Coventry Local Plan

Evidence base to support planning policies relating to sustainable buildings and low carbon/renewable energy

August 2015

Coventry City Council

Contents

1. Introduction

Purpose and scope of document

The Government's National Planning Policy Framework[1] makes it clear that Local Plans are required to be based on robust evidence. Paragraph 158 states:

> *'Each local planning authority should ensure that the Local Plan is based on adequate, up-to-date and relevant evidence about the economic, social and environmental characteristics and prospects of the area.'*

Furthermore, the Framework goes on to say that 'plans and decisions need to take local circumstances into account, so that they respond to the different opportunities for achieving sustainable development in different areas'.

The purpose of this paper is to present the evidence available to support the development of climate change and sustainability-related policies for inclusion within Coventry's Local Development Plan (or LDP for short). It covers the following policy areas:

- Sustainable buildings (Section 3)
- Zero and local carbon energy (Section 4)
- Water efficiency (Section 5)
- Climate change adaptation (Section 6)

The structure of this document is as follows:

Section 2 reviews the existing and likely future regulatory and policy framework in place at both local and national levels. For each legislative or policy instrument, an overview of what it covers is given, followed by an outline of how it is relevant to and the implications for the work being undertaken here.

Sections 3 to 6 deal with specific policy areas, as described above. In each section, an outline of why the issue is relevant in this context is given, the available evidence base relating to this issue is examined, and recommendations are made on how it should be treated within the Local Development Framework.

Background information on Coventry

Population

Coventry is a medium-sized city, having a population in 2010 of just under 316,000[2], or 0.6% of the total in England, making it the 13th largest city in the UK. Between the mid-1970s and the mid-1990s the population declined, primarily as a result of younger people leaving the area to find work elsewhere, and this was followed by a decade during which the population remained relatively stable. However, it is now increasing. Between 2009 and 2010 Coventry's population grew by approximately 2,900 (just under 1%), a growth rate in keeping with both England as a whole and other metropolitan areas of a similar size. Population

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[1] Communities and Local Government (2012). *National Planning Policy Framework.* London: DCLG
[2] Coventry Partnership (2010). *State of the City 2010*. Available online at: http://facts-about-coventry.com

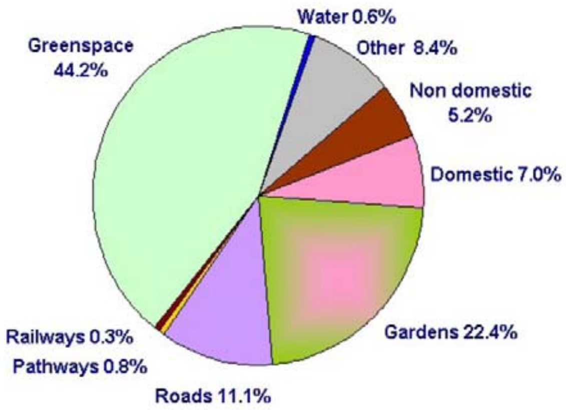
projections made by the Office for National Statistics predict that, if the recent strong upward trends were to continue at their current rate, Coventry would have almost 439,000 residents by 2035.[3]

The median age of people living in the city is currently 34.9 years, significantly lower than the average for England of 39.5 years.[2]

Physical characteristics

The City of Coventry has a land area of approximately 985km^2, the majority of which is urban in nature, with the exception of an area of green belt land to the north west of the city. The breakdown of land use types for the city as a whole is shown in table/figure 1.1.

Table/figure 1.1: Land use types in Coventry (2005)[4]



Two rivers run through Coventry, the Sowe and the Sherbourne. The Sherbourne runs closest to the city centre, passing from west to east through the city before draining into the Sowe. It is currently culverted where it runs through the central part of the city enclosed by the ring road and occupies a narrow corridor through the remainder of the city. The river Sowe, the larger of the two rivers, occupies a more defined and heavily meandering channel through the eastern suburbs of the city. It drains into the River Avon near Stoneleigh.

The city is served by two waterways, the Oxford Canal and Coventry Canal, the latter being a 38-mile link between the centre of Coventry and the Trent and Mersey Canal to the north.

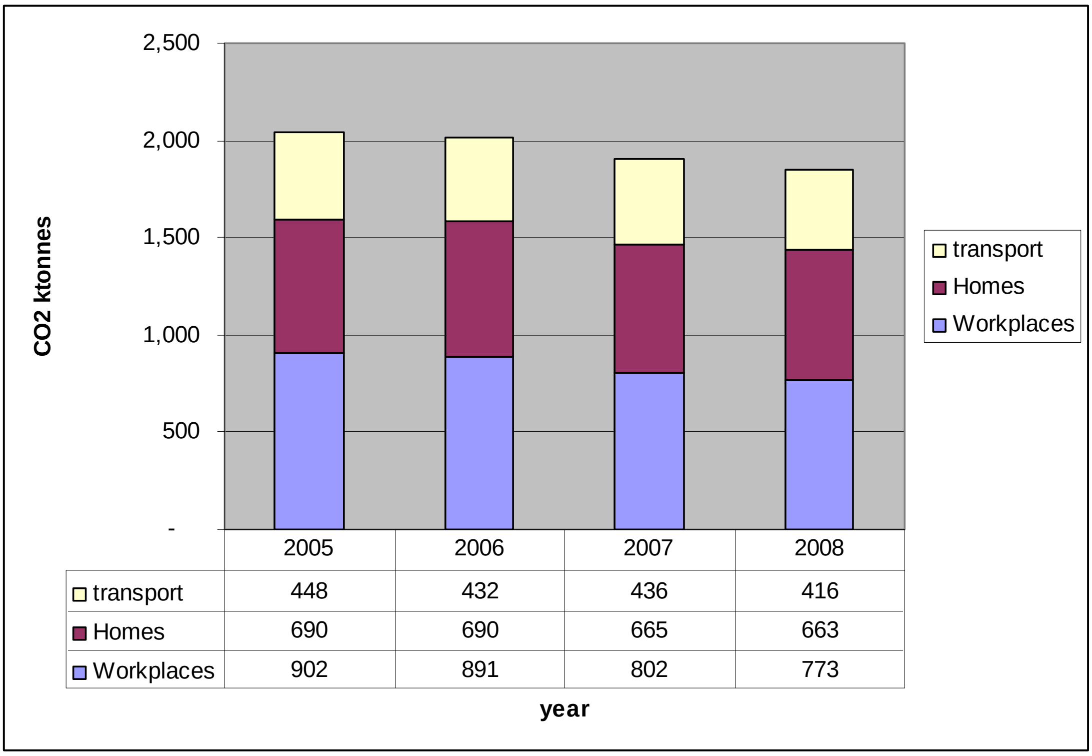
In terms of topography, the City comprises higher elevations and steeper slopes in the largely greenbelt area to the north western part of the city (north west of Keresley) (maximum elevation 160m AOD), and gradually decreasing elevations in a south-easterly direction, the lowest elevations, of approximately 65m AOD, being found in the Willenhall, Binley and Stivichall areas of the City. Coventry's geology is dominated by clay rich rocks where soils are not very well drained.

Energy use and carbon dioxide emissions

[3] Office for National Statistics (2010). Available at: www.ons.gov.uk
[4] ONS Neighbourhood Statistics (2011). Available at: www.neighbourhood.statistics.gov.uk

The Department of Energy and Climate Change (DECC) has been publishing data on carbon dioxide (CO_2) emissions from the housing, road transport and business sectors (excluding motorways and air traffic) at a local authority level since 2005[5]. Figure 1.2 shows Coventry's annual emissions for the period 2005-2008. As can be seen from the chart, Coventry's total emissions have fallen by 188kT per annum from 2,040kT in 2005 to 1,852kT in 2008, equivalent to a 9% reduction over the 4 year period.

Figure 1.2: Total carbon dioxide emissions for Coventry for period 2005-2008

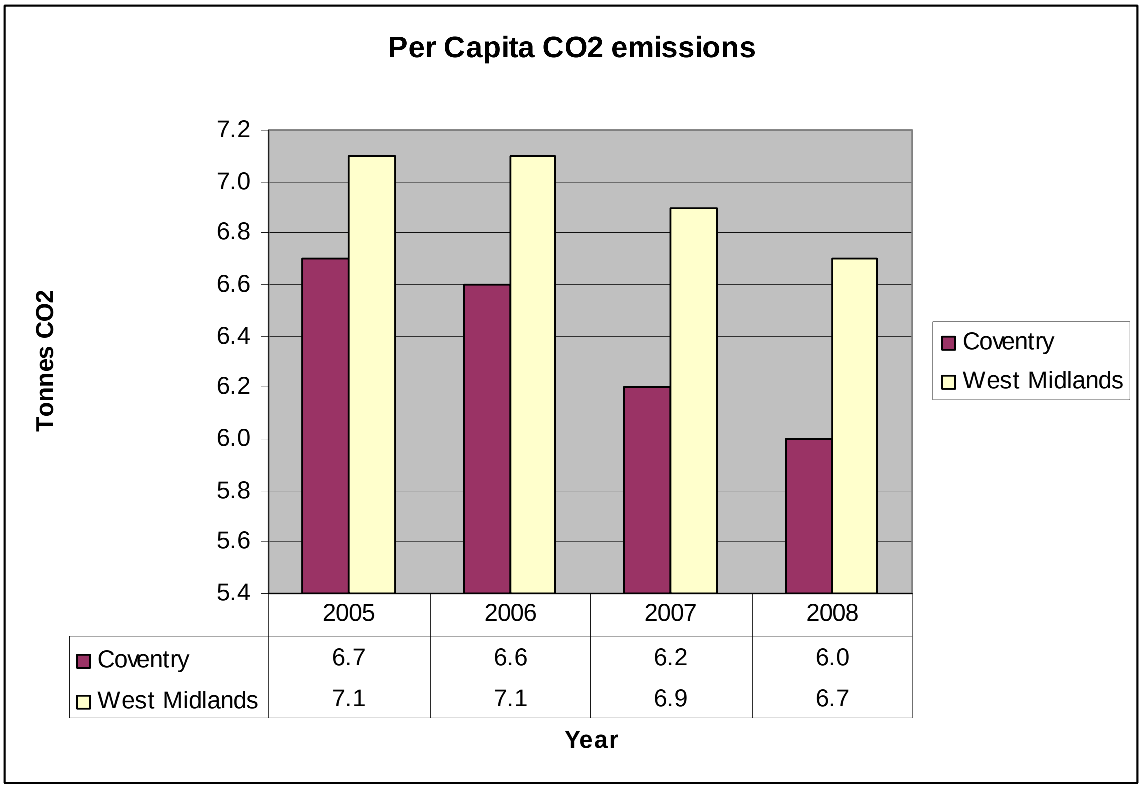


	2005	2006	2007	2008
transport	448	432	436	416
Homes	690	690	665	663
Workplaces	902	891	802	773

In terms of annual per capita emissions, it has been estimated at 6.0 tonnes for 2008, some 0.7 tonnes less than the West Midlands average for the same period, as shown in figure 1.3.

Figure 1.3: Per capita CO_2 emissions for Coventry / West Midlands Region, 2005 - 2008

[5] DECC (2011). Available at www.decc.gov.uk

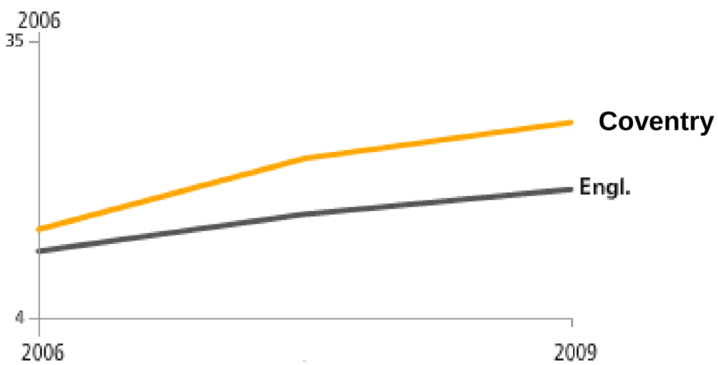


	2005	2006	2007	2008
Coventry	6.7	6.6	6.2	6.0
West Midlands	7.1	7.1	6.9	6.7

Fuel poverty

The number of dwellings in the city is approximately 132,000, of which approximately 82% is in private ownership. Figures published in 2008 by the Department for Energy and Climate Change[6] show that 21.9% of Coventry households were in fuel poverty, compared to 15.6% for England as a whole. This is an increase of 7% on the 2006 figure (13.9%, compared to 11.5% for England). Figure 1.4 shows the trends in percentage of households in fuel poverty for both Coventry and the country as a whole and demonstrates that fuel poverty is increasing at a higher rate in Coventry than nationally.

Figure 1.4: Percentage of households in fuel poverty for the period 2006-2009 for Coventry and England as a whole.



Proposed approach to development

[6] Department of Energy and Climate Change (2008). Available online at: http://www.decc.gov.uk/assets/decc/Statistics/fuelpoverty/1297-subregional-fuel-poverty-data-2008.xls

Coventry City Council published a Proposed Core Strategy Consultation document[7] in September 2011. This proposes a hub and spokes approach to development, whereby development is focused on the city centre and certain key areas across the city including Willenhall / Whitley, Bell Green / Wood End/ Henley Green, Canley, Foleshill / Arena Park, and Holbrook. Furthermore the strategy will be jobs led and development on green belt will not be permitted. Key objectives for the plan are to:

- Stop green belt land being used for housing estates
- Encourage regeneration
- Support sustainable development
- Bring brown field land back into use
- Support local shopping centres, health provision and other services
- Improve roads and public transport on key routes into the city
- Reduce the city's carbon footprint
- Use the land required for new homes efficiently
- Provide easy access to the jobs already available
- Focus on the city centre as a showcase for the whole city
- Improve the health and wellbeing of Coventry citizens.

A further consultation, on housing numbers, was carried out between March and May 2012[8]. The options for consideration were as follows:

1. 9,690 new homes - 570 every year for 17 years in a row - no green belt land required
2. 11,373 new homes - 669 every year for 17 years in a row - no green belt land required
3. 20,655 new homes - 1,215 every year for 17 years in a row - building on green belt may be required

Following the consultation, option 2 has been selected as the preferred option.

[7] Coventry City Council (2011). *Coventry Proposed Core Strategy 2011*.
[8] Coventry City Council (2012). *Core Strategy: Housing Numbers Consultation*. Available online at: http://www.coventry.gov.uk/info/1004/planning_policy/1350/core_strategy-housing_numbers_consultation

2. Policy context

National policy

National Planning Policy Framework[9]

The new National Planning Policy Framework (NPPF) came into effect in March 2012, and sets out the Government's economic, environmental and social planning policies for England. The policies apply to the preparation of local and neighbourhood plans, and to development management decisions. The NPPF has replaced the majority of pre-existing planning guidance, including the Planning Policy Statements (PPS) on sustainable development (PPS1 and its supplement) and renewable energy (PPS22).

According to the NPPF, the purpose of the planning system is to 'contribute to the achievement of sustainable development'. Sustainable development is considered to have three interdependent dimensions: economic, social and environmental, the latter being concerned with 'protecting the natural built and historic environment; and, as part of this, helping to improve biodiversity, use natural resources prudently, minimise waste and pollution, and mitigate and adapt to climate change including moving to a low carbon economy'. Amongst the core principles which should underpin both plan-making and decision taking are that planning should:

- *'Seek to secure high quality design and a good standard of amenity for all existing and future occupants of land and buildings'*
- *'Support the transition to a low carbon future in a changing climate, taking full account of flood risk…,and encourage the reuse of existing resources, including conversion of existing buildings, and encourage the use of renewable resources (for example, but the development of renewable energy'*
- *'Contribute to conserving and enhancing the natural environment and reducing pollution. Allocations of land for development should be prefer land of lesser environmental value, where consistent with other policies in this Framework'*
- *'Promote mixed use developments, and encourage multiple benefits from the use of land in urban and rural areas, recognising that some open land can perform many functions (such as for wildlife, recreation, flood risk mitigation, carbon storage, or food production.'*

The Government's interpretation of what constitutes sustainable development means in practice is described in the 'Delivering Sustainable Development', 'Plan-making' and 'Decision-taking' sections of the Framework.

The sections of the document most relevant to the development of an evidence base to support policies relating to sustainable buildings and renewable / low carbon energy include:

- Paragraph 59 - local planning authorities should consider using design codes to guide the overall scale, density, massing, height, landscape, layout, materials and access of new development

[9] Communities and Local Government (2011*). Draft National Policy Framework*. London: DCLG

- Paragraph 65 - planning permission should not be refused for buildings or infrastructure promoting high levels of sustainability on the basis of concerns they are incompatible with an existing townscape, as long as the concerns can be mitigated
- Paragraph 111 - planning policies and decisions should encourage the use of previously developed land, as long as it is not of high environmental value
- Paragraph 114 - local planning authorities should plan positively for the creation, protection, enhancement and management of networks of biodiversity and green infrastructure
- Paragraph 156 - strategic policies should be set covering climate change mitigation and adaptation

Section 10 (paragraphs 93-108) deals specifically with 'Meeting the challenge of climate change, flooding and coastal change'. Paragraph 93 iterates the key role of planning in 'securing radical reductions in greenhouse gas emissions, minimising vulnerability and providing resilience to the impacts of climate change, and supporting the delivery of renewable and low carbon energy and associated infrastructure'.

Furthermore, planning authorities should 'adopt proactive strategies to mitigate and adapt to climate change', and 'plan for new developments in locations and ways which reduce greenhouse gas emissions' and 'actively support energy efficiency improvements to existing buildings'.

In terms of renewable energy, planning authorities are required to have a positive strategy to promote energy from renewable and low carbon sources, design policies to maximise renewable and low-carbon energy development, support community-led renewable and low-carbon energy projects and identify opportunities for development to obtain its energy from decentralised, renewable or low carbon sources (paragraph 97).

In addition, the Local Plan needs consider the impacts of climate change over the longer term, including increased flood risk, water supply issues, and impacts on biodiversity and landscape (paragraph 99). Also:

> *'New development should be planned to avoid increased vulnerability to impacts arising from climate change. When new development is brought forward in areas which are vulnerable, care should be taken to ensure that risks can be managed through suitable adaptation measures, including the planning of green infrastructure'.*

The framework then goes on to detail requirements for identifying and managing flood risk (paragraphs 100-1004), stating that *'inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood risk elsewhere'*.

Building a Greener Future: towards zero carbon development[10]/ Building a Greener Future: policy statement[11]

[10] CLG (2006). *Building a Greener Future: Towards Low Carbon Development. Consultation.* London: CLG
[11] CLG (2007). Building a Greener Future: policy statement. London: CLG

In December 2006, the Government issued the consultation document 'Building a Greener Future: Towards Zero Carbon Development', which outlined a 10-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 the future tightening up of Building Regulations, defining zero carbon as equivalent to the CO_2 reduction requirements of Code Level 6, which meant that both Regulated emissions (i.e. those associated with heating, hot water, fixed lighting and building services) and Unregulated emissions (those associated with cooking and plug-in appliances) had to be taken into account. This approach was confirmed in the policy statement published in July 2007.

However, as a result of further work carried out by the 2016 Taskforce and associated organisations such as the Zero Carbon Hub, the definition of zero carbon has since been amended, as announced by the Government in the March 2011 Budget. Instead of being aligned to the CO_2 reduction requirements of Code Level 6, zero carbon is now considered to be equivalent to the requirements of Code Level 5, which means that Unregulated emissions need not now be taken into account. Table 2.1 shows how the CO_2 reduction requirements of the Building Regulations will be tightened up between now and 2016 (compared to a 2006 baseline) and the equivalent Code for Sustainable Homes level.

Table 2.1: Relationship between CO_2 reduction requirements for Building Regulations and Code for Sustainable Homes

Date	2010	2013	2016 (Zero Carbon – new definition)
Required reduction in CO_2 emissions compared to Part L (Building Regulations 2006)	25%	44%	100%
Equivalent Code for Sustainable Homes Level	3	4	5

For non-domestic buildings, the government's stated ambition is for all new development to be zero carbon by 2019. This will be implemented in a similar way to the requirement for dwellings, i.e. by progressive tightening of Part L of the Building Regulations, although the detailed timetable for achieving this has yet to be agreed.

Climate Change Act 2008

This sets out the UK's targets for reduction CO_2 emissions, which are as follows:

- 34% reduction over 1990 levels by 2020; and,
- 80% reduction over 1990 levels by 2050.

It also requires government to introduce carbon budgets that cap emissions over 5-year periods, the first 3 of which are 2008-2012, 2013-2017 and 2018-2022. The fourth carbon budget, covering the period 2023-27 was set in June 2011 and requires emissions to be reduced by 50% below 1990 levels.

***UK Low Carbon Transition Plan*[12]**

Published in 2009, the UK Low Carbon Transition Plan – National Strategy for Climate Change sets out the UK's transition plan, to deliver cuts in CO_2 emissions of 34% on 1990 levels, as set out in the Climate Change Act. Other goals include maintaining secure energy supply, maximising economic opportunities and protecting the most vulnerable people in society from rising energy costs.

***The Carbon Plan: Delivering our low carbon future*[13]**

This sets out how the UK will achieve cuts to carbon emissions in the coming decades in line with legal and policy requirements. During the next 10 years it is anticipated that the UK will complete, as far as practicable, the installation of proven and cost effective technologies, such as cavity walls and lofts in homes and fuel efficiency technologies in vehicles, carbon dioxide emissions from new cars being expected to fall by around a third. Many existing coal-fired power stations will close and will be replaced, primarily by gas-powered plant and renewables. More diverse sources of electricity will improve energy security and reduce exposure to fossil fuel imports. Also over the next decade the UK will demonstrate and deploy key new technologies required to decarbonise power, buildings and road transport in the 2020s and beyond. These technologies will include carbon capture and storage for power stations, ultra-low emission vehicles, and building-related technologies such as heat pumps and the use of heat from power stations. Following demonstration and deployment, in the 2020s these key technologies will be rolled out on a mass scale. It is estimated that by 2030 between 40 and 70 gigawatts of new low carbon power will be required to be deployed, and between 21% and 45% of heat supply to buildings will need to be low carbon.

Relevant local policy and strategy

Climate Change Strategy for Coventry[14]

The second climate change strategy for Coventry, published in 2012, presents the vision for how Coventry will respond to the challenges and opportunities presented by climate change, as follows:

> *'To ensure that by 2020 Coventry is a world-leading low carbon, resilient and sustainable city. That Coventry:*
>
> - *Will have a thriving low carbon economy providing economic growth and employment, building on our foundations as a centre for developing new technologies*
> - *Will have the lowest carbon footprint compared to similar cities in the UK*
> - *Will have adapted to become resilient to extreme weather events and to long term climate change*
> - *Will have reduced fuel poverty in line with Government targets'.*

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[12] HM Government (2009). *The UK Low Carbon Transition Plan. National Strategy for Climate and Energy*
[13] HM Government (2011). *The Carbon Plan: Delivering our low carbon future.*
[14] Coventry City Council & Coventry Partnership (2012). *Climate Change Strategy for Coventry, March 2008*.

Based on this vision a number of aims have been identified, as follows:

- *'To fully inform and educate all stakeholders of the city on climate change*
- *To influence the people of Coventry to reduce their carbon emissions and improve energy efficiency at home and at work*
- *To ensure climate change is considered in every aspect of operations, services and informs decision making in the city*
- *To support and encourage economic growth in low carbon industries*
- *To protect the most vulnerable people in Coventry by ensuring they can afford to heat (and cool) their homes*
- *To reduce the city's reliance on carbon intensive fuels through low carbon energy generation*
- *To ensure all new buildings, developments and infrastructure are sustainable*
- *To be at the forefront of design, development and management of low carbon technologies*
- *To be a resource efficient city, using energy wisely and reducing / recycling waste*
- *To prepare the city for a changing climate and consequent impacts.'*

In addition, nine specific objectives have been set, the first of which is to reduce carbon dioxide emissions by 27.5% (based on NI 186 data) by 2020, compared to a 2005 baseline. This is equivalent to the national carbon dioxide emissions target of 34% reduction by 2020, which uses 1990 as the baseline. Other relevant objectives are:

Objective 2 – *'to achieve an increase in the city's gross domestic product of £1.9bn by 2020 compared to a 2010 baseline, and in so doing create 26,000 jobs within the low carbon and environmental sectors'*

Objective 4 – *'to improve home energy efficiency and reduce the number of people living in fuel poverty in line with Government targets'*

Objective 5 – *'to systematically implement a dynamic climate change community engagement plan that engages, informs and empowers over 20 per cent of the population by 2020 to build a sustainable city'*

Objective 8 – *'to increase green space and protect natural habitats, and encourage the production of locally grown food'*

Objective 9 – *'to improve the city's resilience to a changing climate by working with partners to raise awareness of the risks resulting from climate change and encouraging infrastructure improvements''*

The new Core Strategy is identified as being a key vehicle for the realisation of the city's vision, aims and objectives relating to climate change.

