 1. Applying this methodology produces the following results. The results are given as both the energy capacity (MW either electricity or heat) and as power generated (MWh again for electricity and heat). For completeness the associated CO_2 reduction is given. This reduction represents the change in CO_2 produced compared with the current mix of fossil energy production.

Table 1 Technical Potential

Technology	Technical Capacity		Potential Energy Generation		Potential CO_2 reductions[4]
	Electricity (MW_e)	*Heat (MW_{th})*	*Electricity (MWh)*	*Heat (MWh)*	*tCO_2/yr*
Large Scale Wind Turbines	112.500		246,375		105,941
Smaller Scale Wind Turbines	66.450		116,420		50,061
PV	187.065		135,932		58,451
Hydro	0.390		3,077		1,323
Biomass	1.539	21.620	12,308	60,230	14,929
Solar Thermal Hot Water		93.911		63,540	11,755
Geothermal heat		0.050		150	28
Ground source heat pumps	-122.103	427.361	-244,206	854,722	53,115
Totals	245.8	542.9	269,906	978,642	295,603

If all of the technical potential shown in the table above was to be realised it would constitute almost half of the current domestic carbon dioxide emission from B&NES.

Figure 1 Technical Potential CO_2 Reductions According to Technology



[4] *For consistency with the B&NES energy demand and CO_2 emissions calculation the DEFRA long term marginal carbon factor of 0.43 tonnes per MWh for electricity has been used along with 0.185 tonnes per MWh for natural gas and 0.025 for biomass. Note that it would also have been acceptable to use the factors used in the Building Regulations Standard Assessment Procedure (SAP) of - 0.568 for renewable electricity, -0.194 for renewable heat, 0.422 for brown electricity. Defra also provides the option of using 0 for biomass heating or CHP.*

5.2 Target Potential

Definition of Target Potential

For the purpose of this project, Target Potential means the amount of renewable energy that can be generated once market conditions, landscape and visual considerations have been taken into consideration, 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, landscape and visual considerations can be highly subjective and again the local value ascribed to the landscape can change over time.

An aspirational 'target potential' has been calculated for 2010 and 2020 in line with the RSS's target time frames, using assumptions based on Camco's professional judgement and the latest predictive research available for renewable energy (where possible). The assumptions for each technology are outlined in Appendix 1.

5.2.1 Summary of Target Potential

New building developments within B&NES will greatly influence the uptake of renewable energy and it is easier for planning policies to influence uptake in new property than existing buildings. This means that the certainty of the uptake of renewable energy within new developments is greater, driven, as it is, by policy requirements, than the certainty that can be ascribed to retro fitting renewable technologies to the existing building stock. However, because of the carbon emissions that currently (and will continue into the future) come from the existing building stock, it is essential that renewable energy opportunities are realised for both technologies integrated into buildings and larger scale "free standing" technologies. If B&NES is to achieve widespread and deep cuts in carbon emissions both new and existing buildings will need to remain a joint focus for carbon emission cuts.

In order that the new developments can be taken fully into account, a target for 2026 has been calculated, when the new developments are due for completion. The target for 2020 has been determined on the assumption that 54% of the new build will have been achieved by 2020, with the larger developments starting construction by the beginning of 2014.

The table below gives the full detail of each technology for 2010, 2020 and 2026. In summary the carbon dioxide reduction achieved by introducing all of these technologies by 2026 equates to some 17% of the expected domestic carbon dioxide emissions for that date (excluding transport)

Table 2 Target Potential

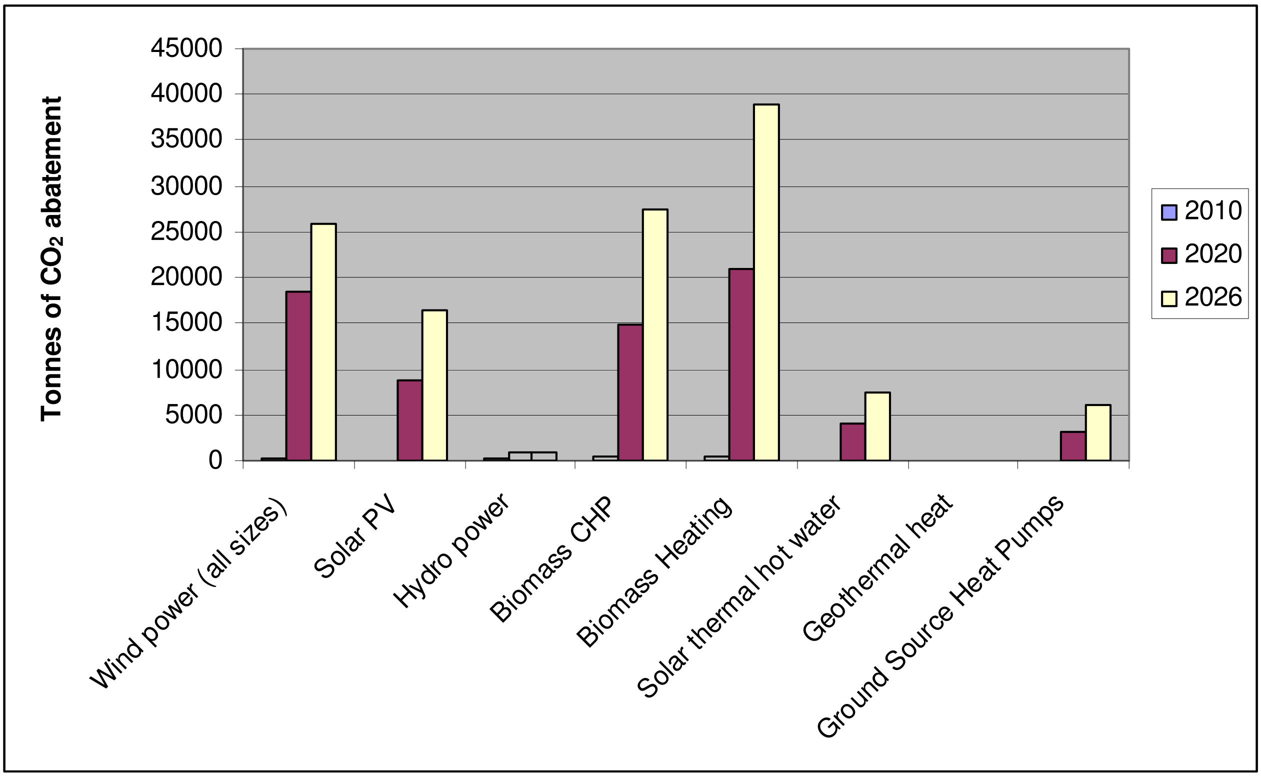
	2008	2010	2020	2026
Wind power (all sizes)				
Capacity - Electricity (MW_e)	0.0	0.4	25.4	27.9
Energy - Electricity (MWh_e)		657	42,983	60,398
CO_2e abatement (tCO_2 per year)		283	18,483	25,971
Solar PV				
Capacity - Electricity (MW_e)	0.0	0.012	33.9	58.7
Energy - Electricity (MWh_e)		8.5	24,635	42,646
CO_2e abatement (tCO_2 per year)		3.7	10,593	18,338

	2008	2010	2020	2026
Hydro power				
Capacity - Electricity (MW_e)	0.0	0.1	0.2	0.2
Energy - Electricity (MWh_e)		499	1,846	1,846
CO_2e abatement (tCO_2 per year)		215	794	794
Biomass CHP				
Capacity - Electricity (MW_e)		0	3.5	6.4
Capacity - Heat (MW_{th})	0.000	0	5.6	10
Energy - Electricity (MWh_e)		0	17,347	32,123
Energy - Heat Actual (MWh_{th})		0	27,755	51,397
CO_2e abatement (tCO_2 per year)		0	10.725	19,862
Biomass Heating				
Capacity - Heat (MW_{th})	0.000	1.223	41.1	76
Energy - Heat (MWh_{th})		2,445	90,095	166,843
CO_2e abatement (tCO_2 per year)		452	16.668	30,866
Solar thermal hot water				
Capacity - Heat (MW_{th})	0.0105	0.4	28.2	52.2
Energy - Heat (MWh_{th})		301	20,016	37,067
CO_2e abatement (tCO_2 per year)		56	3,703	6,857
Geothermal heat				
Capacity - Heat (MW_{th})	0.050	0.10	0.10	0.10
Energy - Heat (MWh_{th})	300	300	300	300
CO_2e abatement (tCO_2 per year)	56	56	56	56
Ground Source Heat Pumps				
Capacity - Electricity (MW_e)		-0.1	-7.3	-14
Capacity - Heat (MW_{th})	0.0105	0.3	25.7	48
Energy - Electricity (MWh_e)		-143	-14,698	-27,481
Energy - Heat (MWh_{th})		500	51,442	96,185
CO_2e abatement (tCO_2 per year)		31	3,197	5,977
Total Renewable Energy				
Capacity - Electricity (MW_e)	0.000	0.38	56	80
Capacity - Heat (MW_{th})	0.07	2.04	101	186
Energy - Electricity (MWh_e)	0	1,022	72,114	109,795
CO2e abatement from renewable electricity (tCO2 per year)	0	439	31,009	47,212
Energy - Heat (MWh_{th})	300	3,563	161,853	299,473
CO2e abatement from renewable heat (tCO2 per year)	56	659	29,943	55,403

The figure below show the potential CO_2 reductions that could be achieved from renewable energy technologies compared with the emissions for fossil fuel generated energy – calculations based on DEFRA's carbon factors of 0.43 for electricity and 0.185 for natural gas. Although targets in the

SW Draft RSS are not expressed in CO_2, Camco has calculated them to enable a comparison of the effectiveness of each technology, independently of whether it generates electricity or heat.

Figure 2 Graph showing potential contribution to CO_2 abatement per annum from renewable energy technologies in 2010, 2020 and 2026 in B&NES



5.2.2 How does this compare with regional targets?

A B&NES target of $0.38MW_e$ for electricity capacity and $2MWt_h$ of heat by 2010 will not make a significant contribution to the Former Avon and South West targets and is certainly not proportional to the population figures. This is partially due to the fact that B&NES is building from a very low starting point of renewable energy deployment in 2008 with only a few solar thermal hot water and PV installations in the B&NES-wide area and very localised use of the geothermal hot springs in the centre of Bath.

However, by 2020 it is possible that B&NES targets could make a significant contribution to the Former Avon and SW Targets depending on the supporting mechanisms that are put in place to turn the proposed potential into reality.

Table 3 Comparison between potential B&NES targets and the Former Avon and South West targets

	B&NES Potential Targets	South West Targets
Electricity 2010 Target Capacity	0.38 MWe	509 MWe
Electricity 2020 Target Capacity	56 MWe	850 MWe
Electricity 2026 Target Capacity	80 MWe	
Heat 2010 Target Capacity	2.0 MWth	100 MWth
Heat 2020 Target Capacity	101 MWth	500 MWth
Heat 2026 Target Capacity	186 MWth	

5.2.3 What would the suggested target require in B&NES for 2010?

The suggested targets are based on scenarios that make certain assumptions about the development of each technology. Some of these assumptions are very specific, resulting from detailed analysis e.g. the GIS analysis of the wind energy potential, other assumptions are broader based. The table below shows the type of actions and assumptions that are needed to achieve the suggested targets for 2010. These are indicative, showing how the targets might be achieved**.**

Technology	**2010 target**
Wind turbines – large scale	Zero large turbines as they can take a significant time to develop (often over three years).
Wind turbines – small scale	Five small turbines of average 75kW capacity.
Biomass	5% of the current dry wood chip biomass resource to be utilized and 5% of the annual organic resource to be converted to biogas using AD technology.
Hydro	One micro-hydro power project to have been developed with a capacity of 60kW
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.
Solar thermal hot water	Assumes a 0.5% uptake on building stock roof tops. This is 248 systems equalling 0.5MW. 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 EST programme targeting owner-occupiers.
GSHP	Assumes an uptake of 50 x 5kW systems in the next two years. Bath's first GSHP has recently received permission to progress after consulting B&NES council with regard to the Avon Act. The Low Carbon Buildings Programme and new EST existing homes initiative should also assist uptake.
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.

5.2.4 What would the suggest target require in B&NES for 2020?

The table below outlines the actions that are likely to be required to achieve the suggested target for 2020. Again these are indicative, showing how the targets can be achieved.

Technology	**2020 target**
Wind turbines – large scale	Up to 9-10 large turbines
Wind turbines – small scale	Up to 10 smaller turbines
Biomass	Would require 117,850MWh of biomass resource for potential demand from new and existing build. B&NES current biomass resource is 98,200MWh.

