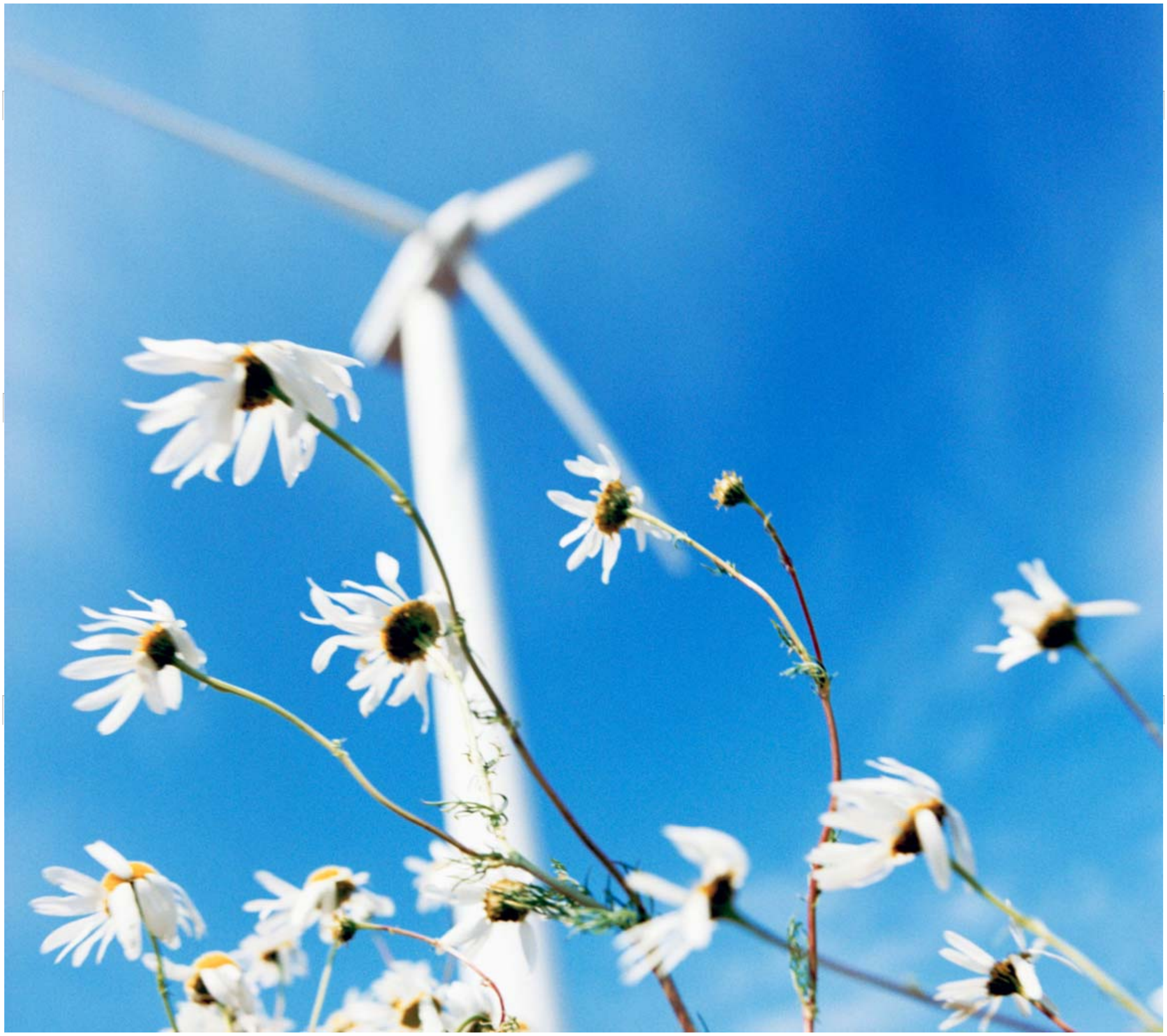
Harrogate Borough Council May 2011

# Harrogate District Planning and Climate Change Study



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| Rev No | Comments | Checked by | Approved by | Date |
|---|---|---|---|---|
| 1 | Draft report | HP | RS | 31/3/10 |
| 2 | Draft report QA | HP | RS | 15/4/10 |
| 3 | Revised draft report submitted to Harrogate Borough Council | NI | NI | 29/4/10 |
| 4 | Final draft report | APA | ZG | 25/10/10 |
| 5 | Final | BS | ZG | 25/01/10 |
| 6 | Final with minor amendments | BS | BS | 10/05/11 |

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Job No 60142943 Reference Draft Report Date Created May 201

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# Non Technical Summary

# Non Technical Summary

This study identifies low carbon and renewable energy generation resources in Harrogate District. It considers opportunities to exploit these resources in the existing building stock, in new development and through community-scale projects, and recommends appropriate planning policies.

This study report is part of the evidence base for Harrogate Borough Council's 'Sites and Policies' Development Plan Document. It has been prepared in accordance with national guidance, primarily Planning Policy Statement: Planning and Climate Change – Supplement to Planning Policy Statement 1.

**The need for a Planning and Climate Change Study**

There is a clear national policy framework for planning to mitigate and adapt to climate change. The Climate Change Act requires the UK to reduce $CO_2$ emissions by 80% by 2050 compared to 1990 levels. In Europe, the UK has made a binding commitment to generate 15% of its energy from renewables by 2020. The Low Carbon Transition Plan and the Renewable Energy Strategy set out how these challenging targets will be met.

New buildings must comply with Part L of the Building Regulations, which govern the level of $CO_2$ emissions that are permissible from any building. Changes to the Building Regulations introduced in October 2010 and due in 2013 are expected to bring in demanding $CO_2$ emissions targets, leading to zero carbon homes by 2016 and non domestic buildings by 2019. These changes will gradually shift most of the onus for delivering on-site energy efficiency, low carbon and renewable energy generation away from planning and onto the Building Regulations.

This study forms part of the evidence base for the emerging Harrogate District Sites and Policies Development Plan Document, which will include development control policies, site allocations and a Proposals Map. The Sites and Policies DPD will identify specific sites for new homes and jobs across the District.

**Harrogate District in Context**

The District of Harrogate has an area of 1,305km$^2$ and is one of the largest shire districts in England. With three major settlements comprising Harrogate Town, Knaresborough and Ripon and over 120 smaller settlements. The District's western area includes the Nidderdale Area of Outstanding Natural Beauty, which is comparatively sparsely populated. Much of the District's landscape has a strong character and high quality.

The recent economic slowdown and election of the new coalition government has cast uncertainty over the future of regional housing targets. Harrogate Borough Council has already adopted housing targets within their Core Strategy which provides greater certainty of delivery within the District and consequently greater opportunity to introduce community scale, low carbon and renewable energy infrastructure. The Sites and Policies DPD sets out policies and allocations to deliver the Core Strategy.'

**Opportunities for energy efficiency**

The existing building stock is responsible for the largest energy demand in Harrogate District. Any strategy for $CO_2$ reduction in buildings should consider the potential for increased energy efficiency in the existing stock as well as new developments. There are approximately 69,000 homes in the District and the current replacement rate is negligible, with virtually all new dwellings being built to increase supply rather than replace older stock. This means that most of the current existing stock will be retained, certainly over the period of influence of the Core Strategy and probably for decades afterwards. This presents a great potential for making improvements.

**Opportunities for district heating networks and low carbon and renewable energy generation**

The opportunities for district heating networks and low carbon and renewable energy installations have been assessed across existing and new development and at the community scale. The available opportunities involve establishing supply chains to manage local biomass, hydro energy schemes, large and small scale wind energy, and microgeneration technologies. District heating networks could provide community heat (preferably with CHP to provide community electricity) on larger developments. However, due to its largely rural nature and relatively low density of the building stock in Harrogate District, district heating is unlikely to play a role outside of the urban centres of Harrogate Town, Knaresborough and Ripon.

The expected tightening of the Building Regulations means that the installation of onsite microgeneration technologies will increasingly fall beyond the remit of planners. Local authorities will need to support developers in fulfilling their regulatory obligations and, where necessary and appropriate, set targets for building performance standards ahead of the Building Regulations. Post 2016, the Council may need to assist by identifying “allowable solutions;” the proposed mechanism for new development to achieve “zero carbon” status, by linking to off-site solutions.

These opportunities cannot be delivered through planning alone. However, planning is able to build up a comprehensive spatial understanding of the opportunities and constraints. This study has enabled the preparation of an Energy Opportunities Plan that maps the low carbon and renewable opportunities available, and also outlines some appropriate delivery mechanisms. This will provide the basis for developing site specific and development planning policies and targets. It will be a key resource to:

- Prioritise and bring forward the delivery of local energy opportunities. Many of the recommendations are likely to have significant financial and organisational implications for the Council and further work will be required to explore these in greater detail.
- Prioritise areas for further work for the Council, including more detailed studies of areas of change, including setting site-specific targets and policies, where necessary.

**Policy Recommendations**

This study proposes new policies for development located within one of three Energy Opportunity Areas, as defined on an Energy Opportunities Plan - Figure 1:  Energy Opportunities Plan for Harrogate District

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- District Heating Opportunity Areas where district heating beyond the site boundary may be a viable option.
- Wind Energy Opportunity Areas where large scale wind turbines could be a viable option.
- Energy Constrained Areas where no community or large scale renewable or low carbon energy resources are likely to be available. Policy options will be limited to what can be achieved onsite, especially through microgeneration technologies.

A carbon fund has been recommended as an alternative for developers unable to comply with the recommended policies.

**Recommended policy 1: Delivering the Energy Opportunities Plan.**

Harrogate Borough Council considers climate change to be one if its highest priorities. Planning applications for new development will need to demonstrate how they contribute to delivery of the opportunities identified in the current Energy Opportunities Plan.

Where necessary, the Council will seek to protect land for decentralised renewable and low carbon energy. Development that falls within an Energy Opportunity Area should not unnecessarily restrict the exploitation of that opportunity.

**Recommended policy 2: Development in District Heating Opportunity Areas.**

All new development in District Heating Opportunity Areas should consider district heating as their first option for the heat supply to the site. This should be assessed as part of the Design & Access statement or equivalent. An assessment should consider density, mix of use, layout, phasing and specification of heating, cooling and hot water systems.

The secondary elements of a district heating network (i.e. from the wider network to buildings) should be installed where a network exists.

Where a district heating and / or cooling network is planned but does not yet exist, applicants should install heating and / or cooling equipment that can be connected at a later date.

Where appropriate, applicants may be required to provide land, buildings and/or equipment for an energy centre to serve existing or new development. In cases where the applicant can demonstrate that this is not viable, a payment into a carbon fund may be required.

**Recommended policy 3: Development in Wind Energy Opportunity Areas.**

The Energy Opportunities Plan identifies potential locations for large scale wind turbines as Wind Energy Opportunity Areas. New developments in Wind Energy Opportunity Areas should demonstrate that they have considered delivering a reduction in $CO_2$ emissions using wind turbines on site. In doing so, applicants should engage with the Council, third parties and communities.

An assessment should be contained within the Design & Access statement or equivalent. It should include expected $CO_2$ savings from wind turbines and, in the case that an

Environmental Impact Assessment is not required, describe the environmental impact of the wind turbine(s) in the vicinity of the development and cumulative impacts for turbines larger than 50m in tip height.

**Delivery of energy opportunities in Harrogate District**

The Energy Opportunities Plan identifies a number of low carbon and renewable opportunities that are not deliverable through individual developments or planning applications. To deliver these, Harrogate Borough Council will need to take an active role in management and delivery to improve the energy performance of the existing building stock, promote faster uptake of microgeneration technologies than could be expected by relying on national support measures alone, develop support for community scale infrastructure such as large scale wind energy and district heating networks and create a biomass supply chain.

The Wellbeing Power, introduced through the Local Government Act 2000, promotes innovation in the way that local authorities provide services. This includes the setting up or participating in local energy services companies (ESCo) and other joint ventures, to supply heat and/or power.

Alongside the Wellbeing Power, Prudential Borrowing could enable Harrogate Borough Council to borrow money to establish and deliver services that they would otherwise be unable to. The loans, obtained at public sector borrowing rates can be serviced by energy sales and other related income sources.

Other potential income sources include money raised through a carbon offset fund or similar charge, revenue from Renewable Obligations Certificates (ROCs), the feed-in-tariff, the renewable heat incentive and bonds issued to local communities.

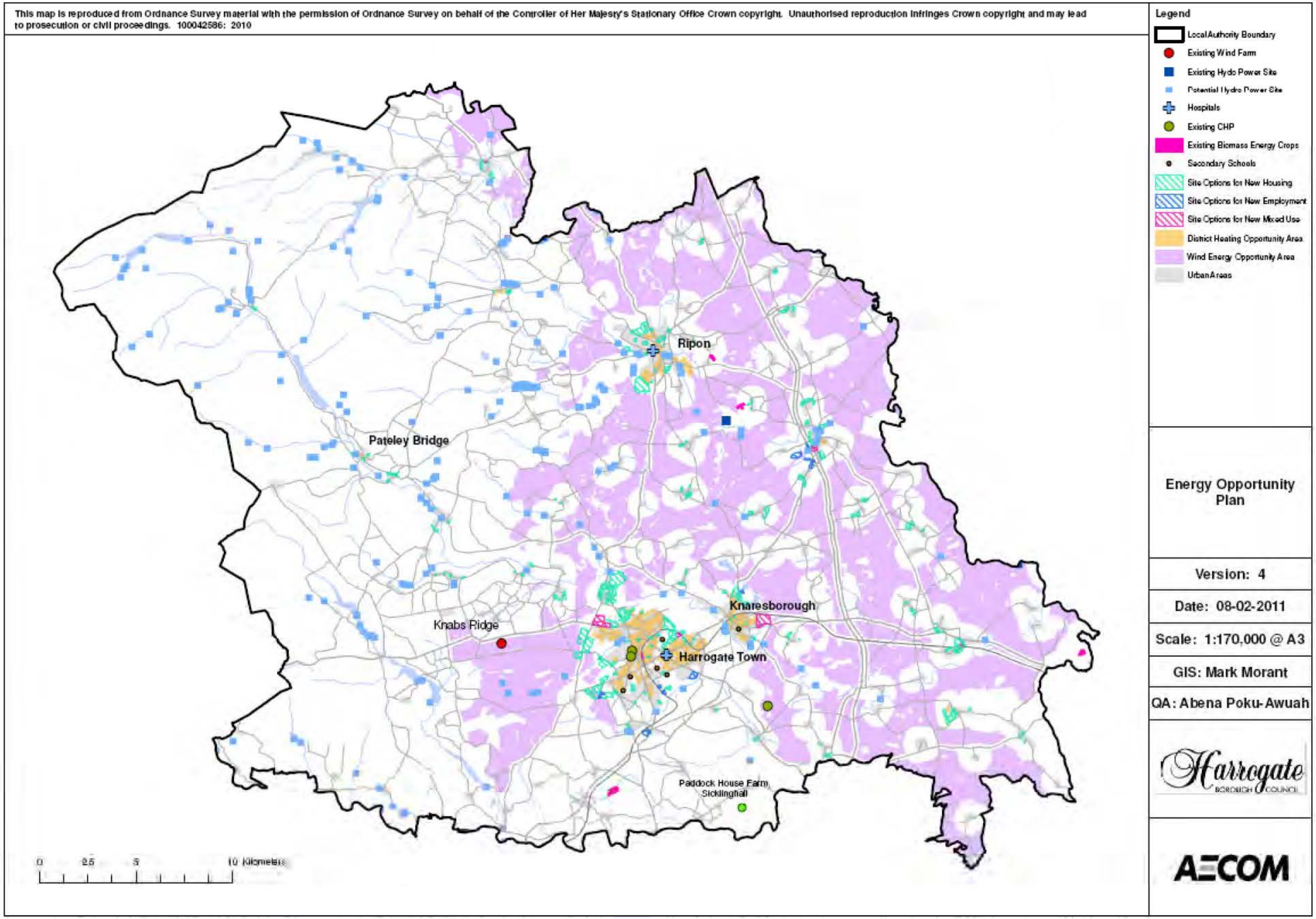


Figure 1: Energy Opportunities Plan for Harrogate District

# Introduction

# 1 Introduction

Harrogate Borough Council commissioned AECOM to undertake a Planning and Climate Change Study for Harrogate District. This chapter describes the purpose and scope of the study, and the key policy drivers and context.

## 1.1 Purpose of the study

The purpose of this Planning and Climate Change study is to gather and present information on energy use, carbon emissions, and 'decentralised low carbon and renewable energy' resources and opportunities in Harrogate District. The results will inform Harrogate Borough Council's activities to support carbon emissions reductions from homes and non-domestic buildings, and to increase the supply of renewable and low carbon energy in the District.

The study forms part of the evidence base for the emerging Harrogate District **Sites and Policies** Development Plan Document (DPD). The DPD will include development control policies, site allocations and a Proposals Map. The DPD and Harrogate District Core Strategy will replace the Harrogate District Local Plan (Adopted 2001, Selective Alterations 2004, Saved Policies 2007).

## 1.2 National context

### 1.2.1 Climate change policy and targets

The **Climate Change Act (2008)** sets a legally binding target to reduce UK carbon emissions by 80% by 2050. The Committee on Climate Change is responsible for setting binding 5-year carbon budgets on a pathway to achieve the 2050 target. The first three carbon budgets, announced in the 2009 Budget, aim for carbon savings of 34% by 2020.

The **UK Low Carbon Transition Plan (2009)** sets out an approach to meeting national carbon saving targets. The plan calls for carbon emissions from existing homes to be reduced by 29% by 2020 and emissions from places of work to be reduce by 13% by 2020 (against a 2008 baseline).

The UK is committed to supply 15% of all energy use from renewable sources by 2020. (This is part of an EU commitment to increase the proportion of energy supplied from renewables to 20% by 2020.) The UK **Renewable Energy Strategy (2009)** anticipates that renewables will need to contribute around 30% of electricity supply, 12% of heating energy and 10% of transport energy to meet this target.

The Coalition: our programme for government (2010) includes support for an increase in the EU emission reduction target to 30% by 2020.[1] It also confirms that the Coalition intends to retain the target of 80% emissions reductions by 2050[1].

The Government's **Household Energy Management Strategy**[2] sets out a commitment to district heating and describes the role of local authorities and communities in facilitating delivery. It also describes the role of local authorities in delivering improved energy performance of homes across the private and affordable housing sectors, as part of a more coordinated approach including Pay as You Save and a new obligation on energy supply companies.

### 1.2.2 Planning policy on climate change and renewables

**PPS 1 Supplement on Planning and Climate Change** expects local authorities to encourage the uptake of decentralised renewable and low carbon energy generation through the Local Development Framework.

The PPS 1 Supplement states that planning authorities should have "*an evidence-based understanding of the local feasibility and potential for renewable and low-carbon technologies".* It goes on to explain that, by drawing on the evidence base and with consistency in housing and economic objectives, planning authorities should:

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

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

*(iii) set out the type and size of development to which the target will be applied; and*

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

The PPS 1 Supplement states that in preparing Core Strategies, planning authorities should:

[1] HM Government, The Coalition: our programme for government http://programmeforgovernment.hmg.gov.uk/ (accessed 08/07/10)
[2] HM Government (February 2010) Warm Homes, Greener Homes: A Strategy for Household Energy Management

*"Consider identifying suitable areas for renewable and low-carbon energy sources, and supporting infrastructure. Care should be taken to avoid stifling innovation including by rejecting proposals solely because they are outside areas identified for energy generation and…*

*Expect a proportion of the energy supply of new development to be secured from decentralised and renewable or low-carbon energy sources."*

These policies recognise that local authorities can play a key role in delivering low carbon communities that will contribute to meeting national carbon reduction targets.

**PPS 22: Renewable Energy**[3] describes national policy and requirements for local authorities in relation to planning for renewable energy infrastructure. Parts of PPS 22 have been superseded by contents of the PPS 1 Supplement.

PPS 22 applies to onshore renewable energy development, and to CHP that does not use renewable fuels. It encourages planners to support and promote renewable energy development "*in locations where the technology is viable and environmental, economic, and social impacts can be addressed satisfactorily*". It requires local planning authorities to set out clear criteria for assessing planning applications. It states that "*the wider environmental and economic benefits*" of renewable energy projects are material considerations with "*significant weight*" in determining planning applications. It also requires local authorities and their partners to encourage community involvement in renewable energy projects and promote public understanding and acceptance. The PPS describes constraints that should be taken into account in planning for renewable energy development, including designated sites, green belt, visual impact, noise and odour.