The Climate Change Strategy incorporates a detailed action plan setting how objectives are to be met. Actions identified include to:

- Produce a Sustainable Energy Action Plan for the city

- Produce a citywide energy demand map to investigate the potential for district heating and decentralised energy networks
- Set five-year long carbon budgets for the city reflecting the national carbon budgets
- Develop a district heating network to provide heat to the city centre and potentially expand the network to include new business districts and domestic properties and other areas of the city
- Incorporate climate change mitigation and adaptation policies into the Local Development Framework and Core Strategy
- Core Strategy to specify that all new developments and major refurbishments must include water efficiency and water reuse measures
- Complete the Surface Water Management Plan for Coventry
- Complete a Flood Risk Management Plan for Coventry
- Conduct an educational and awareness-raising programme relating to climate change adaption for planning applicants
- Research climate change impacts associated with medium and high emission scenarios and use this knowledge to underpin future infrastructure developments
- Work with developers to encourage them to install sustainable urban drainage systems where required and encourage the use of green roofs for new developments or major refurbishments
- Encourage developers to retain or create green space within new developments.

***The Coventry Sustainable Community Strategy*[15]**
This sets out the long-term vision and strategic objectives and outcomes for Coventry to be a growing, accessible city where people chose to live, work and be educated and where businesses choose to invest. It is organised according to eight key themes, as follows:

- Economy, learning, skills and employment
- Health, well-being and independence
- Community safety
- Cleaner, greener streets and open spaces
- Children and young people
- Housing
- Transport
- Culture, sport and physical activity.

In addition to these, there are two underpinning themes, which are:

- Equality of opportunity and involved, cohesive communities and neighbours; and,
- Making a positive environmental contribution to tackling climate change.

Some of the relevant plans outlined in the document include:

6f Climate change and housing:
'Housing design and improvements to existing stock to make Coventry homes more energy efficient will have positive impact on the city's carbon footprint – 42% of the city's carbon emissions come from homes. We must plan to minimise any potential negative effects of housing growth upon Coventry's environment including reducing journeys to school,

[15] Coventry City Council & Coventry Partnership (2008). *Coventry: The Next 20 Years. The Coventry Sustainable Community Strategy*

employment and leisure opportunities. New developments should be designed to cope with the ill-effects of climate change, including hotter temperatures and more extreme weather events such as storms and flooding.

10d Opportunities and challenges of growth:
'The future growth of the city needs to plan for climate change and ensure that sustainable growth is achieved. We should plan new developments of jobs and homes to minimise commuting and build low or zero carbon homes. ……Mitigation against climate change needs to include landscape features that will absorb sudden peak flows in watercourses and flooding'

Nottingham Declaration
Coventry City Council signed the Nottingham Declaration on Climate Change in October 2006. This commits the Council to act decisively in its role as community leader to tackle the causes and effects of climate change in the following ways:

- Work with central government to contribute locally to the delivery of the UK Climate Change Programme
- Prepare a climate change action plan with the local community
- Declare a commitment to reduce greenhouse gas emissions from its own activities
- Encourage all sectors in the community to also reduce greenhouse gas emissions
- Work with key providers such as the Primary Care Trust to assess the effects of climate change and identify how we can adapt
- Provide opportunities for the development of renewable energy
- Monitor progress against the plan and publish results.

Sustainability policies of neighbouring local planning authorities

The following section presents the policies included in recently-adopted or consultation version core strategies of neighbouring local authorities.

Birmingham City Council core strategy[16]

Birmingham City Council carried out a public consultation on its proposed core strategy between December 2010 and March 2011. The principal proposed city wide policies relating to sustainable buildings are SP4-SP11, a summary of which is given below.

SP4 Sustainable Urban Neighbourhoods

SUNs will be created in areas of regeneration and will form exemplary high quality housing settlements that utilise low carbon forms of energy production and promote the best sustainable practices.

SUNs will incorporate the following sustainable standards:

- Low carbon housing that meets the required Code for Sustainable Homes level
- Use of low carbon, renewable and energy efficient technologies
- Measures to adapt to the impacts of climate change
- Access to sustainable modes of transport
- Digital connectivity and infrastructure
- Sustainable waste management
- Access to a variety of high quality open space.

Wherever possible the sustainability benefits of SUNs will be extended to serve surrounding residential neighbourhoods.

SP6 Adapting to climate change

The city will need to adapt to the impacts of extreme weather and climate change. Measures to help manage the impacts will include:

- Managing flood risks and promoting sustainable urban drainage systems (SP10)
- Promoting and enhancing a green infrastructure network in the city (SP11)
- Protecting the natural environment (SP49)

In order to minimise the impact of overheating, new commercial and residential buildings should also:

- Demonstrate how the design of the development minimises overheating and reduces reliance on air conditioning systems
- Demonstrate how the development integrates green infrastructure as part of the design process to encourage urban greening
- Where feasible, provide an accessible green roof to aid cooling, enhance biodiversity and promote sustainable drainage
- Where applicable, maintain and enhance the canal network to reflect the canal's role in urban cooling.

SP7 Sustainable Construction

[16] *Birmingham Core Strategy 2026. A Plan for Sustainable Growth. Consultation Draft December 2010*

All new residential development should at least meet Code for Sustainable Homes Level 3 (or any future national equivalent) from the adoption of this strategy, at least Code level 4 from 2013 and Code level 6 from 2016.

All non-residential built developments in excess of 1,000sqm gross permitted floorspace or being developed on a site having an area of 0.5ha or more should meet BREEAM Very Good (or any future national equivalent) from the adoption of this strategy and from 2013 BREEAM standard Excellent.

Developers will need to demonstrate how their proposals accord with the above standards through their Design and Access Statement and will need to undertake a post construction review certificate.

Measures to adapt, enhance and where appropriate regenerate existing communicates to achieve the same standards of sustainability as in new developments will also be encouraged.

SP8 Low Carbon Energy Generation
Large residential developments on sites over 50 units and non-residential developments over 1,000sqm offer the economies of scale necessary to include combined heat and power generation or a network connection to an existing CHP facility.

Unless there are exceptional circumstances or an alternative means of energy reduction is proposed, combined heat and power or a network connection to an existing district heating scheme should always be incorporated as part of such developments. A feasibility study will need to be submitted where CHP is not being utilised on grounds of efficiency or viability or where similar levels of energy reduction can be achieved by utilising other technologies such as solar energy.

Other small developments should connect to an existing district heating scheme unless it is demonstrated that such a connection is not practicable or viable. Encouragement will also be given to the development and implementation of new technologies which reduce energy consumption such as SMART Grid and promoting new homes to be SMART Grid ready.

SP10 Managing Flood Risk
Flood risk assessments
Flood risk assessments (FRAs) will be required in accordance with PPS25 for all sties over 1ha in size and for all sites located within fluvial Flood Zones 2, 3a and 3b. In addition FRAs will be required for all sites considered to be at risk from other sources of flooding. This will include:

- Sites which are over 1ha
- Sites which are located within Flood Zones 2, 3a and 3b
- Sites which are located within areas susceptible to surface water flooding
- Sites which are at high or moderate susceptibility to groundwater flooding
- Sites which are located within 250m of an historic flooding location.

Sustainable Urban Drainage (SUDs)
Wherever possible the natural drainage of surface water from new developments into the ground will be expected, and direct flows into watercourses will be controlled in order to

lessen the impact of flash floods and decrease the risk of flooding. The extraction of ground water from areas of high water table will be encouraged for commercial and industrial use in order to reduce demands from more vulnerable sources of water and reduce problems associated with high levels of ground water.

Rivers and Streams
Rivers and streams are liable to natural flooding and will be managed in ways which will ensure that natural flooding can take place in locations which will not place built development or sensitive uses at risk. The Sustainable Management Urban Rivers Framework (SMURF) SPD provides more detailed guidance. River corridors are also important elements of the city's green infrastructure network (see Policy SP11).

Enhancement of Water Resources
As well as providing water and drainage, the city's rivers, streams, lakes and ponds are an important amenity and are also valuable as wildlife habitats. The opening up of culverted streams and rivers as part of development proposals will be encouraged, as will other measures which would increase the wildlife and amenity value of natural water features, provided that there is no adverse effect upon water quality and drainage.

SP11 Green Infrastructure Network
The city has a network of green spaces many of which are connected by linear open space corridors. The integrity of the linear open space network will be protected from development. Where possible the linear network will be enhanced and opportunities to extend the network and improved links will be taken.
Any development proposal that would adversely affect of the integrity of a linear corridor will be refused.

In addition new development offers the opportunity to created new green infrastructure through schemes such as green roofs and this will be encouraged.

The City Council will also seek to conserve and enhance Birmingham's woodland resource. All trees, groups, areas and woodlands will be consistently and systematically evaluated for protection and all new development schemes should allow for tree planting in both the private and public domains.

The importance of street trees in promoting the character of place and strengthening existing landscape characteristics will be recognised.

Rugby Borough Council core strategy[17]

Rugby's Core Strategy was formally adopted in June 2011. The main sustainability requirements for new development are covered in policies CS16 and CS17, shown below.

Policy CS16: Sustainable Design

All development will demonstrate high quality, inclusive and sustainable design and will only be allowed where proposals are of a scale, density and design that would not cause any material harm to the qualities, character and amenity of the areas in which they are situated.

Developers will ensure that the amenities of existing and future neighbouring occupiers are safeguarded.

New development should seek to complement, enhance and utilise where possible, the historic environmental and must not have a significant impact on existing designated and non-designated heritage assets and their settings.

Sustainable drainage systems (SUDS) should be proportionately incorporated in all new scales of developments. Infiltration SUDS should be promoted where it is practical. Where infiltration SUDS are not applicable surface water should be discharged to a watercourse in agreement with the Environment Agency.

Considerations in reducing the use of non renewable resources and taking into account the impacts of climate change include:

- Urban heat islands and cooling
- Promoting sustainable methods of transport
- Conserving and enhancing the built and natural environment

All new residential development should meet the water conservation standards in Level 4 of the Code for Sustainable Homes. Non-residential development shall demonstrate water efficiency of the relevant BREEAM Very Good standard.

Actual provision will be determined through negotiation, taking account of individual site characteristics and issues relating to the viability of the development.

Policy CS17: Reducing Carbon Emissions

All development shall comply with the published Building Regulations relevant at the time of construction.

As a minimum, all new development of 10 dwellings of 1000m^2 of non-residential floor space or more shall incorporate decentralised and renewable or low carbon energy requirement to reduce predicted carbon dioxide emissions by at least 10%.

Development of the Sustainable Urban Extensions will achieve the highest technically feasible and financially viable carbon efficiency standards of the Code for Sustainable Homes possible, even when these standards are higher than those expected at the national level.

[17] *Rugby Borough Council Local Development Framework. Final Version Core Strategy June 2011*

Actual provision will be determined through negotiation, taking account of individual site characteristics and issues relating to the viability of development.

Black Country Authorities (Dudley, Sandwell, Walsall and Wolverhampton) joint core strategy[18]

Dudley, Sandwell, Walsall and Wolverhampton have produced a joint Black Country core strategy, which was adopted in February 2011. The main policies relating to sustainable buildings, climate change and renewable energy are outlined below.

ENV3 Design Quality

Each place in the Black Country is distinct and successful place-making will depend on understanding and responding to the identity of each place with high quality design proposals. Development proposals across the Black Country will deliver a successful urban renaissance through high quality design that stimulates economic, social and environmental benefits by demonstrating that the following aspects of design have been addressed through Design and Access Statements reflecting their particular Black Country and local context:

1. Implementation of principles of 'By Design' to ensure the provision of a high quality network of streets, building and spaces;
2. Implementation of principles of 'Manual for Streets' to ensure urban streets and spaces are designed to provide a high quality public realm and an attractive, safe and permeable movement network;
3. Use of the Building for Life criteria for new housing developments, to demonstrate a commitment to strive for the highest possible design standards, good place-making and sustainable development, given local circumstances;
4. Meeting Code for Sustainable Homes Level 3 or above for residential development and Building Research Establishment Environmental Assessment Method (BREEAM) Very Good or above for other development, or the national requirement at the time of submitting the proposal for planning permission, to demonstrate a commitment to achieving high quality sustainable design;
5. Consideration of crime prevention measures and Secured by Design principles;
6. Including design features to reduce the urban heat island effect such as tree cover, green roofs and the inclusion of green space in development.

ENV5 Flood Risk, Sustainable Drainage Systems and Urban Heat Island

The Black Country Authorities will seek to minimise the probability and consequences of flood risk by adopting a strong risk-based approach in line with PPS25. Development will be steered to areas with a low probability of flooding first through the application of the sequential test. The Exception test will then be required for certain vulnerable uses in medium and high probability flood areas.

Proposals for development must demonstrate that the level of flood risk associated with the site is acceptable in terms of the Black Country Strategic Flood Risk Assessment and its planning and development management recommendations as well as PPS25 depending on which flood zone the site falls into and they type of development that is proposed.

To assist in both reducing the extent and impact of flooding and also reducing potential urban heat island effects, all developments should:

[18] *Black Country Core Strategy Adopted 3rd February 2011.*

a) Incorporate Sustainable Drainage Systems (SUDs) unless it would be impractical to do so, in order to significantly reduce surface water run-off and improve water quality. The type of SUDs used will be dependent on ground conditions;
b) Open up culverted watercourse where feasible and ensure development does not occur over existing culverts where there are deliverable strategies in place to implement this;
c) Take every opportunity, where appropriate development lies adjacent to the river corridors, their tributaries, or the functional floodplain, to benefit the river by reinstating a natural, sinuous river channel and restoring the functional floodplain within the valley where it has been lost previously;
d) On sites requiring a Flood Risk Assessment, reduce surface water flows back to equivalent Greenfield rates;
e) Create new green space, increase tree cover and/or provide green roofs.

No development will be permitted within a groundwater SPZ1 which would physically disturb an aquifer, and no permissions will be granted without a risk assessment demonstrating there would be no adverse effect on water resources.

ENV7 Renewable Energy
Proposals involving the development of renewable energy sources will be permitted where the proposal accords with the local, regional and national guidance and would not significantly harm the natural, historic or built environment or have a significant adverse effect on the amenity of those living or working nearby, in terms of visual, noise, odour, air pollution or other effects.

All non-residential developments of more than 1,000 square metres floor space and all residential developments of 10 units or more gross (whether new build or conversion) must incorporate generation of energy from renewable sources sufficient to offset at least 10% of the estimated residual energy demand of the development on completion. The use of on-site sources, off-site sources or a combination of both should be considered. The use of combined heat and power facilities should be explored for larger development schemes. An energy assessment must be submitted with the planning application to demonstrate that these requirements have been met.

The renewable energy target may be reduced, or commuted sum accepted in lieu of part or all of the requirement, only if it can be demonstrated that:

- a variety of renewable energy sources and generation methods have been assessed and costed;
- achievement of the target would make the proposal unviable (through submission of an independently assess financial viability appraisal);
- the development proposal would contribute to achievement of the objectives, strategy and policies of the core strategy.

Leicester City Council core strategy[19]
Leicester's Core Strategy was formally adopted in November 2010. The main policy dealing with sustainable development is CS Policy 2, which states the following:

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[19] *Leicester Local Development Framework Core Strategy, adopted November 2010*

All development must mitigate and adapt to climate change and reduce greenhouse gas emissions. The Council will prepare a Climate Change Supplementary Planning Document to provide more detailed guidance and information on sustainable energy, building methods and climate change adaptation to minimise the impact of development.

The following principles provide the climate change policy context for the City:

1. The Code for Sustainable Homes Level 3 will be required where feasible. This will be increased progressively over the plan period, where feasible, to support the Government's longer term aspiration for new homes to achieve Level 6.
2. Best practice energy efficiency and sustainable construction methods, including waste management, should be incorporated in all aspects of development, with use of locally sourced and recycled materials where possible, and designed to high energy and water efficiency standards.
3. Wherever feasible, development should include decentralised energy production or connection to an existing Combined Heat and Power or Community Heating System.
4. Development should provide for and enable commercial, community and domestic scale renewable energy generation schemes. Development of large scale renewable energy schemes will be considered in all suitable locations.
5. Development should be directed to locations with the least impact on flooding or water resources. Where development is proposed in flood risk areas, mitigation measures must be put in place to reduce the effects of flood water. Both Greenfield and brownfield sites should be assessed for their contribution to overall flood risk, taking into account climate change. All development should aim to limit surface water run-off by attenuation within the site as a means to reduce overall flood risk and protect the quality of the receiving watercourse by giving priority to the use of sustainable drainage techniques in developments.

3. Building Sustainability Standards

Requirements for new development to meet specified sustainability standards such as minimum Code for Sustainable Homes and BREEAM ratings is now commonplace in local authority planning policy in England and Wales. According to data published by the Building Research Establishment, out of the 368 local planning authorities in England, 219 have in place, or are intending to adopt, planning policies that require minimum Code for Sustainable Homes and/or BREEAM ratings to be achieved by new development in their area[20]. In line with this, a number of Coventry's neighbouring authorities have in place BREEAM and Code for Sustainable Homes requirements, as detailed in Section 2 above.

Given their frequent use in England and Wales, BREEAM and the Code for Sustainable Homes are relatively well understood within the property development industry. Moreover, as compliance is evidence-based and independently assessed, use of these standards in the planning system represents a relatively straightforward, consistent way for developers to demonstrate that minimum sustainability requirements have been achieved, and for planners to verify that this is the case. Furthermore, they enable priority actions such as carbon emissions and water efficiency to be targeted, and encourage best practice and innovation in the way that new buildings are designed and built.

The following sections look in more detail at the Code for Sustainable Homes and BREEAM respectively. For each standard, a brief description is given of what it covers and how credits are awarded and this is followed by a summary of the available evidence to support its use within planning policy.

Code for Sustainable Homes

Background

The Code for Sustainable Homes is an assessment method for rating and certifying the sustainability of new homes at the design and post-construction stages. Introduced in 2007, it is a Government-owned national standard and its primary purpose is to encourage continual improvement in sustainable home building. Performance is assessed using a credits-based system, and 6 performance levels are achievable – Level 1 to Level 6. Compliance with the Code is usually voluntary, except for new-build housing grant funded by the Homes and Communities Agency, which is at the time of writing required to achieve Level 3, or where minimum Code standards are stipulated by Local Planning Authorities as a condition of planning approval.

Performance is assessed against nine design categories, subdivided into a number of issues, each of which is allocated credits and a weighting factor. Credits are awarded on the basis of meeting certain predefined criteria. The categories, associated issues, available credits and weighting factors are shown in table 3.1 below.

Table 3.1 Code for Sustainable Homes categories, issues and weighting factors

[20] Yates, A., and Halewood, J. (2010). An Introduction to Judging the Viability of Sustainability Standards. Watford: BRE Global

Category		Issue	No. credits available	Category weighting factor	Approx. weighted value of each credit
1	Energy & CO_2 emissions	Ene1: Dwelling Emission Rate (M) Ene2: Fabric energy efficiency (M) Ene3: Energy display devices Ene4: Drying space Ene5: Energy labelled white goods Ene6: External lighting Ene7: Low & zero carbon technologies Ene8: Cycle storage Ene9: Home office **Category total**	10 9 2 1 2 2 2 2 1 **31**	36.4	1.17
2	Water	Wat1:Indoor water use (M) Wat2: External water use **Category total**	5 1 **6**	9.00	1.50
3	Materials	Mat1: Environmental impact of materials (M) Mat2: Responsible sourcing of materials – basic building elements Mat3: Responsible sourcing of materials – finishing elements **Category total**	15 6 3 **24**	7.20	0.30
4	Surface water run-off	Sur1: Management of surface water run-off from developments (M) Sur2: Flood risk **Category total**	2 2 **4**	2.20	0.55
5	Waste	Was1: Storage of non-recyclable waste and recyclable household waste (M) Was2: Construction site waste management Was3: Composting **Category total**	4 3 1 **8**	6.40	0.80
6	Pollution	Pol1: Global Warming Potential (GWP) of insulants Pol2: NOx emissions **Category total**	1 3 **4**	2.80	0.70
7	Health and well-being	Hea1: Daylighting Hea2: Sound insulation Hea3: Private space Hea4: Lifetime Homes (M – Level 6 only) **Category total**	3 4 1 4 **12**	14.00	1.17
8	Management	Man1: Home user guide Man2: Considerate Constructors Scheme Man3: Construction site impacts Man4: Security **Category total**	3 2 2 2 **9**	10.00	1.11
9	Ecology	Eco1: Ecological value of site Eco2: Ecological enhancement Eco3: Protection of ecological features Eco4: Change in ecological value of site Eco5: Building footprint **Category total**	1 1 1 4 2 **9**	12.00	1.33
Total			107	100	

'M' after the issue entry denotes that mandatory minimum performance standards have been set for that issue. For three of these, a single mandatory requirement is set which must be met, whatever Code Level rating is sought. Credits are not awarded for these issues. The three un-credited issues are:

- Environmental impact of materials (Mat1) – requirement for 3 out of 5 building elements to have Green Book rating of A+ to D
- Management of surface water run-off from developments (Sur1) – requirement for no increase in peak run-off
- Storage of non-recyclable waste and recyclable household waste (Was1) – requirements to provide sufficient storage space.

The remaining four mandatory issues relate to:

- Dwelling emission rate (DER) (Ene1)
- Fabric energy efficiency (Ene2)
- Indoor water use (Wat1)
- Lifetime Homes (Hea4)

The way in which these are applied depends on which Code level is being sought. Details of requirements in respect of Ene1 and Wat1 are shown in table 3.2. It should be noted that Ene1 credits are allocated on the basis of percentage improvement over minimum 2010 Building Regulations (Part L) requirements.

Table 3.2 – Code levels for mandatory minimum standards in CO_2 emissions (Ene1) and indoor water consumption (Wat1)

Code Level	Indoor water use (L/person/day) (Wat1)	% Improvement on 2010 Dwelling Emission Rate/ Target Emission Rate (Ene1)	Minimum score to achieve level
1	120	-	36
2	120	-	48
3	105	-	57
4	105	25*	68
5	80	100**	84
6	80	Net zero CO_2 emissions	90

*equivalent to requirements of Part L of 2013 Building Regulations
** broadly equivalent to requirements of Part L of 2016 Building Regulations (although see note below relating to whether emissions reductions are achieved on- or off-site)

Ene2 deals with fabric energy efficiency, and is relevant only for Code levels 5 and 6. To achieve an overall rating of level 5 or 6 a fabric efficiency of 39kWh/m^2/year or better for apartments or mid-terrace dwellings or 46kWh/m^2/year or better for other dwelling types must be attained. The remaining mandatory issue is Hea4, which currently applies only to Code level 6. To meet this requirement it must be demonstrated that all Lifetime Homes principles have been complied with.

Further credits are available on a free-choice basis. The overall rating is obtained by adding together the credits obtained for each design category, multiplying this by the environmental weighting factor for that category and then adding the totals. The minimum score which must be achieved to attain each of the 6 available levels is shown in table 3.2

Intended approach

The Council intends to set minimum Code for Sustainable Homes standards for all new development. In order to avoid imposing excessive costs on developers, it is intended to align Code requirements broadly with those of Part L of the Building Regulations, on the basis that the highest costs associated with meeting Code levels are typically those associated with achieving the energy-based credits, so if the energy requirements are kept in line with what would be required anyway to comply with legislation, the extra over costs associated with Code compliance are minimised[21]. Therefore the intended approach is to require as a default the following minimum standards for all developments:

- Prior to the introduction of 2013 Part L – Code Level 3
- From 2013 – Code Level 4
- From 2016 – Code Level 5.

Evidence

Technical feasibility

Mandatory entry level (uncredited) requirements

It is not considered that there are any specific technical constraints which would prevent houses in Coventry meeting the three uncredited requirements necessary for any Code rating to be given – Mat1, Sur1, Was1 – as described above.

Site-dependent credits

A number of credits in the Code are site-dependent, that is to say, their achievability is determined by their location. They include the following:

- Sur2 (flood risk) – 2 credits available (taking category weighing into account, this represents 1.11% of overall available points)
- Eco1 (ecological value of site) – 1 credit available (1.33% of available points)
- Eco3 (protection of ecological features) – 1 credit available (1.33% of available points)
- Eco4 (change in ecological value of site) – 4 credits available (5.33% of available points)

For Sur2, two credits are given where the development is located in Flood Zone 1 and where the site-specific flood risk assessment (FRA) indicates that there is low risk of flooding from all sources. Where the development is located in Flood Zones 2 and 3a, one credit can be achieved if the finished ground floor level of all habitable parts of dwellings and access routes to the ground level and the site are place at least 600mm above the design flood level of the flood zone.

As one of the criteria used to select housing sites for development, as detailed in the Strategic Housing Land Availability Assessment[22], is vulnerability to flooding, it is not anticipated that in most cases site constraints will prevent one or both of these credits being achieved.

Eco1 encourages the development of land with low ecological value, whilst Eco4 credits are based on minimising reduction in – or increasing – the ecological value of the site. Therefore both of these are dependent on having a site of low ecological value in the first place. Although this would need to be looked at on a site-by-site basis, given the council's approach of prioritising sites which have been previously developed, many of which have low ecological value, these credits will be achievable in most instances.

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[21] This assumes that the Code will be revised to incorporate allowable solutions at Level 5 in the same way as has been proposed for Part L of the Building Regulations from 2016. The Government has previously indicated that it is minded to do this, but intends to consult on this issue during the spring of 2012.

[22] Coventry City Council (2011). *Strategic Housing Land Availability Assessment. September 2011 Review. Draft.*

In terms of Eco3, which relates to protecting the site's existing ecological features, if there are no ecological features to protect, as may be the case in some instances, the available credit can be awarded by default.