Technology	2020 target
	In other words to supply the demand within B&NES the resource would need to be augmented by fuel from outside the district double. 5% biomass heating uptake on existing stock. Remainder from new development demand.
Hydro	Approximately 3 hydro sites (and 60% of the technical hydro capacity) would need developing. 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 may also be boosted if PV fields and PV façade cladding become more financially viable prior to 2020.
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.
GSHP	5% uptake on existing stock and a similar level of uptake in the new developments. The target suggested for GSHP are fairly low as: • existing buildings would need to change for existing heat distribution systems to either larger radiators or underground heating • it is competing with biomass heating • it requires electricity to operate.
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.

Wind energy, biomass and waste potential are discussed further below and the methodologies and assumptions for all technologies are provided in Appendix 1.

5.2.5 Wind Energy Assessment

5.2.5.1 Large Scale Wind Turbines

Following GIS constraints mapping, potential sites were identified for 45 large wind turbines – this is the ‘technical potential’.

However, this number of turbines is not likely to be acceptable on landscape and visual grounds and following a high level landscape review, which took the Landscape Character Area and cumulative impact into account, at least 50% of this potential was identified as not likely to be acceptable. Obviously it is not possible to conduct an in-depth landscape and visual assessment for every potential site identified through this study, but such assessments would be required for any planning application for a large wind turbine. Such detailed studies on a site by site basis might further erode the potential sites suitable for wind turbines.

A further review of the most economically viable sites that would most likely attract wind energy development narrowed the maximum target figure to 15 large wind turbines. This does not in any way mean that B&NES Council endorses these sites and suitable environmental assessments and a planning application would be required before the development of any wind turbines. However the analysis does provide a good indication of the scale of development that could be undertaken and the consequential CO_2 reduction opportunities

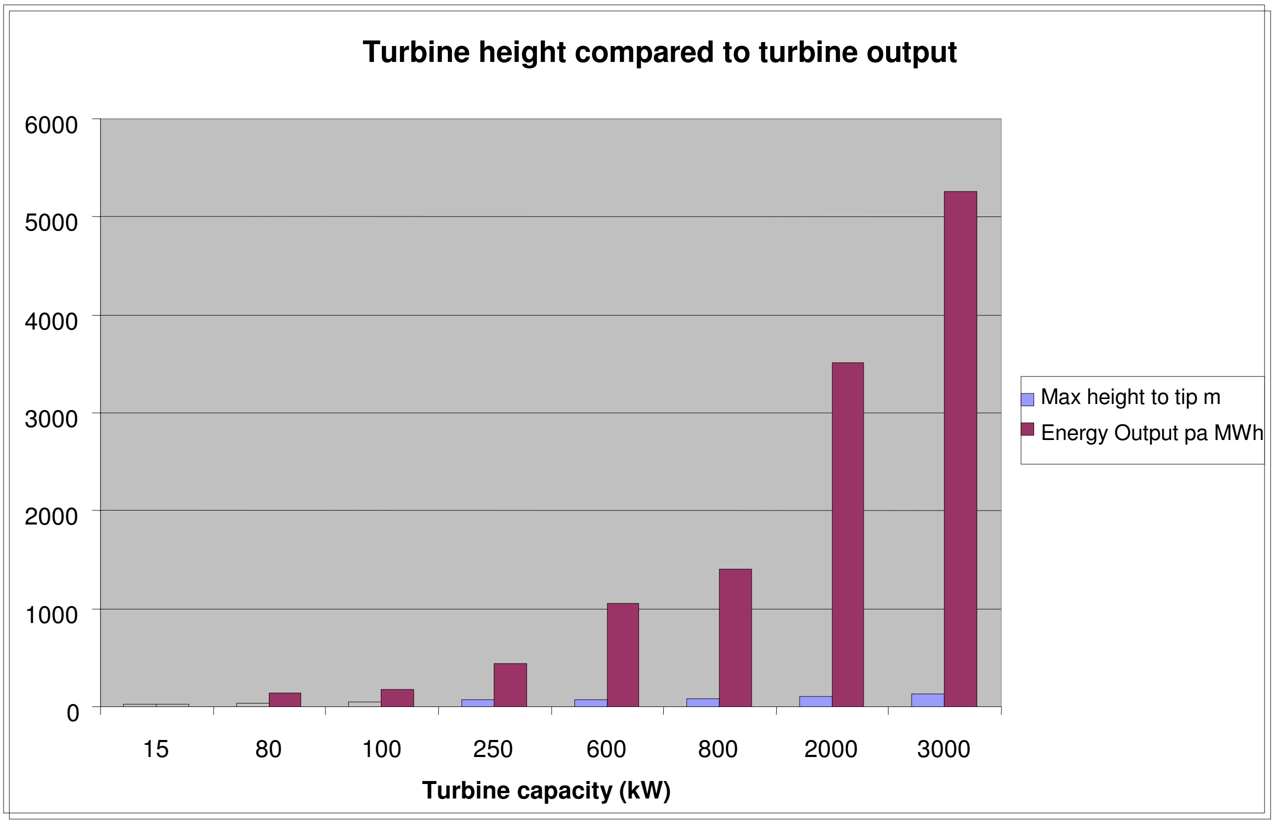
Table 4 Potential for large scale wind turbines

Technical Potential		Target Potential 2010		Target Potential 2020		Target Potential 2026	
Number of turbines	Capacity (MWe)	Number of turbines	Capacity (MWe)	Number of turbines	Capacity (MWe)	Number of turbines	Capacity (MWe)
45 large turbines	112.5	0	0	10 large turbines	30	11 large turbines	37.5

5.2.5.2 Smaller Scale Wind Turbines

One of the reasons larger scale wind turbines are preferred to smaller scale (and hence the relatively low target for smaller scale) is that proportionally to their height, large turbines generate far greater energy and hence increased CO_2 savings. An 80kW turbine standing at 40m to tip will still look fairly big but will only generate 4% of the energy of a 2MW (2000kW) turbine standing at 100m to tip. Hence it is usually considered preferable, on visual grounds, to have a small number of larger turbines than a large number of smaller turbines to meet the targets.

Figure 3 Impact of Turbine height on energy output

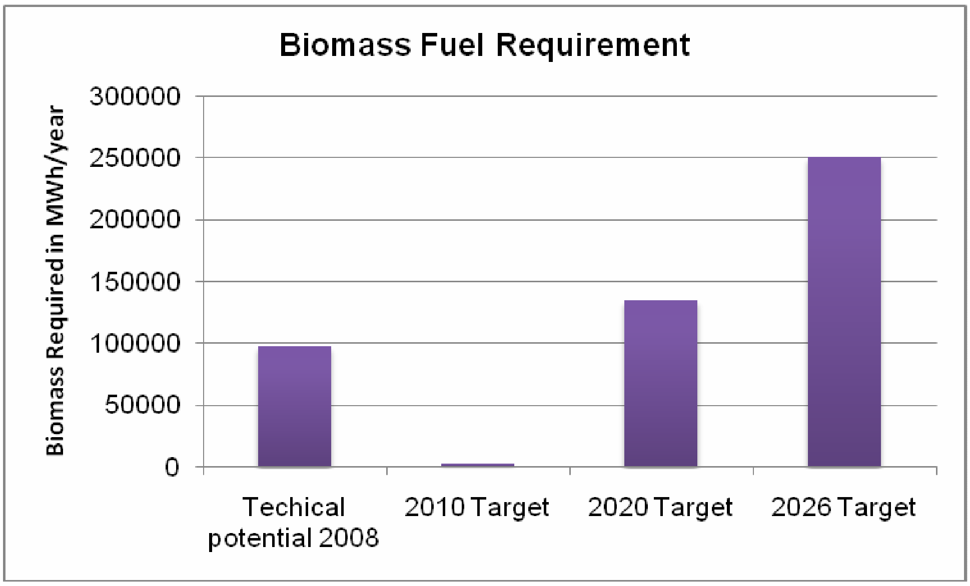


5.2.6 Biomass and Waste

A comparison between the current technical potential for biomass within B&NES and the future demand required to achieve requirements of new development and district wide renewable energy targets is shown in the figure below. These biomass resources are expressed in MWh of fuel. The potential is shown in terms of fuel supply because this is likely to be the limiting factor to the development of biomass energy generation.

The first column represents the estimated technical potential based on this resource assessment. The second column shows the target potential by 2010. The third and fourth columns show the target potential for 2020 and 2026, and the sectors to which this potential is expected to go.

Figure 4 Biomass resource requirements to meet potential demand in 2020 and 2026



The current technical potential for biomass in Bath is estimated at 98,000 MWh of fuel. This fuel is expected to come largely in the form of either dry chip or digestible sludge for anaerobic digestion. There are also smaller amounts of material available for municipal solid waste plant, and straw, off cuts and wet chip available for small CHP or heat systems. There is no resource currently identified for producing pellets for the domestic market. The materials making up the seven different fuel supply markets are shown below.

Table 5 Biomass fuel supply markets

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

Market	System size	Resource (ODT equivalent)	Sources considered
			contaminated waste wood.
Total		**19,646**	

By 2020 an estimated 135,000MWh of fuel will be needed to meet the renewable energy demand within B&NES. This further increases to 250,000MWh, by 2026.

This means that based on the current resource potential calculations, B&NES would fall short of supplying the biomass fuel, from within the district, required for 2026. In order to meet the renewable energy targets B&NES would therefore need to either, more than double the biomass fuel production within the local authority area above the current estimates, or import fuel from the open market. The local authority is well placed to initiate with partners a drive toward fuel supply chain development. There are good examples across the UK where local authorities, or regional agencies, have facilitated these developments e.g. Worcester, Barnsley and Bristol amongst others.

The existing stock and urban in-fill make up most of this demand, the majority of which will be in the form of small biomass heating systems requiring either pellets or well specified dry chip for fuel.

6 New Developments

6.1 What is required of B&NES?

The Draft South West Regional Spatial Strategy (Draft RSS) requires 15,500 new homes and associated mixed use non-residential development within B&NES by 2026.

The Draft RSS expects local planning authorities to set local targets in their Development Plan Documents for the energy to be used in new development to come from decentralised and renewable or low-carbon energy sources where it is viable. The targets developed must have a clear rationale and should be ambitious where feasible and viable. They must also be consistent with meeting the community's needs for economic and housing development.

The supplement to Planning Policy Statement 1 'Planning and Climate Change' helps to support the achievement of zero carbon homes through the planning system. It 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.

While DPDs are being put in place RE5 sets out interim targets to be applicable for certain types and sizes of new development where feasible and viable. Local planning authorities in applying the interim target should not be prescriptive on technologies and be flexible in how carbon savings from local energy supplies are to be secured.

6.2 Timescales for housing growth

B&NES Planning Policy Department estimates that the bulk of new development will not commence before end of 2013 as the large Urban Extensions in particular will take a number of years to design and be processed through the planning system.

However, a number of projects will commence before this time, including the Bath Western Riverside project of 2,500 homes which has already gained planning consent and so further sustainable energy requirements are not applicable. It is also likely that other Urban Brownfield developments may start prior to 2013.

All 15,500 homes plus associated non-residential buildings are due for completion by 2026.

Thus an assumption has been made that 30% of the new build will have been completed by 2016 and that 54% will be completed by 2020. – these assumptions were made before the current deep slow down in the new build housing market.

6.3 Methodology

It is necessary for B&NES to clearly demonstrate local circumstances that would warrant and allow B&NES to establish higher than national standards for new development. The Draft RSS Proposed Changes were published by the Government in July 2008. The increased growth agenda i.e. housing and employment requirements in the Proposed Changes will have an effect on the renewable energy targets, however, the final number is not confirmed yet, and it was agreed that this research takes the Draft RSS housing allocation as a baseline for analysis. Once the RSS requirements are agreed, an addendum report will be published separately.