Communities and Local Government consulted on a **draft PPS 1 Supplement: Planning for a Low Carbon Future in a Changing Climate**[4] in March 2010. This replacement PPS 1 Supplement combines and updates the contents of the existing PPS 1 Supplement and PPS 22. The draft represents an evolution in the way planners are expected to deal with climate change. It reflects legislative and policy changes, provides a clear policy framework for planners, and supports the spatial and facilitative approach that a growing number of authorities have been adopting. It supports the notion that the role of planning is to spatially identify energy and climate risks and opportunities and to use this understanding as the basis for planning policies designed to support action and delivery.

One of the key statements in the draft replacement PPS 1 Supplement is that "*Targets for application across a whole local authority area which are designed to secure a minimum level of decentralised energy use in new development will be unnecessary when the proposed 2013 revisions to Part L of the Building Regulations (for both domestic and non-domestic buildings) are implemented*". This reflects the statement in PPS12: Local Spatial Planning (2008) that "*the Core strategy should not repeat or reformulate national or regional policy*" and the note in the current PPS1 Supplement that *"controls under the planning, building control and other regulatory regimes should complement and not duplicate each other"*.

The draft Overarching National Policy Statement for Energy (EN-1) (2009) and National Policy Statement for Renewable Energy Infrastructure (EN-3) (2009) are the most recent description of policy for determining applications for major renewable energy infrastructure (over 50 MW for onshore wind, biomass and energy from waste projects and over 100 MW for offshore wind). Following the abolition of the Infrastructure Planning Commission, planning applications for such schemes are expected to be determined by a dedicated team in the Planning Inspectorate, reporting to the Secretary of State.

### 1.2.3 Future changes to the planning system

The coalition government has announced that it will make significant changes to the planning system, including commitments to abolish Regional Spatial Strategies and return decision-making powers on housing and planning to local councils and to maintain environmental designations including Green Belt and Sites of Special Scientific Interest (SSSIs), and create a new designation for green areas of particular importance to local communities.

Some of the government's proposals will require primary legislation before they can be implemented. Although the primary legislation has not yet been passed, action has already been taken to dismantle the regional level of planning.

Regional Spatial Strategies remain a material consideration in planning terms but it is expected that this is time limited, they are not expected to be a part of the local development framework in the future.

It is our understanding, however, that where local authorities are keen to retain regional policies and targets, they can be

[3] CLG (2004) Planning Policy Statement 22: Renewable Energy
[4] CLG (March 2010) Consultation on a PPS: Planning for a Low Carbon Future in a Changing Climate

incorporated in the local development framework and adopted, where justified by the existing regional evidence base.

## 1.3 Regional policy context

### 1.3.1 Regional planning policy

The **Regional Spatial Strategy (RSS)**, commonly known as the **Yorkshire and Humber Plan**, was adopted in 2008 and contained a number of policies designed to increase the installed renewable energy capacity in the region.The Plan expected local authorities to set targets for grid-connected renewable energy and set an interim 'decentralised and renewable or low carbon energy' target for new developments for the period before Local Development Frameworks are adopted.

Policy ENV5 proposed an indicative target for Harrogate District to install 70 MW of grid-connected renewable energy by 2021. It also set out an interim 'decentralised and renewable or low carbon energy' target for new developments for the period before local authority policies in their own Local Development Frameworks are adopted:

*"In advance of local targets being set in DPDs, new developments of more than 10 dwellings or 1000 $m^2$ of non-residential floor space should secure at least 10% of their energy from decentralised and renewable or low-carbon sources, unless, having regard to the type of development involved and its design, this is not feasible or viable."*[5]

On 6 July 2010 the Secretary of State for Communities and Local Government announced the revocation of Regional Spatial Strategies with immediate effect. A **letter to chief planning officers**[6] stated that:

*"Regional Strategies are being revoked under s79(6) of the Local Democracy Economic Development and Construction Act 2009 and will thus no longer form part of the development plan for the purposes of s38(6) of the Planning and Compulsory Purchase Act 2004."*

In relation to renewable and low carbon energy the letter stated:

*"Through their local plans, authorities should contribute to the move to a low carbon economy, cut greenhouse gas emissions, help secure more renewable and low carbon energy to meet national targets, and to adapt to the impacts arising from climate change. In doing so, planning authorities may find it useful to draw on data that was collected by the Regional Local Authority Leaders' Boards (which will be made available) and more recent work, including assessments of the potential for renewable and low carbon energy."*

CALA Homes, a housing developer, sought a judicial review of the revocation of the RSS, arguing that parliamentary scrutiny was needed for a fundamental change to the planning system and that the environmental impact of removing RSS should be considered, in line with European law. This legal challenge was successful, leaving the future of RSS uncertain.[7]

Whatever the fate of the RSS, there remains a need for strategic planning which transcends local authority boundaries, to ensure that the approach to tackling climate change and increasing the supply of renewable and low carbon energy is both efficient and effective.

### 1.3.2 Regional evidence base on decentralised and renewable or low carbon energy

Work by Local Government Yorkshire and Humber on a **Renewable and Low Carbon Energy Capacity Study** as part of a regional evidence base is continuing. A draft report for Part B of the study was issued in June 2010 to all local authority and other regional stakeholders. The study follows the DECC methodology for regional capacity assessments[8] (hereafter referred to as the "DECC methodology") and focuses on opportunities and constraints mapping and an initial assessment of resources in the region. The report includes individual energy opportunities maps and resource assessment results for each local authority, including Harrogate Borough Council. The report also set out an approach for a Part C study, which will look in more detail at economic viability, deployment constraints and delivery options[9], to inform target setting.

## 1.4 Local policy context

### 1.4.1 Local planning policy

**Harrogate Borough Council Core Strategy** (2009) sets out the District's direction and strategy for development and

[5] Harrogate Borough Council (2010) Validation Certificate: Sustainable Construction and Design [WWW] (www.harrogate.gov.uk/pdf/DS-P-LDF_CS_EQ1validationcriteria_020610.pdf)
[6] Letter to Chief Planning Officers: Revocation of Regional Strategies. http://www.communities.gov.uk/documents/planningandbuilding/pdf/1631904.pdf

[7] Planning, The Journal of the Royal Town Planning Institute Issue 1895, November 2010
[8] Renewable and Low-carbon Energy Capacity Methodology for the English Regions, SQW Energy, January 2010
[9] The Part C report was issued in January 2011.

conservation to the year 2021 and beyond. Policy EQ1 of the Harrogate District Core Strategy states that

*"…until a higher national standard is required, all new development requiring planning permission should:*

*For residential development (excluding extensions)*

*Attain the following levels of the Code for Sustainable Homes:*

- *Up to 2010: Code level 3*
- *2011 to 2015: Code level 4*
- *2016 onwards: Code level 6"*

*For other types of development*

*"Attain 'very good' standards as set out in the Building Research Establishment Environmental Assessment Method (BREEAM)."*

Developers may ask for Code for Sustainable Homes targets to be waived. In such cases, they are expected to demonstrate that it is not feasible to achieve the targets or that meeting them would threaten the viability of development.

The Code for Sustainable Homes (the Code) is a national system for rating the environmental performance of new housing in England, introduced in 2007. Developments are assessed under nine environmental categories: energy and $CO_2$ emissions; water; materials; surface water run-off; waste; pollution; health and well-being; management; and ecology. A rating from Level One to Level Six is awarded to each dwelling type in a scheme. There is a mandatory performance standard for carbon emissions at each Level.

The Code is mandatory for homes built with public housing grant and subject to the Homes and Communities Agency Scheme Development Standards, which currently require Code Level 4[10]. In terms of national policy, the Code remains voluntary for new private homes. (The Secretary of State for Communities and Local Government laid an Order in Parliament suspending Home Information Packs in May 2010 and confirmed that they will be abolished. This effectively removes the requirement for developers to provide information on the environmental performance of all new homes in the form of a Code certificate, and to provide a nil-rated certificate where homes are not assessed, which was part of the mandatory content of Home Information Packs.)

BREEAM is a voluntary system for rating the environmental performance of new non-residential buildings. (There is also a BREEAM scheme for existing offices.) It assesses developments under nine environmental categories: energy, water, materials, waste, pollution, health and well-being, management, land use and ecology and transport. As of August 2008, the ratings that can be achieved are Pass, Good, Very Good, Excellent and Outstanding, with mandatory standards for $CO_2$ emissions for each rating.

There are number of other Core Strategy policies that have relevance to this study. For example, SG4 covers 'Settlement growth: design and impact' and EQ2 focusses on protecting the Green Belt.

#### 1.4.2 Harrogate Borough Council drivers, corporate policy and commitments

**Harrogate District Planning and Climate Change Study** sets out how the Council intends to reduce $CO_2$ emissions across its own operations and across the District, and prepare for the effects of climate change. The aim is to reduce $CO_2$ emissions by 40% by 2020 and by 80% by 2050.

The strategy includes plans: to implement energy efficiency measures and an energy saving campaign, to "carry out feasibility study on developing an Energy Services Company", to "evaluate Ground Source Heat Pump installations in council homes by the end of 2010, with a view to determining the cost benefits... to the remaining Council housing stock", and to "participate in EST renewable research".

The Council has also signed the **Nottingham Declaration**, committing the District to "work with central government to contribute, at a local level, to the delivery of the UK Climate Change Programme, the Kyoto protocol and the target of carbon dioxide reduction by 2020."

### 1.5 Building Regulations and Zero Carbon Buildings

#### 1.5.1 Current Building Regulations Part L

Energy use and carbon emissions in new and existing buildings are covered by Part L (Conservation of fuel and power) of the Building Regulations. The latest version of Part L took effect in October 2010 and requires a 25% reduction in $CO_2$ emissions (relative to 2006) from heating, ventilation, fixed lighting and air conditioning systems (regulated emissions).

Certain classes of historic buildings are expressly exempted from the need to comply with the energy efficiency requirements of the Regulations where compliance would unacceptably alter their character and appearance. These are

[10] "Affordable homes to become renewable with £5m share of government grant" press release (Homes and Communities Agency website, November 2009)

listed in Regulation 21(2),(c) and Regulation 21(3), and comprise buildings which are:

- Listed buildings at Grades I, II* and II (listed in accordance with section 1 of the Planning (Listed Buildings and Conservation Areas) Act 1990.)
- Buildings in a conservation areas - designated in accordance with section 69 of that Act.
- Scheduled monuments - included in the schedule of monuments maintained under section 1 of the Ancient Monuments and Archaeological Areas Act 1979.

### 1.5.2 Zero carbon buildings policy

Following consultation, the Government announced in July 2007 that all new homes will be zero carbon from 2016. In the Budget 2008, the Government also announced its ambition that all new non-domestic buildings will be zero carbon from 2019 and all new schools and other public buildings will be zero carbon from 2016.

### 1.5.3 Future Building Regulations Part L

In July 2007, Communities and Local Government published "A forward look at what standards may be in 2010 and 2013" indicating that 2013 Building Regulations could be based on a 44% reduction in regulated emissions for new homes (relative to 2006), to ease the transition to zero carbon homes from 2016. The 44% reduction in 2013 would still apply only to regulated emissions. The zero carbon policy and indicative proposals for 2016 Regulations apply to all energy-related emissions, including cooking and appliances.

Communities and Local Government consulted on the Definition of Zero Carbon Homes at the beginning of 2009. It proposed a definition of zero carbon new homes, based on:

- High energy efficiency standards, for the building fabric and services;
- 'Carbon compliance', meaning on- or near-site systems that reduce carbon; and
- 'Allowable solutions', for dealing with the remaining emissions.

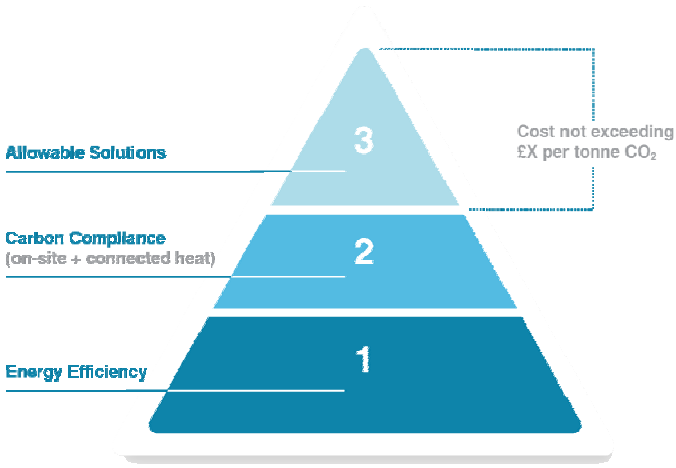


Figure 2: The governments proposed zero carbon hierarchy

The consultation indicated that the proportion of carbon savings to be delivered by energy efficiency could be in the range 25% to 44%. The consultation invited views on levels of carbon compliance of 25%, 44%, 70%, and 100% of regulated emissions and 100% plus emissions from cooking and appliances. 'Allowable solutions' were not finally defined but included:

- Further carbon reductions on site;
- Energy efficient appliances;
- Advanced forms of building control system which reduce the level of energy use in the home;
- Exports of low carbon or renewable heat from the development to other developments, and
- Investments in low and zero carbon community heat infrastructure.

Other allowable solutions remain under consideration.

For non-domestic buildings an 'aggregate approach' is being considered, whereby different building types will contribute different levels of $CO_2$ emissions reductions such that the overall 25% reduction would be achieved annually across all types. The level of emission reductions will be set on the basis of the technical and financial feasibility.

### 1.6 Key considerations emerging from this chapter

The previous sections have considered the wider policy context which will influence the development of policies for Harrogate. Key considerations emerging from this chapter are:

- There are challenging policy drivers for both the reduction of $CO_2$ emissions and the inclusion of renewable and low carbon technologies from a national level.
- These drivers are reinforced by targets and policy at a regional level, although to some extent regional targets are out-of-date due to recent changes in national policy and in the Building Regulations.
- The Harrogate District Core Strategy already contains policies requiring relatively high standards of sustainable construction and a percentage of a new home's energy requirements to be sourced from onsite, renewable energy generation. This study will identify strategic sites within Harrogate where potential for additional $CO_2$ reductions exist, in accordance with the PPS1 Supplement.
- The proposed changes to Building Regulations may create demand for 'allowable solutions,' where after 2016, new development will be allowed to incorporate renewable and low carbon solutions outside of the site boundary to achieve a reduction in $CO_2$ emissions.

# Baseline carbon emissions

# 2 Baseline carbon emissions

This chapter presents information on the existing building stock in Harrogate District, expected future growth over the period of the Core Strategy, and current $CO_2$ emissions from the building stock.

### 2.1 Existing Building Stock

Harrogate District has a population of around 157,900 (June 2009)[11] in approximately 69,000 households. It is primarily rural with three main settlements: Town of Harrogate (population in 2005: 73,000), Knaresborough (population in 2005: 15,000) and Ripon (population in 2005: 16,300). There are at least 120 smaller settlements across the District, including several small market towns.[12]

Building use (homes, employment), built form, and tenure have an influence on energy use and $CO_2$ emissions and on the options for energy efficiency interventions in buildings.

Detached properties, which tend to have relatively high energy use and $CO_2$ emissions, make up 59% of the housing stock in Harrogate District, a higher proportion than for the Yorkshire and Humber region overall.

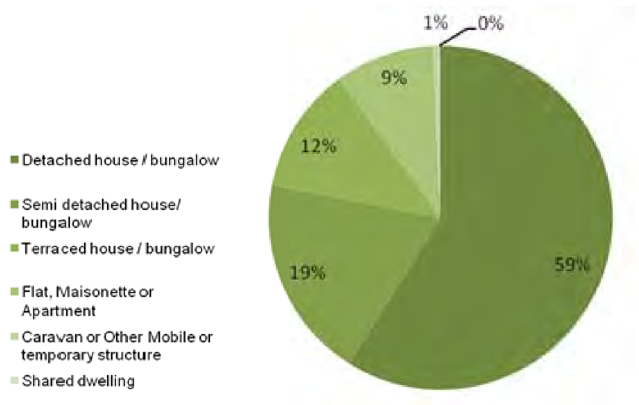


Figure 3 Breakdown of house types in Harrogate District (Source: Strategic Housing Market Assessments for Yorkshire and Humber, final report on Harrogate market area, June 2009)

91% of homes are owner-occupied. Uptake of energy efficiency will therefore be reliant on dissemination of best practice using existing levers and routes to home owners, such as planning, building control, advertising campaigns and financial incentives. Social housing in the District consists mostly of flats and terraced houses.

Table 1: Housing stock in Harrogate District by tenure (Source: Neighbourhood Statistics, Dwelling Stock by Tenure and Condition, 2008; and Dwelling Completions data from Harrogate Borough Council)

| Housing Tenure | Number of occupied households | Proportion |
|---|---|---|
| Owned | 62,714 | 91% |
| Social rented | 6,354 | 9% |
| **Total** | **69,068** | **100%** |

Employment uses are concentrated primarily in urban locations of Harrogate Town, Knaresborough and Ripon.

Further detail on the characteristics of buildings in Harrogate District is included in section 3.

### 2.2 Future growth in Harrogate District

As part of the Coalition Government's commitment to localism and decentralisation, the Secretary of State for Communities and Local Government wrote to local planning authorities and the Planning Inspectorate in June 2010 highlighting plans to abolish regional spatial strategies such that decisions on housing supply *"...will rest with LPAs without the framework of regional numbers and plans"*. This will not have a material impact on housing targets for Harrogate District, which have already been included in the adopted Core Strategy.

The overall new dwellings target in the District is 7,410 for the period 2004 to 2023. Table 2 shows potential housing development as identified in the Strategic Housing Land Availability Assessment. The Harrogate Annual Monitoring Report for 2009 noted that housing development between 2010 and 2016 was likely to be higher than the average requirement set out in the Harrogate District Core Strategy of 390 dwellings per year, and that it was probable that some homes would need to be built on greenfield land.

[11] http://www.harrogate.gov.uk/harrogate-4072
[12] Strategic Housing Market Assessments for Yorkshire and Humber, final report on Harrogate market area, June 2009

Table 2: Housing supply versus RSS housing requirement up to 2023/4

| Years | SHLAA supply | RSS housing requirement |
|---|---|---|
| 0 - 5 | 7,309 | 1,950 |
| 6 - 10 | 13,521 | 1,950 |
| 11 – 15 | 11,617 | 1,950 |
| **Total 0 - 15** | **32,447** | **5,850** |
| **Housing supply for beyond 16 year** | | **2,882** |

Performance indicator JB3 details plans for land for jobs and business including what the council believes is a good range and mix of employment sites. Provision has been made for 45 hectares of land from 2005-2021 for employment and so far development land has already been allocated to Boroughbridge (0.86ha), Harrogate Town (4.36ha), Knaresborough (8.95ha), Ripon (15.3ha), Rural East (5.02ha) and Rural West (2.36ha). A further 5ha and 3ha have been identified for the provision of new employment land in Harrogate Town/Knaresborough and Boroughbridge (respectively). The specific location of new employment sites will be set out within the Sites and Policies DPD.

## 2.3 Baseline Energy Consumption and $CO_2$ Emissions

The National Indicator 186 statistics provides a breakdown of $CO_2$ emission sources for each local authority area in North Yorkshire across three sectors – industry/commercial, domestic and road transport as shown in Table 3. Sector $CO_2$ emissions in the Harrogate District are relatively evenly split between industry and commercial, domestic and road transport sectors (see Figure 4). Emissions within Harrogate District are the highest of the local authorities within North Yorkshire and with the exception of Selby's industry and commercial sector Harrogate District has higher emissions by sector than all of the other local authorities.

The spatial distribution of gas consumption across Harrogate District is shown in Figure 29.

