Centre for
Sustainable Energy

Teignbridge District Council

Renewable Energy and Sustainable Construction Study

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We are a national charity that shares our knowledge and experience to help people change the way they think and act on energy.

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Executive summary

1) Introduction

New development and energy infrastructure are areas where much can be done to combat and prepare for the impacts of climate change and local authorities are best placed to understand the opportunities and constraints specific to their areas. Local planning systems can therefore be used as an effective tool to legislate and encourage effective climate change mitigation and adaptation measures in the design of new buildings and energy supply systems. The Government's Planning White Paper, 'Planning for a sustainable future' published in May 2007, sets out detailed proposals for the reform of the planning system and makes it clear that local planning authorities have a crucial role to play in tackling energy efficiency and climate change.

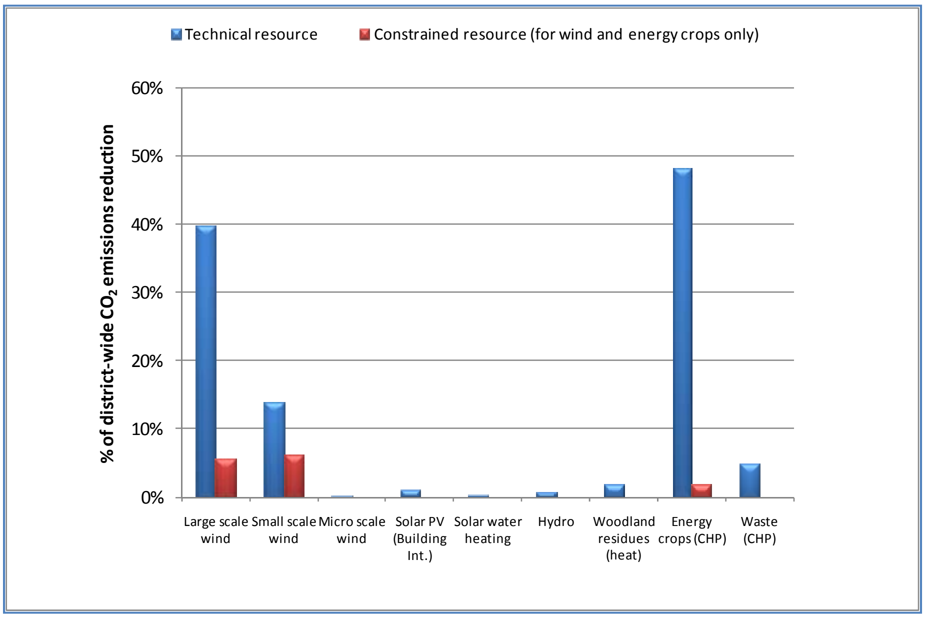
This study therefore aims to provide planning evidence for renewable energy and sustainable construction policies in Teignbridge District Council. A comprehensive range of planning evidence has therefore been drawn together in this report to provide technical expertise and support in generating locally specific evidence related to the potential for sustainable energy generation in Teignbridge, current and future energy demand and the development of sustainable construction policies.

2) Sustainable energy resources in Teignbridge

In assessing the existing installed renewable energy capacity in Teignbridge District, it was found that the total estimated capacity currently installed is approximately 6.2MWe of electricity, 96% of which is comprised of landfill gas at Heathfield, and 0.015 MWth of heat. In terms of annual energy supply, these totals represent around 3% of Teignbridge's total annual gas and electricity use during 2008.

To establish the remaining potential for sustainable energy generation, renewable and low carbon energy resources across Teignbridge District have been assessed by applying a set of constraints specific to each type of resource or technology. By sequentially applying layers of constraints, using GIS techniques where possible, a theoretical resource followed by a more limited 'accessible' resource can be quantified. The categories considered are generally based on government guidance for assessing regional renewable and low carbon energy capacity, but exclude those resources specifically related to transport (biofuels), deep geothermal energy, off-shore wind, marine renewables and fuel cells.

The following chart summarises the assessed renewable energy capacity in terms of the potential impact on reducing district-wide carbon dioxide emissions.



Summary of resource assessment for study area showing the potential proportional contributions from each technology to savings of district-wide carbon emissions. Also shown is the emissions reduction from the constrained resource for wind and energy crops.

An estimate of the potential resource specifically linked to future housing development has also been estimated using a database model and data from the Strategic Housing Land Availability Assessment (SHLAA). A number of target scenarios relating to Building Regulations were drawn up and the least-cost technology mix was identified for each. The analysis found that photovoltaics were likely to be the predominant technology for the lower, earlier targets considered, and that biomass combined heat and power would tend to feature most for the later, more demanding targets, such as that for ‘zero carbon’ homes.

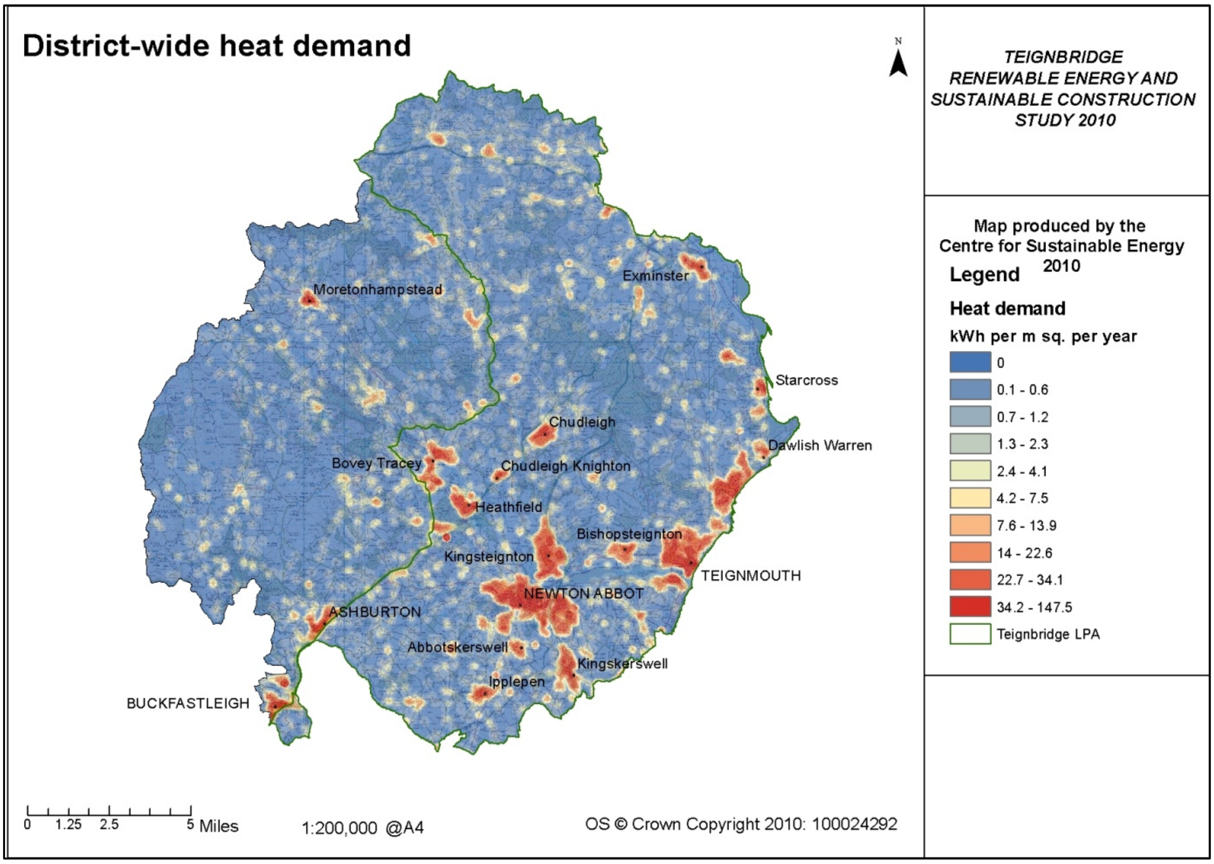
3) Potential for district heating

District heating is an infrastructure for delivering heat to multiple buildings from a central heat source through a network of pipes to deliver heating and hot water. In this way heat can usually be generated and delivered more efficiently than with multiple individual systems. There is generally believed to be significant potential for district heating in the UK, although the size and complexity of schemes tend to act as a significant constraint along with the cost and associated risk. The technology itself is less of a constraint as demonstrated by the many successful installations outside of the UK.

One of the main constraints to district heating is the need to identify a sufficient heat demand density. Heat demand density is a spatial characteristic that indicates the degree to which building heat loads are concentrated in a particular area and can be used as a broad indication of areas with potential for district heating. Urban areas with high population density offer most potential for district heating schemes.

The phasing of large developments can present challenges to district heating schemes as the system needs to be able to adapt and accommodate future heat loads as they come on line. Existing buildings situated within or close to new developments which are considering district heating can offer significant benefits in that they can act as district heating ‘anchor’ points around which new systems could be established. As these heat loads already exist, incorporating them into the network would provide a stimulus for early implementation of the scheme. The inclusion of large public sector 'anchor load' sites such as social housing schemes, universities and local authority buildings can be particularly beneficial.

To identify areas of potential for district heating, data from the heat demand map of the South West of England (an address-level model of annual demand for space and water heating) was used to prepare a heat map (see below) for Teignbridge District showing annual heat demand per square metre. Heat Priority Areas can then be identified for further investigation.

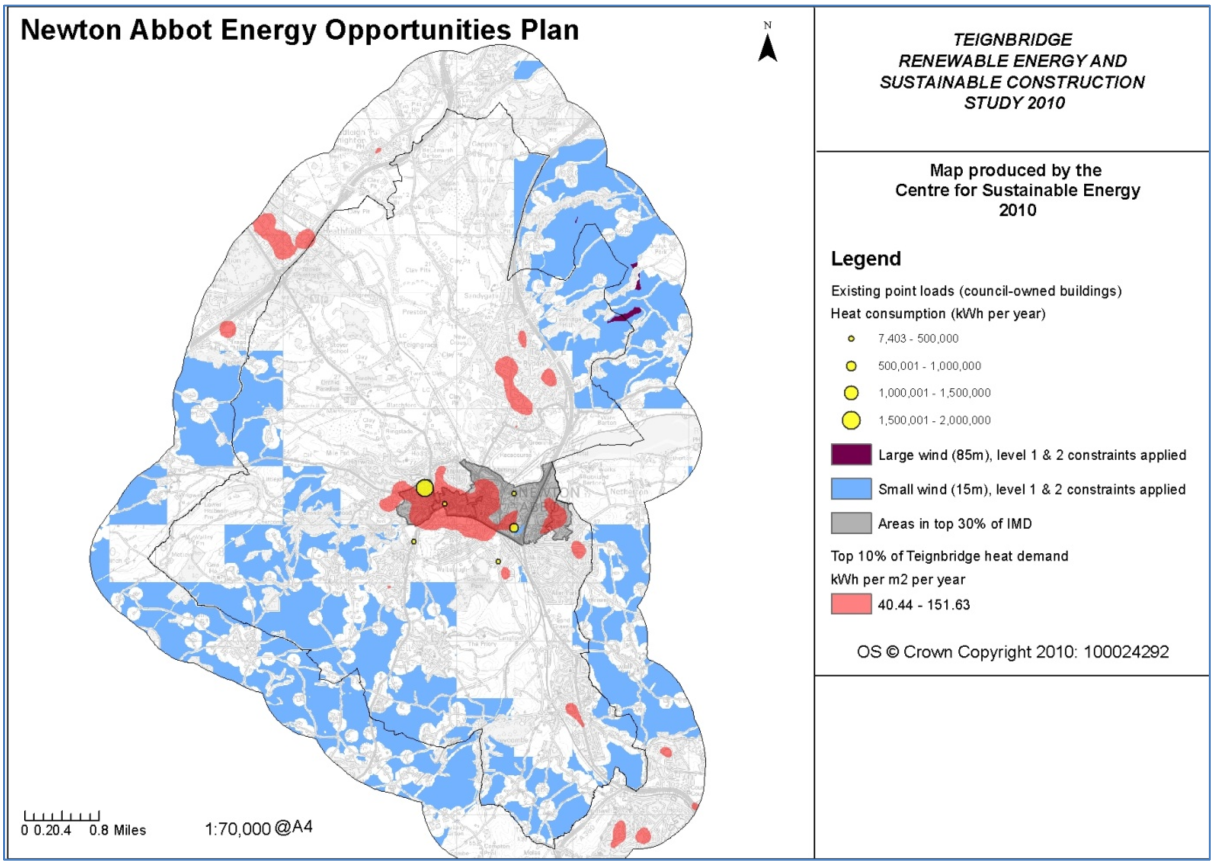


4) Energy Opportunities Plans

Certain areas in Teignbridge are expected to experience significant growth in future years in terms of housing and associated infrastructure. The Teignbridge Core Strategy Issues and Alternative Options (2010) document puts forward four spatial options for housing growth, based around the need to provide around 740 dwelling per year. This indicates that the most significant housing growth is expected to be located around the area of Newton Abbot and Kingsteignton. These are the types of areas that should be strategically considered for specific renewable and low carbon energy opportunities at the master-planning stage.

Due to the early stage of housing development planning in regard of the Core Strategy and the SHLAA, the degree of analysis and modelling that would normally be required to inform the development of specific energy policies and targets for these areas is limited. However, key opportunities for strategic sites can initially be assessed by considering the outputs of the resource assessment, heat mapping and issues such as development scale and form.

Energy Opportunities Plans (example for Newton Abbot shown below) aim to pull together an initial set of information in order to assess the combined opportunities and constraints for renewable and low carbon developments. These, and similar maps of other areas where there is likely to be significant growth can be further developed with additional data and be useful in exploring the potential for setting site-specific targets on sustainable construction.



5) Cost of zero carbon development

For new residential development expected in Teignbridge, the additional costs modelled for the sustainable energy scenarios considered (compared to a 2006 Building Regulations baseline) ranged from 12–20%. Previous research commissioned by the Government has indicated that the average construction cost premium for delivering zero carbon homes entirely within the development site could be between 17 – 24% over current build costs by 2016, but would decrease from this peak as the costs of key technologies fall.

More recent evidence identified by the Government has re-examined the costs relating to the Code for Sustainable Homes standards, which cover a wider scope of measures than those directly related to reducing carbon emissions from energy use. Typical costs, again relating to a 2006 Building Regulations baseline, have been found to range up to 40%. A crucial point to consider however is the cost impact of the emerging definition of zero carbon/Code Level 6, which includes off-site 'allowable solutions', and which may, with certain assumptions, reduce cost uplift by a third.

Costs for non-residential zero carbon developments are much less documented but are currently being assessed by the Government following a consultation earlier this year. There is currently little conclusive evidence regarding the additional costs of BREEAM standards that can be used to generalise across non-residential development categories. This is mainly due to the complexity and range of building types and uses in this sector, which clearly impacts both potential carbon reduction solutions and costs. The Government is currently researching costs in the lead up to a new Zero Carbon definition for new non-domestic buildings alongside a review of BREEAM and a potential Code for Sustainable Buildings.

6) Policy implementation

With the forthcoming changes in Building Regulations, local authorities will need to fully understand the implications and prepare in advance for any additional resource capacity needed to manage and implement the requirements. Development Management in particular will need to fully understand the requirements and range of solutions so that they can confidently enter into planning negotiations with developers and adopt systems for checking compliance, including allowable solutions. This will be particularly important should local policies be adopted that exceed national standards. In addition, ensuring that local renewable and low carbon energy projects are appropriately monitored at both the planning application stage and once they are implemented will help to track the effectiveness of policies and the progress towards local, regional and national sustainable energy targets.

There are a number of opportunities potentially available to the Council to help facilitate the financing and delivery of renewable or low carbon developments including Planning Obligations, the Community Infrastructure Levy and the formation of Energy Service Companies (ESCOs).

7) Conclusions and recommendations

The evidence gathered by this study is intended to set the context and provide guidance on policy development for the areas of sustainable construction and decentralised renewable or low carbon energy generation. The main policy-related conclusions and recommendations are therefore outlined below under the specific policy areas being assessed. Additional recommendations are then outlined separately. Further explanatory text is included in the main report.

Policy Recommendation 1: District-wide sustainable construction policy for new development

The Council should assess further whether local conditions and its in-house capacity could be developed sufficiently in the short term to justify the adoption of standards in advance of Building Regulations. In particular, the capacity and resources needed to draw up and offer developers a form of ‘allowable solution’ for local deployment in advance of 2016 should be evaluated.

Should this capacity be available, the Council could consider implementing standards in advance of Building Regulations (such as Scenario 2) as a carbon emission standard for all larger scale new residential development, but with allowable solutions also an option for pre-2016 standards where developments can prove that the standards are not technically or economically viable.

Once the national definition of Zero Carbon non-domestic buildings is better defined, along with the corresponding future trajectory of Building Regulation carbon reduction standards, a similar policy for non-domestic development could also be implemented, but would again need allowable solutions as an option for pre-Zero Carbon standards.

Should there be significant doubt over the local conditions and the Council's in-house capacity required to implement the above district-wide standards, similar policies could instead be focused on strategic development sites, which may have more proven potential to meet higher standards by virtue of their location and other specific circumstances (see Policy Recommendation 3 below).

The Council should also require an explicit site energy strategy to accompany all larger scale development proposals. This strategy should demonstrate consistency with the following energy hierarchy:

1. Apply energy efficiency measures to reduce demand as far as possible
2. Supply energy efficiently i.e. using decentralised low carbon energy sources where feasible
3. Meet residual demand with as much on-site renewable energy as is practical

Development proposals should also show evidence of having considered wider sustainability issues with reference to the South West Sustainable Construction Checklist.

Policy Recommendation 2: District-wide target for percentage reduction in new development site emissions

It is recommended that a district-wide on-site generation policy should be adopted for all new development. This should be applied in the context of an energy hierarchy where energy demand reduction and efficient supply of energy should be considered first, with the on-site generation policy then used to reduce residual emissions. For example:

"New development will be required to include sufficient on-site renewable energy generation to reduce total CO_2 emissions by at least 20% after accounting for energy efficiency and low carbon energy sources, wherever feasible"

Policy Recommendation 3: Energy/carbon targets for strategic development sites

Once finalised, the Strategic Housing Land Availability Assessment data should be mapped for the district and included on the Energy Opportunities Plans of strategic growth areas, along with other relevant data layers mentioned in this report. The data layers should then be assessed using the GIS package supplied with this report to identify any demonstrable opportunities at new development sites for an increased reduction in emissions when compared to district-wide or national standards, through use of decentralised and renewable or low carbon energy sources. Site-specific targets should then be drawn up as appropriate.

Policy Recommendation 4: Identification and promotion of sites for stand-alone renewable energy generation

The maps, GIS data and resource estimates resulting from this study should be used to help identify sites that hold the best opportunities for renewable energy generation. The Council should then consider ways to allocate or identify them in local development documents, so that applications to develop generation plant within these sites can perhaps be viewed more favourably than elsewhere.

It may be appropriate to develop this policy in conjunction with one on district-wide targets for renewable energy generation (see below).

Policy Recommendation 5: District-wide targets for renewable energy generation

The Council should consider setting district-wide target(s) for renewable energy generation for future milestones. These could potentially be related or aligned to national targets such as the UK target of 15% renewables contribution to total energy use by 2020. It is recommended that the targets state total capacity and energy yield for both renewable electricity and heat but are not prescriptive on technologies, although a 'lead scenario' may serve to illustrate how the targets may be achieved. The targets should be developed through stakeholder consultation and be achievable whilst being suitably challenging.

Policy Recommendation 6: Climate change adaptation

The Council should review the range of policies and guidance proposed or adopted by other local authorities as summarised in this report and consider implementing stand-alone adaptation policies and/or SPD guidance on flooding and summer overheating as a minimum. These should be fully compatible with sustainable construction policies and be periodically reviewed in response to any future changes in climate change prediction data.

General recommendations

Other general recommendations relating to sustainable construction and energy use are as follows:

- To justify and contextualise the development specific policies, the Council should prepare an overarching statement focused on climate change and CO_2 reduction targets. An overall greenhouse gas reduction target of 80% by 2050 and 34% by 2020 is recommended, in line with the latest UK policy set out in the Climate Change Act (2008). Both these targets are set against a 1990 baseline.

- Consideration should be given to material to be included within Supplementary Planning Documents (SPD), such as detailed criteria-based policies, additional details on the required structure and content of proposals for sustainable energy supply (site energy strategies) submitted as part of planning applications, and details on any 'allowable solutions' offered to developers. These should include increased flexibility to encourage the development of district heating in Heat Priority Areas.

- Build on the heat demand analysis undertaken and incorporate finalised SHLAA data and other relevant data layers into Energy Opportunities Plans and examine in more detail the opportunities available for district heating. Explore the Council's potential role in facilitating partnerships and funding mechanisms for low or zero carbon developments, such as establishing Energy Service Companies (ESCos) and identifying opportunities to use the Community Infrastructure Levy (CIL)

- In support of any district-wide renewable energy targets, the Council should consider developing a strategy and action plan to include the following:

    - Develop a strategic plan to establish woodfuel supply chains across Teignbridge
    - Coordinate further discussion on wind power development and the level of landscape-type constraints that should be applied in light of setting area-wide renewable energy targets
    - Investigate further the use of local waste arisings for use in smaller scale energy from waste plant including anaerobic digestion.
    - Undertake a survey of Council-owned buildings to explore opportunities for renewable energy installations.

1 Introduction

1.1 Aim and scope of study

This study aims to provide planning evidence for renewable energy and sustainable construction policies in Teignbridge District Council. A comprehensive range of planning evidence has therefore been drawn together in this report to provide technical expertise and support in generating locally specific evidence related to the potential for sustainable energy generation in Teignbridge, current and future energy demand and the development of sustainable construction policies.

The study explores the viability and feasibility of a set of proposed energy related policies within the Local Development Framework in line with the relevant PPS requirements, most notably PPS1 supplement on Planning and Climate Change. Teignbridge District Council is at the early stages of its Local Development Framework preparation but the emerging documents will set the planning policy context for future development in the district up to 2031 and beyond.

The key objectives of the study are to establish the viability of developing:

1. District-wide sustainable construction policy for a Core Strategy Policy on sustainability of new development
2. District-wide target for the percentage of decentralised and renewable or low carbon energy in new developments to support a Core Strategy Policy on sustainability of new development
3. Specific localised requirements for levels of sustainable construction and/or decentralised and renewable or low carbon energy for new development to support Core Strategy Strategic Allocations Policies
4. District-wide policies regarding unique and significant opportunities to support stand-alone renewable energy generation
5. District-wide renewable energy targets
6. Policies or guidance on climate change adaptation requirements and opportunities

Although the study considers opportunities and constraints across Teignbridge District as a whole, it should be noted that the local planning authority for Dartmoor National Park is the Dartmoor National Park Authority (DNPA). As such, planning decisions within Park boundaries are made in the context of the Dartmoor National Park Local Development Framework[1].

1.2 Study context

The potential impacts from climate change, principally as a result of carbon dioxide emissions, are now sufficiently understood to cause grave concerns about our future environmental and socio-economic welfare. To better understand these impacts at a local level, the probabilistic climate change impacts on UK regions can now be established using the UK Climate Projections Data 2009 (UKCP09), which is currently the best available source of data for analysing potential scenarios of future climate change.

[1] http://www.dartmoor-npa.gov.uk/index/planning/pl-forwardplanning/pl-localdevframework.htm

Appendix D of this report presents a summary of these impacts for Teignbridge and the South West and concludes that the region will experience increased mean temperatures in both winter and summer, for all emissions scenarios. Other impacts assessed include precipitation and extreme weather events such as heat waves, storm surge and sea level rise. Over the last few decades the UK Government has introduced a range of policies, targets and guidance on mitigating and adapting to the effects of climate change and there is now an emphasis on local authorities to do the same.

New development and energy infrastructure are areas where much can be done to combat and prepare for the impacts of climate change and local authorities are best placed to understand the opportunities and constraints specific to their areas. Local planning systems can therefore be used as an effective tool to legislate and encourage effective climate change mitigation and adaptation measures in the design of new buildings and energy supply systems.

2 Policy and regulatory context

The land use planning system is one of the most powerful tools available for supporting the move towards greater use of sustainable energy. It was given additional importance in this respect following the Government's Planning White Paper, 'Planning for a sustainable future' published in May 2007. This sets out detailed proposals for the reform of the planning system and makes it clear that local planning authorities have a crucial role to play in tackling energy efficiency and climate change.

There is an extensive range of policy and legislation at various levels which supports the development and implementation of low-carbon and renewable energy. This section of the report provides an overview of the most relevant planning policies and legislation at the national and regional level.

2.1 National policy developments

There have been a number of key national policy drivers of change in terms of the agenda to tackle climate change and increase both the development and use of sustainable and renewable energy sources. These key drivers include the following, some of which are discussed below:

- Climate Change Policy:
    - Climate Change Act 2008
    - Copenhagen 2009
    - UK Low Carbon Transition Plan 2009
- Energy Policy:
    - Energy White Paper 2007
    - EU Energy Directive 2009
    - UK Renewable Energy Strategy 2009
- Planning Policy:
    - PPS22 – Planning for Renewable Energy 2004
    - PPS1 – Supplement on Climate Change 2007
    - Planning and Energy Act 2008
    - Energy Act 2008

Climate Change Act 2008

The Act puts in place a number of legally binding targets, including the reduction of greenhouse gas emissions by at least 80 per cent by 2050. Although the Act does not reference the role of local authorities in any great depth, the carbon targets and budgets and the work of the Committee on Climate Change will be important in guiding the work of local authorities going forward.

Copenhagen 2009

The UN Climate Change Conference, held in December 2009, was a crucial moment in the international fight against climate change. However, for many the outcomes of the conference fell short of the high expectations. The UK, however, still faces the challenge of meeting the targets set by the European Union and its own national targets.

UK Low Carbon Transition Plan, 2009

The UK Low Carbon Transition Plan was launched in summer 2009 and sets out the UK's first ever comprehensive plan to deliver emission cuts of 18% on 2008 levels by 2020. The plan sets out a range of actions that Government will take.

Energy White Paper 2007

The Energy White Paper highlights that the planning system should give weight to the wider benefits of renewables, even if there are no immediate apparent local benefits; this is covered explicitly in the 'Renewables Statement of Need'.

European Energy Directive 2009

The EU Energy Directive requires that 15% of the UK's total energy use should be supplied by renewable energy sources by 2020.

UK Renewable Energy Strategy 2009

This is the framework proposed by the Department of Energy and Climate Change (DECC) to increase the electricity, heat and energy for transport which is generated from renewable sources. It is core to the UK's wider climate strategy which aims to reduce carbon emissions by 80% by 2050 (based on 1990 levels).

Planning Policy Statements

Planning Policy Statements (PPSs) set out the Government's national policies on different aspects of spatial planning in England. They set out a range of guidance on planning policy that LPAs should take into account when drafting their Local Development documents and determining planning applications. The ambitions and policies outlined in PPSs should be fully reflected by planning authorities in the preparation of Local Development Frameworks. The most relevant PPSs to this study are outlined in Box 1 below.

Box 1: Key Planning Policy Statements

- **PPS22 – Planning for Renewable Energy (2004)** requires regional and local planning policies to include renewable energy targets, criteria policies and the identification of broad areas for renewable energy development at the regional level. PPS22 identifies a number of key objectives including:
    - Renewable energy developments should be capable of being accommodated throughout England in locations where the technology is viable and environmental, economic and social impacts can be addressed satisfactorily
    - Development proposals should demonstrate any environmental, economic and social benefits as well as how any environmental and social impacts have been minimised through careful consideration of location, scale, design and other measures.

  In terms of landscape and visual effects of renewable energy development, PPS22 advises that effects will vary depending on location and landscape setting. It also notes that some of these effects may be minimised through appropriate siting, design, and landscaping schemes. Therefore, the consideration of environmental criteria is key in the siting and design of renewable technologies. The guidance requires that policies in local development documents should address the minimisation of visual effects, e.g on the siting, layout, landscaping, design and colour of schemes.

  The companion guide to PPS22, provides guidance on criteria based policy, and suggests that there should be two forms: one for stand-alone renewable schemes and one for building integrated renewable energy technologies. For standalone schemes, the policy should cover impact on landscape, townscape, natural, historical and cultural features and areas. These aspects can often be assessed by reference to the landscape character and sensitivity assessment, which is typically prepared at the county or regional level. The policy should also cover the impact on the amenity of the area in relation to visual intrusion, noise, dust, odour and traffic generation. The guide, also advises that local authorities will need to consider the use of zones of visual influence, cumulative effect and separation distance.

- **PPS1 Supplement: Planning and Climate Change (2007)** makes it clear that tackling climate change is central to what is expected of good planning. The PPS1 supplement highlights the following requirements:
    - That it should take precedence over other PPS's if there is a policy conflict
    - That Core Strategies should add to RSS policy in order to achieve progress in achieving the PPS's key objectives
    - That planning authorities should "alongside any criteria-based policy developed in line with PPS22, consider identifying suitable areas for renewable and low carbon energy sources".
    - If renewable energy targets are not being achieved a prompt and effective response is required.

- **PPS7 – Sustainable Development in Rural Areas (2004)** generally encourages good quality design and emphasises the importance of landscape designations. It sets a number of key objectives and two that will be most relevant to renewable energy developments are:
    - Good quality, carefully-sited accessible development within existing towns and

villages should be allowed where it benefits the local economy and/or community, and

- All development in rural areas should be well designed and inclusive, in keeping and scale with its location, and sensitive to the character of the countryside and local distinctiveness.

Note – the PPS1 Supplement on Climate Change makes it clear that, where there is any difference in emphasis on climate change between the policies in the PPS1 Supplement and other PPS in the national series, the difference is intentional and that PPS1 takes precedence. This precedence of the PPS1 supplement should be viewed only in terms of the difference in policy in relation to climate change, with all other policy requirements also needing to be met by LDFs (such as affordable housing policy). Only where other policy documents conflict with or contradict the policy set out in the PPS1 supplement (addressing climate change) should the policy in the PPS1 Supplement be the guiding policy.

It should also be noted that, in March 2010, a Draft PPS consultation: Planning for a Low-Carbon Future in a Changing Climate was issued, which aimed to update and bring together in one place existing planning policy on climate change (PPS1 Supplement) and renewable energy (PPS22). It was originally intended that this streamlined policy will be central to the national series of Planning Policy Statements, and operate alongside the new suite of National Policy Statements for energy infrastructure. However, the future of this Draft PPS is currently uncertain pending Government announcements on the future of the planning system.

Planning and Energy Act 2008

The Planning and Energy Act 2008 enables local planning authorities in England and Wales to set requirements for energy use and energy efficiency in local plans.

This gives local authorities the power to introduce policies that impose reasonable requirements for:

- A proportion of energy used in development to be delivered using renewable energy technologies in the locality of the development;
- A proportion of energy used in development to be low carbon energy technologies in the locality of the development; and
- Development in their area to comply with energy efficiency standards that exceed the energy requirements of the Building Regulations (Part L1).

This establishes the legality of so-called ‘Merton Rule’ policies (see Section 7.4). The Act does not provide a definitive answer to what is classed as ‘reasonable’ but does state that the policies must be consistent with relevant national policies.

Energy Act 2008

This Act included the Feed-in Tariffs (Specified Maximum Capacity and Functions) Order 2010 (“the FITs Order”), which came into effect on 1 April 2010. Feed-in tariffs (FITs) offer financial support for low-carbon electricity generation in projects up to 5 megawatts (MW). The aim is for generators to receive a guaranteed payment for generating low-carbon electricity.[2]

Note – as announced as part of the Government's Comprehensive Spending Review in October 2010, a similar national scheme for renewable heat, the Renewable Heat Incentive (RHI), is now likely to go ahead in 2011.

Box 2: The Coalition Government
Following the recent General Election held in May 2010; the new Coalition Government has published its 'Programme for Government' which sets out the programme for partnership over the next five years. This strategy includes the Coalition plans in relation to energy and climate change, stating that the Coalition Government believes that climate change is one of the gravest threats we face, and that urgent action at home and abroad is required.

The programme states that we need to use a wide range of levers to cut carbon emission, decarbonise the economy and support the creation of new green jobs and technologies. It is this support of green technologies where the planning system has is significant role to play.

In the programme the Coalition Government lists its intentions in relation to energy and climate change, the following list summarises those that are most relevant to planning at both the national and local level.

- Push for the EU to demonstrate leadership in tackling international climate change, including support for an increase in the EU emission reduction target to 30% by 2020
- Increase the target for energy from renewable sources, subject to the advice of the Climate Change Committee
- Continue public sector investment in carbon capture and storage technology for four coal-fired power stations
- Establish a full system of feed-in tariffs in electricity – as well as the maintenance of banded Renewables Obligation Certificates
- Introduce measures to promote a huge increase in energy from waste through anaerobic digestion
- Introduce measures to encourage marine energy
- Establish an emissions performance standard that will prevent coal-fired power stations being built unless they are equipped with sufficient carbon capture and storage to meet the emissions performance standard
- Give an Annual Energy Statement to Parliament to set strategic energy policy and guide investment
- Deliver an offshore electricity grid in order to support the development of a new generation of offshore wind power
- Encourage community-owned renewable energy scheme where local people benefit from the power produced. Allowing communities that host renewable energy projects to keep the additional business rates they generate.
- Work towards an ambitious global climate deal that will limit emissions and explore the creation of new international source of funding for the purpose of climate change adaptation and mitigation

[2] See : http://www.ofgem.gov.uk/sustainability/environment/fits/Pages/fits.aspx

- The Liberal Democrats oppose any new nuclear construction. Conservatives, however, are committed to allowing the replacement of existing nuclear power stations provided that they are subject to the normal planning process for major projects (under a new National Planning Statement), and also provided that they receive no public subsidy
- Implement a process allowing the Liberal Democrats to maintain their opposition to nuclear power while permitting the Government to bring forward the National Planning Statement for ratification by Parliament so that new nuclear construction becomes possible.

The Government has also indicated that it is committed to giving a greater say to people, communities and councils through a faster and more democratically accountable planning system. As part of this, it has ambitious plans to reform planning policy and publish a simple and consolidated framework covering all forms of development. This framework will include national economic, environmental and social priorities and will be presented to Parliament.

Clearly little of the above is policy yet under the new Coalition Government, and the existing national level policy will remain in place until it is superseded by new policy. However, a number of significant changes have already occurred under the new Coalition Government affecting the status of regional planning policy or legislation and this is reviewed in the following section.

2.2 Regional policy developments

Following regional reorganisation in 2009, the Strategic Leaders Board (an executive arm of South West Councils) has responsibility for planning, transport and housing as was formerly undertaken by the Regional Assembly. This includes the publication of the new Single Regional Strategy (SRS) to replace the emerging Regional Spatial Strategy and Regional Economic Strategy as proposed under the previous Government administration. Prior to the General Election held in May 2010, only initial evidence gathering work had been commenced to inform the new SRS. Therefore, at the regional level, planning policy is still provided by the Regional Spatial Strategy (RPG10) which was adopted in September 2001.

Regional Planning Guidance RPG10

The adopted regional guidance provides only limited guidance in terms of renewable energy. Policy RE6 – Energy Generation and Use, states that local authorities should support and encourage the region to meet the national targets as well as encouraging greater use of renewable energy. In terms of local planning policy, documents should set criteria for assessing renewable energy projects and promote energy conservation measures through policies for design, layout and construction techniques.

Regional Analysis and Studies

A key sustainable energy study in the South West was REvision 2020 (2005), a project funded by the Government Office for the South West (GOSW) in partnership with the South West Regional Assembly (SWRA). It took forward the Revision 2010 target setting report for renewable electricity published in 2004. REvision 2020 extended the existing body of work by looking to establish regional targets for renewable electricity to 2020, adding targets for renewable heat for 2010 and 2020 and a target for on-site generation within new development. The objective was for the outcomes of REvision 2020 to be considered for incorporation within the proposed Regional Spatial Strategy (RSS).

Regen SW is the sustainable energy agency for the South West region, and more recently assessed the opportunities for renewable energy deployment across the region in '*The Road to 2020*'.[3] Recent studies indicate that generating 20% of all energy consumed in the region from renewables is possible by 2020 but to achieve this it will require rapid changes in national policy and stronger support form decision makers at the local level. For local decision makers to be able to give this stronger support there needs to be the appropriate local policy framework in place. Regen SW predicts that without the changes less than 5% of the region's energy requirement will come from renewable sources.

2.3 Overview of sustainable construction standards

2.3.1 Building regulations and the definition of zero carbon homes

Background

In December 2006, alongside the introduction of the Code for Sustainable Homes, the Government issued the consultation document 'Building a Greener Future: towards zero carbon development' which outlined a ten-year timetable for moving towards zero carbon new build dwellings by 2016. The document proposed to use the minimum carbon dioxide reduction requirements of the Code for Sustainable Homes as the basis for future improvements to the Building Regulations. This timetable was confirmed in the 'Building a Greener Future: policy statement' published in July 2007.

It was proposed that there will be three rounds of improvements to the carbon dioxide requirements in Part L of the Building Regulations, as shown in Table 1 below.

Table 1: Increasing emissions reduction requirements of Part L of the Building Regulations

Date	2010	2013	2016
Emissions reduction improvement of the dwelling compared to 2006 Part L Building Regulations	25%	44%	Zero carbon
Equivalent standard of the Code for Sustainable Homes	Level 3	Level 4	Level 6

For a new home to be genuinely zero carbon it would need to deliver zero carbon (net over the year) for all energy use in the home – cooking, washing and electronic entertainment appliances as well as space heating, cooling, ventilation, lighting and hot water. This suggested that the CO_2 emissions from appliances and cooking, and cooling within the home, might be brought under control using the Building Regulations. The Government later acknowledged that the high-level definition of zero carbon set out in this policy statement (and that under Code level 6) might not apply in all situations.

[3] See http://www.regensw.co.uk/projects/support-for-decision-makers/targets-progress

Currently the carbon reduction targets for 2010 and 2013 still stand – these relate to 'regulated emissions' only i.e. those resulting from space and water heating, fixed lighting and ventilation. The relationship between regulated and unregulated emissions is shown in Figure 1 below, where it can be seen that regulated emissions only account for around two-thirds of total emissions.

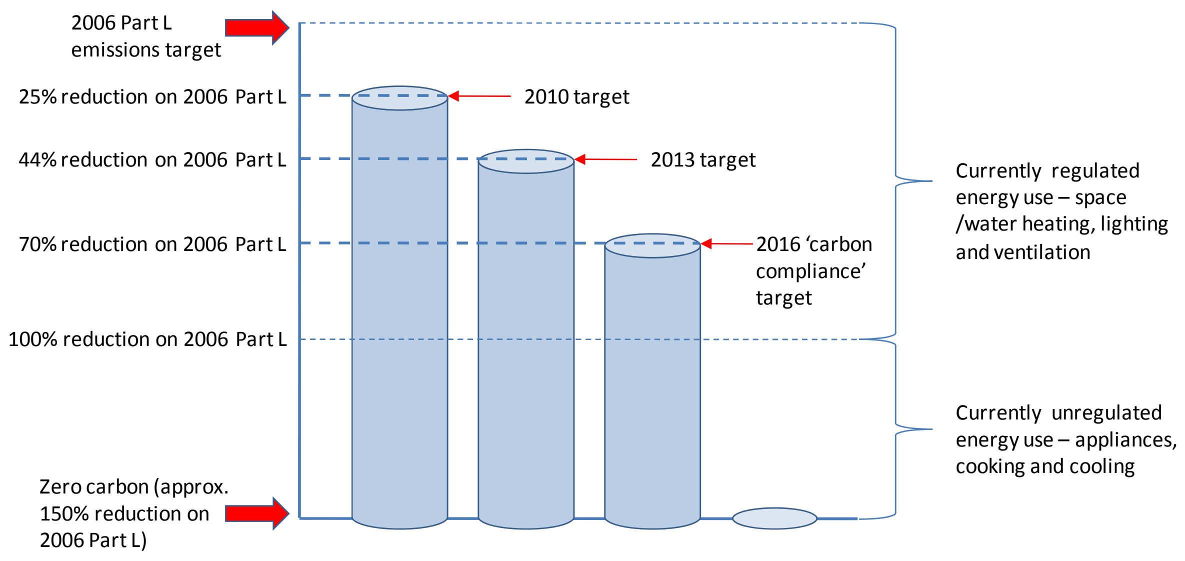


Figure 1: Reduction of CO_2 emissions from new housing

The Government has since completed a consultation on the definition of zero carbon homes and non-domestic buildings to assess the requirements from 2016. This has resulted in a proposed hierarchy of carbon reduction measures to achieve 'zero carbon' status as described below.