The following approach has been adopted:

- The new development in B&NES has been split into the following specific and generic sites:
  - Bath Urban brownfield development - small scale (below 500 units on each site): total of 3,500 dwellings
  - Bath Urban brownfield development – larger scale (500 units and above on each site): total of 2,500 dwellings

- Bristol Urban Extension: 6,000 dwellings and associated non-residential buildings
- Bath Urban Extension: 1,500 dwellings and associated non-residential buildings
- Keynsham brownfield development - small scale (below 500 units on each site): total of 700 dwellings
- Norton Radstock brownfield development - small scale (below 500 units on each site): total of 600 dwellings
- Rural - small scale (below 500 units on each site): total of 700 dwellings

- The characteristics and building mix of each development has been determined based on a "standard" B&NES profile. The expected electricity and heat demand was then calculated as if they were built to today's Building Regulation Standards. This has been determined using benchmarks for different building types[5].
- An assumption has been made for the reduction in energy demand associated with energy efficiency measures of 20% reduction in heat and 20% reduction in electricity[6].
- A scenario for the most likely mix of renewable energy technologies to achieve zero carbon for each development type has been applied. This scenario is based on the most likely choice for each development based on current technology and costs and the availability of renewable resources at each location; however at design phase each developer will need to produce their own Sustainable Energy Strategy and choose the best means available at the time to achieve targets.
- The cost of the sustainable energy scenario for each development has been calculated with today's capital costs, electricity and heat tariffs and biomass fuel prices so that a figure for both capital costs and Net Present Value (NPV) is given. The NPV assumes that Renewable Obligation Certificates must be retired and a discount rate of 3.5% has been applied.
- The additional cost to the development has then been determined by assuming the development will have to pay all the capital costs of the energy efficiency measures, building integrated technologies (PV, STHW, GSHP) and communal infrastructure (heat networks, additional cabling). For communal systems that require an Energy Services Company (ESCo) to maintain and operate it is assumed that the development would have to bear upfront the cost of any systems with negative NPV plus 20% of the capital costs (i.e. it assumes that the ESCo would contribute to its capital cost as long as they receive a 20% return on their investment over the lifetime of the system). For communal systems that are likely to have a positive NPV, such as wind energy, it is assumed that the development would not bear any costs towards it, i.e. an ESCo would pay all capital costs and take all profit.
- Sensitivity analysis has been conducted to test the impact on costs of achieving zero carbon of firstly using the maximum amount of wind energy that is potentially viable within an approximate 3km radius of the development search area, and secondly if no wind energy were available to the development.
- The domestic buildings have then been singled out to test the impact on costs of achieving the different energy requirements of levels 3-6 of the Code for Sustainable Homes in order to test out the possibility of applying higher standards in advance of national requirements.
- A financial viability model has been developed for B&NES council use, so that the viability of achieving set targets for each development can be tested more accurately during developer negotiations. It requires accurate development costs, which should be obtained from the developer at the time, an update of energy systems costs and an update of market sales prices and land value. The objective of the model is to provide B&NES with a tool to

[5] *Benchmark's from CIBSE, Carbon Trust, London Renewable's Toolkit and The Energy Savings Trust. The building mix for Urban Extensions has been based on B&NES 'Land Use Budgets 0208'.*
[6] *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.*

help base policy decisions, with the onus on the developer to prove if and why they cannot meet certain targets.

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Table 6 Characteristics of the different development sites in B&NES

	Bath Urban brownfield - small scale	Bath Urban brownfield - larger scale	Bristol Urban Extension	Bath Urban Extension	The rest of the district- Urban brownfield and Rural developments
Characteristics	Small numbers of typically around 50-150 housing units, but up to 499 units, dotted around the urban environment – few other building types. High density.	Urban brownfield over 500 units. High density.	Finished urban extension as of 2026. Large urban extension with a good mix of public buildings and employment uses.	Finished urban extension as of 2026. Medium scale urban extension with a good mix of public buildings and employment uses.	Small numbers of typically around 50-150 housing units, but up to 499 units, dotted around the urban environment – few other building types. High density.
No. of dwellings	3,500	2,500	6,000	1,500	2,000
Area of non-residential (ground area m2)			98,541	24,635	
BAU Energy requirement - electricity (MWh_e)	17,973	12,838	43,197	10,798	10,270
BAU Energy requirement - heating (MWh_{th})	27,391	19,565	71,994	17,998	15,652
% of above emissions attributable to non-domestic	0%	0%	32%	32%	0%
BAU CO_2 emissions	14,307	10,219	35,887	8,972	8,175
CO_2 emissions (according to proposed changes to Building Regulations 2013 and	1,624	1,160	3,569	915	928

	Bath Urban brownfield - small scale	Bath Urban brownfield - larger scale	Bristol Urban Extension	Bath Urban Extension	The rest of the district- Urban brownfield and Rural developments
2016)					

BAU = Business as Usual. In this case it means if all new development is built to Building Regulations 2006 standards.

6.3.1 Base case scenario for achieving zero carbon

This scenario is based on the most likely choice for each development based on current technology and costs and the availability of renewable resources at each location.

6.3.1.1 Electricity sources in order of preference:

1. Energy efficiency. Inputting energy efficiency measures into the Building Regulation's standard assessment procedure (SAP) calculation actually increases the requirement for electricity by 4% (whilst decreasing the heat requirement by 20%) NB the increase in electricity arises from the need for control systems and technical solutions such whole house heat exchangers. However, it is assumed that through energy efficient appliances and occupant behaviour the demand will drop especially if electricity prices continue to rise; therefore this scenario uses a 20% reduction in demand.
2. Wind and hydro energy. Wind and hydro are likely to be a developer's electricity generation of choice where ever possible as they are currently more cost effective than other renewable electricity technologies. B&NES does not have a significant hydro power resource and so developers are likely to look to wind wherever possible. Under the current definition of zero carbon in Code for Sustainable Homes, the wind and hydro turbines would need to be connected to a private wire for the development. Thus potential wind and hydro sites within approximately 3km from the proposed Urban Extensions have been considered; this proximity also means that the development have a sense of ownership of any wind turbines and can see where their electricity is coming from.
3. Biomass CHP. Electricity from biomass CHP will be the next preferred option to meet the electricity demand of the development. The scenario assumes the CHP is operated to follow heat demand in order that heat is not wasted, and that likely operational hours are 5000 hours per year.
4. Solar PV. If the full potential from wind, hydro and biomass CHP cannot meet the annual electricity demand, the developer is most likely to choose PV to supply the remainder of the electricity. This scenario uses 2008 prices, which mean PV is the least cost effective and therefore the last choice to generate electricity. However, in future if PV prices fall significantly (with the advent of printable third generation PV technologies becoming mass produced), PV may become far from last choice especially considering it is easy to operate and maintain.

6.3.1.2 Heating sources in order of preference:

1. Energy efficiency. SAP methodology calculates that 20% reduction in heating demand is easily achievable through improved building fabric measures (improved U values and air tightness over Building Regulations 2006 standards). It is possible to reduce demand further by applying standards such as those for 'Passivhaus' but for this scenario 20% has been used.
2. Communal Infrastructure. In order to achieve zero carbon, a heat distribution network is likely to be the developers' preferred option because without one the development will find it extremely hard to achieve zero carbon as biomass CHP would not be an option and either GSHP or individual biomass heating would be required. Communal systems would

require an Energy Services Company (ESCo) to operate and the developer would likely try to finance some of the capital costs with the help of ESCo finance (private or public) as the heat distribution network is likely to be one of the most significant upfront costs for a development's sustainable energy strategy.

3. Biomass/biogas CHP. Because this scenario assumes wind energy is the preferred means to generate electricity over biomass/biogas CHP, it is assumed that biomass/biogas CHP will only be used to generate the shortfall in electricity requirements and biomass heat rather than biomass CHP will be used to provide sufficient heat load. If however, there is no wind energy, or insufficient to mean that the maximum heat potential of CHP could be used (assuming a1.6:1 heat:electricity ratio), the scenario assumes that CHP would be able to provide all but 9% of the heat load. This is based on the fact that if the CHP is run for 5000 hours per year, there still remains 43% of the year when there is hot water demand – if hot water demand represents 20% of the overall heating demand there remains 9% of the heat demand that CHP would not be able to fulfill.
4. Biomass communal heating. It is assumed that once sufficient electricity is produced for the development from wind and biomass/biogas CHP, that the preferred choice for the remainder of the heat load would be supplied by communal biomass heating. In reality the ESCo may wish to run a CHP to maximum and sell surplus electricity, over and above the requirement for the development, to the main grid in order to obtain the double ROCs for it. However, this scenario assumes considers meeting the requirement of the development only.
5. For sites that are not suited to communal systems, the remainder of heating would need to come from either individual biomass boilers or from GSHP. It is assumed that biomass heating would be the preferred choice as it does not require electricity to operate.
6. There will be situations the above options might not be practicable and an assumption has been made that GSHP will be utilised at 5% of their technical potential on small scale urban brownfield developments, 2% of technical potential on larger scale urban brownfield developments and 30% of the non-residential technical potential for urban extensions (this assumes some businesses will want or need to operate their own systems and that many would prefer the ease of GSHP over biomass heating).

6.4 Technical Feasibility

It is technically feasible for all the developments, apart from the small scale urban and rural small scale, to achieve zero carbon status, i.e. reduce the net CO_2 emissions over the course of the year, resulting from all energy consumption within the buildings, to zero by using renewable energy on or near the site.

Camco believe that with current technology the average small scale Bath urban brownfield developments, often consisting of high density flats, will struggle to achieve 60% CO_2 reductions unless it 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 brownfield developments it may not be technically feasible.

However the less dense urban brownfield developments in Keynsham and Norton Radstock, as well as the rural developments can achieve a higher level of CO_2 reduction but are still likely to fall short of the 100% reduction.

For larger Urban brownfield developments over 500 dwellings, the chances of achieving zero carbon are greater if biomass/biogas CHP can be used. Without biomass/biogas CHP the larger Urban developments will also find it very difficult to achieve zero carbon due to insufficient potential to generate renewable electricity.

The Urban Extensions are more easily able to achieve zero carbon using a range of renewable technologies and communal heat networks, with the majority of electricity provided by wind energy, biomass/biogas CHP and PV.

Table 7 Potential technology mix for achieving zero carbon (and 58% of total CO_2 reductions in the case of small scale Urban brownfield) for the different developments

	Bath Urban Brownfield - small scale	Bath Urban Brownfield - larger scale	Bristol Urban Extension	Keynsham Brownfield Small Scale	Bath Urban Extension	Norton Radstock Brownfield Small Scale	Rural Small Scale
% of development's energy requirements:							
Energy efficiency % of heat	**-20%**	**-20%**	**-20%**	**-20%**	**-20%**	**-20%**	**-20%**
Energy efficiency % of electricity	**-20%**	**-20%**	**-20%**	**-20%**	**-20%**	**-20%**	**-20%**
After energy efficiency savings are deducted, renewable energy % reductions are as follows:							
Wind % of electricity	0.0%	0.0%	31.7%	0.0%	126.8%	0.0%	0.0%
PV % of electricity	35.4%	14.3%	2.4%	103.5%	0.0%	103.5%	103.5%
Hydro % of electricity	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Biomass CHP % of electricity	0.0%	87.1%	67.1%	0.0%	0.0%	0.0%	0.0%
Biomass CHP % of heat	0.0%	91.4%	64.4%	0.0%	0.0%	0.0%	0.0%
Biomass heating % of heat	43.2%	0.0%	27.1%	41.4%	2.6%	8.0%	8.0%
STHW % of heat	-3.5%	-1.4%	-1.2%	-3.5%	-1.2%	-3.5%	-3.5%
Geothermal % of heat	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
GSHP % of heat	8.0%	3.2%	2.6%	8.0%	2.6%	8.0%	8.0%
GSHP % of electricity	-3.5%	-1.4%	-1.2%	-3.5%	-1.2%	-3.5%	-3.5%
Total % of electricity	31.9%	100.0%	100%	100%	126%	100%	100%
Total % of heat	56.8%	100.0%	100%	59%	100%	59%	60%
Total % CO2 abatement	58.3%	100.0%	100%	88%	111%	88%	89%

Base case scenario technology mix for achieving low and zero carbon

NB It is assumed that a reduction in energy use through improved energy efficiency is achieved of 20%. Both STHW and GSHP technologies require electricity to function. It is assumed here that this electricity comes from the national grid and therefore is a "negative" benefit for carbon dioxide – if this electricity is supplied from renewable sources then the "negative" effect will not occur.

6.5 Financial Implications of Achieving Zero Carbon Developments

The cost of the base case sustainable energy scenario for each development has been calculated with today's capital costs, electricity and heat tariffs and biomass fuel prices so that a figure for both capital costs and Net Present Value (NPV)[7] is given.

The NPV assumes that Renewable Obligation Certificates must be retired and a discount rate of 3.5% has been applied. A current cost of £75 per oven dried tonne (ODT) for biomass has been used. Clearly the calculations do not take account of detailed site layout and exact development mix etc – once these parameters have been established an exact cost of the development costs to achieve the targets can be ascertained.

The additional cost to the development has then been determined by assuming the development will have to pay all the capital costs of the energy efficiency measures, building integrated technologies (PV, STHW, GSHP) and communal infrastructure (heat networks, additional cabling). For communal systems that require an Energy Services Company (ESCo) to maintain and operate it is assumed that the development would have to bear upfront the cost of any systems with negative NPV plus 20% of the capital costs (i.e. it assumes that the ESCo would contribute to its capital cost as long as they receive a 20% return on their investment over the lifetime of the system). For communal systems that are likely to have a positive NPV, such as wind energy, it is assumed that the development would not bear any costs towards it, i.e. an ESCo would pay all capital costs and take all profit.