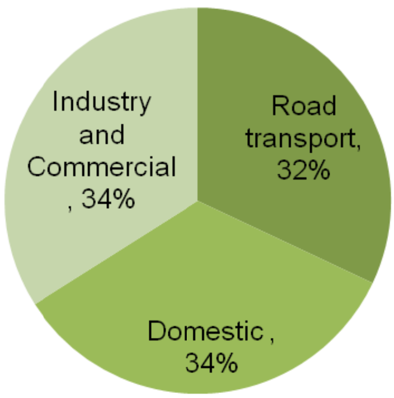


Figure 4: Breakdown of $CO_2$ Emissions in '000 tonnes in Harrogate by sector (Source: NI 186, 2006).

Table 3: Summary of $CO_2$ emissions per sector for Harrogate District ('000 tonnes) and other North Yorkshire local authorities.[13]

| Local Authority | Industry and Commercial | Domestic | Road Transport | Total | Proportion of $CO_2$ emissions | Proportion of population |
|---|---|---|---|---|---|---|
| Craven | 166 | 159 | 208 | 534 | 9% | 9% |
| Hambleton | 300 | 235 | 498 | 1,033 | 17% | 15% |
| Harrogate | 489 | 443 | 433 | 1,366 | 23% | 27% |
| Richmondshire | 132 | 128 | 243 | 503 | 8% | 8% |
| Ryedale | 237 | 141 | 215 | 592 | 10% | 9% |
| Scarborough | 330 | 302 | 202 | 834 | 14% | 19% |
| Selby | 525 | 212 | 365 | 1,101 | 18% | 13% |
| **Total** | **2,179** | **1,620** | **2,165** | **5,964** | **100%** | **100%** |

[13] National Indicator Set, Audit Commission, release date - 2009

## 2.4 Key considerations emerging from this chapter

The baseline for $CO_2$ emissions in Harrogate District has been established in this chapter. Key considerations emerging from this chapter are:

- An understanding of the scale of existing and future local energy demand is important in order to set appropriate planning policies and targets.
- Harrogate District is a key growth location and has an RSS target of 390 new homes annually between 2008 and 2026. This housing number is also set out in the Harrogate District Core Strategy (adopted February 2009)
- $CO_2$ emissions in the Harrogate District are relatively evenly split between industry and commercial, domestic and road transport sectors. Harrogate District's emissions are the highest of the local authorities within North Yorkshire, although this is consistent with the high population.

# Opportunities for Energy Efficiency

# 3 Opportunities for Energy Efficiency

To make significant reductions in energy use and $CO_2$ emissions, Harrogate Borough Council should explore opportunities to address the efficiency of the existing stock alongside promoting high standards in new development.

This chapter considers the potential for increased energy efficiency in the existing building stock as well as higher standards of energy efficiency in new developments.

## 3.1 Factors that influence building energy efficiency

The energy performance of buildings depends on a number of factors including:

- **Building types:** All other things being equal, terraced houses and flats, with shared walls and reduced heat loss area, have lower heat demands than detached homes.
- **Age:** Thermal performance of buildings has improved with time, particularly following the introduction of Part L of the Building Regulations and progressive increases in its minimum requirements. Insulation, glazing performance and air-tightness has all improved significantly. Generally the opportunities or ‘key wins’ for improving energy efficiency are greater on older building stock.

  The uptake of some energy efficiency measures is relatively independent of age (e.g. loft insulation), whilst for other measures building age is a key factor. Key examples of age dependent interventions include glazing (some replacements may require consent) and solid walls (typically found on pre 1920 dwellings) requiring internal or external insulation.
- **Tenure:** Tenure and the utility billing arrangements affect the energy use of a property, and more specifically the opportunities for energy efficiency intervention. The most recent English House Condition Survey revealed that social sector homes are the most energy efficient and have also shown the highest rate of improvement since 1996[14]. This is due to government funded schemes such as the first phase of Powergen’s Warmfront programme under the The Home Energy Efficiency Scheme (England) Regulations 2000, large scale retrofit opportunities, and the generally newer nature of the social housing stock.

In some rented or leased properties, payment of a fixed service charge rather than utility bills linked to metered consumption reduces the incentive for tenants to minimise their own energy use.

Landlords face a ‘split incentive’ in terms of the energy efficiency of rented properties: they pay for improvements while tenants (who pay utility bills) benefit from savings. The Landlord Energy Saving Allowance addresses this, allowing up to £1,500 spent on certain efficiency improvements to be offset against taxable profits. This applies until April 2015 to spending on: cavity wall and loft insulation, solid wall insulation, draught proofing and hot water system insulation, and floor insulation.

Under The Home Energy Conservation Act 1995 (HECA), local authorities with housing responsibilities are required to implement practical and cost-effective measures to improve the energy efficiency of all accommodation in their area and report on progress. The national target is to achieve a 30% reduction in energy consumption across the entire housing stock (including private housing) from 1995 levels by 2011.

## 3.2 Existing building stock in Harrogate District

### 3.2.1 Harrogate Town

The Draft Conservation Area Character Appraisal[15] charts the historical development of Harrogate Town and provides an indication of the age, construction and conservation status of its existing dwellings. This is of some limited benefit in considering potential energy efficiency interventions for buildings in the town. There are 9 character areas within the existing conservation area. Maps within the character appraisal show that buildings immediately surrounding the conservation area are predominantly either 1920’s – 1960’s or post 1960’s.

### 3.2.2 Other parts of Harrogate District

Around half of the population of the District resides in Harrogate Town, but it is also important to consider building types and potential for energy efficiency intervention in the smaller settlements of Knaresborough, Ripon, Boroughbridge, Pateley Bridge and Masham and numerous other smaller villages and countryside settlements.

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[14] English House Condition Survey, 2007 (Department for Communities and Local Government, September 2009)

[15] Draft Conservation Area Character Appraisal, October 2009

### 3.3 Energy efficiency improvements to date

Data collected in 2003 indicated that the energy efficiency of private sector homes in the Harrogate District is lower than both the national and the regional averages. In 2006 the average SAP Rating (Standard Assessment Procedure where 1=inefficient; 120=highly efficient) for new private sector homes in the District was 46, compared to a regional average of 51 (Source: Regional Spatial Strategy 2006). However, ongoing monitoring has shown that recent energy efficiency improvements in the District's housing stock have exceeded the average improvements at the regional and national levels. Energy efficiency improvement in the Harrogate District for the years 1996-2007 was 28.09%, in the Yorkshire and Humber Region it was 22.05% and nationally it was 21.29%. (Source: DEFRA)

Data from the Home Energy Efficiency Database (HEED) indicates that the many of the external wall cavities (42% of respondents) have already been filled for homes in Harrogate District.

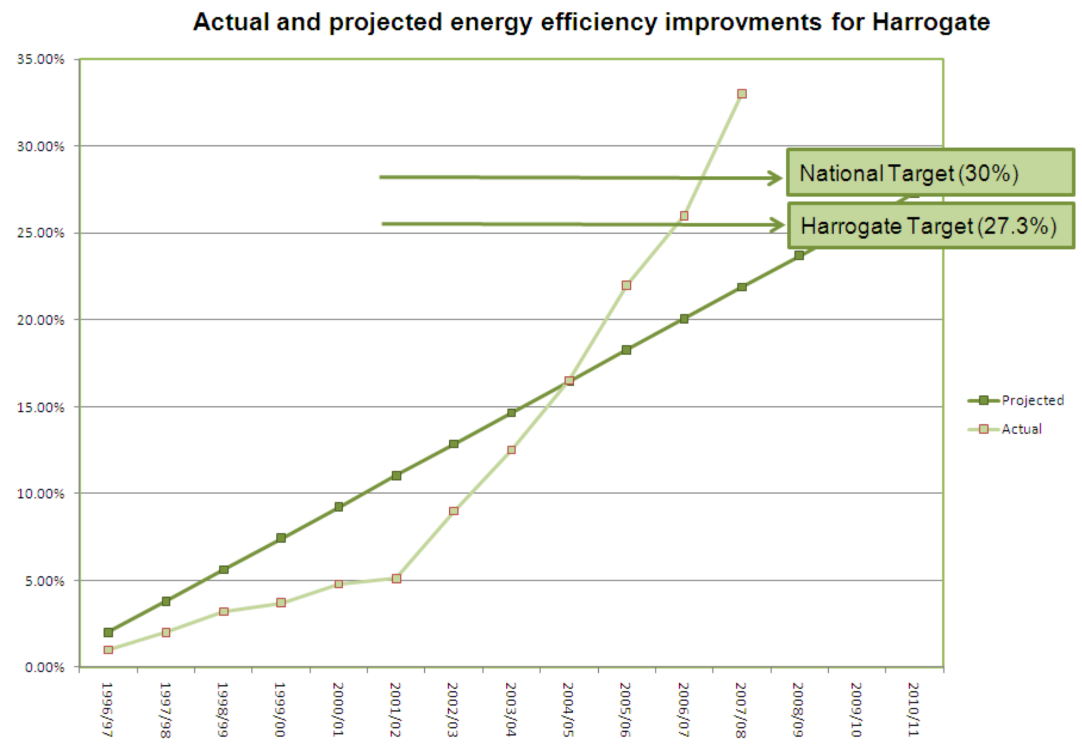


Figure 5 Graph showing actual and projected energy efficiency improvmenst for existing homes in Harrogate

### 3.4 Potential for future energy efficiency improvements

The latest HECA results for Harrogate District reports an energy efficiency improvement of around 7% over the year April 2007 to March 2008 with the greatest savings found in owner occupier dwellings. This is part of an overall improvement in energy efficiency from April 1996 to 31st March 2008 of 33% and an estimated saving of 975 tonnes of $CO_2$. This is an improvement on both the locally set target of 27.3% (by 2011) and the nationally set 30% improvement target.[16]

Table 4 Domestic loft insulation of dwellings within Harrogate District (Source: 2010 Area Summary Report)[17]

| Loft Insulation | | |
|---|---|---|
| Properties with no loft insulation | 347 | 1.9% |
| - less than 25mm | 57 | 0.3% |
| - with 25 - 49mm | 200 | 1.1% |
| - with 50 - 74mm | 864 | 4.7% |
| - with 75 - 99mm | 502 | 2.7% |
| - with 100 - 149mm | 1,424 | 7.7% |
| - with 150 - 199mm | 1,006 | 5.4% |
| - with 200 - 249mm | 465 | 2.5% |
| - with 250 - 299mm | 1,047 | 5.7% |
| Unknown / Not Available | 12,598 | 68.1% |
| **Total** | **18,510** | **100%** |

Table 5 Domestic external wall types within Harrogate District (Source: 2010 Area Summary Report)[17]

| External Wall Type | | |
|---|---|---|
| Solid | 1,495 | 8.1% |
| Stone | 1,140 | 6.2% |
| Timber Framed | 189 | 1.0% |
| Cavity | 1,817 | 9.8% |
| Filled Cavity | 3,571 | 19.3% |
| Other Construction | 310 | 1.7% |
| Unknown / Not Available | 9,988 | 54.0% |
| **Total** | **18,510** | **100%** |

This data indicates that the uptake of efficiency measures across the District and the efficiency of council-funded energy efficiency grants continue to be successful. Grants have primarily been offered to those residents most at risk of suffering from fuel poverty and approximately 1,000 school children and their families were engaged as part of the Council's Climate Action Programme.

Table 6 National Indicator 187 - Tackling Fuel Poverty results for Harrogate District (2008/9). Results are based on a total sample size of 5,000 homes.

| Survey Results | Number | Proportion |
|---|---|---|
| Those with a SAP rating of less than 35 | 62 | 13.5% |
| Those with a SAP rating of more than 65 | 186 | 39% |
| Those with a SAP rating in between | 226 | 47.5% |
| **Total** | **474** | |

### 3.5 Improving Energy Efficiency of Existing Homes

Approved Document L1B (ADL1B) applies to existing homes. It seeks to improve the energy efficiency of existing dwellings as and when they are renovated, extended or altered.

The regulations take a component approach, defining minimum standards for specific elements of a dwelling (e.g.walls, doors etc). This is in contrast to Part L1A for new dwellings, which sets an overall energy efficiency target for the building as a whole.

The minimum standards were tightened as part of the 2010 update, for thermal elements, controlled fittings and services. The biggest change is in the standard for replacement windows and is presented in two different metrics. If assessed using the Window Energy Rating, the standard has been raised by two grading bands (from "E" to "C"). If assessed using area-weighted U-values, the standard has been raised from 2.0 W/($m^2$.K) to 1.6 W/($m^2$.K). Additional guidance is provided

[16] Home Energy Conservation Act Progress report 2007/8, Harrogate Borough Council, October 2008
[17] Home Energy Efficiency Database

where the new standards are not possible to achieve because of the need to maintain the external appearance of the façade or the character of the building.

In respect of the practical measures that can be considered to improve efficiency of existing dwelling, key measures, benefits and practical considerations are set out below.

It should be noted that improving energy efficiency does not always result in a reduction in energy consumption. A “rebound effect” has been identified where any $CO_2$ savings from energy efficiency improvements are nullified by changes in occupier behaviour. A better insulated house needs less fuel to maintain a given temperature but as fuel costs decline, people might turn up the thermostat in a process of increased “comfort taking”. Cheaper fuels can create affordable warmth, but also lead to increased energy consumption.

### 3.5.1 Insulation

The rate of heat loss through the building fabric will depend upon the thermal properties of the building material and the area through which heat loss can take place; this is measured by a parameter known as a U-value. A lower U-value means a lower rate of heat loss.

In existing buildings, the main method of improving the U-values of the fabric is through improved insulation in the loft and cavity walls where possible; this is straightforward to apply and relatively cheap.

Insulation can be applied internally, but this can reduce the size of rooms and can be disruptive to occupants. Alternatively, insulation can be applied externally, which can be costly, may require units in blocks of flats to be treated simultaneously and may be restricted by planning constraints. Improved window glazing is also effective.

Reducing U-values can affect the construction of new buildings. Achieving lower U-values for walls can result in them being thicker than conventional specifications, although this will depend upon the insulation type that is being used.

### 3.5.2 Air Tightness and Thermal Bridging

In existing buildings, draught-proofing of the building envelope, for example sealing joints around service pipes and at junctions will reduce heat loss through air infiltration.

### 3.5.3 Lighting

The penetration of natural daylight should always be enhanced to reduce the use of artificial lighting within buildings.

All buildings could make use of dedicated low energy light fittings (i.e. fittings which only accept low energy lamps), in conjunction with appropriate controls to reduce energy consumption. For example, smart controls can be specified which enable all lights to be switched off from a single switch, thus avoiding lights being left on during the night or periods of non-occupancy. External lighting can be controlled using daylight sensors or timers to avoid lights being switched on during daylight hours. Similarly, PIR sensors should be used for security lighting.

### 3.5.4 Heating and Hot Water

Heating fuel demand can also be reduced by replacing an old boiler with a high efficiency condensing boiler. These recover heat from the flue of the boiler, which would otherwise be wasted, and can convert over 86% of the energy in the fuel into heat, compared to as low as 65% for an old, inefficient boiler.

$CO_2$ emissions can be reduced by switching heating fuel for a less carbon-intensive alternative. Where a connection to the gas grid is available, natural gas produces lower $CO_2$ emissions per unit of heat supplied than grid-supplied electricity, oil or coal. The latest HEED report for Harrogate District suggests that 91% of respondent’s homes are on the gas network.

## 3.6 Energy efficiency in new dwellings

The measures which improve energy efficiency in new dwellings are largely the same as for existing homes but the regulatory drivers for energy efficiency when being designed into new homes is much stronger, and the opportunities are better when considered properly through the project design phase.

Part L1a deals with energy and carbon in new dwellings. Under this part of the building regulations developers must design a home to improve upon the target emission rate (TER). The target emission rate is calculated in computer software using the same dwelling size and geometry as proposed for the actual building but assuming fixed values for performance of fabric and plant. The actual building specification is then entered into the model to calculate the actual building emission rate (BER). The BER must be below the TER to pass building regulations. Currently there is some degree of flexibility about how the emissions targets are met – developers can opt to focus on efficiency or to spend less on efficiency and offset some carbon using low and zero carbon technologies. This has not always resulted in the most efficient homes being built. Proposals for Part L1a for 2016 include a mandatory minimum performace standard for fabric energy efficiency which will drive more energy efficiency homes. The Government's zero carbon hub has been working to propose these 2016 fabric energy efficiency (FEES) targets.

There are some concerns that improved fabric performance in a warming climate may lead to future problems of overheating. This needs to be considered in design.

The zero carbon hub's proposed FEES standards were defined considering buildability, form, construction type and cost. The standards can be achieved with natural ventilation. It is possible to build even more efficient new homes (e.g Passivhaus). Improving further on efficiency (beyond the minimum standard) will help reduce overall $CO_2$ emisisons.

### 3.6.1 Air tightness and thermal bridging - new buildings

The type of construction used in new building design affects how straightforward it is to achieve improvements in air tightness. For timber construction and other pre-fabricated constructions, an air tightness barrier can be incorporated into the panels so that the construction team only need to seal joints between panels. Structurally insulated panelised systems can also achieve good standards of air tightness. Conventional wisdom suggests that achieving this air tight membrane is more difficult in traditional masonry build, although air leakage rates of less than 3 $m^3/m^2hr$ @ 50 Pa have been recorded.

Homes with very low air permeability levels may require mechanical ventilation in order to achieve adequate ventilation. Such systems should incorporate heat recovery wherever possible, where heat from the air extracted from kitchens and bathrooms is used to warm incoming fresh air, thereby reducing the energy demands for heating. Additional electrical energy is required to operate the fans but if the fan power is low and the efficiency of heat recovery is high then the system should provide a net benefit in terms of reducing $CO_2$ emissions over the course of a year.

Thermal bridging can be designed out through attention to design detailing and careful construction. Accredited and enhanced construction details allow designers to reduce the number of thermal bridges.

### 3.6.2 Lighting – new buildings

For new buildings, the design should take advantage of south facing orientations and consider shading, internal layouts and window dimensions and specifications, all of which influence the levels of daylight and energy consumption for artificial lighting.

### 3.6.3 Passive Design and Reducing Overheating

There is a real risk of overheating in many of our buildings as higher temperatures are becoming more commonplace due to the effects of climate change. Overheating is often caused by excessive solar gains, particularly high angle and intensity sun during summer. Mechanical cooling is often used to avoid overheating, which can increase $CO_2$ emissions. Passive approaches include building orientation, shading (e.g. external louvres, shutters, or overshading from balconies) and the specification of green roofs and walls. Effective design can reduce overheating and provide beneficial solar gains during the winter months.

Layout design should also take account of the wind direction. Tree and shrub planting schemes can act as windbreaks, which will ensure wind chill factor is reduced.

Thermal mass can help control internal temperatures by acting as a buffer to the temperature variations through the day, by absorbing heat as temperatures rise and release heat as temperatures fall. For traditional masonry or stone construction, external walls will have large areas of external thermal mass. For timber or steel construction, thermal mass can be incorporated into the floors and internal walls. The addition of phase change materials to walls and floors in both existing and new buildings can add thermal mass.

### 3.6.4 PassivHaus

PassivHaus is a standard for ultra-energy-efficient homes where demand for space heating is dramatically reduced, often to the point where a separate heating system (such as a gas boiler) is no longer necessary.[18] A system will still be needed to supply hot water. The standard is met by using passive design, specifying very low U-Values, air tightness, thermal bridging, and the use of mechanical ventilation with heat recovery. Such buildings are high maintenance and need commitment, technical understanding and skill from occupants to operate to their intended performance. The standard is generally only targeted at new buildings.

Recent research suggests that once initial design and construction skills have developed, it is possible to construct PassivHaus buildings more easily and for less money than conventional buildings of similar types. There is currently considerable interest in this building technique in the UK, as evidenced by its mention in the recent zero carbon

[18] PassivHaus Institut website, http://www.passiv.de/07_eng/index_e.html, accessed August 2010

consultation. It remains to be seen whether it will take off as a viable option for new development.

## 3.7 Energy efficiency in non-domestic buildings

Many of the options for reducing $CO_2$ emissions from housing are also applicable to non-domestic buildings. However, non-domestic buildings tend to be more complex due to the variety of building types, the range of activities that they accommodate and the use of more sophisticated building services. Analysis of monitored data suggests that the energy performance of a non-domestic building is generally determined by its fabric, the mechanical services and the occupants. These operate as a system and each controls a range of performance. A poorly performing building may require greater input from services, which if badly managed can lead to high energy consumption. The reverse may also be true. The variation in the fabric, mechanical services or occupant behaviour can result in a 20 fold variation in energy performance.