Code Level 3
Code Level 3 homes are now commonplace, achievement of this level having been a mandatory requirement of homes funded by the Homes and Communities Agency since 2007. There are a number of examples of Code Level 3 developments in and around Coventry, including the following, recently constructed by Orbit Heart of England:

- Sampson Close - a development of 18 flats and 5 terraced houses in the north of Coventry
- Poachers Pocket, Nuneaton – 23 two-, three- and four-bedroom houses
- Staunton Road, Rugby – a development of 5 three-bedroom houses and a two-bedroom bungalow

Owing to the fact that the energy requirements of Level 3 are in line with current Building Regulations and there is a wide choice of other credits which can be targeted to achieve the minimum score, it is not considered that there are any particular technical issues associated with constructing new dwellings to Code Level 3. The minimum water efficiency (Wat1) requirement of 105L/h/d, which applies for both Levels 3 and 4 (see table 3.2), can be achieved using standard low cost water efficiency measures such as low flow showers and taps. A typical specification which would achieve the requirement is as follows:

- WC dual-flush: 4L full-flush volume, 2.6L part-flush volume
- Wash-hand basin: maximum tap flow of 6L/min
- Shower: maximum flow of 9L/min
- Bath: 150L capacity[23]

Code Level 4
Whilst there are a number of Code Level 4 houses in existence, they are not yet commonplace. However, their technical feasibility is well established, particularly in terms of meeting the energy requirements, due to the fact that Code Level 4 is aligned in energy terms with the next round of Part L of the Building Regulations, due to come into force in 2013.

In the Coventry context a study has been carried out into the feasibility of building 700 homes to Code Levels 3 and 4 in the Canley area of the city.[24] As part of this study strategies were devised for meeting Level 4 based on using or not using combined heat and power, and installing or not installing cycle storage. The latter was included because the Council's current SPD relating to sustainable buildings, 'Delivering a More Sustainable City'[25] includes a minimum requirement for the provision of cycle storage. No particular technical constraints were identified, except in respect of the ecology credits. This was due to the nature of the site, which is largely greenfield, and limitations in space available for planting. However, these constraints did not affect the overall ability of the site to achieve Code Level 4. A summary of the recommended strategies is shown in table 3.3.

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[23] NHBC Foundation (2010). *The Code for Sustainable Homes Simply Explained*. Revised January 2010. Amersham: NHBC Foundation
[24] Faber Maunsell AECOM (2009). *Canley Climate Change Feasibility Study. Final Report. Coventry City Council. March 2009.*
[25] Coventry City Council (2009). *Supplementary Planning Document: Delivering a More Sustainable City*.

Table 3.3 Summary of Code for Sustainable Homes Level 4 strategy for Canley

Code category	Recommended approaches to achieve Code Level 4
Energy	The development should maximise the credits in this area through: • Installation of standalone or district renewable/low carbon technologies, e.g. gas-fired or biomass CHP • 75% dedicated energy efficient internal lighting and high efficiency external lighting • Provision of drying space • Facility for home office (where CHP is not used) • Cycle storage • Measures to further increase percentage improvement of DER over TER
Water	• In-house water efficient fixtures, fittings and appliances • Rainwater butts provided for external use
Materials	• Use of 'A' rated materials maximised • Requirement to procure responsibly sourced materials (with increased requirements where CHP is not used)
Waste	• Site Waste Management Plan • Waste storage facilities for recyclables • Composting facilities
Surface water run-off	• SUDS system designed to achieve the attenuation rates which are a mandatory requirement of both the Code and PPS25
Pollution	• Only materials with zero or low (<5) Global Warming Potential to be used in construction • Further credits could be achieved for NOx emissions, depending on the choice of system provided for space heating and hot water (biomass CHP would not achieve any credits)
Health and well-being	• Improvements to sound insulation over and above Building Regulations • Good daylighting levels in kitchen areas, living rooms, dining rooms and studies • Lifetime Homes Standard
Management	• Registration under the Considerate Constructors Scheme • Dwellings designed to meet 'Secured by Design' standards • Provision of Home User Guide
Ecology	What can be achieved in this category is limited due to site constraints (greenfield, with limited space available for tree planting).

Code Level 5

Since it is likely that the minimum DER (Ene1) and Fabric Energy Efficiency (Ene2) requirements of Code Level 5 - as described in the Background section above – will be aligned with the government's definition of zero carbon, to be enacted through the 2016 version of Part L of the Building Regulations, a large amount of work has been carried out at the national level into the technical feasibility of meeting them[26,27]. As the recommended timetable for the introduction of escalating Code level requirements in Coventry matches, but does not exceed, the progressive tightening of the Building Regulations the results of this work are not covered here, on the basis that these standards will have to be met regardless of any locally-imposed building sustainability standards.

For Code Levels 5 and 6, the maximum permitted design indoor water consumption (Wat1 credit) is 80L/head/day. In order to meet this requirement it is usually necessary to install rainwater harvesting and/or greywater recycling systems. Whilst there are cost implications,

[26] Zero Carbon Hub (2009). *Defining an Fabric Energy Efficiency Standard for Zero Carbon Homes. Task Group Recommendations. November 2009*. London: Zero Carbon Hub

[27] Zero Carbon Hub (2011). *Carbon Compliance: Setting an Appropriate Limit for Zero Carbon Homes. Findings and Recommendations. February 2011*. London: Zero Carbon Hub

which are discussed below, from a technical perspective the technologies for achieving the reduced water consumption rates are well-established, and so there are no particular issues of technical feasibility of these.

In terms of the other available credits, as the discussion above shows, for most sites in Coventry there will be no or few constraints to prevent them being achieved.

Cost implications

A number of studies have been carried out into the cost implications of meeting Code for Sustainable Homes requirements[28,29,30]. These indicate that the cost of meeting Code Level 3 and above is very dependent on:

- dwelling type
- site conditions
- cost of achieving required energy credits.

The most recent report, entitled *'Cost of building to the Code for Sustainable Homes Updated Cost Review'*[31] was published in August 2011. Its main purpose was to update the two previous CLG Code cost reports in the light of availability of a much larger market tested industry dataset. In particular, it seeks to:

- identify what solutions builders typically use in order to achieve credits under individual Code issues and the associated costs
- gain a greater understanding of strategies adopted to obtain each Code level, and the extent to which these strategies are affected by the characteristics of a development
- understand the costs associated with meeting different Code level and how these are influenced by dwelling type and development characteristics
- identify how the costs of meeting Code requirements have changed since its introduction and how they are likely to change in the future.

The study involved consultation with home builders and the development of a Code cost model using data obtained from the consultation as inputs. The model was used to produce Code cost estimates for four dwelling types: two-bed flat, two-bed terraced house, three-bed semi-detached house and four-bed detached house. These dwelling types were combined to create five development scenarios, which differ by size, density, dwelling mix and whether greenfield or brownfield. These are shown in table 3.4 below.

Table 3.4: The five development scenarios used for cost modelling

Development scenario	Type	No. of dwellings	Density (dwellings/ha)	Dwelling mix (% of total)			
				2-bed flat	2-bed terrace	3-bed semi	4-bed detached
Small brownfield	Brownfield	20	40	0	40	40	20
City infill	Brownfield	40	150	100	0	0	0
Edge of town	Greenfield	100	40	24	30	30	16

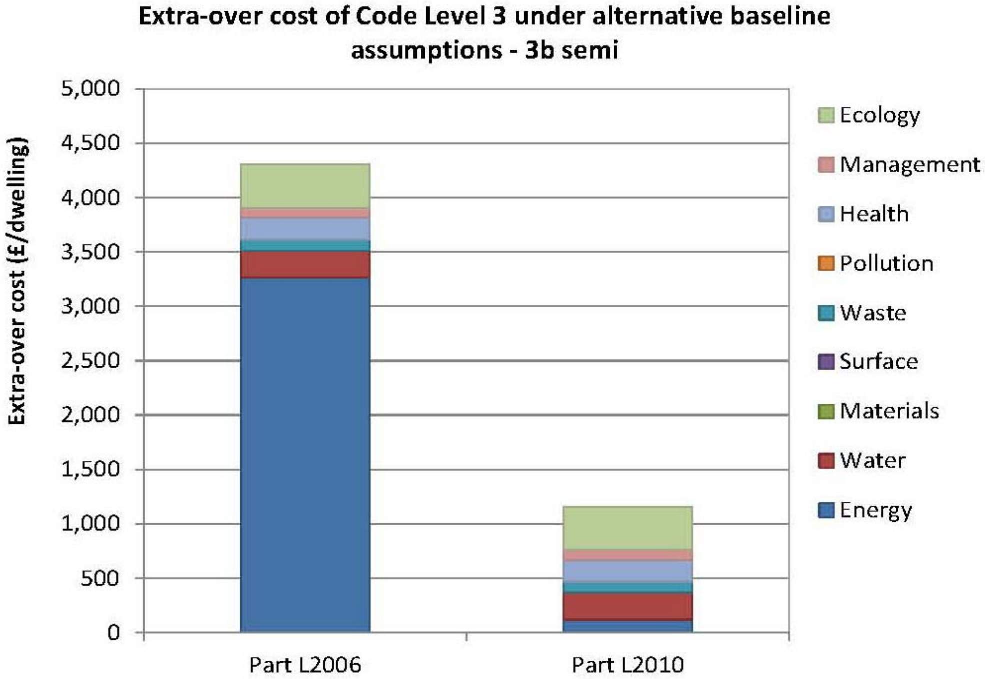
[28] English Partnerships, Housing Corporation (2007). *A Cost Review of the Code for Sustainable Homes. Report for English Partnerships and the Housing Corporation. February 2007*
[29] Communities and Local Government (2008). *Cost Analysis of The Code for Sustainable Homes. Final Report'* London: CLG
[30] Communities and Local Government (2010). *Code for Sustainable Homes: A Cost Review*. London: CLG
[31] Communities and Local Government (2011). *Cost of Building to the Code for Sustainable Homes. Updated Cost Review*. London: CLG

Strategic greenfield	Greenfield	2,000	40	10	30	30	20
Urban regeneration	Brownfield	2,000	150	70	20	5	5

Code Level 3

One of the key findings of the report is that a significant fraction of the costs of building to Code standards are incurred under the Energy and CO_2 category, and within this category a large part of the spending is related to the energy solutions adopted in order to meet the mandatory Dwelling Emission Rate (DER) standards set out under issue Ene1 of the Code. However, as the Ene1 requirements for Code Level 3 are encompassed within the current (i.e. 2010) version of Part L of the Building Regulations and need to be met regardless of whether or not the Code is being used, the extra-over costs specifically associated with achieving Code Level 3 are now significantly lower than was the case prior to the introduction of the most current version of Part L. This is illustrated in the example shown in figure 3.5 below, which shows Code extra-over costs for a 3-bed semi-detached house on a small brownfield site against Part L 2006 and 2010 baselines.

Figure 3.5: Impact of incorporating 2010 revisions to Part L into the base build cost on Code extra-over costs



The extra-over costs to achieve Code Level 3 against a Part L 2010 baseline for the range of development scenarios modelled are presented in figure 3.6.

Figure 3.6: Modelled extra-over costs against a Part L 2010 baseline to achieve Code Level 3 under various development scenarios

Development scenario	2b-flat		2b-terrace		3b-semi		4b-detached		Average	
	E/O Cost	%	E/O Cost	%	E/O Cost	%	E/O Cost	%	E/O Cost	%
Small brownfield	-	-	£840	1.0%	£1160	1.3%	£1,000	1.1%	£1,000	1.2%
City infill	£750	1.4%	-	-	-	-	-	-	£750	1.4%

Edge of town	£1470	2.7%	£1360	1.7%	£1590	1.8%	£1370	1.5%	£1457	1.9%
Strategic greenfield	£1450	2.7%	£1350	1.7%	£1570	1.8%	£1350	1.5%	£1436	1.8%
Urban regeneration	£680	1.2%	£700	0.9%	£910	1.1%	£750	0.8%	£699	1.1%

As can be seen from the data, percentage increases range from less than 1% for a 4-bed detached house on an urban regeneration site, to 2.7% for a 2-bed flat forming part of an edge of town or strategic greenfield development. The most relevant results for Coventry will be those for small brownfield, city infill and urban regeneration scenarios, where both the absolute and percentage cost increases are lowest, typically at just over 1%.
A summary of how these costs are apportioned between Code categories for a 3-bed semi under four different development scenarios is shown in figure 3.7.

Figure 3.7: Breakdown of Code Level 3 extra-over costs by Code Category for a 3-bed semi against a 2010 Part L baseline.

Code Category	Development scenario							
	Small brownfield		Edge of town		Urban regeneration		Strategic greenfield	
	Credits	E/O Cost	Credits	E/O Cost	Credits	E/O Cost	Credits	E/O Cost
Energy	13	£120	12	£120	12	£55	12	£120
Water	4	£250	4	£250	4	£250	4	£250
Materials	14	£0	14	£0	14	£0	14	£0
Surface water run-off	2	£0	2	£0	2	£0	2	£0
Waste	7	£100	6	£50	6	£50	6	£50
Pollution	4	£0	4	£0	4	£0	4	£0
Health	8	£200	8	£200	8	£200	8	£200
Management	7	£90	7	£18	7	£2	7	£1
Ecology	6	£400	5	£950	7	£350	5	£950
Total	**65**	**£1160**	**62**	**£1588**	**64**	**£907**	**62**	**£1571**

In general, the costs do not vary greatly according to development type, except for the ecology costs, which vary from £350/£400 for an urban regeneration/small brownfield sites respectively (i.e. sites of low inherent ecological value) to £950 in the case of the edge of town and strategic greenfield sites, which will usually be expected to have higher initial ecological value. As the ecology credits are the most expensive, this has a significant impact on the overall cost. In the case of Coventry, it is expected that most of the sites coming forward for development will be brownfield or regeneration sites and therefore ecology – and hence total - costs will be towards the lower end of the range. In several of the categories – materials, surface water run-off and pollution – the credits required to achieve Code Level 3 can be attained at zero extra-over cost. It should be noted though, that this does not mean that there are no costs associated with achieving the credits, just that there are no *additional* costs specifically associated with the Code. In many cases the issue has to be dealt with as a result of legal and other requirements, regardless of whether the Code is being used.

Code Levels 4 and 5

Given that the intention is to align Code requirements for new development with the progressive tightening of Part L of the Building Regulations - that is, the Code Level 4 requirement would not come into effect until 2013 and the Code level 5 requirement until 2016 - it is appropriate to estimate costs of meeting future Code 4 and 5 requirements by looking at the overall costs of meeting those Code levels – as presented in the CLG report - minus the costs of those energy credits which are related to Building Regulations compliance. In practice a large majority of the cost of gaining the required energy credits for Code Levels 4 and 5 is associated with achieving the DER and fabric energy efficiency standards (FEES) required by Building Regulations. Therefore most of the energy-related costs can be subtracted from the total in order to get an estimate of the extra-over costs associated with future Code levels. The exact cost of gaining the non-DER/FEES credits is not given in the report in all cases (i.e. all house types, all development scenarios), so to simplify matters, the following have been assumed:

a) for Code Level 4, the cost of non-DER/FEES energy credits is approximately £300,
b) for Code Level 5, the cost of non-DER/FEES energy credits is approximately £500

regardless of dwelling type or development scenario. These are based on figures given in the report, and in most cases are an overestimate of the likely true figure. Table 3.8 gives estimates of extra-over costs for Code 4 and Code 5, assuming implementation dates of 2013 and 2016 respectively.

Table 3.8: Estimated extra-over costs against future Part L baselines

Development scenario	2-bed flat	2-bed terrace	3-bed semi	4-bed detached
Code Level 4 (Part L 2013 baseline)				
Small brownfield (or city infill for flat)	£1528 (4799-3571+300)	£1340 (6471-5431+300)	£1490 (7726-6536+300)	£1174 (8693-7819+300)
Edge of town	£2072 (5343-3571+300)	£2118 (7249-5431+300)	£2268 (8504-6536+300)	£1352 (9471-7819+300)
Urban regeneration	£1456 (4727-3571+300)	£1052 (6183-5431+300)	£1202 (7438-6536+300)	£1036 (8475-7739+300)
Strategic greenfield	£2055 (5326-3571+300)	£2101 (7232-5431+300)	£2251 (8487-6536+300)	£1935 (9454-7819+300)
Code Level 5 (Part L 2016 baseline)				
Small brownfield (or city infill for flat)	£8688 (16617-8429+500)	£7745 (21636-14391+500)	£7825 (23141-15816+500)	£7364 (24913-18049+500)
Edge of town	£9232 (13455-4723+500)	£8223 (22964-15241+500)	£8303 (24469-16666+500)	£7842 (26241-18899+500)
Urban regeneration	£7954	£7482	£7577	£7140

	(16182-8728+500)	(18176-11194+500)	(19550-12473+500)	(21285-14645+500)
Strategic greenfield	£9215 (19138-10423+500)	£8206 (22947-15241+500)	£8286 (24452-16666+500)	£9825 (28224-18899+500)

Note that the costs presented in the table are based on today's prices, and do not attempt to take into account any reduction in costs which may occur as a result of the technologies being taken up more widely.

In the case of Level 4 the extra-over costs are not much higher than those for Code Level 3 (Table 3.1.6), but significant increases are seen for Code 5. Much of this increase is due to the internal water consumption requirement (Wat1) of 80L/h/d (Wat1), as shown in table 3.9.

Table 3.9: Extra-over costs of specifications to achieve the mandatory Wat1 consumption standards at Code Levels 3/4 and 5/6

Water specification extra-over cost	Two-bed flat	Two-bed terrace	Three-bed semi	Four-bed semi
Code Levels 3 & 4 (105L/h/d)	£150	£150	£200	£200
Code Levels 5 & 6 (80L/h/d)	£6150	£4650	£4700	£4700

Although at the present time the costs of meeting Code Level 5 requirements are high, particularly with respect to meeting Wat1 requirements, the expectation is that by the time these requirements come into effect (2016), they will have reduced significantly and viability will be greatly improved. At the local level Severn Trent Water is seeking to stimulate innovation within the supply chain to bring down the costs of domestic and community scale rainwater harvesting and greywater recycling systems. An innovation workshop is planned for autumn 2012, with a view of trial pilot scale systems being installed to homes from 2015.

The costs of meeting Code Level 4 were included in the Affordable Housing Economic Viability Assessment commissioned by Coventry City Council. The study assessed the viability of various levels of affordable housing provision in five distinct Housing Sub-Market areas in Coventry, identified as Higher Value South, Mid Value Outer West / South West Suburbs, Mixed Character Inner East / West, Large Peripheral Estates (Henley, Binley and Willenhall), and Lower Value North. Based on the findings of the study, the Council intends to set differential affordable housing requirements of 35% for the Higher Value South and Mid Value Outer West / South West Suburbs areas and 25% for other areas of the city, with a minimum applicability threshold of 20 units in each case. Although costs of achieving Code Level 5 were not included in the assessment, the intention is to include them in any follow-on work that may be carried out in future years.

BREEAM

Background

Overview

In terms of sustainability standards covering buildings other than dwellings, BREEAM (Building Research Establishment Environmental Assessment Method) is the best-known and most widely used standard both in the UK and worldwide, although other standards do exist. The aims of BREEAM can be summarised as follows:

1. To mitigate the life cycle impacts of buildings on the environment
2. To enable buildings to be recognised according to their environmental benefits
3. To provide a credible, environmental label for buildings
4. To stimulate demand for sustainable buildings.

BREEAM was first introduced in the UK and since then a number of versions of the standard have been published, the latest and most relevant being BREEAM New Construction[32], released in 2011. As the name suggests, this is a performance-based assessment method and certification scheme for new buildings. The types of development covered under BREEAM New Construction are summarised in table 3.10.

Table 3.10: Building types which can be assessed using BREEAM New Construction

Sector	Building type	Description
Commercial	Offices	• General office buildings • Offices with research and development areas
	Industrial	• Industrial units – warehouse storage/distribution • Industrial units – process / manufacturing / vehicle servicing
	Retail	• Shops / shopping centres • Retail parks / warehouses • 'Over the counter' service providers (e.g. financial, estate and employment agencies) • Showrooms • Restaurants, cafés and drinking establishments • Hot food takeaways
Public (non-housing)	Education	• Pre-schools • Schools and sixth form colleges • Further educational / vocational colleges • Higher education institutions
	Healthcare	• Teaching / specialist hospitals • General acute hospitals • Community and mental health hospitals • GP surgeries • Health centres and clinics
	Prisons	• High security prisons • Standard secured prisons • Young offender institutions and juvenile prisons • Local prisons • Holding centres
	Law courts	• Crown and criminal courts • County courts • Magistrates' courts

[32] Building Research Establishment (2011). *BREEAM New Construction. Non-Domestic Buildings. Technical Manual SD5073-2.0:2011* Watford: BRE Global Ltd.

Sector	Building type	Description
		• Civil justice centres • Family courts • Youth courts • Combined courts
Multi-residential accommodation	Residential institutions	• Residential care homes • Sheltered accommodation • Residential colleges / schools (halls of residence) • Local authority secure residential accommodation • Military barracks
Other	Residential institutions	• Hotels, hostels, boarding and guest houses • Secure training centres • Residential training centres
	Non-residential institutions	• Art galleries, museums • Libraries • Day centres, halls, civic / community centres • Places of worship
	Assembly and leisure	• Cinema • Theatres, music / concert halls • Exhibition / conference halls • Indoor or outdoor sports / fitness / recreation centres (with or without swimming pool)
	Other	• Transport hub (coach/bus station, above ground rail station) • Research and development establishments (cat 2 / 3 labs – non-higher education) • Crèches

In terms of the life cycle stages of the building, the following are covered:

- Design stage (DS) – leading to an Interim BREEAM certified rating
- Post-Construction Stage (PCS) – leading to a Final BREAM certified rating.

Existing, in-use buildings are covered by a separate BREEAM scheme, BREEAM In-Use, which is not covered here as it is not relevant to the discussion. Also BRE is in the process of producing a separate scheme specifically covering the refurbishment and fit-out of existing buildings, although as an interim measure these can be assessed using other, existing schemes.

In much the same way as the Code for Sustainable Homes, BREEAM involves credits (organised into environmental sections and assessment issues) being awarded for sustainability features incorporated into a building, which are then converted into an percentage score using the section weighting. An overall rating is given according to the scored attained. The sections, associated issues and section weightings are shown in table 3.11.

Table 3.11: BREEAM 2011 New Construction environmental sections and assessment issues

Environmental section	Assessment issues	Section weighting
Management (Man)	Man1: Sustainable procurement Man2: Responsible construction practices Man3: Construction site impacts Man4: Stakeholder participation Man5: Service life planning and costing	12%

Environmental section	Assessment issues	Section weighting
Health and wellbeing (Hea)	Hea1: Visual comfort Hea2: Indoor air quality Hea3: Thermal comfort Hea4: Water quality Hea5: Acoustic performance Hea5: Safety and security	15%
Energy (Ene)	Ene1: Reduction of CO_2 emissions Ene1:Energy monitoring Ene3: Energy efficiency external lighting Ene4: Low or zero carbon technologies Ene5: Energy efficient cold storage Ene6: Energy efficient transportation systems Ene7: Energy efficient laboratory systems Ene8: Energy efficient equipment (process) Ene9: Drying space	19%
Transport (Tra)	Tra1: Public transport accessibility Tra2: Proximity to amenities Tra3: Cyclist amenities Tra4: Maximum car parking capacity Tra5: Travel plan	8%
Water (Wat)	Wat1: Water consumption Wat2: Water monitoring Wat3: Water leak detection and prevention Wat4: Water efficient equipment (process)	6%
Materials (Mat)	Mat1: Life cycle impacts Mat2: Hard landscaping and boundary protection Mat3: Responsible sourcing of materials Mat4: Insulation Mat5: Designing for robustness	12.5%
Waste (Wst)	Wst1: Construction waste management Wst 2: Recycled aggregates Wst 3: Operational waste Wst 4: Speculative floor and ceiling finishes	7.5%
Land use and ecology (LE)	LE1: Site selection LE2: Ecological value of site / protection of ecological features LE3: Mitigating ecological impact LE4: Enhancing site ecology LE5: Long term impact on biodiversity	10%
Pollution (Pol)	Pol1: Impact of refrigerants Pol2:NOx emissions from heating / cooling sources Pol3: Surface water run-off Pol4: Reduction of night-time light pollution Pol5: Noise attenuation	10%
Innovation (Inn)	Inn1: New technology, process and practices	10% (additional)

The number and types of credits available within each section depend on the building type.

The available overall ratings and minimum score required to achieve each are as follows:

- Outstanding: 85%
- Excellent: 70%
- Very Good: 55%
- Good: 45%

- Pass: 30%
- Unclassified: <30%

As with the Code, there are specific minimum requirements which much be attained at each level. For BREEAM New Construction, these are shown in table 3.12.