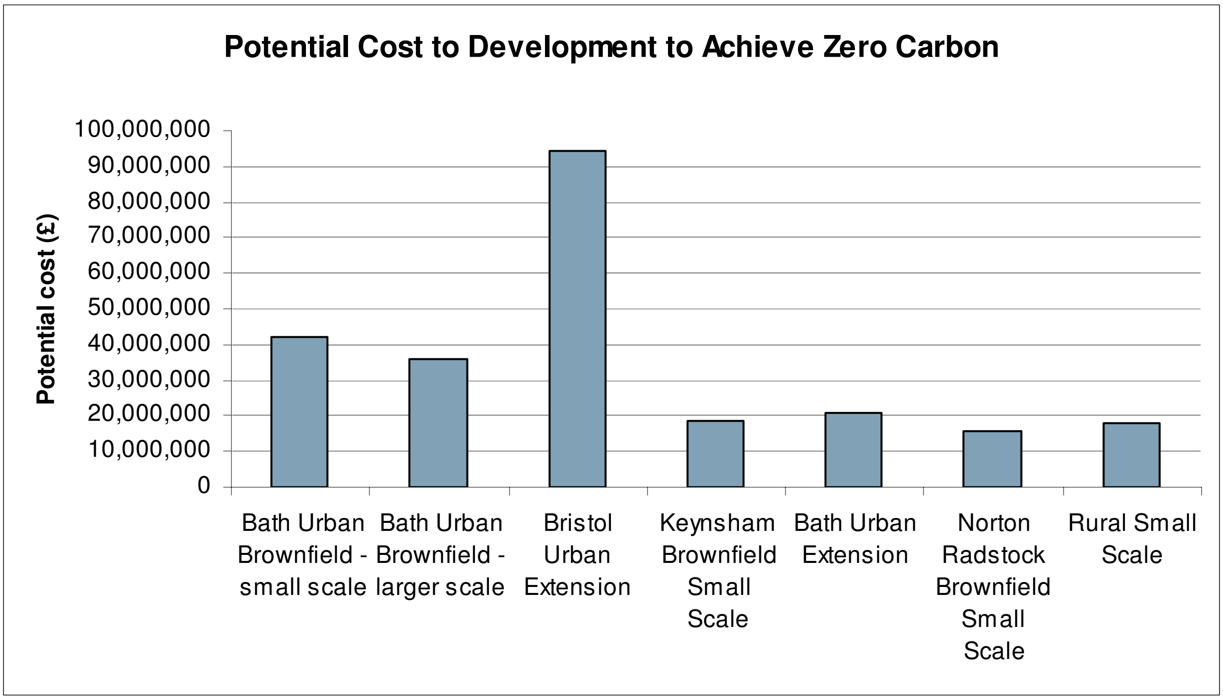
Table 8 Base case scenario financial costs for achieving low and zero carbon

	Bath Urban Brownfield - small scale	**Bath Urban Brownfield - larger scale**	**Bristol Urban Extension**	**Keynsham Brownfield Small Scale**	**Bath Urban Extension**	**Norton Radstock Brownfield Small Scale**	**Rural Small Scale**
Energy efficiency measures / unit	14,910,000	10,650,000	25,560,000	2,982,000	6,390,000	2,556,000	2,982,000
Wind turbines - capital cost	0	0	1,349	0	1,349	0	0
Wind turbines - NPV (lifetime)	0	0	5,750,000	0	5,750,000	0	0
Infrastructure - cabling to private wire network (capital cost)	0	0	5,574,879	0	5,574,879	0	0
PV - capital cost			300,000		300,000		
PV - NPV (lifetime)	24,500,000	7,088,749	4,068,259	14,332,510	0	12,285,008	14,332,510
Hydro turbines -	-17,357,652	-5,022,206	-2,882,262	-10,154,233	0	-8,703,628	-10,154,233

[7] The Net Present Value of a project is a figure which represents the potential profitability of that project. It shows this by calculating the total of future cash inflows from a project, less cash outflows, inflation, and/or a required Rate of Return. It is generally accepted that if the Net Present Value of a project is positive, then it should be carried forward, whereas if it is negative, then it should not.

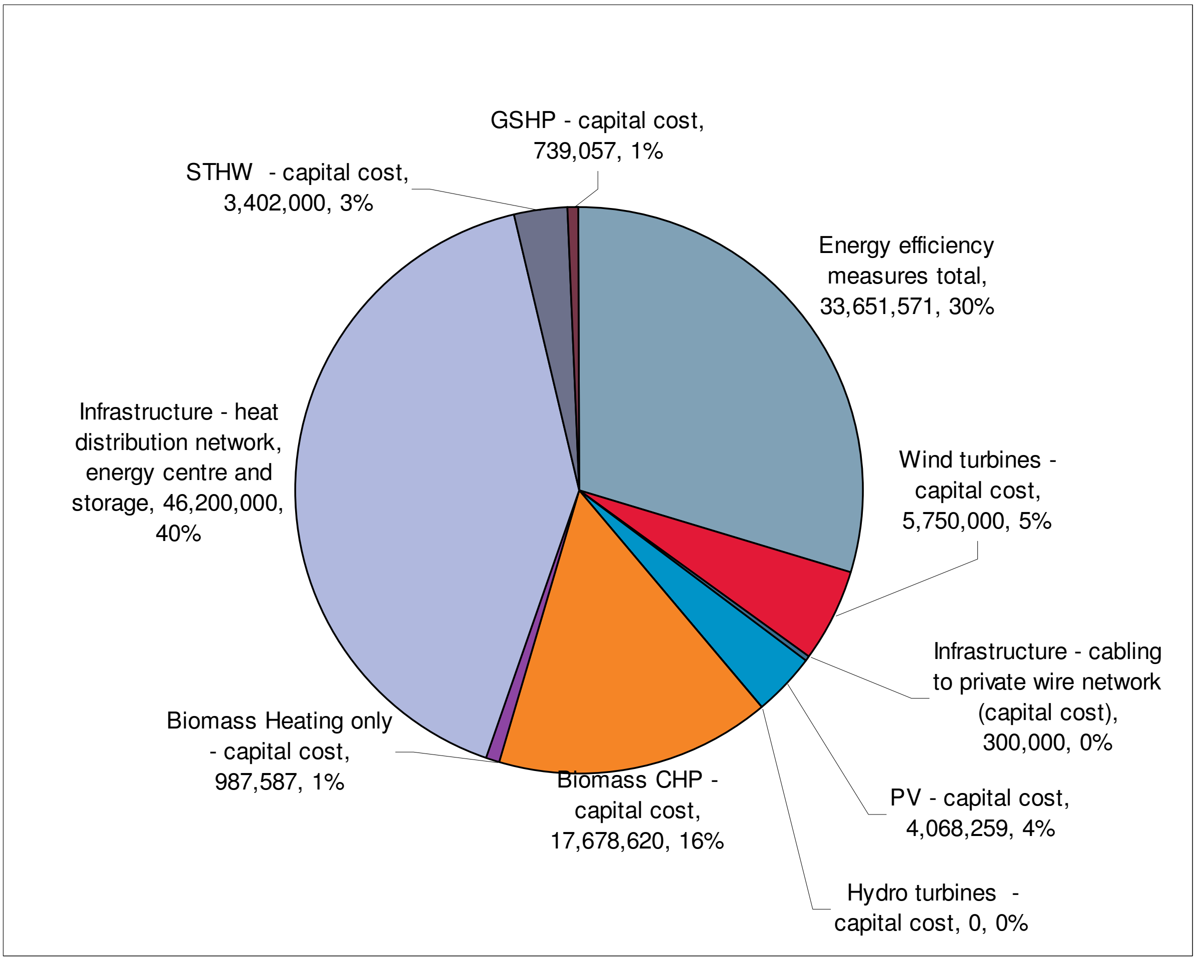
	Bath Urban Brownfield - small scale	Bath Urban Brownfield - larger scale	Bristol Urban Extension	Keynsham Brownfield Small Scale	Bath Urban Extension	Norton Radstock Brownfield Small Scale	Rural Small Scale
capital cost							
Hydro turbines - NPV (lifetime)	0	0	0	0	0	0	0
Biomass CHP - capital cost	0	0	0	0	0	0	0
Biomass CHP - NPV (lifetime)	0	-1,934,680	-5,016,010	0	0	0	0
Biomass Heating only - capital cost	599,250	0	987,587	115,020	834,175	98,588	111,397
Biomass Heating only - NPV (lifetime)	-38,966	0	-64,217	-7,479	-54,242	-6,411	-7,243
Infrastructure - heat distribution network, energy centre and storage		15,083,333	46,200,000		11,550,000		
STHW - capital cost	1,842,750	658,125	3,402,000	793,800	850,500	680,400	510,300
STHW - NPV (lifetime)	-1,247,768	-445,632	-2,303,572	-537,500	-575,893	-460,714	-345,536
Geothermal - capital cost							
Geothermal - NPV (lifetime)							
GSHP - capital cost	875,000	250,000	739,057	175,000	184,764	150,000	175,000
GSHP - NPV (lifetime)	-874,164	-249,761	-738,351	-174,833	-184,588	-149,857	-174,833
Total capital cost	42,727,000	40,548,869	112,777,093	18,398,329	27,882,332	15,769,996	18,111,206
Total NPV	-34,428,550	-33,385,612	-85,581,104	-13,856,045	-15,502,736	-11,876,610	-13,663,845

Figure 5 Potential cost to the development of the base case zero carbon scenario (smaller scale urban brownfield development not included due to current difficulty achieving zero carbon)



The Bristol Urban Extension is used as an example in Figure 6 below to show the breakdown of capital costs. It highlights the very high upfront cost of the communal heat network. The developer is likely to try and gain at least part finance for this from an Energy Services Company (ESCo).

Figure 6: Bristol urban extension - breakdown of capital costs (in £) for the base case scenario



6.5.1 Could any of the developments achieve zero carbon without a communal heat network?

From analysis of the technology mix Camco believe that none of the developments proposed could achieve zero carbon without using a communal heat network even if the likely maximum wind resource were to gain planning permission.

6.5.2 The role of wind energy in achieving zero carbon

The least cost means for the Urban Extensions to achieve zero carbon would be to maximise the amount of wind energy used; thus for Bristol Urban Extension the maximum potential is likely to be 2 large wind turbines and for Bath Urban Extension 2 turbines (no turbines are assumed for Urban Brownfield developments). However, until detailed environmental assessments have been conducted it is not possible to determine which, if any, of the turbines would gain planning permission.

Therefore sensitivity analysis has been conducted to test the impact on costs of achieving zero carbon with and without wind energy. The first case uses the maximum amount of wind energy that is potentially viable within an approximate 3km radius of the development search area. The second case uses no wind energy with the percentage of other technologies increased according to the order of preference described in the base case scenario.

The table below shows that the net present value of achieving zero carbon at the Urban Extensions could decrease by a range of 12 – 37% if wind energy is not utilised. The actual potential cost to the development is slightly less impacted (increased by 8-18%) due to the assumption that the housing developer would most likely contract a wind energy developer to develop, construct and operate any large scale wind turbines and hence the wind energy developer would gain all financial benefit from the turbines.