We have described below the principles that should be adopted when improving energy efficiency in non-domestic buildings.

- Excessive areas of glazing should be avoided.
- CIBSE TM23[19] sets out best practice air permeability rates for different building types which should be adopted for all buildings.
- The most appropriate and efficient form of heating for a non-domestic building depends on the use. For buildings used intermittently (such as churches) or which have large air volumes (such as industrial units) radiant heating may be an effective form of heating. For buildings which are used more regularly and those with smaller air volumes, central hot water systems will be more effective.

The use of air conditioning has become widespread and is likely to become more so as summertime temperatures increase due to climate change. Air conditioned offices can consume about twice as much energy as naturally ventilated buildings[20]. However, studies have shown that in spite of the extra capital and running costs, occupant satisfaction is no greater (and often lower) than in naturally ventilated buildings. There is, therefore, a case for implementing strategies in non-domestic buildings that reduce the need for air conditioning.

These can include:

- Controlling solar gains through glazing - making maximum use of daylight while avoiding excessive solar gain.
- Selecting equipment with reduced power requirements (e.g. flat screen monitors).
- Separating high heat demand processes (including industrial processes, mainframe computers, large photocopiers, etc.) from office accommodation.
- Making use of thermal mass (and enhancing thermal mass with phase change materials) and night ventilation to reduce peak temperatures.
- Providing effective natural ventilation.
- Shading devices for the windows.
- Using task lighting to reduce background illuminance levels.
- Reducing energy demand for lighting by installing energy efficient lighting with a high light output ratio and selecting lamps with a high luminous efficacy.
- The use of pale colours on walls and ceilings to reduce the need for artificial lighting.
- Providing effective controls which prevent lights being left on unnecessarily.

Effective window design is essential in naturally ventilated buildings. Windows should allow ease of control by occupants regardless of desk arrangements. The benefits of daylighting and good window design are not only related to energy savings. There is growing evidence that the view from windows and the perception of the presence of daylight, even without direct views, is valued by occupants. This can lead to increased well-being and productivity, and also increased tolerance of non-neutral environmental conditions.

## 3.8 Key considerations emerging from this chapter

The sections above have considered the opportunities for reducing $CO_2$ emissions through increased energy efficiency in the existing stock and in new development in Harrogate District. Key considerations emerging from this chapter are:

- Harrogate Borough Council could play a key role in increasing energy efficiency of existing buildings. Existing buildings make up the bulk of the future

[19] TM23 Testing buildings for air leakage (CIBSE, 2000)
[20] Energy consumption guide 19: Energy use in office (CIBSE)

energy demand, and hence efforts must be made to reduce energy demand of existing stock.

- Existing non-domestic buildings often receive less focus than existing homes. The Council should support initiatives to increase energy efficiency in non-residential buildings in their area, particularly large energy users.
- Planning can affect $CO_2$ emissions by affecting the density of development and mix of house types. Higher densities should be encouraged where suitable.

# Opportunities for District Heating and CHP

# 4 Opportunities for District Heating and CHP

The PPS1 Supplement supports the development of networks to supply electricity and heat at a community scale from local sources (referred to as decentralised energy). This chapter discusses the opportunities in Harrogate District for establishing such networks.

### 4.1 District heating

District heating is an alternative method of supplying heat to buildings using a network of pipes to deliver heat to multiple buildings from a central heat source. Heat is generated in an energy centre and then pumped through insulated underground pipes to the building. Building systems are usually connected to the network via a heat exchanger, which replaces individual boilers for space heating and hot water. This is a more efficient method of supplying heat than individual boilers and consequently, district heating is considered to be a low carbon technology that can contribute towards $CO_2$ targets.

### 4.2 Combined Heat and Power (CHP)

The traditional method of generating electricity at power stations is inefficient, with at least 50% of the energy in the fuel being wasted. A CHP plant is essentially a localised power station but makes use of the heat that would normally be wasted through cooling towers. This heat can be pumped through district heating networks for use in buildings. Since it is generated closer to where it is needed, electricity losses in transmission are reduced (Figure 6).

A standard, gas-fired CHP typically achieves a 35% reduction in fuel use compared with conventional power stations and gas boilers. CHP can also run on biomass or biogas, reducing $CO_2$ emissions by almost 100% and contributing towards renewable energy targets.

The size of a CHP facility will be somewhat dependent on the number of homes it is to serve. For a facility to serve 1500 homes, a facility with a 500m$^2$ footprint will probably be required. If fuelled by biomass then the facility would also need to incorporate a fuel storage area. The majority of the building could be 4m high, but a section rising to 7-9m would also be needed to house the heat store and there would also be a flue which will need to be a few metres higher than surrounding development.

As CHP works best in higher density areas, siting facilities can become a challenge. However with sensitive and creative urban design, there is no reason why energy centres cannot be integrated into the townscape. The figure below highlights some potential options for urban design of CHP facilities. Particular care will need to be taken in Harrogate District to respect landscape character, particularly if there are cases

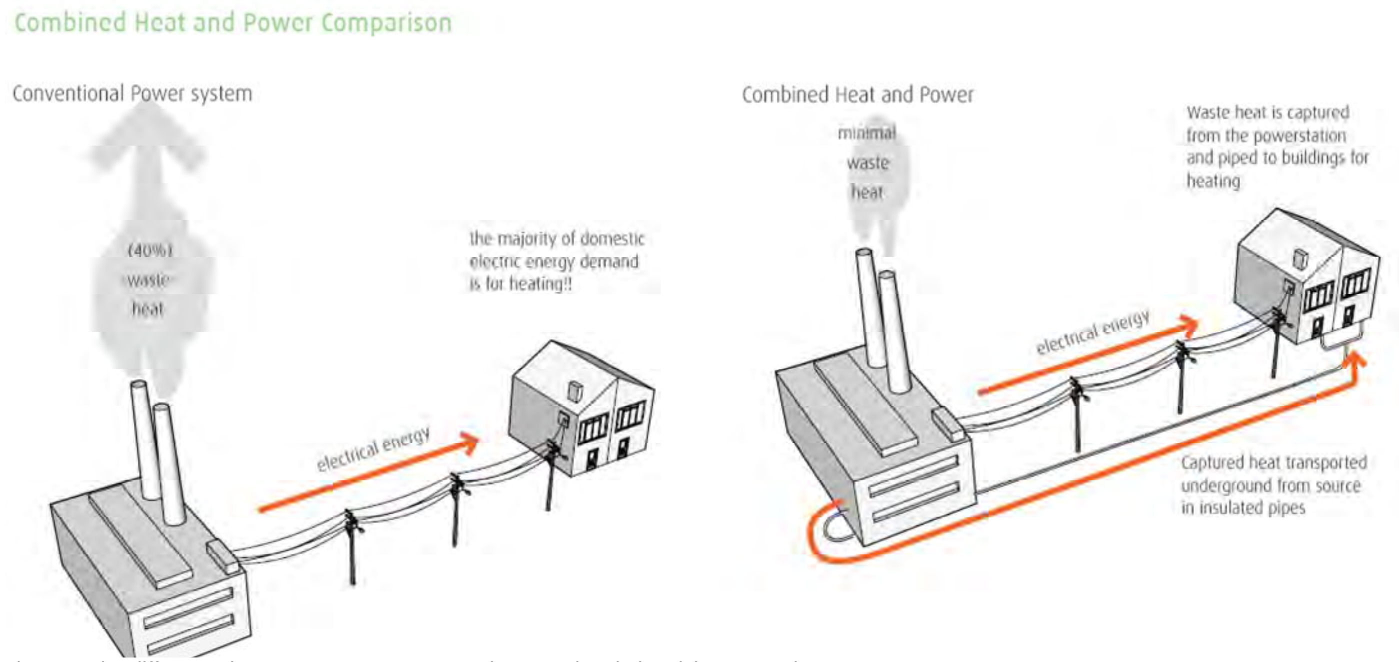


Figure 6 The difference between a CHP system and conventional electricity generation.

where CHP energy centres are proposed for developments on urban fringes.

Figure 7: Options for integrating CHP energy centres in urban settings

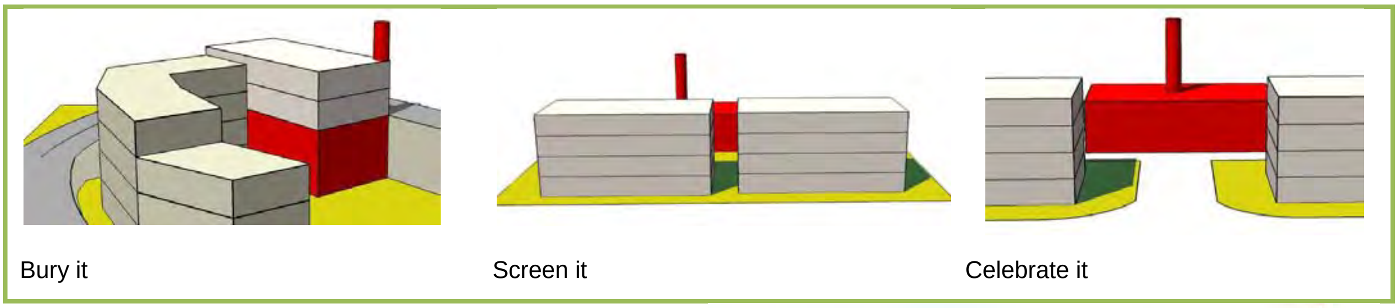


Figure 8: Energ100kWth, 70kwe CHP plant, installed at Highbury Stadium redevelopment, London. The 70 kWe electrical output feeds the landlord's supply and provides a base load for communal services. All new homes are on a district heating system; the heating and hot water is controlled through a heat interface unit inside each property (Source: AECOM, 2009).

Figure 9 The energy centre for the Station Road district heating network in Newmachar, Scotland. It serves 14 semi-detached 2&3 bedroom houses and comprises a 12.5kWth, 5.5kWe Baxi DACHS CHP unit and two 38kW condensing gas-fired boilers. (Source: Community heating for planners and developers, Energy Saving Trust and Carbon Trust, December 2004)

Figure 10: A heat exchanger inside one of the flats connected to the Aberdeen district heating network. Equipment is similar in size to a gas boiler (Source: Aberdeen City Council: a case study of community heating CE65, Energy Saving Trust, October 2003)

### 4.3 Existing district heating and CHP capacity

There is an 8.65 MW gas fired district heating network in the centre of Harrogate Town that connects the town's municipal offices, Turkish baths, tourist information centre, Royal Hall, Hall M, Queen's suite, Springfield House, Harrogate International Centre, Hall D and the International Hotel. The system is currently at capacity however nearby potential opportunities for expansion have been identified. These new opportunities have not been examined in detail and are subject to agreement and major changes to the existing system design.

The following table lists the CHP installations in Harrogate.

Table 7 CHP installations in Harrogate District (Source: Delivering Sustainable Energy in North Yorkshire, National Energy Foundation and Land Use Consultants, October 2005)

| Name | Electrical output (kW) | Heat output (kW) |
|---|---|---|
| Harrogate District Hospital, HG2 7SX | 304 | 445 |
| Harrogate South Sewage Treatment Works, HG5 8ND | 36 | 65 |
| Hydro Pool, Harrogate | 100 | 167 |
| St George Swallow Hotel, HG1 2SY | 95 | 150 |
| The Whitehart Training & Conference Centre, HG2 0NF | 38 | 70 |
| Harrogate International Conference Centre (Biofuel) | 250 | 387 |

### 4.4 Local potential for district heating and CHP

Due to its largely rural nature and relatively low density of development, the potential for district heating and CHP in Harrogate District is likely to be limited to the urban areas. We have identified some areas where there may be sufficient heat demand from existing buildings to support a commercially viable district heating or CHP system and have also considered on-site district heating and CHP as an option for major new development. The discussion around viability presented here is very high level, and all potential CHP and district heating schemes should be assessed on a case by case basis, taking into account local conditions and heat users, and financial models. Further analysis of identified areas within Harrogate will be necessary to determine CHP viability.

#### 4.4.1 Opportunity assessment

Heat demand in Harrogate District has been mapped to identify locations with high heat demand which may be suitable for district heating and CHP. Further details of the heat mapping process are provided in Appendix C.

The areas of highest demand are concentrated in the town centres of Harrogate, Knaresborough and the city centre of Ripon [Appendix A Figure 29 to Figure 32]. Although there are a number of major new developments expected over the next 20 years, the scale of heat demand in these new developments will depend on which version of the Building Regulations is applicable at the time; beyond 2016, demand for space heating and hot water should have been minimised.

District heating could also play an important role in providing low carbon energy to harder to treat existing properties, including conservation areas where visible energy efficiency and microgeneration technologies may be unsuitable.

### 4.4.2 Constraints assessment

It is theoretically possible to develop a district heating network anywhere that there are multiple heat consumers. However, since the main driver of the cost of a new heat network is the length of underground pipe work required, it is preferable to limit the distance between heat customers, by prioritising areas of higher density development.

The economics of district heating networks and CHP are determined by technical factors including the size of the CHP engine and annual hours of operation (or base load). Ideally, a system would run for at least 4,500 hours per year for a reasonable return on investment which is around 17.5 hours per day, five days per week, or 12.5 hours every day of the year. CHP is therefore most effective when serving a mixture of uses, to guarantee a relatively constant heat load. High energy demand facilities such as hospitals, leisure centres, public buildings and schools can act as anchor loads to form the starting point for a district heating and CHP scheme. These also use most heat during the day, at a time when domestic demand is lower.

Another contributory factor to the economic viability of CHP is the difference between the cost of electricity and gas, referred to as the “spark gap”. The greater the cost of electricity compared to gas, the more likely a CHP installation is to be viable due to the increased revenues from the sale or use of electricity.

For new development, the improving insulation standards mean the requirement for space heating is very low and demand is only present during the winter months. The only constant source of heat demand will be for domestic hot water and in terms of reducing $CO_2$ emissions, and much of this demand could be met by solar water heating as an alternative.

One method of maximising the benefits of CHP and district heating in new developments is to link smaller developments together to optimise the load and potential efficiencies. Likewise, benefits can be realized by linking the new developments to existing areas.

### 4.4.3 Available resource

The potential for district heating powered by CHP can be assessed at a high level by setting a threshold heat density above which schemes become viable. Previous research into the economics of district heating and CHP has suggested that at a threshold of 3,000 kW/ $km^2$ district heating is estimated to be viable for 78% of existing building heat demand and can give financial returns of 6%, which is below typical commercial rates of return but greater than the discount rate applied to public sector financial appraisal.[21]

Figure 30 shows that the existing gas based district heating system in Harrogate town centre could potentially be extended to nearby buildings with sufficient heating demand. Harrogate Town and Knaresborough have significant numbers of Council housing and other buildings that could provide suitable anchor loads (such as schools, hospitals, public buildings or leisure centres) with high heat demand located near or within areas. There is the potential to connect these larger, more diverse energy users as anchor loads to branch out from and incorporate council housing properties within district heating schemes. Proposed residential developments located in areas near high heat demand and anchor loads could also benefit from connection to district heating.

Ripon has a smaller number of council houses or anchor loads located near or within areas of high heat demand. However, the same opportunities would apply in these cases. If they were to go ahead, the proposed site options to the northern edge of the town and one to the south if they were to go ahead could each have sufficient heat demand to qualify for district heating systems in their own right. The proposed site options to the west of Ripon is situated within an area of high heat demand where a potential CHP and district heating system should be given consideration.

Regarding new development, discussions with Harrogate Borough Council have implied that new developments expected over the period of the Core Strategy are currently estimated to be around 35 dwellings per hectare. New development would need to be higher density (around 55dph) to make district heating with CHP viable on these sites. Design of development at urban fringes should, however, be appropriate to Landscape Character in order to meet local policies and Government guidance on design.

[21] The potential and costs of district heating networks, Faber Maunsell & Poyry, April 2009

### 4.5 Potential for cost and $CO_2$ savings from district heating with CHP

Figure 10 shows the potential cost per tonne of $CO_2$ saved for a range of heat generating technologies. The figures are based on carbon factors that reflect today's grid mix. District heating with CHP is cheaper in terms of cost per tonne of $CO_2$ saved than heat pumps; air source heat pumps can actually result in a net increase in $CO_2$ emissions. Tabel 8 shows the cost of providing district heating with CHP to homes and non-domestic buildings.  These costs assume no prior district heat network infrastructure in the area and that existing dwellings are fitted with individual heating systems.

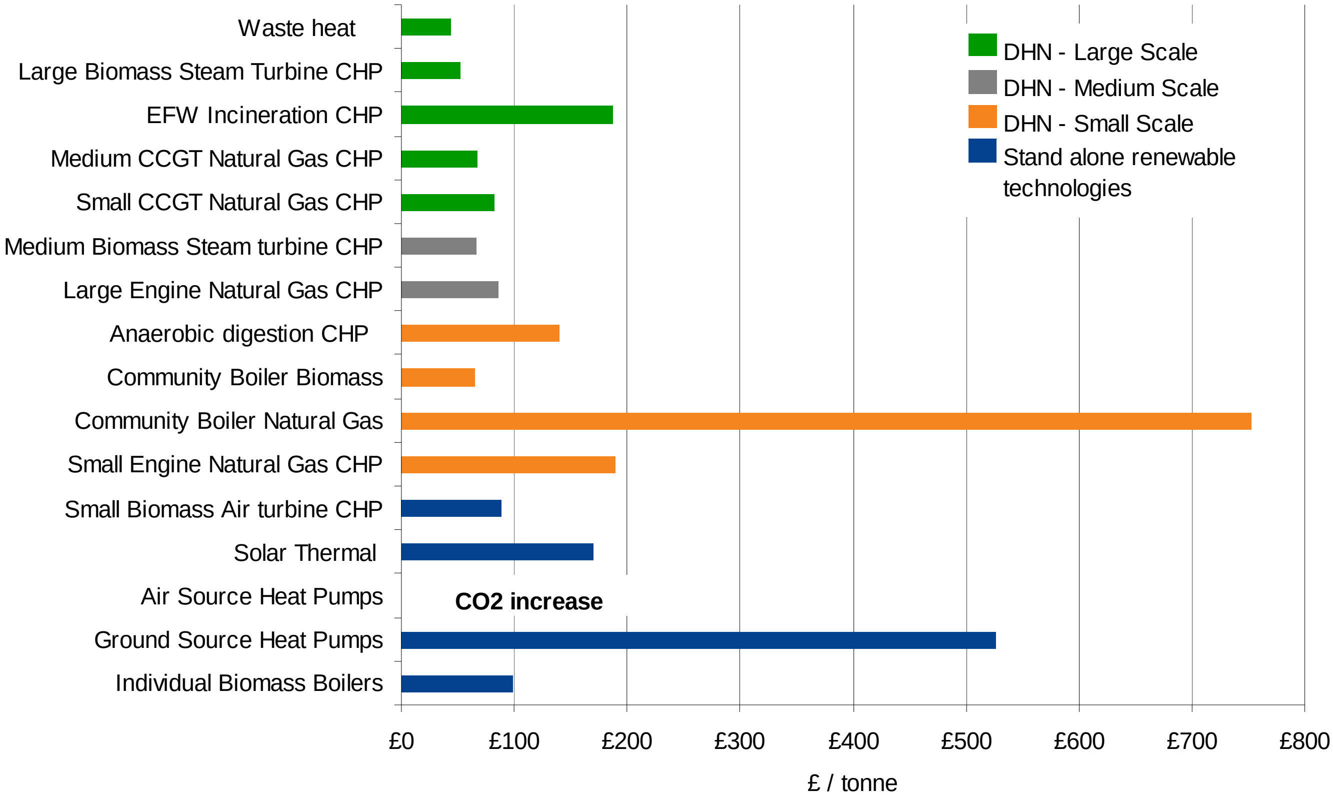


Figure 11 Indicative cost per tonne of $CO_2$ saved for different system types, compared to individual, gas condensing boilers (Source: The potential and costs of district heating networks, Faber Maunsell & Poyry, April 2009)