Table 3.12: Minimum BREEAM standards by rating level

BREEAM issue	Minimum standards by BREEAM rating level				
	Pass	Good	Very Good	Excellent	Outstanding
Man01: Sustainable procurement	1 credit	1 credit	1 credit	1 credit	2 credits
Man02: Responsible construction practices	None	None	None	1 credit (Considerate Constructor Scheme)	2 credits (Considerate Constructor Scheme)
Man04: Stakeholder participation	None	None	None	1 credit (Building user information)	1 credit (Building user information)
Hea01: Visual comfort	Criterion 1 only (high frequency ballast on fluorescent lighting)	Criterion 1 only (high frequency ballast on fluorescent lighting)	Criterion 1 only (high frequency ballast on fluorescent lighting)	Criterion 1 only (high frequency ballast on fluorescent lighting)	Criterion 1 only (high frequency ballast on fluorescent lighting)
Hea04: Water quality	Criterion 1 only (legionella control)	Criterion 1 only (legionella control)	Criterion 1 only (legionella control)	Criterion 1 only (legionella control)	Criterion 1 only (legionella control)
Ene1: Reduction of CO_2 emissions	None	None	None	6 credits (25% improvement on 2010 Building Regs)	6 credits (40% improvement on 2010 Building Regs)
Ene02: Energy monitoring	None	None	1 credit (1st sub-metering credit)	1 credit (1st sub-metering credit)	1 credit (1st sub-metering credit)
Ene04: Low or zero carbon (LZC) technologies	None	None	None	1 credit (specification of LZC technology)	1 credit (specification of LZC technology)
Wat01: Water consumption	None	1 credit	1 credit (12.5% improvement over baseline)	1 credit (12.5% improvement over baseline)	2 credits (25% improvement over baseline)
Wat02: Water monitoring	None	Criterion 1 only (meter supplied to each building)	Criterion 1 only (meter supplied to each building)	Criterion 1 only (meter supplied to each building)	Criterion 1 only (meter supplied to each building)
Mat03: Responsible sourcing	Criterion 3 only (timber sourced according to govt policy)	Criterion 3 only (timber sourced according to govt policy)	Criterion 3 only (timber sourced according to govt policy)	Criterion 3 only (timber sourced according to govt policy)	Criterion 3 only (timber sourced according to govt policy)
Wst01: Construction waste management	None	None	None	None	1 credit (max volume waste generated / $100m^2$ floor area=$13.3m^3$)
Wst03: Operational waste	None	None	None	1 credit (storage for recyclables)	1 credit (storage for recyclables)
LE03: Mitigating ecological impact	None	None	1 credit (minimal change in ecological value of site)	1 credit (minimal change in ecological value of site)	1 credit (minimal change in ecological value of site)

Benefits of use of BREEAM requirements in planning policies
Many of the benefits of the use of BREEAM are similar to those outlined in the section above relating to the Code for Sustainable Homes, in particular that BREEAM provides a flexible, transparent, independently-assessed method for developers to demonstrate that minimum sustainability standards have been met, and for planning officers to check that this is the case.

In terms of the financial benefits to be gained by developers to building to BREEAM standards, available evidence on the financial performance of 'green' buildings is limited outside of the United States, and demonstrating the financial implications of sustainable buildings requires a rigorous analysis on the determinants of property values and rents, and how these are influenced by a BREEAM rating. There are many factors at work however, and isolating the value of sustainability requires independent research. In order to address this issue, BRE Global has joined forces with Maastricht University and the Royal Institution of Chartered Surveyors (RICS) in a study to assess the economic and financial value of incorporating sustainability into non-domestic buildings in the UK. Although no results have yet been officially published, according to BRE:

> *'The research team has already assimilated data from a substantial number of BREEAM-rated office buildings, matched to financial information of three independent data providers. The initial analysis shows a positive relation between the 'green' rating and property values and rental incomes. However to ensure the research has a strong and robust statistical basis, the study has been widened to include a greater number of buildings across the property spectrum.'*[33]

Relevance of BREEAM for Coventry
In the Coventry context, there are a number of buildings already within and around the city which have a BREEAM rating of Excellent. These include:

- Severn Trent Headquarters
- Coventry University 'Hub' building
- Coventry University Computing and Engineering building (currently under construction)
- Warwick University Digital Laboratory
- QCDA Earlsdon Park
- Manufacturing Technology Centre, Ansty Park.

Also, interest is increasing in the use of BREEAM in speculative developments. One example of this is Loades EcoParc, a business park consisting of compact units of up to 3000 square feet, located just outside of the northern perimeter of the city, on Bayton Road Industrial Estate. The site is being developed such that a minimum BREEAM rating of Very Good will be achievable by future occupants should they wish to gain a BREEAM rating for their building. Some of the features being incorporated into the site include:

- PV array on the roof of one of the buildings and remaining buildings PV-enabled
- North-south orientation of buildings to maximise solar gain
- Incorporation of roof lights into roof structure and large windows on southern facades
- Thermally efficient structure, with an Energy Performance Certificate B rating

[33] Source: BRE. Available online at: www.breeam.org/value

- Sustainable urban drainage systems, including swales and permeable paving under car park
- Provision of a travel plan
- Cycle parking facilities
- Electric vehicle charging points on 4 communal parking spaces, plus ducting to enable future charging points to be installed outside individual units
- Option of a green lease for tenants.

In addition, the potential importance of the use of BREEAM at a local level is highlighted in a report produced for Coventry City Council by Atkins in 2010 looking at opportunities presented to city by the transition to a low carbon economy[34]. This examined eight diverse sectors, including motor vehicle manufacture and transport, construction, public services and materials manufacture, and concluded that the construction sector was among those sectors offering the greatest opportunities, ranking second of the eight. Amongst the key opportunities identified were those relating to low carbon design and construction, with a specific mention being made to the use of BREEAM standards. The impacts of all opportunities identified were graded as high, medium or low, and for low carbon design and construction the impact was graded high.

Intended approach

The intended approach is to require a minimum BREEAM rating of Very Good for new development and refurbishments in Spoke / other areas of the city and Excellent in Hub areas.

The requirement to achieve a specified BREEAM rating will not apply to development not classed as Major, although all development, regardless of size will need to meet the Wat1 (water consumption) mandatory standard required for a BREEAM Good/Very Good rating (see Section 4 of this document).

Evidence

Technical feasibility

A number of the credits available in BREEAM New Construction are site or location-dependent and therefore may not be achievable on some sites. The most strongly site-dependent issues include the following:

- *Tra1: Public transport accessibility*
  The maximum number of credits available for this issue depends on the building type, varying from 2 for prisons to 5 for retail, higher education and healthcare buildings. Credits are awarded on the basis of Accessibility Index, which depends on:
    1. Distance to public transport nodes
    2. The type of public transport available
    3. The frequency of the transport services

- *Tra2: Proximity to amenities*
  This carries a maximum of 1 credit, and applies to all building types except prisons. To gain the credit a minimum number/type of amenities must be present within 500m.

[34] Atkins (2010). *Opportunities in the Low Carbon Economy. Coventry. May 2010.*

- *LE1: Site selection*
  Two credits are available for this issue, regardless of the building type, the first being awarded where the building is located on previously-developed land and the second where the site was contaminated and has been remediated by the developer.

- *LE2: Ecological value of site*
  One credit is available for this issue, regardless of the building type. To gain this credit the following criteria must be met:
  1. Land within the construction zone is defined as being of low ecological value
  2. All existing features of ecological value surrounding the construction zone and site boundary area are adequately protected from damage during clearance, site preparation and construction activities
  3. In all cases, the principal contractor is required to construct ecological protection prior to any preliminary site construction or preparation works.

- *Pol3: Surface water run-off*
  Five credits are available for this issue, regardless of the building type. It is divided into 3 parts as follows:
  1. Flood risk (2 credits available) – credits awarded where the site has is located in a zone with a low annual probability of flooding and where flood risk from all sources is low.
  2. Surface water runoff (2 credits available) – these are given when:
     - Drainage measures are specified to ensure that the peak rate of run-off from the site to watercourses (natural or municipal) is no greater for the developed site than it was for the pre-development site (1 credit), and
     - Flooding of the property will not occur in the event of local drainage system failure, and the post development run-off volume, over the development lifetime, is no greater than it would have been prior to the assessed site's development (1 credit).
  3. Minimising watercourse pollution (1 credit available) – a range of criteria to be met are specified, including that:
     - There is no discharge from the developed site for rainfall up to 5mm, and
     - SUDs or source control systems are specified where runoff drains are in areas with a low risk source of watercourse pollution

For Coventry, it is likely that where land is identified for development under the proposed 'hub and spoke' approach (see introductory section), the majority of these credits should be available, since:

- they will on the whole be close to public transport and local amenities
- because the preferred approach is to use brownfield sites the Land Use and Ecology credits will be available in most instances.

In terms of flood risk, a Level 1 Strategic Flood Risk Assessment (SFRA)[35] carried out for the Council in 2007/8, following which 19 locations were subject to Level 2 initial site

[35] Coventry City Council (2008). *Strategic Flood Risk Assessment for Local Development Framework. Level 1. Volume 1.*

assessments[36]. In the majority of cases the sites lie either entirely in Flood Zone1 or are predominantly within Zone 1 but with a small portion in a higher Flood Zone. Four sites were identified as requiring further SFRA level 2 work. They are as follows: Swanswell Regeneration area, land West of Browns Lane, land at Tile Hill and land at Lentons Lane. In addition, a Level 2 SFRA has been carried out in respect of the city centre[37]. This was based on the previous proposed Area Action Plan, which has since been withdrawn, but some of the sites included may still be relevant. Once the proposed development sites have been identified it will be necessary to use the SFRA findings in order to identify which of them are likely to be problematic in terms of achieving Pol3 credits.

However, overall, it would appear that development sites in Coventry are likely to be favourable in terms of their ability to achieve BREEAM credits, but it is acknowledged that more work needs to be done to establish BREEAM feasibility at individual sites once they have been identified. More detailed assessments will therefore be made at Site Allocations / Area Action Plan stages.

In addition to gaining an overview of the city as a whole, it is instructive to learn from the approach taken at existing sites in Coventry that either have achieved a particular BREEAM rating or at least have been assessed in detail in terms of the feasibility of them achieving a given rating. A number of case studies are presented below, showing adopted or recommended strategies in order to achieve a BREEAM Excellent rating. Case Study 1 covers the Severn Trent building in Coventry city centre, whilst Case Study 2 relates to the recently-completed Coventry University HUB building. Case Study 3 presents the results of a feasibility study carried out in 2009 by AECOM in respect of the Canley regeneration scheme[30]. Whilst the latter scheme has still to be built, it still gives a useful indicator of the technical feasibility of achieving BREEAM Excellent in one of the city's main development locations.

Case Study 1

Severn Trent Water Headquarters

Location: Coventry City Centre
Scheme assessed under: BREEAM Offices 2008
Rating achieved: Excellent
Score: 73.70%
Net useable floor area: 16,075m^2

Credits achieved

Issue	Number of credits/max available	Issue	Issue	Number of credits	Number of credits
Man1	2 / 2	Ene4	1 / 1	Mat6	1 / 2
Man2	2 / 2	Ene5	3 / 3	Mat7	1 / 1
Man3	4 / 4	Ene8	2 / 2	Wst1	4 / 4
Man4	1 / 1	Tra1	3 / 3	Wst3	1 / 1
Hea3	1 / 1	Tra2	1 / 1	Wst4	1 / 1
Hea4	1 / 1	Tra3	2 / 2	LE1	1 / 1
Hea5	1 / 1	Tra4	1 / 1	LE3	1 / 1

[36] Coventry City Council (208). *Strategic Flood Risk Assessment. Level 2. Initial Site Assessments. July 2008*
[37] Coventry City Council (2010). *Strategic Flood Risk Assessment. Level 2. Coventry City Centre. April 2010*

Issue	Number of credits/max available	Issue	Issue	Number of credits	Number of credits
Hea6	1 / 1	Tra5	1 / 1	LE4	2 / 2
Hea8	1 / 1	Tra6	1 / 2	LE5	2 / 3
Hea9	1 / 1	Wat1	2 / 3	LE6	2 / 2
Hea10	1 / 1	Wat2	1 / 1	Pol2	1 / 2
Hea11	1 / 1	Wat3	1 / 1	Pol5	3 / 3
Hea12	1 /1	Wat4	1 / 1	Pol6	1 / 1
Ene1	7 / 15	Mat1	1 / 4	Pol7	1 / 1
Ene2	1 / 1	Mat2	1 / 1	Pol8	1 / 1
Ene3	1 / 1	Mat5	2 / 3		

Note: as this scheme was assessed under an older version of BREEAM (2008),the issue references will not be the same as for BREEAM 2011 New Construction (as discussed above) in all cases

Main strategies employed to achieve credits:

- Reduction of energy demand through enhanced fabric performance, appropriate solar gain, solar shading, installation of energy efficient equipment, use of thermal mass, high efficiency cooling system, etc.
- Reduction of water use through water efficient fittings and rainwater harvesting
- Installation of biomass boiler
- Installation of roof-mounted photovoltaics
- Favourable city centre location in close proximity to transport facilities and local amenities
- Limited car parking provision

Constraints:

- Limited external space made attainment of maximum Land Use and Ecology credits very difficult
- SUDs originally specified could not be installed due to space constraints
- Depth of rooms prevented daylighting credits (Hea1), view out (Hea2) and natural ventilation (Hea7) credits being achieved

Case Study 2

Coventry University HUB Building

Location: University area, adjacent to city centre
Scheme assessed under: BREEAM Bespoke 2006
Rating achieved: Excellent (Design and Procurement stage assessment)
Score: 73.63%

Credits achieved

Issue	Number of credits/max available	Issue	Issue	Number of credits	Number of credits
Man1	2 / 2	Hea17a	1 / 1	Mat7	0 / 1
Man2	0 / 1	Hea27	1 / 1	Mat8	2 / 3
Man4	2 / 2	Ene1	9 / 15	Mat10	1 / 1
Man5	4 / 4	Ene2	1 / 1	Mat12	1 / 1

Issue	Number of credits/max available	Issue	Issue	Number of credits	Number of credits
Man8	2 / 2	Ene3	1 / 1	Mat17	0 / 1
Man12	1 / 1	Ene4	1 / 1	LE1	1 / 1
Man14	1 / 1	Tra1	4 / 5	LE2	0 / 1
Man21	1 / 2	Tra2	5 / 5	LE3	1 / 1
Man24	1 / 1	Tra3	1 / 1	LE4	1 / 1
Man25	0 / 1	Tra4	1 / 1	LE5	3 / 3
Hea1	1 / 1	Tra5	0 / 2	LE6	2 / 2
Hea2	1 / 1	Tra6	1 / 1	Pol1	0 / 1
Hea3	0.64 /1	Tra8	1 / 1	Pol2	0 / 2
Hea4	1 / 1	Tra10	1 / 1	Pol3	0 / 1
Hea5	1 / 1	Tra12	1 / 1	Pol4	1 / 1
Hea6	1 / 1	Wat1	3/ 3	Pol5	0 / 1
Hea7	1 / 1	Wat2	1 / 1	Pol6	3 / 3
Hea8	1 / 1	Wat3	1 / 1	Pol7	2 / 3
Hea9	0 / 1	Wat4	1 / 1	Pol8	1 / 1
Hea10	1 / 1	Wat5	1 / 1	Pol11	2 / 3
Hea11	1 / 1	Wat6	0 / 1	Pol12	1 / 1
Hea14	1 / 1	Mat1	3 / 7	Pol13	1 / 1
Hea15	0 / 1	Mat2	1 / 1	Pol14	0 / 1
Hea16	1 / 1	Mat5	0 / 1		
Hea17	1 / 1	Mat6	0 / 1		

Note: as this scheme was assessed under an older version of BREEAM (2006),the issue references will not be the same as for BREEAM 2011 New Construction (as discussed above) in all cases

Main strategies employed to achieve credits:

- Reduction of energy demand through enhanced fabric performance, use of natural daylight, efficient lighting, etc.
- Reduction of water use through water efficient fittings and rainwater harvesting tank
- Use of ground source cooling
- Incorporation of green roof into building structure
- Favourable location adjacent to city centre and in close proximity to transport facilities and local amenities
- Use of site which predominantly previously developed and of low ecological value

Constraints:

- Credit relating to indoor ambient noise levels (Hea17) not achievable due to building use
- Tra 5 (cyclist facilities) credits not sought due to requirement for all stands to be covered
- Composting credit (Mat17) not sought due to fact that local authority planning an organic waste collection in near future
- Credits relating to refrigerants expensive to achieve and therefore not sought

Case Study 3

Canley Estate Regeneration Scheme Community Hub (Not yet assessed)

Location: Canley

Scheme feasibility assessed against: BREEAM Healthcare 2008

Target rating: Excellent

Target score: 72.54%

Credits achieved

Issue	Number of credits/max available	Issue	Issue	Number of credits	Number of credits
Man1	2 / 2	Hea12	1 /1	Wat3	1 / 1
Man2	2 / 2	Hea13	2 / 2	Wat4	1 / 1
Man3	4 / 4	Hea15	1 / 1	Wat6	1 / 1
Man4	1 / 1	Hea19	1 / 1	Mat1	3 / 6
Man6	2 / 2	Ene1	6 / 15	Mat2	1 / 1
Man7	2 / 2	Ene2	2 / 2	Mat5	2 / 3
Man8	1 / 2	Ene3	1 / 1	Mat6	1 / 2
Man11	1 / 1	Ene4	1 / 1	Mat7	1 / 1
Man12	1 / 2	Ene5	2 / 3	Wst1	3 / 4
Man13	1 / 1	Ene8	2 / 2	Wst2	1 / 1
Hea1	2 / 2	Ene15	1 / 1	Wst3	1 / 1
Hea2	2 / 2	Tra1	1 / 5	Wst4	1 / 1
Hea3	1 / 1	Tra2	0 / 1	Wst5	1 / 1
Hea4	1 / 1	Tra3	2 / 2	LE4	2 / 2
Hea5	1 / 1	Tra4	1 / 1	LE5	2 / 3
Hea6	1 / 1	Tra5	1 / 1	LE6	2 / 2
Hea7	1 / 1	Tra6	1 / 1	Pol2	2 / 2
Hea8	1 / 1	Tra7	1 / 1	Pol5	3 / 3
Hea9	1 / 1	Tra8	1 / 1	Pol6	1 / 1
Hea10	1 / 1	Wat1	2 / 3	Pol7	1 / 1
Hea11	1 / 1	Wat2	1 / 1	Pol8	1 / 1

Note: as this scheme was assessed under an older version of BREEAM (2008),the issue references will not be the same as for BREEAM 2011 New Construction (as discussed above) in all cases

Main strategies employed to achieve credits:

- All available management (Man) credits except 2nd life cycle costing credit targeted
- All available health and wellbeing (Hea) credits targeted
- Mandatory minimum number of credits only for Ene1 (reduction in CO_2 emissions)
- All other available energy (Ene) credits targeted, except Ene16 (community CHP)
- Most of site in Flood Zone 1 therefore Pol5 (flood risk) credits straightforward to achieve

Constraints:

- Limited access to local transport and amenities would reduce number of credits achievable for Tra1 (provision of public transport) and Tra (proximity to amenities)
- Site defined as greenfield space therefore some of Land Use and Ecology credits difficult (not possible?) to achieve

Cost implications

There exists very little published data on extra-over costs associated with achieving BREEAM ratings. This is in part because of the range of building types covered by the standard, and also because, even among buildings of the same type, designs can vary hugely, making comparisons difficult. However, a report produced by the Building Research Establishment and the consultancy Cyril Sweett in 2005, entitled 'Putting a Price on Sustainability'[38] assessed the costs incurred in achieving BREEAM ratings for 3 building types, as follows:

- Naturally ventilated office
- Air-conditioned office
- PFI healthcare centre.

The study looked at the impact of location on overall costs, based on the ability of a building to attain certain location-specific credits relating to:

- Location of public transport
- Proximity to local amenities
- Existing ecological value of the land.

Sites at which no location-specific credits could be attained were classified as 'Poor', those where some, but not all, location-specific credits could be attained were classified as 'Typical', whilst those sites at which all of the location-specific credits could be attained were classified as 'Good'.

Some of the key results of this study are summarised in table 3.2.4.

Table 3.2.4 Increase in capital costs to achieve different BREEAM ratings in different locations for a number of building types

Building type	Location	BREEAM score & rating for the base case	% increase in capital cost to achieve rating above base case			
			Pass	Good	Very Good	Excellent
Naturally ventilated office	Poor	25.4 (Pass)	-0.4	-0.3	2.0	-
	Typical	39.7 (Pass)	-	-0.4	-0.3	3.4
	Good	42.2 (Good)	-	-	-0.4	2.5
Air-conditioned office	Poor	20.3 (Unclassified)	0	0.2	5.7	-
	Typical	34.6 (Pass)	-	0	0.2	7.0
	Good	37.1 (Pass)	-	0	0.1	3.3
PFI health centre	Typical	44.3 (Good)	-	-	0	1.9
	Good	48.4 (Good)	-	-	0	0.6

[38] BRE and Cyril Sweett (2005). *Putting a Price on Sustainability*. Watford: BRE

Another study, published by Target Zero in 2010[39], looked at cost uplift associated with constructing a school building to BREEAM Very Good, Excellent and Outstanding standards (BREEAM Education (2008) scheme), comparing modelled costs associated with a case study school (Knowsley School on Merseyside - 900 pupils, 50 staff, and a gross internal floor area of 9,637m^2) with costs modelled according to various scenarios, including:

- Two site-related scenarios – urban and suburban (greenfield), representing the best and worst cases in terms of the likely site conditions
- Two scenarios relating to the approach to early design decisions: poor approach and best approach.

The results are summarised in table 3.13.

Table 3.13: Cost uplift associated with specified BREEAM ratings under various scenarios

Scenario	BREEAM Rating		
	Very Good	Excellent	Outstanding
Case study (Knowsley School)	0.22%	0.71%	5.82%
Urban location	0.22%	0.48%	5.6%
Greenfield location	0.22%	0.8%	7.18%
Poor design approach	0.2%	1.1%	10.6%
Best design approach	0.03%	0.3%	2.9%

The results show that:

a) Even in unfavourable locations, a rating of Excellent can be achieved at minimal cost uplift

b) Where a poor approach to design has been taken, the cost uplift is significantly higher than where the best possible design approach is taken

c) The higher the required rating the more important a favourable location and a good approach to design become.

This is one of a series of studies produced by Target Zero with the aim of estimating BREEAM uplift costs for a range of steel-framed buildings. The other studies cover the following types of development:

- Warehouse[40]
- Supermarket[41]
- Office[42]
- Mixed use[43].

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[39] Target Zero (2010). *Guidance on the Design and Construction of Sustainable, Low Carbon School Buildings. Report V1.0 February 2010.*

[40] Target Zero (2011). *Guidance on the Design and Construction of Sustainable, Low Carbon Warehouse Buildings. Report V2.0 June 2011*

[41] Target Zero (2011). *Guidance on the Design and Construction of Sustainable, Low Carbon Supermarket Buildings. Report V2.0 June 2011*

[42] Target Zero (2011). *Guidance on the Design and Construction of Sustainable, Low Carbon Office Buildings. Report V1.0 July 2011*

In each case a real-life (non-BREEAM) building was used as a case study and the additional costs which would be incurred to achieve BREEAM ratings were modelled. The results are summarised in table 3.14.

Table 3.14: Cost uplift for specified BREEAM ratings for various building types

Building type	BREEAM Rating		
	Very Good	Excellent	Outstanding
Warehouse (DC3 distribution warehouse, Stoke)	0.22%	0.71%	5.82%
Supermarket (Asda food store, Stockton-on-Tees)	0.24%	1.76%	10.1%
Office (One Kingdom Street, London)	0.17%	0.77%	9.83%
Mixed use (Holiday Inn, Media City, Manchester)	0.14%	1.58%	4.96%

Limited information is available about extra-over costs incurred by local developments to achieve a given BREEAM rating. However, Severn Trent Water quotes a build cost of £1241/m^2 for their new headquarters, compared to a standard build cost of £1303/m^2, i.e. a 4.8% reduction[44].

[43] Target Zero (2011). *Guidance on the Design and Construction of Sustainable, Mixed Use Buildings. Report V1.0 September 2011*
[44] Severn Trent Water (2010). *The Severn Trent Centre Coventry.*

4. Water efficiency

Background

In a joint statement issued in 2007[45], the Departments of Communities and Local Government and Environment and Rural Affairs, acknowledge the importance of conserving water resources. They say:

> *'Water is a precious and increasingly scarce resource. The drought of 2004-6 across much of England raised the profile of water supply and demand issues and raised awareness of the vulnerability of water resources to prolonged dry spells. Despite the severe flooding we have seen recently in parts of England, the case for improving water efficiency remains compelling'*

Furthermore, 2010 saw the driest first seven months to a year since 1929. Severn Trent Water issued communications requesting customers to conserve water, and a hosepipe ban was narrowly avoided. More recently still, having already declared a number of drought zones in the south and east of the country, in April 2012 the Environment Agency confirmed a further 17 drought zones, encompassing much of the South West and Midlands, and including Warwickshire and the West Midlands. The decision to declare a drought was taken after the driest year on record in 2011, a second winter of below-average rainfall and only just over 40% of expected rainfall in February and March. This has led to low groundwater levels and exceptionally low river levels across the region, and it is predicted to take months of sustained rainfall to replenish supplies.

Results of climate change modelling indicate that droughts will occur more often in the future. Also, an increased frequency of high intensity rainfall events will mean that rainfall, when it does occur, is less likely to replenish underground water resources as rainwater under these circumstances makes its way rapidly into the surface water drainage system (and thence into watercourses, often causing flooding) and rather than seeping into the ground.

Against this backdrop, average household demand as increased by approximately 55% over the last 25 years and is currently increasing at a rate of 1% per annum. The per capita consumption in England and Wales was around 150L/head/day in 2005/6, an increase in 10L/head/day since 1992/3. For the areas covered by Severn Trent Water, which includes Coventry, the current figure is 128L/head/day[46]. The growth in consumption can be explained primarily in terms of an increase the number and types of water-consuming appliances, such as dishwashers and power showers. Another important factor is demographic change, resulting not only in a greater overall number of households, but a larger number of single person households. This important in this context because the water per person use of a single person household is typically some 40% higher than that of a two person household.