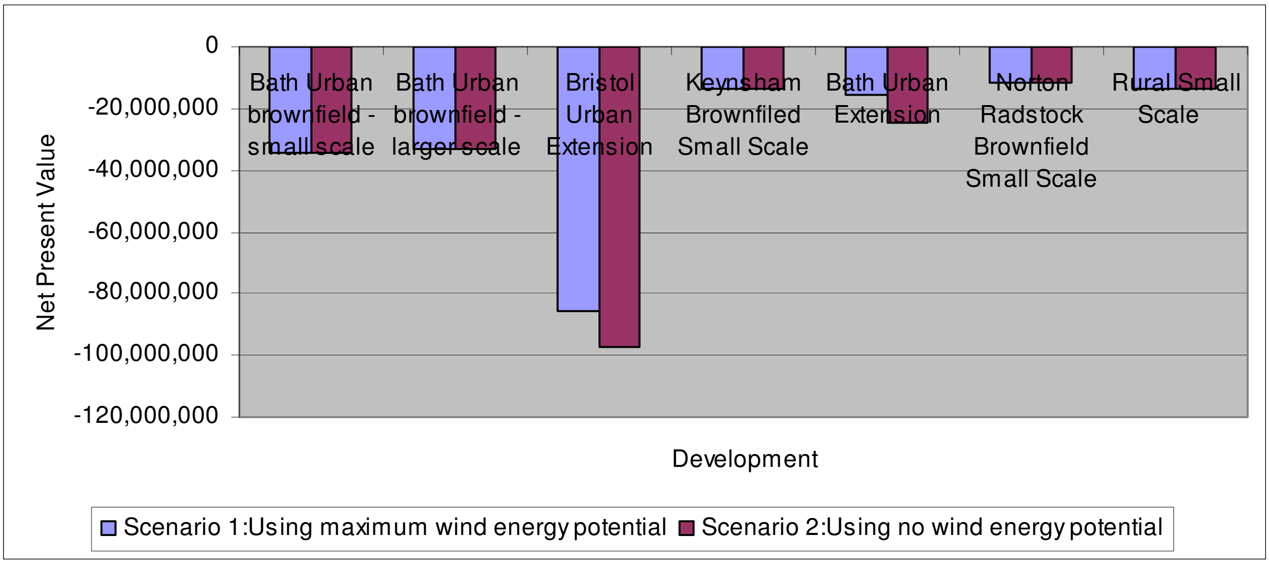
As well as the cost implications to an Urban Extension of not having wind energy it should also be noted that the amount of biomass required will also substantially increase. Effort will be required in B&NES to increase biomass resource without impacting food production to meet the predicted biomass demand even if wind energy is used. The greater the distances that biomass must travel, the less sustainable the development.

Table 9 costs of achieving zero carbon at the developments (58% CO_2 reduction in the case of small scale Urban Brownfield developments)

	Bath Urban brownfield - small scale	**Bath Urban brownfield - larger scale**	**Bristol Urban Extension**	**Keynsham brownfield Small Scale**	**Bath Urban Extension**	**Norton Radstock brownfield Small Scale**	**Rural Small Scale**
Scenario 1: Using maximum wind energy potential							
Capital cost (£)	42,727,000	40,548,869	112,777,093	18,398,329	27,882,332	15,769,996	18,111,206
Total NPV (£)	-34,428,550	-33,385,612	-85,581,104	-13,856,045	-15,502,736	-11,876,610	-13,663,845
Potential Cost to Development to become zero carbon	42,174,509	36,051,824	94,157,159	18,292,284	21,063,247	15,679,101	18,008,502
Scenario 2: Using no wind energy potential							
Capital cost (£)	42,727,000	40,548,869	119,382,499	18,398,329	30,070,625	15,769,996	18,111,206
Total NPV (£)	-34,428,550	-33,385,612	-97,395,086	-13,856,045	-24,573,772	-11,876,610	-13,663,845
Potential Cost to Development to become zero carbon	42,174,509	36,051,824	102,532,338	18,292,284	25,633,085	15,679,101	18,008,502
% increase in NPV	0%	0%	12%	0%	37%	0%	0%
% increase in cost to the Development if wind energy potential not used	0%	0%	8%	0%	18%	0%	0%

The calculation in Table 9 shows that where wind energy can be integrated with a development, eg urban extensions at Bristol and Bath, then there is a lower overall cost for the developments when compared with alternative technology options. It is therefore important to understand, inter alia, the implications on the cost of a low carbon development when considering whether wind turbines are granted planning permission.

Figure 7: Potential net present value of the sustainable energy strategies according to amount of wind energy used (zero carbon strategies for all developments apart from small scale urban brownfield developments, which achieve 58% CO_2 reductions)



6.6 Achieving the Energy Requirements for Code for Sustainable Homes

The impact on cost per dwelling of the energy implications of CSH levels 4 – 6 has been determined as shown below. This has been calculated with and without wind energy.

To calculate the costs for zero carbon it has been assumed that 20% of all CO_2 emissions will be reduced by energy efficiency measures (compared to the emissions that would result if the developments where built to Building Regulations 2006 standards). Costs for these measures are included. To calculate costs for CSH level 5 it has been assumed that 70% of emissions are regulated and that all of the 70% must be reduced. For CSH level 4, 44% of the regulated emissions need reducing.

The additional costs per dwelling has been calculated making the assumption that the costs of achieving zero carbon per m^2 for residential and non-residential are similar and thus the costs for the entire development has been pro-rated to obtain the cost per dwelling. Both the net present value and 'cost to development' are shown.

Table 10 Sensitivity analysis showing additional cost per dwelling for CSH levels 4-6, with and without wind energy

Additional Cost per Dwelling	Bath Urban Brownfield - small scale*	Bath Urban Brownfield - larger scale	Bristol Urban Extension	Keynsham/Norton Radstock Brownfield Small Scale	Bath Urban Extension	Rural Small Scale	Comments
Level 6 potential 'cost to development' – with wind			15,807		14,774		
Level 6 NPV – with wind			-14,264		-10,335	-	
Level 6 potential 'cost to development' - no wind		16,220	18,796		18,588		
Level 6 NPV - no wind		-13354	-14264		-10335		
Level 5 potential 'cost to development' – with wind			10,400		5,700		Bath Urban Extension achieve level 5 without a communal heat network
Level 5 NPV - with wind			-9,600		-3,700		
Level 5 potential 'cost to development' - no wind	*12,044*	13,100	11,000	11,000	11,000	11,000	Communal heat network required to achieve without wind energy
Level 5 NPV - no wind	*-9,832*	-12,400	-10,500	-10,500	-10,500	-10,500	
Level 4 potential 'cost to development' – with wind			4,200		4,200		All developments can achieve this without communal heat network. Urban Extension cost is less due to wind energy.
Level 4 NPV - with wind			-3,600		-2,200		NPV rises substantially due to wind energy
Level 4 potential 'cost to development' - no wind	7,000	7,000	7,000	7,000	7,000	7,000	Approximately 70% of these costs are from energy efficiency measures, the rest from STHW and PV
Level 4 NPV - no wind	-6,000	-6,000	-6,000	-6,000	-6,000	-6,000	

* figures in italics are for small scale urban brownfield developments obtaining 58% of zero carbon and 80% of level 5.

Figure 8: Potential 'cost to development' per dwelling using full wind energy potential

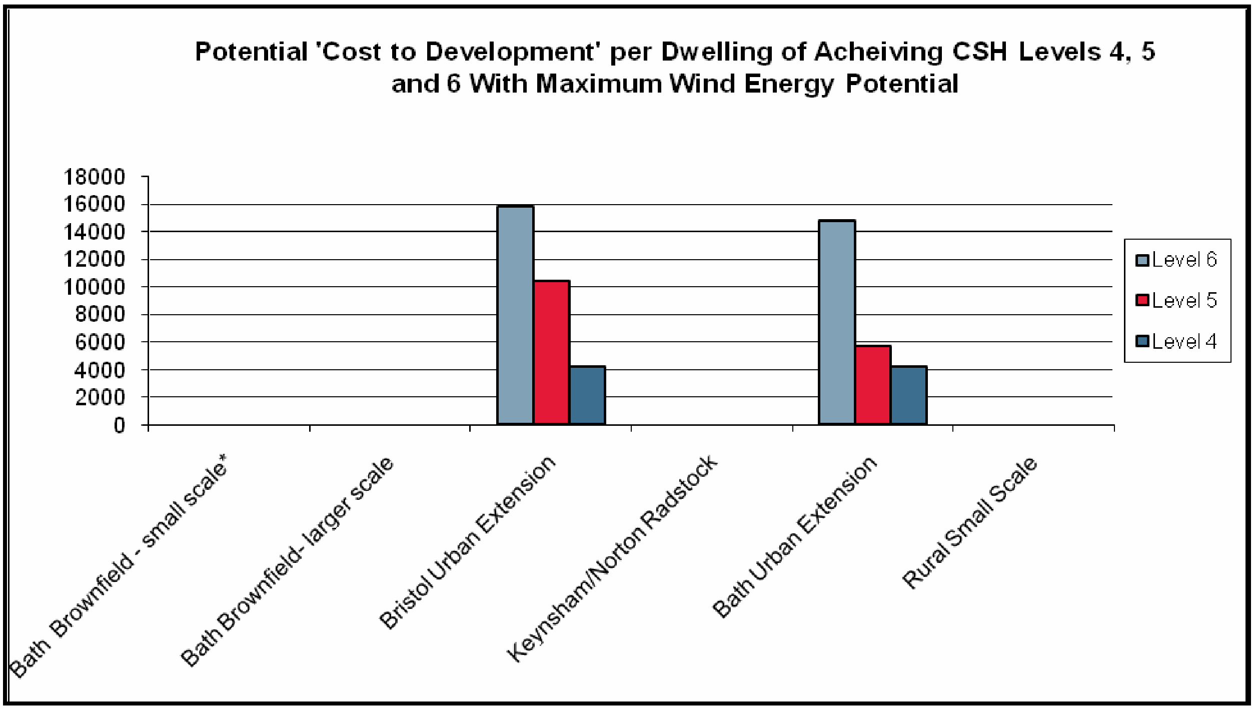
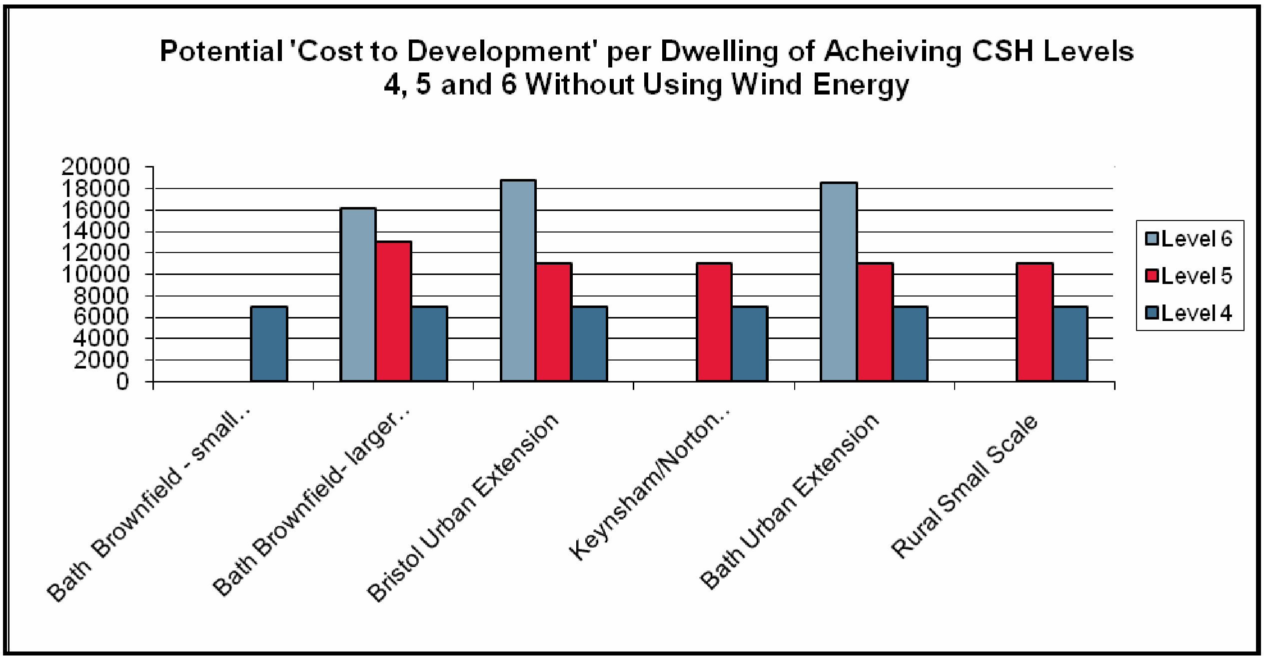


Figure 9: Potential 'cost to development' per dwelling without using wind energy



6.6.1 Key points

6.6.1.1 Zero Carbon

- With current technology, a communal heat network will be required to achieve CSH level 6, with or without using wind energy for large scale Urban Brownfield developments and Bristol and Bath Urban Extensions.
- Small scale Bath Urban Brownfield developments are likely to achieve 58% of required CO_2 reductions.

- Other Urban Brownfield developments and Rural developments will also find it difficult to achieve zero carbon – although because of the lower density they will fare better than the Bath urban brownfield developments.

6.6.1.2 100% reduction in regulated emissions only (i.e. CSH Level 5 for dwellings and similar standard for non-residential)

- Using maximum wind energy potential Bath Urban Extensions could potentially meet this requirement without a communal heat network, which significantly reduces costs but means level 6 would be difficult to attain for the development. Bristol Urban Extension would still require a communal heat network.
- Without wind energy, all developments would require a communal heat network to achieve level 5.