Proposed approach

There are three elements to the hierarchal definition of zero carbon homes proposed in the consultation:

- **Energy efficiency** – high standards;
- **Carbon compliance** - on-site solutions and connected heat; and
- **Allowable solutions** – potentially a range of solutions to mitigate residual emissions that are difficult to achieve on-site

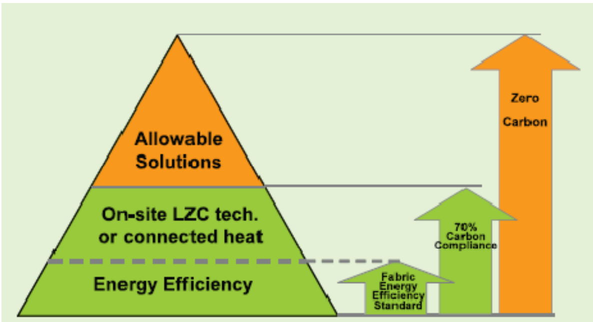


Figure 2: Zero carbon and carbon compliance (source: Zero Carbon Hub)

Energy efficiency

It is proposed that high levels of energy efficiency be included as standard regardless of the mix of carbon reduction measures adopted. The key factors in minimising energy demand are to ensure a home is airtight and well-insulated so that it uses little or no energy for space heating. In July 2009, the Zero Carbon Hub set up a specialist task group to advise on a minimum fabric energy efficiency standard that would help achieve this. The resulting standard describes the maximum energy demand per square metre of floor area per year with which the fabric design must comply.[4]

To simplify the process, there are just two levels of energy demand proposed, covering space heating and cooling for all building types. For apartment blocks and mid-terrace houses, the maximum energy demand is 39kWh/m^2/y. For detached, semi-detached and end of terrace houses, where the heat loss is greater, the maximum energy demand has been relaxed to 46kWh/m^2/y (see Figure 3).

To provide a reference, this level of energy demand equates to an approximate 20-25% reduction in CO_2 emissions compared with 2006 Part L regulations for a gas heated home. A key aspect of the standard is that one specification will work for almost all dwellings, with the exception of a detached house where the specification for some fabric elements will need to be slightly enhanced.

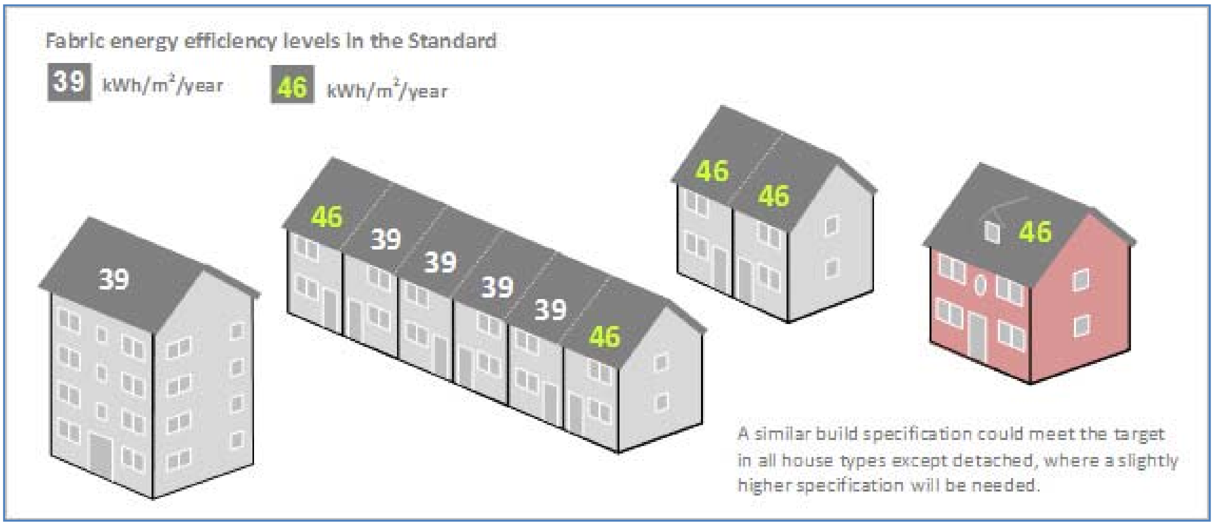


Figure 3: Proposals for a zero carbon fabric energy efficiency standard [source: Zero Carbon Hub]

The recommendation from both the Task Group and through the consultation process is for a two step introduction, with the Standard implemented in 2016 but with an interim step at 2013. Within the timescales available for this initial project the Task Group has concluded that the exact details of what the '2013 step' might include requires further research.
The discussions have centred around either:-

- an interim performance target which is less onerous than the 2016 level, or,
- an increased testing and monitoring programme from 2013 focusing on key aspects including air permeability, thermal bridging and installation quality to accelerate industry learning prior to 2016

Carbon compliance

The carbon compliance standard would require at least a minimum level of carbon reduction (compared to Part L 2006 Building Regulations) through:

[4] *Defining a fabric energy efficiency standard for zero carbon homes*: Task Group Recommendations; Zero Carbon Hub, Nov 2009

- a combination of energy efficiency measures to meet the minimum building fabric standard;
- incorporation of on-site low and zero carbon (LZC) energy technologies and/or directly-connected heat (not necessarily on-site).

Important findings from the analysis undertaken for the consultation include:

- the higher the carbon compliance level is set, the fewer technology combinations that can meet the requirement, and the greater the capital cost;
- no technology combination eliminates 100% (regulated and unregulated) of emissions in flats; and
- beyond 70% regulated carbon reductions, biomass technologies feature more strongly among the viable technology combinations (and almost exclusively for the most demanding standard).

A written statement[5] from CLG issued in July 2010 has since confirmed that a minimum standard for fabric energy efficiency will be introduced to future revisions of Part L Building Regulations, but that the **70% of regulated emissions** carbon compliance figure will be re-examined (see Figure 1). Building Regulation Part L reviews between now and 2016 will decide the exact level and details, and any potential variation by dwelling type, based on the latest information available at the time the review takes place.

Allowable solutions

The energy efficiency and carbon compliance standards set out in the Government's consultation and outlined in the preceding section will significantly reduce the carbon emissions of a new home compared to current regulations. However, this leaves a residual carbon footprint that needs to be addressed in order to meet the zero carbon home standard (100% carbon reduction, including regulated and unregulated emissions).

The Government has therefore proposed 'allowable solutions' to deal with the residual emissions. So far, proposed allowable solutions include[6]:

- Carbon compliance beyond the minimum standard – for example, improved fabric energy efficiency
- Credits for energy-efficient appliances or building controls to reduce the energy demand from appliances
- Exporting low carbon or renewable heat from a development – for example, from a domestic CHP system
- Credit for a contribution by the developer towards local low- or zero-carbon (LZC) infrastructure such as a local heat network
- Improving the energy of existing buildings in the vicinity
- Investment by the developer in LZC energy infrastructure, where the benefits of ownership are passed to the purchaser of the home

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[5] http://www.publications.parliament.uk/pa/cm201011/cmhansrd/cm100727/wmstext/100727m0001.htm
[6] see *Towards Zero – Working with the Zero Carbon Hub to deliver tomorrow's new homes*, Zero Carbon Hub, June 2010

- Credit for emissions savings relative to grid electricity where offsite renewable energy is connected directly to the development

The 'Towards Zero' report by the Zero Carbon Hub also states that many stakeholders would like to see the inclusion of a buy-out mechanism or fund. Other allowable solutions remain under consideration and the Government has also proposed a mechanism providing a capped cost that industry is expected to bear in deploying the allowable solutions. For the purposes of the impact assessment undertaken for the consultation, a level of £100 per tonne of CO_2 was assumed and that any residual emissions would be covered for 30 years. Allowable solutions are expected to be finalised in the near future to provide clarity to developers and enable them to plan ahead with sufficient confidence.

2.3.2 Code for Sustainable Homes

The Code for Sustainable Homes was introduced in April 2007 as a single national standard and sustainability rating system for new build homes. The Code looks at the overall sustainability of a new home against a full range of criteria including energy, water, waste, materials, biodiversity and other sustainability criteria. The Code was introduced as a direct replacement for the EcoHomes standard. Since April 2008 all new social housing in England must be built to a minimum of Code level 3 and as of May 2008 a rating against the Code has been mandatory for all new build homes.

Privately-built housing does not have to be built to any specific level of the Code other than the increased energy standards specified in the Building Regulations, unless specified within Local Development Documents (LDD).

Figure 4 illustrates the nine 'tradable credit' categories appraised in Code assessments and show those that carry mandatory standards.

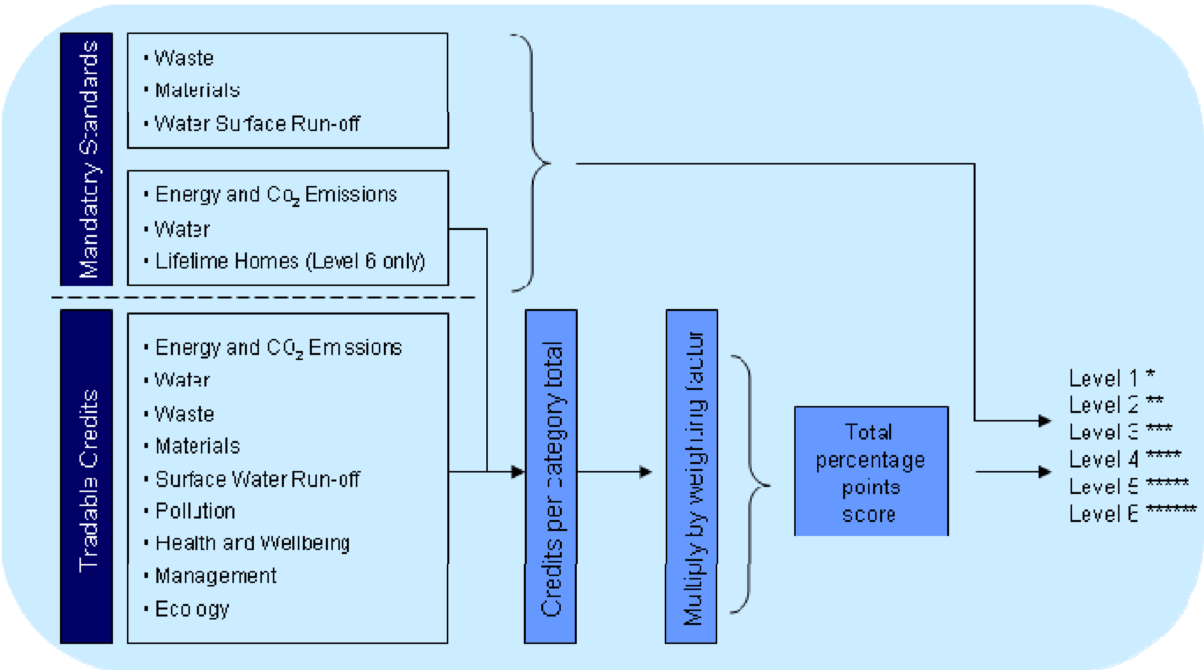

Figure 4: Assessment scope of the Code for Sustainable Homes. (Source: http://www.thecsh.co.uk/howitworks.htm, BRE Global Code for Sustainable Homes)

As discussed in the previous section, the government is currently finalising the definition of the zero carbon standard for new homes beyond 2016 and how this will fit with a revised Code Level 6 standard.

2.3.3 BREEAM

The Building Research Establishment Environmental Assessment Method (BREEAM) is currently regarded by the UK's construction and property sectors as the measure of best practice in environmental design and management. As with the Code for Sustainable Homes, BREEAM certification is undertaken by licensed assessors, ensuring that assessment services are offered by assessors working within a rigorous quality assurance framework.

BREEAM assesses buildings' performance in the following areas:

- Management: overall management policy, commissioning site management and procedural issues;
- Energy use: operational energy and carbon dioxide (CO_2) issues;
- Health and well-being: indoor and external issues affecting health and well being;
- Pollution: air and water pollution issues;
- Transport: transport-related CO_2 and location-related factors;
- Land use: green and brownfield sites;
- Ecology: ecological value conservation and enhancement of the site;
- Materials: environmental implication of building materials, including life-cycle impacts;
- Water: consumption and water efficiency.

Credits are awarded in each area according to performance. A set of environmental weightings then enables the credits to be added together to produce a single overall score. The building is then rated on a scale of Pass, Good, Very Good, Excellent and Outstanding.

2.3.4 Code for Sustainable Buildings

In its 2008 Budget the Government announced its ambition that all new non-domestic buildings should be zero carbon from 2019 (with earlier targets for schools and other public buildings). Following this announcement a UK Green Building Council Task Group published a report in March 2009 recommending the introduction of a Code for Sustainable Buildings to cover all non-domestic buildings, both new and existing. More recently the Government published in November 2009 a consultation on Zero Carbon for New Non-domestic Buildings[7] which closed in February 2010.

This research is currently being considered by the Government and will inform a future sustainable standard for non-domestic buildings which may replace BREEAM and provide details of a Building Regulations trajectory towards a zero carbon standard. It is likely that a similar hierarchical approach to that proposed for zero carbon dwellings will be adopted for non-residential buildings, including a high level of energy efficiency, carbon compliance level and allowable solutions.

[7] http://www.communities.gov.uk/publications/planningandbuilding/newnondomesticconsult

The consultation highlighted the fact that there is a much wider variation in buildings than for homes, which can impact on both potential solutions and costs. For this reason, the forthcoming changes to the Building Regulations in late 2010 are likely to adopt an 'aggregate approach', to deliver the 25 per cent improvement in the most cost-effective way. This means that an overall 25 per cent improvement will be achieved across all new build, but that individual building types will be required to contribute to different levels based upon cost-effectiveness.

2.3.5 South West Sustainable Construction Checklist

The SW Sustainability Checklist[8] was developed by BRE, WWF and Future Foundations. It is an online tool created specifically to help developers in interpreting and helping to deliver regionally significant policies, and originally related to the sustainability issues in the Regional Spatial Strategies first and foremost, although it does have significant innate flexibility and as such can be adapted for local use.

Development policy G of the now defunct draft SW RSS stated:

"Developers, local authorities, regional agencies and others must ensure that their strategies, plans and programmes achieve best practice in sustainable construction by ……. requiring the use of sustainability statements for larger scale residential and/or mixed-use planning applications, the contents of which should meet, or exceed, the South West Sustainability Checklist for Developments."

The draft SW RSS also states in section 3.7.7 that *"The use of the South West Sustainability Checklist for Development is to be encouraged to promote a consistent approach to realising the opportunities of sustainable design and construction"*

As a result, planning authorities across the region had already included policies referencing this in their draft core strategies. However, as described in Section 2.1, the abolition of RSS now means that the decision to include the SW Sustainability Checklist in any emerging Core Strategy now rests entirely with the local planning authority. The abolition of the RSS should not be taken to mean that the Checklist is no longer a useful tool, and a brief description of it is included below.

The Checklist recognises that a range of tools and standards already exist to ensure that the sustainability credentials of individual buildings are of increasingly high standards (BREEAM, Code for Sustainable Homes etc). The Checklist is designed to cover the 'next level up', assessing sustainability issues at masterplanning and application stages in order to help both developers and local authorities deliver sustainable communities.

The Checklist is broken into a series of questions under the following main themes, all of which should be relevant to new large-scale developments:

- Climate Change and Energy
- Community
- Place Making
- Transport and Movement
- Ecology
- Resources

[8] http://www.checklistsouthwest.co.uk/

- Business
- Buildings

Developers can use the checklist to 'interrogate' their proposed designs before submission to the local planning authority. The Checklist's online interface generates a single-page graphical overview of the sustainability performance of the proposed development, which local authority planning officers can use to convey information to Committee members in a consistent format.

The Checklist can be tailored to produce a local version; indeed, many of the minimum standards are not specified and merely state 'compliance with locally developed policy'. Where local policy is actually more stringent than that described under the 'good' or 'best practice' standards in the Checklist, it is possible for a local authority to create new, more stringent descriptions for those standards, effectively raising the bar for their local authority as compared with the regional standards. Local authorities can also add entirely new questions and performance descriptors to address issues that are locally specific, and/or alter the relative weighting of the standard questions.

In the South West, Bath and North East Somerset Council have included a requirement in their draft Core Strategy that new developments are required to use the Checklist.

Other regions have versions of a checklist that are essentially identical to the South West Checklist, as a result of BRE/WWF teaming up with other Regional Development Agencies. In the South East region, Brighton and Hove have an adopted SPD on Sustainable Building Design that clearly states that applications for any residential development or conversion that is not accompanied by a report from the checklist will be considered invalid. Brighton and Hove's checklist[9] is essentially a 'localised' version of the SW Checklist, which contains the best of both the regional and local standards they expect developers to adhere to.

2.4 Local policy – a review of current practice

In order to gauge current practice in local sustainable energy and climate change planning policy formulation, a review of other local authorities across England was undertaken. This looked at both mitigation and adaptation polices included in adopted Core Strategy and SPD policies, along with certain relevant policies outlined in draft Core Strategies that have been through public consultation and have either been submitted for inspection or will do imminently.

2.4.1 Mitigation policies

Mitigation policies have now been adopted by many local authorities although it is evident that a range of policy types have been considered. Factors influencing the choice of policies are varied but include interpretation of government policy guidance, relevant skills/knowledge of planning officers and the level of understanding around local sustainable energy opportunities and constraints. Most local authorities tend to limit the scope of policies to those outlined in Section 1, but some also include additional elements such as an energy/heating/cooling hierarchy (London Plan) and specific policies on district heating (Plymouth).

[9] http://brighton-hove.sustainabilitychecklist.co.uk/

2.4.2 Adaptation policies

A number of climate change adaptation strategies have been developed across the UK, which provide the framework for policy development, but do not currently contain any detailed policies. Although the adaptation strategies themselves have not been reviewed, examples of policies that exceed the requirements of the national standards (PPS/CSH) either in whole or in part were considered. The areas of interest were as follows:

- Resilience to flooding (to adapt to increased frequency/severity of flooding events)
- Water use reductions (to adapt to potential drought)
- Coastal management (adapting to sea level rise/preparing for retreat)
- Green fabric contributions (specifically to mitigate heat island effects)
- Materials requirements (especially planning for future high temperatures)
- Passivhaus or other zero-heating/cooling design requirements (making homes both 'liveable' and affordable in extremes of temperature)

A summary of the review including links to specific documents is given in Appendices A and B.

3 Planning policy options

3.1 Policies to be assessed

The policies being specifically evaluated under the key objectives of this study (as listed in Section 1.1) have, in the large part, been selected by the Council after considering the relevant PPS guidance. As seen in the previous section, such polices actually form part of a suite of potential climate change related policy options that are being considered within various local authority core strategies across the country. As discussed above, the future plans for national guidance revision of PPS1 and PPS22 are currently unclear, but the launch of the South West Planners' Toolkit on Climate Change[10] currently provides further guidance on policy development and the required evidence base. This contains additional policy objectives that local authorities could consider which include:

- Informing site allocation for sustainable energy maximisaton
- Sustainable energy infrastructure fund
- District heating networks
- Local development orders

3.2 Carbon reduction scenarios

In order to illustrate the effects of setting district-wide sustainable energy standards in advance or excess of building regulations, a set of carbon reduction scenarios was assumed against which Strategic Housing Land Availability Assessment (SHLAA) data for Teignbridge was modelled. Although this data has not been finalised, it provides an early indication of the likely housing mix and scale of developments for the district in the short/medium term. Both of these parameters can be used to help model the likely mix of renewable or low carbon energy technologies and their costs that may result when applying specific target scenarios for carbon reduction.

[10] http://www.regensw.co.uk/climate-change-pps

These scenarios assume a certain level of carbon reduction for three distinct phases of development up to and beyond 2016 – these phases also correspond to the expected trajectory of building regulation carbon reduction requirements leading to the zero carbon standard for homes from 2016. Scenario 1 effectively assumes a ‘baseline’ of these building regulation minimum standards i.e. a ‘do nothing’ scenario. Scenarios 2 and 3 introduce more demanding targets. The scenarios are presented in Table 2 below.

Table 2: Carbon reduction scenarios for new development

		Phase 1 (2010-2013)	**Phase 2 (2013-2016)**	**Phase 3 (2016 on)**
Scenario 1 (baseline)	CO_2 reduction target relative to Part L 2006	**25% of regulated emissions**[11] through energy efficiency and carbon compliance measures	**44% of regulated emissions** through energy efficiency and carbon compliance measures	**Zero carbon: 70% of regulated emissions** through energy efficiency and carbon compliance measures plus ‘allowable solutions’ for residual emissions
	Equivalent level of the Code for Sustainable Homes[12]	Level 3	Level 4	Level 4/5
Scenario 2	CO_2 reduction target relative to Part L 2006	**44% of regulated emissions** through energy efficiency and carbon compliance measures	**70% of regulated emissions** through energy efficiency and carbon compliance measures	**Zero carbon: 70% of regulated emissions** through energy efficiency and carbon compliance measures plus ‘allowable solutions’ for residual emissions
	Equivalent level of the Code for Sustainable Homes	Level 4	Level 4/5	Level 4/5
Scenario 3	CO_2 reduction target relative to Part L 2006	**44% of regulated emissions** through energy efficiency and carbon compliance measures	**70% of regulated emissions** through energy efficiency and carbon compliance measures	**Zero carbon ‘plus’: 100% of regulated emissions** through energy efficiency and carbon compliance measures plus ‘allowable solutions’ for residual emissions
	Equivalent level of the Code for Sustainable Homes	Level 4	Level 4/5	Level 5

As will be seen in Section 8, the scenarios were used to model SHLAA data in order to estimate the following parameters:

- the likely technology mix that each standard would promote
- the installed generation capacity per technology
- the resulting emissions savings compared to the baseline scenario
- the estimated costs over and above those for current Building Regulations

[11] Regulated emissions only include those associated with space heating, ventilation, hot water and fixed lighting. Total emissions include regulated emissions plus those associated with cooking and other appliances.
[12] The level shown refers to the carbon reduction achieved through energy efficiency and carbon compliance (onsite generation or direct connection of low or zero carbon heat) measures only.

4 Baseline emissions

4.1 Existing development

Estimating existing energy use and associated emissions is important to establish a baseline from which to measure future changes and monitor progress towards any relevant targets. Total energy consumption across the industrial/commercial, domestic and transport sectors for 2007 was 3,348 GWh.[13] Figure 5 shows the sector split of total emissions for Teignbridge during 2007, with the total emissions figure being 1,022 kt CO_2.[14] This represents approximately 17% of the total for Devon and 2.5% of South West emissions.

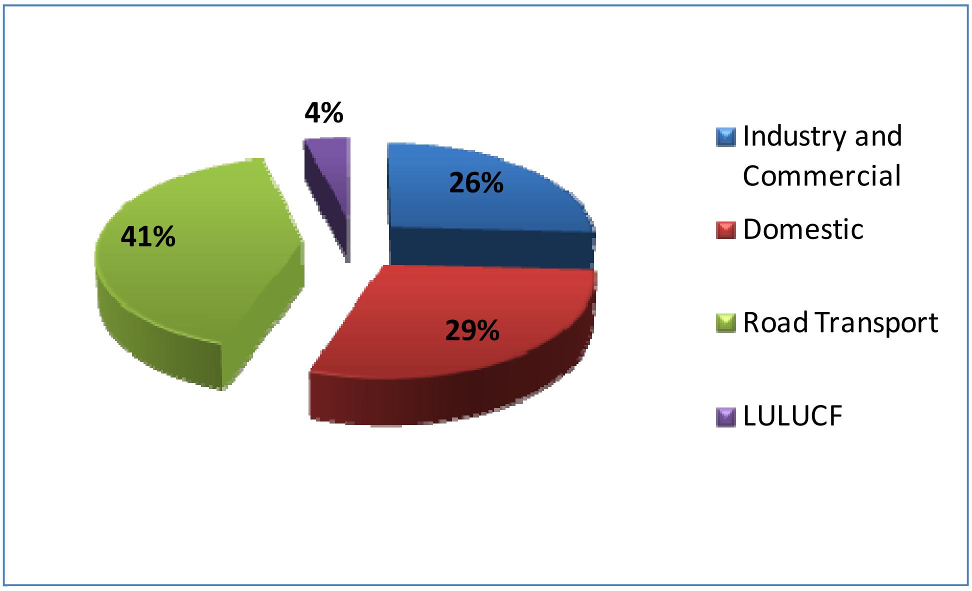

Figure 5: Local CO_2 emission estimates for Teignbridge (2007 figures). Note – LULUCF refers to the emissions and removals from the landuse, landuse change and forestry sector.

Table 3 presents a sub-set of this data for 2008 in the form of building-related (i.e. non-transport) energy consumption in Teignbridge, mostly based on metered data, as split between domestic and industrial/commercial users.

[13] http://www.decc.gov.uk/en/content/cms/statistics/regional/total_final/total_final.aspx
[14] Note – these figures may periodically be revised by DECC. See: http://www.decc.gov.uk/en/content/cms/statistics/climate_change/gg_emissions/uk_emissions/2008_local/2008_local.aspx

Table 3: Teignbridge energy consumption statistics (non-transport)					
Sector	**Electricity [MWh/yr]**	**Gas [MWh/yr]**	**Other [MWh/yr]**	**Total [MWh/yr]**	**CO_2 emissions [tonnes/yr]**
Domestic heat	75,426	607,377	166,192	848,996	199,610
Domestic power	182,610	-	-	182,610	98,062
Total domestic	**258,037**	**607,377**	**166,192**	**1,031,606**	**297,672**
Industrial / commercial heat	-	238,933	164,025	402,958	90,299
Industrial / commercial power	243,134	-	-	243,134	130,563
Total industrial / commercial	**243,134**	**238,933**	**164,025**	**646,092**	**220,862**
Total	**501,170**	**846,311**	**330,217**	**1,677,698**	**518,534**

Note – figures are for 2008 and exclude some large industrial energy users for reasons of commercial confidentiality.

The figure for gas consumption in the domestic sector is likely to decrease slightly over the next decade due to energy efficiency initiatives, although other changes in factors such as comfort levels and electricity consumption may reduce or reverse the effect on overall carbon emissions.

4.2 Future development

4.2.1 Energy demand

In predicting emissions from any potential new development, the effect of any proposed carbon reduction targets on both heat and power demands needs to be considered. More specifically, the proportional reduction that energy efficiency measures are likely to contribute in meeting the targets when compared to that from low or zero carbon energy generation is of particular interest, as the former that will influence energy demands.

For the purpose of estimating projected energy demands from future residential development, baseline heat and power demands for a range of housing types were first identified using those typical of Part L 2006 Building Regulations. One level of energy efficiency ‘backstop’ was then assumed from 2010, which is approximately equivalent to that associated with Level 3 of the CFSH, i.e. an achievement of 20-25% reduction in CO_2 over the Part L 2006 Target Emission Rate (regulated emissions). As indicated in the Energy Saving Trust Guide CE290, for most house types this level of reduction is usually achievable using energy efficiency measures without the need for on/offsite generation. It is also approximately equal to the minimum fabric energy efficiency standard proposed by the Zero Carbon Hub for the 2016 zero carbon homes standard.

4.2.2 SHLAA

The above assumptions were applied to SHLAA data as supplied by Teignbridge DC in order to model energy demand from new residential development up to 2031, which involved a dataset of

27,826 dwellings making up 190 sites (note – the published Teignbridge SHLAA Review 2009[15] refers to a slightly lower figure of 26,850 dwellings).

Note – it is important to note that the SHLAA data has yet to be finalised and that inclusion of a site in the SHLAA does not guarantee allocation in the LDF or indicate that planning permission will be granted for development. As the SHLAA Review points out, it is likely that many sites identified in the dataset may be found unsuitable for development when subjected to more rigorous testing. However, the dataset makes a useful base on which to model and illustrate the implications of carbon reduction policies on future residential development.

For modelling purposes, a specific mix of housing types has been assumed, based on the assumed housing density within each site. This is an assumption made by Teignbridge DC about the number of dwellings per hectare the site will contain. There are three different density bands (40 dwellings per hectare, 50 dwellings per hectare, and 100 dwellings per hectare)[16].

Sites with higher dwelling densities are likely to have more flats, while sites with a higher proportion of detached homes will by necessity be less dense. In the model, energy consumption is calculated by dwelling type, so it is necessary to make assumptions about the types of dwellings on each site. The table below shows the assumptions which have been made about the mix of dwelling types for each density band.

Table 4: Housing density mix assumption

	Dwelling type mix			
Density (dph)	**flat**	**terrace**	**semi**	**detached**
40	15%	20%	20%	45%
50	35%	35%	15%	15%
100	40%	30%	15%	15%

Energy demands after applying the energy efficiency ‘backstop’ discussed above were then calculated and are shown in Table 5. The demands were then used to predict emissions according to the scenarios shown in Section 3.2 – see Section 8.

Table 5: Modelled energy demand from potential SHLAA sites

Number of sites	Electricity demand (MWh/year)	Heat demand (MWh/year)
190	**79,305**	**149,618**

[15] http://www.teignbridge.gov.uk/CHttpHandler.ashx?id=24919&p=0
[16] In fact the assumed number of dwellings divided by the site area is not exactly this amount, but each site is allocated to a different density band so that sites with similar densities can be easily compared.

5 Renewable and low carbon energy generation opportunities and constraints

5.1 Introduction

This section considers the renewable and low carbon energy generation opportunities and constraints that arise in the Teignbridge district and aims to quantify their generation capacity where appropriate. Certain sustainable energy resources are easier to quantify in that their potential can be independently expressed in terms of stand-alone (i.e. non-building integrated) technology capacities, although in practice their application will be linked to developments. These include wind, woodfuel and waste. Woodfuel in particular will be a key resource in meeting higher carbon reduction targets due to the importance of biomass CHP and community heating systems at this level.

In general, solar and heat pump technologies in the UK are specifically building-related and so are directly influenced by development policies. However, large scale stand-alone solar photovoltaic (PV) systems (solar farms) are beginning to gain interest, mainly as a result of the Feed-in Tariff (see Section 2.1). The theoretical potential of siting these in open spaces is clearly very large, but has not been specifically assessed here.

The categories of low or zero carbon energy sources or technologies considered are listed in Table 6. These are based on the guidance produced by DECC on assessing regional renewable and low carbon energy capacity[17].

Table 6: Summary of low or zero carbon energy source or technology

Category	Sub-category level 1	Sub-category level 2
Wind	Wind - commercial scale Wind - small scale	–
Biomass	Plant biomass	Managed woodland Energy crops Industrial wood waste
	Animal biomass	Agricultural arisings Wet organic waste Poultry litter
	Solid municipal waste	–
	Bio-gas	Landfill gas Sewage gas
	Co-firing of biomass	–
Hydropower	Small scale hydropower	–
Microgeneration	Solar	Solar photovoltaics Solar hot water
	Heat pumps	Ground source heat Air source heat
Combined Heat and Power (CHP) or Trigeneration	Community/large scale Small/micro scale	–
District heating/cooling	–	–

[17] Renewable and Low Carbon Energy Capacity, Methodology for the English Regions, January 2010; DECC

Section 5.8 shows how the assessed renewable energy generation capacity relates to the district's electricity and gas consumption, and illustrates its potential impact on CO_2 reduction compared to district-wide emissions.[18]

Sustainable energy resources specifically related to transport e.g. biofuels, are beyond the scope of this study. In addition, the following technologies will not be considered for the reasons given:

- Geothermal (hot rocks) energy – apart from certain known areas e.g. Cornwall, this resource is currently thought to be minimal in the UK
- Off-shore wind and marine renewables (incl. wave and tidal) – these technologies fall outside the planning jurisdiction of Teignbridge DC
- Fuel cells – these are an emerging technology with emission savings being dependent on hydrogen production technique

Note – there will be a certain amount of renewable energy generation capacity that will be inherent within future development. Whilst some of this capacity is already 'captured' in the assessment that follows (e.g. biomass resources, hydro and wind), some will be intrinsically linked to the type and form of development yet to be built (e.g. solar and heat pumps). This latter capacity is not included below, but is instead considered in the analysis presented in Section 8.

5.2 Existing low carbon and renewable energy generation

The existing installed renewable energy capacity was assessed using information from several sources[19]. The total estimated capacity currently installed in Teignbridge is approximately 6.2MWe of electricity, 96% of which is comprised of landfill gas at Heathfield, and 0.015 MWth of heat. Table 7 provides a breakdown of these figures. In terms of annual energy supply, these totals represent around 3% of Teignbridge's total annual gas and electricity use during 2008.

[18] In estimating potential savings in CO_2 from renewable energy, emission factors of 0.43 $kgCO_2/kWh$ (grid electricity), 0.185 $kgCO_2/kWh$ (mains gas) and 0.025 $kgCO_2/kWh$ (woodfuel) have been used in this section. The emissions factor for electricity is generally used for long term broad evaluation of policies and represents an average figure when considering the UK's future electricity generation mix. However, this figure is regularly revised. Up-to-date figures and a more detailed methodology for evaluating the impact of policies on carbon savings can be found at: http://www.decc.gov.uk/assets/decc/statistics/analysis_group/122-valuationenergyuseggemissions.pdf.

[19] The main source is Regen SW's 2010 Annual Survey, forthcoming. www.regensw.co.uk. Additional information was obtained from Devon Sustainable Energy Network www.dsen.org.uk, Renewable Energy for Devon www.re4d.org and Devon County Council www.devon.gov.uk.

Table 7: Low carbon and renewable energy generation installations			
Name	**Technology**	**Capacity [MW_e]**	**Capacity [MW_{th}]**
Heathfield A Landfill	Landfill Gas	3.641	–
Heathfield C Landfill	Landfill Gas	2.378	–
River Dart Country Park	Biomass	–	0.13
Old Walls Hydro	Small Hydro	0.108	–
Torhill Farm	Biomass	–	0.055
River Dart Country Park	Small Hydro	0.048	–
Honeybag Cottage	Biomass	–	0.035
The Devon English School	Biomass	–	0.03
Sowton Mill	Small Hydro	0.028	–
Stover Park	Ground Source Heat Pump	–	0.024
Pengelly Centre	Biomass	–	0.023
Twelve Oaks Farm	Wind	0.02	–
Dornafield Caravan Park	Solar Water Heating	–	0.007
Bowden Mill	Small Hydro	0.005	–
Bovey Tracy Cricket Club	Solar photovoltaics	0.004	–
Honeybag Cottage	Solar photovoltaics	0.004	–
Ugbrooke Park Hydro	Small Hydro	0.004	–
Ashburton Husbandry School	Wind	0.003	–
Domestic property, Chagford	Solar Water Heating	–	Unknown
Chudleigh Primary School	Solar Water Heating	–	Unknown
Bovey Tracey Swimming Pool	Solar Water Heating	–	Unknown
	Total	**6.243**	**0.304**

It is likely that in addition there could be several other small installations on domestic properties which have been carried out privately and are not captured by any surveys.

The map in Figure 6 below shows the location and capacity of the known installations.

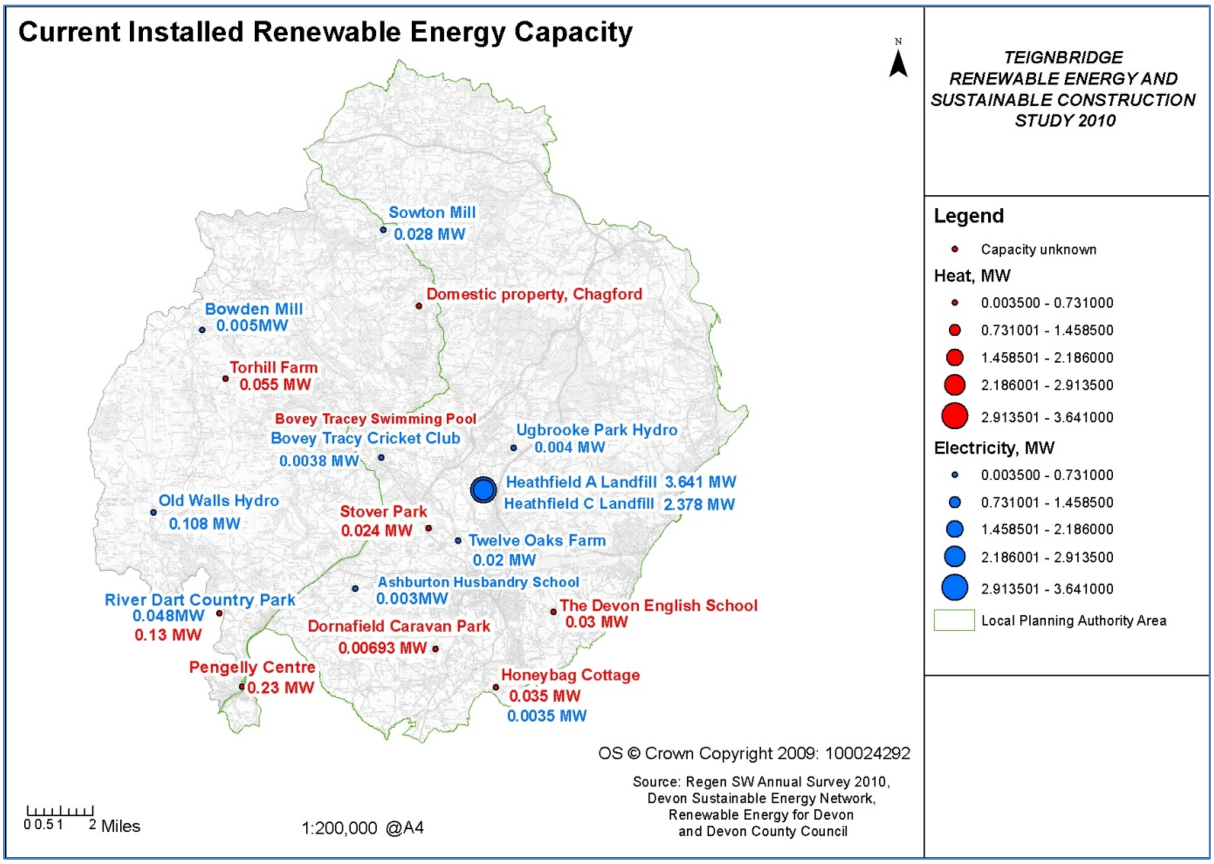

Figure 6: Current Installed Renewable Energy Capacity in Teignbridge

5.3 Wind power

On-shore wind power is an established and proven technology with thousands of installations currently deployed across many countries. The UK has the largest wind resource in Europe yet wind energy currently generates only around 2% of the UK's electricity supply, with an expectation in the 2009 UK Renewable Energy Strategy of this rising to around 20% by 2020. It is planned that this will be delivered by both onshore and offshore plants comprising around 33GW of capacity.[20]

Although there are no rigid categories relating to the scale of wind turbines, individual on-shore turbines tend to fall within four size bands: micro, small, medium and large. These typically range from 5 Watt battery charging models up to 2-3 megawatt commercial scale turbines. The number of turbines used per site ranges from the deployment of single turbines up to large groups of turbines (known as wind farms) capable of generating tens of megawatts. For the purposes of this study, two scales of wind power are assessed – large/commercial scale and small scale, with the latter category also split into small scale stand-alone and building-mounted turbines.

Micro-scale turbines (typically up to 2kW, but can be larger) are generally building-mounted, whereas small and medium scale turbines are supplied with a free-standing mast and are most commonly deployed as single installations supplying specific buildings or developments, for example, a 15kW turbine supplying a farm building, school or small businesses. Larger turbines, typically 100-500kW (still generally considered 'medium' scale), have often been deployed individually under community-ownership schemes. Individual large scale turbines can also be deployed as single machines but are

[20] See UK Renewable Energy Strategy, 2009

more often used in groups in the form of a wind farm development. Wind farms tend to be located in more remote areas and directly supply power to the national grid i.e. they are not associated with a particular development.

An appropriately sited large scale turbine (e.g. 2-2.5MW) will typically generate an amount of electricity equivalent to the annual needs of around 1,200-1,600 homes[21]. This compares to a small scale (e.g. 15kW) turbine which, at a good site, may typically meet the needs of 6-8 homes. Although the wind resource is variable, a typical turbine will generate electricity for 70-85% of the time and its output will vary between zero and full rated output in accordance with the local wind speed. However, the combined output of the UK's entire wind power portfolio shows less variability, given the differences in wind speeds over the country as a whole.

For the majority of developments, particularly ones comprising dwellings, large scale wind is not a feasible option as an on-site solution although under the 'Building a Greener Future' zero carbon definition (and that of Code for Sustainable Homes Level 6), connection by 'private wire' to the development is permitted[22]. Crucially, 'direct physical connection' of off-site renewable electricity is included as an 'allowable solution' in the list mentioned in the Government's Definition of Zero Carbon Homes and Non-domestic Buildings consultation, but is not permitted under the 'carbon compliance' requirements. However, a July 2009 statement by the Government[23] did not list this measure as one that had received 'broad support' under allowable solutions during the consultation.