Table 8 District heating costs for existing dwellings. Costs assume no prior district heat network infrastructure in the area and that existing dwellings are fitted with individual heating systems. The Hydraulic Interface Unit (HIU) is the exchanger device that replaces the boiler and transfers heat from the district heating network into the home. (Source: The potential and costs of district heating networks, Faber Maunsell & Poyry, April 2009)

| Dwelling Type | District Heating Infrastructure Cost | District Heating Branch Cost | Heat Interface Unit (HIU) and Heat Meter Cost | Total Cost |
|---|---|---|---|---|
| Small terrace | £2,135<br>Based on outline network design and costing | £1,912<br>Based on outline network design and costing plus additional costs for HIU and metering. | £2,300<br>(includes £1,600 HIU, £200 for heat meter, and £500 for installation) | **£6,347** |
| Medium / Large terrace | £2,135<br>Based on outline network design and costing | £2,255<br>Based on outline network design and costing plus additional costs for HIU and metering. | £2,300<br>(includes £1,600 HIU, £200 for heat meter, and £500 for installation) | **£6,690** |
| Detached | £2,719<br>Based on outline network design and costing | £2,598<br>Based on outline network design and costing plus additional costs for HIU and metering. | £2,300<br>(includes £1,600 HIU, £200 for heat meter, and £500 for installation) | **£7,617** |
| Semi detached | £2,719<br>Based on outline network design and costing | £3,198<br>Based on outline network design and costing plus additional costs for HIU and metering. | £2,300<br>(includes £1,600 HIU, £200 for heat meter, and £500 for installation) | **£8,217** |
| Converted flat | £712<br>Assumes that infrastructure costs for a 3-story converted terrace are split between 3 flats. | £752<br>Assumes that branch costs for a terrace are split between 3 flats with an HIU and heat meter for each flat. | £2,300<br>(includes £1,600 HIU, £200 for heat meter, and £500 for installation) | **£3,764** |
| Low rise flat | £1,500<br>Estimate | £1,500<br>Internal pipework | £2,300<br>(includes £1,600 HIU, £200 for heat meter, and £500 for installation) | **£5,300** |
| High rise flat | £1,000<br>Estimate | £1,500<br>Internal pipework | £2,300<br>(includes £1,600 HIU, £200 for heat meter, and £500 for installation) | **£4,800** |

Table 9 Indicative district heating costs for non-domestic buildings. Costs assume no prior district heat network infrastructure in the area and that existing dwellings are fitted with individual heating systems. The Hydraulic Interface Unit (HIU) is the exchanger device that replaces the boiler and transfers heat from the district heating network into the building. (Source: The potential and costs of district heating networks, Faber Maunsell & Poyry, April 2009).

| Type of Area | Total District Heating Network Cost | Heat Interface Unit (HIU) and Heat Meter Cost |
|---|---|---|
| City Centre | £8.40 per $m^2$ of floor area | £20.00 |
| Other urban area | £16.50 per $m^2$ of floor area | £20.00 |

### 4.6 Key considerations emerging from this chapter

The sections above have considered the opportunities for reducing $CO_2$ emissions through the supply of low carbon heat in Harrogate District. Key considerations emerging from this chapter are:

- District heating with CHP is a way of generating and distributing energy more efficiently than conventional power plant and can contribute to $CO_2$ and renewable and low carbon energy targets.
- Due to its largely rural nature and relatively low density of development, the potential for district heating and CHP in Harrogate District is likely to be limited to the urban areas.
- The town centres of Harrogate, Knaresborough and the city centre of Ripon have some potential for district heating and CHP.
- New development will need to be designed to higher density (around 55dph) than is currently being planned to make district heating with CHP viable on these sites.

# Opportunities for Renewable and Low Carbon Technologies

# 5 Opportunities for low carbon and renewable energy technologies: Large/community scale

This chapter outlines the opportunities for renewable and low carbon energy installations in Harrogate, at a community scale.

These opportunities and constraints vary on a local level according to the features of the natural environment and the built environment.

The analysis in this chapter has been carried out using the DECC methodology, which assesses what it describes as the "physically accessible" resource (the resource if no planning or environmental constraints were applied) and the "practically viable resource." We have defined the practically viable resource as the resource available once physical constraints where renewables schemes cannot practically be built have been accounted for, and constraints relating to the current planning and regulatory framework (such as areas with statutory protections) have been applied.

This does not take into account economic viability or other deployment constraints. It is a useful method for identifying areas of opportunity but is likely to overestimate the actual deliverable resource in Harrogate District. Further study would be required to identify schemes which could be delivered in practice.

## 5.1 Key issues to consider in relation to low carbon and renewable energy technologies in Harrogate District

Key issues to consider in relation to the installation of large scale renewable energy technologies have been summarised below in Table 10.

Table 10: Key Issues to be considered with the installation of large scale renewable energy technologies.

| | Large scale wind | Biomass | Hydro |
|---|---|---|---|
| Available resource | Wind speeds of 5.5m/s or above at turbine hub height are typically needed to operate a large scale wind turbine efficiently.<br><br>For optimum output, turbines should be located in areas with high wind speeds, with few obstacles to create turbulence, i.e. with limited trees and buildings. Turbines should also be spaced to avoid turbulence affecting each other. | Different varieties of energy crops are suited to different soil types and have specific climatic and hydrological requirements.<br><br>Forests under management can produce a sustainable yield of biomass and have the potential to supply a large volume of wood without compromising existing land uses. Reduced cover and cleared grounds can also bring ancillary environmental benefits. | Each weir would require a bespoke design which responds to the unique flow characteristics and site constraints. |
| Landscape impact and impact upon land use management, for example, visual impact | A large free standing wind turbine is usually highly visible in the landscape. Turbine locations should be carefully considered to ensure that they do not detrimentally impact on landscape character and particularly key view corridors.<br><br>The actual footprint of wind turbines is relatively small and adjacent land can still be used for grazing, farming, etc. Crane hard standings and access tracks are usually required at each turbine location.<br><br>Development of wind turbines on areas of high flood risk was previously restricted by PPS 25. The March 2010 version of this document included revisions to Tables D1 and D2 in Annex D to clarify the definition of functional floodplain, and to amend how the policy is applied to essential infrastructure, including......... wind turbines in flood risk areas.[22] | Cumulative effects of extensive plantations could impact on landscape character and block long views and create enclosure, although planting could also be beneficial in the screening of urban clutter.<br><br>Energy crops can cause adverse hydrological impacts, such as reduce aquifer recharge and/or stream flow, which may feed reservoirs, wetlands, water meadows or other fragile ecosystems. Biomass grown on steep, sloping fields can generate large amounts of run off, especially when combined with high rainfall and light soils. Care is needed to ensure that the presence of energy crops does not deplete the available water resource. | An extraction licence is required on hydro schemes on rivers via the Environment Agency to ensure the water levels in rivers are not compromised;<br><br>The Environment Agency requires fish passes to be installed which can increase the construction costs of any future schemes;<br><br>Access in terms of ownership of land can be an issue for site development; |
| Impact upon environment and nearby communities | Rotating wind turbine blades can cast moving shadows that cause a flickering effect and can affect residents living nearby. This can be an issue at certain times of day when the wind is blowing, but effects can usually be mitigated. | n/a | n/a |

[22] http://www.communities.gov.uk/documents/planningandbuilding/pdf/planningpolicystatement25.pdf

| | | | |
|---|---|---|---|
| Local infrastructure | It is advantageous if turbine sites have good access to roads, railway lines, rivers and canals, to enable delivery of components during construction and access for maintenance. Large scale turbines will be connected to the National Grid by arrangement with the local electricity network operator. It is ideal to locate turbines close to a 10-30 kV power line. The electrical grid near the wind turbine should be able to receive the incoming electricity; if there are already many turbines connected to the grid, then the grid may need reinforcement. | n/a | The accessibility of the sites to construction vehicles and machinery should be considered. |
| Safety | An exclusion distance is observed to reduce the risks to property and human health in the unlikely event of a turbine failure. "Consideration should be given to reducing the minimum layback of wind turbines from overhead lines to three rotor diameters"[23]. Turbines should be at least 200m from blade tip to bridle paths; the British Horse Society recommends "a separation distance of four times the overall height should be the target for National Trails and Ride UK routes…and a distance of three times overall height from all other routes."[24] A distance of 3 rotor diameters should be maintained from power transmission lines.[25] | n/a | n/a |
| Electromagnetic, aeronautical and defence impacts | Turbines above a certain height may interfere with the operation of local air traffic control or radar systems used for military purposes. They can also interfere with radio signals, television reception and telecommunications systems including fixed radio links and scanning telemetry links, which are a vital component of UK telecommunications infrastructure. | n/a | n/a |
| Gas pipelines and other sub terrain analysis | The feasibility of the construction of a large turbine should be supported by geotechnical investigations.<br>Any impacts on archaeology in the area will have to be assessed in more detailed studies. | n/a | n/a |

[23] NGET Technical Report TR(E) 453 A Review Of The Potential Effects Of Wind Turbine Wakes On National Grid's Overhead Transmission Lines (NGET, 2009)
24 Advisory Statement on Wind Farms AROW20s08/1 (The British Horse Society)
[25] Review of the Potential Effects of Wind Turbine Wakes on Overhead Transmission Lines, TR (E) 453 Issue 1 (National Grid – internal use only, May 2009)

## 5.2 Landscape character in Harrogate District

Landscape Character Assessment is typically carried out to distinguish areas of distinct character, with their own "sense of place." Guidelines can then be developed by the Council, in consultation with the local community and key stakeholders, for the management of landscape change in these areas.

The DECC methodology recommends that in order to assess the potential for renewable energy deployment within international and national landscape and nature conservation designations, the following five step approach can be applied:

Step 1: Identify the purposes of the landscape/ nature conservation area (reasons for designation).

Step 2: Identify which technologies might affect these purposes/ integrity of the designation.

Step 3: Identify how each technology might affect the purposes/ integrity.

Step 4: Identify the type and level of renewable and low carbon infrastructure that could be accommodated without compromising the purposes/ integrity of the designations.

Step 5: Provide guidance on how to integrate renewable/ low carbon energy without compromising the purposes/integrity.

There are four National Countryside character areas covered by Harrogate District: the Yorkshire Dales, the Pennine Dales Fringe, the Southern Magnesian Limestone and the Vale of York. Two other character areas have a minor influence in the District; the Southern Pennines and the Vale of Mowbray.

The Harrogate District Landscape Character Assessment, produced in February 2004, provides a further detailed breakdown of the District into 106 character areas, each with their own distinct character and sense of place. These areas are described in detail with regard to geology, landform, drainage, land use, vegetation, wildlife, built form and communications.

It is outside the scope of this study to carry out a full assessment of the sensitivity of each of these character areas to renewable energy technologies. Although it is recognised that certain landscapes could be significantly impacted by the deployment of large scale wind turbines, the DECC methodology states that "*with regard to national designated landscapes (e.g. National Parks, AONBs) and international and national nature conservation areas (e.g. SPAs, SACs, SSSIs etc), detailed consultations with Natural England concluded that these areas should not be excluded from the assessment as they have the potential to deliver renewable energy*." In this study, we have presented figures for the available resource both if these areas are included in the assessment and if they are excluded from consideration.

## 5.3 Large scale wind energy

Wind turbines convert the energy contained in the wind into electricity. Large scale, free standing turbines have the potential to generate significant amounts of renewable energy. For the purpose of this report 'large scale' refers to anything over 100kW – in line with DECC guidance.

### 5.3.1 Existing large scale wind Installations

The only large scale wind installation in Harrogate District at present is the Knabs Ridge Wind Farm, which contains eight 2 MW wind turbines (i.e. total installed capacity of 16MW).

A scoping study is currently being undertaken into the possibility of installing eight 2 MW turbines at Melmerby (north of Ripon).

### 5.3.2 Opportunity assessment

The assessment for the potential for large scale wind energy in Harrogate District was carried out in two stages and closely followed the DECC methodology.

First, an opportunity assessment was carried out to determine where the physical wind speed resource would justify a large turbine. The DECC methodology defines large scale wind turbines as those with a generating capacity of 100kW or more.[26] Turbines installed in commercial wind farms typically have a generating capacity of 2.5 MW or more. The opportunity assessment established the physically accessible resource across the study area based on the UK wind speed database (NOABL). A lower limit of 5 m/s measured at 45m above ground level was considered to be potentially suitable for large scale wind energy, in accordance with the DECC methodology.

### 5.3.3 Constraints assessment

A constraints assessment was then carried out to taking into account physical constraints (such as lakes), and then considering more subjective constraints. Table 13 shows the datasets that were used to carry out the constraints assessment. The constraints assessment established the practically viable resource.

[26] Renewable and Low-carbon Energy Capacity Methodology - Methodology for the English Regions (January 2010).

### 5.3.4 Engineering constraints

Engineering constraints are based on areas where it is physically impossible to develop turbines and include:

- Roads
- Railways
- Inland Waters – rivers, canals, lakes, reservoirs
- Built up areas – houses, buildings
- Airports
- Buffer around roads and rail lines of 132 m (110% of turbine height).
- Buffer around existing wind farms.

### 5.3.5 Non-engineering constraints

Large scale wind turbines may conflict with local land uses. Such constraints will not physically inhibit the performance of wind turbines and should not be automatically considered as an absolute constraint, but local circumstances may affect the size or scale of large scale wind turbines.

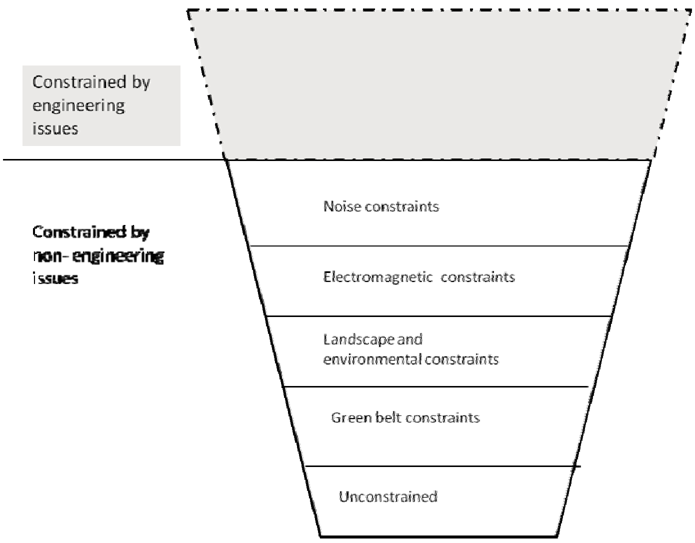


Figure 12: Effect of constraints on land area available for large scale wind turbines in Harrogate.

Wind farm development in these areas should be considered on a site by site basis. Detailed feasibility studies should always be carried out to confirm the suitability of these areas and precise locations for turbines on a case by case basis. This analysis should always challenge the further constraints identified in line with PPS 22 to assess whether developing wind turbines in these areas will have an adverse impact.

#### 5.3.5.1 Noise constraints

A 600 m buffer zone has been assumed from urban built up areas to mitigate against potential noise issues. This buffer distance is relatively conservative and could be reduced if visual impact and noise mitigation could be improved, or if the wind turbines are community owned resulting in a higher level of acceptance with local residents.

#### 5.3.5.2 Electromagnetic constraints

Large scale wind turbines may be restricted due to risk of interference with propagation of electromagnetic links have been considered as a separate constraint. These include Ministry of Defence (MoD) sites and areas where the presence of wind turbines could affect the performance of defence and aviation radar systems.

#### 5.3.5.3 Landscape and environmental constraints

Harrogate District contains international, national and locally designated landscapes that are recognised for natural beauty. Wind energy developments in these areas can result in changes to their special qualities and compromise the purposes of designation. Large scale wind farm development in these areas is therefore highly unlikely to be permitted.

The Nidderdale AONB covers 603 $km^2$ in the county of North Yorkshire. The management plan for the Nidderdale AONB does not refer to wind energy specifically but says that applications for major development in the AONB that is incompatible with the AONB's landscape will be resisted, including large-scale renewable energy installations. [27]

There are currently no wind farm developments within AONBs in the UK. The current PPS on Renewable Energy does not specifically exclude wind farm developments in landscapes with a national designation but states that "*particular care should be taken in assessing proposals for developing renewable energy projects, in National Parks, AONBs, the Broads and SSSIs."* A position paper by the National Association for AONBs in 2002 states that "*there should be a presumption against commercial wind energy developments in AONBs or in locations outside the AONB which affect people's enjoyment of the AONB."*[28]

[27] Evidence Base to Management Plan 2009-2014, December 2008
[28] Wind Energy Developments in AONBs - A Position Statement by the National Association for AONBs, National Association for AONBs, September 2002.

Planning policy does not prohibit major development within protected landscapes, but PPS7 clearly states that the conservation of the natural beauty within AONBs should be given great weight in planning policies and development control decisions and that major development within these areas should not take place, except in exceptional circumstances.[29]

Harrogate District also contains a number of designated sites and buildings that are recognised for their biodiversity, architectural and historical features. The size and scale of large scale wind turbines will not necessarily be restricted in all of these areas, but siting should be carefully considered to minimise adverse impact or damage to these assets and their setting .

Planning Policy Statement 5 sets out the Government's planning policies on the conservation of the historic environment. Specialist advice should be sought when considering any wind (or other) energy developments within protected areas. These environmentally protected areas include:

Table 11: Environmental protected areas that should be considered in sitng wind turbines.

| | **Protected Areas** |
|---|---|
| Landscapes | • Amenity Open Space;<br>• Biodiversity Action Plan habitats;<br>• Historic Parks and Gardens;<br>• Local Biodiversity Action Plan species;<br>• Local Nature Reserves;<br>• Special Areas of Conservation;<br>• Sites of Importance for Nature Conservation;<br>• Special Landscape Areas;<br>• Conservation Areas; |
| Other | • Scheduled Ancient Monuments;<br>• Historic Battlefields;<br>• Spa waters;<br>• Listed Buildings;<br>• Sites of Special Scientific Interest;<br>• Special Protection Areas;<br>• World Heritage Site. |

[29] Making space for renewable energy: assessing on-shore wind energy development, Natural England, 2010

The Yorkshire and Humber Plan RSS Policy ENV5 made clear that wind energy development within Natura 2000 sites is very unlikely to be acceptable. The presence of Sites of Special Scientific Interest, National Nature Reserves, and sites designated under Natura 2000 in Harrogate District will substantially reduce the degree to which wind energy development can be accommodated.

#### 5.3.5.4 Green belt

The current PPS22 on Renewable Energy advises that in areas with Green Belt status, planning permission for wind farms should only be granted where the objectives of the designation will not be compromised.

Planning Policy Guidance (PPG) 2 recognises five purposes for including land in the Green Belt and these are generally related to the need to restrict urban sprawl. [30] The Harrogate District Core Strategy states that the main purpose of the local Green belts "*are to check the further growth of the West Yorkshire conurbation and to protect the special character of the towns of Harrogate and Knaresborough and prevent them from merging. The main purpose of the York Green Belt is to protect the special character of the City of York*."

It is not clear whether renewable energy applications, e.g. wind turbines should be considered in the same way as built development and to do so could be seen as a negative approach by a local planning authority, and thus in conflict with PPS22: Renewable Energy. There is an established precedent for wind farms being approved within green belt designations as they were not deemed to affect the 'openness' of the designation.[31]

[30] Planning Policy Guidance 2: Green belts, CLG, March 2001

[31] 225kW, 36 m hub height V29 turbine at RES headquarters, Beaufort Court, Kings Langley, Hertfordshire (Three Rivers District Council)

On the other hand, there have been a number of planning decisions in the Yorkshire and Humber region where wind turbines were considered to constitute inappropriate development in the Green Belt.

PPG2 suggest that development that might be visually detrimental by reason of its siting, materials or design should be restricted. The issue of 'visual impact' of wind turbines is subjective and whether a wind farm development could be considered "detrimental" should be assessed on a case by case basis, using the same methodology as for any other site and balanced with the wider environmental benefits that wind energy brings.

### 5.3.6 Available wind energy resource

The total unconstrained wind energy resource was calculated using GIS and shown as the total available land area ($km^2$).

The DECC methodology is based on a typical 2.5 MW installed capacity wind turbine (tip height: 135m, rotor diameter: 100m, hub height: 85m). It assumes that the maximum installed capacity is 9 $MW/km^2$.