6.6.1.3 44% reduction in regulated emissions only (i.e. CSH Level 4 for dwellings and similar standard for non-residential)

- All developments could potentially achieve 44% reduction in regulated emissions without communal infrastructure.
- If the maximum wind energy potential is used the cost to the Urban Extension developments is likely to be just additional cost of energy efficiency measures, as it is assumed that a wind developer would invest in the wind turbines and operate them as a separate ESCo taking the full financial return.
- If no wind energy is used, then 70% of costs to the development would be for energy efficiency. The remainder of the CO_2 reductions could be met by solar thermal and PV, negating the need for communal infrastructure.

6.6.1.4 Comparison with other research

In 2007 Cyril Sweet produced the report 'A Cost Review of the Code for Sustainable Homes' on behalf of English Partnerships and the Housing Corporation. It provides benchmark figures per dwelling for achieving the various CSH levels of:

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

This is similar to Camco's research for level 4 and 5; however, level 6 costs have been calculated to be lower for the B&NES developments. This may be due to the fact that Camco has assumed that some of the costs of the infrastructure will off-set by ESCo finance and that the Cyril Sweet report assumed a high degree of building integrated microgeneration rather than heat networks..

6.7 Financial Viability Model

Camco has developed a financial viability modeling approach in order to assist the determination of the possible additional financial burden of the sustainable energy requirements on a development. The objective of the model is to provide a tool to help base policy decisions. The onus will always be on the developer to demonstrate how they can deliver any given target, therefore any policy must be based on best practice calculation. Because this report is working with indicative site development configurations the final analysis of the site compliance ability will differ from that presented here. The approach used also allows for an analysis on how the percentage of affordable homes will influence the return on the development.

To determine a detailed cost for any given development will require accurate development costs which should be obtained from the developer during the design phase, and an update of energy systems costs, market sales prices and land value at that time – B&NES will need to work closely with developers to ensure that the highest possible targets are achieved.

Interpretation of the results also requires a judgement to be made as to whether the additional costs will be borne by the end consumer (the buyers of the homes and buildings), the landowner (who could take a drop in sales price) and/or the developer – or a combination of all three parties. This requires analysis on a case by case basis depending on the condition of the property market at time of selling and if the developer either already owns the land or has an option on it.

For the purposes of the current analysis, an assumption has been made that development costs are £100,000 per dwelling and £1000 per m^2 for non-residential and, importantly, do not include the cost of land purchase.

These costs should be refined for each development once they are known and the cost of the Sustainable Energy Strategy scenario updated so that the financial viability of achieving zero carbon can be re-assessed on a development by development basis. Prior to requesting costs from the developer at the appropriate time, it may be possible that B&NES council can use the costs from their internal, Ernst and Young financial model when they are available.

Using the above assumption the potential impact of the Sustainable Energy Strategy scenarios on the overall development costs has been calculated as shown below.

Table 11 Potential percentage of total development costs for achieving CO_2 reductions

Potential % of development costs	Bath Brownfield - small scale*	Bath Brownfield - larger scale	Bristol Urban Extension	Keynsham /Norton Radstock Brownfield	Bath Urban Extension	Rural Small Scale
Zero carbon:						
% of development costs – with wind energy	*n/a*	n/a	14%	*n/a*	13%	*n/a*
% of development costs – without wind energy	*n/a*	14%	15%	*n/a*	15%	*n/a*
100% reduction in regulated CO_2 emissions:						
% development costs – with wind energy	*n/a*	n/a	13%	n/a	8%	n/a
% of development costs – without wind energy	*n/a*	13%	14%	14%	14%	14%
44% reduction in regulated CO_2 emissions:						
% development costs – with wind energy	n/a	n/a	5%	n/a	5%	n/a
% of development costs – without wind energy	7%	7%	9%	9%	9%	8%

The key issue to note from the analysis is that where wind energy is viable for any given development then, the overall development cost is likely to be lower than by achieving the desired carbon reductions by other combinations of technology.

6.8 Conclusions

6.8.1 Zero Carbon

The results show that zero carbon is achievable for all developments apart from small scale urban brownfield developments and rural brownfield developments (less than 500 units), which will find 60-80% challenging. Proportionally, the current cost to each development of achieving zero carbon does not vary significantly between the developments and is likely to be under 15% of total development costs. This figure should be tested during the design phase for each development when accurate development costs are known.

Realising the full wind energy potential close[8] to the urban extensions does not have a huge impact in terms of cost to the developer to achieve zero carbon. However, if wind energy is not used there will be significant increase in the amount biomass required for CHP. Camco predict that demand for biomass will more than double by 2026 even if all wind energy potential close to the new developments is realised and that a significant effort will be required to increase the biomass resource in B&NES without significantly impact local food production. The more biomass imported from further afield, the less sustainable the developments.

6.8.2 100% Reduction in Regulated CO_2 Emissions

The cost of achieving 100% reductions in regulated emissions is significantly less for Bath urban extensions if the full wind energy potential is used. This is because they could in theory achieve this standard without the need for a communal heat network by increasing the use of GSHP run on surplus wind energy, increasing the amount of STHW and having some individual building biomass heating systems.

For Bristol urban extension, where the wind energy potential is not as significant compared to the size of the development, a communal heat network would still be required. The reduction in cost of the overall development is likely to be less than 2% compared to achieving zero carbon. Or in other words it will not be a significantly greater effort to achieve level 6 than level 5.

6.8.3 44% Reduction in Regulated CO_2 Emissions

All the developments are technically able to meet this standard, including small scale urban and rural brownfield developments, using energy efficiency with wind energy, or energy efficiency with PV and STHW as appropriate. Communal heat networks are not necessary.

Wind energy would allow the developments to meet this standard with only 5-7% of the overall development costs, the majority of which would be for energy efficiency measures. Using PV and STHW instead of wind energy might incur 7-9% of development costs.

[8] *Within approximately 3km of the search area for each development.*

7 Recommendations for Local Development Framework Policies

7.1 Overall Targets for Electricity and Heat in B&NES

Camco recommend that the following targets are aimed for:

	B&NES Potential Target Capacity (MW)	B&NES Potential Renewable Energy Generation Target (MWh)
Electricity 2010 Target Capacity	0.38 MWe	1,000
Electricity 2020 Target Capacity	56 MWe	70,000
Electricity 2026 Target Capacity	80 MWe	110,000
Heat 2010 Target Capacity	2.0 MWth	3,500
Heat 2020 Target Capacity	101 MWth	160,000
Heat 2026 Target Capacity	186 MWth	300,000

It is good practice to have MWh targets in order that they can be easily converted to tonnes of CO_2 emissions abatement. Also a capacity only target can be somewhat misleading as, for example, PV can have a high capacity rating in MW but generate significantly less energy in MWh than say a hydro system of the same MW rating due to the efficiency of the system. However, the SW Regional targets are expressed as MW capacity and so it may be useful to have both.

Also, Camco believe that it will be useful to include a target for 2026 when all the new development specified in the RSS is due for completion.

7.1.1 What might be required for the 2020 electricity and heat target

The table below outlines a potential mix of technologies to achieve the suggested 2020 target, along with an overview of recommendations to help turn the target into reality.

Table 12 Potential 2020 target recommendations

Technology	2020 target	Recommendations to help turn target into reality
Wind turbines – large scale	Up to 9-10 large turbines	Ensure potential wind turbine sites close to new developments are considered when allocating land. Ensure B&NES has the resources for quick turnaround of wind energy applications.
Wind turbines – small scale	Up to 10 smaller turbines	Encourage farm awareness and have clear planning guidelines for smaller wind turbines. Consult with Highways Department and agree if they are acceptable to be placed at blade distance from roads rather than maximum height to tip.
Biomass	Would require 250,000MWh of biomass resource for potential demand from new and existing build by 2026. B&NES current biomass resource is 98,200MWh. In other words to	It is recommended that a wood-fuel group is set up to enable the establishment and promotion of a wood-fuel supply chain for the local authority, and that the farming industry is engaged with to facilitate the growth of energy crops and the promotion of agri-

Technology	2020 target	Recommendations to help turn target into reality
	supply the demand within B&NES the resource would need to double. There will be a 5% biomass heating uptake on existing stock, the remainder will come from new development demand.	forestry systems which allow for food and wood production on the same land.
Waste	All organic kitchen, garden, supermarket and farm wastes should be processed in Anaerobic Digesters (AD) in order to produce biogas and fertilizer.	Liaison and integration with the waste strategy is vital.
Hydro	Approximately 3 hydro sites would need developing along the Avon	B&NES may be in a position to progress some sites, such as the Pultney Weir site, in partnership with private developers.
Solar PV	13.5% uptake on existing stock, uptake on new build will vary according to the development configuration and location	Clear definition of what could be acceptable on listed buildings - some products might be more acceptable e.g. PV roof tiles or roof integrated panels rather than bolt on, or if they are not seen from a main highway. Consultation and education of planning officers.
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)	Like PV, STHW is now a permitted development on roof tops in the World Heritage Site and Conservation Areas, but not on listed buildings. Investigate the possibility of planning officers being more tolerant if the STHW collectors are not visible from a main highway.
GSHP	5% uptake on existing stock, uptake on new build will vary according to the development configuration and location	Ensure that local regulations e.g. the Avon Act do not overly reduce the opportunity for this technology
Geothermal heat	Heat from the hot spring discharge used e.g. for heating local buildings.	Encouragement of officers already looking into this possibility.

7.1.2 Developing the Supply Chain

7.1.2.1 Increasing the Biomass Resource

There is no substantial sawdust resource within B&NES. Some small amounts of sawdust may come from local joinery operations but it is likely to be uneconomic to convert these resources into pellets or briquettes for woodfuel. The local authority area does not host a sawmill, however there is a sawmill close to the southern border of B&NES which could house a pellet production facility. This facility could provide pellet fuel for blown delivery to the existing stock of houses and or businesses within B&NES. Sawdust arisings on this sawmill are estimated at 5,000 oven dry tonnes per year, equivalent to about 25,000 MWh. This would leave 195,000 MWh of fuel to be obtainable from clean chip.

There is a considerable potential to develop a dry chip source within B&NES. If 10% of the set-aside, crop and bare fallow land were used for energy crops then a substantial resource could be realised. There is also considerable resource which could be obtained from local woodlands. The issue in the woodland sector is that only a small quantity of woodland is likely to be under management and therefore available for harvesting wood for wood-fuel. Because of this a conservative estimate of only 0.25 tonnes per Ha of woodland has been used for the current technical potential. This assumes that large parts of woodland are inaccessible and that most of the woodland is uneven-aged so that extraction is on a fairly ad-hoc rather than commercial basis. There is also a small amount of resource which is assumed to come from clean wood waste. With these assumptions the estimate of resource is 42,708 MWh. This would leave a further 152,000 MWh of fuel resource needing to come from somewhere The following actions could be taken to enhance this resource:

- make more set-aside, crop and bare fallow land available for energy crop production – this could possibly be done by using an integrated agri-forestry system so that forestry and livestock or crops could be grown on the same piece of land. Such systems are commonly used in for example the permaculture type systems used by many small scale farming cooperatives where enhanced management practices enable higher yields to be obtained from the land. To meet the target from set-aside, crop and bare fallow land would require increasing the amount of land converted to energy crops to 50%.
- Bring more woodland into management and manage as commercial forestry for woodchip production. Just over 2,000 ha of non-ancient woodland was identified in this study. If all of this was managed as commercial forestry for the express purpose of woodfuel creation then 100,000MWh of woodfuel could be produced per year. This would require major investment in the woodland resource and increase in the number of foresters working in the area.

It is therefore recommended that a wood-fuel group is set up to enable the establishment and promotion of a wood-fuel supply chain for the local authority, and that the farming industry is engaged with to facilitate the growth of energy crops and the promotion of agri-forestry systems which allow for food and wood production on the same land.

Around 55,000 MWh of the available resource would go to biomass CHP systems, whereas the demand from CHP in 2026 is expected to be 300,000MWh. This leaves a short-fall of 245,000. The main way to enhance the AD resource is by establishing an AD-fuel supply group. This group could engage with local food companies, farmers and waste disposal companies, pooling the total AD resource for use on some of the new developments within B&NES.

7.1.3 Council leading by example

Use public buildings as an anchor heat load around which to establish a district heating network.

- Public sector buildings to lead the way in installing CHP and renewables so as to provide 'anchor loads' for district heating and low carbon infrastructure networks;
- Identify a number of public sector demonstration projects.