It is therefore more likely that small scale, and to some extent, medium scale turbines will be the on-site wind power options for developers. Planning restrictions and decreased economy of scale however will still limit their viability when compared to other forms of zero carbon generation.

Note – in the following analysis, various geographical layers of constraint are applied to the theoretical wind resource to assess their impacts. For the purpose of the analysis, the terms 'level 1' and 'level 2' constraints have been used. Broadly speaking, level 1 represents technical or physical constraints and level 2 designated areas. It is important to note that the two levels do not imply any particular order of importance.

5.3.1 Large (commercial scale) wind

a) Technical constraints and limitations

The potential for installations of large-scale wind turbines was assessed using a Geographical Information Systems (GIS)-based constraints analysis. The first level of constraints applied ('level 1') were technical and physical constraints, as detailed in the table below:

[21] assuming an average annual domestic consumption of 3,300 kWh and a load factor of approx. 25%
[22] It should be noted that 'private wire' type arrangements run contrary to recent policy thinking and are made more difficult by recent European Court of Justice findings (see para 5.19 in *Definition of Zero Carbon Homes and Non-domestic Buildings* consultation Dec 2008)
[23] http://www.communities.gov.uk/statements/corporate/ecozerohomes

Table 8: Assumptions and level 1 constraints for large wind	
Turbine size	2.5MW
Hub height	85m above ground level
Minimum wind speed	6 metres / second at hub height
Minimum distance from dwellings*	600m
Minimum distance from non-residential buildings	400m
Minimum distance from roads and rail	150m
Areas excluded (data source)	Lakes (OS Strategi) Rivers (OS Strategi) Ancient Woodland (Natural England) Areas of broadleaved and coniferous trees (Forestry Commission) Scheduled monuments (English Heritage) Historic Parks and Gardens (English Heritage)

*Although there is currently no definitive measure of the minimum distance a turbine should be located from a dwelling, figures generally range from 400 to 700m and are mainly concerned with minimising noise levels. In the analysis below, the inclusion of a buffer zone of 600m around dwellings automatically excludes all conservation areas and amenity greenspace such as public parks. Scheduled ancient monuments and historic parks and gardens are level 1 constraints here because it is assumed that there would be no room for wind turbines in these areas.

Figure 7 below illustrates the areas which are not excluded by these 'level 1' constraints. At this stage areas within Dartmoor National Park have not been excluded, but Dartmoor is shown on the map to illustrate the extent of the resource falling within the National Park.

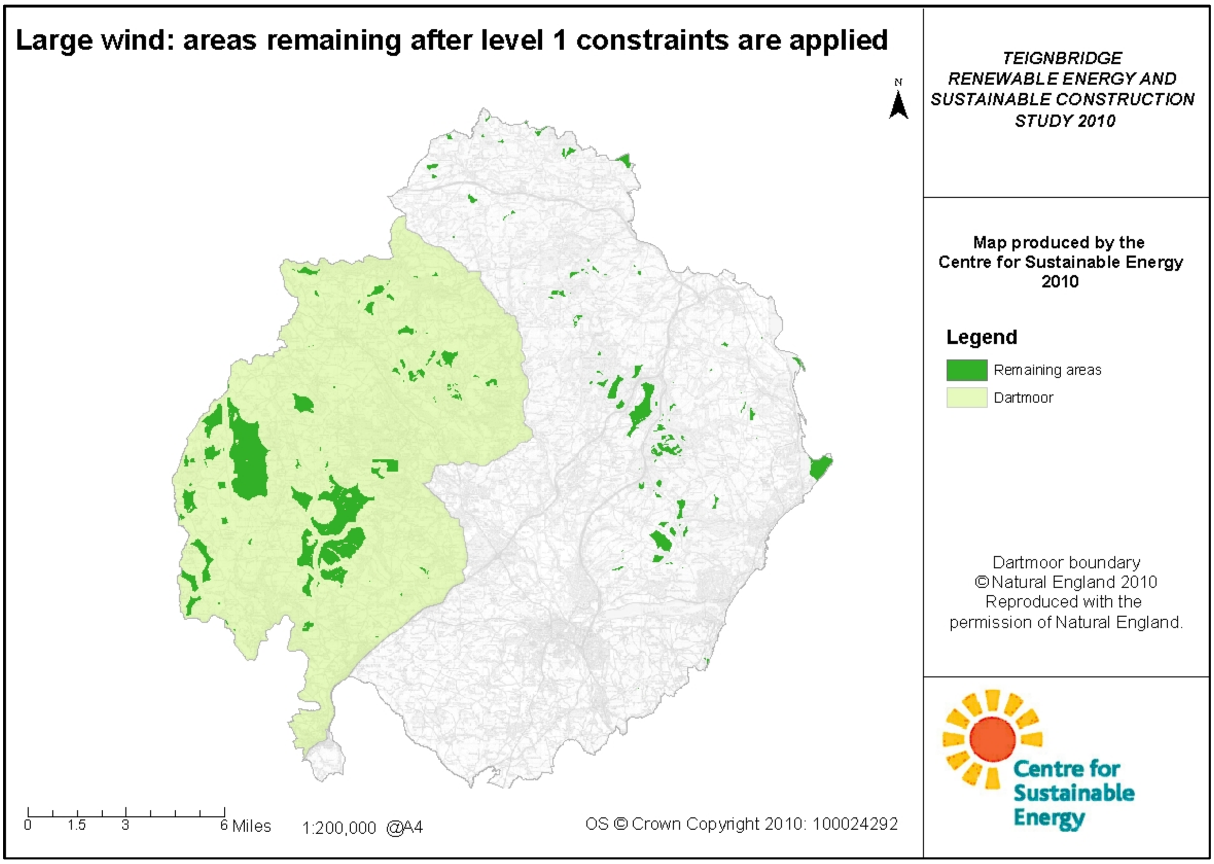

Figure 7: Large wind: areas remaining after level 1 constraints are applied

The land remaining at this stage has a total area of 2,873 hectares.

An additional technical constraint concerns the impact of wind turbines on radar sights and so when locations for wind turbines are chosen the presence of radar coverage needs to be taken into account. The MoD has produced radar 'safeguarding' maps which show areas where wind turbines may interfere with radar. Different areas are affected at different heights above ground level. In these areas, the MoD must be consulted about the location of turbines. However, this does not mean that turbines cannot be located within the safeguarding areas; this will depend on the specific site. Figure 8 shows the same areas as in Figure 7, but with radar safeguarding areas for 140m above ground level overlaid. It can be seen that a large area of the district is affected.

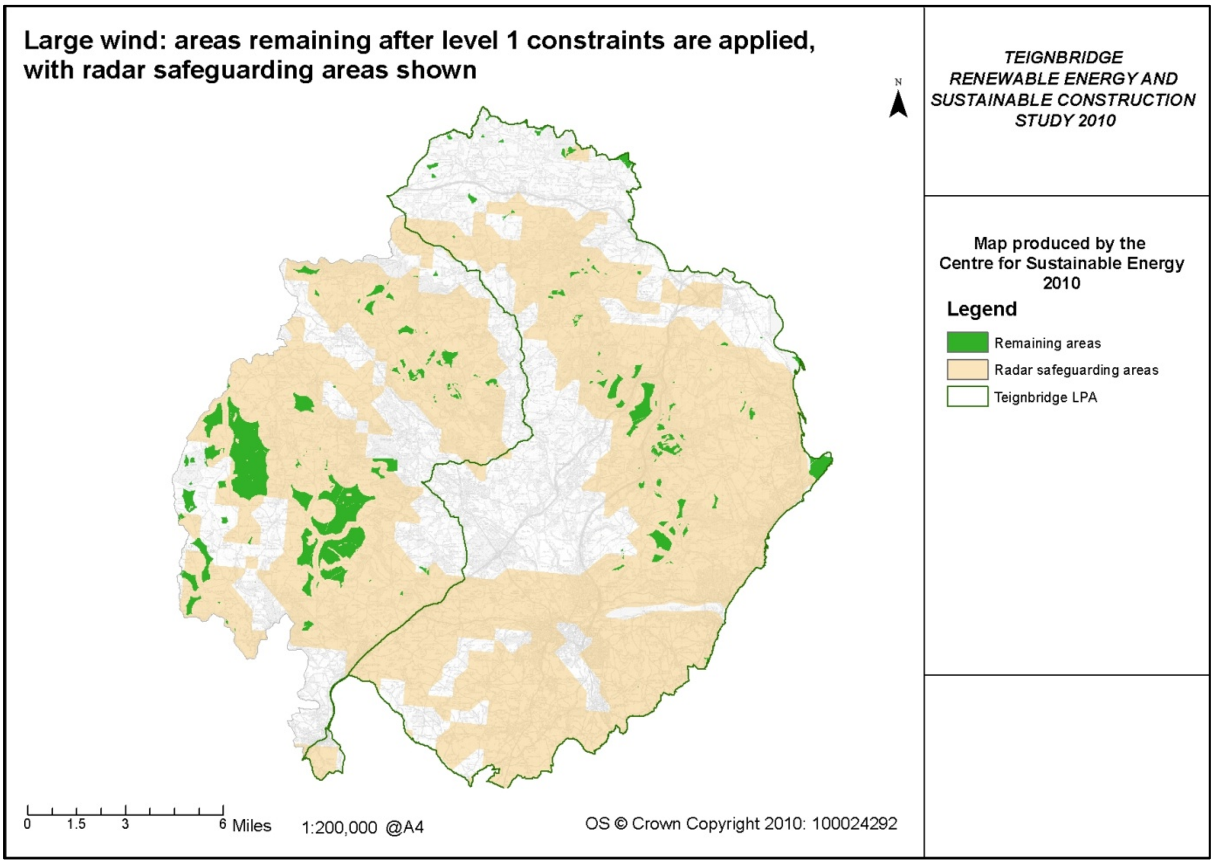

Figure 8: Large wind: areas remaining after level 1 constraints are applied, with radar safeguarding areas overlaid and Teignbridge LPA boundary shown

Other 'technical' constraints that need to be addressed when considering wind power development are very site-specific and are therefore not included in the analysis. For Teignbridge these may include (but not be limited to):

- Practical access to sites for abnormal loads, e.g. turbine blades
- Effect of slope and aspect of site topography on wind speeds
- Hydrology & hydrogeology impacts
- Detailed noise impact assessments (the dwelling buffers used above are a crude approximation of acceptable noise limits)

- Shadow flicker effects on nearby buildings[24]
- Line of sight for telecommunications links
- The capacity of the local grid infrastructure to accept new generation capacity
- Landowner agreement
- Potential ecological, ornithological, cultural heritage and archaeological impacts

b) Landscape and visual impact

The constraints discussed in this section refer to national and international landscape designations and landscape sensitivity to wind turbines. In this document, the term 'designated areas' refers to all of the designations listed in Table 9. The names of all Teignbridge's designated areas can be found in Appendix E.

While large scale wind turbine development is not formally prohibited within designated areas, it is more likely to be problematic due to potential landscape impact and potential impacts on important species. For example, the Core Strategy (2006-2026) of the Dartmoor National Park Authority LDF states that: *"Protection of the special qualities of the National Park means that wind farms, large scale hydro-generation plant or biomass energy systems would generally not be appropriate." (para 5.6.7).*

Depending on the site designation, proposed developments will need to be assessed in relation to any adverse impacts they may have on the integrity of the site and/or the objectives of the designation.[25]

Figure 9 shows the land areas which remain after nationally and internationally designated areas are added as a constraint (here labelled 'level 2' constraints). The designated areas included in the level 2 constraints are listed in Table 9. When level 2 constraints are added, the remaining land does not include any Local Nature Reserves, as these are all located within constrained areas (either designated areas or the residential buffer zone).

Table 9: Designated areas included in level 2 constraints	
Designated areas used as constraints (all data from Natural England)	Dartmoor National Park (National)
	National Nature Reserves (National)
	Sites of Special Scientific Interest (National)
	Ramsar sites (International)
	Special Areas of Conservation (International)
	Special Protection Areas (International)

In practice for Teignbridge, any large scale wind turbine proposal will to be subject to Appropriate Assessment (i.e. in the planning context), while medium and small scale turbines may be subject to Appropriate Assessment depending on their location in relation to Special Areas of Conservation and Special Protection Areas.

[24] Shadow flicker will typically impact a single building for a few minutes at certain times of the day during short periods of the year. The effect can be mitigated by switching off the turbine during these periods. The effect only tends to occur within a distance equivalent to ten times the turbine rotor diameter e.g. 800m for an 80m diameter rotor.
[25] See PPS22 para 9-11

Teignbridge District hosts several designated European wildlife sites which are strongly protected against harm under the Conservation of Habitats and Species Regulations 2010. Legally, the Council must not adopt a plan or issue a planning permission that would result in harm to such sites or their features of special interest, whether in or outside the designated area, through direct or indirect impacts. The district's European wildlife sites are:

- Parts of the South Hams Special Area of Conservation (SAC), where the special interest feature is Greater Horseshoe Bats. In addition to the designated SAC area Natural England has issued maps of sustenance zones and strategic flyways where special consideration must be given to the bats.
- Part of the Exe Estuary Special Protection Area, where the special interest feature is migrating and wintering wildfowl and waders.
- Dawlish Warren SAC, where the special interest feature is dune habitats
- Dartmoor SAC, the special interest feature is moorland habitats and salmon
- South Dartmoor Woods SAC, the special interest feature is woodland habitats

Sites of Special Scientific Interest also receive legal protection and the Council must seek to protect them from harm in the planning process. All bats receive legal protection from harm under British and European law. Many species of birds also receive legal protection.

PPS22[26] stipulates that where proposed renewable energy developments are likely to have an adverse effect on an internationally designated site, such as the European sites listed above, permission should only be granted once an assessment has shown that the integrity of the site would not be adversely affected, unless there are imperative reasons of overriding public interest.

In relation to nationally designated sites, such as National Nature Reserves and National Parks, permission for renewable energy developments should only be granted where the objectives of the designation will not be compromised by the development.

[26] Planning Policy Statement 22: Renewable Energy, Communities and Local Government, 2004, Available from: http://www.communities.gov.uk/publications/planningandbuilding/pps22

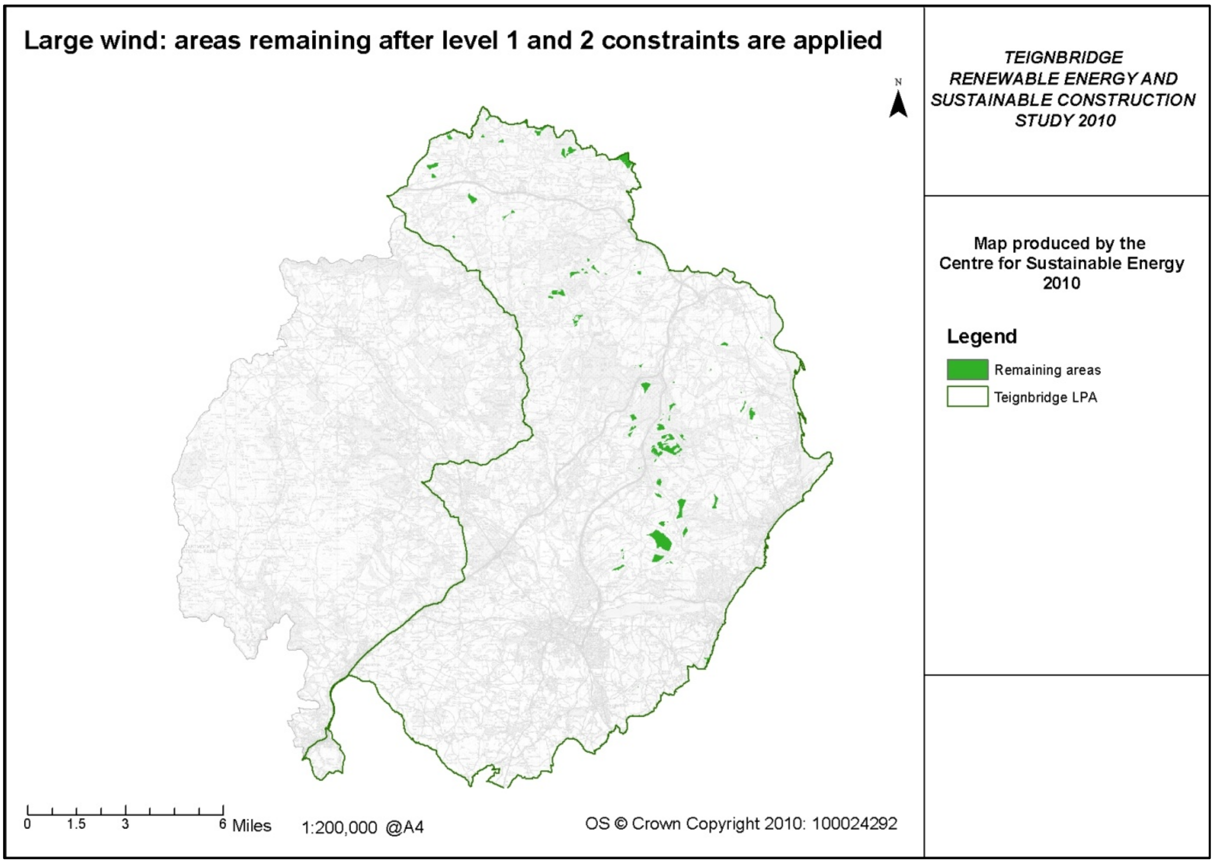

Figure 9: Large wind: areas remaining after level 1 (technical and physical) and level 2 (designated areas) constraints are applied

An additional constraint to wind power concerns landscape sensitivity. This term refers to the extent to which the technology has the potential, in the wrong location, to have significant impact on landscape character. In other words, 'sensitivity' in this context is the extent to which the character of the landscape is susceptible to change as a result of proposed wind developments. The cumulative impact of more than one wind development should also be considered.

Guidance produced by the Countryside Agency and Scottish Natural Heritage includes Landscape Character Assessment Guidance[27] and Topic Paper 6, which states that:

'Judging landscape character sensitivity requires professional judgement about the degree to which the landscape in question is robust, in that it is able to accommodate change without adverse impacts on character. This involves making decisions about whether or not significant characteristic elements of the landscape will be liable to loss... and whether important aesthetic aspects of character will be liable to change'

Although a landscape sensitivity assessment is outside the scope of this study, an example study can be viewed[28] as undertaken within the scope of the West Sussex Sustainable Energy Study. The report summarises key attributes of the landscapes across West Sussex, highlights the special qualities of designated areas (which includes the South Downs National Park), provides a sensitivity judgement highlighting those attributes that would be sensitive to specific renewable technologies, and provides guidance on how these technologies can be located to minimise adverse impacts.

[27] Countryside Agency and Scottish Natural Heritage (2002) Landscape Character Assessment: Guidance for England and Scotland CAX 84
[28] Landscape Sensitivity Analysis & Guidance for West Sussex Low Carbon Study
http://www.arun.gov.uk/assets/Planning/Policy_from_2010/Sustainable_Energy_Study.pdf

Key conclusions from the study, which are also likely to be relevant to Teignbridge, include:

- Results indicate that a strategy to accept character change in some areas may be needed if large/medium scale wind is to contribute to renewable electricity generation in the study area
- When considering the impact of renewable energy generation technologies on landscape character, it is important to recognise that climate change itself will result in changes to our landscapes
- Planning can be used to guide renewable energy proposals so as to spread them apart to avoid cumulative issues, or to cluster them in certain parts of the landscape & keep other areas free of development.

c) Potential energy yield

The remaining land area for large scale wind when both level 1 and 2 constraints are applied (not including potential radar constraints) totals 402 hectares. However, this includes some land parcels which would be too small to locate a 2.5MW turbine within. When all land parcels of less than 1,000 square metres are excluded, this reduces only slightly to 401 hectares. Assuming a density of 1 turbine per 20 hectares (i.e. in land parcels where it would be possible to install more than one turbine), this gives a total potential capacity of 50MW.

Table 10 below summarises the land areas and estimates potential capacity after level 1 constraints are applied, split into those land areas outside of designated areas and those areas inside of designated areas. By definition, the areas outside of designated areas would also pass the level 2 constraint test, while those inside of designated areas would be removed by the level 2 constraint test. The total potential output is equal to 188% of the district's 2008 electricity consumption.

Table 10: Areas for large scale wind and estimated capacity (small land parcels excluded) after applying level 1 constraints

	Hectares	Potential installed capacity MW	Potential output MWh/year
Outside of designated areas	401	50	131,729
Inside designated areas	2,469	309	811,067
Total	**2,870**	**359**	**942,795**

Note - energy yield calculations assume a turbine spacing of 0.05 per ha and a load (or capacity) factor of 0.3. Wind speed is above 6 m/s at hub height. Cumulative impact is not considered.

Load factor (sometimes called 'capacity factor') is a measure of how much energy a generation plant can produce over the course of a year under ideal conditions i.e. continually operating at its maximum output, compared to how much energy it produced in practice under actual conditions. A factor of 0.3 is an industry standard, but this figure varies year by year depending on wind conditions e.g. the average load factor for UK onshore wind in 2009 was 26.9%.[29] As newer, larger and more efficient turbines are deployed, average load factors are likely to increase over previous levels.

[29] Energy Trends, Table 6, DECC Sept 2010

5.3.2 Small scale wind (stand-alone)

a) Technical constraints and limitations

Technical constraints to small scale wind are broadly similar to those for large scale, but impacts are obviously scaled down appropriately. As with large scale wind, an assessment was undertaken using a constraints-based GIS analysis, using the following 'level 1' technical and physical constraints:

Table 11: Level 1 constraints for small wind	
Turbine size	15kW
Hub height	15m above ground level
Minimum wind speed	5.5 metres / second at hub height
Minimum distance from dwellings	120m
Minimum distance from non-residential buildings	20m
Minimum distance from roads and rail	20m
Areas excluded (data source)	Lakes (OS Strategi) Rivers (OS Strategi) Ancient Woodland (Natural England) Areas of broadleaved and coniferous trees (Forestry Commission) Scheduled monuments (English Heritage) Historic Parks and Gardens (English Heritage)

Figure 10 below shows the areas remaining after these constraints are applied. As for large scale wind, small scale turbines may also affect radar sights and so the MoD has identified areas where it should be consulted if the installation of a turbine is proposed. Figure 11 shows the radar safeguarding areas at a height of 20m above ground level. Fewer areas are affected at this height above ground level, compared to 140m for large wind as was illustrated in Figure 8.

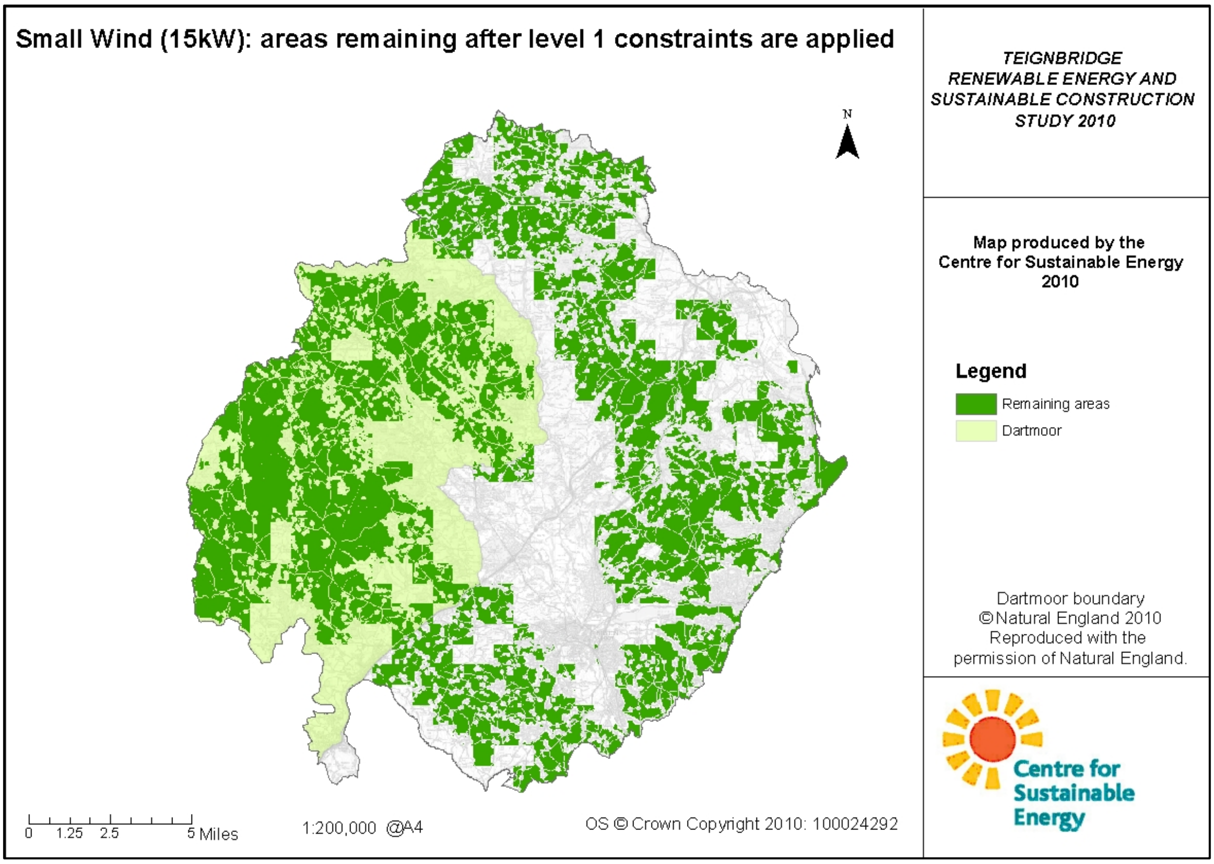

Figure 10: Small wind (15kW): areas remaining after level 1 constraints are applied

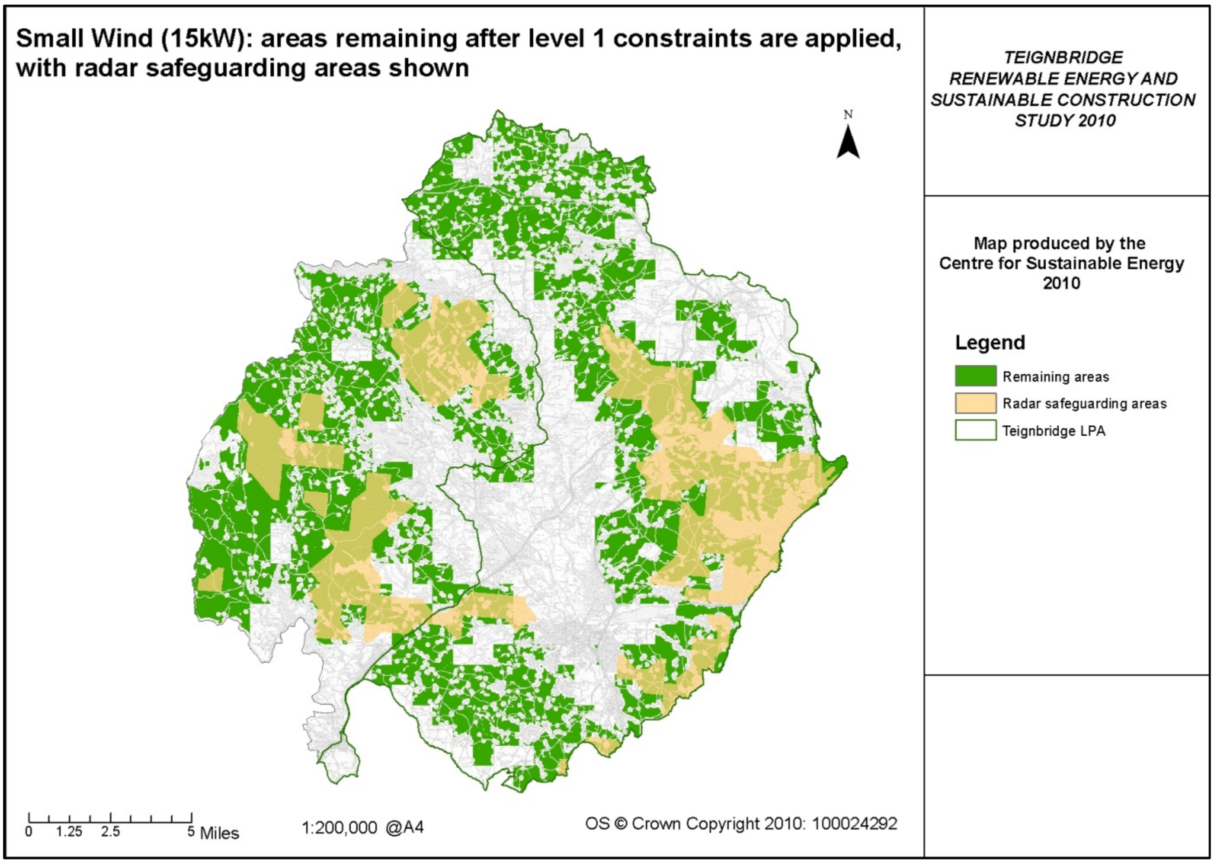

Figure 11: Small wind (15kW): areas remaining after level 1 constraints are applied, showing radar safeguarding areas

b) Landscape and visual impact

Level 2 constraints (designated areas) have not been applied in this analysis for small scale wind. This is because it is generally more feasible to locate small scale wind in designated areas as the landscape impact is less than for large scale wind. However, a landscape sensitivity assessment may still be undertaken in the same way as for large scale wind to compare the impact across different landscapes. Additionally, some designations are based on biodiversity issues as well as landscape and therefore may equally need to be considered. In practice, the wind capacity potential shown below may therefore be reduced accordingly.

c) Potential energy yield

The table below shows the remaining land area and estimated wind capacity after level 1 constraints are applied, divided into areas within and areas outside of designated areas (level 2 constraints). Radar safeguarding areas have not been subtracted from the total land area because wind development is not precluded in these areas.

Table 12: Constrained areas for small scale wind and estimated capacity after applying level 1 constraints

	Hectares	Potential installed capacity MW	Potential output MWh/year
Outside of designated areas	15,159	227	199,189
Inside designated areas	13,751	206	180,688
Total	**28,910**	**434**	**379,877**

Some areas have been identified as suitable for both large and small wind. Table 13 below shows the land area suitable for small wind, excluding overlaps with large wind. It is assumed that large wind takes precedence outside of designated areas, while small wind takes precedence inside of designated areas. However, when specific wind developments are proposed, certain local constraints such as the potential impact on bats and birds in designated areas will need to be assessed.

Table 13: Constrained areas for small scale wind and estimated capacity after applying level 1 constraints, assuming large wind takes precedence outside designated areas

	Hectares	Potential installed capacity MW	Potential output MWh/year
Outside of designated areas	11,297	170	148,443
Inside designated areas	13,751	206	180,688
Total	**25,048**	**376**	**329,131**

Note - energy yield calculations assume a turbine spacing of 1 per ha and a capacity factor of 0.1 (compared to large scale wind, this lower figure reflects the smaller hub heights and hence lower wind speeds that are likely to apply to the modelled turbine). Cumulative impact is not considered.

5.3.3 Micro-scale (building-mounted) wind

In order to assess the capacity for building-mounted, micro-scale wind, the methodology outlined in DECC guidance for assessing renewable energy capacity at regional level was used[17]. This recommends using GIS data to identify the number of buildings in an area, and selecting the buildings in areas with a high enough wind speed at 10m above ground level. Urban, suburban and rural areas were identified at output area level using Defra's Rural Definition dataset. A higher wind speed was required in urban and suburban areas, to allow for turbulence caused by more densely located buildings. The wind speeds, number of buildings, and resulting potential capacity and output are shown in Table 14 below:

Table 14: Potential for building-mounted turbines

Location	Wind speed at 10m above ground level	Number of buildings in these areas	Potential installed capacity MW	Potential output MWh/year
Rural	4.5 m/s	8,103	12.15	5,323
Suburban	6.7 m/s	65	0.098	43
Urban	8 m/s	0	0	0
	Total	**8,168**	**12.25**	**5,366**
	Total within designated areas	***2,075***	***3.11***	***1,363***

Note - energy yield calculations assume a 1.5kW turbine[30] and a capacity factor of 0.05 (compared to larger scale turbines, this lower figure reflects the significantly lower wind speeds that are likely to apply to building-mounted installations – see also Warwick Wind Trials[31]). Cumulative impact is not considered.

These calculations assume a 1.5 kW turbine and a 5% capacity factor. The figures above give the theoretical resource; in practice there would be many types of buildings and locations that would be unsuitable for roof-mounted turbines. Performance is highly dependent on sites with suitable wind speeds and it has been shown that urban rooftops generally suffer from turbulence and low annual average wind speeds making this technology less viable for the majority of urban sites.[31] Sites such as tower blocks or very exposed buildings will offer the most potential.

As with small scale wind, landscape and biodiversity issues may still need to be assessed for micro scale wind at site specific level on a case by case basis, which may in practice lower the estimates shown above.

5.3.4 Total potential energy yield for wind

The capacities for stand-alone and building-mounted small scale wind can be added together to give a total figure for potential small scale wind capacity:

Table 15: Total potential for small wind (15kW mast mounted and 1.5kW building mounted)

	Potential installed capacity MW	Potential output MWh/year
Outside designated areas	230	200,551
Inside designated areas	215	184,691
Total	**446**	**385,243**

The potential output from both large and small scales of wind is shown in Figure 12 below. Where large and small scale wind overlap, large wind has been assumed to take precedence outside designated areas while small wind has been assumed to take precedence within designated areas.

[30] The DECC methodology recommends assuming a turbine size of 6kW but a turbine this size is more often a stand-alone installation rather than building mounted and so we have assumed a smaller turbine size.

[31] See http://www.warwickwindtrials.org.uk/ and http://www.carbontrust.co.uk/PublicationsLibrary/CTC738.pdf

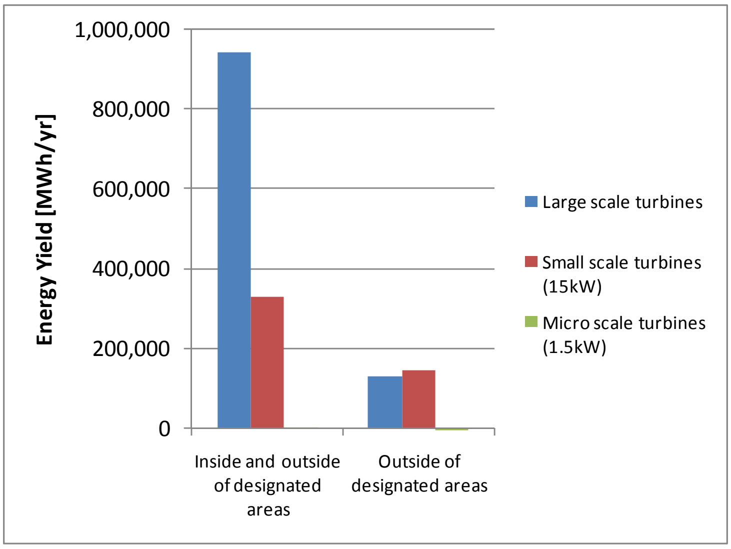

Figure 12: Potential energy yields from all scales of turbine

5.4 Biomass

5.4.1 Types of biomass

Biomass can be generally defined as material of recent biological origin, derived from plant or animal matter. It is often categorised as either ‘dry’ or ‘wet’ biomass, with the former more commonly combusted either to generate heat or to produce electricity, and the latter anaerobically digested to generate ‘biogas’ or used to produce a transport ‘biofuel’.

Biomass is widely used in many countries as a feedstock for modern heating systems. Modern biomass heating technology is well developed and can be used to provide heat to buildings of all sizes, either through individual boilers or via district heating networks. Biomass is also increasingly being used to fuel electricity plant or combined heat and power (CHP) plant due to the low carbon emissions associated with its use.

The most common types of biomass include woodfuel from forestry sources, energy crops or wood waste, agricultural residues and the biodegradable fraction of municipal solid waste.

The principal sources of biomass fuel are as follows:

- Woodlands – products from management of existing woodlands (small diameter roundwood from coppicing or branches, lop and top as forest residues). Alternately biomass may be derived from new woodlands specifically planted for the purpose (e.g. short rotation forestry).
- Energy crops - multi-annual short rotation coppice willow and poplar (SRC) which are coppiced every 2-4 years and miscanthus and other energy grasses (e.g. reed grass and switchgrass) which are cut annually.
- Primary processing co-products (sawdust, slabwood, points etc) and clean wood waste from industry (e.g. pallets, furniture manufacture). General wood waste can also be used as a renewable fuel but contains contaminants which severely constrain the type and size of plant in which it can be used.
- Agricultural by-products e.g. straw, poultry litter and slurry.

- Biodegradable fractions of Municipal Solid Waste (MSW) and commercial/industrial waste.

5.4.2 Woodfuel – woodland residues, co-products and energy crops

a) Overview

The woodfuel resource considered here includes virgin (untreated) wood residues (from forestry, arboriculture, etc.) and energy crops (Miscanthus and short rotation coppice). There is some overlap with waste where virgin wood is present in certain waste streams, but this can be difficult to segregate from non-virgin (contaminated) wood. The distinction between virgin or contaminated wood will determine the areas of legislation that will apply to its use regarding emissions permits. Woodland residues and energy crops are generally considered to be clean or 'untreated' whereas other waste wood residues may contain contaminants such as paint, preservative, etc. and would fall under stricter emission and pollution prevention controls.

Biomass is considered to be a sustainable fuel, with low carbon emissions as the carbon dioxide (CO_2) released when energy is generated from biomass is balanced by that absorbed during its growth. The ultimate carbon balance can only be assessed once the fossil fuels used in the biomass growing process, processing and transport have been taken into account. However, overall CO_2 emissions per unit of energy generated are much lower for biomass when compared with fossil fuels.

Woodland residues are normally sourced as the residues of the sustainable management of existing woodland. Various processes are used to prepare the feedstock prior to it becoming suitable for use in a range of forms, which for woody biomass include logs, woodchips, pellets and briquettes. These processes largely dictate the final specification of the biomass in terms of moisture content, size and form. Quality control of these parameters is vital for use in specific types of energy plant.

The two main woodfuel energy crops are Miscanthus and short rotation coppice (SRC) willow, which are planted specifically for energy production. Both woodland residues and energy crops can be used to produce either heat-only or electricity and heat (combined heat and power) via a range of energy conversion technologies including direct combustion, gasification and pyrolysis. The form and quality of the woodfuel product, particularly size and moisture content, will potentially influence the type of conversion technology employed.

b) Technical constraints and limitations

The woodland residue technical resource can be estimated by first considering the total area of woodland in the study area and making assumptions about the woodfuel yield that can be sustainably extracted. The woodland area in this study was assessed using the Forestry Commission's National Inventory of Woodland and Trees[32] and is illustrated in Figure 13 below.