The total unconstrained land area available for large scale wind in Harrogate District was calculated as 1,291 $km^2$**.** Based on this area and applying assumptions for turbine capacities provided in the DECC methodology, this could provide a physically accessible resource of 11,619 MW.

We have assessed the capacity for large scale wind energy in Harrogate District based on consideration of each type of constraint. The results are presented in Table 12 below and Figure 38 which shows in purple the potential areas where large scale wind turbines could be installed. Most of the available wind resource and be found in the east of the District. The total potential installed capacity for Harrogate District, if all types of constraints are taken into account, is estimated as 2,592 MW.

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Lindhurst Wind Farm, 5 x 125m tip height turbines, Mansfield, Nottinghamshire (Sherwood District Council)
http://www.landuse.co.uk/portfolio/project.php?id=245

11kW, 25m Colney Heath wind turbine (Hertfordshire Council)
http://www.hertsad.co.uk/news/council_overturns_decision_on_colney_heath_wind_turbines_1_787118

Alveston Wind Farm, 3x 64m hub height turbines (South Gloucestershire Council)
http://www.gazetteseries.co.uk/news/8369054.Ecotricity_still_plan_to_build_Alveston_wind_farm/

Crook Hill Wind Farm, 8 of the 12, 90m hub height turbines are in Green Belt (Rochdale Borough Council)
http://www.coronationpower.com/docs/CHWFNTS.pdf

Table 12 Large scale wind energy resource in Harrogate District.

| Resource | Number of turbines | Potential capacity (MW) |
|---|---|---|
| Resource after Opportunity Assessment | 4,648 | 11,619 |
| Resource considering above + engineering constraints | 4,018 | 10,044 |
| Resource considering above + noise constraints | 2,815 | 7,038 |
| Resource considering above + landscape, environmental and Green belt constraints | 1,040 | 2,601 |
| Unconstrained resource | 1,037 | 2,592 |

Table 13 GIS datasets used in the large scale wind energy constraints assessment for Harrogate District.

| Constraint assessment | |
|---|---|
| **Non accessible areas** | |
| **GIS dataset** | **Source** |
| Roads [motorway, primary, A-Roads, B-Roads] | OS Strategi |
| Railways | OS Strategi |
| Inland water [rivers, canals, lakes, reservoirs] | OS Strategi |
| Built-up areas | OS Strategi |
| Airports | OS Strategi |
| MoD training sites | REstats |
| **Exclusion areas** | |
| **GIS dataset** | **Source** |
| Ancient woodland | MAGIC website, www.magic.gov.uk |
| Sites of historic interest [Scheduled Monuments, Listed Buildings, Registered Historic Battlefields, and Registered Parks and Gardens] | MAGIC website, www.magic.gov.uk |
| 150m buffer around roads and rail lines | OS Strategi |
| 600m buffer around all built-up areas | OS Strategi |
| 5km buffer around all airports | REstats |
| Civil air traffic control constraints | CAA VFR Charts |
| MoD training areas | CAA VFR Charts |
| **Designated landscape and nature conservation areas** | |
| **IS dataset** | **Source** |

| Constraint assessment | |
|---|---|
| Landscape areas [National Parks, AONB, Heritage Coast] | MAGIC website, www.magic.gov.uk |
| Nature conservation areas [NNR, RAMSAR, SAC, SPA, SSSI] | MAGIC website, www.magic.gov.uk |
| **MoD constraints** | |
| **GIS dataset** | **Source** |
| Additional exclusion areas relating to MoD sites and radar issues | CAA VFR Charts |

## 5.4 Biomass Energy

Biomass is a collective term for all plant and animal material. It is normally considered to be a renewable fuel, as the $CO_2$ emitted during combustion has been (relatively) recently absorbed from the atmosphere by photosynthesis.

### 5.4.1 Existing biomass cultivation sites

Paddick House Farm in Sicklinghall currently grows 30 acres of willow short rotation coppice (SRC). Optimum moisture content of the fuel is 25% however fuel of up to 50% moisture content is accepted by the 150kW Talbott's wood fuelled heating system, which supplies heat to a range of office buildings and several on-site houses.[32]

### 5.4.2 Opportunity assessment

The physically accessible resource for establishing biomass crops in Harrogate District was assessed using DEFRA mapping to identify the crop with the most potential across the District based on a 5km$^2$ grid. Where the yield for an area is the same for all crop types, Miscanthus planting has been assumed. Table 14 shows the GIS datasets used for the constraint assessment.

The opportunities assessment established the physically accessible resource across the study area, through a "high" scenario. The high scenario assumed that all available arable land and pasture could be planted with energy crops as defined by DEFRA Regional Energy Crop Opportunity Maps for Miscanthus and Short Rotation Coppice. 'Arable land and pasture' has been assumed to refer to Agricultural Land Classification Grades 1 to 5. The high scenario is an absolute maximum and is likely to be much greater than actual available resource in Harrogate District once other factors (such as competing demand for land for food production) are factored into the equation.

The low scenario is related to the practically viable resource across the District and assumes that only the existing energy crops, as identified by the DEFRA energy crop scheme, within the study area will be used as the available resource. Under this scenario no additional land will be made available for the planting of energy crops. There are no geographic constraints associated with the low scenario.

The amount of fuel produced from a hectare as oven dried tonnes (odt) is assumed as follows[33]:

- 10 odt/ha (SRC)
- 15 odt/ha (Miscanthus)

For electricity, a benchmark of 6,000 odt/MW is assumed to convert the total biomass feedstock to installed capacity. For heat the following standard calorific values of wood fuel categories are applied:

- 12.5 GJ/odt (woodchip)
- 17 GJ/odt (wood pellet)
- 13 GJ/odt (baled Miscanthus)

For all fuel categories it is assumed that there is a plant conversion efficiency factor of 80% and a plant availability factor of 80% for combined heat and power generation. A conversion rate of 3.6 GJ/MWh has been assumed.

Table 14 GIS datasets used in the biomass constraints assessment for Harrogate District.

| Constraint assessment | |
|---|---|
| **GIS dataset** | **Source** |
| Agricultural land classification | www.magic.gov.uk |
| Permanent pasture and grassland | www.magic.gov.uk |
| Common land | www.magic.gov.uk |
| Nature conservation designations [SSSI] | www.magic.gov.uk |
| Historic designations [Scheduled Monuments] | www.magic.gov.uk |

### 5.4.3 Constraints assessment

We have applied a number of assumptions to derive a more practical assessment of the practically deliverable resource, as indicated by Figure 13.

[32] Paddick House Farm: Short Rotation Coppice (SRC) (Willow) heats 'Green' office development, Forestry Commission
[33] Please note: the yield could vary significantly across the different agricultural land classes

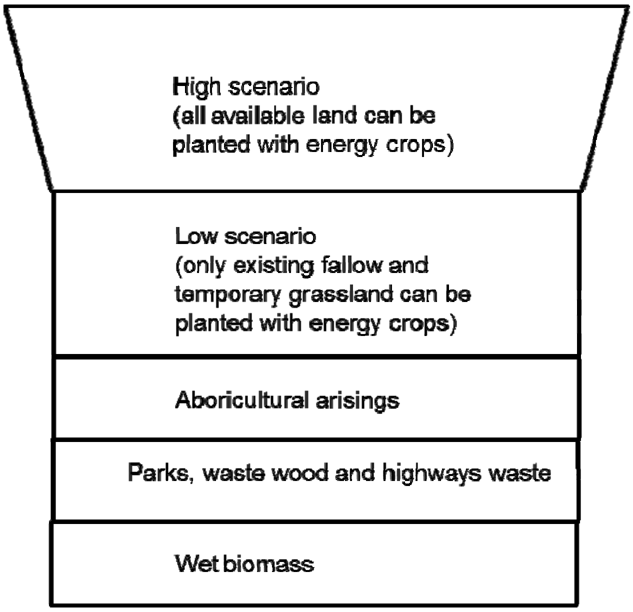



Figure 13 Effect of constraints on land area available biomass planting in Harrogate District.

### 5.4.4 Energy crop constraints

Different varieties of energy crops are suited to different soil types and have specific climatic and hydrological requirements. The following criteria have been used to assess the practically deliverable resource for energy crops:

- Grades 1 and 2 land have been omitted as being reserved for food production;
- Cultivation and planting of energy crops on permanent pasture and moorland has been excluded;
- The total energy crop potential includes use of 75% of grade 3 land and 20% of grade 4 land;
- Miscanthus will be the primary energy crop. It has been assumed that 13 oven dried tonnes of Miscanthus SRC could be derived per hectare. [34]

This assessment suggests that the District can generate 53,649 MWh per year from energy crops.

Future resource assessment work should also consider any potential reductions on this figure due to impact on Landscape Character or Historic Landscape Character.

[34] Biomass-related facts, figures and statistics (Biomass Energy Centre website, accessed October 2009)

### 5.4.5 Aboricultural constraints

Forests under management can produce a sustainable yield of biomass and have the potential to supply a large volume of wood without compromising existing land uses. Reduced cover and cleared grounds can also bring ancillary environmental benefits. However, long term trends in timber prices have rendered forest management uneconomic[35]. A strengthened market for locally sourced biomass would encourage greater exploitation of the existing resource. It is estimated that management of woodland areas could provide around 1,237 MWh energy per year.

### 5.4.6 Constraints on arisings from parks, waste wood and highways waste

Local authorities produce large quantities of green waste, through management of parks, trees and community land. It is commonly composed of wood, trimmings, cuttings and grasses and biodegradable waste which is usually high in nitrogen. Traditionally this green waste has been sent to landfill or used in composting. Instead green waste can be used as a fuel, creating a valuable resource.

Waste wood has been a largely overlooked resource to date, partly due to it often arising as part of a mixed waste stream, with limited facilities for its segregation, and also a result of its predominantly contaminated nature, which often makes recycling and energy recovery difficult. Contaminated wood streams need to be burnt in WID (Waste Incineration Directive) compliant boilers.

Waste wood has relatively low moisture content (18-25%), potentially making it preferable to forestry and biomass crops (approximately 40%)[36], although waste wood from arboriculture management usually has higher moisture content and requires drying before use. Forestry products are generally clean and can be burnt in a wider range of boilers without need to ensure

The potential resource from management of parks, gardens and allotments in the District has been estimated to be only 84 MWh of fuel. This is not likely to be sufficient to justify its collection.

### 5.4.7 Constraints on wet biomass

The potential wet biomass energy resource from the District's farms has been estimated to be around 41,074 MWh per year

[35] Biomass for London: wood fuel demand and supply chains (BioRegional Development Group, SE Wood Fuels and Creative Environmental Networks, December 2008)
[36] Waste wood as a biomass fuel, market Information report (DEFRA, April 2008)

of heat, which could be generated from biogas produced from cattle manure.

### 5.4.8 Supply chain

The biomass fuel supply chain in the Yorkshire and Humber region is currently in its infancy and the market conditions are extremely variable. This makes the long-term forecasting of biomass system costs extremely difficult. For example, biomass fuel, particularly waste wood, has in the past been either free of charge or attracted a gate fee (where the supplier pays the user a fee which is lower than the alternative disposal cost). However, as the market for biomass increases with additional biomass electricity, heat, and CHP capacity being installed, the demand will increase and the fuel will command a higher premium. It will be important for Harrogate Borough Council to consider the longer term potential market conditions for new developments. There is a potential role for the Council to collaborate with Yorkshire's functional sub-regions or the region to assist with establishing a supply chain to provide some degree of long term stability.

### 5.4.9 Available Resource

The practically deliverable resource for biomass is shown in Table 15 to Table 18. The geographic extent of unconstrained biomass energy crop resource is shown in Appendix A Figure 33.

Table 15 Available land for energy crop biomass production in Harrogate District (physically accessible resource).

| Scenario | Energy Crop | Area (ha) | Yield (odt) | Installed electrical energy |
|---|---|---|---|---|
| High | Miscanthus | 84,182 | 1,262,730 | 245 MW |
| | SRC | 20,466 | 204,660 | |
| Low | Miscanthus | 62 | 930 | 0 |
| | SRC | 0 | 0 | |

Table 16 Potential heat energy (installed capacity) from biomass in Harrogate District (physically accessible resource).

| Heat | | |
|---|---|---|
| **Scenario** | **Wood fuel** | **MW (Installed)** |
| High | Baled Miscanthus | 33 |
| | Woodchip | 52 |
| | Wood Pellet | 71 |
| Low | Baled Miscanthus | 0 |
| | Woodchip | 0 |
| | Wood Pellet | 0 |

Table 17 Practically deliverable biomass resource across Harrogate District

| Energy generation technology | Energy generation (MWh) |
|---|---|
| Biomass energy crops | 53,640 |
| Biomass aboricultural arisings | 1,237 |
| Biomass parks and highways waste arisings | 85 |
| Wet biomass | 41,074 |

## 5.5 Hydro Energy

Hydro energy is electricity generated from passing water (from rivers, or stored in reservoirs) through turbines. The energy extracted from the water depends on the flow rate and on the vertical drop through which the water falls at the site, the head.

### 5.5.1 Existing hydro installations

An 83kW installation exists at Newby Hall in the north east of the District. [37]

### 5.5.2 Opportunity and constraints Assessment

The Environment Agency's report 'Mapping Hydropower Opportunities in England and Wales' (2009) has been used to identify the physically accessible, hydropower resource in Harrogate District. This provides a high level assessment of scale of potential and the sensitivity of micro-hydro schemes, taking into account fish passage as well as other ecological and amenity considerations. The results of this assessment are shown in Appendix A Figure 34. Ten locations have been identified as having potential for hydro electricity generation[38] with a combined capacity of 1,394kW. These sites lie predominantly along the River Nidd between Pateley Bridge and Knaresborough.

[37] British Hydro Association

[38] Development of a Renewable Energy Assessment and Targets For Yorkshire and the Humber: Final Report to Government Office Yorkshire and the Humber (2002)

Derwent Hydro's report for the Nidderdale AONB[39] has identified 13 potential sites for Hydro.

### 5.6 Geothermal Energy

Geothermal energy is derived from the very high temperatures at the Earth's core and requires extraction of heat from deep wells (geothermal energy should not be confused with the extraction of low grade heat using ground source heat pumps at the earth's surface). The exploitation of geothermal resources in the UK continues to be minimal since there are only a few places where hot dry rocks are sufficiently close to the surface to make exploitation cost effective. Most of the hot dry rocks resource is concentrated in Cornwall; studies have concluded that *"generation of electrical power from hot dry rock was unlikely to be technically or commercially viable…in the UK, in the short or medium term."*[40]

A number of test 300m deep boreholes were drilled under East Yorkshire and Lincolnshire in 1994, to investigate the potential for the potential for capturing energy from geothermal aquifers. The report concluded that geothermal aquifer systems were likely to cost at least 2.5 times as much per unit of useful heat as competing systems.[41]

This technology has therefore not been considered further.

### 5.7 Marine, Wave and Tidal Energy

There is no coastline in the District and so marine wave and tidal technologies have not been considered further.

### 5.8 Key considerations emerging from this chapter

Key considerations emerging from the assessment of community scale, low carbon and renewable energy resources in Harrogate District are:

- No geothermal, tidal, or wave resource has been identified. An assessment of the potential for energy from waste was not considered in this study.
- All opportunities are delivery dependant – resource potential in itself does not contribute to targets, therefore focus should be on enabling delivery.
- There is potential to generate energy from wind, biomass and hydro in Harrogate District.

[39] http://www.nidderdaleaonb.org.uk/nidderdale-429

[40] Sustainable Energy — without the hot air (Mackay, D.J.C, November 2008)

[41] Technology Status Report 016 Geothermal Aquifers, ETSU, October 1994

## Opportunities for Microgeneration Technologies

# 6 Opportunities for Microgeneration Technologies

This chapter describes the potential in Harrogate District to generate low carbon and renewable energy from microgeneration technologies. These encompass the array of small scale technologies, typically less than 50 kW electricity generation and 100 kW heat generation, that can be integrated as part of the development of individual sites, or retrofitted to existing buildings.

These technologies tend to be less location specific and therefore have little influence on the spatial arrangement of sites.

### 6.1 Practical implementation of microgeneration technologies

Combinations of microgeneration technologies can be applied as part of a building or system but some combinations can lead to competition between systems and therefore sub-optimal performance, which will affect both output and maintenance. Generally, conflict occurs where multiple technologies are competing to provide heat, as opposed to electricity which can be exported if excess is generated.

The impact of competition can be avoided through appropriate sizing and design of the systems. For example, two heat supplying technologies could work effectively together if one is sized to meet the annual hot water demand while the other is sized and operated to meet only the winter space heating demands. Figure 14 shows potential combinations of technologies with high conflict (red), no conflict (green) and conflicts that can be avoided through appropriate design (yellow).

The majority of microgeneration technologies will be eligible for financial support, either through the feed-in-tariffs introduced in April 2010 to replace the support provided by the Low Carbon Buildings Programme or through a similar mechanism, known as the Renewable Heat Incentive, to be introduced in April 2011. Further information about the feed-in-tariff and Renewable Heat Incentive is provided in section 6.7.

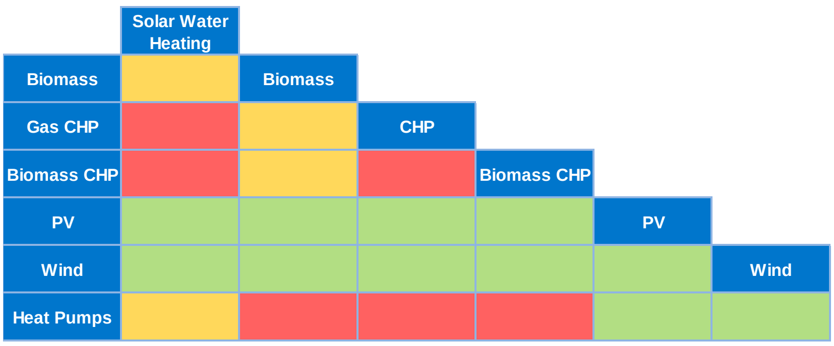



Figure 14 Potential conflicts between performance of different low-carbon technologies

## 6.2 Small Scale Wind Energy

### 6.2.1 Existing Small Scale Wind Installations

As of January 2010 permitted small scale wind installations in the District totalled 192kW [Table 18].

Table 18 Existing small scale wind installations (free standing and building mounted) in Harrogate District.

| Location of small scale wind | Number of turbines | Installed capacity (kW) | Type |
|---|---|---|---|
| Banks Farm, Huby | 1 | 11 | Free standing monopole |
| Hopewell House, Hay A Park, Knaresborough | 2 | 30 | Free standing monopole |
| Pannal Primary School, Pannal | 1 | 6 | Free standing monopole |
| Glebe Farm, Ribston Hill, Spofforth | 1 | 6 | Free standing monopole |
| Upper Nidderdale High School, Pateley Bridge | 1 | 20 | Free standing monopole |
| Swallow Croft, Ings Lane, Bishop Monkton | 1 | n/a | Free standing monopole |
| 3 Dallow Cottages, Belford | 1 | 6 | Free standing monopole |
| Bluecoat Nurseries, Otley Road, Harrogate | 1 | 6 | Free standing monopole |
| Moor Cottage, Stainburn | 1 | 5 | Free standing monopole |
| RHS Harlow Carr, Crag Lane, Harrogate | 1 | 15 | Free standing monopole |
| Cow Close Farm, Hartiwith | 1 | 9 | Free standing monopole |
| The Old Farmhouse, Watsons Lane, Norwood | 1 | 5 | Free standing monopole |
| Hollins Farm, Marton Lane, Arkendale | 1 | 1 | Gable Mounted |
| Tewit Farm, Duck Street, Greenhow | 1 | 1 | Gable Mounted |
| High Austby House, Nesfield, Ilkley | 1 | 6 | Free standing monopole |
| Northside Head Farm, Middlesmoor | 1 | 6 | Free standing monopole |
| Kendall Bank Farm, Carlesmoor Lane, K'Malzeard | 1 | 6 | Free standing monopole |
| adj Scargill Reservoir, Haverah Park | 1 | 6 | Free standing monopole |
| Bilberry Farm, Top Lane, Norwood | 1 | 20 | Free standing monopole |
| Skipton Road Farm, Hampsthwaite | 1 | 6 | Free standing monopole |
| Park Top Farm, Penny Top Lane, Norwood | 1 | 6 | Free standing monopole |
| Cockstone Hill Farm, Station Rd, Goldsborough | 1 | 15 | Free standing monopole |
| Higher Platts Farm, Thruscross | 1 | n/a | Free standing monopole |
| Total | 23 | 192 kW | |

### 6.2.2 Carbon saving potential of small scale wind

The relatively high wind speeds across Harrogate District mean that smaller scale turbines could be a significant opportunity for reducing $CO_2$ emissions (Table 25).