7.1.4 Linking existing communities to emerging heat networks

CHP and district heating has good scope for delivering carbon reductions in existing buildings which are more energy inefficient than new developments and are therefore responsible for greater carbon emissions. In addition, the more energy efficient a building is, then the lower its heating demand, and therefore 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 will be required in order to capitalize on the low carbon infrastructure for new communities, and develop this into existing communities. Measures will 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.

7.1.5 Supporting communal infrastructure

The installation of low carbon infrastructure, such as 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 combined heat and power and district heating systems under current market conditions.

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

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

7.1.6 Potential for a developing a Local Development Order on Microgeneration

Due to the amendment to The Town and Country Planning (General Permitted Development) (Amendment) (England) Order 2008, that will come into force on 1st October, it is not necessary for B&NES to have a Local Development Order for Microgeneration. The amendment allows for the installation, alteration or replacement of solar PV or solar thermal equipment on any roof slope within a conservation area or which is a World Heritage Site to be a Permitted Development.

7.2 New Development

Camco believe a clear rationale has been used to set the following targets and that there are clear opportunities for significant use of decentralised and renewable or low carbon-energy. They are also ambitious in line with the South West RSS recommendations.

7.2.1 Sustainable Construction Policy

The RSS states that there will be situations where it could be appropriate for local planning authorities to anticipate higher levels of building sustainability in advance of those set out nationally, for identified development area or site-specific opportunities. When proposing any local requirements for sustainable buildings, local planning authorities must be able to demonstrate clearly the local circumstances that warrant and allow this and set them out in Development Plan Documents.

From the analysis of results, Camco recommends the following (Table 13) could be achievable. The onus must be on developer to prove they cannot reach this target with a proper consideration of more detailed development costs and an update of energy systems costs, market sales prices, number of affordable homes, and land value at that time. Consideration should also be given as to whether the additional costs can or will be borne by the end consumer and the landowner as well as the developer.

Table 13 Recommendations for New Development

Development	Sustainable Construction Recommended Targets
Urban Brownfield developments (less than 500 dwellings and non-residential under 1000m^2)	2008 – 2010: CSH Level 3 energy requirements and 25% reduction in regulated CO_2 emissions for non-residential buildings. 2010 – 2012: CSH Level 3 energy requirements and 25% reduction in regulated CO_2 emissions for non-residential buildings. 2013 – 2016: CSH Level 4 energy requirements as per Building Regulations and 44% reduction in regulated CO_2 emissions for non-residential buildings. 2016 -19: CSH Level 6 energy requirements as per Building Regulations and 70% reduction in regulated CO_2 emissions compared to Building Regulation 2006 standards. .
Urban Brownfield developments (over 500 dwellings and non-residential over 1000m^2)	2008 – 2010 CSH Level 3 energy requirements and 25% reduction in regulated CO_2 emissions for non-residential buildings. 2010 – 2012 CSH Level 4 energy requirements and 25% reduction in regulated CO_2 emissions for non-residential buildings. 2013 – 2016 Dwellings - CSH Level 4 energy requirements plus a requirement for communal heat network for densities over 50 dwellings per ha, unless it can be proven that zero carbon is possible for the development as a whole without one. Non-residential buildings - 44% reduction in regulated CO_2 emissions compared to Building Regulation 2006 standards. 2016 -2019: Dwellings - CSH Level 6 energy requirements as per Building Regulations Non-residential buildings - 70% reduction in regulated CO_2 emissions compared to Building Regulation 2006 standards. 2019 onwards: Zero carbon for all buildings.
Urban Extensions	2008 – 2010 CSH Level 3 energy requirements 2010 – 2012: Dwellings - CSH Level 4 energy requirements Non-residential buildings - 25% reduction in regulated CO_2 emissions compared to Building Regulation 2006 standards. 2013 – 2016: Dwellings - CSH Level 5 energy requirements plus a requirement for communal heat network for densities over 50 dwellings per ha, unless it can be proven that zero carbon is possible for the development as a whole without one. Non-residential buildings - 44% reduction in non-residential regulated CO_2 emissions compared to Building Regulation 2006 standards. 2016 – 2019: Dwellings - CSH Level 6 as per Building Regulations Non-residential buildings - 100% reduction in non-residential regulated CO_2 emissions compared to Building Regulation 2006 standards. It is recommended that all urban extensions in B&NES are set the same standard so there is a level playing field.

The analysis in the report demonstrates local circumstances that warrant higher than national standards, particularly for those developments that are able to have a communal heat network and/or wind energy from large turbines. Hence the recommendations for smaller scale urban brownfield developments are less stringent as they are less likely to be feasible. However, CSH level 3 should be feasible for smaller scale urban brownfield developments prior to 2013 as this has been proven viable by the Housing Corporation and English Partnerships (now the Homes and Communities Agency) and new urban brownfield developments sites in London. Whilst London urban brownfield developments can expect higher sales values to accommodate some of the additional costs, they must also pay more for the land.

An additional policy option for urban brownfield developments, where the recommended targets are less stringent than for the urban extensions, is for a carbon neutral target for *regulated* emissions 2013 – 2016. This would mean that whilst they would be required to meet CSH Level 4 and 44% reduction in regulated CO_2 emissions for non-residential buildings on-site, it would mean that they could meet 100% reduction in regulated emissions either on-site or by paying into a fund so that the amount of CO_2 reductions could be met with projects elsewhere e.g. cavity wall insulation of existing buildings. This concept is used by Milton Keynes Council. In summary, to acknowledge the difficulty that small scale urban and rural developments will have in achieving carbon zero, they could reduce emissions from the development as far as possible and then make a contribution to a local fund that would reduce emissions from existing buildings through energy efficiency measures e.g. cavity wall insulation, heating controls. These measures could be targeted at the fuel poor to supplement other national energy efficiency schemes.

7.2.2 RSS Policy RE5

The advice given in the South West RSS is that whilst DPDs are being put in place RE5 sets out interim targets to be applicable for certain types and sizes of new development where feasible and viable, and that Local planning authorities in applying the interim target should not be prescriptive on technologies and be flexible in how carbon savings from local energy supplies are to be secured. It also recommends that local planning authorities consult Revision2020: South West Renewables, Electricity, Heat and On-Site Generation Targets for 2020. The text of the interim RE5 policy is as follows:

Box 1

> At least 10% of the energy to be used in new development of more than 10 dwellings or 1000m^2 of non-residential floor space should come from decentralised and renewable or low-carbon sources, unless, having regard to the type of development involved and its design, this is not feasible or viable.

However, Camco believe that there is merit in the recommendations and rationale of the report "Supporting and Delivering Zero Carbon Development, Final Policy Report" (January 2007)[9] that the target be more ambitious and require:

Box 2

> Larger scale developments [over 10 dwellings or 1000m^2 of non-residential use] will be expected to provide, as a minimum, sufficient on-site renewable energy to reduce emissions from energy use by users of the buildings constructed on site by the equivalent of 20% of regulated emissions. Developers will be expected to demonstrate that they have explored all renewable energy options, and have designed their developments to incorporate any renewable energy requirements.

[9] *Prepared for the South West Regional Assembly, SERDA and GOSW by Faber Maunsell and Peter Capener*

This target is more in line with that of the London Plan; however, the wording was rejected by the Secretary of State in July 2008 in favour of the 10% of energy use from renewable or low-carbon technologies target wording that is now the RSS.

The main rationale for the more ambitious target, and the reason why the policy was suggested in addition the Sustainable Construction Policy targets, was to provide "the micro-renewables industry with a clear requirement to ensure bankability of the industry with the finance sector e.g. for product development or for new start-up companies seeking finance". This is an important consideration as micro-renewables will need to play a significant role if the overall 2020 renewable energy targets are to be realised.

There is currently a government consultation to determine the nature of "on-site" and "off-site" renewable, and what can be constituted as acceptable when accessing the carbon neutrality of any given development. This will be clarified shortly and in expectation of a more flexible definition of the carbon neutrality definition Camco recommends that the elevated target be adopted i.e. that from "Supporting and Delivering Zero Carbon Development, Final Policy Report" (January 2007)[10] identified in Box 2 above. The overall analysis suggests that this elevated target could be achieved above that identified in RE5 of the RSS – Box 1: This would be an interim target before the extended Building Regulation and Code for Sustainable Homes (CSH) requirements come into effect in 2013 and 2016. This would provide a clear indication to the renewables industry that there is a clear commitment to carbon reductions in the B&NES area.

7.2.3 Energy Services Companies

All new developments should develop a Sustainable Energy Strategy during design phase and consult with B&NES Council. Particularly where the developer is considering communal infrastructure the Council should encourage developers to engage with expert entities in order to most effectively progress energy infrastructure within their developments. Key steps include:

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

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 or energy efficiency 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 who 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'.

The ESCo is generally given a long lease for the energy centre building and plant and the distribution systems with the responsibility to operate, maintain, and replace as necessary. A key benefit of the ESCo being wholly owned by the Residents' Management Organisation (RMO) is that a commercial ESCo's assets could be sold off in the event of bankruptcy. Implementing a full ESCo project is a long and complex process which relies upon expert business, procurement, legal and technical advice. Contracts bring together the procurement, finance and management arrangements for an ESCo. The particular procurement strategy that is followed for an ESCo will differ from case to case, but will follow the basic contract structure of a relationship between a

[10] *Prepared for the South West Regional Assembly, SERDA and GOSW by Faber Maunsell and Peter Capener*

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.

7.2.4 Finance

7.2.4.1 Addressing investment challenge for communal infrastructure such as district heating

- 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 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.

7.2.4.2 Managing contractual complexities & project uncertainties

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

7.3 Monitoring and Evaluation

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

As per the recommendations in Faber Maunsell and Peter Capener's 2007 report 'Supporting and Delivering Zero Carbon Development, Final Policy Report', B&NES could prepare CO_2 emissions trajectories of how they expect emissions to be from now until 2026 to compare with the monitored data as it comes in. The report recommends separate trajectories for dwellings and non-residential buildings and in this way the Sustainable Construction Policy targets can be checked.

Monitoring is also important for the existing building stock in terms of CO_2 emissions for B&NES as a whole; this should be captured in National Indicator 186. It would also be useful to monitor the number and type of renewable energy installations progressed throughout B&NES to compare with overall CO_2 emissions; however, with the General Permitted Development Order it will be more difficult for B&NES to track building integrated technologies.

Appendix 1: Renewable Energy Assessment Methodology and Assumptions

Wind Energy – Large Scale Turbines

Technical Potential

Methodology: Technical potential has been determined through GIS constraints mapping (for the B&NES study it has built upon the existing work conducted for the SW Regional GIS mapping conducted by Wardell Armstrong).
Analysis has taken the following constraints into account:

- Wind speed greater than 5.9m/s at 45m agl
- Space requirements around buildings and infrastructure
- Air safeguarding and radar constraints from MOD and civil aviation interests
- Electromagnetic interference to communications radar (TV, radio, weather, mobile phone etc.)
- Electricity Distribution Network
- Topography
- Designations for ecology, heritage, archaeology and landscape (but not landscape character areas)

Calculation Assumptions: B&NES has fairly low wind speeds, some of which border on the current commercial viability for wind development, therefore the turbine size chosen for the assessment is a 2.5MW, class III (designed for low wind speeds) machine rather than the 3MW machine used in the SW Regional REVision 2020 assessment. Such a turbine would likely be between 100m to 125m maximum height from ground to blade tip.

A 25% capacity factor has been assumed.

Target Potential 2010

Most wind energy projects take at least 3-4 years in development, hence no wind energy projects can be relied on to start operation before 2010.

Target Potential 2020

Assumes 10 large turbines are in operation, just 1 less than the 2026 potential target (see assumptions below) due to the fact that wind turbines will be commercially viable for the new developments and so will be erected sooner rather than later.

Target Potential 2026

Assumption that at least 50% of turbines will not be acceptable on landscape and visual grounds (following discussion with B&NES Landscape Officer based on landscape character areas) and that cumulative impact will limit this further.

It is important to note that individual sites would need suitable landscape and visual assessments prior to planning application. Inclusion on the potential wind energy map of B&NES does not indicate acceptability on landscape and visual grounds.

The target assumes that potential turbine sites close to the new developments will go ahead.

Schemes with 2 to more turbines will be more favourable to developers and will likely go ahead if the landowners are also willing.

Assumes 70% of landowners would be willing to have wind energy on their land in return for financial return.

Assumes there are no issues with the grid as long as % of electricity generated by wind energy is below 20 - 30% of the total electricity demand.

Wind Energy – Smaller Scale

Technical Potential

There are 892 farms in B&NES, of which 455 are under 5ha and 437 are over 5ha.

Assumes that farms over 5ha have space for a 50kW turbine, and farms under 5ha have space for a 25kW turbine. Building integrated wind turbines have not been considered as they are currently not well suited to built up areas (low output) and noise and vibration issues to be resolved.