[32] See http://www.forestry.gov.uk/inventory

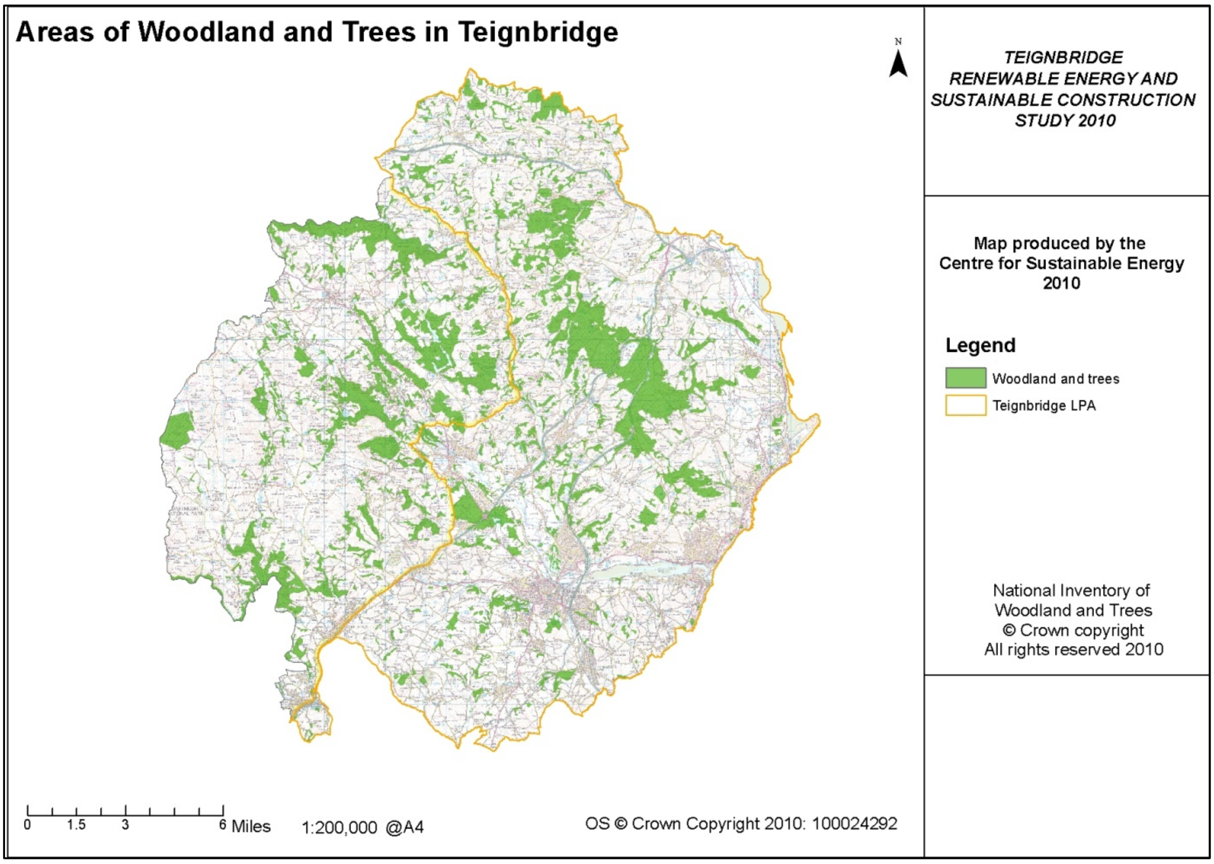

Figure 13: Areas of woodland and trees in Teignbridge

Woodfuel yields vary according to woodland types but are assumed to be between 2 and 2.5 oven dried tonnes (odt) per hectare per year. The constraints on using this resource clearly depend on how much woodland can be brought under active management and the incentives available for landowners to extract and process woodfuel. A further potential source of wood residue is cutting of hedgerows. It has not been possible to assess the potential resource from hedgerow cutting because there is no reliable yield factor for the amount of woodfuel that can be obtained from a given area or length of hedgerow, but it should be borne in mind that this is another potential resource.

The technical resource for energy crops can be broadly based on the amount of arable land across the study area. Energy crops can be grown on agricultural land of grades 1, 2 or 3.

Miscanthus typically yields 16-18 odt per hectare per year; almost twice as much as SRC, which yields 8-10 odt per hectare per year. However, Miscanthus does not grow well in exposed areas, defined in this study as being those areas where the average annual wind speed is more than 7 metres per second at 10m above ground level. For this resource assessment, it is assumed that Miscanthus would be planted in all areas of potential i.e. less exposed arable land, whereas SRC would only be planted in areas which are not suitable for Miscanthus i.e. exposed arable land.

Clearly much of the land is currently being used to produce other crops and so a number of land-take scenarios have been calculated to illustrate the size of the resource – including the theoretical maximum for the study area and a figure assuming five per cent of this maximum is exploited. Conflicts over land use for food production and energy crops (including transport biofuels) will need to be considered in relation to the scale of energy crop production envisaged.

The production of energy crops will be dependent on landowners and farmers being offered sufficient incentive to grow and harvest the crops, with longer-term supply contracts often needing to be arranged well in advance with end-users. As with woodland residues, the logistics of fuel processing and establishing supply chains may initially act as a barrier to the widespread take-up of this resource. Other issues that may limit the exploitation of this resource include the planning and permitting of generating plant and the question of alternative markets for Miscanthus and SRC.

The constraints used in the analysis for energy crops are shown in the table below:

Table 16: Constraints for energy crops	
Wind speed	Areas with wind speed of more than 7 metres/ second at 10m above ground level are not suitable for miscanthus, but are suitable for SRC. Areas with a lower wind speed are suitable for both crops, but miscanthus has a higher yield and so it has been assumed that miscanthus would be planted in the areas of lower wind speed.
Areas excluded (data source)	Grassland types: lowland heathland, upland heathland, lowland meadows, coastal and floodplain grazing marsh, lowland dry acid grassland, and lowland calcareous grassland[33] (Natural England)
	Public Rights of Way (Natural England)
	Common Land (Natural England)
	Ancient Woodland (Natural England)
	Areas of woodland (Forestry Commission)
	Scheduled monuments (English Heritage)
	Historic parks and gardens (English Heritage)
	Buffer zone of 10m around buildings (Teignbridge Council Local Land and Property Gazetteer)

Areas with potential for energy crops are shown in Figure 14 below. Designated areas are not among the constraints because the cultivation of energy crops is not specifically prohibited in designated areas; however, none of the areas identified in the energy crops resource assessment are within any of the designated areas, apart from Dartmoor National Park. Although there are no formal prohibitions against growing energy crops within the national park, it may be less appropriate than other areas without such constraints.

33 P. 15, Renewable and Low Carbon Energy Capacity, Methodology for the English Regions, January 2010; DECC, recommends excluding "permanent pasture /; grassland". The grassland types listed in the table above correspond to the available datasets grassland types.

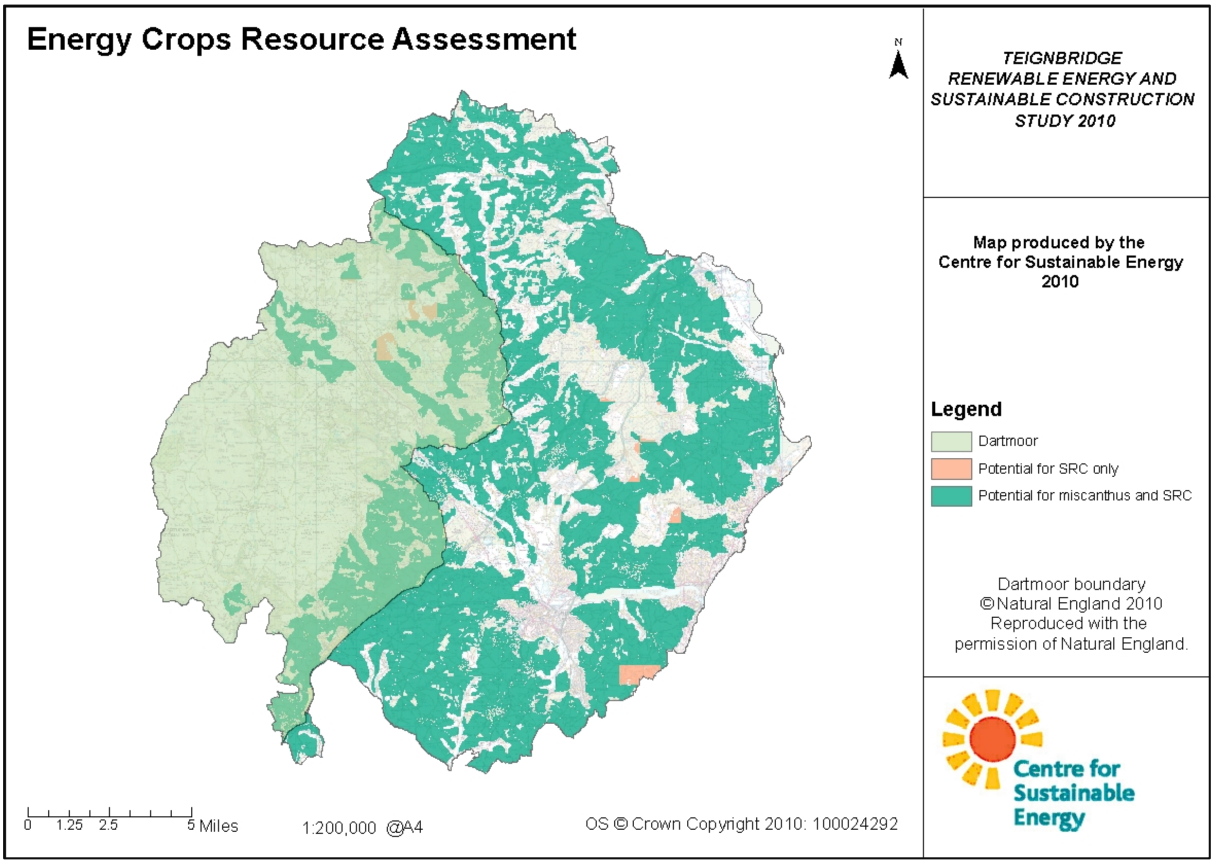

Figure 14: Energy crops resource assessment

c) Landscape and visual impact

Miscanthus is a woody grass species which can be harvested annually and grows to around one metre in height within in a year. It has a productive life of around 15 years.

Short Rotation Coppice uses high-yield varieties of willow which are densely planted and harvested every three years, growing to around four to eight metres high. The rootstock is left in the ground after harvesting and new shoots emerge from this. A SRC plantation remains productive for approximately thirty years before replanting is required.

In 2007 a study by the Centre for Sustainable Energy, Land Use Consultants and ADAS was undertaken for the Devon Wildlife Trust to assess geographically the potential for, and constraints on, the cultivation of miscanthus and SRC in Devon. The report concluded that there was significant potential for cultivation of energy crops in the county without compromising the existing landscape character. It also emphasised that the greatest challenge in the short term would not be protection of the existing landscape, but would be encouraging landowners and farmers to cultivate energy crops[34].

A detailed consideration of the wildlife impacts of energy crop cultivation is beyond the scope of this study, but extensive planting of energy crops could impact on existing valuable wildlife habitats.

Combustion of biomass also has air quality impacts, for example nitrogen and sulphurous oxides and particulates. Teignbridge has several Air Quality Management Areas (AQMAs) in Newton Abbot

[34] For more information see www.cse.org.uk/projects/view/1095

(extended to Kingsteignton), Kingskerswell, Dawlish and Teignmouth. Within Local AQMAs the use of domestic biomass boilers is restricted to approved types.

Energy from waste plants fuelled by woody biomass vary in their appearance depending on technology and scale, but normally comprise a number of buildings, which can be several storeys high, to house equipment and sufficient surrounding space to accommodate waste transfer vehicles and deliveries. Incineration, gasification and pyrolysis plants are more common at the larger scale and will also incorporate a chimney of varying height depending on the scale of the plant.

d) Potential energy yield

The total technical resource available from sustainable management of woodland in Teignbridge is shown in the table below along with corresponding energy generation capacity and energy yield. The Sustainable Yield Factor represents the amount of wood that can be sustainably retrieved from woodland from standard forest management practices. The resource identified is assumed to be used in heat-only plant for reasons of fuel cost i.e. the market value of green wood chip or logs is likely to be in excess of that acceptable for larger scale biomass CHP plants.

Table 17: Woodland residue resource in Teignbridge

Type	Hectares	Sustainable yield factor [odt/ha/yr][a]	Sustainable annual yield [odt/yr]	Capacity[b] [MWth]	Potential output[c] [MWh/yr]
Broadleaved	6,374	2.588	16,496	23.6	72,912
Other	6,220	2	12,440	17.8	54,985
Total	12,594	–	28,936	41.3	127,897

Notes:

a) Source: *Woodfuel Supply and Demand in Dorset*. Report to Dorset Woodlink by Crops for Energy and the Centre for Sustainable Energy 2009.

b) Assumes 700 odt (oven dried tones) is required per MWth per year

c) Assumes an energy content of 5,200kWh/odt and a seasonal plant efficiency of 85%

Table 18 below quantifies the energy crop resource by applying several land-take scenarios to the theoretical maximum yields. The resource identified is assumed to be used in larger scale CHP plant.

Table 18: Energy crop areas and yields under various constraint scenarios across study area

Land-take scenario	Land area [ha]		Yield [odt/yr]		Capacity[a] [MWe]		Energy[b] [MWh]	
	Mi	SRC	Mi	SRC	Mi	SRC	Mi	SRC
1. Constraints as in Table 16	32,859	410	525,744	3,280	70.1	0.4	624,884	3,899
2. As (1), excluding designated areas and national park	26,223	230	419,568	1,840	55.9	0.2	498,687	2,187
3. Five per cent of land area defined in (2)	1,311	12	20,978	92	2.8	0.012	24,934	109

Notes:

a) Assumes 7,500 odt is required per MWe per year

b) Assumes an energy content of 5,200kWh/odt and a seasonal CHP plant efficiency of 80% with an electricity:heat ratio of 1:2.5

Figure 15 below compares the potential energy yields from the three scenarios for energy crops and woodland residue resource across the study area.

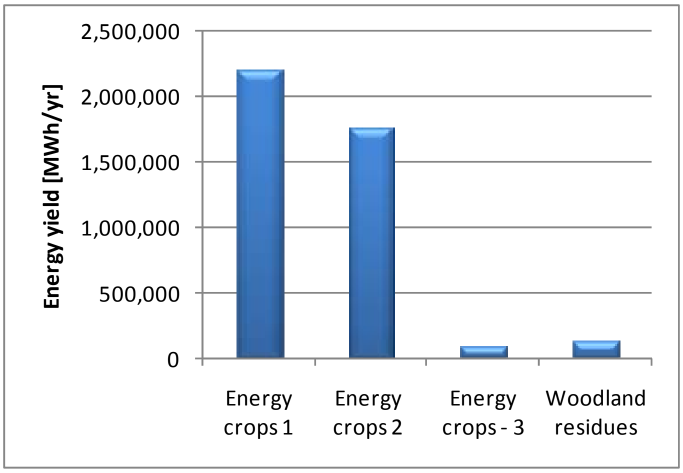

Figure 15: Summary of woodland residue and energy crops

5.4.3 Waste – Municipal Solid Waste, agricultural and commercial/industrial

a) Overview

The Renewables Obligation Certificates (ROCs) system has generally provided revenue support for renewable electricity generators, including systems using the biomass content of waste treated in gasification, pyrolysis, anaerobic digestion and good quality combined heat and power plants. Energy from waste plant is also exempt from the Climate Change Levy, recognising the renewable fraction of waste. However, since April 2010, most generators under 5MW capacity have been eligible for the Feed-in Tariff (FiT). The type and size of technology will therefore determine which financial incentive will apply. Most anaerobic digestion projects, for example, will benefit from FiTs as plants are rarely over 5MW capacity.

Energy from waste (EfW) processes vary significantly depending the biomass feedstock used. In general, most dry wastes are used in thermal processes such as combustion, gasification or pyrolysis whilst wet wastes can be used in anaerobic digestion (AD) plant. AD is the process of breaking down plant or animal matter by microbial action in the absence of air, to produce a gas with a high methane content, which can then be used as a fuel. Both wet and dry wastes can be used in energy plant to produce heat, electricity or a combination of the two (CHP).

The main types of organic material feedstock used in AD are sewage sludge, farm slurry, and some elements of MSW and commercial food waste. In addition to biogas which can be used for energy generation, AD also produces a nitrogen-rich liquor (digestate) and residual solid by-products which can be used respectively as a fertiliser or soil conditioner. AD is most likely to be part of an integrated farm waste management system. However, larger-scale centralised anaerobic digesters (CADs) also exist which use feedstocks imported from a number of sources.

An alternative option to energy recovery from waste plant is to process waste streams into Refuse Derived Fuel (RDF). In this process, non-combustibles, hazardous, and valuable recyclable materials are normally removed before a shredding and/or steam pressurised treatment converts the material to the RDF product, which usually consists of a mix of unrecyclable waste plastics and biodegradable waste. This fuel can then be used to fuel CHP plants.

Devon County Council as Waste Disposal Authority take the lead role in terms of residual waste treatment and disposal activities within Devon. At the time of writing there are currently two energy from waste facilities being progressed which will be used to generate energy from municipal waste. The first is based in Exeter and has scope to deal with 60,000 tonnes per annum of waste, including that from the north of the Teignbridge district using incineration technology. This facility is set to be operational by September 2010. The second is still in the planning stages and is being developed through the South Devon Waste Partnership. The operational target date is 2014/15 for a 200,000 tonnes per annum facility, also likely to be incineration. This will deal with the remaining residual municipal waste from Teignbridge and is likely to have capacity to deal with waste arisings from an increased population.

b) Technical constraints and limitations

The Waste Strategy for England 2007 recommends use of a waste management hierarchy as follows:

1. Reduce
2. Re-use
3. Recycle
4. Recover
5. Dispose

It also sets the following targets in relation to the treatment of waste:

- recycling and composting of household waste – at least 40% by 2010, 45% by 2015 and 50% by 2020; and
- recovery of municipal waste – 53% by 2010, 67% by 2015 and 75% by 2020.

Energy recovery from waste must therefore be considered in the light of the hierarchy above in terms of priorities. Many local authorities currently practise the recycling of paper, card, textiles, plastics, metals and glass and the composting of food and garden waste.

Agricultural waste also represents a significant resource. Defra statistics on animal numbers[35] for 2007 suggest a total yield within Teignbridge of 473,230 tonnes/ yr from cattle and pig slurry and 3,864 tonnes/ yr from poultry litter.

There is potential for smaller scale energy from waste facilities linked to any significant housing developments. Small scale decentralised AD (typically less than 1MW) could be considered for treatment of food waste if the scale is appropriate and site characteristics allow. Similarly smaller scale thermal treatment options could be considered (e.g. gasification or pyrolysis) for residual waste

[35] Figures quoted from the Agricultural and Horticultural Survey – England (June 2007), Defra, for Teignbridge District

treatment although the economics at this scale are not certain and the need for such is likely to be negated by the incineration facilities already being progressed.

Varying amounts of wood waste will be included within all of the controlled waste streams. This will comprise of a range of materials from a variety of sources and will contain a mixture of clean and contaminated wood which will influence the type and scale of energy plant in which it can be used. Contaminated wood is classified under stricter pollution control legislation and suitable energy plants tend to be larger scale in order to justify the more costly and complex emission control technology required. Separating clean from contaminated wood can be a costly and difficult process and is unlikely to be viable unless there is an efficient way of undertaking this at source.

Typical sources of waste wood are as follows:

- Packaging waste
- Construction and demolition waste
- Secondary wood processing industry waste e.g. off cuts from furniture manufacturing, joinery, wood shavings, sawdust or similar
- Municipal/household waste including civic amenity (CA) sites

The mixed content of waste streams therefore makes it difficult to quantify the waste wood resource.

A recent publication by WRAP[36] assessed the volume of waste wood produced in the regions of the UK. An estimate of the proportion available within Teignbridge is shown in Table 19 below. However, a large proportion of this wood is currently re-used for other purposes and so not all of it would be available for use as a fuel.

A brief survey of sawmills in Teignbridge was undertaken to find out if there was any possibility of using waste from sawmills as biomass feedstock. Data was scarce on the potential quantities of wood waste arisings but availability would depend on the market price as it was found that most sawmills already dispose of their waste wood profitably by selling it for various uses such as woodchip for paths.

c) Landscape and visual impact

Landscape and visual impacts of energy from waste plant will be similar to those described for woodfuel above. However, as the feedstock is waste and potentially hazardous, the processes and infrastructure for delivery and storage are likely to differ.

Anaerobic digestion is currently more common at the smaller (farm) scale and is most commonly used to process food and agricultural waste. Most AD plants will be located close to the waste source, and so smaller scale facilities treating locally produced waste are often sited on farms and other agricultural locations. Centralised anaerobic digestion facilities that handle large quantities of agricultural wastes, sewage sludge or municipal waste are likely to be located within or adjacent to existing commercial/industrial areas or wastewater treatment works. Typical AD plant will consist of digester tank(s), buildings to house ancillary equipment such as a generator, a biogas storage tank and a flare stack.

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[36] Waste Resources Action Programme (WRAP), *Wood Waste Market in the UK Summary Report,* August 2009. Available from http://www.wrap.org.uk/downloads/Wood_waste_market_in_the_UK.52a41708.7547.pdf [Accessed 9th June 2010]

d) Potential energy yield

Table 19 summarises the estimated biomass resource for waste. It can be seen that a significant number of assumptions need to be made in estimating this resource – these reflect the often complex nature of the various waste streams and their management and so need to be understood when making strategic decisions on their use as a sustainable energy source. The logistics of waste collection/ transport and of any requirement to sort or pre-treat remains a significant barrier to the widespread use of this resource, as does alternative and competing uses for certain types of waste.

Table 19: Estimated quantities, capacities and energy yields of waste available for energy recovery in Teignbridge

Waste stream available for energy recovery	Quantity [tonnes/yr]	Generation capacity[a] [MW_e]	Total energy yield[b] [MWh/yr]
Commercial and industrial waste[c]	30,181	3.0	83,280
Residual Municipal Solid Waste[d]	21,941	2.2	60,545
Agricultural waste[e]	477,094	1.6	44,083
Waste wood – Total resource	8,870	1.2	36,901
Food waste – commercial and industrial[g]	13,097	0.1	1,948
Food waste – Municipal Solid Waste[h]	19,645	0.1	2,922
Total	**570,829**	**8.2**	**229,679**

Notes:

a) MSW and commercial/industrial waste have a lower calorific value than wood and in estimating potential plant size, a figure of 10,000 tonnes per year is assumed for each MWe of electrical generation capacity.[37]

b) Assumes that plants are operated as Combined Heat and Power (CHP) units with an electricity:heat output ratio of 1:2.5

c) Based on Devon Waste Local Plan[38] predictions for residual Commercial and Industrial Waste in 2010/11 (predictions made in 2005). Teignbridge share based on population. Excludes an assumed 12% food waste.

d) Figures shown are residual amounts of combustible materials after recycling and organic fractions have been diverted. Here, municipal waste is defined as waste collected by the Council, which is mostly household waste but includes a small amount of commercial waste

e) Assumes anaerobic digestion is employed for cattle and pig waste. 30 cattle = 1 tonne slurry/day; 275 pigs = 1 tonne slurry/day; 50% is collected. 10,000 poultry birds = 365 tonnes litter/yr.[39]

f) See section 5.4.3 b) on waste wood above.

g) Figure derived from Devon Waste Local Plan predictions as for (c). Assumes 12% of total commercial and industrial waste is food waste[40]. Assumes anaerobic digestion is employed.

h) Figure derived from Devon Waste Local Plan predictions as for (c). Assumes 18% of total MSW is food waste[41]. Assumes anaerobic digestion is employed.

[37] Based on Municipal Solid Waste with a calorific value of 14 GJ/tonne (source – *Stepping Forward – a resource flow and ecological footprint analysis of the South West of England; Scenarios Report* (2005).
[38] www.devon.gov.uk/index/environmentplanning/planning-system/planning_minerals_and_waste/waste_planning/waste_local_plan-2.htm, section 4
[39] Assumptions taken from *REvision 2020 – South West Renewable Electricity, Heat and On-site Generation Targets for 2020* – see http://www.oursouthwest.com/revision2020
[40] Environment Agency: Commercial and Industrial Waste Survey 2002/03
[41] UK Energy Strategy 2007, Annex C1

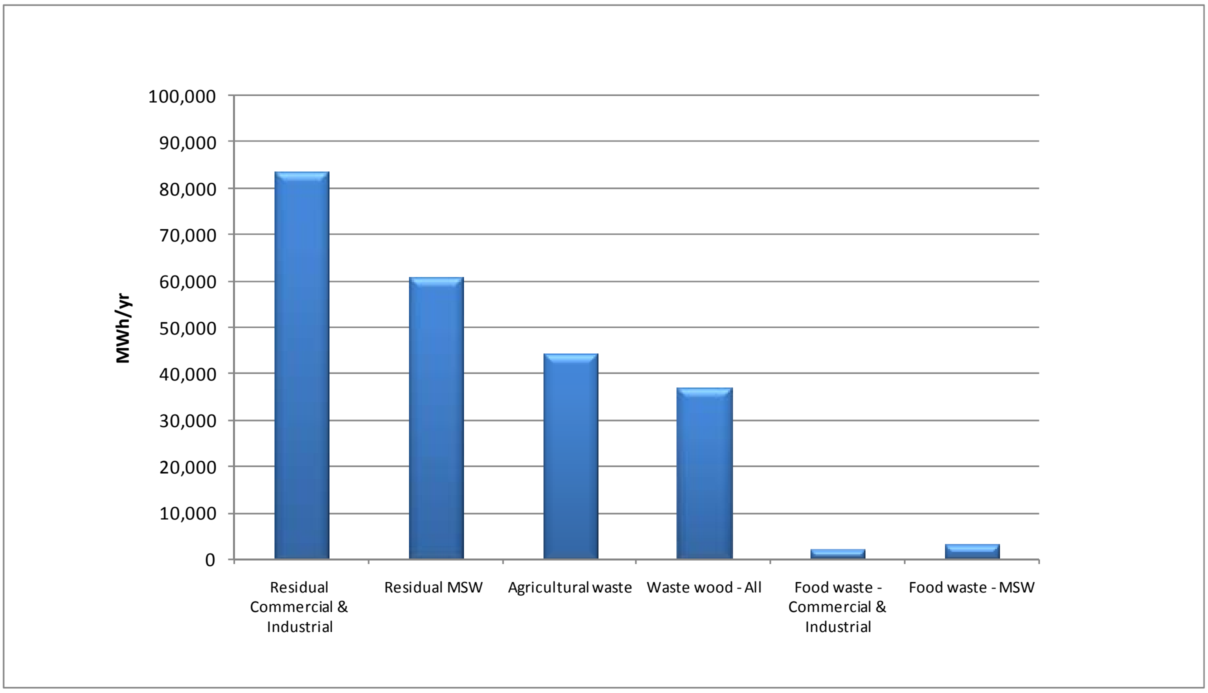

Figure 16: Summary of potential energy yields from waste resource

5.5 Hydropower

a) Overview

Hydropower is the use of water flowing from a higher to a lower level to drive a turbine connected to an electrical generator, with the energy generated proportional to the volume of water and vertical drop or head. Although it is a well developed form of renewable energy, environmental constraints on large multi-MW scale plant means that most potential exists for mainly small or micro-scale schemes. Small scale hydropower plants in the UK generally refer to sites ranging up to a few hundred kilowatts where electricity is fed directly to the National Grid. Plants at the micro-scale (typically below 100kW) may include schemes providing power to a single home.

'Low head run of river' schemes are typically sites in lowland areas, often installed on historic mill sites using the existing channel system and weir or dam. 'High head run of river' schemes are typically found on steeper ground in upland areas and the diverted water is typically carried to the turbine via an enclosed penstock (pipeline).

b) Technical constraints and limitations

Hydropower is a well-established and proven technology and there are few technological constraints to its use other than ensuring that heads and flow rates are adequate throughout the year, that there is adequate site access, that the site can accommodate the necessary equipment and that the electricity generated can be transmitted to its end use. For the same reasons, energy yields can be accurately predicted and economic viability established relatively easily.

Apart from visual impacts, other important considerations include hydrology and the river ecology. Fish populations in particular can be vulnerable to changes in water flows and measures such as 'fish passes' are often incorporated to mitigate the impact.

c) Landscape and visual impact

Small-scale hydro schemes will typically include dams, weirs, leats, turbine houses and power lines, which will have a visual impact on the locality, but which can usually be minimised by careful siting and design. Plants may also have an impact on upstream water flows, particularly waterfalls.

d) Potential energy yield

A recent study by the Environment Agency aimed to assess and map opportunities for small-scale hydropower on rivers in England and Wales and to assess the basic environmental sensitivity associated with exploiting them[42]. The report included an annex with maps showing sites with potential in the South West region. Using this map it is possible to estimate the potential resource within Teignbridge. From this map, 88 sites can be identified (although some of these are located on the borders between Teignbridge district and its neighbours). These are summarised in Table 20 below.

Table 20: Potential hydro power sites identified by the Environment Agency in Teignbridge

Scale (kW)	Number of sites	Total kW (low estimate)	Total kW (high estimate)
0-10	60	300	60
10-20	8	80	160
20-50	6	120	300
50-100	8	400	800
100-500	5	500	2,500
500-1,500	1	500	1,500
Total	**88**	**1,900**	**5,320**

5.6 Solar

a) Overview

Solar energy generation involves the use of the sun's energy to provide hot water via solar thermal systems or electricity via solar photovoltaic (PV) systems. Both technologies are technically well-proven with numerous systems installed around the world over the last few decades.

Solar thermal systems use solar collectors, usually placed on the roof of a building, to preheat water for use in sinks, showers and other hot water applications. While the UK climate is not sufficiently hot and sunny to meet all domestic hot water requirements year round, a well designed solar thermal system should meet 50-60% of demand during May-September.

Solar Photovoltaic (PV) systems use solar cells to generate electricity directly from sunlight. The solar cells are normally packaged together into panels or other modular forms which, like solar thermal collectors, are normally roof-mounted. Other forms of solar PV technology are becoming more common in the UK, such as solar tiles, which can be integrated into new buildings or refurbishments alongside conventional roofing tiles or slates.

[42] For more information see www.environment-agency.gov.uk/shell/hydropowerswf.html . At time of writing, RegenSW are working towards making this resource available to local authorities in GIS format.

For both types of solar system, panels or collectors are becoming increasingly incorporated into a new or existing roof in much the same way as roof windows. For best performance in the UK, systems need to be inclined at an angle of 30-40 deg, facing due south and clear of the shade of trees and buildings.

Since the introduction of the Feed-in Tariff, there is increased interest from developers in 'solar farms', where large-scale multi-MW PV systems operate as a stand-alone energy plant in open spaces such as fields. Cornwall Council, for example, recently became the first UK local authority to approve a business case for a multi-MW solar farm near Newquay Airport.[43]

The theoretical district-wide resource from this type of system is clearly very large but the practical resource will be highly dependent on local factors such as land ownership/use, planning issues and cost of grid connection. This is better assessed at a more local, site-specific level and hence the resource has not specifically been evaluated here.

Solar PV is often favoured by developers as it is simple to install, can form part of a building's structure (often offsetting costs of conventional materials) and is currently the most accessible (but more expensive) alternative to wind power for generating zero carbon electricity. Solar water heating is also straightforward to install, is much cheaper and typically requires less roof space than PV. However solar water heating saves considerably less carbon than solar PV per square meter installed.

b) Technical constraints and limitations

The main technical constraints concern the availability of suitably orientated and unshaded roof or external wall space, both in terms of area and structural integrity (to support the weight of panels, etc). Additional space for system components within a building may also be a constraint, i.e. a hot water tank in the case of solar thermal and a battery storage system with an off-grid PV system.

Energy yields from solar systems can be reasonably well-predicted and economic viability established relatively easily. Both types of systems have very low operation and maintenance costs and are relatively simple to install on buildings. Technically, they are highly accessible to both domestic and non-domestic users. The main financial constraint to their use is the high capital cost of systems, particularly in the case of PV. The extent to which these solar technologies are exploited on new development will therefore depend on the preferred mix of technologies a developer will choose to meet a particular emissions target – usually based on the least cost option.

In order to meet more demanding carbon reduction targets on new development, both technologies will in most cases need to be implemented alongside other measures. Solar water heating is limited to supplying a proportion of a building's hot water demand, which in itself may comprise a relatively small proportion of total energy demand, whilst PV can be limited in its capacity to meet electricity demand by lack of roof space, particularly on larger multi-storey buildings.

c) Landscape and visual impact

Within certain bounds, roof-mounted solar panels are now 'permitted development' under the General Permitted Development Order (GPDO), meaning that planning permission is not usually required. Again with certain exceptions, this includes World Heritage Sites and Conservation Areas, but not listed buildings – where listed building consent is required. Solar systems can have a modernising effect on buildings but generally have no other significant visual impact other than more site-specific

[43] http://www.thisiscornwall.co.uk/news/Council-need-163-14m-loan-build-solar-farm/article-2751950-detail/article.html

issues such as the impact of sunlight glare on adjacent buildings. Ground-mounted large scale solar farms however may have a significant visual and landscape impact due to their size and potential contrast with the surrounding countryside. Careful site selection can minimise this impact where possible.

d) Potential energy yield

The solar resource in this study has been evaluated by considering the total number of buildings and therefore roofs in the district and applying assumptions regarding the applicability of appropriately sized solar energy systems. Table 21 shows the potential resource when all suitable roofs are fitted with solar PV, while Table 22 shows the potential resource when all roofs are fitted with solar water heating panels. The two figures are mutually exclusive because the same roofs are used in each assessment. Figure 17 shows the estimated annual energy yield for each technology. It can be seen that fitting all suitable roofs with PV would give a higher energy yield than fitting them with solar water heating panels.

It should be noted that the solar resource that could be realised through future new development has not been included here, but the modelling presented in Section 8 suggests that for PV this could be in the order of 14 MW for Scenario 2.

Table 21: Solar PV resource (building integrated)

No. of residential buildings[a]	No. of non-residential buildings[a]	Total capacity[b] of residential 2kW systems [MW]	Total capacity[c] of non-residential 5kW systems [MW]	Total energy yield [MWh/yr]
50,271	3,371	25	8.4	26,462

Table 22: Solar water heating resource

No. of residential buildings	No. of non-residential buildings	Total capacity[d] of residential 2.1kW systems [MW]	Total capacity[e] of non-residential 5kW systems [MW]	Total energy yield [MWh/yr]
50,271	3,371	26	2.1	17,845

Notes:

a) The number of buildings has been calculated from Teignbridge's Local Land and Property Gazetteer. Some buildings have both residential and non-residential uses and these have been shared out between the two categories.

b) Assumes 25% of residential roofs will be suitable for 2kW systems having a load factor of 0.09

c) Assumes 50% of non-residential roofs will be suitable for 5kW systems having a load factor of 0.09

d) Assumes 25% of residential roofs will be suitable for 2.1kW systems having a load factor of 0.07. This size system is approximately equivalent to a typical 3m^2 panel domestic installation.

e) Assumes 25% of non-residential roofs will be suitable for 5kW systems having a load factor of 0.09, and will have compatible solar water heating requirements

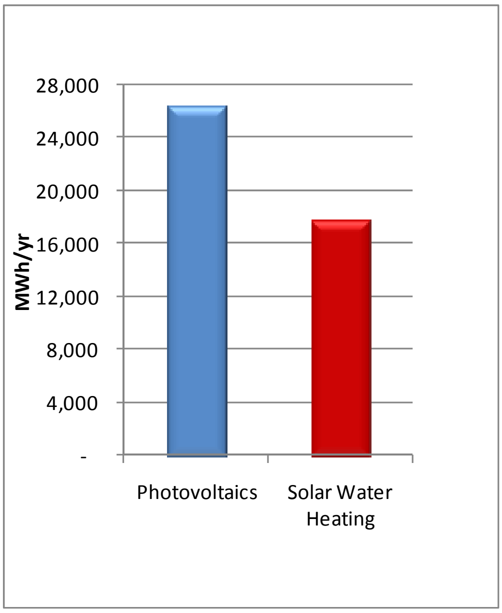

Figure 17: Solar Energy Resource

5.7 Heat pumps

a) Overview

Heat pumps systems capture the environmental solar heat energy stored in the ground (ground source heat pumps), bodies of water (water source heat pumps) or air (air source heat pumps). Applications include space heating, water heating, heat recovery, space cooling and dehumidification in both the residential and commercial building sectors.

Although all the heat delivered by heat pumps comes from renewable energy (stored solar energy), a supply of electricity is required to pump the system, which may or may not come from renewable sources. However, a typical good quality installation will extract at least three times as much useful heat energy as it uses electrical energy to operate. In this case, the efficiency of the system (Coefficient of Performance) would be 3. Although not strictly a renewable technology where mains electricity is used, the system can still offer significant carbon savings over certain conventional fossil fuel systems.

A typical ground source heat pump (GSHP) system has three major components: a heat pump (located within the building and similar in size to a large refrigerator), a ground collector loop (either pipes laid in trenches in the ground or vertical pipes within boreholes) and an interior heating or cooling distribution system. Air source systems are commonly mounted directly on an external wall and are similar in appearance to conventional air-conditioning units.

b) Technical constraints and limitations

Due to the heat sources considered, the potential resource for this technology is extremely large as in theory almost every building could have either an air or ground source system. However a number of technical constraints limit the use of heat pumps. For ground source systems, the availability of space around buildings for ground loop installations is a constraining factor. Ground loops can be either laid in trenches or boreholes and although the latter require less space, they involve greater cost. Whilst air source systems are cheaper, simpler to install and do not require any groundworks, they rely on ambient air temperature to provide heating and so operate at reduced efficiencies during winter periods.

Installations in older existing buildings are very limited as the technology works best in highly insulated buildings with low temperature heat distribution systems such as under floor heating. The building heating demands and load profile needs to be well understood in order to optimise the design of a system. Although heat pumps can be designed to provide the total heat demands of a property, many are sized to provide the large majority, but not all of a building's space and water heating requirements. In this case, systems need to work in conjunction with a supplementary heat source, often in the form of an electric immersion heater, mostly to provide top-up heat for domestic hot water. This is usually done to reduce the capital cost of the system, which may be significantly higher if sized to supply the total heat demand.

Emission savings will vary depending on type of building, the fuel displaced and the proportion of total heat demand supplied. Take up rates are mostly driven by new development and the likely technology mix chosen by developers in meeting emissions targets. On the basis of capital cost per tonne of carbon saved, heat pumps are currently a relatively expensive low carbon technology and in general developers are less likely to choose them over more cost effective options such as biomass heating. However, their economics improve when compared against higher cost heating fuels such as oil, LPG or electricity i.e. in areas without access to mains gas.

c) Landscape and visual impact

Once installed ground source heat pumps are not visible externally as the ground loop is hidden under the ground and the heat pump unit is located within the building. Their visual impact is therefore minimal. However, systems using a trenched ground loop will need a significant amount of space adjacent to the building to accommodate the buried pipe. Sites of archaeological interest may also be a constraining factor on ground source heat pumps, where ground works may potentially disturb important features or artefacts.

Air source heat pumps are aesthetically similar to standard air conditioning units seen on the external walls of buildings and will therefore have a limited visual impact, particularly in conservation areas or on listed buildings. They may also result in a modest increase in noise levels at nearby properties during operation, although this can be minimised through use of anti-vibration mountings and acoustic insulation. Air source heat pumps are not currently permitted development under the General Permitted Development Order (GPDO), but are being considered for inclusion in the future.

d) Potential energy yield

An approximate calculation can be made of the theoretical domestic heat pump resource if all suitable existing homes were to have heat pumps installed, based on DECC guidance for resource assessment at regional level.[44] This is illustrated in Table 23 below:

[44] www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/renewable/ored/ored.aspx Scroll down for link

Table 23: Potential heat pump resource for existing homes				
Type	**Number[45]**	**Proportion assumed suitable for heat pumps**	**Number of suitable dwellings**	**Total installed capacity at 5kW system per dwelling [kW]**
Off-gas	3,890	100%	3,890	19,450
On-gas detached	16,880	75%	12,660	63,300
On-gas semi-detached	11,650	75%	8,738	43,688
On-gas terraced	11,280	50%	5,640	28,200
On-gas flats	6,560	25%	1,640	8,200
Total	**50,260**	**-**	**32,568**	**162,838**

However, as heat pump installations will mostly be limited to new development for reasons described above, the above assessment is of very limited use, and is therefore not included in the summary figures below. The SHLAA analysis presented in Section 8 assumes a least-cost approach to the choice of technologies in meeting specific targets and therefore, for the purpose of modelling, heat pumps are excluded due to their relatively high capital cost.

5.8 Summary

Figure 18 below summarises the resource assessment by comparing the technical resource, in terms of installed MW capacity, of the technologies considered. Also shown are the capacities for wind and energy crops when additional constraints are applied i.e. designated areas for wind, and a 5% land-take of suitable arable land for energy crops (see previous sections). Figure 19 presents the same information but in terms of the potential carbon savings from each resource when compared with the overall carbon emissions from the district.

The two graphs serve a purpose in highlighting the difference between installed capacity and annual energy yield – the latter of which equates to annual carbon emissions. For example, one MW of wind capacity does not produce the same annual electricity yield as one MW of biomass CHP, as wind turbines are more intermittent in their operation and hence have lower load factors. Additionally, the energy crop and waste resource capacity are expressed separately in terms of their electrical and heat output from CHP plant. The actual resource becomes much more significant when expressed in terms of total energy yields or carbon reduction potential from the combined production of heat and electricity.

Table 24 and Table 25 also present the summary details of the resource assessment and compare renewable electricity and heat annual generation capacity with that of the District's non-transport energy consumption for 2008.

[45] This is an approximate figure based on output area-level Census data and postcode-level data on the extent of the gas network. The figures have been rounded to the nearest ten to avoid 'spurious accuracy'.