The Water Act 2003 gives the Environment Agency overall responsibility for ensuring the proper and efficient use of water resources. In 2007 Defra asked the Environment Agency to advise the Secretary of State on which areas of the country are considered to be seriously

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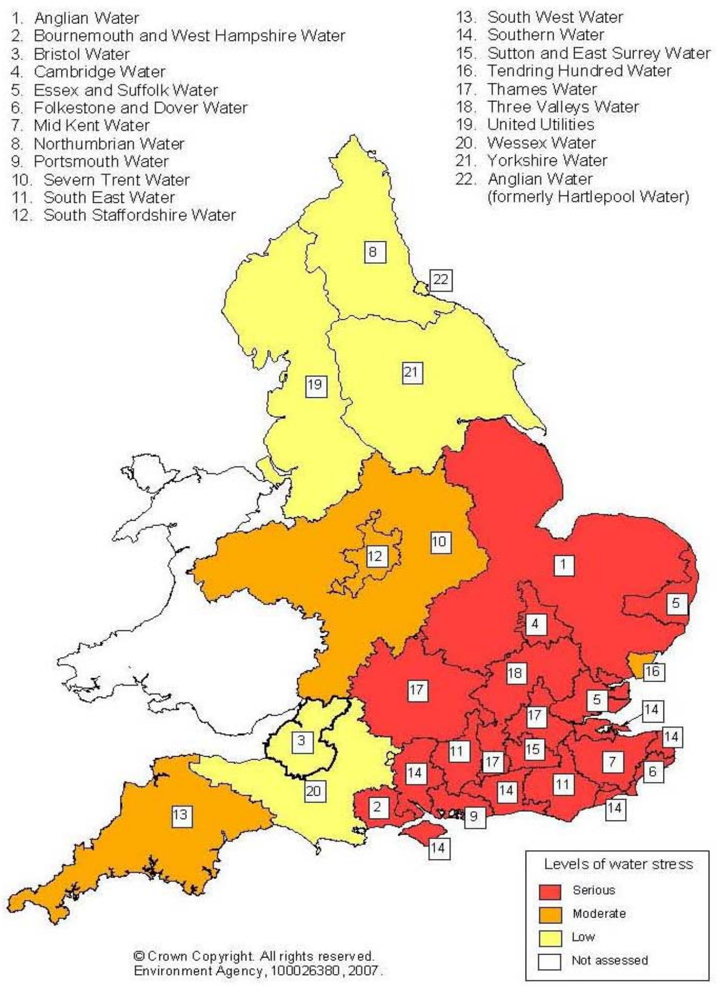
[45] Communities & Local Government and Defra (2007). *Water Efficiency in New Buildings: A Joint Defra and Communities and Local Government Policy Statement.* London: CLG/Defra
[46] Pers comm

water stressed and as a result the Agency came up with a methodology for carrying out an assessment, using the following criteria[47]:

- Current per capita demand for water
- Forecast growth in per capita demand for water
- Forecast population growth
- Current water resource availability
- Forecast resource availability.

The area served by each company was scored according to these criteria and then given an overall classification of either 'Serious', 'Moderate' or 'Low' . The results are shown in figure 4.1. As can be seen from the map, the most seriously stressed areas are in the south and east of the country, but Severn Trent's area received a 'Moderate' classification.

Figure 4.1: Map of areas of relative water stress



In the report, the Agency says:

[47] Environment Agency (2007). Areas of water stress: final classification. Bristol: Environment Agency

'In designating areas as water stressed, we have taken into account that water is a scarce resource across England. We believe that even in those areas designated as 'low' water stress, there should be some activity to ensure that water is used more efficiently. Water companies and water users cannot disregard the environmental consequences of their abstractions and energy use'.

Under the Water Act 2003 water companies are required to prepare a Water Resources Management Plan giving details of the current and predicted future supply-demand balance together with their plans for how demand will be met. The current Plan covering Coventry was published by Severn Trent Water in June 2010[48]. Assessment of water supply and demand balance is based on long term projections of:

- Housing and population growth
- Changes in water use
- Risks to existing water resources and supply capabilities
- Future performance of asset base.

A summary of the predicted impact of these factors to 2035 to be addressed by the plan is shown in table 4.2.

Table 4.2: Impact of factors affecting supply and demand in the Severn Trent area to 2035 to be addressed by Water Resources Management Plan

Demand	
Household	+99ML/d
Non-household	-79ML/d
Leakage deterioration*	+275ML/d
Net change in demand	+295ML/d
Supply	
Change in available supply due to deteriorating water quality	-31ML/d
Restoration of sustainable abstraction	-1ML/d
Climate change impacts	-154ML/d
Net change in available supply	-186ML/d

** Risk in leakage that would result if mains renewed only to maintain serviceability*

The increase in household demand is based on a projected growth of 767,000 households across Severn Trent's area by 2035, but coupled with a per capita consumption reduction of 3.6 litres / head /day. In terms of the impacts of climate change, the Environment Agency's

[48] Severn Trent Water (2010). *Water Resources Management Plan. Final Version June 2010.*

recommended rainfall – runoff modelling approach was used. Four scenarios were modelled, as follows:

- Baseline 'no impact' flows
- Dry climate change scenario
- Mid-range climate change scenario
- Wet climate change scenario.

The mid-range scenario was used in the central estimate forecast of deployable output, and the wet and dry scenarios in the headroom assessment. Of the six water resource zones comprising Severn Trent's area, the Severn Water Resource Zone (WRZ), of which Coventry forms a part, will be affected to the greatest extent, seeing a predicted reduction of available supply of over 66ML/day.

Severn Trent's strategy to ensure that future demands can be met can be summarised as follows:

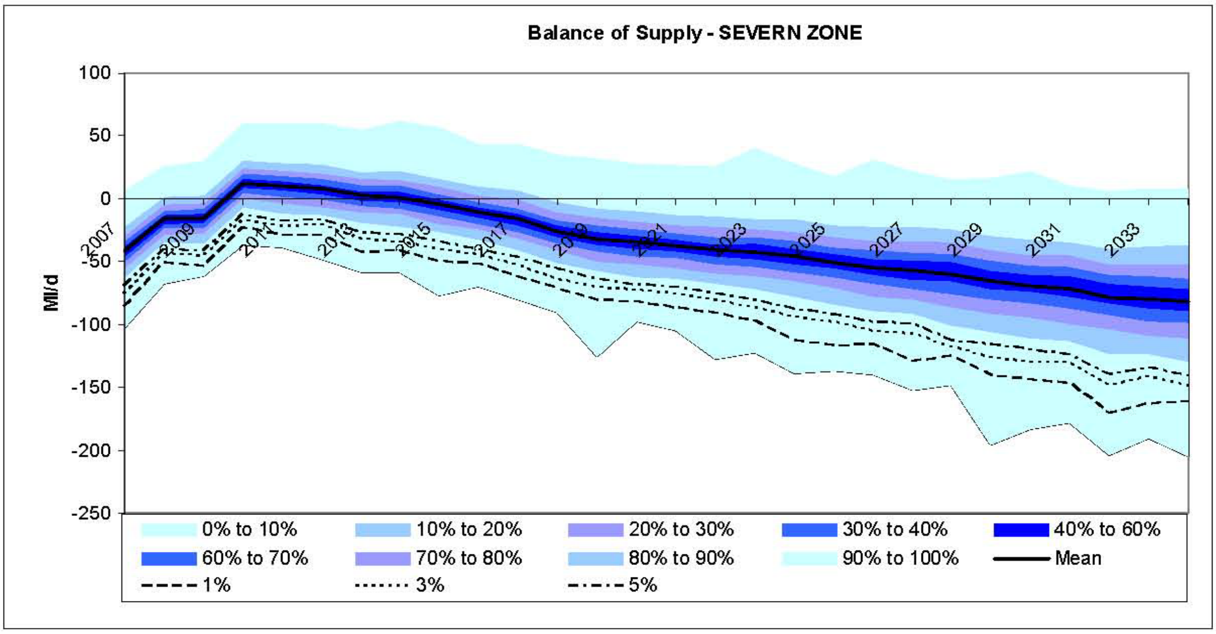
- Reduce demand through driving down leakage and setting leakage targets of 453ML/d by 2015 and 409ML/d by 2035. Leakage reduction will be achieved through more active leakage control and pressure management
- Reduce demand by accelerating the rate of household metering through promotion of free metering and by a targeted policy of metering on change of occupier
- Reduce demand by increasing water efficiency activities, with a target of achieving efficiency savings of 16ML/d by 2015
- Duplicate a section of the Derwent Valley Aqueduct in order to improve resilience within the East Midlands and Severn zones
- Construct new aquifer storage and recovery schemes
- Provide new groundwater sources in Birmingham and Shropshire
- Prevent the loss of deployable output due to deterioration of water quality through a nitrate treatment and blending strategy

The previous plan, published in 2004[49], identified likely shortfalls in future supply affecting the Severn WRZ. As a result, a strategy was developed to increase supply capacity to the required level, i.e. to achieve a supply / demand balance at the 80% confidence level, by 2010. Whilst good progress has been made with respect to some of the identified actions, such as leakage reduction, increase in metering, implementation of water conservation measures and the installation of granular activated carbon technology at the Frankley water treatment works, as a result of problems encountered with a proposed new water treatment works at Ombersley on the River Severn, there is a continued supply-demand risk within the Severn WRZ. According to Severn Trent's assessment, the baseline supply-demand balance for the Severn WRZ was due to become negative in 2010-11, and remain negative thereafter. Without intervention, the supply shortfall is predicted to increase to 100ML/d by 2020 and

[49] Severn Trent Water (2004). *Water Resources Management Plan.*

145ML/d by 2035. This is illustrated in figure 4.3. (Note that for the period up to 2020 the 80th percentile confidence level is used, whereas for the 2035 horizon the 50th percentile confidence level is deemed to be more appropriate.)

Figure 4.3: Baseline supply – demand balance projection for Severn WRZ

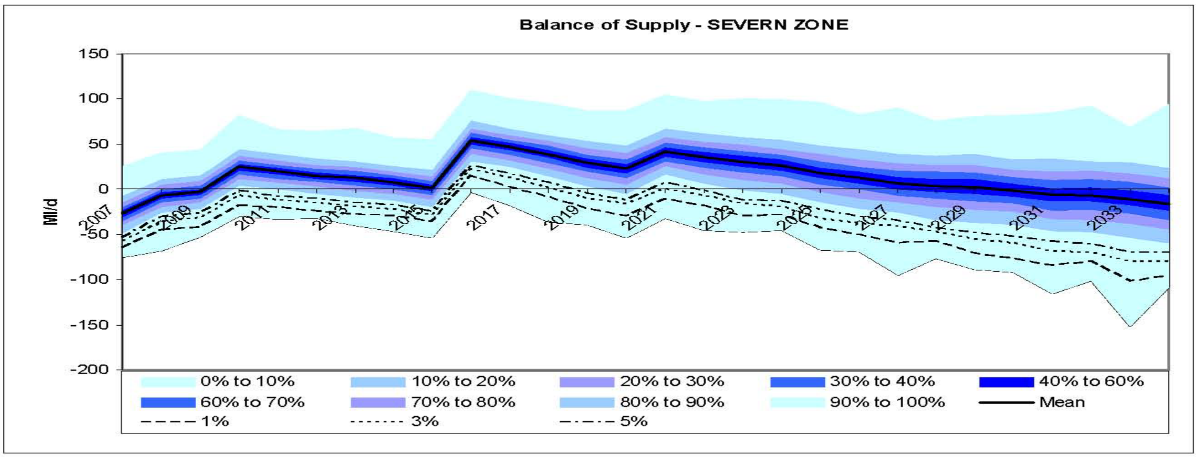


A strategy has been devised, covering both the Severn and Birmingham WRZs, to address this shortfall, as follows:

- Maximise the use of existing resources by increasing strategic distribution links
- Use aquifer storage and recovery to utilise spare resource and treatment capacity during times of low demand
- Provide a small amount of groundwater source development
- Significantly reduce leakage
- Carry out measures to help customers become more water efficient.

The impact of these measures is shown on figure 4.4.

Figure 4.4: Impact of supply / demand strategy for Severn and Birmingham WRZs – balance of supply for Severn WRZ



In 2009 the Warwickshire local planning authorities commissioned a joint water cycle study[50]. This not only looked at Warwickshire's water resources, primarily using the Severn Trent Water Resources Management Plan, but also assessed flood risk and approaches to surface water management. Although Coventry City Council did not participate in this study, some of the findings are relevant, particularly since most of the study area lies within the Severn WRZ, i.e. the same zone as Coventry. One of the key recommendations relates to the Code for Sustainable Homes, as follows:

> *'Due to the current and predicted supply-demand deficit within the study area, the local planning authorities should implement planning policies to ensure the efficient use of water in both the new and existing housing stock. It is recommended that all new development is built at CSH level 3 / 4* [i.e.105 L/head/d] *for water as a minimum, although achieving CSH level 5 / 6 should be considered as an aspiration of the partner authorities'.*

Finally, DEFRA, the Welsh Assembly Government and the Environment Agency have produced a river basin management plan for the River Severn basin[51]. This examines some of the pressures affecting the water environment, including abstraction and other artificial flow regulation and the consequent ability to maintain water resources at the required level. One of the key actions identified is the inclusion of strong water efficiency policies in local development frameworks.

Water efficiency is also important in the Coventry context because of the high number of low income households, as outlined in section 1. Installing water efficiency measures to meet CSH level 3 / 4 minimum requirement will result in a saving of 20L/head/day when compared with a Part G-compliant dwelling. If an occupancy rate of 2.4 is assumed the reduction in consumption will be 48L/dwelling/day, and applying a cost of 3p/L will result in typical annual cost savings of approximately £52 for householders. This figure is conservative, as it does not

[50] Halcrow (2010). *Warwickshire sub-regional water cycle study. March 2010.*
[51] DEFRA, Welsh Assembly Government and Environment Agency (2009). *Water for life and livelihoods. River Basin Management Plan Severn River Basin District.* Bristol: Environment Agency

account for the fact that some of the water saved will be hot water and there will therefore also be fuel savings in addition.

Intended approach

The intended approach of the Council is to adopt backstop water consumption standards over and above current Building Regulations Part G requirements (125L/head/day for dwellings), in line with the Code for Sustainable Homes and BREEAM.

For dwellings: a maximum permitted design internal water consumption of 105L/head/day – in line with the Code for Sustainable Homes Levels 3 and 4 requirements – will apply. In cases where a higher level of the Code is stipulated then the higher Code requirement will take precedence.

For non-domestic buildings: the water efficiency standards required to achieve a 'Good' or 'Very Good' rating under the applicable BREEAM scheme will apply. In cases where a higher level of BREEAM is stipulated, the higher level requirement will take precedence.

Evidence

Technical feasibility

The technical feasibility of this approach is covered in Sections 3 above, and the evidence demonstrates that there are no particular technical constraints associated with it.

Cost implications

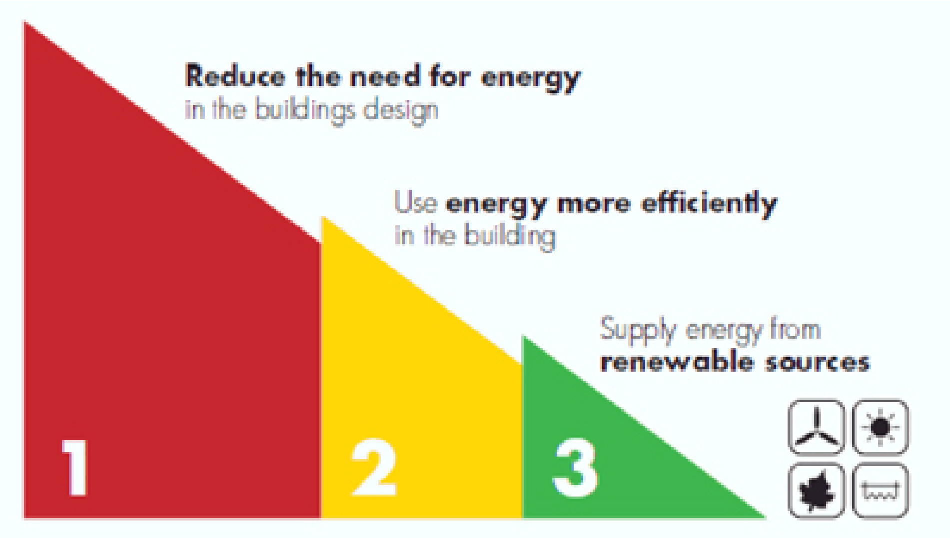
The evidence presented in Section 3 shows that, in the case of dwellings, the proposed levels of water efficiency can be achieved at minimal costs. As shown in table 3.1.9, a design domestic water consumption of 105L/head/day can be achieved at an extra-over cost of £150-200 per property, depending on building type. These costs are likely to reduce with time, as market penetration of water efficiency measures increases.

5. Building energy efficiency / zero and low carbon energy

Background

The 'energy hierarchy' approach to reducing energy use and CO_2 emissions – illustrated below in figure 5.1 - requires that demand reduction and energy efficiency is maximised before the use of zero and low carbon energy sources is considered.

Figure 5.1: Energy hierarchy



Potential demand reduction / energy efficiency measures include:

- Improved insulation and air tightness
- Use of thermal mass
- Use of daylighting and solar gains
- Provision of solar shading
- Provision of mechanical ventilation with heat recovery
- Use of energy efficient plant, lighting and appliances.

Low and zero carbon technologies include:

- Wind turbines
- Solar photovoltaics
- Solar thermal systems
- Hydro turbines
- Biomass heat
- Biomass combined heat and power
- Ground source heat pumps
- Air source heat pumps
- Fossil-fuel powered combined heat and power.

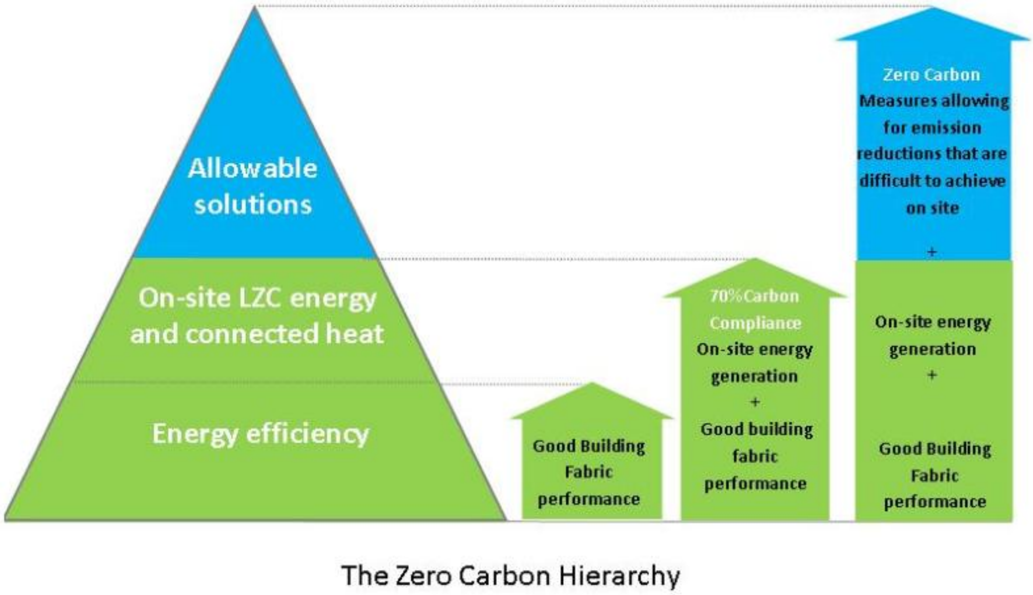
Demand reduction and energy efficiency measures should always be implemented ahead of low and zero carbon technologies because these measures will help secure energy and carbon savings over the lifetime of the building, and do not rely on the investment and behavioural choices of occupants. Demand reduction measures that are part of the fabric of the home should have a considerably longer lifetime than energy supply technologies and are less vulnerable to the risk of occupants not using them or removing them altogether.

This approach is being increasingly incorporated into Building Regulations. As discussed in section 2, from 2016 all new dwellings are required to be zero carbon. This will be achieved by a combination of:

- Setting a minimum fabric energy efficiency standard (covers passive demand reduction measures only);
- Reducing CO_2 emissions on site through fabric energy efficiency measures, performance of heating, cooling and lighting systems, and low and zero carbon technologies;
- Mitigating the remaining carbon emissions through Allowable Solutions, which generate further carbon savings either on or off-site.

This approach is illustrated in figure 5.2.

Figure 5.2: Approach to zero carbon



Source: Zero Carbon Hub (2009)

(Note: the carbon compliance level is no longer set at 70%, and will vary according to building type. See below for further details)

The proposed minimum energy efficiency standard varies according to housing type, as follows:

- 39kWh/m^2/yr for apartment blocks and mid terrace houses
- 46kWh/m^2/yr for semi-detached, detached and end of terrace houses[52].

The fabric energy efficiency standard and on-site CO_2 emissions reduction are together referred to as Carbon Compliance, defined in terms of kilograms of carbon dioxide emitted per

[52] Zero Carbon Hub (2009). *Defining a Fabric Energy Efficiency Standard for Zero Carbon Homes. Task Group Recommendations November 2009*

square meter per annum. Again, following feasibility work carried out by the Zero Carbon Task Force, proposed compliance levels will be dependent on dwelling type, as follows:

- 10 $kgCO_2/m^2$/year for detached houses
- 11 $kgCO_2/m^2$/year for attached houses
- 14 $kgCO_2/m^2$/year for low rise apartment blocks (four storeys and below)[53].

The limit for high rise apartment block has not yet been established.

These limits refer to built performance rather than design standards, as is the case with current Building Regulations, so the recommendations cannot be directly compared with current standards. However, to give an indication, in addition to any potential carbon savings achieved by moving from designed to built performance, the percentage improvements compared to the 2006 standards would be:

- 60% for detached houses
- 45% for attached houses
- 44% for low rise apartment blocks.

The final element of zero carbon, Allowable Solutions, is the subject of a recent report by the Zero Carbon Hub[54], produced at the invitation of the Minister for Communities and Local Government. The concept of Allowable Solutions involves the developer making a payment to an Allowable Solutions provider, who will take the responsibility and liability for ensuring that Allowable Solutions, which may be small, medium or large scale carbon-saving projects, deliver the required emissions reductions.

The key parts of the framework proposal presented in the report are:

1. Local planning authorities will have the option to develop a policy on Allowable Solutions and set up a Community Energy Fund, which gives responsibility to the local authority to develop a list of Allowable Solutions projects and then deliver carbon savings from this list of projects;
2. In areas where the relevant local authority has set up a Community Energy Fund, housing developers will be able to seek out best value for Allowable Solutions, having the choice either to pay into the Community Energy Fund or enter into a private contract with a third party Allowable Solutions provider
3. In areas where the relevant local authority has not set up Community Energy Fund, the developer contracts with a Private Energy Fund in order to deliver the required carbon savings through Allowable Solutions
4. A verification and certification scheme to show that an investment will achieve the required carbon emissions reductions. The scheme will monitor Allowable Solutions delivery and release credits, certificates and funds to facilitate Allowable Solutions project development and Building Regulations approval;

[53] Zero Carbon Hub (2011). *Setting an Appropriate Limit for Zero Carbon New Homes. Findings and Recommendations February 2011*.
[54] Zero Carbon Hub (2011). *Allowable Solutions for Tomorrow's New Homes. Towards a Workable Framework. July 2011*

5. A single Allowable Solutions Fund Holding to provide a secure 'Bank' for the Allowable Solutions investment flow.

For local planning authorities the framework provides the opportunity to steer the selection of local Allowable Solutions projects towards those that maximise benefits to local communities and constituents. Additionally there is the option of developing a Community Energy Fund which may provide a stimulus for local investment in carbon saving projects. This will further increase the opportunities for development of more significant local schemes, such as decentralised energy networks. However, to take this opportunity local planning authorities will need to develop policies related to Allowable Solutions, which is recognised as a major commitment.

Intended approach

As the evidence presented below demonstrates, the best opportunities for Coventry in terms of low and zero carbon energy are district heat networks, combined heat and power and microgeneration. Therefore it is essential that planning policy supports these approaches, whilst at the same time recognising the fact that carbon reduction requirements are increasingly falling under the scope of Building Regulations.

The proposed approach, therefore, consists of the following:

- development of policies which support the installation of standalone and building-scale zero and low carbon energy technologies;
- development of policies encouraging / requiring:
    - connection to decentralised energy networks where they exist
    - future proofing of new development where it is likely that decentralised energy networks will be developed at a future date
    - creation of new networks to serve new developments where appropriate
- enabling the future use of Allowable Solutions to further stimulate investment in low and zero carbon energy within the city
- exploring possibilities for use of the Community Infrastructure Levy to finance decentralised heat networks.

As the Core Strategy is unlikely to be adopted until 2013, when the next round of Part L of the Building Regulations is due to come into force, it is considered that a policy requiring carbon reductions over and above Building Regulations requirements is not justifiable in the Coventry context. However, it is recommended that provision be made within the Core Strategy to allow options for higher carbon reductions to be explored at Site Allocations stage and / or within Area Action Plans.