Table 19 Potential $CO_2$ savings from installation of small scale, wind turbines in Harrogate District. (Source: Costs based on Proven wind turbines, obtained June 2010, capacity factor of 15% assumed. See Appendix A for more details).

| Technology | Small scale wind turbine |
|---|---|
| Approximate size required | 6 kW for homes<br>15 kW for schools, farms, etc |
| Capital cost of system | £19,647 for a 6kW wind turbine<br>£50,886 for a 15kW wind turbine. |
| Potential for $CO_2$ savings | 42% of total emissions for existing homes (6kW turbine) |

### 6.2.3 Opportunity Assessment

To estimate the physically accessible resource, the DECC methodology assumes a 6kW turbine will be technically feasible at each address point that is located in an area where the wind speed is above 4.5 m/s, as indicated by the NOABL database.

The Ordnance Survey Address Point was used to pinpoint the geographic location of homes and non-domestic buildings in Harrogate District.

It should be noted that in practice there will be landscape and ecological constraints on the development of small-scale wind generation infrastructure. The DECC methodology will therefore provide an overestimate of the available resource.

### 6.2.4 Constraints Assessment

The constraints assessment established the practically viable resource across the study area by applying wind speed scaling factor that took into account the effect of obstructions and increased turbulence in built-up areas.

Built-up areas were categorised as urban, sub-urban and rural at Output Area level based on the 'DEFRA Rural-Definition dataset'. The average annual wind speed for each of these landscape types was scaled by a factor that took into account the changes to the wind speed typically recorded within each of the landscapes (urban: 56%, semi-urban: 67%, and rural: 100%). Wind speed areas above 4.5m/s at 10m agl (once scaling factors has been applied) were considered to be viable for small scale wind turbines.

### 6.2.5 Available Resource

The total numbers of properties considered to be suitable utilising the DECC method is 16,852 properties. This assumes that all properties (residential and non-residential) could potentially support a 6kW small scale turbine if they are in suitable wind speed areas. The total potential installed capacity for Harrogate was calculated as 99.5 MW (Table 20).

There are many localised factors that can influence viability of small scale wind installations, such as structural implications for building-integrated turbines, cumulative impact of multiple installations, cost, shadow flicker, impact of local buildings on wind speeds and turbulence. The practically viable resource calculated through the DECC methodology is likely to be a significant overestimate of what could actually be delivered across Harrogate District.

Table 20 Potential for small scale wind turbines in Harrogate District.

| Small Scale Wind Turbines | |
|---|---|
| Number of turbines | 16,852 |
| Hub Height | 10 metres |
| Installed capacity | 6 kW |
| Annual generation | 99,492 kW (installed capacity) |

### 6.2.6 Building Mounted Wind turbines

Over the last few years, a number of companies have started to market wind turbines designed specifically for building mounted applications. There is limited data on energy generation from building mounted turbines but early examples appear to have generated significantly less than was predicted by manufacturers (in many cases only around 10% of the predicted output or even less).

Harrogate Borough Council has already carried out a study of building mounted wind turbines. Structural analysis showed a requirement for building strengthening which would approximately double the cost of installation.

AECOM rarely recommend building mounted wind turbines within development level renewable energy feasibility assessments due to uncertainties over expected energy outputs and concerns over mainentance.

## 6.3 Solar Energy

The two main solar microgeneration technologies currently in use are solar PV and solar water heating.

Solar PV panels use semi-conducting cells to convert sunlight into electricity. The output is determined by the brightness of natural light available (although panels will still produce electricity even in cloudy conditions) and by the area and efficiency of the panels. PV is expensive in comparison to other renewable energy options, but is one of the few options available for renewable electricity production and is often one of the only on-site solutions to mitigate $CO_2$ reductions associated with electricity use.

Solar water heating panels are used primarily to provide hot water. Output is constrained by the amount of sunlight available, panel efficiency and panel area. Devices are most cost effective when sized to meet 50-70% of average hot water requirements, which avoids wasting heat in the summer. It should be noted that solar water heating supplements and does not replace existing heating systems.

### 6.3.1 Carbon saving potential of solar technologies

Figure 15 shows how the output of solar systems varies by orientation and tilt of the installation. Panels should be mounted in a south-east to south-west facing location. The optimum angle for mounting panels is between 30º and 40º, although this is often dictated by the angle of the roof. Careful consideration should be given to placing the systems so that they are not over shaded by adjacent buildings, structures, trees or roof furniture such as chimneys.[42] The potential for $CO_2$ savings compared to the approximate capital cost of installation is shown in Table 21.

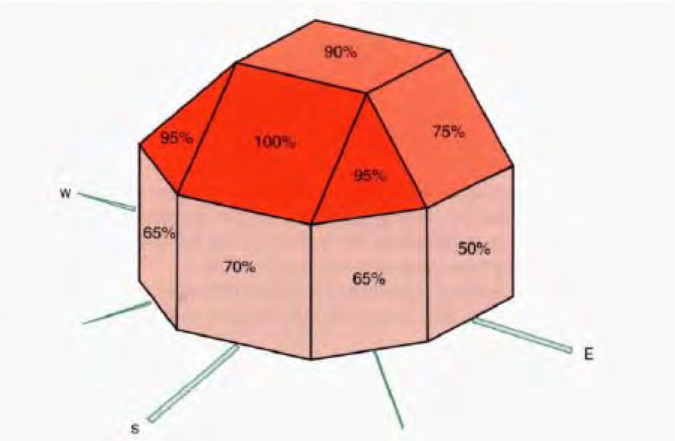



Figure 15 Optimum orientation for solar panels in the UK. The diagram shows the percentage of maximum output according the orientation (Source: Sustainability at the Cutting Edge, Smith, F, 2007)

[42] Sustainability at the Cutting Edge (Smith , F, 2007)

Table 21 Indicative performance parameters for domestic solar installations (Note. All buildings are assumed to have at least good practice energy efficiency measures installed).

| Technology | Solar Hot Water | Solar Photovoltaics (PV) |
|---|---|---|
| Approximate size required | ~4 $m^2$ per dwelling | ~8 $m^2$ per dwelling |
| Total cost of system | £2,500 for new build homes (2 kW system)<br>£5,000 for existing homes (2.8 kW system)<br>£1,000/kW for new build non-domestic<br>£1,600/kW for existing non-domestic | £5,500 for new build homes (1 kWp system)<br>£6,000 for existing homes (1 kWp system)<br>£4,500/kW for new build non-domestic<br>£5,000/kW for existing non-domestic |
| Annual Generation Potential | 396 kWh/$m^2$ for flat plates<br>520 kWh/$m^2$ for evacuated tubes | 850 kWh/$m^2$ for high performing systems |
| Potential for $CO_2$ savings | 13% of total emissions for existing homes<br>23% of total emissions for new build homes | 26% of total emissions for existing homes<br>38% of total emissions for new build homes |

### 6.3.2 Existing solar installations in Harrogate District

It has not been possible to ascertain details of existing solar installations in the District.

### 6.3.3 Opportunity Assessment

The methodology employed to establish the solar energy resource available across Harrogate District was based on the DECC methodology. As Figure 16 shows, the solar resource, in terms of annual irradiation per year, is similar across much of the UK, with Harrogate District in the mid to lower end of the solar spectrum.

In order to estimate the physically accessible resource for solar energy generation, it has been assumed that the following proportion of the building stock in Harrogate District would be able to accommodate solar installations:

- Homes (including flats) – 50%
- Commercial properties – 40%

- Industrial buildings – 80%

The following assumptions have been applied for average systems capacity for existing buildings as well as new development:

- Domestic – 2kW (thermal or electric)
- Commercial – 5kW (electric only)
- Industrial (assume same as commercial)


Figure 16 Indicative solar resource across the UK.

### 6.3.4 Constraints Assessment

The DECC methodology does not define any specific parameters to further constrain the solar resource, as it is assumed that most constraints have already been taken into account in the opportunity assessment. In practice, the physically accessible resource would be limited by factors such as available roof space, shading from other buildings or trees, roof angle and direction of the roof.

### 6.3.5 Available resource

The total resource is shown in Table 22. It has been assumed that the potential capacity for homes is the same whether solar PV or solar water heating panels have been installed. For commercial buildings, the installed capacity is always assumed to refer to solar PV.

Table 22 Potential solar resource in Harrogate District by property type.

| Property Type | Total Potential Installed Resource (kW) |
|---|---|
| Domestic properties | 34,534 |
| Commercial buildings | 12,444 |
| Industrial buildings | 4,960 |
| New domestic developments | 29,458 |
| **Total** | **81,396** |

## 6.4 Heat Pumps

Heat pumps are considered to be renewable energy devices and can provide significant $CO_2$ savings in comparison to standard electrical heating systems, since they require around a third of the electricity. However, due to the current carbon intensity of the grid, $CO_2$ emissions from heat pumps are similar to those of an efficient gas heating system. As electricity is currently around four times more expensive than gas, running costs are also comparable with, and often higher than an equivalent gas system.

Heat pumps are primarily space-heating devices and the best efficiencies are achieved by running systems at low temperatures. For this reason, they are ideally suited for use in conjunction with under floor or air-based heating systems.

This creates a significant challenge for heat pumps installed in future homes, where hot water demands are likely to be comparable to the (reduced) space heating requirements. In such cases, heat pumps might be complemented by other microgeneration systems that are sized in relation to domestic hot water requirements, for instance, solar hot water systems.

It can be easier to install heat pumps in a new building as a low temperature heating system can be designed in from the outset and the ground works incorporated more easily. Retrofitting is likely to be significantly more difficult in existing buildings both in terms of completing the ground works in and around existing structures and also with the potential need to replace high temperature space heating systems.

Table 23 shows the potential carbon savings from installing a heat pump in a new or existing building. The high cost of ground works for ground source heat pumps means that air source heat pumps are around half the installed cost, albeit with a lower efficiency. For air source heat pumps, retrofit costs are slightly higher than new build to allow for increases in plumbing and electrical work. For GSHPs, the cost for retrofit is higher to allow for modifications to existing plumbing and removal of existing heating system, plus ground works costs when digging up an established garden.

There is a wide variation in costs for ground source heat pumps at the 20-100kW scale, principally due to differences in the cost of the ground works. The cost of the heat pumps themselves is also dependent on size as commercial systems are usually made up of multiple smaller units rather than a single heat pump. Due to these variations, heat pumps in the 20-100kW range are shown with an indicative cost of £1,000 per kW installed. A borehole ground source heat pump system is more costly due to a high drilling cost of £30 per metre. A typical 70m borehole provides 3-5kW of heat output, giving a drilling cost of £4200 for an 8kW system[43]

Table 23 $CO_2$ saving potential of heat pumps (2007 costs). A borehole ground source heat pump system is more costly due to a high drilling cost of £30 per metre. A typical 70m borehole provides 3-5kW of heat output, giving a drilling cost of £4200 for an 8kW system. (Source: The Growth Potential for Microgeneration in England, Wales and Scotland, Element Energy for BERR, 2008)

| Technology | Air Source Heat Pump | Ground Source Heat Pump |
|---|---|---|
| Approximate size required | 5 kW | 5kW trench system for new build<br>11kW trench system for existing |
| Total cost of system | £5,000 for new build<br>£7,000 for existing<br>£500/kW for non domestic | £8,000 for new build<br>£12,000 for existing<br>£1,000/kW for non domestic |
| Potential for $CO_2$ savings | 5% of total emissions for existing homes<br>0.25% of total emissions for new build homes | 12% of total emissions for existing homes<br>8% of total emissions for new build homes |

[43] The Growth Potential for Microgeneration in England, Wales and Scotland (Element Energy for BERR, June 2008)

### 6.4.1 Existing ground source heat pump installations

In 2005, Harrogate Borough Council carried out a trial of 4kW, domestic ground source heat pumps in eight, Council owned properties in Copt Hewick. The trial resulted in a 53% - 71% reduction in $CO_2$ emissions compared to the previous heating method of solid fuel heating (coal) and electric storage heating. It also demonstrated that the technology can be appropriately deployed into existing housing stock. Following on from the success of this trial the council has since gone on to install a further 85 systems with plans for more in the future.

It has not been possible to ascertain details of any other existing heat pump installations in the District.

Figure 17 Ground panels laid out prior to ground work commencing on installation of ground source heat pumps (Source: Copt Hewick Ground Source Heat Pump Project Case Study 2007, Ryedale Energy Conservation Group)

### 6.4.2 Opportunity Assessment

The assessment of the potential for heat pumps is based on the premise that most buildings (existing stock and new build) are suitable for the deployment of at least one type of heat pump.

Analysis of local heat demand suggests that there is potential for non-domestic ground source resource within the town of

Harrogate. The area known as The Stray has sections of open space that would be suitable for ground source heat pumps with minimal disruption to use during installation and without impacting upon use or the aesthetics of the area once installed. The Stray is surrounded by existing residential housing and could be considered for 11kW trench systems per building offering potential annual $CO_2$ savings of 12% per annum.

There is potential for air source heat pumps in Harrogate District. It should be noted that the ability of air source heat pumps to transfer heat from the outside air to the house depends on the outdoor temperature. Typical winter temperatures in Harrogate District means that the performance air source heat pumps will be significantly reduced for much of the year. The performance of the air source heat pumps may be further reduced when it operates in defrost mode at these times.

### 6.4.3 Constraints Assessment

The DECC methodology does not define any specific parameters to further constrain the resource for heat pumps. In practice, the performance of ground source heat pumps is linked to the average ground temperature, while air source heat pump performance is influenced by the average air temperature. Harrogate Borough Council have pointed out that buried archealogy could be a constraint on installation of underground coils for ground source heating.

### 6.4.4 Available Resource

An estimate of the heat pump resource in Harrogate District is shown below in Table 24. It has been assumed that the installed capacity will be the same whether an air source or ground pump heat pump is installed.

Table 24 Heat pump resource in Harrogate District

| Property Type | Total Potential Installed Resource (kW) |
|---|---|
| Domestic properties (off grid) | 29,927 |
| Detached and semi-detached | 18,401 |
| Terraced properties | 36,072 |
| Flats and commercial | 155,550 |
| New domestic developments | 73,645 |
| **Total** | **313,595** |

## 6.5 Small Scale Biomass Heating

Biomass heating is most appropriate in lower density situations due to fuel supply and storage issues. The most common application is as one or more boilers in a sequenced (multi-boiler) installation where there is a communal system, i.e. a block of flats or district heating.

Table 24 shows the $CO_2$ savings and cost of small scale biomass boilers. It is more expensive to install these systems in existing building due to the extra building (e.g. external plant rooms) and plumbing work. Costs are generally installation based and not size variable; this is because the actual boiler makes up a small proportion (around 39%) of the overall cost.[44]

Table 25 Potential $CO_2$ savings from installation of small scale, biomass heating in Harrogate.

| Technology | Small Scale Biomass Boiler |
|---|---|
| Approximate size required | 8.8 kW for homes |
| Capital cost of system | £9,000 for new build homes<br>£11,000 for existing homes |
| Potential for $CO_2$ savings | 34% of total emissions for existing homes<br>33% of total emissions for new build homes |

## 6.6 Fuel Cells

Fuel cells can be used as CHP systems in buildings and are considered to be an emerging technology. They are similar to batteries in that they produce electricity from a chemical reaction. However, whereas a battery delivers power from a finite amount of stored energy, fuel cells can operate indefinitely provided that a fuel source is continuously supplied; this is currently usually natural gas which is reformed to produce hydrogen.

There is debate as to whether electricity generation from hydrogen is better than generating electricity directly from renewable sources such as PV and wind. The virtue of fuel cells is that they guarantee continuity of supply and clean, quiet, and very efficient electricity generation.

The capital cost of fuel cells is currently much higher than most other competing micro-generation technologies. Commercial models currently available cost approximately £3,000/kW. Fuel cell prices are expected to drop to £500-£1500/kW in the next

44 Biomass heating A practical guide for potential users (Carbon Trust, January 2009)

decade with further advancements and increased manufacturing volumes.

### 6.7 Incentives for microgeneration

All of the microgeneration technologies introduced in this chapter will be able to take advantage of the feed in tariff and the forthcoming Renewable Heat Incentive.

The feed in tariff (FIT) scheme came into force in April 2010 for installations not exceeding 5 MW and has been designed to incentivise small scale, low carbon electricity generation by providing payments according the amount of energy produced by householders, communities and businesses. Wind, solar photovoltaics (PV) and hydro installations are eligible for the tariff. The tariff levels have been set at a level that encourages investment in small scale, low carbon electricity generation and should ensure that as well as the energy saving benefits, the installation will provide a reasonable rate of return on the initial investment.

The scheme includes:

- Fixed payment from the electricity supplier for every kWh generated (the “generation tariff”).
- A guaranteed minimum payment additional to the generation tariff for every kWh exported to the wider electricity market (the “export tariff”).
- Generators receiving FITs will also benefit from on-site use: where they use the electricity they generate on-site, they will be able to offset this against electricity they would otherwise have had to buy.
- Technologies included: wind, solar PV, hydro, anaerobic digestion and non-renewable micro CHP.
- Tariffs will be paid for 25 years for PV. Other eligible technologies benefit from the tariif for 20 years, except microCHP where the tariff is only available for 10 years.
- The tariff levels proposed have been calculated to ensure that the total benefits an investor can be expected to achieve (from the generation tariff, the export tariff and/or the offsetting benefit) should compensate the investor for the costs of the installation as well as provide such a rate of return.
- The proposed tariff levels for new projects will decrease by predetermined rates each year (“degression”). The tariff rate agreed at the project outset will be maintained for the 20 year period – this therefore incentivises early take-up for maximum revenue return.

The Government is currently consulting on introducing a Renewable Heat Incentive in April 2011. Renewable heat producers of all sizes will receive payments for generation of heat. The payments are intended to give a 12% rate of return will be 'deemed' rather than metered. There is no upper limit to the size of heat equipment eligible under the Renewable Heat Incentive and anyone who installs a renewable energy system producing heat after July 15th 2009 is eligible. The following technologies are included in the scheme.

- Air and ground source heat pumps, anaerobic digestion to produce biogas for heat production, biomass heat generation and CHP, liquid biofuels (but only when replacing oil-fired heating systems), solar thermal heat and hot water and biogas injection into the grid
- Unlike FITs, tariffs will be paid not on the basis of a metered number of kWh generated, but instead on a “deemed” number of kWh, namely the reasonable heat requirement (or heat load) that the installation is intended to serve.
- Tariff levels will be calculated to bridge the financial gap between the cost of conventional and renewable heat systems at all scales, with additional compensation for certain technologies for an element of the non-financial cost and a rate of return of 12% on the additional cost of renewables, with 6% for solar thermal.

AECOM have carried out an indicative calculation on the estimated payback for a typical, Victorian built residential property in Harrogate. This suggests that a solar PV array will payback in around 17 years (Table 27).