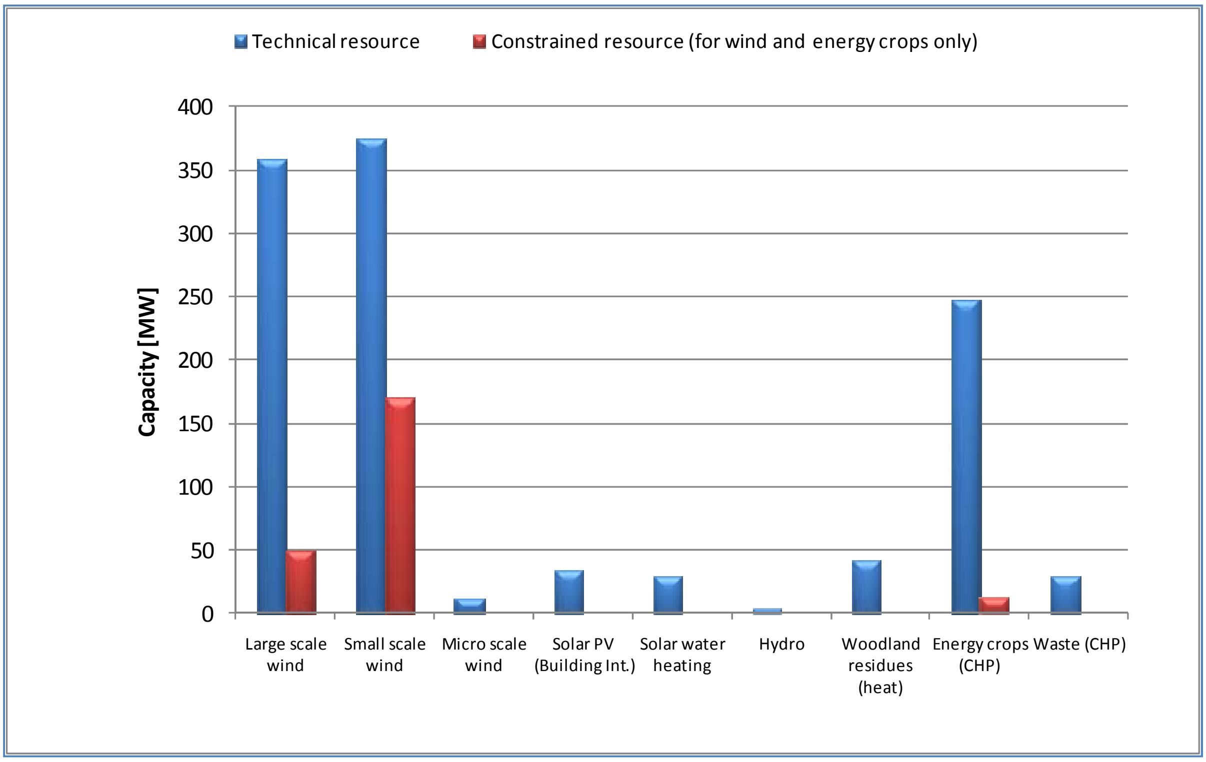

Figure 18: Summary of resource assessment for study area showing the technical resource as installed capacity for each technology. Also shown is the installed capacity from the constrained resource for wind and energy crops (i.e. designated areas excluded for wind and 5% land-take for energy crops).

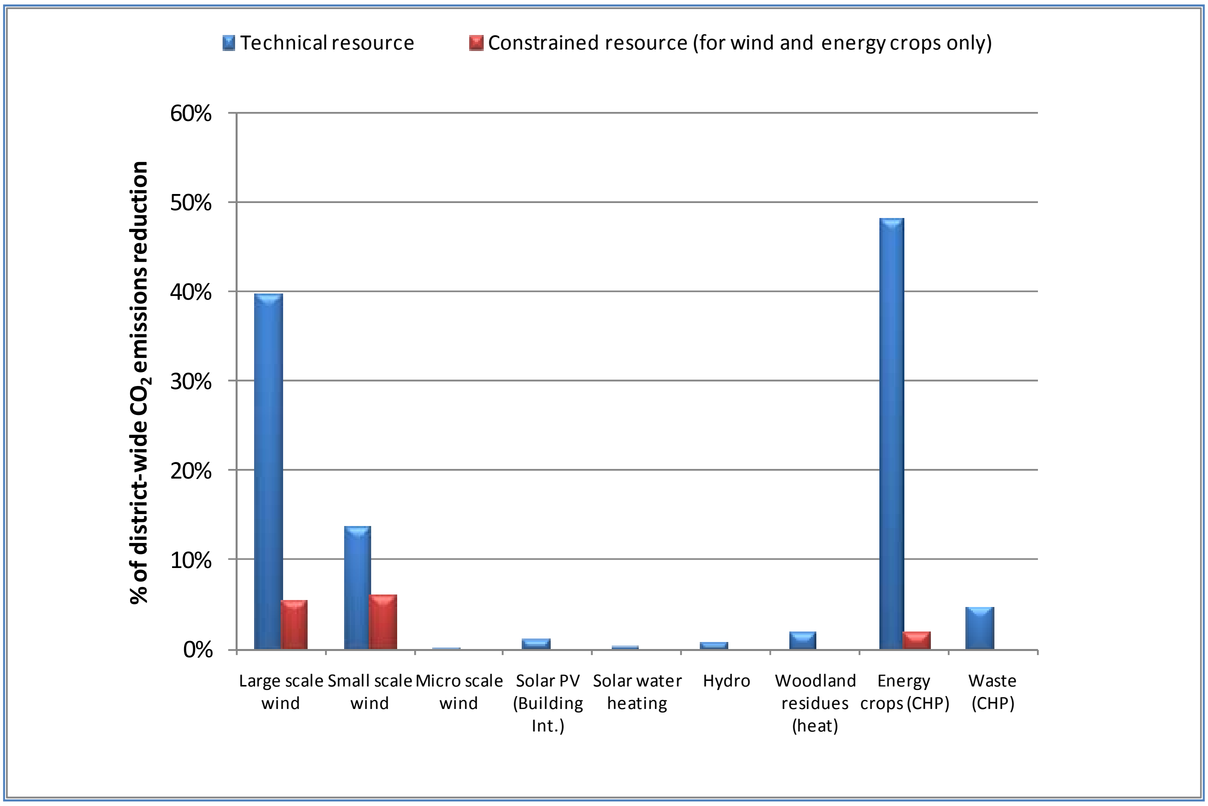

Figure 19: Summary of resource assessment for study area showing the potential proportional contributions from each technology to savings of district-wide carbon emissions. Also shown is the emissions reduction from the constrained resource for wind and energy crops (i.e. constraint ‘C’ for wind and 5% land-take for energy crops).

Resource/technology	Capacity [MWe]	Capacity [MWth]	Annual electricity yield [MWh]	% of Teignbridge's 2008 electricity consumption	Annual heat yield [MWh]	% of Teignbridge's 2008 gas and other non-electricity heating fuel consumption	Emissions reduction potential [tonnes CO_2 per year]	Emissions savings as % of Teignbridge's 2007 total emissions
Large scale wind (level 1 constraints)	359	0	942,795	188.1%	0	0%	405,402	39.7%
Small scale wind (level 1 constraints)	376	0	329,131	65.7%	0	0%	141,526	13.8%
Micro scale wind	12.3	0	5,366	1.1%	0	0%	2,307	0.2%
Solar PV	33.6	0	26,462	5.3%	0	0%	11,378	1.1%
Solar Water Heating	0	28.5	0	0%	17,845	1.5%	3,301	0.3%
Hydro	3.6	0	20,498	4.1%	0	0%	8,814	0.9%
Woodfuel (woodland residues)	0	41	0	0%	127,897	10.9%	19,899	1.9%
Woodfuel (energy crops)	70.5	176.3	628,783	125.5%	1,571,957	133.6%	492,416	48.2%
Waste (MSW)	2.2	5.5	17,299	3.5%	43,246	3.7%	15,439	1.5%
Waste (Ind &Comm)	4.2	10.5	23,794	4.7%	59,486	5.1%	21,236	2.1%
Waste (Agr, food)	1.8	4.4	13,987	2.8%	34,967	3.0%	12,483	1.2%
Total	**863**	**267**	**2,008,114**	**401%**	**1,855,398**	**158%**	**1,134,203**	**111%**

Table 24: Summary of resource assessment showing 'technical' resource

Resource/technology	Capacity [MWe]	Capacity [MWth]	Annual electricity yield [MWh]	% of Teignbridge's 2008 electricity consumption	Annual heat yield [MWh]	% of Teignbridge's 2008 gas and other non-electricity heating fuel consumption	Emissions reduction potential [tonnes CO_2 per year]	Emissions savings as % of Teignbridge's 2007 total emissions
Large scale wind (level 2 constraints)	50	0	131,729	26.3%	0	0%	56,643	5.5%
Small scale wind (level 2 constraints)	169	0	148,443	29.6%	0	0%	63,830	6.2%
Micro scale wind	12.3	0	5,366	1.1%	0	0%	2,307	0.2%
Solar PV	33.6	0	26,462	5.3%	0	0%	11,378	1.1%
Solar Water Heating	0	28.5	0	0%	17,845	1.5%	3,301	0.3%
Hydro	3.6	0	20,498	4.1%	0	0%	8,814	0.9%
Woodfuel (woodland residues)	0	41	0	0%	127,897	10.9%	19,899	1.9%
Woodfuel (energy crops - 5% landtake)	3.5	8.8	25,044	5.0%	62,609	5.3%	19,612	1.9%
Waste (MSW)	2.2	5.5	17,299	3.5%	43,246	3.7%	15,439	1.5%
Waste (Ind &Comm)	4.2	10.5	23,794	4.7%	59,486	5.1%	21,236	2.1%
Waste (Agr, food)	1.8	4.4	13,987	2.8%	34,967	3.0%	12,483	1.2%
Total	**281**	**99**	**412,620**	**82.3%**	**346,050**	**29.4%**	**234,945**	**23.0%**

Table 25: Summary of resource assessment including constrained resource for large/small wind (excluding designated areas) and energy crops (5% land take)

Table 26 below then presents an example mix of technologies where each contributes varying proportions of the resource to meet an overall 15% renewables contribution each year towards non-transport energy use in Teignbridge, i.e. 15% of 1,678 GWh (see Table 3). However, this mix would only provide around 7.5% of the district's total annual energy use when transport energy is included. This demonstrates the scale of implementation that would be required for the district to be in line with the Government's national 2020 target of supplying at least 15% of the UK's total energy demand from renewable energy.

This technology mix at these levels of implementation may be the equivalent of:

- 10 large scale turbines
- 267 small scale turbines
- 400 micro scale turbines
- 1,130 domestic PV systems
- 667 domestic SWH systems

- 20 micro scale hydro systems
- 340 domestic and 25 larger scale woodfuel heating systems (for existing buildings)
- 1 energy crop CHP plant
- 1 waste CHP plant (MSW & Ind/Comm)
- 6 farm scale AD plants

Resource/technology	Capacity [MWe]	Capacity [MWth]	% of resource	Annual electricity yield [MWh]	% of Teignbridge's 2008 electricity consumption	Annual heat yield [MWh]	% of Teignbridge's 2008 gas and other non-electricity heating fuel consumption	Emissions reduction potential [tonnes CO_2 per year]	Emissions savings as % of Teignbridge's 2007 total emissions
Large scale wind (level 2 constraints)	25	0	50%	65,864	13.1%	0	0%	28,322	2.8%
Small scale wind (level 2 constraints)	8	0	5%	7,422	1.5%	0	0%	3,192	0.3%
Micro scale wind	0.6	0	5%	268	0.1%	0	0%	115	0.0%
Solar PV	1.7	0	5%	1,323	0.3%	0	0%	569	0.1%
Solar Water Heating	0	1.4	5%	0	0%	892	0.1%	165	0.0%
Hydro	0.7	0	20%	4,100	0.8%	0	0%	1,763	0.2%
Woodfuel (woodland residues)	0	14.5	35%	0	0%	44,764	3.8%	6,965	0.7%
Woodfuel (energy crops - 5% landtake)	1.2	3.1	35%	8,765	1.7%	21,913	1.9%	6,864	0.7%
Waste (MSW)	1.1	2.7	50%	8,649	1.7%	21,623	1.8%	7,719	0.8%
Waste (Ind &Comm)	2.1	5.3	50%	11,897	2.4%	29,743	2.5%	10,618	1.0%
Waste (Agr, food)	0.9	2.2	50%	6,993	1.4%	17,483	1.5%	6,242	0.6%
Total	**42**	**29**		**115,282**	**23.0%**	**136,419**	**11.6%**	**72,534**	**7.1%**

Table 26: Summary of resource assessment assuming an example mix of technologies each contributing various proportions to achieve an overall 15% renewables contribution towards Teignbridge's annual energy consumption (not including transport)

6 Potential for district heating

6.1 Overview

District heating is an infrastructure for delivering heat to multiple buildings from a central heat source through a network of pipes to deliver heating and hot water. In this way heat can usually be generated and delivered more efficiently than with multiple individual systems. There is generally believed to be significant potential for district heating in the UK, although relatively few systems are currently in place.

The technology typically comprises of an energy centre, a network of insulated pipes and a series of heat exchangers with heat meters in buildings being supplied with heat. The energy centre can generate heat alone, or can be designed as a CHP plant to generate both electricity and heat. In some cases, cooling can also be provided to end-users served by the network.

Figure 20: Heat main pipework at Heathrow Airport, Terminal 5 [© Vital Energi | www.vitalenergi.co.uk]

The scale of district heating can range from small scale systems e.g. a biomass boiler supplying a group of ten dwellings, to large scale schemes supplying entire city centres or communities. District heating is adaptable and can utilise a wide range of energy sources such as traditional gas boilers, biomass boilers, gas or biomass CHP systems, and waste heat. As district heat networks are designed to last for many years, this flexibility can also future-proof the system to technological advances.

The energy plant serving a district heating system is now more commonly a Combined Heat and Power (CHP) plant, producing both electricity and useful heat. This can be a much more efficient use of fuel than using thermal process to produce electricity only, provided that the balance of demand for power and heat is right, and that plant is located close to the source of heat demand. Generating plant which produces electricity, heat and chilling (through the use of absorption chillers) is known as Combined Cooling, Heat and Power (CCHP), or Trigeneration.

CHP often uses natural gas, in which case it is an efficient but not renewable energy technology. When a renewable fuel source is used, typically woodfuel, CHP becomes a renewable energy technology. Gas-fired CHP is well-used in industry, but there are few biomass CHP schemes in the UK.

CHP plant is available in a range of scales, from micro-CHP domestic applications and medium size plant serving an office block, to large industrial applications and CHP plant serving district heating schemes. The technology is better established for large scale biomass CHP plants in other parts of northern Europe, but small scale biomass CHP is currently less technically proven or economically viable.

For CHP to be economically viable, it needs to be carefully sized in relation to the heat and power loads it is supplying. In particular, it is important to understand the heat load profile and how this changes on a daily, weekly and annual basis. This is especially important for CHP plant supplying district heating networks, where there may be a range of users with different requirements.

6.2 Opportunities and constraints

One of the main constraints to district heating is the need to identify a sufficient heat demand density. Heat demand density is a spatial characteristic that indicates the degree to which building heat loads are concentrated in a particular area. This characteristic can be used as a broad indication of areas with potential for district heating and can be mapped using GIS methods for both existing and proposed development. Urban areas with high population density offer most potential for district heating schemes. For residential areas, a housing density of at least 40-50 dwellings per hectare is generally found to be a minimum threshold for viability. For a district heating scheme, civil works around the laying of heat mains and establishing connections to individual buildings is expensive; high heat densities therefore mean shorter pipe runs and lower costs.

A lack of overall size and diversity of heat loads can also act as constraints to district heating. Viability is very much site-specific but significant CO_2 savings generally occur at scales above 50 homes, and economies of scale mean that communities of over 500 homes are considered most appropriate for these kinds of schemes[46]. The co-location of existing and new development within district heating schemes can also help to diversify the heat load (i.e. promote a more constant demand for heat) and help to optimise plant design.

[46] *District Heating and Community Energy*. (2009) Energy Efficiency Partnership for Homes.

The phasing of large developments can present challenges to district heating schemes as the system needs to be able to adapt and accommodate future heat loads as they come on line. Existing buildings situated within or close to new developments which are considering district heating can offer significant benefits in that they can act as district heating 'anchor' points around which new systems could be established. As these heat loads already exist, incorporating them into the network would provide a stimulus for early implementation of the scheme. The inclusion of large public sector 'anchor load' sites such as social housing schemes, universities and local authority buildings can be particularly beneficial.

Within the UK, the size and complexity of district heating schemes tend to act as a significant constraint along with the cost and associated risk. The technology itself is less of a constraint as demonstrated by the many successful installations outside of the UK.

6.3 Costs and carbon savings

A report[48] undertaken for DECC in 2009 examined in detail the potential and costs of district heating networks. Although this mainly focused on existing development, it provides a useful indication of the relative costs and potential emission savings from district heating and other technologies. The figures below indicate the cost of heat provision by technology and the implied carbon abatement cost.

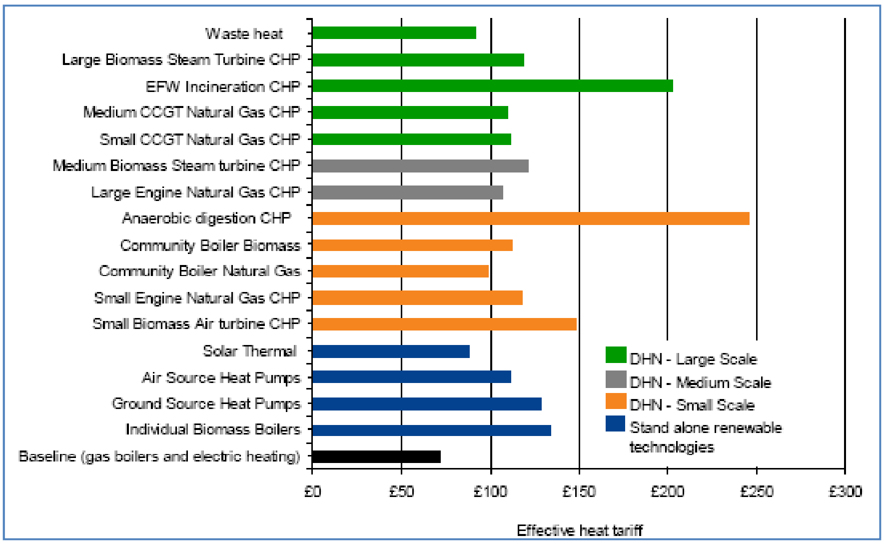

Figure 21: Cost of heat provision by technology (Source: The Potential and Costs of District Heating Networks; Pöyry Energy Consulting and AECOM; 2009)

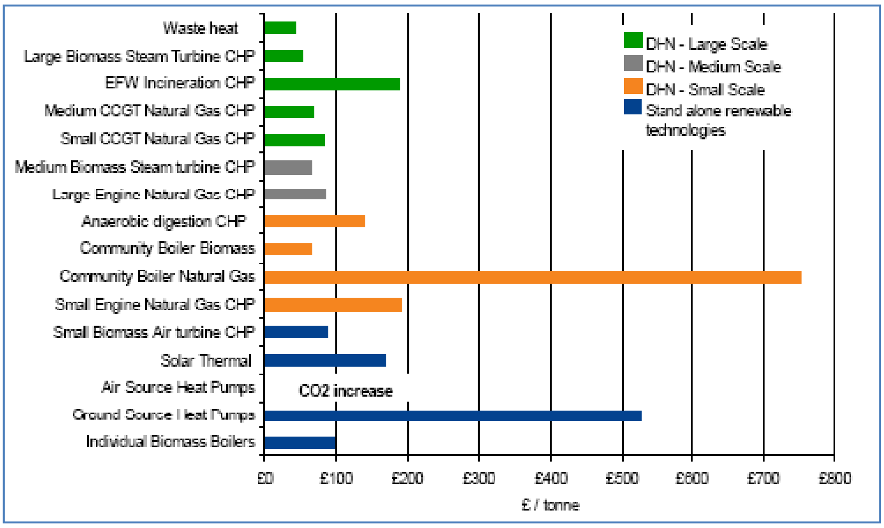

Figure 22: Implied carbon abatement cost (Source: The Potential and Costs of District Heating Networks; PÖYRY Energy Consulting and AECOM; 2009)

6.4 Heat priority areas

As part of its evidence base support programme for planners in the South West, Regen SW, the region's renewable energy agency, commissioned The Centre for Sustainable Energy (CSE) and Geofutures Ltd. to produce a heat demand map of the South West of England. The South West Heat Map is an *address-level* model of annual demand for space and water heating, covering the geographic extent of the South West of England[47]. It was created using a range of large publicly available datasets, combining information on buildings with benchmarks for estimating their heat demand, and is therefore a set of *modelled estimates* of heat demand from all buildings in the South West. The map in Figure 23 uses this data to produce a map of Teignbridge showing annual heat demand per square metre.

[47] For information about how the access the South West Heat Map, see http://www.regensw.co.uk/projects/support-for-decision-makers/sw-heat-map

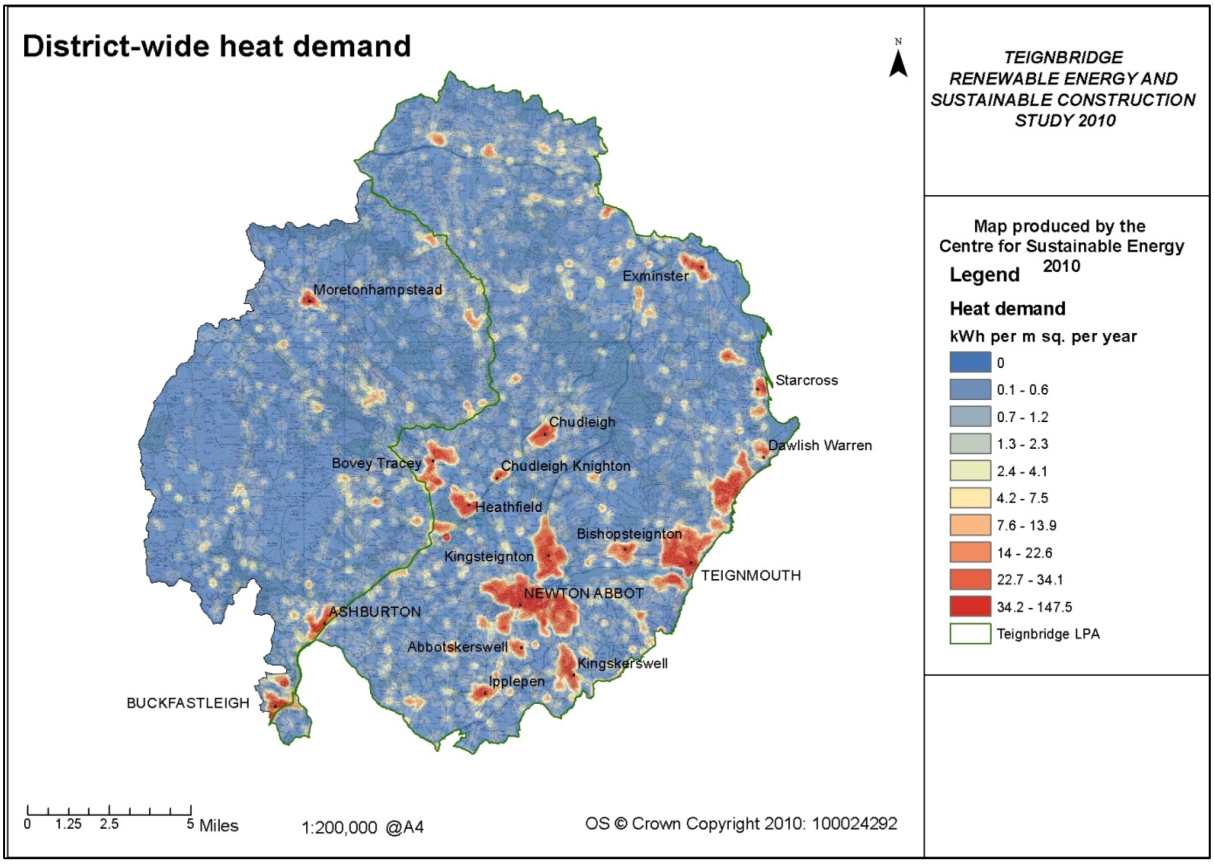

Figure 23: Annual heat demand per square metre

The South West Heat Map can be used by planners and developers to identify areas with the greatest potential for district heating. In this way the South West Heat Map can support the planning system by providing evidence for policies and targets, and by informing negotiations with developers, so that they know when and where to insist on connection to or provision of district heating infrastructure, and when to focus on other carbon reduction opportunities. The South West Heat Map can also be used by developers to help them to 'prospect' for heat distribution project opportunities, identify target areas, identify addresses for further contact and data collection, and to shortlist potential distribution routes for further investigation.

A rule of thumb for district heating is that heat demand density should be 3,000 kW per square kilometre or above[48]. Translating this into the units used in the heat map gives a threshold figure of around 26 kWh per square metre per year. Figure 24 below shows the areas in the district where heat demand is at this level or above. Figure 25 shows expanded sections of this map, focusing on Newton Abbot, Teignmouth, Dawlish and the Edge of Exeter.

[48] For example, see Poyry Energy Consulting and AECOM, *The Potential and Costs of District Heating Networks, A Report to the Department of Energy and Climate Change,* April 2009. Available *from* http://tinyurl.com/34lsnda

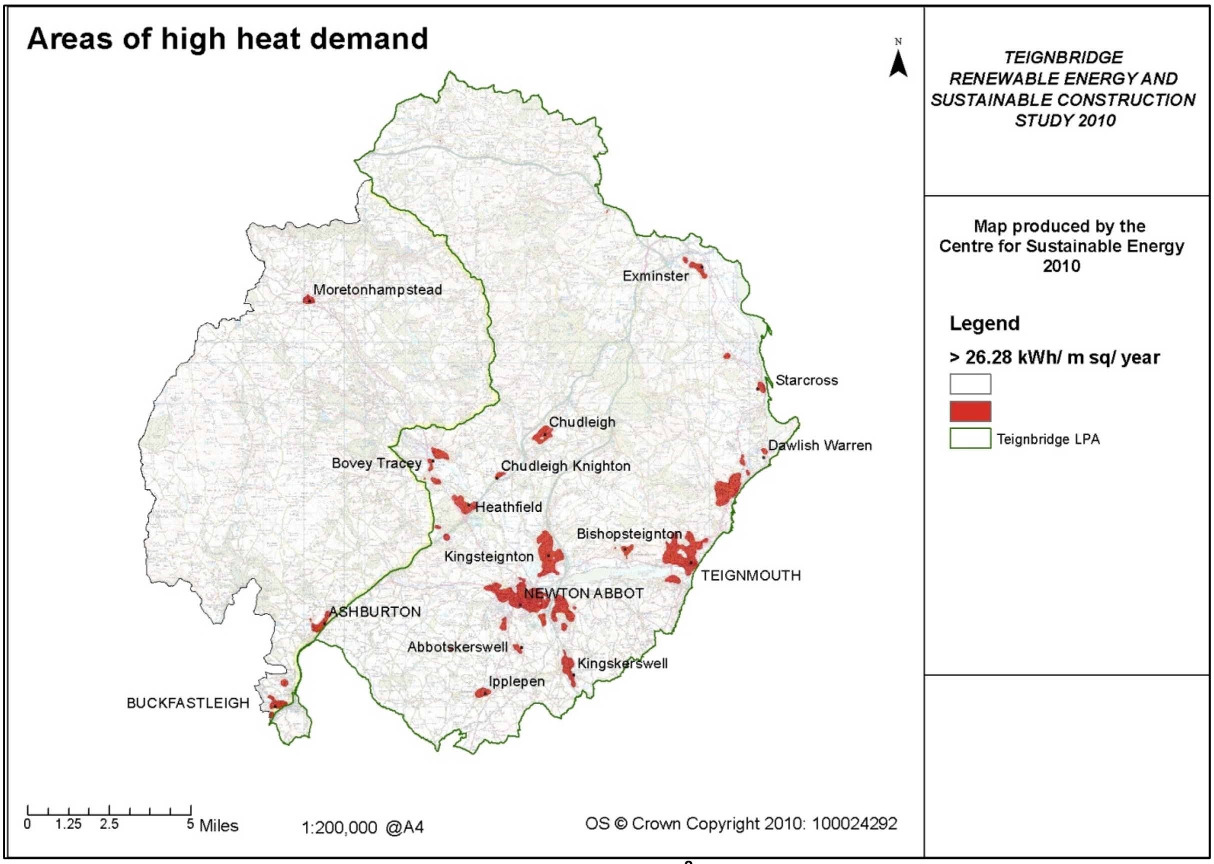

Figure 24: Areas of heat demand greater than 26.28 kWh / m^2 /year – Teignbridge District

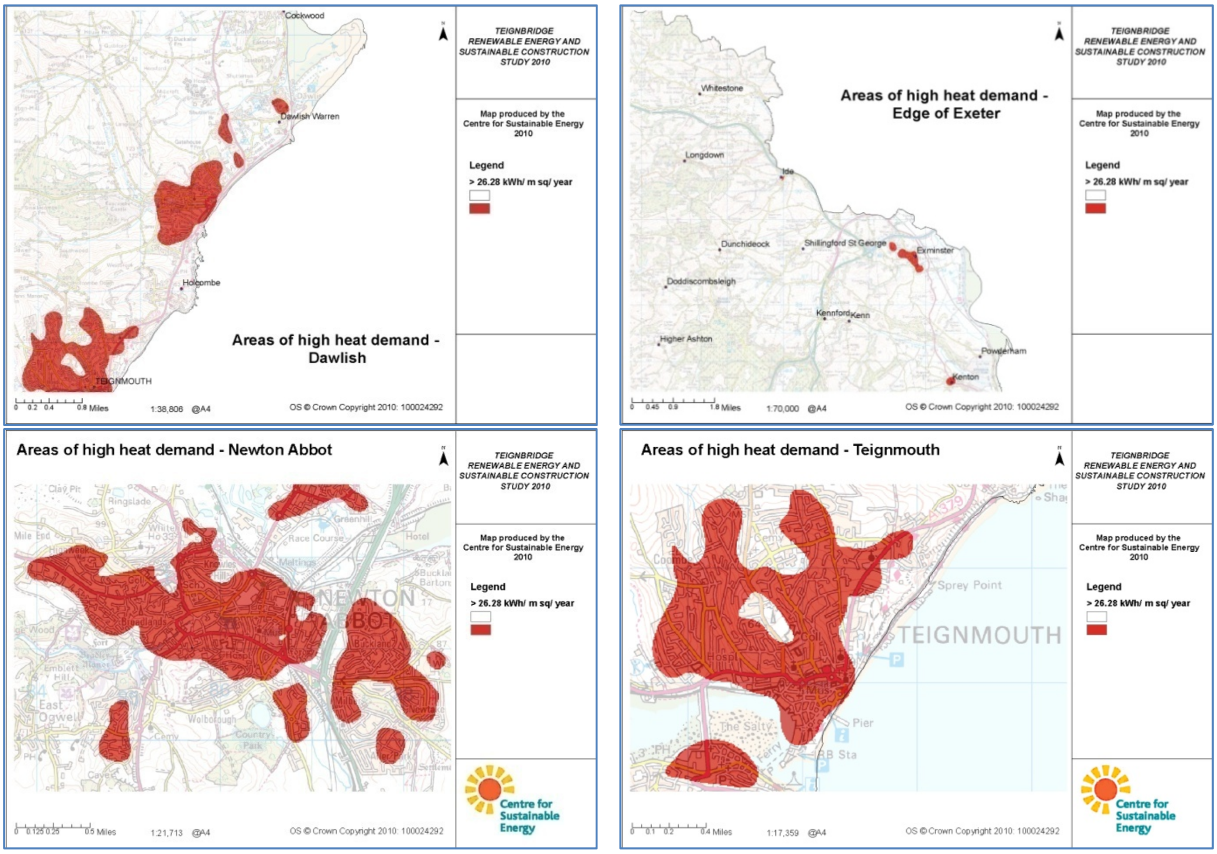

Figure 25: Areas of high heat demand in Dawlish, Edge of Exeter, Newton Abbot and Teignmouth

7 Site energy opportunities

7.1 Strategic development sites

The Teignbridge Core Strategy Issues and Alternative Options (2010) document puts forward four spatial options for housing growth, based around the need to provide around 740 dwelling per year. This indicates that the most significant housing growth is expected to be located around the area of Newton Abbot and Kingsteignton. Other smaller areas are also proposed, most notably the area to the South West of Exeter.[49] These are the types of areas that should be strategically considered for specific renewable and low carbon energy opportunities at the master-planning stage.

This task is referenced in the PPS1 supplement on Climate Change, which states that local authorities should:

"where there are particular and demonstrable opportunities for greater use of decentralised and renewable or low-carbon energy than the target percentage, bring forward development area or site-specific targets to secure this potential" P26(ii), and:

"ensure there is a clear rationale for the target and it is properly tested" P26(iv)

Due to the recent abolishment of the RSS, the Area Action Plans for Newton Abbot and South West of Exeter are no longer being progressed, but these strategic development sites are instead being considered in the context of the Core Strategy. The Core Strategy Issues and Alternative Options (2010)[50] currently presents four spatial options for housing growth across Teignbridge, which include various options for development at these two sites.

Due to the early stage of housing development planning in regard of the Core Strategy and SHLAA, the degree of analysis and modelling that would normally be required to inform the development of specific energy policies and targets for these areas is limited. However, the following sections in this report outline the approaches that should be taken in evaluating the key opportunities for strategic sites by considering the outputs of the resource assessment presented in Section 5 and issues such as development scale and form.

7.2 Energy Opportunities Plan

Energy Opportunities Plans can be used to pull together an initial set of information with a view to assessing the combined opportunities and constraints for renewable and low carbon development. These, and similar maps of other areas where there is likely to be significant growth can be useful in exploring the potential for setting site-specific targets on sustainable construction and should be considered at the masterplanning stage of developments.

Figure 26 – Figure 29 below show examples of Energy Opportunities Plans for key growth areas in Teignbridge. For various reasons, not all information is included so the interpretation of these particular maps is currently limited. For example, the data layer representing SHLAA sites has yet to be included. Additionally, potential woodfuel and energy crop resources have not been included as the catchment area for energy plant using these resources is significantly greater than the areas

[49] Prior to the abolishment of the RSS, the proposed changes to the Draft Regional Spatial Strategy for the South West Policy HMA4 had originally identified potential for around 8,000 dwellings at Newton Abbot and Kingsteignton and 2,000 for the South West of Exeter up to 2026.
[50] http://teignbridge.limehouse.co.uk/portal/core_strategy/cs_options?pointId=1265750

shown. In evaluating this resource for use at a specific site, district-wide maps are better suited to examine potential sources and supply chains. It should be noted that the areas with potential for wind shown on the maps is the resource remaining once level 1 and 2 constraints have been applied (see Section 5.3). There may be further local site-specific constraints that will reduce these areas.

The GIS package accompanying this report will enable the Council to create and tailor more detailed maps by selecting the relevant data layers of interest. However, the maps shown do illustrate some initial opportunities, such as Heat Priority Areas and potential council-owned anchor loads within the Newton Abbot area (for district heating) along with broad areas for small scale wind.