Evidence
A number of studies covering Coventry have been carried out. These are described below.

Renewable energy capacity study for the West Midlands[55]
The aim of this study was to assess, using DECC methodology, the potential accessible renewable energy resources for the West Midlands region at 2030. The total estimated resource is 54.3GW, the majority of which is wind power (71%). The other significant resource is microgeneration (solar thermal, solar PV, ground source heat and air source heat), which comprises 25% of the total. The remainder is made up of biomass (3%) and hydropower (less than 1%).

The results are also presented at local authority level. For Coventry, a capacity of 681MW (1.3% of the total for the region) was identified. The breakdown of the according to energy type is shown in table 5.3.

Table 5.3: Identified renewable energy capacity for Coventry

Type	Capacity (MW)	% of Regional total
Large-scale wind	6	<0.2%
Small-scale wind	0	0
Hydropower	0	0
Microgeneration		
• Solar photovoltaics	60	4.4%
• Solar thermal	52	4.5%
• Ground source heat	107	4.8%
• Air source heat	429	4.8%
Biomass (heat)	5	0.4%
Biomass (electricity)	26	2.5%
Total (heat + electricity)	**681**	**1.3%**
Total (electricity)	**91**	**0.2%**
Total (heat)	**593**	**4.4%**

Notes :
a) Where totals don't add up correctly this is a result of rounding errors.
b) These figures represent potential, although not necessarily deployable, resource. The DECC methodology consists of 7 stages, as follows:
    1. Identification of naturally available resource
    2. Identification of technically available resource
    3. Mapping of physical environmental constraints of high priority
    4. Mapping of planning and regulatory constrains
    5. Identification of economically viable potential
    6. Identification of deployment constraints (supply chain)
    7. Target-setting (regional ambition).

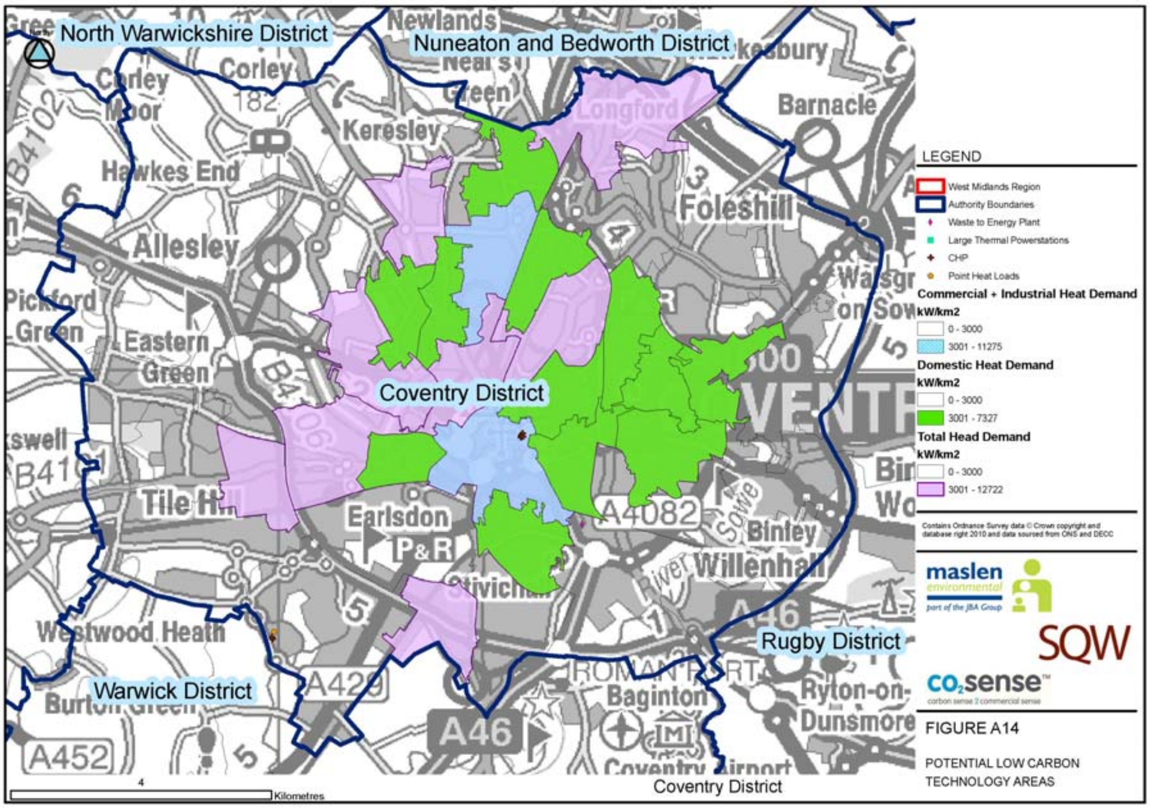
   The study covered only the first 4 of these.
c) In the case of air source heat pumps, the capacity drops from 429MW to 96MW when existing on-grid residential properties are excluded.

[55] SQW (2011). *Renewable Energy Capacity Study for the West Midlands. A Final Report to Telford and Wrekin Council March 2011*

d) The data assume development rates in line with the West Midlands Regional Spatial Strategy.

The study also looked at low carbon energy potential (i.e. possible use of combined heat and power or trigeneration, and district heating). Unlike most renewable energy types which are assessed in terms of available supply, the potential for the use of low carbon technologies is a function of heat density, defined as the annual heat demand within a given area divided by the number of hours in a year, then further divided by the area in square kilometres. Urban areas will usually have a higher heat density than non-urban areas and hence are likely to be more suitable for the deployment of low carbon technologies. Using a strategic heat map for the West Midlands specifically created for the study (based on Middle Level Super Output Area gas consumption statistics) and applying a heat density threshold of 3000kW/km^2 (as recommended by the DECC methodology) it was estimated that currently approximately 15,559 GWh/year (equivalent to a load of 1.8GW) of energy demand could be met through the deployment of low carbon technologies. In the case of Coventry, the figure is 1,315 GWh/year, or 9% of the West Midlands total. Figure 5.4 shows the areas of the city (marked in green, purple and blue) which are potentially suitable for low carbon energy deployment. The areas marked in blue are deemed to be suitable on the basis of the commercial and industrial heat density in these areas, those marked in green are deemed to be suitable on the basis of domestic head demand density, whilst those marked in blue are deemed to be suitable on the basis of total heat demand density.

Figure 5.4: Potential low carbon technology areas within Coventry



Advantage West Midlands Heat Mapping and Decentralised Energy Feasibility Study
This study shows the potential for combined heat and power networks in the West Midlands region. It maps domestic and non-domestic heat and electricity demand by super output areas (LSOA) and models a series of scenarios in order to identify the best options for supporting CHP.

The key findings and opportunities are as follows:

- The main opportunities for CHP are in the domestic, public and commercial sectors, principally in flats, hospitals, offices and retail premises
- There is the potential to treble uptake in the region in the public and commercial sector, yielding over 500 GWh/year of additional heat supply, saving over 57,000 tonnes of CO2 per year and driving an additional £143M of capital investment
- Awareness raising alone in the public and commercial sector would increase uptake by 28%, yielding an additional heat supply of almost 50 GWh/year (saving 5,7000 tonnes of CO2 and requiring £14M of capital investment)
- Industry in the region (mainly chemicals , food and drink, and pulp and paper) could double its uptake of CHP, yielding 10000 GWh/year additional heat.

These opportunities could best be realised by:

- Providing support for targeted awareness-raising, information provision and demonstrations
- Agreeing mechanisms to address ownership and occupancy issues in flats and other shared premises
- Providing grant support to a level of approximately £30/tonne of CO_2 saved
- Undertaking site level scoping studies for applications for CHP and district heating, targeting the domestic, health, public administration and retail sectors, and for combined heat and power in the food and drink, pulp and paper, metal casting, large engineering and textiles industries.

Coventry was identified in the report as one of the areas of the region most suitable for the installation of additional CHP capacity, although data relating to potential yield and carbon saving data specific to Coventry are not given in the document.

Coventry City Council Low Carbon Energy Study
In 2009 /10 Coventry City Council, together with Coventry and Warwick Universities, Advantage West Midlands and The Carbon Trust, commissioned a study to determine the strategic actions required to deliver a district heating network in Coventry, based on using surplus heat from the city's energy from waste plant. The study was carried out in two phases.

Phase 1 [56] looked at a range of new development sites across the city and their potential for low carbon district heating. These sites were selected according to its heat density, proximity to the energy from waste plant and various other factors. Each location was scored on a scale of 0 to 5 under two categories: its planning status, higher scores being awarded for sites in the early stages of the planning process; and, the degree of influence of stakeholders, with the greater level of influence, the higher the score given. The sites included in the study and the

[56] AECOM (2009). *Coventry City Council Low Carbon Energy Study – End of Phase 1 Report*

scores achieved are shown in table 5.5, whilst figure 5.6 maps residential heat demand for the city and shows the location of the development sites considered by the study, together with potential anchor loads for the scheme, this map having been produced using the outputs from the AWM heat mapping study described above.

Table 5.5: results of phase 1 of Low Carbon Energy Study

Ref	Development Name	Mix	Key Stakeholders	Planning Stage	Stakeholder Influence	Total Score
A	Canley	Resi	WARWICK, Whitefriars Housing Group	3	4	7
B	University of Warwick	Non resi	WARWICK	5	5	10
C	Swanswell	Mixed		4	4	8
D	Friargate	Non resi	CANNON KIRK	3	4	7
F,G	Coventry University	Non resi		5	5	10
H	Humber Rd Site /Stoke Aldermore	Resi		3	1	4
I	Whitley Business Park	Non resi	ST.MODWEN	3	2	5
J	WEHM/ NDC area	Resi		3	5	8
K	Ansty	Non resi		1	4	5
L	Ryton	Non resi		3	2	5
M	Coventry City Centre	Non resi	*Precinct land owners	4	5	9
N	UoC Tec Park (London Road Gateway)	Non resi		5	4	9
	Coventry Airport and Middlemarch			0	0	0
	EfW plant			5	5	10

Coventry City Council
Warwick University
Whitefriars Housing group
Advantage West Midlands
ST.MODWEN
BKW
Bovis, Keepmoat & Westbury homes
New Deal for Communities
Project Transform
Homes and Communities Agency
CANNON KIRK

Not submitted for outline planning
Submitted- in determination
Has outline planning permission
Complete / no influence

* Precinct land owners: Aviva, Explore, Royal London Asset Management,Ciref

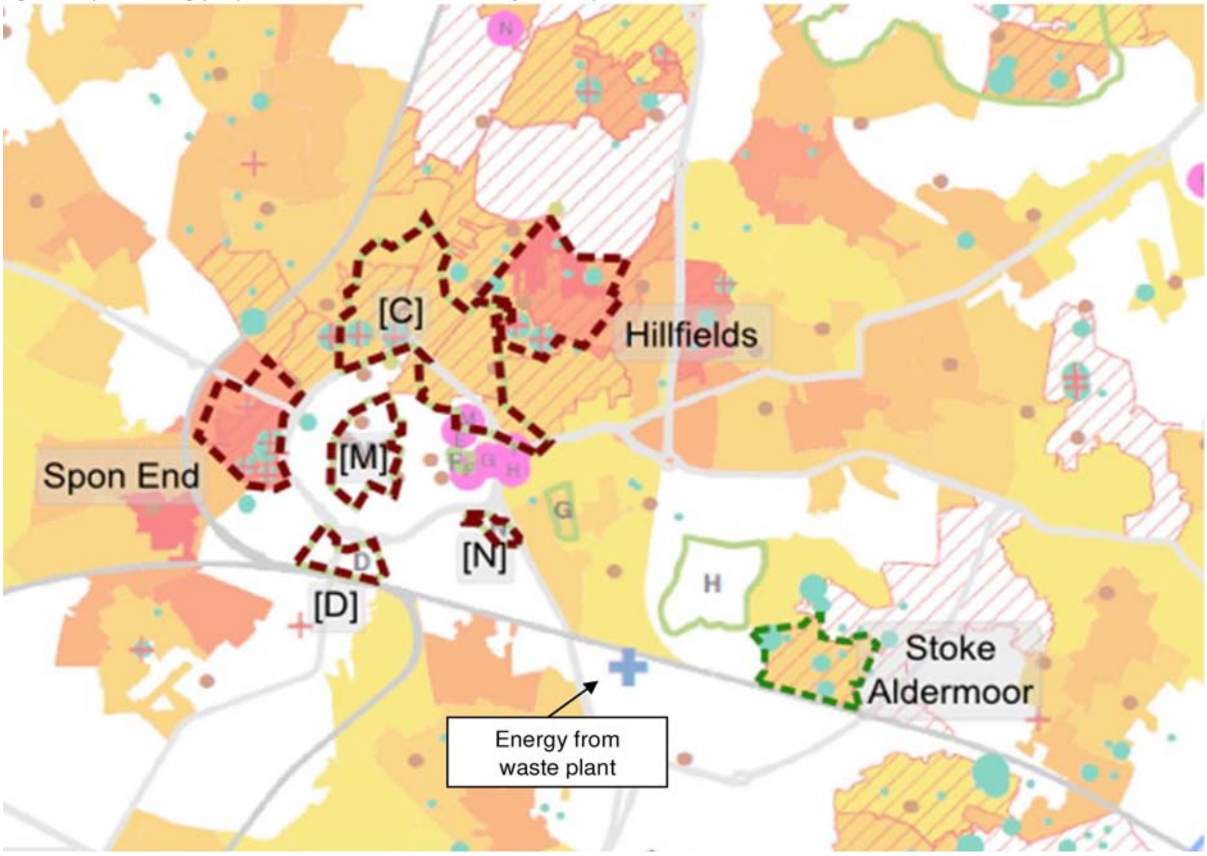
Based on these results, recommendations were made for the scoping of phase 2 of the study. The low scoring sites were excluded, as were the WHEM / NDC and Warwick University / Canley areas, on the basis that there was already other work going on to look at the feasibility of district heating for these locations.

It was therefore proposed that the following new development sites should be subject to further investigation, to be carried out in phase 2:

- Swanswell
- Friargate
- Coventry City Centre, and Coventry University new development sites
- Extension to the Coventry University Technology Park (London Road Gateway), together with the existing residential areas of Hillfields, Spon End and Stoke Aldermoor, as shown in figure 5.7.

Figure 5.6: Heat opportunities for Coventry, including existing heat demand

Figure 5.7: Map showing proposed areas of further analysis for phase 2



Phase 2 [57] of the study consisted of:

- Identification of the benefits to Coventry of a low carbon district heating network
- A review of the suitability for connection to a district heat network of existing and proposed future development within 6 potential district heating zones - Swanswell, city centre, Coventry University, Friargate, University Technology Park and Spon End. For each development, its use, floor area, heating system and opportunities and constraints were identified
- Analysis of potential routes of a heat main from the energy from waste plant into the city centre
- Analysis of costs and benefits
- An action plan setting out the strategic actions required in order to facilitate the delivery of a district heating network.

Figure 5.8 summarises the main potential benefits of a low carbon district heating network.

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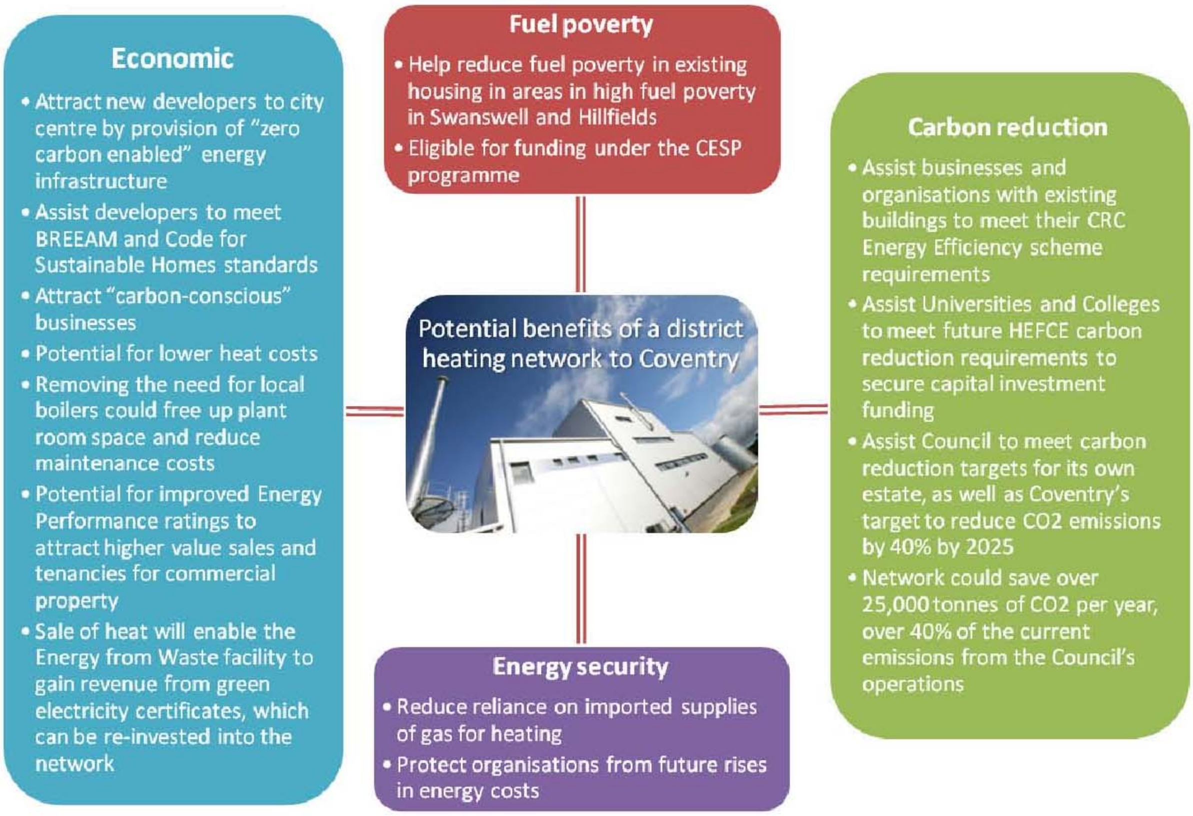
[57] AECOM (2010) . *Coventry City Council Low Carbon Energy Study Final Report. Carbon Trust Reference: PO021903/ P-130944*

Figure 5.8: Potential benefits to Coventry of a district heating network



Source: AECOM (2010)

Further details of the calculated costs and benefits, including carbon savings, associated with different options for the development of the scheme are presented in table 5.9.

Table 5.9: Summary of costs and benefits

Option	Extension from	Cumulative heat demand (MWh/year)	Annual revenue from ROCs and LECs (£m)	Cumulative peak load (MW)	Cumulative total cost (£m)	Simple payback	Net CO_2 saved per annum (tonnes)	Ratio of CO_2 savings to payback (tCO_2/y)
1a City core excluding technology park		16,700	0.37	14.7	4.82	13	2136	165
1b City core including technology park		18,700	0.42	17.7	4.82	12	2392	207
2b Swanswell core extension	1b	26,000	0.58	22.4	8.99	15	3326	215
2. Swanswell full extension	2b	29,500	0.66	29.4	9.71	15	3774	256
3 Friargate extension	1b	24,800	0.55	32	8.14	15	3172	216
4 Spon end extension	3	28,800	0.64	36.5	11.27	18	3684	210
5 All	1b	39,600	0.88	48.2	15.98	18	5066	281
5a All (excluding Spon End)	1b	35,600	0.80	43.7	13.03	16	4554	278

The study recommends that the scheme should be phased as follows:

- Phase 1 – heat line to ring road
- Phase 2 – City centre network to connect existing Coventry City Council, Coventry University and other public sector 'anchor load' buildings
- Phase 3 – heat network extends to perimeter zones to serve Swanswell, Friargate and Spon End via Friargate
- Phase 4 – network expands to existing residential developments in Hillfields and Spon End, and private developments in the city centre, including the lower precinct redevelopment, Ikea and the ice rink.

Heatline project current situation (June 2012)

Following the study, funding of £1.5M was secured from the Homes and Communities Agency and, in late 2011, invitations to tender for a design, build, finance and operate contract in respect of Phases 1 and 2 of the scheme were issued. In April 2012 Cofely District energy Ltd was selected as the preferred partner to deliver the scheme, and all involved main parties – the Council, University, Cofely and Coventry Cathedral – are currently working towards finalising and signing the required contractual agreements (some 16 in total). The timetable for the delivery of the project is shown in table 5.10.

Table 5.10: Heatline delivery timetable

Event	Timescales
Financial and Commercial Close (Signing of all documents)	30 June 2012
Detailed Design	July – Aug 2012
Construction – Thermal Stores, Thermal Substation and Work at Energy from Waste Plant	Sept – Dec 2012
Construction - Laying of Pipe route	Jan – May 2013
Connections – Making and testing of connections to buildings	May – Aug 2013
Go Live date	Sept 2013

Cofely and the Council will also meet with the Department for Energy and Climate Change to progress an innovative solution to the distribution of electricity that is generated at the Energy from Waste Plant to the Heatline Customers. This will require a new mechanism to be put in place by the government to pass the benefit of local low carbon energy generation to the customers, making it attractive to purchase.

Other studies

In addition to the regional and citywide studies referred to above, several studies have looked at low and zero carbon options for specific development areas. These include Friargate, Woodend, Henley Green and Manor Farm, and Canley. Each of these is summarised below.

Canley Climate Change Feasibility Study[58]

This was carried out in 2009 on behalf of Coventry City Council, following its decision to release a series of Greenfield development sites within the Canley area of the city, which will result of the addition of approximately 700 homes to the area's current total of 1,700. The

[58] Faber Maunsell / AECOM (2009). *Canley Climate Change Feasibility Study Final Report. Coventry City Council March 2009*

purpose of the study was to ensure that, in progressing the proposed programme of development, opportunities for the integration of sustainability initiatives are implemented in a planned and strategic manner, and are consistent with the Council's aspiration of creating a sustainability exemplar in this area of the city.

The study covered the following:

- An investigation into the feasibility of the development of a district heating scheme
- An assessment of the feasibility of a wind power installation in or near the Canley estate
- Guidance on achieving aspirations relating to BREEAM and the Code for Sustainable Homes.

The last of these is covered elsewhere in this document. In terms of wind power, a number of sites were identified as being potentially suitable for locating an 850kW V52 turbine (rotor diameter of 52m), mounted on a 65m tower, based on their having suitable average wind speeds and on the ability to achieve a minimum separation distance of 400m from dwellings and 100m from roads and railways. Other potential constraints such as archaeological and ecological impacts, landscape and visual sensitivity, and accessibility of grid infrastructure were not assessed. The potential locations were presented to the project steering group, who considered that none of them were likely to be viable, and therefore the use of wind power at Canley has not been pursued further.

As far as district heating is concerned, the study looked at various options for the extent of the system and type of technology employed. The coverage options are illustrated in figure 5.12, whilst the results of the assessment are shown in table 5.13. A qualitative assessment of three different options for the location of the energy centre was also carried out.

Figure 5.12: Options for extent of connection of district heating for Canley scheme

Faber Maunsell Canley Climate Change Feasibility Study

3.9.3 The Extent of Connection of District Heating

The extent of possible connection to a Canley district heating network is explored in this section. Five possible extents are considered in order to illustrate the implications of scale (see Figure 6). However, there is no reason why a scheme could not be scaled between these. The main balance to be considered when evaluating the extent is the heat load connected vs. the cost of connecting the heat load. The connected heat load has associated revenue to the schemes owner and therefore it is possible to evaluate the extent of connection from a financial perspective. Whilst phasing is to a degree taken into account in the setting of boundaries between the extents, phasing is explored further in section 5.

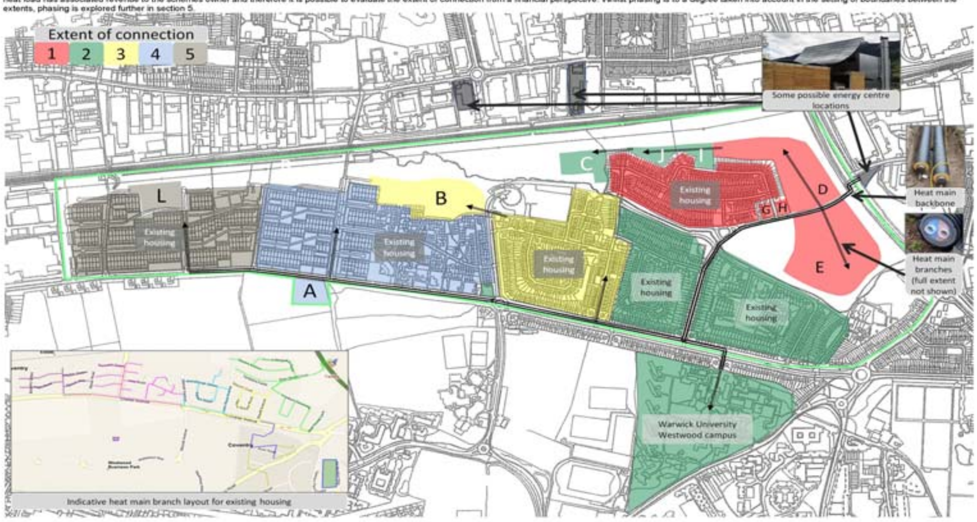


Figure 6: Illustration of the five 'extents of connection'. Each consecutively numbered area is assumed to be connected in addition to the last (i.e. extent option 2 includes both red and green areas).