Assumes a 20% capacity factor.

Target Potential 2010

Assumes only 5 smaller turbines are likely to be installed by 2010, average capacity 75kW (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.)

Target Potential 2026

Assumes:

- priority given to larger turbines as they will produce far greater CO_2 reductions i.e. a 100kW turbine is only half the height of a 2.5MW turbine.
- 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, assumption made that uptake by 2026 is limited to 2.5% of technical resource.

Hydro Power

Technical Potential

A high level assessment has been conducted using the following methodology:

1. determine suitable locations from map e.g. weirs, mills and local knowledge from council
2. determine head - assume viable over 1.8m
3. obtain flow rate from nrfa website (http://www.nwl.ac.uk/ih/nrfa/station_summaries/map.html)
4. decide how much flow can be utilized (flow factor) as some may be needed for navigation or flood defence (use 0.5 as default)
5. decide combined turbine and generator efficiency (use 0.7 as default for low head rivers)
6. apply formula Power = gravity x head x density of water x flow rate x flow factor x efficiency

Target Potential 2010

A feasibility study is being conducted for Pultney Weir, which could potentially by operational in 2010.

Target Potential 2026

Assumption that 60% of all potential hydro sites will be progressed. 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 Photovoltaics (PV)

Target Potential 2010

The target potential is based upon the following methodology and assumptions. It includes domestic and non-domestic buildings and excludes listed buildings, but not non-listed buildings in conservation areas or world heritage sites. It assumes PV is integrated into roof tops only and excludes building facades and PV fields.

Step	Necessary Information	Value	Reference / Assumption
Building Information:			
Houses:			
1	Number of 'entire houses' i.e. detached, semi-detached, bungalow, terrace, four flats (assumption being that 4 flats will have same average roof area as 1 house)	74,403	Census data for 2001 http://neighbourhood.statistics.gov.uk
6	Average ground floor area (m2)	50	Reference: IEA Task 7 Report on BIPV Potential reduced for local conditions
7	Average roof area (m2)	58	Assumption that average roof is pitched at 30 degrees
8	% of listed whole houses in B&NES	9%	Information from B&NES
Non-residential:			

Step	Necessary Information	Value	Reference / Assumption
9	Ground floor area of existing non-residential buildings in B&NES (m2)	2,537,000	http://www.neighbourhood.statistics.gov.uk
10	Ground floor area of proposed new non-residential buildings in B&NES (m2)	62,820	Assumption that average number of stories is 3.
Available area for PV:			
Houses:			
11	Roofs facing SW, S, SE	31%	Assumption
12	Architecturally suitable roof area	75%	Taking into account limitations such as terraces, parapets, sky lights, dormer windows, chimneys etc.
13	Amount of roof space used for other uses (m2)	3	Area for solar thermal hot water panels
14	Average roof area suitable for PV per house (m2)	10.4	=(7) x (11) x (12) - (13)
15	Façade area available per building	0.0	Unlikely that buildings in B&NES will have PV on facades in timescale.
Non-residential:			
16	Roofs facing SW, S, SE	45%	Assumption that a greater number of non-residential buildings will have flat roofs
17	Architecturally suitable roof area	50%	Taking into account limitations such as terraces, parapets, sky lights, dormer windows, air conditioning, maintenance, green roofs etc.
18	Façade area available	0%	Assuming roof will be utilised before façade
PV Data:			
20	Module Efficiency 2010 (%)	13%	Based on polycrystalline silicon
21	Inverter Efficiency	93%	
22	Average power factor for PV for 2010 (KWp/m2)	0.1347	
Capacity and Energy Generated - Roofs:			
23	Annual Solar Radiation kWh/m²	1012	For 30 degree tilt and average of SW, S, SE orientation. Reference: SAP 2005 for the UK
24	Shading factor (%)	0.8	To take into account environmental conditions such as shading and dust
25	Potential output for roofs facing SW, S and SE (kWh/m2 pa)	98	
26	Annual energy factor (kWh/kWp pa)	727	

Target Potential 2010

The 2010 target scenario is based on PV grant availability (B&NES has 3.35% of SW's housing, assuming similar % non-domestic buildings and assuming 0.14MWp per year for the SW region as per REVision 2020 methodology)

Target Potential 2020

A pro-rata of the 2026 target has been used assuming the majority of new development will not commence until 2013 and that build out will be uniform until 2026. For new build it assumes uptake will not be significant until 2014 assuming PV prices drop and grid prices rise.

Target Potential 2026

Assumes:

- smaller scale urban fill will need to rely heavily on PV to meet Building Regulation amendments in 2013 and 2016, and that roofs will be designed to accommodate 2kW_p per dwelling to achieve maximum emissions savings.
- larger scale urban fill will be able to use CHP for some of the electricity requirements and that PV will only be used if residual renewable electricity is required.
- urban extensions will only use PV if there is insufficient wind energy and CHP to meet the electricity requirements of the development.
- 25% of existing stock will have PV systems by 2026. This is an aspirational target and depends significantly on the delivery of third generation PV technology to drop prices.

Biomass

Technical Potential

Methodology:

- Only biomass and waste within administrative boundary should be considered
- Consider dry biomass – woodchip (from managed woodland and saw mill), straw, municipal waste
- Consider wet biomass – silage from cattle, poultry litter, garden wastes, supermarket food wastes
- Desk based assessments – maps and statistics
- Contact local actors as appropriate
- Assumption on set aside and existing crop land (10% to biomass production)

Target Potential 2010

- Only biomass and waste within administrative boundary should be considered
- Only 5% of dry wood chip and 5% of AD plant will come on line by 2010 (from the dry chip projects for the Council being discussed and/or a school project, and AD from the kitchen waste due to be collected in in B&NES from 2009)

Target Potential 2020

Target Potential 2026

- The target is led by the predicted demand from the new developments and an aspirational target of 8% of existing stock with have biomass heating systems.
- All biomass resources will be utilised, apart from Municipal Solid Waste (which is contrary to B&NES waste policy)

Solar Thermal Hot Water (STHW)

Technical Potential

Assumes:

- 62% of houses have at least part of their roof orientated in a SW, W and SE direction
- 3m2 on each entire house and 3m2 for every 4 flats.
- Factories will require some hot water. Www.neighbourhood.statistics.gov.uk indicates that there are 843 factories in B&NES. Assume shops, offices and warehouses have less need for hot water and will not therefore have STHW.
- Glazed flat plate collectors are used (the most common type) with conversion factor of 671Wth per m2 of glazed flat plate collector (as per CDM methodology)
- 454kWh/m2 per year

Target Potential 2010

Assumes 0.5% uptake dictated by number of grants available, but higher uptake than PV due to current shorter payback period.

Target Potential 2020

A pro-rata of the 2026 target has been used assuming the majority of new development will not commence until 2013 and that build out will be uniform until 2026. For existing stock the aspirational target assumes 19% uptake on existing buildings.

Target Potential 2026

Assumes:

- an aspirational 35% target uptake on existing stock (greater percentage than PV's 25% target for 2026 due to the fact that payback period is currently less than PV)
- smaller urban fill 80% of houses will have STHW (the remainder may choose to use GSHP for hot water as well as space heating). Unlikely that biomass will be used to heat water in summer.
- larger urban brownfield developments will have water heated by 50% CHP, 10% GSHP and 40% STHW
- urban extensions will require 40% of technical potential for any buildings not on communal heat network and for summer hot water demand to limit use of biomass.

Geothermal Heat

Technical Potential

It is assumed that 50kW of heat is currently being utilised from the hot springs for the Pump Rooms and Bath Thermae Spa. A further 50kW heating system may be possible from the discharge water (which could potentially heat the Abbey). After discussions with B&NES Council it was determined that this is likely to be the full technical potential of the hot springs. Although there may be some localised hot rock potential in the centre of Bath it may be expensive to borehole here in order to use technology which would not damage the aquifer.

Target Potential 2010

It is assumed that all technical potential will be realised by 2010.

Ground Source Heat Pumps (GSHP)

Technical Potential

Assumes:

- most buildings could have GSHP even if it meant boreholing in pavements/roads for houses without gardens. Exceptions being if there is a protected aquifer underneath (as with central Bath) or for multi-storey buildings (assume over 4 floors).
- For protection of Bath Hot Springs assume that no GSHP are viable in Zone B (County of Avon Act 1982 - excavations limited to 15m without planning permission) - this is approximately 3.5km2 of built up area and 20% of Bath's buildings i.e. estimated 7100 buildings
- Each viable 'entire house' (or 4 flats) has a 5kWth system.
- 5kW for every 150m^2 of non-domestic floor area.
- The systems are run for an average of 2000 hours per year.
- Check to ensure this is not over overall heat demand.

Target Potential 2010

Assume uptake of 50 x 5kW systems by end of 2010. The first application for a GSHP in B&NES under the Avon Act has recently been approved.

Target Potential 2020

Uptake of GSHP in existing stock by 2020 is likely to be minimal due to costs and need to replace the heat distribution system (i.e. radiators) with larger ones or under floor heating. Assume a pro-rated 54% of the 2026 target.

Target Potential 2026

Assumes 10% uptake in existing stock. The longer term (2050) uptake may be greater if there is further legislation at point of refurbishment, sale or let and sustainable biomass reaching limits (of supply and air pollution in dense areas).

Assume uptake by 2026 limited to 75% of 'off-gas' area heating and 10% of other existing (in 2008) area heating.

Assumptions for new development are:

- smaller scale urban brownfield developments: 5%. This is low due to difficulties generating renewable electricity at these developments.
- larger urban brownfield developments: 2% due to the fact that heating is likely to come from CHP.
- urban extensions: 30% of commercial as they may want/need to control their own heating systems. If the urban extensions realise the full wind energy potential close to the sites then this figure may increase significantly reducing the biomass demand.

Appendix 2: B&NES Officer One-to-One Meetings

7.3.1.1 Development Control

Andrew Ryall, DC Team Leader

7.3.1.2 Countryside Strategy/Partnerships

Sue Murtagh, Countryside Strategy/Partnerships Co-ordinator

7.3.1.3 Ecology

Lucy Corner, Ecologist

7.3.1.4 Urban Design

Funda Willets, Senior Urban Designer

7.3.1.5 Building Control

Mark Williams, Building Control

7.3.1.6 Tree Officer

Mark Minkley, Team Leader - Environment

7.3.1.7 Heritage and Environment

Tony Crouch, Heritage and Environment Manager

7.3.1.8 Landscape

Andrew Sharland, Landscape Architect

7.3.1.9 Air Quality

Dr Nicola Courthold, Environmental Monitoring Technical Officer

7.3.1.10 Neighbourhood Services

John Crowther, Neighbourhood Services,

7.3.1.11 Energy Management

Peter Baker, Energy Management Officer

Appendix 3: Glossary

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, technology and in the case of biomass, the resource, may change over time: potential scenarios for these are considered for deriving suggested targets.

*Note that for wind energy the technical potential does not include the constraints imposed by what might be considered acceptable on landscape and visual grounds. This important criteria has been considered for the proposed targets (for further information please see wind energy methodology in Appendix 1).

Target Potential

For the purpose of this project, Target Potential means the amount of renewable energy possible once market conditions and landscape and visual considerations have been considered in addition 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 how these may change over time. Likewise, landscape and visual considerations can be highly subjective and again the feelings of the population majority can change over time.

An aspirational 'target potential' has been calculated for 2010 and 2020 in line with the RSS's target time frames, using assumptions based on Camco's professional judgement and the latest predictive research available for renewable energy (where possible). The assumptions for each technology are outlined in Appendix 1.

MW	Megawatts.
kW	kilowatts.
MWh	Megawatt hours.
MWe	Megawatts electic.

MWth Megawatts thermal.

PV Photovoltaic.

STHW Solar Thermal Hot Water.

GSHP Ground Sourced Heat Pump.

MSW Municipal Solid Waste.
This term describes the waste generated by domestic property.

CHP Combine Heat and Power. This is applied

ODT Oven Dry Tonnes.

AD Anaerobic Digestion.

SAP Building Regulation’s standard assessment procedure

tCO_2 tonnes of carbon dioxide

CSH Code for Sustainable Homes.

RSS Regional Spatial Strategy.

NPV Net Present Value.

ESCo Energy Service Company

Microgeneration. The use of small scale usually building integrated renewable technologies eg PV

AONB Area of Outstanding Natural Beauty

GIS Geographic Information System

Camco Advisory Services Ltd
Overmoor, Neston, Corsham, Wiltshire, SN13 9TZ
t +44 (0)1225 812102   f +44 (0)1225 812103