Along with the finalised SHLAA dataset, future data layers that could be added include the following:

- Potential hydro sites
- Other public sector potential anchor loads
- Social housing
- Existing and planned low carbon or renewable energy generation plant
- Landscape sensitivity to low carbon and renewable energy technologies
- Site-specific wind opportunities and constraints e.g. electricity distribution network

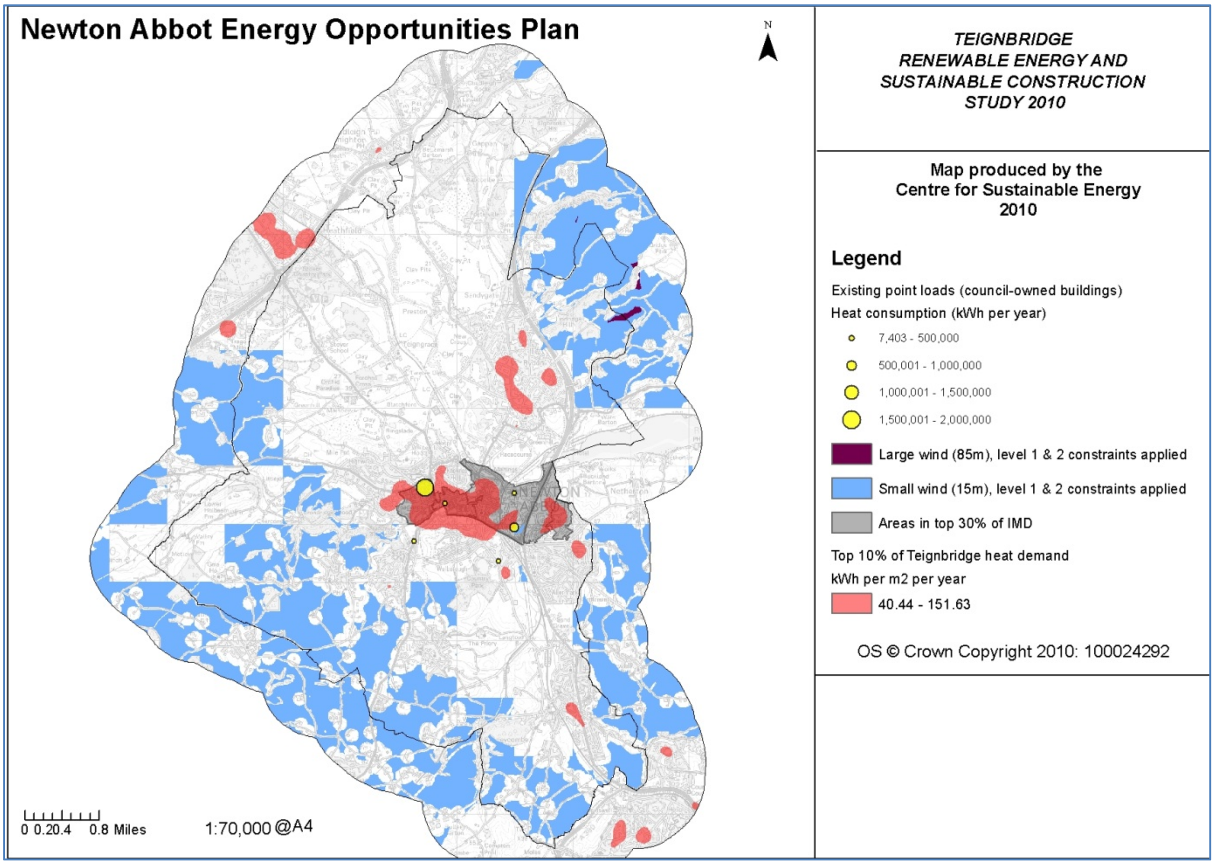

Figure 26: Newton Abbot Energy Opportunities Plan

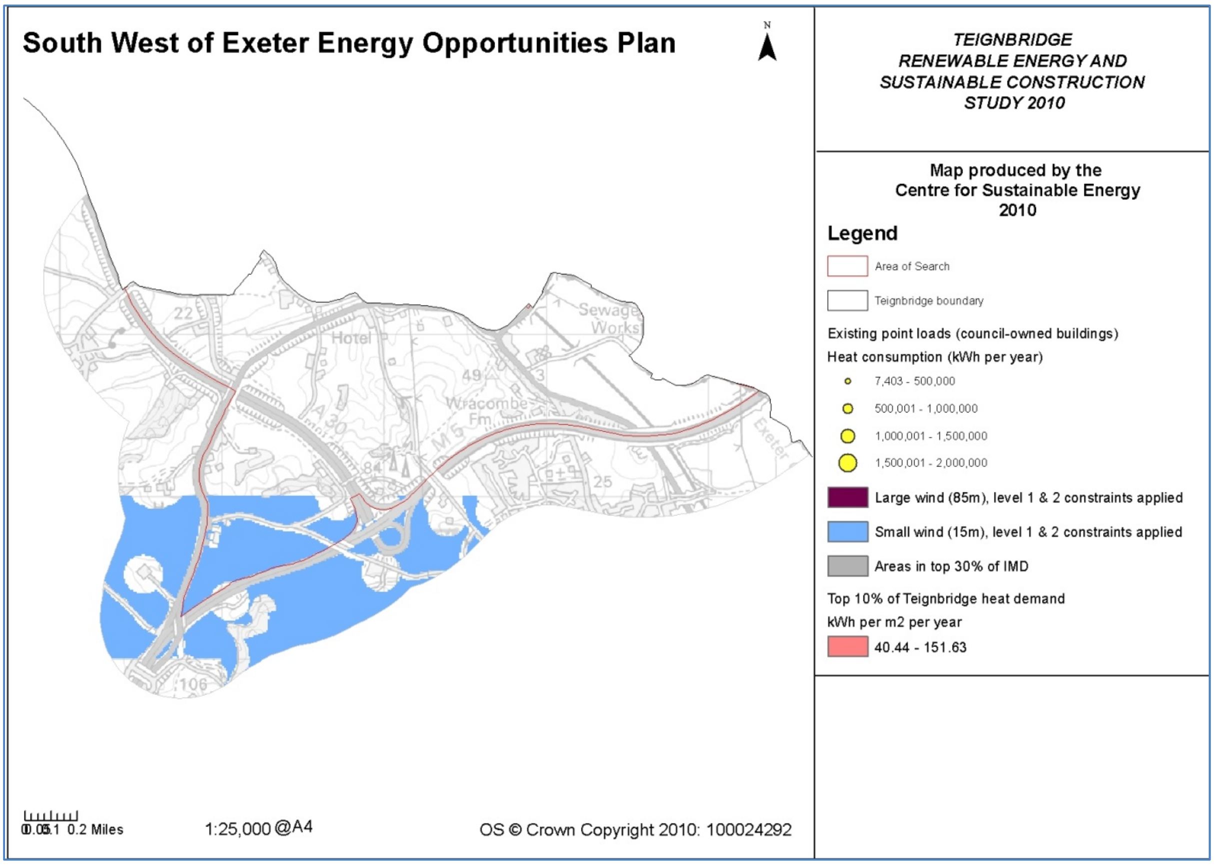

Figure 27: South West of Exeter Energy Opportunities Plan

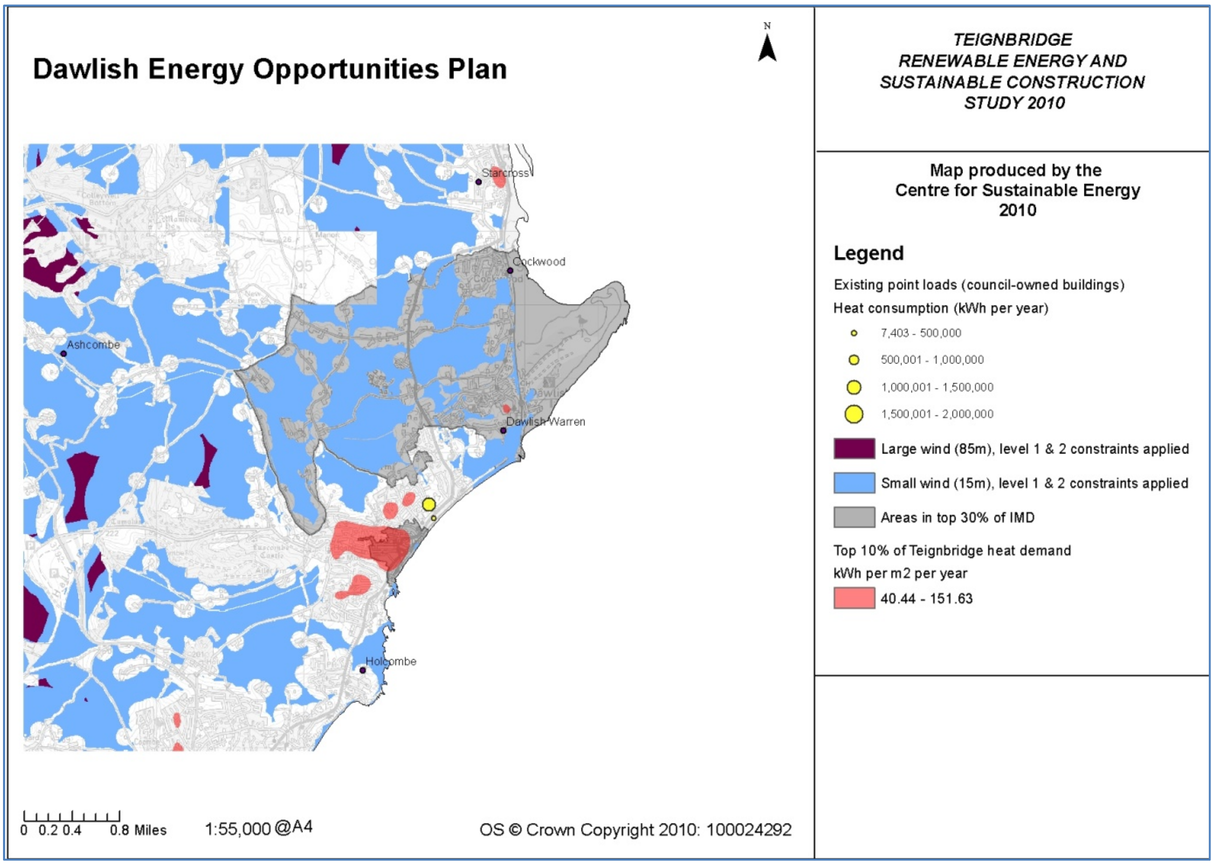

Figure 28: Dawlish Energy Opportunities Plan

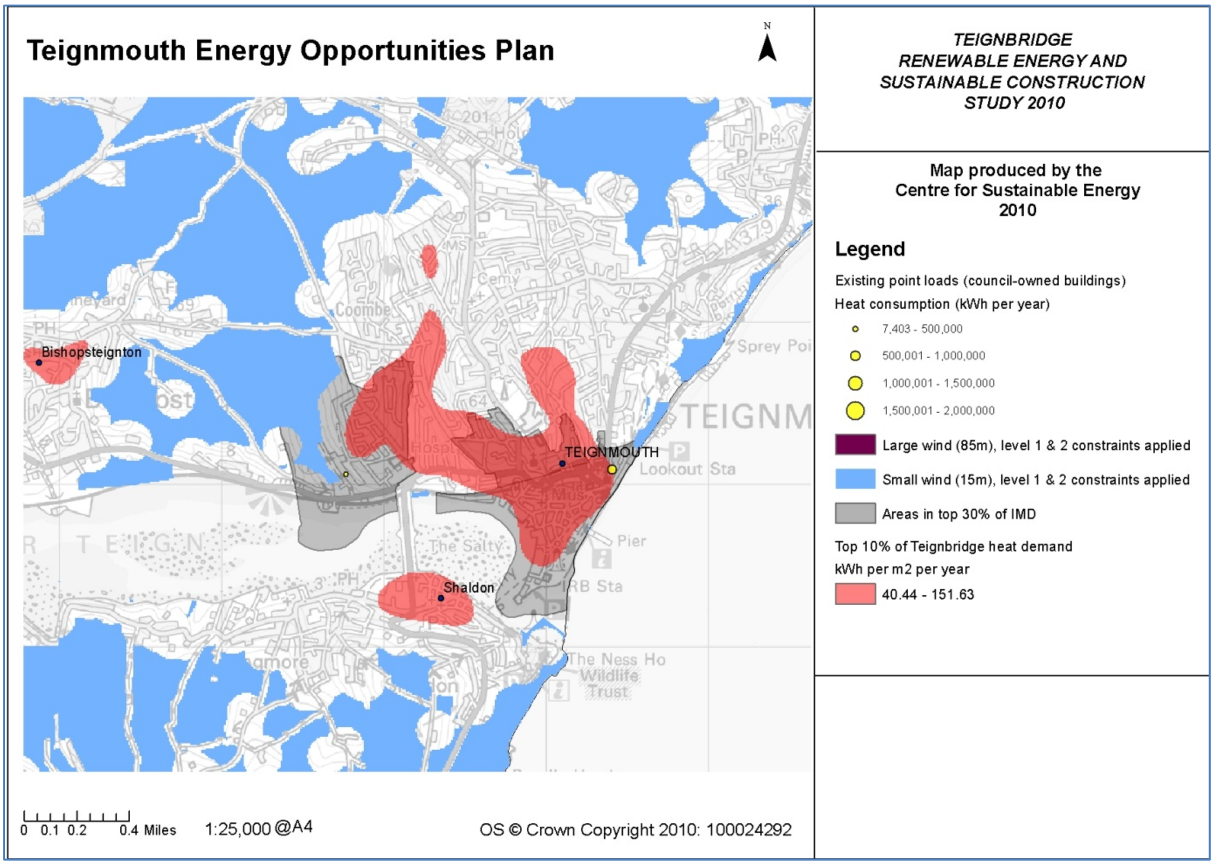

Figure 29: Teignmouth Energy Opportunities Plan

7.3 Development scale

The scale of development clearly has a major influence on the most suitable types of sustainable energy supply options for a given area. Technologies can generally be split into two types, microgeneration and community-scale generation, and developments may use either or a combination of each.

Microgeneration can generally be considered as technologies that can be applied to individual buildings, although strictly speaking this could include technologies falling outside of the scope of the current Microgeneration Strategy consultation issued by DECC, which covers electricity and heat technologies of up to 50kW and 300kW respectively. Typical systems would include:

- Small and micro-scale wind
- Solar photovoltaics (PV)
- Solar water heating
- Ground and air source heat pumps
- Small biomass heating
- Micro CHP

Community scale generation tends to comprise larger scale systems supplying a number of buildings such as:

- Medium/large scale wind turbines
- Large biomass heating (for district heating)
- Gas/biomass/waste fired CHP plants coupled to district heating systems
- Anaerobic digestion plants.

The scale at which community-scale energy supply solutions become more viable than microgeneration options is not defined and will vary depending on a number of factors such as building mix, density, local resources and levels of carbon reduction required.

Box 3: Energy supply options for Plymouth City Centre redevelopment
An example of where the community-scale approach has been considered more appropriate concerns Plymouth City Centre, where planned future redevelopment will involve dense, mixed use developments. As a high proportion of commercial-use buildings are present, microgeneration options were shown to have less potential in meeting higher carbon reduction targets due to the energy usage profiles, which, due to cooling requirements, mean that the electrical load is often considerably larger than the heat load. To achieve higher carbon reduction targets, the bulk of carbon savings therefore need to come from electricity, which, when considering microgeneration, effectively leaves wind and photovoltaics. Although both can have applications in urban settings, they are limited in their ability to achieve drastic carbon savings.

The main reasons for this are that all scales of wind power are limited by the lower wind speeds (and lack of space) encountered in built up areas, and that the areas of roof and façade space available for PV installations tend to constrain the savings that can be achieved. Whilst there could be opportunities for small-scale biomass heating in some buildings (subject to sufficient space being available for plant room, fuel storage and access for fuel deliveries), only a small proportion of savings would be achieved due to the relatively low heat demands. With little hot water demand solar thermal generation is also significantly constrained. Using a combination of microgeneration technologies may achieve higher carbon savings but was considered to be less cost-effective than a community-scale system in achieving a similar carbon target.

Nevertheless, micro-scale solutions have many applications – particularly for 'topping-up' savings in conjunction with community-scale systems, small-scale developments, rural communities or where lower targets apply e.g. Merton Rule policies for on-site generation.

For further information see:
Plymouth City Centre and University Area Action Plan: http://tinyurl.com/37gerr8
Plymouth City Centre Derriford Sustainable Energy Study: http://tinyurl.com/35h648r

The scale of development as proposed for Newton Abbot and potentially the South West of Exeter is such that both could potentially achieve high levels of carbon reduction through community-scale sustainable energy generation, although the spatial distribution of new buildings would need to be known to assess the viability of district heating. Indeed, the zero carbon requirement for residential development through Building Regulations from 2016 is highly likely, through necessity, to draw on community scale solutions such as biomass CHP with district heating once the cost-effectiveness of options are considered. This has implications for the phasing of the two development areas in that it is currently not known which elements may come under the 2016 zero carbon remit and so may be obliged to adopt community-scale solutions regardless of any local targets. In other words, even if the initial phases of the development fall under earlier, less demanding targets, the later phases from 2016 are highly likely to require community-scale solutions and it is therefore prudent to plan for this at the earliest opportunity.

Phasing can also cause complications for community-scale solutions. For example, where a development is built out in phases, the design of a CHP district heating system is likely to require a certain amount of modularity to sequentially accommodate each phase. CHP plant sized for the whole development would also need to account for fewer heat sales during the initial phases, when only a proportion of end-users would be active.

Strategic large scale developments are also likely to benefit from economies of scale from the use of more cost-effective community-scale systems and/or from bulk purchase of equipment and services. DCLG's report: Code for Sustainable Homes: A Cost Review[52] provides some evidence of this e.g. additional cost of achieving Code Level 6 for 3-bed semi (Page 12):

- 43.4% (10 dwellings, small greenfield site)
- 41.2% (20 dwellings, small brownfield site)
- 30.2% (350 dwellings, medium urban site)

However, this trend is not altogether consistent for all the development scenarios considered.

7.4 Energy hierarchy and Merton Rule policies

7.4.1 Energy hierarchy

Defining a hierarchical approach to the application of technologies can also be a useful way to make the most appropriate choice. An energy hierarchy is a simple conceptual tool which can be used as an organising and justifying principle in energy policy development, including in the context of planning policy. The basic hierarchy states the priority order to be adopted when matching energy demand with supply as follows:

1. Apply energy efficiency measures to reduce demand as far as possible
2. Meet the reduced demand with as much renewable energy as is practical
3. Meet any residual demand by supplying energy efficiently i.e. using decentralised low carbon energy sources where feasible

However, a slightly different approach can be taken by switching the order as follows:

1. Apply energy efficiency measures to reduce demand as far as possible
2. Supply energy efficiently i.e. using decentralised low carbon energy sources where feasible
3. Meet residual demand with as much on-site renewable energy as is practical

This alternative hierarchy has the effect of prioritising decentralised energy over renewables. For example, it would encourage a development to connect to an existing heat network if one were available, before meeting the demand separately with on-site renewables. It also can be used in the context of Merton Rule policies, where demand reduction and the efficient supply of energy are first considered, leaving a Merton Rule policy to apply to residual emissions (see below). This is the approach currently taken in London for major development.

It is of course important to note that in real-world situations (such as planning negotiations), the cost and practicality of measures in the three hierarchical categories will have a significant bearing on the outcome.

Heating systems installed in new developments are significant enough to warrant specific attention in planning policy for two main reasons. Firstly, space and water heating contributes around 40-50% of total carbon emissions from new buildings, and there are significant carbon savings available by using more efficient and/or low carbon heating systems.

Secondly, in urban areas, large scale heat distribution has a key role to play in reducing emissions both from new and existing buildings. New development can facilitate both the creation and extension of heat distribution networks – either through the installation of a new site-wide heat network supplied from on-site heating plant, or by connecting as extensions to existing networks, thereby improving their economics and spatial coverage.

The specific heat source is independent of the need for a heat distribution network, which itself will facilitate emissions reductions through allowing the use of larger scale (and hence more efficient) heat sources. In addition, heat networks have much longer lifetimes than the boiler plants that supply them – hence, over time a heat distribution network could facilitate a move from gas heating plant, to combined heat and power with biomass or fuel cells, etc.

There is therefore an order of preference for heating systems in new larger scale developments, which could be applied to strategic sites, which embodies the issues discussed above i.e. maximising the opportunities for large-scale heat distribution and minimising site emissions from heat consumption. Because emissions from existing buildings far exceed those from new development, it is appropriate to prioritise support for the creation of new heat distribution networks as well as for the development of existing networks. The following hierarchy takes this into account and is currently included in the London Plan (Policy 5.6):

1. Connection to existing heating or cooling networks
2. Site wide CHP network
3. Communal heating and cooling

The London Plan also contains a cooling hierarchy for major development (Policy 5.9):

1. Minimise internal heat generation through energy efficient design
2. Reduce the amount of heat entering a building in summer through shading, albedo, fenestration, insulation and green roofs and walls
3. Manage the heat within the building through exposed internal thermal mass and high ceilings
4. Passive ventilation
5. Mechanical ventilation

6. Active cooling systems (ensuring they are the lowest carbon options).

7.4.2 Merton Rule policies

Originally referred to as the "Merton Rule", this style of policy has evolved to become known as a "Merton Plus" policy. The PPS1 Supplement directly encourages such a policy, which should:

"set out a target percentage of the energy to be used in a new development to come from decentralised and renewable or low-carbon energy sources where it is viable. The target should avoid prescription on technologies and be flexible in how carbon savings from local energy supplies are to be secured."

In practice, most policies of this type now state a percentage reduction in emissions rather than energy as this tends to be more effective in reducing emissions due to subtleties around the differing carbon content of gas and electricity. They also now permit 'near site' measures rather than just 'on-site' – an example being the import of low carbon heat from an adjacent site.

Merton Rule polices will be mostly redundant from 2013, when Building Regulations will require a 44% reduction in regulated CO_2 emissions, a level which will almost certainly require on-site renewable generation equal to or in excess of the 10-20% typically demanded by these policies. Such policies are therefore unlikely to have a major role in strategic development sites where the bulk of development will occur beyond 2013. However, they may still have a role in helping to achieve carbon reductions in smaller scale developments in the short term through the use of renewables – particularly for buildings where it is not feasible to connect to community energy systems and for non-residential development which, depending on Government proposals on their route to zero carbon, may lag behind Building Regulation standards for residential development. Such a policy will also stimulate the local renewables industry and encourage developers to maximise energy efficiency.

Box 4: Impact of London Plan energy policies

Over the last few years, the London Plan has included policies on energy/heating hierarchies, decentralised energy incl. district heating and a Merton Rule policy. An analysis of recent London planning decisions has reported on the effectiveness of these policies. This independent report by London Southbank University shows that the London Plan has successfully driven carbon emission reductions from new developments of over 30% beyond building regulations between 2006 and 2009.

The conclusions support the 20% Merton Rule and decentralised energy policies; the indication is that the development industry can adapt to these requirements and that over time the degree of compliance increases. This also supports the argument that it is valid to adopt a challenging target, even if it means that they are not always achieved in every development.

http://www.london.gov.uk/sites/default/files/lon-plan-energy-policies-monitoring-1.pdf

8 Analysis of sustainable construction policy scenarios

8.1 Analysis of potential SHLAA sites

The DCLG's consultation on the *Definition of Zero Carbon Homes and Non-domestic Buildings* includes lists of low carbon technology mixes and costing data tested against a range of targets for a range of housing development types. For each target of interest, the least-cost technology mix was identified and applied to Teignbridge's SHLAA data using a database model. The generation technologies therefore selected included photovoltaics (PV), biomass community heating (BCH) and biomass CHP. Solar water heating, heat pumps and gas-fired CHP were also included in the DCLG study, but are not considered here as they do not occur within the 'least-cost' technology mixes for the targets considered. Wind power is excluded from the DCLG analysis as technical viability is significantly more dependent on site-specific factors than other technologies.

Although these have currently been modelled as the least cost options for specific housing development types, it should be noted that future changes in costs and technological advances may well dictate different optimum mixes with regard to technical and economic viability. Developers, therefore, may select different technologies from those modelled here.

The model is mainly designed to assess the likely technology mix and associated costs resulting from the application of the three scenarios described in Section 3. The charts below present the main findings, as modelled for the SHLAA sites as a whole across Teignbridge District.

Notes

- The 'Multiphase' x-axis category refers to the situation where the modelled scenario occurs throughout Phase 1, 2 and 3, i.e. for each site, a linear build out rate is assumed between 2010 and 2031, meaning targets are progressively increased. The 'Phase 1', 'Phase 2' and 'Phase 3' category results show the effect of building all sites during one particular phase i.e. a single phase target applies to all sites.

- In reality, due to the timescale envisaged for implementing the Teignbridge Core Strategy, any policies are unlikely to be launched until late in Phase 1 and so the effect of policies during this early phase under Scenarios 2 and 3 will be limited.

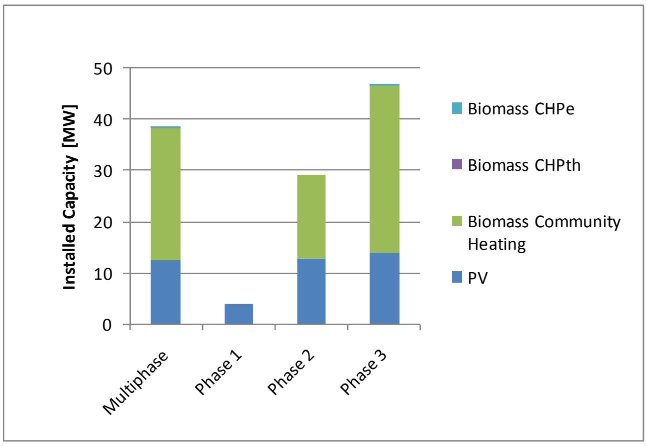

Figure 30: Scenario 1 – installed capacities

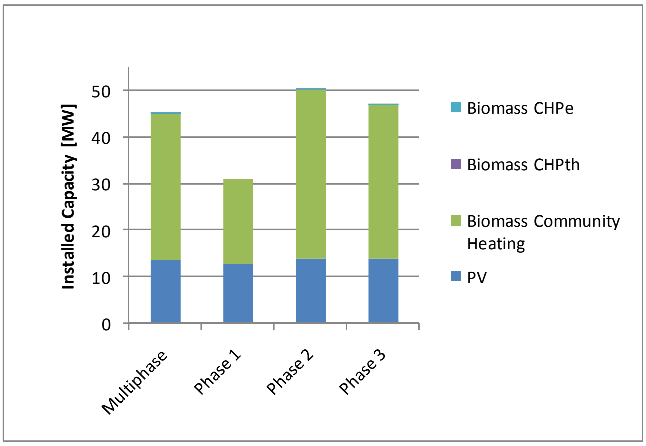

Figure 31: Scenario 2 – installed capacities

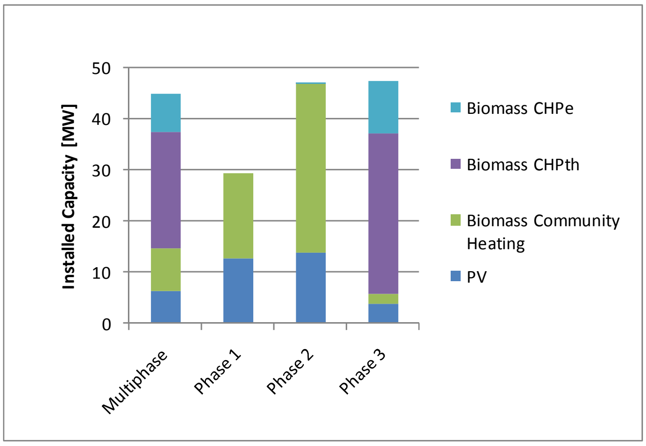

Figure 32: Scenario 3 – installed capacities

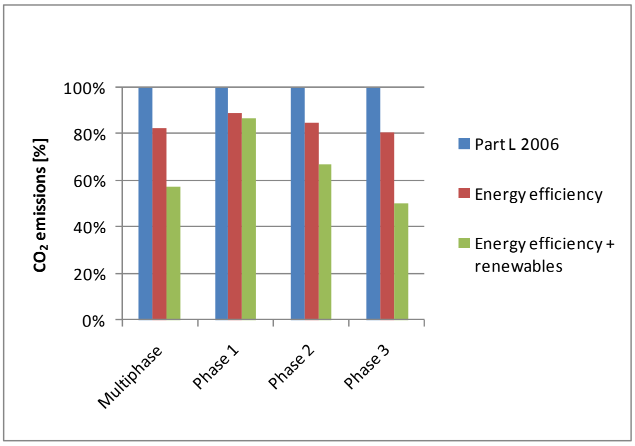

Figure 33: Scenario 1 – total emissions reductions

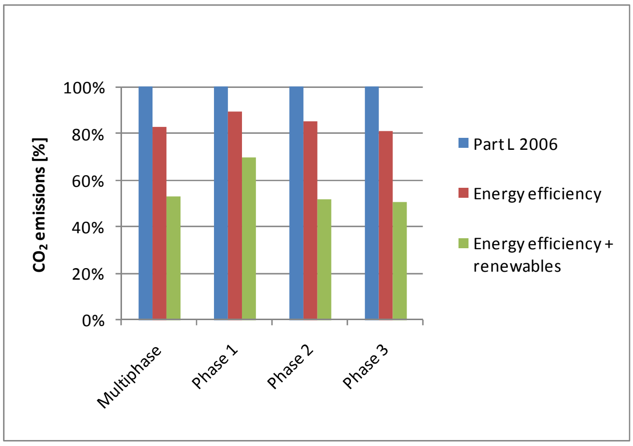

Figure 34: Scenario 2 – total emissions reductions

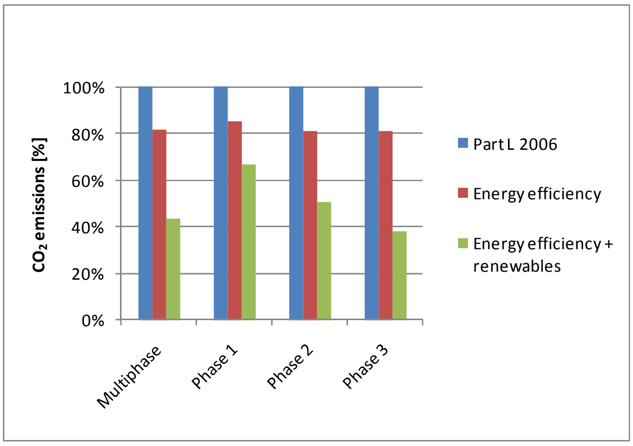

Figure 35: Scenario 3 – total emissions reductions

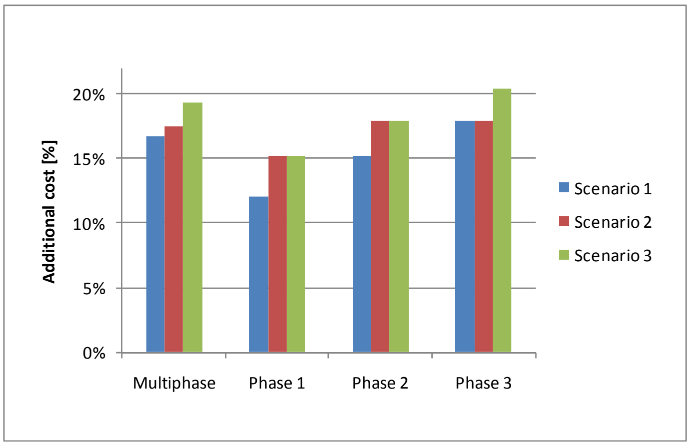

Figure 36: Additional costs over Part L 2006 for each scenario

Figure 30 to 32 show the modelled take-up of generation technologies for the scenarios (as applied after energy efficiency measures). The multiphase figures are also shown in Table 27 below. The results for individual phases indicate that PV and biomass community heating is predominantly used to meet the lower targets, with biomass CHP additionally required for the higher targets.

Figures 33 to 35 indicate the emission reductions relative to Part L 2006 (total emissions) resulting from the modelling of each scenario, assuming a constant level of energy efficiency and varying amounts of renewables required to approach the target.

Figure 36 shows the additional costs over base build (Part L 2006 levels) associated with the emissions reduction measures considered. This is discussed further in the following sections.

Table 27: Summary of on-site generation capacities as modelled on SHLAA sites

	Generation capacity [MW]		
Generation technology	**Scenario 1 (multiphase)**	**Scenario 2 (multiphase)**	**Scenario 3 (multiphase)**
Biomass CHP (electricity)	0	0	8
Biomass CHP (heat)	0	0	23
Biomass community heating	26	31	8
Solar PV	12	14	6

8.2 Cost implications of scenarios

Scenario 1 models the trajectory of Building Regulation changes expected up to 2016 and beyond. These changes will impose additional build costs on new developments, which will need to incorporate a range of low or zero carbon energy measures to meet the targets.

The analysis for Teignbridge as applied to new residential development (SHLAA sites) considers a range of on-site carbon reduction targets up to 100% of regulated emissions. Results are shown for the three scenarios in Table 28 below. As mentioned above, the analysis is based on data from the Government study described above.

Table 28: Increase in additional build cost (relative to the Part L 2006 standard)

	Range of additional build costs across each phase [%]	Multiphase average [%]
Scenario 1	12 – 18	17
Scenario 2	15 – 18	17
Scenario 3	15 – 20	18

9 Research into the cost of zero carbon development

Previous research commissioned by the Government has indicated that the average construction cost premium for delivering zero carbon homes entirely within the development site could be between 17 – 24% over current build costs by 2016, but would decrease from this peak as the costs of key technologies fall.[51] More recent evidence has re-examined the costs relating to the Code for Sustainable Homes standards, which cover a wider scope of measures than those directly related to reducing carbon emissions from energy use. Costs for non-residential zero carbon developments are much less documented but are currently being assessed by the Government following a consultation earlier this year (see Section 2.3).

9.1 Code for Sustainable Homes

DCLG's Code for Sustainable Homes: A Cost Review (March 2010)[52] concluded that typical extra-over costs expressed as a percentage of base build cost (with reference to Part L 2006 standards) range up to 40%. The range of results is shown in the figure below:

[51] *Research to Assess the Costs and Benefits of the Government's Proposals to Reduce the Carbon Footprint of New Housing Development*; DCLG Sept 2008 - http://www.communities.gov.uk/publications/planningandbuilding/housingcarbonfootprint
[52] http://www.communities.gov.uk/documents/planningandbuilding/pdf/1501290.pdf

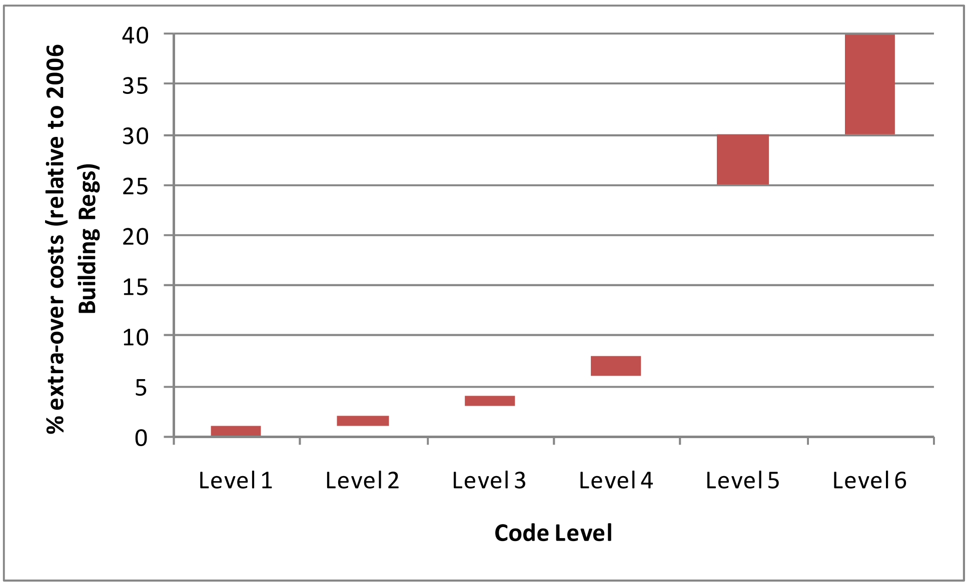

Figure 37: Costs of compliance with the Code for Sustainable Homes

The review found that there was significant variation in the extra-over costs at each Code Level between the dwelling types and across development scenarios considered.

Another DCLG publication[53] looking at case study examples of the Code reported increases ranging from around £4,000 for a Code Level 3 home to £50,000 for a Code Level 6 home. It also suggested that costs to build to Code Level 3 have reduced since an earlier set of case studies were published.

The proposed fabric energy efficiency standard for zero carbon homes (see Section 2.3) estimated that, for the build specifications required to meet the standard, the capital cost increase over a house built to Part L 2006 standards would be between 3% and 9%, with the detached home at the higher end of the scale.

A crucial point to consider however is the cost impact of the emerging definition of zero carbon/Code Level 6, which includes off-site 'allowable solutions', and which may, with certain assumptions, reduce cost uplift by a third. Other factors such as material and equipment costs along with technology learning curves also have the potential to reduce costs. PV costs, for example, are expected to significantly reduce as PV-oriented solutions become more widespread.

9.2 BREEAM

There is currently little conclusive evidence regarding the additional costs of BREEAM standards that can be used to generalise across non-residential development categories. This is mainly due to the complexity and range of building types and uses in this sector, which clearly impacts both potential carbon reduction solutions and costs. As mentioned in Section 2.3, the Government is currently researching costs in the lead up to a new Zero Carbon definition for new non-domestic buildings alongside a review of BREEAM and a potential Code for Sustainable Buildings.

Examples of publications include BRE Information Paper 4/0522 from 2005, which suggests that the 'Excellent' standard could be achieved for a naturally ventilated or air conditioned office for around 7%

[53] http://www.communities.gov.uk/documents/planningandbuilding/pdf/1490945.pdf

increase on capital build cost. Another publication from 2008[54] suggests that the same standard could potentially be achieved on secondary schools with a 4% increase. A limited number of specific case studies exist (Table 29 shows some examples), but few have detailed information on costings.

It is now evident that BREEAM standards are well understood by the building industry, and are increasingly used in marketing. The examples below were developed without incurring costs which had a negative impact on feasibility or delivery.

Table 29: BREEAM case studies

Building	**BREEAM Rating**	**Notes**
Vulcan House, Sheffield	Excellent	• Office building • Additional costs around 5-10% http://tinyurl.com/3ygg7m5
Langley Point, Birmingham	Excellent	• Office building • Additional costs around 20% • Potential annual savings on running costs up to £500k http://tinyurl.com/389qc75
Cardiff Central Library	Excellent	• No additional build cost (helped by former car park location) • 20% CO_2 reductions expected over 2006 Building Regs http://tinyurl.com/33fkcpo
Horizon House, Bristol	Outstanding	• Office building • Expected to save £180k/yr on running costs http://tinyurl.com/2w34g76

[54] Putting a price on Sustainable Schools, BRE Trust and others: http://www.teachernet.gov.uk/_doc/12792/Putting%20a%20Price%20on%20Sustainable%20Schools%20Report%20FB15.pdf

10 Policy implementation

10.1 Internal resources

With the forthcoming changes in Building Regulations, local authorities will need to fully understand the implications and prepare in advance for any additional resource capacity needed to manage and implement the requirements. Development Management in particular will need to fully understand the requirements and range of solutions so that they can confidently enter into planning negotiations with developers and adopt systems for checking compliance, including allowable solutions. This will be particularly important should local policies be adopted that exceed national standards. Tasks that may be required in implementing policies include:

- The provision of detailed information on the Code for Sustainable Homes and BREEAM assessment process to officers in both Planning and Development Management, and other officers involved in sustainability issues
- The provision of detailed information on renewable energy and low carbon technologies to officers in both Planning and Development Management
- The provision of clear and detailed advice to developers during up-front negotiations, such as: the scope and format of an energy strategy, potential funding options and advice on market leadership and development selling points
- Specification of monitoring requirements for installations

10.2 Project financing options

There are also a number of opportunities potentially available to the Council to help facilitate the financing and delivery of renewable or low carbon developments. Some examples are outlined below:

Factoring-in additional build cost to the price paid for land – where a developer is buying land from a local authority, the higher the proportion of extra build cost (resulting from sustainable construction standards) that can be compensated within the initial land value, the less burden placed on developers, and the less risk of additional costs being passed on to the building end-user. However, there is also a risk that pressure on land values may significantly impact the quantity of land being brought forward for development, which could potentially jeopardise the ability to meet wider housing targets.

Planning Obligations – Section 106 (S106) of the Town and Country Planning Act 1990 allows local authorities to enter into a legally binding agreement or planning obligation with a landowner in association with the grant of planning permission. This obligation is termed a Section 106 agreement and is a way of delivering or addressing matters that are necessary to make a development acceptable in planning terms. They are increasingly used to support the provision of services and infrastructure, such as highways, recreational facilities, education, health and affordable housing. Such agreements are a commonly used tool and have been used by a large number of local authorities to require that developers meet ‘Merton Rule’ policies.

Community Infrastructure Levy – the community infrastructure levy is a new local levy that authorities can choose to introduce to help fund infrastructure in their area. CIL will help pay for the infrastructure required to serve new development, which includes development that does not require planning permission, and can be optionally charged by local authorities in England and Wales. Councils must spend income from the levy on infrastructure but they can decide what infrastructure to spend it on and it can be different to that for which it was originally set. Local authorities will still be able to enter into negotiated planning obligations using Section 106 of the 1990 Town and Country Planning Act (Section 106 agreements) alongside use of the CIL.

Energy Service Companies – The ESCo (Energy Service Company) model is based around an energy service provider installing low carbon energy generation or energy saving equipment and charging consumers for the use of their service over a defined contract period. Companies would own and maintain the technology in exchange for consumers signing up to a service contract. There are a number of different types of energy service schemes such as:

- Preferred supplier partnerships/affinity deals;
- Housing energy clubs; and
- Energy supply schemes.

There are many options for who could provide energy services or elements of such, including energy suppliers, third parties working with energy suppliers or bodies which have a permanent connection or relationship to properties such as Distribution Network Operators, gas distributors and water companies. Additionally, the Local Government Act 2000 enables local authorities to set up ESCos either on their own or in partnership with a private company, as Woking, Birmingham, Aberdeen and Southampton have done. Further information is available from the Energy Saving Trust's Directory of Energy Services[55] which contains a range of guidance and case studies.

There is increasing evidence that more local authorities are taking initial steps to develop an overarching ESCo which can take on the management of district heating/CHP schemes from private developers across the council area. Plymouth City Council and Bristol City Council, for example, are both currently considering options for an ESCo partnership for strategic development areas of the two cities.

The London Energy Partnership's publication, *Making ESCOs Work: Guidance and Advice on Setting Up and Delivering an ESCO*[56] found that in the UK there are a variety of models being used for the delivery of energy projects by public authorities. This is due to differences in each authority's attitude to risk and the degree to which they want to involve the private sector in the project, but it is also due to the lack of a well developed standard model for ESCo contracting in the UK.

This lack of standardisation and funding in the UK for ESCo projects has meant that some have been set up through Private Finance Initiatives. Many projects are financially marginal and one of the significant issues has been persuading the private sector to accept sufficient financial and other risk in projects. For example, in the case of heat and power networks, the report found that the private sector is less willing to build a network to distribute heat and power than is it to build and operate the plant itself. This has led to difficulties in some projects due to a funding gap in relation to construction of the network. Developers are more likely to be willing to have district heating networks serving their sites when an ESCo will take some or all of the upfront financial risk for the project.

However, with some of the measures proposed in the Government's Heat and Energy Saving Strategy Consultation Document, there are potentially ways in which risks could be reduced and

[55]Energy Services Directory - A Guide for Local Authorities, Housing Associations and Community Groups; EST Jan 2007
[56] http://www.lep.org.uk/uploads/lep_making_escos_work.pdf

incentives provided to encourage an increased level of activity regarding ESCos and their successful implementation. For example, by packaging different Government subsidies, including CERT and the RHI, Energy Performance Contracting (EPC) arrangements are more likely to be viable for ESCo bodies.

Heat sales would, of course, be subject to regulatory controls which should include quality and continuity of service (including protections for consumers during supply outages), the basis for setting prices in the long term, metering and billing and dispute resolution. Finally, it is important to highlight that ESCos are being considered as an ‘allowable solution’ by Government.

10.3 Monitoring and enforcement

Ensuring that local renewable and low carbon energy projects are appropriately monitored at both the planning application stage and once they are implemented will help to track the effectiveness of policies and the progress towards local, regional and national sustainable energy targets. Local authorities are required anyway to report on core output indicator E3: Renewable Energy Capacity [local level] and are requested to provide information to DECC on the planning and commissioning status of renewable energy projects as part of the Renewable Energy Planning Database (REPD) [national level monitoring]. A database of installations would therefore be useful to facilitate this and to help update the Energy Opportunities Plan.

Development Management will be key in ensuring that sufficient information is being captured to demonstrate the effectiveness of policies. This can be helped by requiring a sufficiently detailed energy strategy and ensuring that any pre or post-construction assessments for the Code for Sustainable Homes/BREEAM are submitted. Other tasks that may be required around monitoring include:

- The inclusion of wording within planning policies to ensure that monitoring systems are installed and that data is collected
- The development of a methodology/protocol for monitoring
- Measures to ensure that the cost of monitoring is not prohibitive and is carried by the developer
- Measures to ensure that the information is provided in a format which can be used by the local authority (for other activities including NI 186 and renewable energy generation reporting); and
- Measures to ensure that the monitoring systems and associated protocol are designed such that the role of the local authority is to review and if necessary check the data, and that the local authority is not required to collect and analyse data from multiple systems on an on-going basis.

11 Conclusions and recommendations

The evidence gathered by this study is intended to set the context and provide guidance on policy development for the areas of sustainable construction and decentralised renewable or low carbon energy generation. The main policy-related conclusions and recommendations are therefore outlined below under the specific policy areas being assessed. Additional recommendations are then outlined separately.