Figure 5.13: Assessment of options for Canley

			Extent of connection				
		Colour reference	1	2	3	4	5
Cumulative		New build parcels connected >	D,E,F,G,H	I, J, C	B	M, A, K	All
		Number of new building dwellings connected >	445	511	654	687	731
		Area of non-residential connected >	1,000 m2	1,000 m2	4,800 m2	4,800 m2	4,800 m2
		Number of existing houses connected >	160	460	735	1058	1146
		Energy linking loads >		Warwick University			
		Total estimated annual heat load >	4,700 MWh	10,900 MWh	15,100 MWh	18,900 MWh	20,100 MWh
		Approximate peak load >	3 MW	6 MW	9 MW	11 MW	12 MW
		Approximate size of lead boiler supported >	0.9 MW	2.1 MW	2.9 MW	3.6 MW	3.9 MW
Common costs		DH network >	£2.3 M	£5.1 M	£6.2 M	£7.7 M	£8.4 M
		Dwelling connections >	£0.5 M	£1.3 M	£2.0 M	£2.9 M	£3.0 M
		DH network cost/annual heat load >	£610 / MWh	£590 / MWh	£542 / MWh	£557 / MWh	£569 / MWh
Centralised Gas CHP		Scale of unit	Small	Medium	Medium	Medium	Medium
		Technical viability	OK	OK	OK	OK	OK
		Code level enabled	Code 4	Code 4	Code 4	Code 4	Code 4
		Total capital cost	£3.6 M	£7.7 M	£9.9 M	£12.7 M	£13.8 M
		Approximate simple payback	12	11	10	10	11
Centralised Biomass Boiler		Scale of unit	Medium	Large	Large	Large	Large
		Technical viability	OK	OK	OK	OK	OK
		Code level enabled	Code 4	Code 4	Code 4	Code 4	Code 4
		Total carbon emissions reduction					
		Total capital cost	£3.4 M	£7.7 M	£10.0 M	£12.8 M	£13.8 M
		Approximate simple payback	25	24	23	23	23
Centralised Biomass CHP		Scale of unit	Small	Small	Medium	Medium	Medium
		Technical viability	Unproven technology	Unproven technology	Caution required	Caution required	Caution required
		Code level enabled	Code level 5	Code level 5	Code level 5	Code level 5	Code level 5
		Total carbon emissions reduction					
		Total capital cost	£4.6 M	£10.5 M	£10.7 M	£13.7 M	£14.8 M
		Approximate simple payback	13	12	15	15	15

Note: this table relates directly to the extents of connection shown on figure 5.12. The simple payback figures shown are approximate and are supplied to illustrate how the extent of connection affects financial performance, rather than how one technology performs against another.

A key finding of the report was that a district heating system could usefully be integrated into new development areas, provided to existing residents and potentially expanded to users with a high or complementary heat demand within the immediate vicinity of Canley (for example, Warwick University Westwood Campus and Tesco at Cannon Park). A gas-fired CHP engine is likely to be the most economically attractive option in the short term, although if a suitable source of fuel could be identified, biomass heating or CHP could also be employed. The report recommends that further discussions are held with Whitefriars Housing and Warwick

University with respect to their willingness to participate in the scheme, and that investigations are carried out relating to financing and operating the scheme.

WEHM District Heating and CHP Feasibility Study[59]

The Coventry New Deal for Communities programme was awarded £54M of funding to enable the Wood End, Henley Green and Manor Farm ('WEHM') area, located approximately 4.5km to the northeast of Coventry City Centre, to undergo long term sustainable urban regeneration. One of the main objectives of the programme is to improve the quality of the housing stock. This will involve demolishing some 2,444 dwellings and replacing them with 3,328 new dwellings, including 1,020 social rented dwellings, 1,158 affordable homes and 138 dwellings for sale at a 50% discount to those homeowners displaced by the programme. In addition, roads, public open spaces, shopping facilities and drainage infrastructure are to be redeveloped.

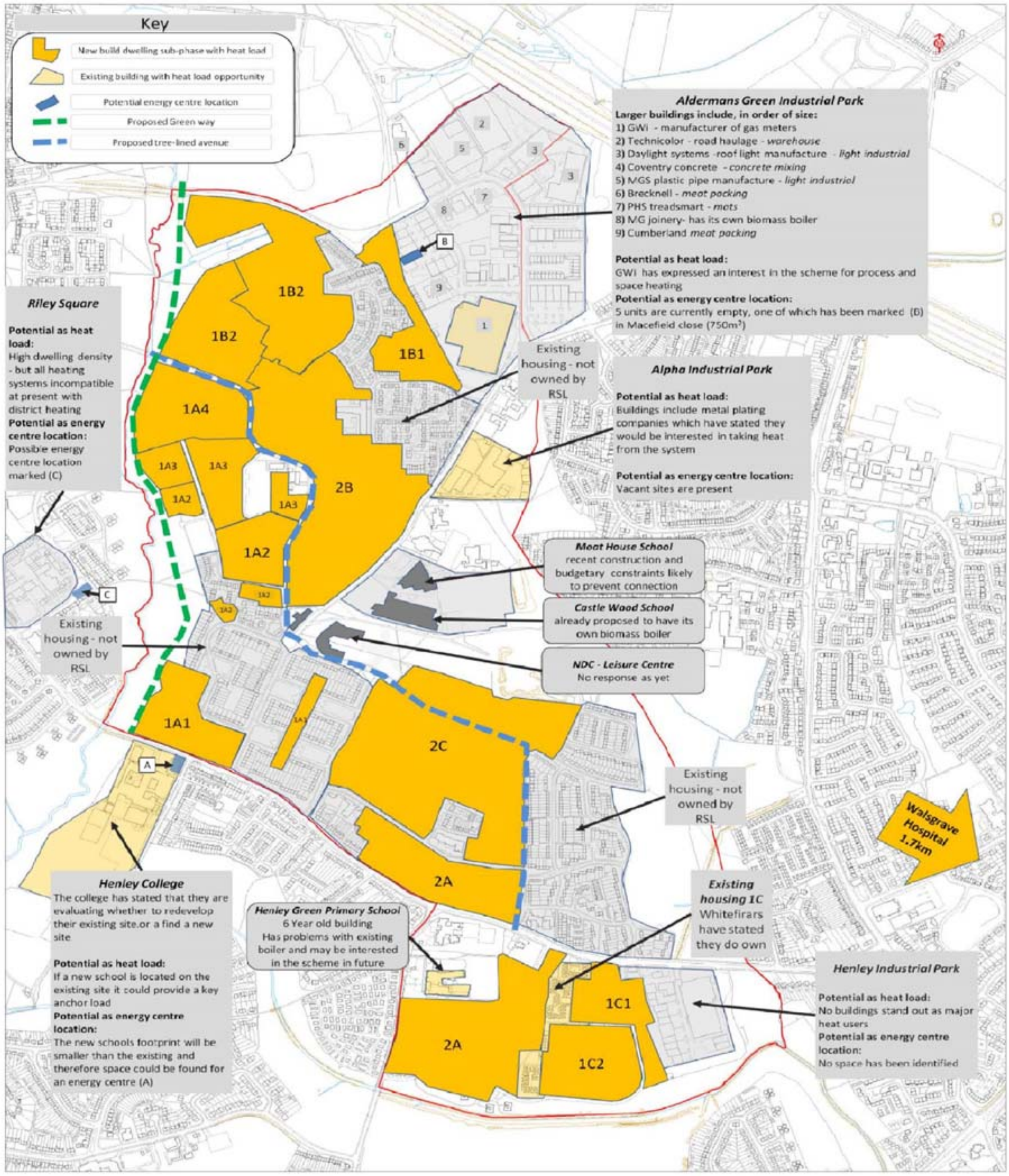
The study looked at:

- potential heat loads provided by new housing, new non-residential buildings, existing housing and other buildings, such as schools and industrial units
- possible heat main routing, in particular identification of opportunities to combine backbone trenching with other infrastructure works to reduce costs
- potential energy centre locations.

The opportunities identified are summarised in figure 5.14.

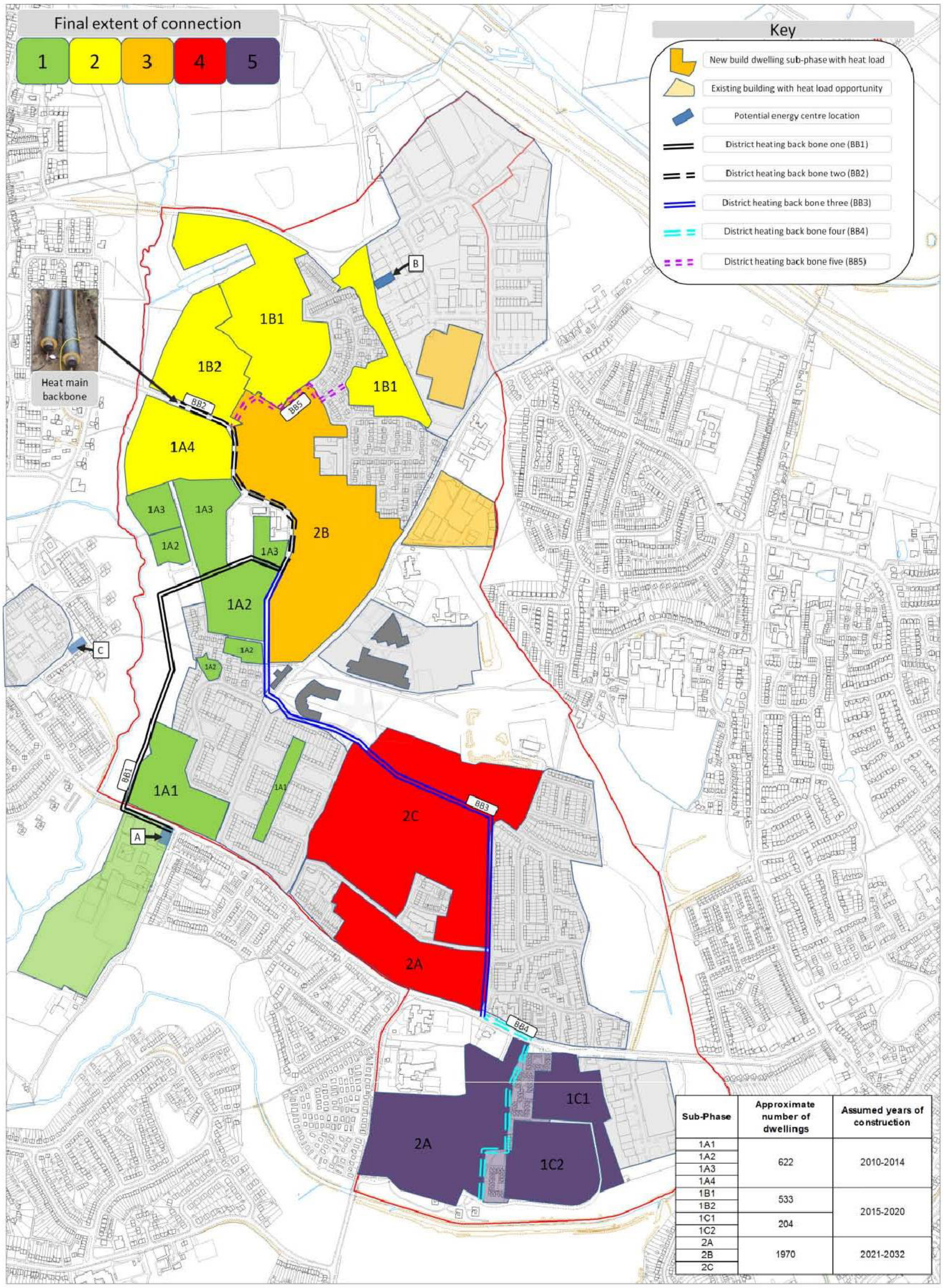
[59] Faber Maunsell / AECOM (2009). *WEHM District Heating and CHP Feasibility Study. Coventry City Council 08/05/09*

Figure 5.14: WEHM area showing opportunities for district heating



As the scale of any district scheme will have major implications for the cost, various final extents of connection were assessed, as shown in figure 5.15.

Figure 5.15: Possible final extent of connection of WEHM district heating network



Sub-Phase	Approximate number of dwellings	Assumed years of construction
1A1	622	2010-2014
1A2		
1A3		
1A4		
1B1	533	2015-2020
1B2		
1C1	204	
1C2		
2A	1970	2021-2032
2B		
2C		

The impacts on cost and payback of the final extent of the scheme are summarised in table 5.16.

Table 5.16: Costs and implications of district heating schemes based on final extent of connection

			Final extent of connection				
		Colour reference	1	2	3	4	5
		New build parcels connected >	1A1, 1A2,1A3	1A4. 1B1, 1B2	2B	2A, 2C	1C1,1C2, 2A
Cumulative		Number of new building dwellings connected >	474	1155	1776	2735	3328
		Number of existing houses connected >	0	0	0	0	50
		Energy linking loads >	Henley College (new buildings)				
				Industrial loads			
					Industrial loads		
							Henley Green Primary
		Total estimated annual heat load >	4,300 MWh	8,400 MWh	12,700 MWh	17,800 MWh	21,900 MWh
		Approximate peak heat load >	4 MW	5 MW	9 MW	12 MW	16 MW
		Approximate size of lead LZC boiler supported >	0.8 MW	1.6 MW	2.4 MW	3.4 MW	4.2 MW
Common costs		DH network >	£3.0 M	£5.2 M	£6.4 M	£9.9 M	£11.5 M
		Dwelling connections >	£0.1 M	£0.4 M	£0.5 M	£0.8 M	£1.1 M
		DH network cost/annual heat load >	£726 / MWh	£657 / MWh	£545 / MWh	£601 / MWh	£576 / MWh
Centralised Gas CHP		Scale of unit	Small	Medium	Medium	Medium	Medium
		Technical viability	OK	OK	OK	OK	OK
		Code level enabled	Code 4	Code 4	Code 4	Code 4	Code 4
		Energy centre cost	£0.97 M	£1.40 M	£2.11 M	£2.90 M	£3.69 M
		Total capital cost	£4.1 M	£6.9 M	£9.0 M	£13.6 M	£16.3 M
		Approximate simple payback	16	14	12	13	13
Centralised Biomass Boiler		Scale of unit	Medium	Large	Large	Large	Large
		Technical viability	OK	OK	OK	OK	OK
		Code level enabled	Code 4	Code 4	Code 4	Code 4	Code 4
		Energy centre cost	£0.83 M	£1.43 M	£2.16 M	£2.96 M	£3.77 M
		Total capital cost	£3.9 M	£6.9 M	£9.1 M	£13.7 M	£16.4 M
		Approximate simple payback	32	29	25	27	26
Centralised Biomass CHP		Scale of unit	Small	Small	Small	Medium	Medium
		Technical viability		Unproven technology		Complex technology	
		Code level enabled	Code level 5	Code level 5	Code level 5	Code level 5	Code level 5
		Energy centre cost	£1.96 M	£3.65 M	£2.96 M	£4.09 M	£5.15 M
		Total capital cost	£5.1 M	£9.2 M	£9.9 M	£14.8 M	£17.8 M
		Approximate simple payback	15	14	16	17	17

Overall, it was concluded that there were significant opportunities for CHP / district heating in the WEHM area. A scheme could be planned on a number of scales, ranging from just the northern half of the site (approximately 1,800 dwellings) to the entire site (3,328 dwellings). The final scale, however, would be likely to be governed by the amount of upfront capital that can be invested and the risk that later phases of the scheme may not deliver the revenue required to pay back the investment. In terms of preferred technology, whilst gas CHP and biomass heating works effectively at all scales, biomass CHP is currently unproven at smaller scales. However, there would potentially be opportunities to integrate biomass CHP into the scheme at a later date.

Although the findings of this study were given serious consideration for the NDC area, in the event district heating was not employed there due to uncertainties in the eventual build-out rate at a time of recession and developer concerns about the saleability of properties connected to a district scheme . However, the study did clearly demonstrate the potential of a decentralised schemes in a regeneration area of the city.

Friargate Coventry CHP Viability Study[60]

This study looks at the potential use of a 1MWe / 1.6MWth combined heat and power / trigeneration system at the proposed mixed-use Friargate development. It concludes that CHP would be viable for the development, there being the opportunity to run the plant for 14 hours continuously every weekday and 13 hours per day at weekends, with potential to increase output for midweek summer and winter periods. Predicted annual energy savings are as follows:

[60] Waterman Building Services (2010). *Friargate Coventry Revised Outline Planning Application CHP Viability Study December 2010*

Electricity: 4,000,000kWh
Heat: 2,500,000kWh
Cooling: 3,000,000kWh

6. Climate Change Adaptation

Introduction

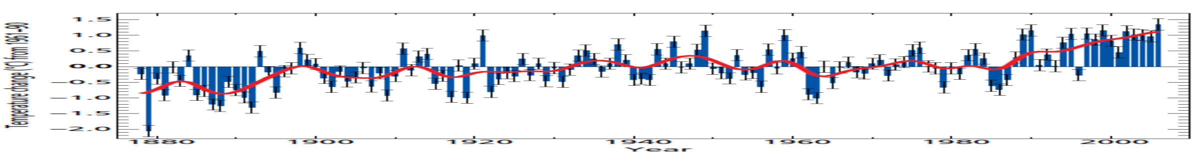
The scientific consensus is now overwhelming that climate change is happening, and that the predominant cause of this warming is the production of greenhouse gases from human activities, mainly from burning fossil fuels, deforestation and cement production. Furthermore, climate change is widely considered to be the greatest long-term threat facing our planet. All ecosystems, all populations, all habitats will experience the consequences of weather patterns that are changing at a rate greater than at any other time during in the last million years. Even if drastic action is taken today to reduce greenhouse gas emissions, the impacts of climate change will still be felt: it is estimated that past emissions are already likely to cause global temperature rises of around 2°C by the end of this century compared to pre-industrial figure. As this temperature rise is inevitable communities have no choice but to adapt to the new climactic conditions.

Recent climate change projections published by the UK Climate Impacts Programme (UKCP09) indicate that during the 21st century most of the UK can expect to see hotter drier summers, warmer wetter winters, rising sea levels and more frequent and extreme weather events such as heat waves, storms and heavy downpours.

Recent trends in Coventry's Climate

The climate of Coventry has been changing. The temperature in Central England (including Coventry) has already risen by about risen by about 1°C since the 1970s, with 2006 being the warmest year in the 348 year record.[61] This is illustrated in figure 6.1. Note that the error bars on the graph enclose the 95% confidence range, whilst the red line emphasises decadal variations.

Figure 6.1: Changes in Central England Temperature annual values (blue bars) from 1877 to 2006 relative to the average over the 1961-90 baseline period (about 9.5 ºC).



Over the last 250 years, there has also been a slight trend for increased rainfall in winter and decreased rainfall in summer, which is in line with what would be expected. In addition, all regions of the UK have experienced an increase in the amount of winter rain that falls in heavy downpours.

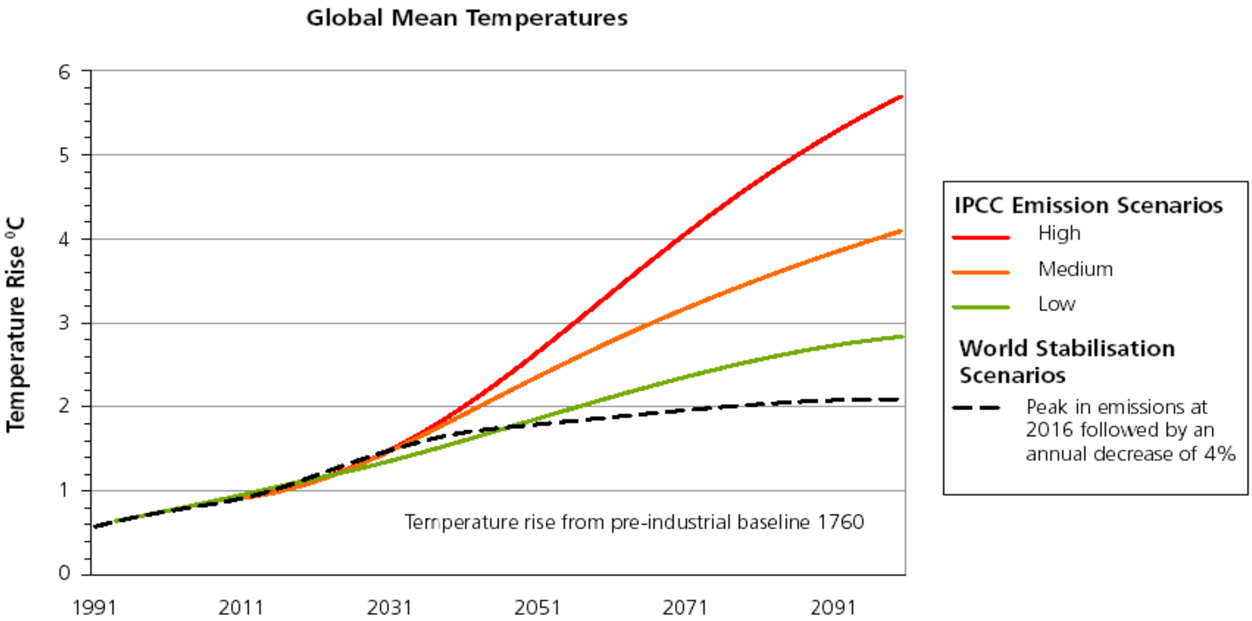
Climate Change projections

[61] UKCIP

The UK Climate Projections 2009 (UKCP09)[62] are provided by the UK Met Office and the UK Climate Impacts Programme (UKCIP), and predict likely temperature changes up until the end of the century under three different emissions scenarios: high (fossil fuel intensive), medium (a combination of fossil fuels and renewable energy sources) and low (where renewable energy becomes the main energy supply). Figure 6.2 shows projections in global mean temperatures under each emissions scenario.

The projections demonstrate the need to reduce greenhouse gas emissions, but also show that some degree of climate change is now unavoidable. Whichever carbon emission scenario is followed a rise in global mean temperatures of around 1°C over the next two decades is unavoidable due to our past and current carbon-emitting activities. During the course of this century the global mean temperature will rise by at least 2°C but could rise as much as 5.8°C.

Figure 6.2: Predicted global mean temperatures under low, medium and high emissions scenarios (UKCP09)



Projected changes to summer temperatures, summer rainfall and winter rainfall for Coventry and the West Midlands – together with the likely associated impacts - are shown in figure 6.3. The figures shown are based upon a medium emissions scenario and all changes are measured against a 1961-1990 baseline.

Figure 6.3: Projected changes to weather variables in the West Midlands (UKCP09)

[62] Available online at: http://ukclimateprojections.defra.gov.uk/

Weather variable	Projected Change in Weather Variable			Impacts
	2020	2040	2080	
Summer Temperatures	↑ 1.5°C	↑ 2.2°C	↑ 3.7°C Temperature on hottest day could increase by up to 10°C	• Increased Tourism • Increased heat stress • Infrastructure risks • Risks to biodiversity • Heat related deaths • Risk to Food Security
Summer rainfall	↓ 6%	↓ 11%	↓ 20%	• Reduced stream flow and water quality • Increased drought • Subsidence • Decreased crop yields • Serious water stress
Winter rainfall	↑ 5%	↑ 11%	↑ 18% Rainfall on the wettest day could increase up to 30%	• Increased winter flooding • Increased subsidence • Risks to urban drainage • Severe Transport disruption • Risk of national infrastructure

Impacts of climate change on development and the role of planning

New buildings usually have an expected life span of well in excess of 50 years, and urban forms even greater longevity. Therefore it is crucial that new development is able not only to withstand current climatic conditions and meet minimum performance standards in the short-to-medium term, but also that it remains fit for purpose over its entire life span. This means that it needs to be designed and constructed such that it is capable of adapting or being adapted to deal with the likely impacts of climate change. The importance of the planning system in bringing this about is widely acknowledged.

Climate change will affect the built environment in numerous ways, including:

- Higher summer temperatures will mean that buildings are more likely to overheat, resulting in greater levels of discomfort and heat stress for occupants. This in turn will lead to increased demand for cooling
- Conversely, higher winter temperatures are expected to decrease heating demand
- Hotter conditions will lead to greater requirements for urban green and blue space and shading, particularly in densely built-up urban areas most prone to the urban heat island effect
- Green and blue space itself will become increasingly vulnerable to the effects of decreased water availability, rising temperatures, and diseases and pests
- Changing rainfall patterns will have significant impacts on the availability of water resources and water quality
- More severe weather events are likely to cause increasing damage to buildings and infrastructure

- More intense rainfall will mean drainage systems are unable to cope, resulting in increased likelihood of flooding
- Subsidence and heave risks are expected to increase for clay soils, due to higher temperatures and lower summer rainfall, adversely affecting susceptible properties and underground service infrastructure.