11.1 District-wide sustainable construction policy for new development

Policy Recommendation 1: District-wide sustainable construction policy for new development

The Council should assess further whether local conditions and its in-house capacity could be developed sufficiently in the short term to justify the adoption of standards in advance of Building Regulations. In particular, the capacity and resources needed to draw up and offer developers a form of 'allowable solution' for local deployment in advance of 2016 should be evaluated.

Should this capacity be available, the Council could consider implementing standards in advance of Building Regulations (such as Scenario 2) as a carbon emission standard for all larger scale new residential development, but with allowable solutions also an option for pre-2016 standards where developments can prove that the standards are not technically or economically viable.

Once the national definition of Zero Carbon non-domestic buildings is better defined, along with the corresponding future trajectory of Building Regulation carbon reduction standards, a similar policy for non-domestic development could also be implemented, but would again need allowable solutions as an option for pre-Zero Carbon standards.

Should there be significant doubt over the local conditions and the Council's in-house capacity required to implement the above district-wide standards, similar policies could instead be focused on strategic development sites, which may have more proven potential to meet higher standards by virtue of their location and other specific circumstances (see Policy Recommendation 3 below).

The Council should also require an explicit site energy strategy to accompany all larger scale development proposals. This strategy should demonstrate consistency with the following energy hierarchy:

1. Apply energy efficiency measures to reduce demand as far as possible
2. Supply energy efficiently i.e. using decentralised low carbon energy sources where feasible
3. Meet residual demand with as much on-site renewable energy as is practical

Development proposals should also show evidence of having considered wider sustainability issues with reference to the South West Sustainable Construction Checklist.

The review undertaken for this study has revealed that local authorities are implementing policies that vary on their requirements for sustainable construction standards. For example, whilst some refer to Code for Sustainable Homes or BREEAM standards in the whole, which go beyond energy requirements, others refer just to the level of carbon reduction inferred by a specific Code/BREEAM level. There is also variation on the geographical scale at which the policy is applied and in some cases the development size thresholds to which certain standards should apply. There are pros and cons for all these variations and the PPS1 supplement is not prescriptive on these points. The key issues are summarised as follows:

- **District-wide *vs* site-specific** – when applied generically across a district, it is important to consider the viability of any standards which exceed Building Regulations, as the conditions that may justify a higher standard at one site may not be present at another. Whilst the proposed Building Regulations are considered by most as being suitably challenging, the carbon reduction levels to be attained on-site or near-site are designed to be achievable in virtually all development scenarios, with allowable solutions in place to meet the gap in accordance with the zero carbon homes definition from 2016. It is therefore likely that district-wide generic local standards set in excess of these, or implemented at an earlier phase, would not be viable for certain types of developments due to the variations in the location and circumstances across sites. A degree of flexibility would therefore be needed such as bringing forward the proposed Zero Carbon 'allowable solutions' option e.g. requiring that developments contribute to a buyout fund for carbon emissions that cannot be offset on-site.
- **Scope of standards** – where Code for Sustainable Homes or BREEAM standards are specified in the whole, a range of environmental categories in addition to energy/carbon standards are included. This offers the advantage of ensuring a comprehensive set of standards for sustainable construction using nationally-recognised methodologies which ultimately will be aligned to Building Regulations. However, when applied district-wide, viability issues may again result in a proportion of developments struggling to meet the requirements and alternative options will need to be in place where the standards are not shown to be viable.
- **Level of standards** – the additional costs relating to the various levels of the Code for Sustainable Homes are now reasonably well documented, with the carbon reduction requirements known to contribute the bulk of the cost and with a significant step-change in costs beyond Level 4. The analysis undertaken for Scenarios 1-3 on the current Teignbridge SHLAA dataset has estimated the additional costs (over and above 2006 Building Regulation standards) relating to carbon reduction to be in the range 12-20%. These costs refer to 'carbon compliance' requirements and do not include costs associated with other categories of the Code or those incurred from allowable solutions as from 2016.

  Scenario 3, as tested in this study, involves a standard in excess of the proposed definition of Zero Carbon i.e.100% of regulated emissions through carbon compliance measures. This is distinct from Scenario 2, which does not actually go beyond standards within the proposed definition of Zero Carbon, but instead advances elements of these standards for implementation at an earlier phase.

***Note**: A policy implementing Phase 1 of the Scenarios would effectively begin from the date of adoption, which is likely to be in the latter part of the 2010-2013 phase rather than 2010 as used in the analysis.*

11.2 District-wide target for percentage reduction in new development site emissions

Policy Recommendation 2: District-wide target for percentage reduction in new development site emissions

It is recommended that a district-wide on-site generation policy should be adopted for all new development. This should be applied in the context of an energy hierarchy where energy demand reduction and efficient supply of energy should be considered first, with the on-site generation policy then used to reduce residual emissions. For example:

"New development will be required to include sufficient on-site renewable energy generation to reduce total CO_2 emissions by at least 20% after accounting for energy efficiency and low carbon energy sources, wherever feasible"

Merton Rule policies can be applied in the context of an energy hierarchy which includes energy efficiency and efficient decentralised energy supply, such as that in the London Plan. This incentivises the developer to firstly maximise the emissions reductions achieved through energy efficiency, CHP and communal heating systems, as the lower the projected remaining site emissions are, the smaller the capacity of (more costly) renewables required to meet a given target.

It is important to note that this style of policy will effectively be made redundant for most development when Building Regulation requirements increase as expected towards the 2016 zero carbon target. This is because carbon reduction standards through Building Regulations will then, for residential development at least, begin to require levels of on-site generation in excess of that typically demanded by these policies. This is particularly relevant for Core Strategies (such as that for Teignbridge) that are in the early stages of their development and won't be fully adopted until the latter half of the 2010-2013 phase. However, it is recommended that Teignbridge adopt such a policy as it will nevertheless have an impact, particularly on non-residential development which, depending on the route to zero carbon, may lag behind Building Regulation standards for residential development. Such a policy also will also stimulate the local renewables industry and encourage developers to maximise energy efficiency.

However, a review of London Plan energy policies (see Box 4) found that, when a high proportion of district heating with CHP is achieved, opportunities can be reduced for thermal renewables, so there can be a tension between the two. This could be addressed by acknowledging that developments which achieve a high proportion of their energy supply from onsite CHP may find it harder to meet the Merton Rule target, and that this will be taken into account in planning negotiations.

11.3 Energy/carbon targets for strategic development sites

Policy Recommendation 3: Energy/carbon targets for strategic development sites

Once finalised, the Strategic Housing Land Availability Assessment data should be mapped for the district and included on the Energy Opportunities Plans of strategic growth areas, along with other relevant data layers mentioned in this report. The data layers should then be assessed using the GIS package supplied with this report to identify any demonstrable opportunities at new development sites for an increased reduction in emissions when compared to district-wide or national standards, through use of decentralised and renewable or low carbon energy sources. Site-specific targets should then be drawn up as appropriate.

The PPS1 Supplement states that well-founded site specific targets drawn up in line with its guidance may expect significant proportions of the energy supply of new development to be secured from decentralised and renewable or low carbon energy sources. This policy option therefore aims to identify specific sites where there are demonstrable opportunities for an increased reduction in emissions when compared to district-wide or national standards, through use of decentralised and renewable or low carbon energy sources.

The form of these targets would be similar to those discussed above for a district-wide sustainable construction policy but would be based on a greater understanding of the site in terms of building mix, energy demands and site-specific energy opportunities.

The Teignbridge Core Strategy Issues and Alternative Options (2010) document puts forward four spatial options for housing growth, based around the need to provide around 740 dwelling per year. This indicates that the most significant housing growth is expected to located around the area of Newton Abbot and Kingsteignton. Other smaller areas are also proposed, most notably the area to the South West of Exeter. Energy Opportunities Plans for both areas currently indicate limited opportunities, but do not yet include spatial data on proposed new development as this data, along with the specific development mix, is not yet finalised.

11.4 Identification and promotion of sites for stand-alone renewable energy generation

Policy Recommendation 4: Identification and promotion of sites for stand-alone renewable energy generation

The maps, GIS data and resource estimates resulting from this study should be used to help identify sites that hold the best opportunities for renewable energy generation. The Council should then consider ways to allocate or identify them in local development documents, so that applications to develop generation plant within these sites can perhaps be viewed more favourably than elsewhere.

It may be appropriate to develop this policy in conjunction with one on district-wide targets for renewable energy generation (see below).

This type of policy aims to identify sites of specific opportunity for renewable energy generation rather than placing a reliance solely on using a criteria-based planning approach. This is a similar approach to that currently being used by Unitary and County local authorities to identify potential sites, or areas of search, for locating energy from waste facilities. Potential stand-alone sites for renewables occur where a relevant resource is geographically constrained to specific area. Such sites could potentially be classed as an 'area of search' or allocated in the Core Strategy, and although referred to as 'stand-alone', may or may not be linked in some way to development.

This study has attempted to quantify and where possible map the potential areas of opportunity for renewable energy generation. The key resources comprise wind, waste and biomass. Potential sites for wind are relatively easy to identify as they rely on locations with higher wind speeds and which are least affected by a specific range of constraints. Sites for waste and biomass however are not always constrained to pre-determined locations due to the option of transporting both materials, although they would tend to be limited to within a specific radius of the material source(s). Specific land designations at international, national and local level have been included in the assessment; these often act as a key constraint to many renewable or low carbon technologies.

Although a relatively small resource, sites for small-scale hydro power in Teignbridge have also been indicated, most of which would be operated as a stand-alone plant. Since the introduction of the Feed-in Tariff, some developers have expressed an interest in 'solar farms', where large-scale PV systems operate as a stand-alone energy plant. The theoretical district-wide resource from this type of system is clearly very large but the practical resource will be highly dependent on local factors such as land ownership/use, planning issues and cost of grid connection. This is better assessed at a more local, site-specific level.

Additionally, the heat map provided may also influence the location of CHP plants, which may potentially be operated as a stand-alone electricity plant, but with heat also being supplied to nearby buildings.

11.5 District-wide targets for renewable energy generation

Policy Recommendation 5: District-wide targets for renewable energy generation

The Council should consider setting district-wide target(s) for renewable energy generation for future milestones. These could potentially be related or aligned to national targets such as the UK target of 15% renewables contribution to total energy use by 2020. It is recommended that the targets state total capacity and energy yield for both renewable electricity and heat but are not prescriptive on technologies, although a 'lead scenario' may serve to illustrate how the targets may be achieved. The targets should be developed through stakeholder consultation and be achievable whilst being suitably challenging.

A policy indicating specific targets for renewable energy generation within the district can be a useful way for a local authority to align with national targets, based on the proportion of its own renewable resources that may be deliverable in practice up to and beyond 2020. It can also provide encouragement to developers and other stakeholders in increasing the deployment of renewable energy in the district.

Targets are generally expressed in total generation capacity (MW or GW) individually for heat and electricity alongside estimated annual energy yields, and should draw on the results of the district-wide renewable energy opportunities and constraints assessment. Some care may be needed in expressing technology-specific targets due to the potential advancements in technologies or their economics over the time period concerned which may impact or change the original opportunities and constraints assessment. Future changes in government policy may also influence the roll-out of particular technologies. Annual emission reductions can also be calculated, again as a comparator to national targets and to the impact on district-wide emissions.

The opportunities and constraints assessment undertaken in this study has quantified Teignbridge's various resources in terms of the energy content of raw materials and/or the theoretical technology capacity and energy yield ('technical' resource). The results have indicated that nearly 4,000 GWh of renewable or low carbon energy could be generated annually, which would reduce district-wide CO_2 emissions by around 111% compared to 2007 levels, should these resources be fully exploited. In the case of wind and energy crops, further constraints have been applied to illustrate what might be a more accessible resource, which would lower the total potential to approximately 759 GWh per year or a CO_2 reduction of around 23%.

In considering a district-wide renewable energy target for Teignbridge, an example technology mix was developed to illustrate what may be needed to achieve an overall 15% renewable contribution towards non-transport energy use i.e. 15% of 1,678 GWh (see Table 3). When measured against the district's total annual energy use including transport, this mix would only make a contribution of around 7.5%. This provides a useful comparator to the Government's national 2020 target of supplying at least 15% of the UK's total energy demand from renewable energy. This particular technology mix would result in a district-wide CO_2 reduction of around 7% from 2007 levels (see Table 26), which is well below the potential 23% mentioned above.

It is important to note that in quantifying certain resources, the available data has combined the areas covered by both Teignbridge District Council and Dartmoor National Park Planning Authorities. It is therefore recommended that both authorities liaise closely in the setting of any targets across the district.

Setting a district-wide renewable energy target can be a useful step towards establishing an overall district-wide CO_2 reduction target, as it then sets the context of what else needs to be achieved in terms of transport energy, energy efficiency and encouraging behavioural changes. Although there are clearly many different combinations of technologies that can be implemented to achieve the same target, it is worth noting that electricity generating plant will currently achieve more carbon savings per MWh than for heat generation plant due to the different carbon intensities associated with each form of generation. Should the Council wish to set targets, it is suggested that further consultation is undertaken with stakeholders to gather local views on what may be appropriate and achievable. The Dartmoor National Park Authority in particular should be consulted on any cross-boundary issues relating to the geographical spread of resources across the district.

11.6 Climate change adaptation

Policy Recommendation 6: Climate change adaptation

The Council should review the range of policies and guidance proposed or adopted by other local authorities as summarised in this report and consider implementing stand-alone adaptation policies and/or SPD guidance on flooding and summer overheating as a minimum. These should be fully compatible with sustainable construction policies and be periodically reviewed in response to any future changes in climate change prediction data.

In addition to policies requiring Code for Sustainable Homes or BREEAM standards of sustainable construction, climate change adaptation and mitigation can be specifically targeted through separate policies covering issues such as flooding risk, summer overheating and green infrastructure requirements. These types of measures may also provide opportunities to help the existing community adapt to impacts arising from climate change.

This study has reviewed example policies from a range of local authorities covering over-arching climate change themes in addition to areas such as resilience to flooding, water conservation, coastal management, green fabric, urban heat island/summer overheating, Passivhaus design and waste segregation. The policies are at various stages of adoption and are often found in Supplementary Planning Documents when they are not included in Core Strategy.

Adaptation policies are often emphasised by local authorities whose locations hold specific or heightened risk of climate change impacts such as summer overheating (London), coastal erosion/flooding (Waveney) and water conservation (Brighton and Hove). The location of Teignbridge would suggest that coastal erosion/flooding and summer overheating would be of most importance in terms of adaptation measures. Appendix C includes a list of potential strategies to encourage flood resilient buildings that could be included in an SPD.

11.7 General recommendations

Other general recommendations relating to sustainable construction and energy use are as follows:

- To justify and contextualise the development specific policies, the Council should prepare an overarching statement focused on climate change and CO_2 reduction targets. An overall greenhouse gas reduction target of 80% by 2050 and 34% by 2020 is recommended, in line with the latest UK policy set out in the Climate Change Act (2008). Both these targets are set against a 1990 baseline.

- Consideration should be given to material to be included within Supplementary Planning Documents (SPD), such as detailed criteria-based policies, additional details on the required structure and content of proposals for sustainable energy supply (site energy strategies) submitted as part of planning applications, and details on any ‘allowable solutions’ offered to developers. These should include increased flexibility to encourage the development of district heating in Heat Priority Areas.

- Build on the heat demand analysis undertaken and incorporate finalised SHLAA data and other relevant data layers into Energy Opportunities Plans and examine in more detail the opportunities available for district heating. Explore the Council's potential role in facilitating partnerships and funding mechanisms for low or zero carbon developments, such as establishing Energy Service Companies (ESCos) and identifying opportunities to use the Community Infrastructure Levy (CIL)

- In support of any district-wide renewable energy targets, the Council should consider developing a strategy and action plan to include the following:

    - Develop a strategic plan to establish woodfuel supply chains across Teignbridge
    - Coordinate further discussion on wind power development and the level of landscape-type constraints that should be applied in light of setting area-wide renewable energy targets
    - Investigate further the use of local waste arisings for use in smaller scale energy from waste plant including anaerobic digestion.
    - Undertake a survey of Council-owned buildings to explore opportunities for renewable energy installations.

Appendix A. Summary of local policy examples on climate change mitigation

Local Authority	Key Documents	Document Status	Key Policies/Guidance	Web Link to Document
Greater London	The London Plan	Preferred Options 2010	• Energy Hierarchy • Zero carbon targets • Technology-specific renewable energy installation targets • New development requirements	The London Plan online
	Renewable Energy SPD	Forthcoming	–	–
Ashford Borough Council	Core Strategy	Adopted 2008	• Sustainable Design & Construction	Ashford Core Strategy online
	Sustainable Design & Construction SPD	Adopted 2009	• Detailed guidance for applicants on achieving zero carbon development	Ashford Sustainable Design & Construction SPD online
Bath & North East Somerset Council	Core Strategy	Preferred Options 2009	• Overall and technology specific targets • Electricity and heat targets for the district • Technology mix • On-site renewables to reduce emissions by 20% • Accelerated CSH targets for large brownfield sites	Bath & NE Somerset Core Strategy Consultation online
	Energy SPD	Being considered	–	–
Bristol City Council	Core Strategy	Examination 2010	• Tackling climate change is key objective • Measures to reduce carbon emissions (80% target) • Sustainable energy – requirement to reduce energy demand of new development • Sustainable Design & Construction	Bristol City Council Core Strategy online
	Sustainable Building Design & Construction SPD	Adopted 2006	• Detailed guidance for applications on meeting the requirements for sustainable design and construction	Bristol's Sustainable Building Design & Construction SPD online
Plymouth City Council	City Centre Area Action Plan	Adopted 2010	• Combined Heat & Power, District Heating & Cooling	Plymouth City Centre AAP online
	Sustainable Design SPD	Adopted 2009	• Guidance to developers on the full range of	Plymouth's Sustainable SPD online

			sustainability issues	
Waveney District Council	Core Strategy	Adopted 2009	• Renewable Energy Cluster (Energy Park)	Waveney's Core Strategy online
	Development Management Policies Local Development Document	Preferred Options 2010	• Low carbon & renewable energy (includes renewable energy generation targets) • Energy Opportunities Plan • Sustainable Design & Construction	Waveney's Development Management Policies LLD online
Milton Keynes Council	Core Strategy	Pre- submission 2010	• Off-setting payment (Policy MI2)	Milton Keynes Core Strategy online
	Sustainable Construction SPD	Adopted 2007	• Guidance for applicants on how to reach requirements of Code for Sustainable Homes	Milton Keynes Sustainable Construction SPD online
Authorities Neighbouring Teignbridge District Council				
East Devon District Council	Core Strategy	Issues & Options 2008	Question topics: • Should specific locations identified for renewables? • What level of renewable energy generation should be sought for future developments? • What criteria should be used for assessing locations for decentralised energy?	East Devon Core Strategy consultation online
	No SPD in place	–	–	–
Mid Devon District Council	Core Strategy	Adopted 2007	• Development of renewable energy capacity • Energy efficiency measures • All new development to be carbon neutral	Mid Devon Core Strategy online
	Carbon Neutral Development SPD	Forthcoming	–	–
West Devon Borough Council	Core Strategy	Submitted to SoS 2010	• Decentralised, renewable & low carbon energy for new development (minimum targets) • Requirement for on-site renewables (no specific level) • Renewable energy (criteria based policy for new installations)	West Devon Core Strategy online
	No SPD in place	–	–	–

South Hams District Council	Core Strategy	Adopted 2006	• Reduce energy demand (increase efficiency) • 10% on-site renewables for new development • Sustainable design and location of new development	South Hams Core Strategy online
	Sustainable Development SPD	Draft 2001	• Separate guidance for both small and large sites	South Hams Sustainable Development SPD online
Torbay Council	Core Strategy	Issues & Options 2009	Key Issues: • Greater demand for renewable energy generation • Scope for CHP through urban extension	Torbay's Core Strategy online
	No SPD in place	–	–	–
Exeter City Council	Core Strategy	Proposed Submission 2010	• Decentralised energy networks • Reduction of carbon emissions (10% target) • Sustainable design and construction standards	Exeter City Core Strategy online
	Renewable Energy SPD	Forthcoming	–	–
Dartmoor National Park Authority	Core Strategy	Adopted 2008	• Renewable energy installations (small-scale) accepted subject to impacts, presumption against large-scale technology	Dartmoor Core Strategy online

Policy descriptions – mitigation

The London Plan

The London Plan, which provides a spatial development strategy for all of greater London, sets out an energy hierarchy within Policy 5.2. The plan hierarchy is:

- Be lean (use less energy)
- Be clean (supply energy efficiently)
- Be green (use renewable energy)

In addition the policy sets carbon reduction targets to reach zero carbon for domestic properties by 2016 and for non-domestic by 2020.

Policy 5.3 of the draft plan set out the requirements for sustainable design and construction; with the overarching strategic requirement that, “the highest standards of sustainable design and construction should be achieved in London to improve the environmental performance of new development”.

To ease the implementation of this policy at the planning decision stage, the policy also provides a number of key principles that developments should adhere to from the outset of the design process. These principles include:

- Minimising carbon emissions
- Avoidance of overheating
- Efficient use of natural resources
- Avoiding pollution
- Minimising waste and maximising reuse and recycling
- Avoidance of natural hazards
- Sourcing local materials
- Protecting biodiversity

The Plan also sets targets for installed energy capacity generated from different renewable energy sources. These targets are set by both year and technology. For example, 134MWth from large-scale biomass by 2020.

The plan also set out a series of requirements for new developments, these include:

- Target reductions in CO_2 emissions in advance of Building Regulations
- On-site renewables and 20% CO_2 reduction (included in supportive text rather than policy)
- Retrofitting existing stock
- Decentralised energy networks
- Renewable energy target 5% by 2020 (not including transport).

The plan places emphasis on Boroughs identifying broad areas for renewables. In terms of LDF preparation the plan states that boroughs should develop more detailed policies and proposals to support the development of renewable energy in London. Boroughs are advised to identify broad areas where specific renewable energy technologies, including large scale systems and the large scale deployment of small scale systems, are appropriate. The plan notes that the identification of areas should be consistent with guidelines and criteria outlined in the Mayor's forthcoming supplementary guidance on Renewable Energy and that all renewable energy systems should be located and designed to minimise any potential adverse impacts on biodiversity, the natural environment and historic assets.

Ashford Core Strategy

The Ashford Core Strategy was adopted in 2008. Sustainable design and construction is one of the underpinning policies of the document.

Policy CS10 requires that all major development meets it sustainable design and construction criteria by:

- Helping to deliver zero carbon growth
- Reducing CO_2 emissions by on-site sustainable technology
- Being carbon neutral by on-site measures, or by making a financial contribution to enable residual emissions to be offset elsewhere in the borough
- Meeting CSH and BREEAM levels, and minimum percentage CO_2 reduction targets, linked to specific development situations – town centres, urban extensions, villages etc

The planning policy team has also produced a detailed Sustainable Development and Construction Supplementary Planning Document that was adopted in 2009. The purpose of this SPD is to provide guidance on the measures and opportunities available to developers and householders to integrate sustainability into their development.

Bath and North East Somerset Core Strategy

The Bath and North East Somerset Core Strategy has been out to public consultation and it is target for adoption is 2011. The plan sets both overall and technology specific targets.

The key renewable energy targets contained within the plan are:

- Electricity and heat targets for the district for 2020 and 2026
- An indication of the level and mix of technologies required to meet the targets – e.g. up to 10 large wind turbines, 5% biomass heating in existing stock, 3 hydro schemes etc
- Large scale developments to provide on-site renewables to reduce emissions by 20%
- Accelerated CSH levels on large brownfield sites (not including carbon offsetting)

Bristol Core Strategy

The Bristol Core Strategy is currently at Examination stage, following its submission to the Secretary of State in November 2010. Tackling climate change and reducing carbon emissions are key objectives throughout the strategy and the plan identifies climate change as one of three key challenges for the city.

<u>Policy BCS13 – Climate Change</u>

This policy sets out a wide range of measures to reduce carbon emissions in the context of an 80% cut. These measures include:

- High standards of energy efficiency and efficient use of natural resource in new buildings
- Use of decentralised, renewable and low-carbon energy supply systems
- Patterns of development that encourage more sustainable modes of travel
- Use of green infrastructure to minimise and mitigate the heating of the urban environment
- Avoiding responses to climate change impacts which lead to increases in energy use and carbon emissions

The plan notes that these measures should be integrated into the design of new development. The policy also requires that new development should demonstrate through Sustainability Statements how it would contribute to mitigating and adapting to climate change and to meeting targets to reduce carbon emissions by the identified measures.

<u>Policy BCS14 – Sustainable Energy</u>
This policy sets out a requirement for development to minimise its energy requirements and incorporate renewable and low-carbon energy supplies to reduce its carbon emissions. The policy also sets out the following broad criteria to be considered in assessing proposals for renewable and low-carbon energy development:

- Environment and economic benefits (afforded significant weight)
- Implications for public health and safety
- Impacts on biodiversity, landscape character, historic environment, and residential amenity.

The policy also set out the following energy hierarchy to assist development with meet the carbon reduction targets identified in the plan:

- Minimise energy requirements
- Incorporate renewable energy sources
- Incorporate low-carbon energy sources.

<u>Policy BCS15: Sustainable Design and Construction</u>
The aim of this policy is to ensure new developments are designed and constructed to minimise their environmental impact, and contribute to meeting targets for reductions in carbon emissions. The policy sets out broad criteria to be considered in the design and construction of new developments and also sets out increasingly high standards against relevant national methodologies for the period to 2016. The policy also sets out principles for the management of waste in new development.

The key issues identified in the policy are:

- Maximising energy efficiency and integrating the use of renewable and low-carbon energy
- Waste and recycling during construction and in operation
- The type, life cycle and source of materials to be used
- Flexibility and adaptability, allowing future modification of use or layout, facilitating future refurbishment and retrofitting
- Opportunities to incorporate measures which enhance the biodiversity value of development, such as green roofs.

Plymouth City Council City Centre & University Area Action Plan

The Plymouth City Centre AAP was adopted in April 2010. As part of the evidence base for the Local Development Framework Plymouth City Council commissioned The Plymouth City Centre and Derriford Sustainable Energy Study (2009), which demonstrated that die to the size, mix, location and phasing of new development proposals, the government's aspirations for low or zero carbon developments can only realistically be met through the use of combined heat and power, and district heating/cooling solutions. The study advises that using such an area wide approach has the potential to significantly reduce the level of carbon emissions from new and existing development whilst also reducing the cost burden to the developer.

This is primarily through the delivery of an integrated Combined Heat and Power and District Heating and Cooling Network throughout the city centre and university area. Through the policy (CC5) the location of an energy centre has been identified and thresholds are set out for qualifying development. The policy also includes a provision for early development, so where development comes forward in advance of the network being operational, an offsite contribution is required to be made and consequently the on-site renewable energy requirement (Policy C20) is relaxed. However, the policy does require that all new development is designed to be connection ready.

Waveney District Council – Development Management Policies Local Development Document

The Development Management Policies LDD was published for consultation during the first quarter of 2010, once the representations have been reviewed the LDD will be submitted to the Secretary of State with the Examination likely to take place in October 2010.

<u>Policy DM03 – Low carbon and renewable energy</u>

The Council commissioned a study to assess the potential for renewable energy generation, energy efficiency and sustainable construction which was completed in November 2009. The study identified wind energy, landfill gas and biomass as the major renewable energy technologies available across the District with the greatest potential to meet local future energy needs. The study has also produced an Energy Opportunities Plan to assist in delivering renewable energy opportunities in the District. Although, the plan does not exclude energy generation from other renewable source if it is deem a viable solution for a certain location or development.

Through the policy the Council commits to achieving the latest renewable energy generation, and provides criteria for assessing project and identifying potential impacts of the scheme.

The document also provides a policy on sustainable construction, which commits to the Code for Sustainable Homes and BREEAM standards for non-residential buildings. There is also a specific policy setting targets for the reduction in carbon emissions, which requires that once Building Regulation have been met a further 15% reduction in residual carbon emissions must be achieved, either by connection to on or offsite technology, or where that its not possible by a contributions to a buyout fund.

Finally, the LLD includes an Energy Opportunities Plan which identifies key areas and locations for the installation of renewable and low-carbon energy technologies.

Appendix B. Summary of local policy examples on climate change adaptation

Local Authority	Key Documents	Document Status	Key Policies/ Guidance	Web link to Document
Greater London	The London Plan	Preferred Options 2010	• Overheating & cooling hierarchy • Urban greening • Green roofs & development site environs • Flood Risk Management • Sustainable Drainage • Water quality & sewerage infrastructure • Water use & supplies	The London Plan online
City of London	Core Strategy	Consultation Draft 2009	• Sustainable development & climate change • Flood Risk • Design • Historic environment	City of London Core Strategy online
	Development Management Policies	Forthcoming (2010)	–	–
Gloucester City Council ***Prepared jointly with Tewkesbury & Cheltenham Councils***	Core Strategy	Issues & Options 2009	• Strategic Objective : Ensure effective adaptations are developed to improve the resilience of the local area to the impact of climate change • Flood Risk policy in current Local Plan will be integrated into Core Strategy	Gloucester City Core Strategy online
Harrow Council	Sustainable Building Design SPD	Adopted 2009	• Guidance on various adaptation methods through building design. • Policies on exceeding CSH/BREEAM requirements	Harrow Sustainable Building Design SPD online
Brighton & Hove City Council	Core Strategy	Submitted to SoS 2010	• Sustainable buildings (CSH & BREEAM standards)	Brighton & Hove Core Strategy online
	Sustainable Building Design SPD	Adopted 2008	• Detailed guidance on designing buildings to adapt to climate change	Brighton & Hove Sustainable Building Design SPD online
Waveney District Council	Core Strategy	Adopted 2009	• Flooding & Coastal Erosion	Waveney's Core Strategy online
Plymouth City Council	Sustainable Design & Construction SPD	Adopted 2009	Guidelines on how new development can adapt to cope with future changes to the	Plymouth's Sustainable SPD online

			climate • Passive solar design • Energy efficiency • Renewable energy • Alternative modes of transport • Materials • Water conservation	
North Norfolk District Council	Core Strategy	Adopted 2008	• Development & Flood Risk • Coastal Erosion	North Norfolk's Core Strategy online
New Forest District Council	Core Strategy	Adopted 2009	• Flood Risk • Sustainable Development Principles • Safe & Healthy Communities (coastal erosion)	New Forest's Core Strategy online
Southwark Council	Core Strategy	Submitted to SoS 2009	• Sustainable development	Southwark's Core Strategy online
	Sustainable Design & Construction SPD	Adopted 2009	Whole section on adapting to climate change • Urban heat island • Living roofs & walls • CSH & BREEAM • RTPI acclaimed policy on flooding	Southwark's Sustainable Design & Construction SPD online
Authorities Neighbouring Teignbridge District Council				
East Devon District Council	Core Strategy	Issues & Options 2008	• No explicit reference to climate change adaptation	East Devon Core Strategy consultation online
Mid Devon District Council	Core Strategy	Adopted 2007	• No explicit reference to climate change adaptation	Mid Devon Core Strategy online
West Devon Borough Council	Core Strategy	Submitted to SoS 2010	• No policy on climate change adaptation. • Strategic Objective: To ensure that new development is designed and constructed so as to minimise the energy demand generated and withstand the long-term impacts of climate change	West Devon Core Strategy online
South Hams District Council	Core Strategy	Adopted 2006	• Requires new development design to take account of solar gain and minimise heat loss	South Hams Core Strategy online

Torbay Council	Core Strategy	Issues & Options 2009	• New development & flooding	Torbay's Core Strategy online
Exeter City Council	Core Strategy	Proposed Submission 2010	• Strategic Objective: To make the fullest contribution possible to the mitigation of, and adaptation to, climate change and the transition to a low carbon economy • Adaptation in building design	Exeter City Core Strategy online
Dartmoor National Park Authority	Core Strategy	Adopted 2008	• Adapting to climate change is part of the strategic objectives of the Core Strategy, but there is no explicit policy.	Dartmoor Core Strategy online

Policy descriptions – adaptation

Over-arching policies			
LPA	**Type of policy document**	**Adoption status**	**Policy detail**
City of London	Core Strategy	Awaiting submission	**Policy CS13: Sustainable Development and Climate Change** To enable City businesses and residents to make sustainable choices in their daily activities creating a more sustainable City, adapted to the changing climate… …1. Requiring all redevelopment proposals to demonstrate the highest viable sustainability standards in the design, construction, operation and "end of life" phases of development. Proposals for major new development will be expected to achieve a BREEAM rating of "excellent" or "outstanding"… …4. Incorporating climate change adaptation measures into new development and the City's infrastructure, including street scene, transport and utility
Greater London Authority	London Plan	Awaiting submission – expected EiP autumn 2010. Expected final publication late 2011.	**Policy 4A.3 Sustainable design and construction** The Mayor will and boroughs should ensure future developments meet the highest standards of sustainable design and construction and reflect this principle in DPD policies. These will include measures to: ▪ make most effective use of land and existing buildings ▪ reduce carbon dioxide and other emissions that contribute to climate change ▪ design new buildings for flexible uses throughout their lifetime ▪ avoid internal overheating and excessive heat generation ▪ make most effective and sustainable use of water, aggregates and other resources ▪ minimise energy use, including by passive solar design, natural ventilation, and vegetation on buildings ▪ supply energy efficiently and incorporate decentralised energy systems (Policy 4A.6), and use renewable energy where feasible (Policy 4A.7) ▪ minimising light lost to the sky, particularly from street lights ▪ procure materials sustainably using local suppliers wherever possible ▪ ensure designs make the most of natural systems both within and around the building ▪ reduce air and water pollution ▪ manage flood risk, including through sustainable drainage systems (SUDS) and flood resilient design for infrastructure and property ▪ ensure developments are comfortable and secure for users ▪ conserve and enhance the natural environment, particularly in relation to biodiversity and enable easy access to open spaces

			▪ avoid creation of adverse local climate conditions ▪ promote sustainable waste behaviour in new and existing developments, including support for local integrated recycling schemes, CHP and CCHP schemes and other treatment options ▪ encourage major developments to incorporate living roofs and walls where feasible (Policy 4A.11) ▪ reduce adverse noise impacts. The Mayor will and the boroughs should require all applications for major developments to include a statement on the potential implications of the development on sustainable design and construction principles. This statement should address demolition, construction and long-term management. Boroughs should ensure that the same sustainability principles are used to assess other planning applications. The Mayor will and boroughs should ensure that developments minimise the use of new aggregates and do not use insulating and other materials containing substances which contribute to climate change through ozone depletion. Developers should use best practice and appropriate mitigation measures to reduce the environmental impact of demolition and construction.
Greater London Authority	London Plan	Awaiting submission – expected EiP autumn 2010. Expected final publication late 2011.	**Policy 4A.9 Adaptation to climate change** The Mayor will and other agencies should promote and support the most effective adaptation to climate change, including: ▪ minimising overheating and contribution to heat island effects (Policy 4A.10) ▪ minimising solar gain in summer (Policy 4A.10) ▪ contributing to reducing flood risk including applying principles of sustainable urban drainage (Policies 4A.13 and 4A.14) ▪ minimising water use (Policy 4A.16) ▪ protecting and enhancing green infrastructure.
Brighton & Hove City Council	SPD on Sustainable Building Design	Adopted	Planning applications involving residential new build and conversions not accompanied by a completed sustainability checklist will be considered invalid. The SPD breaks developments into small, medium, major and Greenfield, and provides a range of standards that must be adhered to for each type. The SPD especially recognises future water stress in the SE Region as being a significant issue for the Borough, and lays out achievement of 'water neutrality'[57] as the main challenge. All scales of new development are required to achieve reductions in water use in advance of national guidance.

[57] Water neutrality is a relatively new concept. The steering group for the Thames Gateway water neutrality project has defined water neutrality as meaning "total water use after new development must be equal to or less than total water use in the area before the planned development (both domestic and non domestic)." Brighton & Hove's proposed Core Strategy also contains a policy requiring developers to show they have addressed this.

			Medium and large scale developments, and all developments on Greenfield sites are required to meet CSH standards on an accelerated timetable (e.g. Greenfield sites at CSH 5 as of 2008)
London Borough of Harrow	SPD Sustainable Building Design	Adopted	The SPD outlines objectives and then over-arching achievements that "the Council expects all development to meet". Most pertinent for adaptation is Achievement 1: Meeting the Code for Sustainable Homes and BREEAM Standards ensure that all residential development achieves, as a minimum, Level 3 of the Code for Sustainable Homes, with an aim of achieving Level 4 and beyond by 2010 ahead of national targets. To ensure that all non-residential development achieves a minimum rating of 'VERY GOOD' of the BREEAM standards. This is specified in detail in section 4.5.6, where "After 2010 this SPD will require the attainment of Level 4 of the Code, and by 2013 the Council will seek Code Level 6 for all residential developments" and in section 4.5.9 "This SPD will require the attainment of Very Good in all non-residential development. After 2010 this SPD will require the attainment of Excellent under the BREEAM Standards or equivalent if other legislation or standards are introduced". This will result particularly in reduced demand for water consumption, and an increase in the use of passive solar design and natural ventilation.
Plymouth City Council	SPD Sustainable Building Design	Adopted	**Section 10.10** Applications for all major development proposals should submit a Climate Change and Sustainability section as part of their Design & Access Statement, responding to the following design considerations: • Has the development maximised the potential of Passive Solar Design? • How has the development incorporated energy efficiency measures? • How has the development incorporated renewable energy? • Does the development proposal enable alternatives to travel by car? • Does the development facilitate the future sustainable management of waste? • What design measures are incorporated to promote water conservation and recycling? • Is the development ready for the higher temperatures that climate change will bring? • Does the development reduce the risk of flooding? • Does the development reduce carbon emissions through selection of materials? ***More detail on what developers should address under each of those points is laid out in the relevant sections, below.***
Brighton & Hove City Council	Core Strategy	Withdrawn from EiP due to scrapping of RSS (housing numbers to be re-assessed)	**POLICY CP1.3.a** All development proposals (including conversions, extensions and changes of use) are required to demonstrate how the development addresses climate change mitigation and adaptation;

Resilience to flooding			
LPA	**Type of policy document**	**Adoption status**	**Policy detail**
Gloucester City	SPD	Adopted	The SPD contains an explanation of the different components of a SUDS as well as complementary detail such as discouragement of the use of culverts. Good use of knowledge of Gloucester's soil type (predominantly clay) to discourage developers from assuming high rates of infiltration, and to support requirements for large ponds.
Greater London Authority	London Plan	Awaiting submission – expected EiP autumn 2010. Expected final publication late 2011.	**Policy 4A.14 Sustainable drainage** The Mayor will, and boroughs should, seek to ensure that surface water run-off is managed as close to its source as possible in line with the following drainage hierarchy: ▪ store rainwater for later use ▪ use infiltration techniques, such as porous surfaces in non-clay areas ▪ attenuate rainwater in ponds or open water features for gradual release to a watercourse ▪ attenuate rainwater by storing in tanks or sealed water features for gradual release to a watercourse ▪ discharge rainwater direct to a watercourse ▪ discharge rainwater to a surface water drain ▪ discharge rainwater to the combined sewer. The use of sustainable urban drainage systems should be promoted for development unless there are practical reasons for not doing so. Such reasons may include the local ground conditions or density of development. In such cases, the developer should seek to manage as much run-off as possible on site and explore sustainable methods of managing the remainder as close as possible to the site. The Mayor will encourage multi agency collaboration (GLA Group, Environment Agency, Thames Water) to identify sustainable solutions to strategic surface water and combined sewer drainage flooding/overflows. Developers should aim to achieve greenfield run off from their site through incorporating rainwater harvesting and sustainable drainage. Boroughs should encourage the retention of soft landscaping in front gardens and other means of reducing or at least not increasing the amount of hard standing associated with existing homes

London Borough of Barking & Dagenham	SPD on Sustainable Building	Adopted	**Policy UDF 23 'Enhancing Existing Waterways'** This policy requires developers to restore existing heavily engineered waterways to create a 'softer' and more resilient landscape for flooding. "Where developments include existing waterways, these should be enhanced by restoring heavily engineered and straightened canalised water courses to natural profiles where appropriate, to mitigate flood risk with retention ponds, wetland and marshland habitats where appropriate as part of Sustainable Drainage Systems.
Brighton & Hove City Council	Core Strategy	Withdrawn from EiP due to scrapping of RSS (housing numbers to be re-assessed)	Although most of the policy on managing flood risk does not go beyond the requirements of PPS25 and supplementary Environment Agency guidance, the LPA have taken the opportunity to require developers to link flood management to wider sustainability issues: **Policy CP10 'Managing Flood Risk':** The council will seek to manage and reduce flood risk… …Where flood risk management or mitigation measures are required, the opportunity to simultaneously achieve wider sustainability and biodiversity objectives for the city (as identified in CP1 and CP5) should be investigated. The council will produce a Surface Water Management Action Plan to manage surface water flood risk and help mitigate the effects of climate change on the city. The supporting text for this policy specifically outlines green roofs as a means of reducing flood risk and simultaneously increasing biodiversity that developers should show they have investigated.
Southwark Council	SPD Sustainable Design and Construction	Adopted	The SPD clearly delineates between 'Flood Resistant' and Flood Resilient' design and guides developers on where to use one or the other. The SPD lays out the minimum standards required by PPS25 and then goes on to include more stringent 'Preferred Standards' that developers should aim for: *Preferred standards* In addition to the minimum standards, development should aim to: • Run-off from the site reduced to green-field levels (8L/s/ha), using SUDS techniques • Reduce area of hard standing surfaces on a site • Drainage should be designed so that is does not flood during the worst storm likely to occur within a 100 year period

Water use reductions			
LPA	**Type of policy document**	**Adoption status**	**Policy detail**
Brighton & Hove City Council	Core Strategy	Withdrawn from EiP due to scrapping of	**POLICY CP1 – Sustainable Buildings** All development proposals (including conversions, extensions and changes of use) are required to demonstrate how the development:

		RSS (housing numbers to be re-assessed)	a. addresses climate change mitigation and adaptation; b. avoids contributing to an increase in the city's current level of greenhouse gas emissions by delivering significant reductions in fuel use and greenhouse gas emissions via passive design, energy efficiency measures and incorporation of on-site low or zero carbon technologies; c. aspires towards water neutrality by meeting high water efficiency standards and incorporating new technologies to recycle, harvest and conserve water resources
London Borough of Harrow	SPD Sustainable Building Design	Adopted	**Section 5.4.4** Developments should minimise the need for water. Water saving devices incorporated into new and refurbished buildings that will reduce the amount of water consumed. The simplest way to do this is through installing efficient water fittings and plumbing such as: • dual flush toilets, • low flow shower fittings, • low water consuming white goods and other appliances such as washing machines as well as the use of more durable plumbing which can prevent leakages. **Section 5.4.5** Using non-potable sources of water (water not suitable for drinking) can greatly reduce the amount of potable water being used unnecessarily. Simple measures can be put into place which enable storage of rainwater for non-potable uses. Rainwater can be captured and stored for uses such as flushing toilets. Sources like grey water and water recycling can be used for non-potable uses such as using shower water to flush toilets. **Section 5.4.7** Planning applications should demonstrate that grey water and water recycling initiatives have been investigated and where feasible implemented. Justification should be provided where such initiatives are not utilised. Development should make use of grey water and water recycling sources for suitable non-potable uses where it is feasible to do so.
Plymouth City Council	SPD Sustainable Building Design	Adopted	**Section 10.32 …** The Climate Change and Sustainability Statement should include consideration of the following techniques: • Rainwater Harvesting Techniques **–** Where possible, harvested rainwater should be substituted for mains water. It can be used for flushing toilets (unless harvested from a green roof), watering plants/ gardens, topping up garden ponds and wetland habitats, and for general cleaning tasks such as car washing. • Systems should be connected to the mains supply to ensure that water is always available, even at times of low rainfall. SUDS can also be integrated with rain-water harvesting schemes and can be designed to provide water attenuation during storms. • Grey water recycling **–** water that has already been used in washbasins, showers and baths can be filtered and disinfected before being used again in toilet flushing and other non-potable activities (e.g. watering the garden or washing the car).
Southwark Council	SPD Sustainable Design and Construction	Adopted	**The SPD lays out the minimum standards required by PPS25 and then goes on to include more stringent 'Preferred Standards' that developers should aim for:** ***Preferred standards*** In addition to the minimum standards, development should aim to: • Residential developments should achieve a potable water use target of 80L per person per day. • Non-residential development should achieve at least 2 BREEAM credit for water consumption. • Use of grey-water for all non potable uses
Brighton & Hove City	Core Strategy	Withdrawn from EiP due	**Policy CP1. 3.c** All development proposals (including conversions, extensions and changes of use) are required to aspire towards water neutrality by

Council		to scrapping of RSS (housing numbers to be re-assessed)	meeting high water efficiency standards and incorporating new technologies to recycle, harvest and conserve water resources;

Coastal management			
LPA	**Type of policy document**	**Adoption status**	**Policy detail**
North Norfolk	Core Strategy	Adopted	**Policy EN 12** **Relocation and Replacement of Development Affected by Coastal Erosion Risk** Proposals for the relocation and replacement of community facilities, commercial and business uses that are considered important to the well-being of a coastal community affected by coastal erosion will be permitted, provided that: • the development replaces that which is affected (or threatened) by erosion within 50 years of the date of the proposal; • the new development is beyond the **Coastal Erosion Constraint Area** shown on the Proposals Map and is in a location that is well related to the coastal community from which it was displaced; • the site of the development / use it replaces is either cleared and the site rendered safe and managed for the benefit of the local environment, or put to a temporary use that is beneficial to the well-being of the local community, as appropriate; and • taken overall (considering both the new development and that which is being replaced) the proposal should result in no detrimental impact upon the landscape, townscape or biodiversity of the area, having regard to any special designations. Proposals for the relocation and replacement of dwellings affected by erosion will be permitted, provided that: • the development replaces a permanent dwelling (with unrestricted occupancy), which is affected (or threatened) by erosion within 20 years of the date of the proposal; • the new dwelling is comparable in size to that which it is to replace; • the relocated dwelling is within or adjacent to a selected settlement and is beyond the **Coastal Erosion Constraint Area** shown on the Proposals Map; • the site of the dwelling it replaces is either cleared, and the site rendered safe and managed for the benefit of the local environment, or put to a temporary use that is beneficial to the well-being of the local community, as appropriate. The future use of the site should be secured (by legal agreement) in perpetuity. Interim use as affordable housing will be considered beneficial to the well-being of the local community in interpreting this clause; and • taken overall (considering both the new development and that which is being replaced) the proposal should result in no detrimental impact upon the landscape, townscape or biodiversity of the area, having regard to any special designations.
New Forest	Core Strategy	Adopted	**Policy CS6 Flood risk** …Developer contributions may be required towards publicly-funded flood alleviation schemes.

			A sustainable and practicable approach to coastal protection and flood defence for the built-up areas, to a level consistent with predicted sea level rise and increased river flows arising from climate change, will be established. This will include identification of opportunities for managed retreat of the coastline where defence is no longer the most economic or environmentally sustainable option , or to provide for replacement habitats in mitigation for continuing to maintain some of the sea defences along the district's coastline….
Waveney District Council	SPD Planning and Coastal Change	Post consultation, but not yet adopted	Waveney District Council is developing a detailed SPD to outline their approach both to dealing with new development in areas of potential coastal erosion, and on dealing with managed retreat from existing developments in vulnerable coastal areas. The SPD refers to PPG20: Coastal Planning, as well as the proposed new PPS on Development & Coastal Change, and adds detail to their Core Strategy policy CS03 (see below). **Development in areas of Coastal Erosion** In essence, the SPD relies on the predictions of coastal erosion assessed in the two Shoreline Management Plans for the district. These break the likely coastal erosion into 3 'epochs' 2010-2025, 2025-2055, and 2055-2015. The background information explains that: *"Areas shown in the SMP as being at risk in the first epoch i.e. up to 2025 are those where there is currently no effective defence or where existing defences are likely to fail within the period. Here only a limited range of types of development directly linked to the coast, such as beach huts, cafes, car parks and sites used for holiday or short let caravan and camping will be permitted subject to time-limited planning permissions. Areas within the medium-term erosion risk area i.e. those areas likely to be affected by erosion between 2025 and 2055 may be suitable for development such as extensions including householder development. In the long-term risk areas (i.e. from 2055 to 2105) uses such as hotels, shops, offices and leisure uses requiring a coastal location and providing social and economic benefits for coastal communities may be acceptable. Within this context, favourable consideration may also be given to the redevelopment or upgrading of existing development, for example holiday facilities and relatively small-scale development associated with existing buildings, such as extensions to existing properties and some commercial development may also be acceptable. However, new dwellings will not be permitted within this area. Applicants can produce their own Coastal Erosion Vulnerability Assessment (to an approved methodology) to provide more detailed information if they wish to challenge the SMP".* The proposed policy wording for the control of new development in areas of coastal erosion is: **Policy DM06 - Coastal Change Management Area** Any proposals for new dwellings or conversion of existing buildings to residential use, will not be permitted in the Coastal Change Management Area identified on the Proposals Map. All other new development, redevelopment, extensions to existing property and development or intensification of land uses will only be permitted where it can be demonstrated through the submission of the Coastal Erosion Vulnerability Assessment that it will result in no increased risk to life or significant increase in risk to property. Proposals for new or replacement coastal defence schemes will only be permitted where it can be demonstrated that the works are consistent with the management approach for the frontage presented in the relevant Shoreline Management Plan and there will be no

			material adverse impact on the environment. Planning applications for all development within and 30 metres landward of the Coastal Change Management Area identified on the Proposals Map must be accompanied by a Coastal Erosion Vulnerability Assessment. **Managed Coastal Retreat** Waveney's Core Strategy makes reference to the fact that alternative sites may need to be identified for the relocation of commercial uses such as tourism, that are affected by coastal erosion. For example, the village of Corton has and will continue to be affected by coastal erosion. While in the short-term the existing defences will be maintained, the medium to long-term plan for Corton village and the adjacent frontages is not to replace existing defences after failure and to allow the coastline to erode naturally. Loss of property is likely to occur when sea defences fail in around 15 to 30 years time (2025 onwards). Policy DM07 of the SPD builds on Policy DM06 and includes detailed criteria against which relocation or replacement proposals should be considered. These aim to balance the desire to see adaptation taking place in advance of property loss in coastal erosion risk areas, with the need to protect the environment. **Policy DM07 - Relocation and Replacement of Development Affected by Coastal Erosion Risk** Proposals for the relocation and replacement of community facilities, commercial and business uses that are considered important to coastal communities affected by coastal erosion will be permitted, provided that: • The proposed development replaces that which is forecast to be affected by erosion within 20 years of the date of the proposal; • The new development is located an appropriate distance inland with regard to the Coastal Change Management Area indicated on the proposals map and other information in the relevant Shoreline Management Plan and where possible it is in a location that is close to the coastal community from which it was displaced; • The existing site is either cleared and made safe or put to a temporary use beneficial to the local community; • The proposal should result in no detrimental impact upon the landscape, townscape or biodiversity of the area.
Waveney District Council	Core Strategy	Adopted	**Policy CS03 - Flooding and Coastal Erosion** Proposals for development in Waveney will need to respect the environment of the District and in particular be aware of the potential impact of climate change. Sustainable design and in particular the provision of sustainable drainage systems will therefore be an important consideration in the determination of all appropriate development. Development that would increase the risk of flooding or coastal erosion will not be permitted. Proposals should avoid high flood risk areas (as defined by PPS25 Flood Zones 2 and 3a) unless it can be demonstrated that: • appropriate land at a lower risk is not available; • there are exceptional reasons for locating the development within such areas; • and the risk can be fully mitigated by engineering and design measures. • Appropriate developments will require a flood risk assessment.

			Land will not be allocated for highly or more vulnerable uses (including housing) in Flood Zones 2 and 3a. The only exception will be within the boundary of the 1st East Urban Regeneration Company area of Lowestoft when the development contributes to the delivery of regeneration objectives set out in Policy CS05 and the Lake Lothing and Outer Harbour Area Action Plan, and the above criteria can be met. Proposals should similarly avoid areas at risk from coastal erosion and ensure they are compatible with the appropriate Shoreline Management Plan. Proposals close to cliff edges or existing coastal defences will be required to undertake a risk assessment.

Green fabric & urban heat islands			
LPA	**Type of policy document**	**Adoption status**	**Policy detail**
City of London	Core Strategy	Awaiting submission	**Policy CS17: Open Space and Recreation** 1. Maintaining a ratio of at least 0.06 hectares of high quality, publicly accessible open space per 1,000 weekday daytime population (i) Protecting existing open space or ensuring that it is replaced on redevelopment;… … (iv) Creating additional civic spaces from underused highways and other land where this would not conflict with other strategic objectives; (v) Encouraging high quality accessible green roofs.
Greater London Authority	London Plan	Awaiting submission – expected EiP autumn 2010. Expected final publication late 2011.	**Policy 4A.11 Living roofs and walls** The Mayor will and boroughs should expect major developments to incorporate living roofs and walls where feasible and reflect this principle in DPD policies. It is expected that this will include roof and wall planting that delivers as many of these objectives as possible: ▪ Accessible roof space ▪ Adapting to and mitigating climate change ▪ Sustainable urban drainage ▪ Enhancing biodiversity ▪ Improved appearance. Boroughs should also encourage the use of living roofs in smaller developments and extensions where the opportunity arises.

Greater London Authority	London Plan	Awaiting submission – expected EiP autumn 2010. Expected final publication late 2011.	**Policy 4A.10 Overheating** The Mayor will, and boroughs should strongly encourage development that avoids internal overheating and excessive heat generation and contributes to the prevention of further over-heating, especially where the urban heat island is most intense. Developers should demonstrate how development could be made heat resilient in design, construction and operation. The Mayor will work with partners to reduce the heat island effect through energy efficiency and appropriate design.
Southwark Council	SPD Sustainable Construction and Design	Adopted	In addition to clear guidance on the causes and effects of the urban heat island phenomenon, and factual guidance on different types of green roof and living walls, the SPD states that, as a minimum: • Buildings should provide for flexibility of uses during their projected operational lives • Buildings are adapted to and mitigate for the effects of the urban heat island and the expected increase in hot dry summers and wet mild winters In addition to these minimum standards, development should aim to: • include living roofs and walls
Brighton & Hove City Council	Core Strategy	Withdrawn from EiP due to scrapping of RSS (housing numbers to be re-assessed)	**Policy CP1.3. e & f** All development proposals (including conversions, extensions and changes of use) are required to: e. protect occupant health and the wider environment by making the best of site orientation and building form and layout via the use of natural light and ventilation, landscaping and materials; f. reduce ‘heat island effect’ and surface water run-off;

Passivhaus			
LPA	**Type of policy document**	**Adoption status**	**Policy detail**
Greater London Authority	London Plan	Awaiting submission – expected EiP autumn 2010. Expected final publication late 2011.	**4A.10 Overheating** The Mayor will, and boroughs should strongly encourage development that avoids internal overheating and excessive heat generation and contributes to the prevention of further over-heating, especially where the urban heat island is most intense. Developers should demonstrate how development could be made heat resilient in design, construction and operation. The Mayor will work with partners to reduce the heat island effect through energy efficiency and appropriate design.

Brighton & Hove City Council	SPD on Sustainable Building Design	Adopted	**Annex to the Sustainable Building Design SPD** states that "all developments are encouraged to make one-off financial contributions towards trees and shrub planting schemes at a rate of £14,000 per hectare." To minimise the urban heat island effect. The annex also provides detail on how this contribution was calculated, and on the responsibilities for maintenance of trees planted through this mechanism.
London Borough of Harrow	SPD Sustainable Building Design	Adopted	**Section 5.2.3** All developments should demonstrate that consideration has been given to [the Mayor of London's] energy hierarchy. Energy efficiency • Use energy wisely • Improve energy efficiency • *Incorporate passive heating and cooling in design* Decentralised heat and power • Cut transmission losses through local generation (ie on site generation using renewables, see above) • Use combined heat and power and community heating Renewable Energy Supply • On site: install renewable energy technologies, such as solar water heating, photovoltaics, biomass heating, micro-scale CHP and wind turbines • Off site: Import renewable energy generated elsewhere conserving natural resources and reducing carbon emissions **Section 5.2.5** Passive solar design ensures that buildings are designed to capture maximum light and heat from the sun. One of the main factors in utilising passive solar heating is the location and orientation of the building. Having the main living or working areas of the building facing south with large double glazed windows can allow natural heating by the sun and reducing the need for artificial light. **Section 5.2.6** Natural ventilation and cooling can be incorporated into a design to reduce the reliance on mechanical ventilation. It is important that large glazed areas such as atriums or conservatories are adequately ventilated and separate from the rest of the building to avoid overheating in summer or excessive heat loss in winter. Also passive shading of windows in summer can reduce the need for artificial cooling by reducing heat trapped inside the building. **Section 5.2.7** Passive solar design can only be considered at the design stage; it provides a one-off opportunity to save energy during the lifetime of a building, generally at no cost. In modern housing, up to 20-25% of heating and lighting energy can be saved by the application of passive solar design principles. Extensions or the refurbishment of buildings can provide another opportunity to incorporate passive solar design, therefore improving the efficiency of a building.
Plymouth City Council	SPD Sustainable Building Design	Adopted	**Section 10.11** The layout of the development should maximise the potential for passive solar gain. Passive solar energy (the energy provided by sunlight entering buildings through windows) can make a significant saving in energy needed for heating and lighting, and so reduce the CO2 emitted by burning fossil carbon fuels. Buildings can be orientated and designed to take advantage of the lower sun angles in winter. **Section 10.12**

			Designing new developments to maximise passive solar energy can provide the following benefits: • Good layout and design results in warm and sunny houses that are attractive to buyers. • Passive solar developments need cost no more than ‘conventional’ developments as they are not dependent on technology, and have no ongoing cost implications. • Providing thermal massing in the construction helps to maximise the benefits of passive solar energy, and also helps to buffer against high internal temperatures in the summer. • By applying simple layout and building design principles, savings of up to 10% on energy costs can be made. **Section 10.16** The simplest and most important way to reduce carbon emissions is to reduce energy use. Examples include: • use of low energy appliances and fittings • passive techniques of ventilation / cooling • natural day-lighting • solar design. **Section 10.17** Energy efficiency measures should be adopted at the earliest design stage (see above section on Passive Solar Design and thermal comfort) so as to minimise dependence on artificial heating, cooling and lighting.
Brighton & Hove City Council	Core Strategy	Withdrawn from EiP due to scrapping of RSS (housing numbers to be re-assessed)	**Policy CP1.3. b & e** All development proposals (including conversions, extensions and changes of use) are required to b. avoid contributing to an increase in the city’s current level of greenhouse gas emissions by delivering significant reductions in fuel use and greenhouse gas emissions via passive design, energy efficiency measures and incorporation of on-site low or zero carbon technologies; e. protect occupant health and the wider environment by making the best of site orientation and building form and layout via the use of natural light and ventilation, landscaping and materials;

Waste segregation			
LPA	**Type of policy document**	**Adoption status**	**Policy detail**
City of London	Core Strategy	Awaiting submission	**Policy CS15: Waste** … (i) Requiring the provision of facilities for waste segregation, handling and management within new developments;….
Brighton &	Core Strategy	Withdrawn	**Policy CP1 3. i and l**

Hove City Council		from EiP due to scrapping of RSS (housing numbers to be re-assessed)	All development proposals (including conversions, extensions and changes of use) are required to i. minimise waste and facilitates recycling, composting and re-use; I. introduce means to encourage users, tenants and householders to reduce their ecological footprint

Appendix C. Flood resilient buildings

Pressure for development combined with potential increases in winter rainfall, storm surge heights and sea levels will all combine to mean that more properties are at risk of flooding, and that flood impacts could be more severe. It may not be possible to ensure that buildings are resistant to flooding, but policies can be introduced to make homes more resilient – i.e. when they are flooded, the damage is less severe, repair time is shorter and repair costs are minimised.

Strategies for flood resistance (preventing water ingress)

Pump and sump systems	A pump which sits below the ground floor to pump out water which enters through the ground. The pump removes water at a faster rate than it can enter.
Flood skirts/barriers	Barriers are erected around any potential inlet for water including windows, doors and air bricks. These are permanently fixed on to the building, but need to be pulled/slid into position and fixed there when there is the threat of flooding.
One-way valves	No-return valves can be fitted to water outlet pipes to prevent water backing up into the property in the event of a flood.
Water resistant sealants	These can include the use of silicone sealants around door and window frames, or anywhere where there may be small gaps which would let water in. Sealants can also be painted onto porous materials such as bricks and mortar to prevent water penetrating them. For floods deeper than a metre, water should be allowed to enter the property to prevent any structural damage that could be caused by a build-up of water outside.
Raised and permeable foundations	Homes can be built with partially open storage areas beneath which water can pass through at times of flood, without entering the main building

Strategies for flood resilience (reducing the cost of water ingress)

Replacement of perishable materials	Some materials will be ruined beyond repair if subjected to flooding, whilst others can be saved. It is therefore possible to replace perishable materials with those that will withstand a flood. For example - replacing chipboard floors with concrete or treated timber, swapping carpet for tiles, and replacing gypsum plaster with lime or concrete render alternative.
Moving expensive electrical equipment out of harm's way	Some items do not have to be housed on the ground floor and instead can be raised up out of harms way. For example, boilers can be moved to higher levels (for example upstairs) to reduce the possibility that they may be damaged in a flood.
Raise electrical points	Electrical points can be raised above likely flood levels.
Use denser concrete screeds on concrete floors	Screeds can be damaged in floods and resistance can be improved by using a denser proprietary concrete screed.
Raise floor levels	This is not always possible, but if it is it can be useful to raise inside floor levels out of harm's way.
Replace insulation	Mineral insulation rots after flooding, but it can be replaced with cell insulation which will survive a flood.
Protect joists	Wall joists can be protected by installing a chemical damp proof course below the joist level. This will limit water seeping upwards and causing more damage to the rest of the property.

Appendix D. Climate change impacts on Teignbridge and the South West

This appendix provides a summary of the probabilistic climate change impacts on Teignbridge and the South West using the UK Climate Projections Data 2009 (UKCP09)[58], which is currently the best available source of data for analysing potential scenarios of future climate change.

1. Emissions scenarios used in the UKCP09 Climate Impacts Model

Before looking at the projections, it is useful to understand the emissions scenarios as used in UKCP09. These are taken from a large family of models used in the Intergovernmental Panel on Climate Change 4th assessment report. UKCP09 uses three scenarios that they label 'low', 'medium' and 'high'. They correspond to the following emission scenarios from IPCC 4th Assessment. It is important to note that even the 'low emissions' scenario does not include stringent global policies aimed at drastically cutting greenhouse gas emissions.

IPCC 4th Assessment emission scenarios

The A1 scenarios are of a more integrated world. The A1 family of scenarios is characterized by:

- Rapid economic growth.
- A global population that reaches 9 billion in 2050 and then gradually declines.
- The quick spread of new and efficient technologies.
- A convergent world - income and way of life converge between regions. Extensive social and cultural interactions worldwide.

There are subsets to the A1 family based on their technological emphasis:

- **A1FI** - An emphasis on fossil-fuels. (What UKCP09 calls 'high')
- **A1B** - A balanced emphasis on all energy sources. (What UKCP09 calls 'medium')
- **A1T** - Emphasis on non-fossil energy sources. (Not used by UKCP09)

B1 (What UKCP09 calls 'low')

The B1 scenario is of a world more integrated, and more ecologically friendly. The B1 scenario is characterized by:

- Rapid economic growth as in A1, but with rapid changes towards a service and information economy.
- Population rising to 9 billion in 2050 and then declining as in A1.
- Reductions in material intensity and the introduction of clean and resource efficient technologies.
- An emphasis on global solutions to economic, social and environmental stability.

[58] The interactive interface for UKCP09 can be found at http://ukcp09.defra.gov.uk/

2. UK Climate Projections Data 2009

The projections in UKCP09 are based on three possible future scenarios of man-made greenhouse gas emissions: Low, Medium and High. These are from the same family of emissions scenarios as those used in the UK Climate Impacts Programme[59] UKCIP02 and UKCIP98, and the assumptions underpinning them are outlined in the previous section. These scenarios are only a sample of possible futures, and none of them include a 'stabilisation scenario' i.e. they do not model a future where concerted global efforts are made to drastically reduce carbon emissions to currently accepted 'safe' levels. Thus it is especially important not to interpret the 'low' scenario as a probabilistic interpretation of the outcome of following a stringent and rigorously applied global emissions agreement.

The following (significant) limitations to the data should be taken on board and utmost care should be taken to ensure that communication of the findings clearly explains the following:

All data from UKCP09 are projections, not predictions. They show what is possible, based on the current understanding of complex climate models. They are not 'accurate forecasts' and users should be particularly wary of interpreting maps as 'snapshots' of future weather; they are merely a visual representations of a probabilistic interpretation of available data. The data cannot be used to model likely weather in a given year, rather they create an average for a given 30-year time period. Nor should subsequent time periods be 'averaged' together to create a smooth progression.

Only the 10% to 90% ranges have been used for the production of vulnerability scenarios. They are based on the best available knowledge and climate change models available to the UK Government in 2010. Climate science is constantly and rapidly changing, and as such any adaptation policies and strategies should be regularly reviewed using the latest available data from UKCIP. The probability bands used should be interpreted as follows:

- 10% probability – the outcome is very unlikely to happen
- 50% probability – the outcome is as likely as not to happen
- 90% probability – the outcome is very likely to happen

– although data exists for projections in the 0% to 99% likelihood, analysis of the data in UKCP09 suggests that robustness of projections outside of the 10%-90% range is significantly reduced and is therefore not a suitable basis for policy making. Thus projections in the 1% (extremely likely to happen) and 99% (extremely unlikely to happen), have not been incorporated.

3. Uncertainties associated with local mapping

Much of the analysis for Teignbridge has been done at the level of the South West region and would thus be relevant to any local authority in the region. In general, climate models reach greater agreement on global scale outcomes, and as the geographic unit of modelling is reduced, additional assumptions have to be made, thus increasing the uncertainty associated with the model.

The lowest resolution at which the UKCP09 data can be mapped is the 5km square. However, it should be noted that the data is no more detailed than that at the 25km square. It is merely broken down into 5km squares to enable the user to see topographical detail more easily.

[59] http://www.ukcip.org.uk/index.php

Projections have been made using storm surge and sea level rise data for individual (25km?) grid squares on the Teignbridge coast. All other projections are relevant to the South West as a whole.

4. Results

4.1 Summary

Likely change in mean temperature during summer and winter has been analysed for all three emissions scenarios, and for three, 30-year time periods, for the South West England region.

The likelihood is that there will be increased mean temperatures in both winter and summer, for all emissions scenarios. These likely increases in temperature have implications for the design of all new buildings and infrastructure.

Local authorities should select policies and develop guidance that ensure that homes and commercial buildings are fit for purpose in future decades. Under the high emissions scenarios, the central estimate suggests an increase in mean summer temperatures of 5.0 °C is possible. Local Authorities should ensure that new buildings are fit for these potential rises through the application of policies requiring passive ventilation and cooling, green roofs and living walls, greater thermal mass etc. Policies should also make clear that 'maladaptation measures' (such as the increased use of air conditioning, which requires more energy to be consumed) are not suitable management techniques.

LOW EMISSIONS	2010-2039	2040-2069	2070-2099
WINTER			
10% (increase in temperature is very unlikely to be less than)	0.5 °C	0.8 °C	1.4 °C
50% (increase in temperature is as likely as not to be)	1.2 °C	1.8 °C	2.4 °C
90% (increase in temperature is very unlikely to be more than)	2.0 °C	2.9 °C	3.7 °C
SUMMER			
10% (increase in temperature is very unlikely to be less than)	0.7 °C	1.1 °C	1.3 °C
50% (increase in temperature is as likely as not to be)	1.6 °C	2.5 °C	2.9 °C
90% (increase in temperature is very unlikely to be more than)	2.7 °C	4.1 °C	4.9 °C

MEDIUM EMISSIONS	2010-2039	2040-2069	2070-2099
WINTER			
10% (increase in temperature is very unlikely to be less than)	0.6 °C	1.1 °C	1.6 °C
50% (increase in temperature is as likely as not to be)	1.3 °C	2.1 °C	2.8 °C
90% (increase in temperature is very unlikely to be more than)	2.0 °C	3.2 °C	4.3 °C

SUMMER			
10% (increase in temperature is very unlikely to be less than)	1.5 °C	1.3 °C	2.1 °C
50% (increase in temperature is as likely as not to be)	1.6 °C	2.7 °C	3.9 °C
90% (increase in temperature is very unlikely to be more than)	2.7 °C	4.6 °C	6.4 °C

HIGH EMISSIONS	2010-2039	2040-2069	2070-2099
WINTER			
10% (increase in temperature is very unlikely to be less than)	0.5 °C	1.3 °C	2.1 °C
50% (increase in temperature is as likely as not to be)	1.2 °C	2.3 °C	3.4 °C
90% ((increase in temperature is very unlikely to be more than)	2.0 °C	3.5 °C	5.1 °C
SUMMER			
10% (increase in temperature is very unlikely to be less than)	0.5 °C	1.4 °C	2.7 °C
50% (increase in temperature is as likely as not to be)	1.5 °C	3.1 °C	5.0 °C
90% (increase in temperature is very unlikely to be more than)	2.6 °C	5.1 °C	7.9 °C

4.2 Precipitation

Likely changes in seasonal mean precipitation were analysed for all three emissions scenarios, and all three 30-year time periods for the South West England region.

The general trend shows a more marked difference between the seasons; winter precipitation is likely to increase (significantly if the high emissions scenario comes to pass), whereas summer precipitation will significantly decrease.

This will have implications for the management of surface water runoff in winter, along with groundwater and fluvial flooding, meaning that both residential and commercial buildings will require greater resilience and/or resistance to flooding. Adaptation strategies and policies should reflect this, for example through providing guidance to developers on internal material and layout specifications.

The predicted changes in seasonal precipitation also have implications for water storage. More efficient and higher capacity facilities are likely to be needed to store and manage excess water in the winter months in order to cope with increased likelihood of water shortages during the summer. Local Authorities and sub-regional partnerships should put in place management strategies and policies to ensure that new developments have water use requirements that are as low as possible to address these likely shortages, and should use their influence at a strategic level to encourage the development of better water storage infrastructure.

LOW EMISSIONS	2010-2039	2040-2069	2070-2099
WINTER			
10% (very unlikely to be less than)	- 3 %	0 %	5 %
50% (as likely as not to be)	6.0 %	12.0 %	19.0 %
90% (very unlikely to be more than)	18.0 %	30.0 %	42.0 %
SUMMER			
10% (very unlikely to be less than)	-25.0 %	-39.0 %	-40.0 %
50% (as likely as not to be)	-7.0 %	-14.0 %	-16.0 %
90% (very unlikely to be more than)	13.0 %	16.0 %	13.0 %

MEDIUM EMISSIONS	2010-2039	2040-2069	2070-2099
WINTER			
10% (very unlikely to be less than)	-2.0 %	4.0 %	6.0 %
50% (as likely as not to be)	7.0 %	17.0 %	23.0 %
90% (very unlikely to be more than)	20.0 %	38.0 %	54.0 %
SUMMER			
10% (very unlikely to be less than)	-27.0 %	-42.0 %	-50.0 %
50% (as likely as not to be)	-8.0 %	-20.0 %	-24.0 %
90% (very unlikely to be more than)	14.0 %	7.0 %	6.0 %

HIGH EMISSIONS	2010-2039	2040-2069	2070-2099
WINTER			
10% (very unlikely to be less than)	-2.0 %	3.0 %	8.0 %
50% (as likely as not to be)	6.0 %	18.0 %	31.0 %
90% (very unlikely to be more than)	18.0 %	41.0 %	73.0 %
SUMMER			
10% (very unlikely to be less than)	-24.0 %	-45.0 %	-58.0 %
50% (as likely as not to be)	-5.0 %	-20.0 %	-30.0 %
90% (very unlikely to be more than)	18.0 %	8.0 %	4.0 %

4.3 Extreme weather events – heat waves

UK Climate predictions are available to show the possible change in maximum daily summer temperature. This is a useful planning aid, as it reveals the possible 'spikes' in temperature that are ironed-out when using only the projections for seasonal means. Possible increases in maximum daily summer temperature have been analysed for all three time periods and all three emissions scenarios, for the South West England region.

As can be seen from the tables below, these possible maximum daily temperatures could be significantly in excess of the projected mean increases, especially under the high emissions and 90% probability (which, though very unlikely are at least plausible). Thus these projections are a valuable tool for local authorities to use in worst-case and long-term strategic planning (e.g. for the provision of cool refuges, and for guidance on design of buildings used by vulnerable groups, such as schools, hospitals and elderly care homes).

LOW EMISSIONS	2010-2039	2040-2069	2070-2099
SUMMER			
10% (very unlikely to be less than)	0.7 °C	1.2 °C	1.3 °C
50% (as likely as not to be)	2.2 °C	3.4 °C	4.1 °C
90% (very unlikely to be more than)	4.0 °C	6.2 °C	7.6 °C

MEDIUM EMISSIONS	2010-2039	2040-2069	2070-2099
SUMMER			
10% (very unlikely to be less than)	0.5 °C	1.4 °C	2.2 °C
50% (as likely as not to be)	2.1 °C	3.8 °C	5.4 °C
90% (very unlikely to be more than)	4.0 °C	6.8 °C	9.6 °C

HIGH EMISSIONS	2010-2039	2040-2069	2070-2099
SUMMER			
10% (very unlikely to be less than)	0.6 °C	1.7 °C	3.0 °C
50% (as likely as not to be)	2.1 °C	4.3 °C	6.9 °C
90% (very unlikely to be more than)	3.8 °C	7.6 °C	11.9 °C

4.4 Extreme weather events – storm surge

UKCP09 relies on a storm surge model that is already used operationally for the projections of the skew in storm surge heights. This model, the Storm Tide Forecasting Service (STFS), has proved itself to be relatively reliable and has modelled accurately extreme storm surges that have already been observed.

Overall UKCP09 models storm surges in a different way to the modelling of other datasets and there are some extra assumptions and limitations that users should be aware of:

1. They combine the STFS model with outputs only from the Hadley Centre's HADCM3 Global Climate Model, and one other IPCC global climate model (Model Q), rather than combining data from a wide range of other global climate models. This is because other global models (apart from Model Q) produce results that were well outside the ranges predicted by the HADCM3 model. Model Q, on the other hand, both reproduces well current storminess over the UK and projects the largest increase in storm intensity, giving confidence that the projected surge sizes are extreme but plausible, rather than a potential underestimate of severity.
2. Although the outputs are considered a plausible spread of potential storm surge size and intensity, limitations in the modelling mean that they are not probabilistic.
3. The projections are available for one emissions scenario only (medium emissions). This should not be taken to mean that this is the most likely emissions scenario.

All of these limitations combine to mean that the storm surge projections are useful for long-term worst case scenario contingency planning (to give a sense of plausible outcomes) but users should guard against expressing them in any probabilistic sense.

The storm surge return period plots were generated for the grid squares marked 1 and 2 in the map below, and the plots were interpreted to give the 95th percentile estimates for increase in the height of storm surge for storms of different 'return period' (more commonly referred to as, for example, 1 in 20 year storm, 1 in 50 year storm etc). Projections are given for the increase in storm surge for the last year in each time slice (2039, 2069 and 2099).

Grid Square 1 – 'Exmouth and Dawlish' (16701)

Return Period→ Year ↓	**1 in 2 year**	**1 in 10 year**	**1 in 20 year**	**1 in 50 year**
2039	1.35 cm	1.64 cm	1.86 cm	2.13 cm
2069	2.11 cm	3.33 cm	3.78 cm	4.32 cm
2099	3.18 cm	5.03 cm	5.70 cm	6.52 cm

Grid Square 2 – 'Teignmouth and Torbay' (16851)

Return Period→ Year ↓	**1 in 2 year**	**1 in 10 year**	**1 in 20 year**	**1 in 50 year**
2039	1.02 cm	1.62 cm	1.86 cm	2.12 cm
2069	2.07 cm	3.30 cm	3.78 cm	4.32 cm
2099	3.12 cm	4.80 cm	5.7 cm	6.51 cm

4.5 Sea level rise

Again, unlike most other components of UKCP09, the sea level rise projections are not probabilistic but instead provide a frequency distribution of projections based on the data from 11 global climate models used in the IPCC reports.

Only the central estimate (50th percentile) is given for each of the three emissions scenarios. Because of the differences in the underlying dataset, these projections are also not averaged over the three time slices, and are instead given for the last year in each time slice (2039, 2069 and 2099).

The projections also take account of the best available data on land movement and are therefore relative rather than absolute (i.e. if the underlying crust is projected to sink slightly over a time period, this is taken into account in the estimate of sea level rise). The data refers 12km grid box reference 25931, which is the best available grid box data for Teignbridge.

Emissions Scenario ↓ Year→	**2039**	**2069**	**2099**
Low	15.4 cm	27.4 cm	41.4cm
Medium	18.5 cm	32.8 cm	49.4 cm
High	21.2 cm	38.1 cm	58.0 cm

5. Difficulties in predicting the effects of climate change on renewable energy installations

The impacts of future climate change on renewable energy installations are difficult to predict using UKCP09. This is because of the variable confidence levels in the range of climate factors. For example, while there is high confidence in the data on surface and air temperature change, confidence in the rainfall precipitation figures (especially summer rainfall) is lower, as are projections of cloudiness. The model is also unable to predict wind speed or snowfall changes due to irreconcilability of the data sets used in the range of global models that have been combined to create the UKCP09 model.

It is therefore not useful to attempt to use the model to project the changes that might affect new renewable energy technologies.

A cautious approach to ensuring best use of renewable resources into the medium and long term would be to consider planning policies that draw on evidence base models that are continually updated. Thus a wind farm granted permission in 2010 based on good wind resource and acceptable landscape impacts could have a time-limited planning permission for the installation based in the expected economic working life of the installation (around 25-30 years). Thereafter, no assumption would be made that the site would automatically receive approval for a further wind farm installation; any future development would be based on a re-assessment of the site; wind speeds may have dropped, gustiness may have increased or the landscape may have changed through the unavoidable impacts of climate change e.g. increased sensitivity due to coastal/upland erosion or flooding.

On the other hand, sites refused planning permission in 2010 for a wind farm on the grounds of unacceptable landscape impact should not necessarily remain 'out of bounds' in perpetuity. Future changes to the landscape and site characteristics may potentially be conducive to wind power, and regular reviews of landscape sensitivity studies may indicate where previously highly sensitive or high value landscapes had become less sensitive. Previously refused sites may also be reconsidered as a result of increased need, government targets and improving technical/economic viability in the future.

Teignbridge's changing landscape

The following extract from the Teignbridge Landscape Character Assessment 2009 outlines the potential impacts of climate change on landscape character:.

1.4.28 Whilst there are still uncertainties regarding exact changes at regional and local levels, it is clear that there could be both direct and indirect impacts on landscape character. The potential implications for landscape character in the Study Area include changes in habitats and species composition, particularly on mudflats, dunes, saltmarshes and upland heaths, habitat fragmentation, rises in sea and river levels leading to coastal and inland flooding, soil erosion, changes in agricultural land use, recreation and tourism and erosion or damage of cultural heritage. The Teignbridge Strategic Flood Risk Assessment 2007 includes maps indicating the extent of high-risk zones of marine/tidal flooding at 2107.

1.4.29 In summary, the key potential pressures and trends associated with climate change are:

- Potential loss of inter-tidal and other coastal habitats & species;

- Potential increase in wetland habitats and need for flood areas due to rising sea and river levels;
- Changes in species composition and habitat fragmentation due to temperature rises and changing rainfall patterns;
- Changes in agricultural land use and patterns of recreation and tourism use;
- Loss or damage of cultural heritage due to coastal and soil erosion and flooding.

Appendix E. List of Designated Areas in Teignbridge District

Designation	Name
Ramsar (International)	Exe Estuary
Special Areas of Conservation (International)	Dartmoor, Dawlish Warren , South Dartmoor Woods, South Hams
Special Protection Areas (International)	Exe Estuary
National Parks (National)	Dartmoor
National Nature Reserves (National)	East Dartmoor Woods & Heaths, Dawlish Warren
Sites of Special Scientific Interest (National)	Aller Sand Pit Blackslade Mire Bovey Heathfield Bovey Valley Woodlands Brocks Farm Buckfastleigh Caves Buckland-in-the-Moor Buller's Hill Quarry Chipley Quarries Chudleigh Caves & Woods Chudleigh Knighton Heath Crockham Quarry Dawlish Cliffs Dawlish Warren East Dartmoor East Ogwell Quarry Exe Estuary Great Haldon Heaths Haldon Forest Haytor & Smallacombe Iron Mines Haytor Rocks & Quarries Holne Woodlands Leusdon Common Little Haldon Heaths Lower Dunscombe Farm Quarry Potters Wood Ransley Quarry River Lemon Valley Woods Ryecroft Quarry Southacre Clay Pits Spara Bridge Stover Park Teign Valley Woods Torbryan Caves Tower Wood Quarry Ugbrooke Park Webberton Cross Quarries Whiddon Deer Park Wolborough Fen Yarner Wood & Trendlebere Down