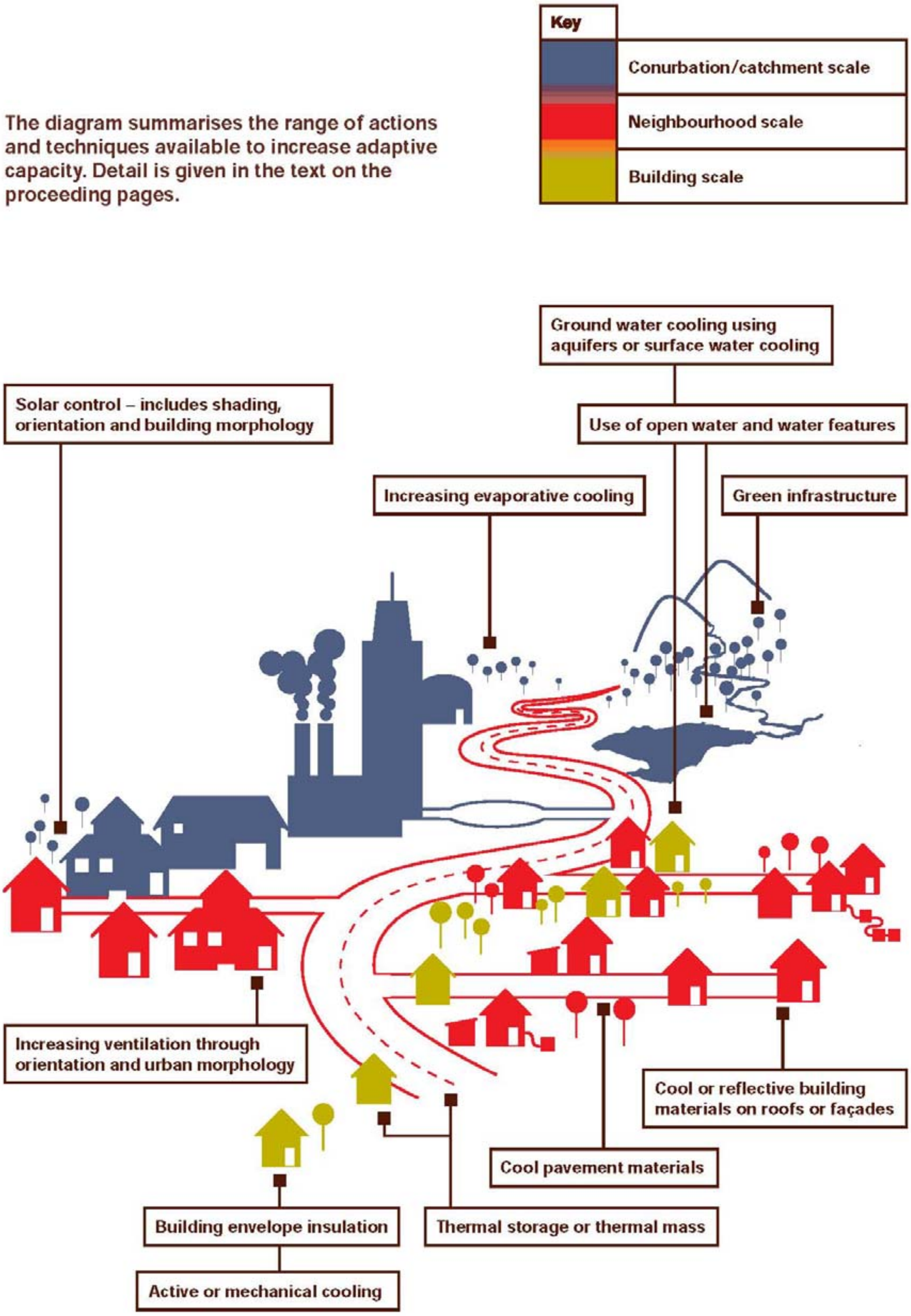
Adaptation strategies
Adaptation strategies can apply at the conurbation / catchment, neighbourhood or building scale. Identification of the most appropriate strategy for a given location / development type can be complex, as there are many factors which need to be taken into account. In devising strategies, it needs to be recognised that:

a) Both climate change mitigation and adaptation are strongly influenced by urban form, but mitigation and adaption measures can sometimes work against each other. For example, whilst at high development densities travel distances are minimised and decentralised energy schemes become more viable, providing opportunities to reduce CO_2 emissions, certain climate change impacts such as urban heat island effect and flooding may at the same time be exacerbated;

b) Whilst climate change adaptation can present opportunities, for example to increase green and blue space, potential conflicts may exist between objectives. For instance, unless carefully designed, buildings designed to minimise heat loss in winter may be prone to overheating in summer.

Figures 6.4, 6.5 and 6.6 illustrate some of the strategies available for managing the impacts of high temperatures, flood risks and changing ground conditions respectively.

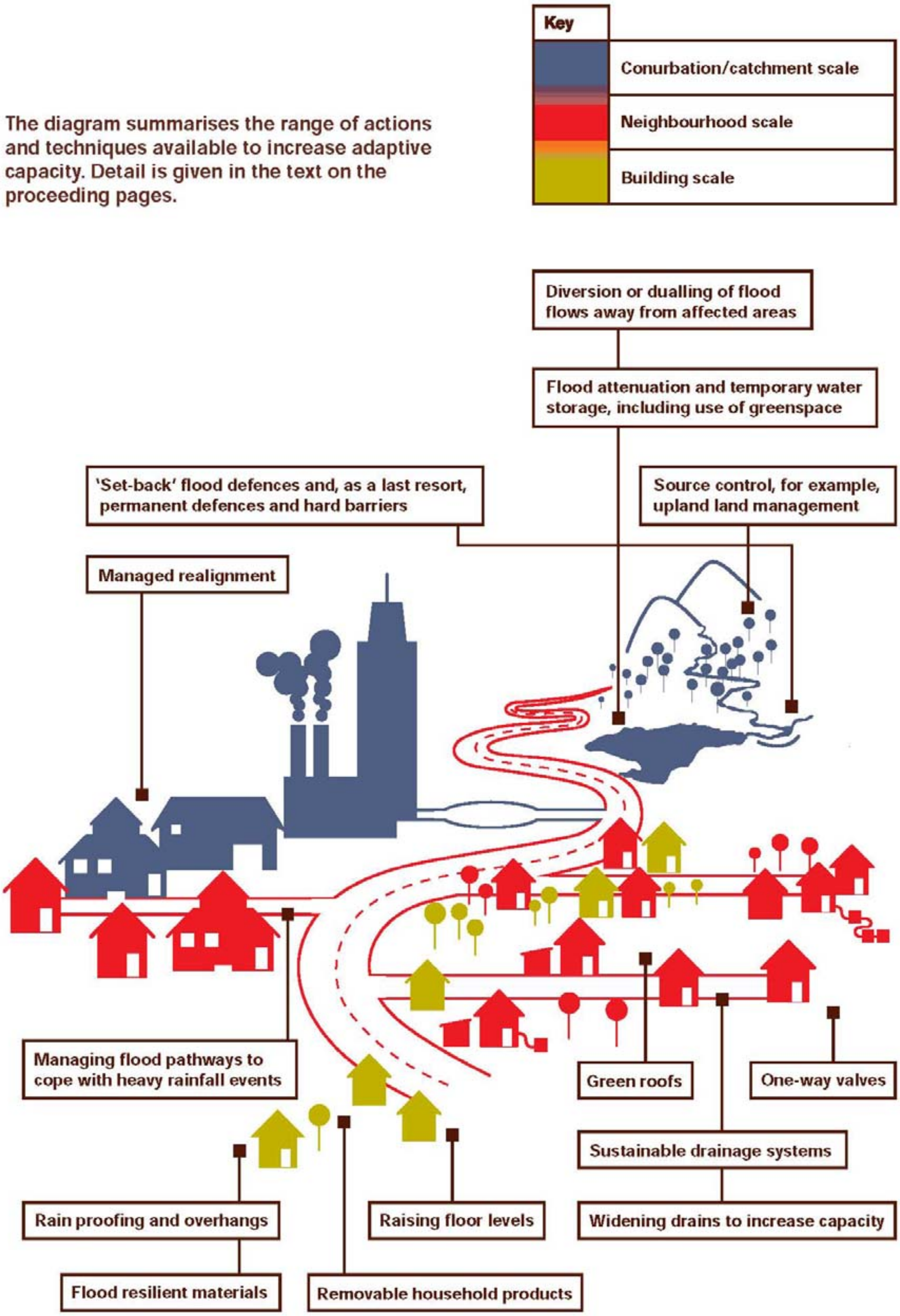
Figure 6.4: Menu of strategies for managing high temperatures



Source: TCPA[63]

[63] Shaw, R., Colley, M. and Connell, R. (2007). *Climate change adaptation by design: a guide for sustainable communities*. TCPA: London

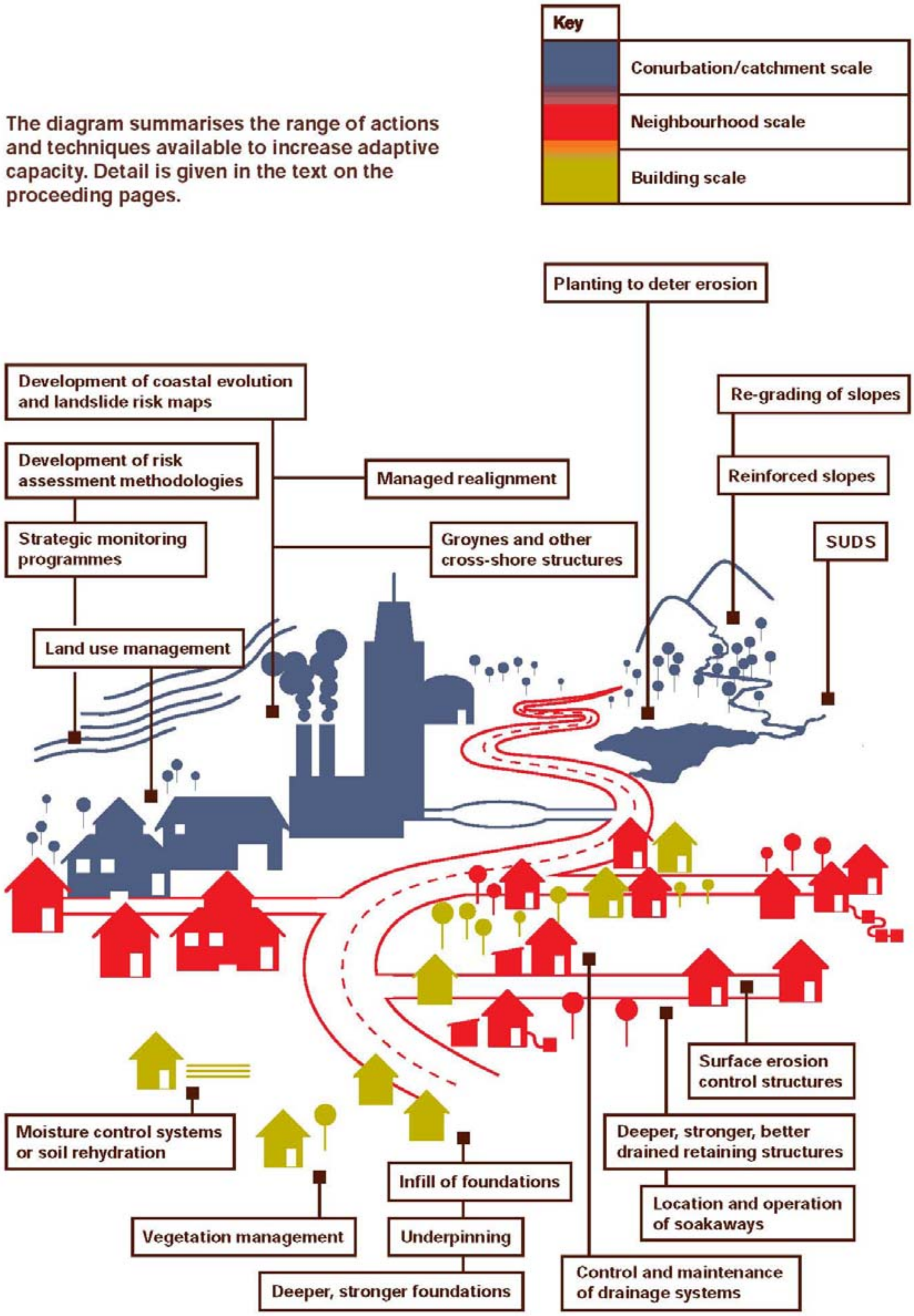
Figure 6.5: Menu of strategies for managing flood risks



Source: TCPA[64]

[64] Shaw, R., Colley, M. and Connell, R. (2007). *Climate change adaptation by design: a guide for sustainable communities*. TCPA: London

Figure 6.6: Menu of strategies for managing changing ground conditions



Source: TCPA[65]

[65] Shaw, R., Colley, M. and Connell, R. (2007). *Climate change adaptation by design: a guide for sustainable communities*. TCPA: London

Proposed approach
For all new development and major refurbishment projects an assessment of the risks and opportunities presented by future climate change will need to be carried out, and measures to control the risks and take advantage of the opportunities incorporated into the development. In particular the following will need to be considered:

- SUDS
- Green roofs
- Green and blue space
- Water efficiency measures (covered in Section 4)
- Flood prevention and mitigation measures.

Also, in selecting sites for development their ability to adapt to the impacts of climate change will be a key consideration.

Evidence
Coventry Local Climate Impacts Profile[66]
Compiled in 2010, this examined the impacts of extreme weather on Council services and operations during recent years. Sources of information included media reports, data from a local weather station (Bablake) and Council records. Some of the key findings included:

- Summer storms in 2005 and 2006 caused over £200,000 worth of damage to city centre shops
- Winds of 90 mph which occurred in January 2007 closed roads, damaged railway lines, left 2,500 houses without electricity, brought down phone lines and damaged guttering and roofs on numerous buildings
- For an 'average' storm in the city, typical clean-up costs as a result of damage to trees are in the region of £5-7000, although the clean-up costs arising from a single storm at Coombe Abbey Country Park were £80,000
- During the period 2004 to 2009 £461,000 worth of claims were made as a result of damage caused by heavy rain and flooding to council property, compared to just £30,500 in the previous 5 years.
- Damage to school buildings following extreme weather events has resulted in insurance claims of approximately £450,000 during the period 1999-2009
- High summer temperatures have resulted in over £1M worth of damage to road surfaces in Warwickshire over the past decade.

[66] Coventry City Council (2010). *A Local Climate Impact Profile for Coventry City Council.*

Coventry City Council Strategic Flood Risk Assessment for Local Development Framework Level 1[67]

This assesses and maps flood risk from groundwater, surface water, sewer and river sources, taking into account future climate change predictions, as detailed in Planning Policy Statement 25. In accordance with the PPS, areas of low, medium and high risk have been identified and mapped. Properties in the city which have historically been most prone to flooding include those in:

- Areas adjacent to the River Sherbourne culvert in the city centre, as a result of surcharging of the culvert
- Brookstray in Eastern Green
- Spon End / the Butts
- The upper reaches of the Sherbourne (Allesley)
- An area in the vicinity Beechwood Gardens (Earlsdon), which is at risk of flooding from a tributary of the Canley Brook
- An area in the vicinity of Radford Road, related to the Radford Brook / surface water sewer
- Areas adjacent to the Hall Brook / surface water sewer through Holbrooks.

In terms of flood zone mapping, a significant number of properties in certain areas of the city have been identified as being located in Flood Zone 2, including certain properties in areas adjacent to the Canley Brook (Tile Hill and Canley), River Sherbourne (Allesley, Spon End, Gosford Green, city centre), the River Sowe (Rowleys Green, Longford, Bell Green, Wyken Green, Walsgrave) and the Hall Brook (Holbrooks).

In addition, twenty three postcode areas of Coventry were identified as being at risk of flooding from artificial drainage systems and surface water runoff. Flooding from groundwater has been identified as being a problem in areas where the decline in manufacturing industry has led to an decrease in industrial groundwater demand.

The report provides recommendations on what should be included in the Council's planning policies relating to flood risk management. This includes an objective (Objective 2) to reduce surface water runoff from new developments by requiring:

- SUDS on all new development, with space being specifically set aside for SUDS and informing the overall site layout
- Greenfield discharge rates, with a minimum reduction of 20%
- 1-in-100 year on-site attenuation taking into account climate change.

Coventry City Council Preliminary Flood Risk Assessment[68]

This was carried out by the Council in its capacity as a Lead Local Flood Authority, as defined under the Flood Risk Regulations 2009, which impose a duty on it to manage flood risk within its area.

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[67] Coventry City Council (2008). *Strategic Flood Risk Assessment for Local Development Framework, Level 1, Volume 1*

[68] Coventry City Council (2011). *Preliminary Floor Risk Assessment*

The assessment involved identification of flood spots using historical flood data and GIS data, and then carrying out a preliminary risk assessment at each location identified (128 in total). The results indicate a moderately high risk associated with surface water flooding in Coventry, with over 5% of the locations assessed being classified as high risk, including the city centre.

Coventry Green Infrastructure Study[69]
The aim of this study, which was carried out in 2008, was to "draw up a bold and imaginative strategy for the provision of high quality Green Infrastructure in Coventry over the next 25-30 years".

It had a number of specific objectives, which included the following:

- To bring together existing data on green infrastructure sites and map out green infrastructure provision
- To identify current deficiencies in existing green infrastructure and to identify present and future needs
- To identify opportunities for green infrastructure within and adjacent to future development sites
- To identify opportunities for green infrastructure connectivity to the wider sub-region
- To encourage wider environmental benefits, such as enhanced flood protection and improved water quality

The study involved a baseline review of existing green infrastructure provision in order to identify deficits - in terms of both the connectivity of the overall network and accessible natural greenspace - and opportunities for new green infrastructure, and to generate an overarching green infrastructure vision for the city. Consideration was also given to how the vision can be achieved in practice, the report including a set of suggested developer standards and a green infrastructure implementation plan.

Although the study is based on the patterns of growth that were assumed for the previous (i.e. 2010) Core Strategy, many of the recommendations made are still relevant in the current context, in particular the proposed Green Infrastructure Standards for Sustainable Development, which include:

- *'Green infrastructure should be considered in the same manner as any other form of infrastructure servicing new development….and should be an essential component of a fully serviced development plot*
- *New green spaces should be designed to deliver a broad range of functions to ensure maximum efficiency in land given over to this use*
- *New green infrastructure elements associated with development should connect into site-level networks which should in turn connect with the City-wide network*
- *Developers should agree robust delivery and funding mechanisms with Coventry City Council prior to commencement of development to secure the high quality creation and ongoing management of green infrastructure*
- *All development should identify key biodiversity habitats, features of ecological interest and all other environmental assets at masterplanning stage and where possible*

[69] Coventry City Council (2008). *Coventry Green Infrastructure Study Draft Report*

enhance these features through positive management, buffering, extension and linkage

- o *All developments should include, where possible, green infrastructure elements which deliver multiple sustainable benefits to the urban environment through their natural processes including sustainable urban drainage systems, urban trees and green roofs'.*

Greenspace Strategy[70]

This study assessed the quantity and quality of existing greenspace in the Coventry, including parks and open spaces, woodlands, games and outdoor sports areas, allotments, and cemeteries and closed churchyards, in order to highlight any deficiencies in provision. A number of recommendations were made, including to "wherever possible implement flood storage or sustainable urban drainage systems to negate flood risk".

Health Effects of Climate Change in the West Midlands[71]

This study uses the latest climate change projections (UKCP09) for the West Midlands to predict the likely effects of changes in temperature and rainfall patterns on human health in the twenty first century. Some of the key findings include:

- o By the 2020s there will be a slight increase (less than 1%) in all-cause mortality in the summer and a decrease in winter of 4% due to warmer temperatures. Food and water born diseases will increase by 5% and respiratory disease admissions by 18%
- o By the 250s, mortality rates will increase by up to 2% in the summer, but decrease by up to 6.5% in the winter. Incidents of food poisoning are predicted to increase by 12% and skin cancer cases could become more common
- o By the 2080s, the predicted increase in summer mortality rates is 11%, with a 3% decrease in winter mortality rates, both figures being relative to current baselines. Cases of some food and water borne diseases could more than double, and small scale outbreaks of vector borne diseases could be seen.

The report also concludes that, due to urban heat island effects, negative health impacts in city centre areas will be exacerbated, with outbreaks of food and water borne diseases being more common than in rural areas due to the greater population density, and pollution episodes increasing respiratory problems. Deprived communities will face greater impacts than more affluent communities due the fact that they are more likely to be located in city centre areas where temperatures will be higher, they are less able to adapt to changing conditions, and they are more likely to be susceptible to negative health impacts due to poorer initial levels of health.

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[70] Coventry City Council (2008). *Greenspace Strategy 2008-2018*

[71] West Midlands Climate Change Office (2010). *Health Effects of Climate Change in the West Midlands: Summary Report.*

Glossary[72]

Bioenergy
Usable energy derived from biological, typically plant, material which is contemporary rather than coming from fossil sources

Blue space
Water features such as canals, streams, lakes and rivers used to make the built environment more pleasant; blue spaces can also contribute resilience to heat waves, floods and other impacts of climate change

Built environment
All the developed settings in which people live and work, from villages to large cities, and including housing, health, educational and government buildings, shops, work and leisure places, transport and energy infrastructure and the places in between them

Carbon
The chemical element in coal, oil and gas whose conversion to carbon dioxide releases energy. Carbon dioxide (CO_2) is the most significant greenhouse gas. The amount of it released can be expressed in tonnes of carbon or of carbon dioxide. To convert from CO_2 to carbon, multiply by 12 and divide by 44.

Climate change
The earth's climate changes constantly, but this term is usually used to mean artificial or man-made climate change caused by greenhouse gas emissions.

Climate change adaptation
Adjustments to natural or human systems in response to actual or expected climatic factors or their effects, including from changes in rainfall and rising temperatures, which moderate harm or exploit beneficial opportunities

Climate change mitigation
Action to reduce the impact of human activity on the climate system, particularly through reducing greenhouse gas emissions

Combined heat and power / combined cooling heat and power (CHP/CCHP)
The simultaneous generation of usable heat and power (usually electricity) in a single process, thereby reducing waste heat and putting to use heat that would normally be wasted to the atmosphere, rivers or seas. CHP is an efficient form of decentralised energy supply providing heating and electricity at the same time. CHP's overall fuel efficiency can be around 70-90% of the input fuel, depending on heat load, much better than most power stations which are only up to around 40-50% efficient.

Decentralised energy supply
Energy supply from local renewable and local low-carbon sources (i.e. on-site and near-site, but not remote off-site) usually on a relatively small scale. Decentralised energy is a broad term used to denote a diverse range of technologies, including micro-renewables, which can locally serve an individual building, development or wider community and includes heating and cooling energy.

Distributed energy
Energy obtained from a large number of small sources, including renewable energy converters, rather than a small number of large, centralised sources

[72] Sources include: *National Planning Policy Framework* (Communities and Local Government, 2012), *Foresight Report – Powering our Lives: Sustainable Energy Management and the Built Environment* (Government Office for Science, 2008), *Planning Policy Statement: Planning & Climate Change – Supplement to PPS1 (*CLG, 2007)

Energy efficiency
Making the best or most efficient use of energy in order to achieve a given output of goods or services, and of comfort and convenience.

Fuel poverty
Inability to afford a basic level of domestic heating and lighting. Defined as spending more than 10% of household income on these

Global warming
An increase in the average temperature of the earth's atmosphere due the greenhouse effect

Greenhouse effect
Warming of the earth by the capture of infrared radiation emitted from its surface by specific molecules in the atmosphere, most importantly carbon dioxide. The concentration of carbon dioxide in the atmosphere rose from 315 to 380 parts per million between 1960 and 2003

Green infrastructure
A network of multi-functional green space, urban and rural, which is capable of delivering a wide range of environmental and quality of life benefits for local communities

Green space
Parks and other urban spaces characterised by extensive vegetation which make the built environment more enjoyable for people and more resilient to external stress

*Heat island effect (*also known as the *urban heat island effect)*
Raising of temperatures in cities by comparison with surrounding rural areas due to buildings and hard urban surfaces absorbing and retaining more head than open land

Low carbon technologies
Energy technologies which use little or no fossil fuel. Examples might include renewable, nuclear power or bioenergy

Mitigation
Involves taking action to reduce the impact of human activity on the climate system, primarily through reducing greenhouse gas emissions.

Renewable and low carbon energy (from PPS1 supplement)
Includes energy for heating and cooling as well as generating electricity. Renewable energy covers those energy flows that occur naturally and repeatedly in the environment – from the wind, the fall of water, the movement of the oceans, from the sun and also from biomass. Low-carbon technologies are those that can help reduce carbon emissions. Renewable and/or low-carbon energy supplies include, but are not exclusively, those from: biomass and energy crops; CHP and CHPP; waste heat that would otherwise be generated directly or indirectly from fossil fuel; energy from waste; ground source heating and cooling; hydro; solar thermal and photovoltaic generation; wind generation.

Resilience
The capacity of human and natural systems to deal with unexpected events or changes including climate change, individual severe weather events, or terrorism

Shell and core
Typically a Shell and Core building covers base building elements such as structure, envelope and fit-out of common areas. A core HVAC system may be provided to allow for tenant connections.

Sustainable
Of technologies, practices or societies: capable of continuing indefinitely with zero or acceptably low and replaceable resource demands

Sustainable drainage systems
Alternatives to the traditional ways of managing runoff from buildings and hardstandings. They are designed to improve the rate and manner of absorption by water of hard and soft surfaces, in order to reduce the total amount, flow and rate of surface water that runs directly to rivers through storm water systems.

Urban cooling
Moderating high summer temperatures, through for example the layout of urban open space and shading from trees. Climate change will exacerbate the temperature gradient that rises from the rural fringe and peaks in city centres. This is described as the 'urban heat island' because the warmer urban air lies in a 'sea' of cooler rural air.

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