Table 26 Tariff payments for renewable energy systems installed in 2011. "FIT" refers to feed in tariff; "RHI" refers to Renewable Heat Incentive. Please note that the RHI tariff is still under consultation. (Source: Consultation on the proposed RHI financial support scheme, DECC, 2010; Valuation of energy use and greenhouse gas emissions for appraisal and evaluation, HM Treasury & DECC, January 2010)

| Technology | Applicable tariff system | Generation tariff (p/kWh) | Export tariff (p/kWh) | Value of energy saved (p/kWh) |
|---|---|---|---|---|
| PV (below 4kW new build or retrofit) | FIT | 41.3 | 3.0 | 12.9 |
| PV (between 4 kW and10 kW) | FIT | 36.1 | 3.0 | 12.9 |
| Hydro (below 15kW) | FIT | 19.9 | 3.0 | 12.9 |
| MicroCHP (below 2kW) | FIT | 10.0 | 3.0 | 12.9 |
| Wind turbine (below 1.5kW) | FIT | 34.5 | 3.0 | 12.9 |
| Wind turbine (between 1.5 kW and 15 kW) | FIT | 26.7 | 3.0 | 12.9 |
| Small scale solid biomass (e.g. wood burning stove) | RHI | 9.0 | n/a | 3.7 |
| Small scale bio liquids | RHI | 6.5 | n/a | 3.7 |
| Biogas onsite consumption (e.g. small scale anaerobic digestion) | RHI | 5.5 | n/a | 3.7 |
| Ground source heat pumps | RHI | 7.0 | n/a | 3.7 |
| Air source heat pumps | RHI | 7.5 | n/a | 3.7 |
| Solar thermal/solar water heating | RHI | 18.0 | n/a | 3.7 |

Table 27 Estimated payback from installation of solar PV on terraced Victorian home in Harrogate District, provided as an example.

| | |
|---|---|
| **Construction date** | Pre 1919 |
| **Costs for annual maintenance, insurance, admin, etc** | £25 |
| **Installation costs for PV** | £5,500 |
| **Energy generated by PV array in first year of operation** | 750 kWh |
| **Proportion of solar electricity used within home** | 50% |
| **Annual degradation of equipment** | 2% |
| **Year 1 return** | 6% |
| **Payback** | 17 years |
| **25 year IRR** | 1% |

### 6.8 Microgeneration in conservation areas

In terms of constraints, the delivery of microgeneration on existing buildings in conservation areas is a key issue for Harrogate, and one where the policy guidance is relatively unclear.

In England, changes to permitted development rights for renewable technologies introduced in April 2008 have lifted the requirements for planning permission for most domestic microgeneration technologies. The General Permitted Development Order (GPDO) grants rights to carry out certain limited forms of development on the home, without the need to apply for planning permission. The GPDO would be applicable to the following types of technologies installed on homes in Harrogate District:

- Roof-mounted solar PV and solar thermal (permitted unless panels protrude more than 200mm when installed).
- Stand alone solar PV and solar thermal (permitted unless more than 4 metres in height) installed less than 5 metres away from any boundary; above a maximum area of array of 9 $m^2$; situated on a wall within any part of the curtilage of the dwelling house and would be visible from a highway in Conservations Areas and World Heritage Sites (such as Fountains Abbey and Studley Royal).
- Wood burning boilers and stoves, and CHP (permitted unless flue exceeds 1m above the roof height (excluding the chimney); installed on the principal elevation and visible from a road in building in Conversation Areas and World Heritage Sites).
- Ground and water source heat pumps.

New legislation was released for consultation in November 2009 on 'Permitted development rights for small scale renewable and low carbon energy technologies, and electric vehicle charging infrastructure' (consultation closed in February 2010). This document proposed conditions of permitted development for small wind turbines and air source heat pumps. Air source heat pumps are proposed as a permitted activity in a conservation area, while wind turbines in conservation areas will require planning permission where the wind turbine would be visible from any highway which bounds the curtilage of the property.

The consultation document also proposes new policies on permitted development for non-domestic buildings. As proposed, all types of micro-generation except ground and water source heat pumps would require planning permission for inclusion on non-domestic properties in a conservation area.

The consultation document provides an indication of the possible direction of future policy. Regarding the local context, the document states:

*'The impacts of renewable and low carbon energy technologies will vary on a case by case basis according to the type of the development, its location and setting. Development that is appropriate in one place may not be acceptable somewhere else and permitted development rights need to reflect this. This consultation therefore proposes that limits to what would be permitted would vary according to their site and location. For instance, in reflecting the impacts of the various technologies, the consultation proposes different limits for detached and non-detached properties, for residential and industrial areas, for conservation areas and national parks etc.'*

Harrogate District contains 52 conservation areas, and hence consideration of conservation is a key issue for the delivery of microgeneration in the District. This does not necessarily mean that visually distinct technologies such as solar PV panels cannot be installed, but planning should ensure that the volume of delivery and the positioning of technologies does not adversely affect the value of the conservation area as a whole.

Figure 18 Houses on the Duchy Estate, within one of Harrogate District's conservation areas

Roof mounted technologies are likely to be the most concerning from a conservation perspective, though it should be noted that other roof-mounted objects such as TV aerials are allowable in conservation areas. Roof mounted microgeneration technologies that may be of concern include solar PV, solar thermal, flues associated with wood-burning stoves/boilers and CHP and building mounted wind turbines.

Consideration is being given by Harrogate Borough Council to making Article 4's to reduce permitted development rights in conservation areas. If Article 4's are approved by planning committee, solar and pv panels will be restricted to roof slopes facing away from the highway, or to ground mounted panels in rear gardens.

Solar PV panels have now been developed that look similar to roof tiles and may be more attractive in areas of Harrogate District where aesthetics are important. At present these are up to £2,000/kW more expensive than conventional PV. [45]

### 6.9 Key considerations emerging from this chapter

Key considerations emerging from the assessment of the potential for microgeneration in Harrogate District are:

- There is the potential to exploit a range of microgeneration technologies across Harrogate District.
- There are relatively few options available for renewable electricity production. Although it is expensive, solar PV and is often one of the only on-site solutions to mitigate $CO_2$ reductions associated with electricity use.
- Incentives are likely to increase the uptake of certain technologies, particularly in the private sector. This may conflict with the desire to maintain the character of certain landscapes within the District, for example, conservation areas.

[45] The Growth Potential for Microgeneration in England, Wales and Scotland (Element Energy for BERR, June 2008)

# Energy Opportunity Areas

# 7 Energy Opportunity Areas

This chapter presents the opportunities and constraints mapping work undertaken as part of the study. The resulting Energy Opportunities Plan provides a visual resource to support the development of decentralised renewable and low carbon energy polices and targets, the identification of priority areas for further study and to inform wider delivery mechanisms.

## 7.1 Potential for low carbon and renewable energy generation in Harrogate District

Based on the DECC methodology, the annual resource for community-scale, low carbon and renewable technologies is shown in Figure 19 and Table 28.

Heat opportunities lie predominantly around the major towns of Harrogate, Knaresborough and the city centre of Ripon, but some smaller opportunities have been identified in Melmerby, Summerbridge, Pateley Bridge, Tockwith and Boroughbridge.

Hydro opportunities have been identified at various locations along the River Nidd from Pateley Bridge in the west of the District to Walshford in the south east of the District. There is a potential site located near to Knaresborough within close proximity to a number of site options for housing.

Wind resource is significant across the District. Local constraints such as AONB land classifications and proximity to residential areas may substantially reduce the practically deliverable resource.

The biomass resource is largely concentrated to the west of the District.

Table 28 Potential for low carbon and renewable energy generation in Harrogate District. The following capacity factors have been assumed to estimate annual energy generation: large scale wind = 27%. Small scale wind = 15%. Hydro energy = 50%.

| Energy generation technology | Energy generation (MWh) |
|---|---|
| Large scale wind | 6,134,797 |
| Small scale wind | 130,822 |
| Biomass energy crops | 53,640 |
| Biomass aboricultural arisings | 1,237 |
| Biomass parks and highways waste arisings | 85 |
| Wet biomass | 41,074 |
| Hydro | 6,110 |
| Solar | 81 |
| Ground source heat pumps | 314 |

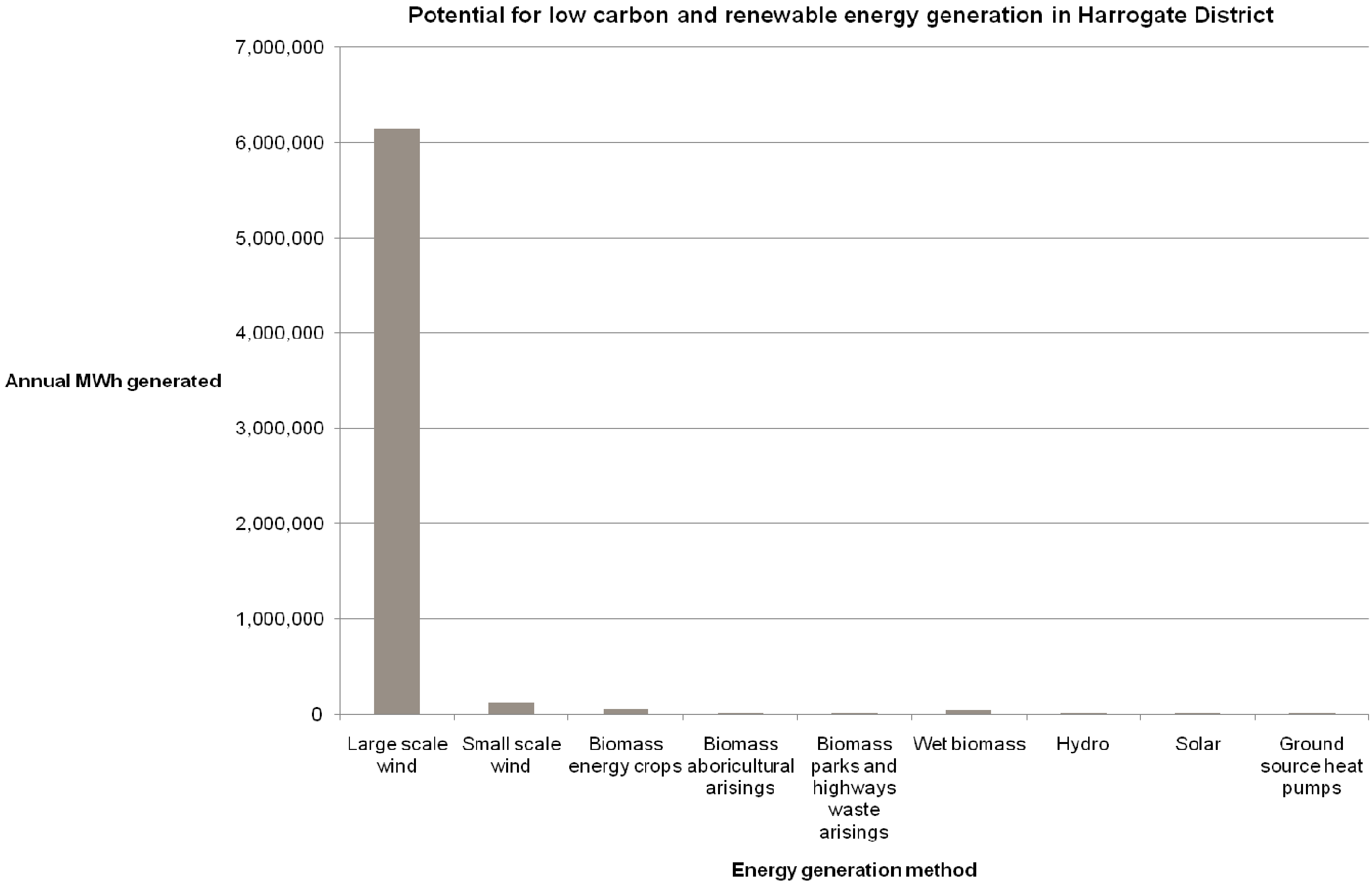



Figure 19 Potential for low carbon and renewable energy generation in Harrogate District, based on the DECC methodology. The following capacity factors have been applied to estimate annual energy generation: large scale wind = 27%. Small scale wind = 15%. Hydro energy = 50%[46].

[46] A guide to UK mini-hydro developments, British Hydro Association, June 2006

## 7.2 The Energy Opportunities Plan

The opportunities for generating decentralised renewable and low carbon energy across the District have been mapped using GIS. We refer to this map as an 'Energy Opportunities Plan (Figure 39 to Figure 42). It has been designed to indicate the spatial distribution of opportunities for low carbon and renewable energy generation that are currently available and those that will be available in the near future based on future growth proposals.

The following information is shown on the Energy Opportunities Plan:

- Existing and planned energy from waste plants (landfill).
- Existing and planned wind farms.
- Areas for potential large scale wind turbine locations.
- Areas with potential for hydropower.
- Areas with potential for district heating with CHP.
- Anchor loads, including public sector assets, leisure centres, schools and hospitals.
- Site options for future development (based on planning applications and potential growth areas).

The Energy Opportunities Plan should provide a tool when developing planning policies, targets and delivery mechanisms within the LDF process, and can bring added benefit and support to development plan documents. It should be used to support policies that stipulate requirements for decentralised energy; whether these are through the setting of targets that exceed Building Regulations, the requirement for Code for Sustainable Homes or BREEAM, or a requirement for connecting to, or investing in, infrastructure to facilitate district heating.

It should be noted that although the Energy Opportunities Plan provides an overview of potentially feasible technologies and systems within an area, it does not replace the need for site specific feasibility studies for proposed development sites.

## 7.3 Energy Opportunity Areas

Developments in some parts of Harrogate will have access to options for decentralised renewable and low carbon energy supply which is not afforded to developments elsewhere in the District.

Based on our analysis in chapters 4 to 6, all development expected in Harrogate District over the period of the Core Strategy can be considered to fall into one of the following four energy opportunity areas, as shown on the Energy Opportunities Plan:

- District Heating Opportunity Areas
- Wind Energy Opportunity Areas
- Hydro Energy Opportunity Areas
- Energy Constrained Areas

Note that developments may lie across more than one area, in which case all of the applicable options should be considered during the planning process. Other site-specific factors, such as grid access, ground conditions, ecology, archaeology and the form of surrounding buildings will affect the feasibility and viability of using these technologies in practice. These will need to be taken into account on a case by case basis as developments come forward for planning.

An assessment of indicative costs and $CO_2$ savings from developments installing the recommended low carbon solution for the Energy Opportunity Area in which it is located is included in section 8.

### 7.3.1 District Heating Opportunity Areas

The Energy Opportunities Plan presents areas where district heating beyond the site boundary may be a viable option (see chapter 4 for more details). This could be because there is sufficient local heat demand from existing buildings to justify establishing a district heating network, or there is a local source of available heat. Criteria that have been used to define District Heating Opportunity Areas are set out below.

- The density of existing and future heat demand;
- The presence of possible existing anchor loads, and;
- The presence of significant amounts of existing social housing (if not already included as an anchor load.

### 7.3.2 Wind Energy Opportunity Areas

Areas in Harrogate District where large scale wind turbines could be a viable option have been identified on the Energy Opportunities Plan, based on the following criteria:

- Sufficient local wind resource;
- Proximity to electricity infrastructure (e.g. 10-30kV power lines, substations) to connect to grid;

- Proximity to roads, railways for easier transport of components to site;
- Consideration of environmentally and archaeologically sensitive areas and areas of high landscape quality (e.g. AONBs);
- Consideration of local airports and defence structures (e.g. radars and flight paths);
- Consideration of potential noise impacts on residential areas.

### 7.3.3 Hydro Energy Opportunities

We have assumed that sites in close proximity to one or more potential small-scale hydropower sites can take advantage of Hydro Energy Opportunities. The feasibility of exploiting the resource will depend on the size of the development, the potential capacity of the hydro site.

### 7.3.4 Energy Constrained Areas

These areas represent areas of Harrogate where no community or large scale renewable or low carbon energy resources are likely to be available in the vicinity of the development site. Options for complying with carbon targets will be limited to what can be achieved onsite, namely through microgeneration technologies (see chapter 6 for more details).

## 7.4 Key considerations emerging from this chapter

Key considerations emerging from the definition of Energy Opportunity Areas in Harrogate District are:

- There are a number of low carbon and renewable resource opportunities across Harrogate District. These are wind (large and small scale), biomass, hydro and microgeneration technologies.
- An Energy Opportunities Plan has been produced as a planning resource which will allow assessment and prioritisation of delivery of opportunities. It is recommended that the it be included as part of the Harrogate District Sites and Policies development plan document.
- Growth plans for Harrogate District should consider where new development can deliver the greatest carbon reduction opportunities, using the Energy Opportunities Plan.
- All opportunities are delivery dependant – resource potential in itself does not contribute to targets, therefore focus should be on enabling delivery.

# Future development in Harrogate District

# 8 Future development in Harrogate District

The potential for new developments in Harrogate District to install low carbon and renewable energy technologies is discussed in this chapter.

Three policy options have been tested for a set of notional development types, which are representative of the development likely to come forward over the Core Strategy period.

## 8.1 Low carbon and renewable energy generation on potential urban extension sites

Where there are demonstrable opportunities for greater use of decentralised, low carbon or renewable energy, the PPS Supplement expects local authorities to bring forward development area or site-specific targets to secure this potential. This section discusses the potential to deploy low carbon and renewable energy technologies on 11 potential urban extension sites that Harrogate Borough Council have identified, where new dwellings could be accommodated.

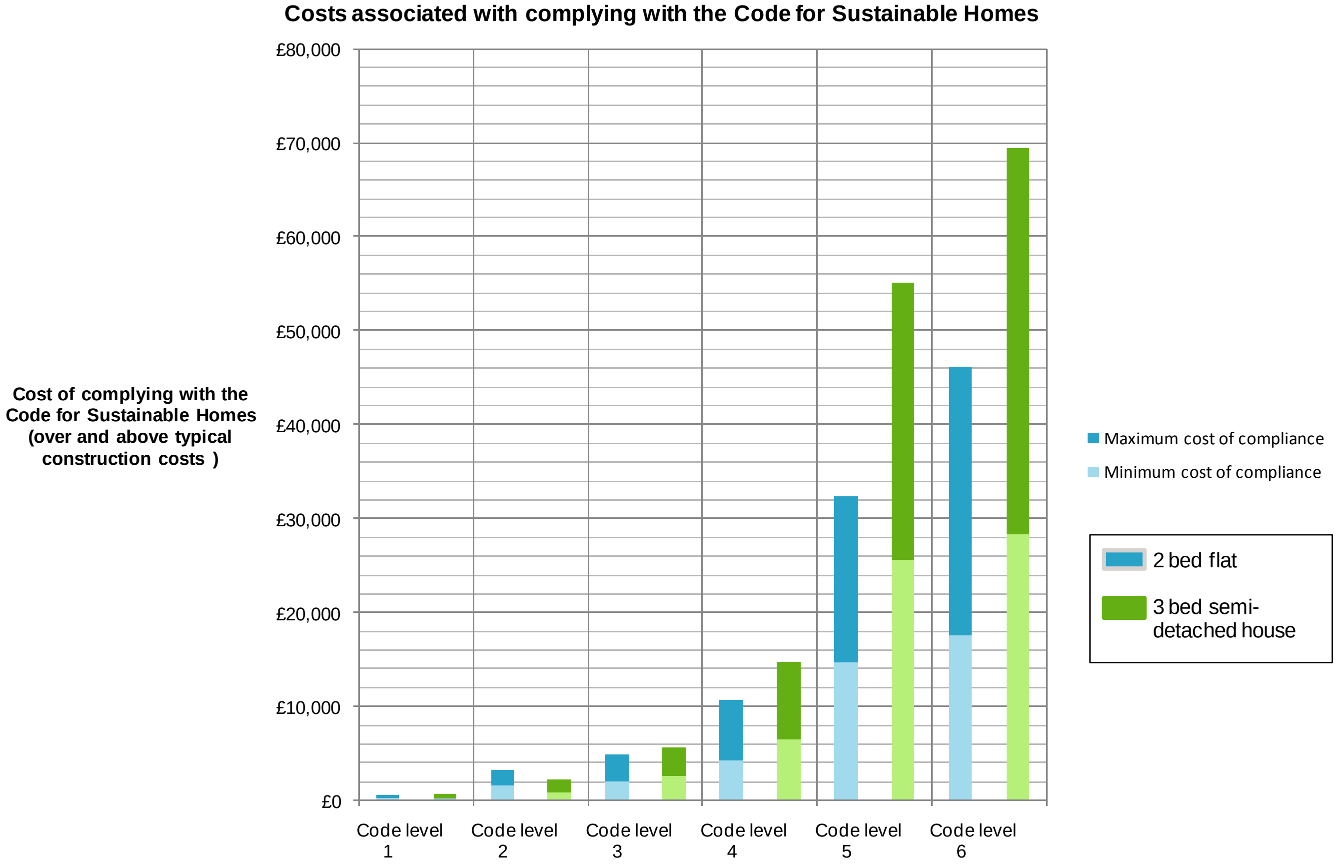
Chapters 6, 7 and 8 of this report have identified the opportunities for renewable and low carbon energy systems across the District. A number of "Energy Opportunity Areas" were defined in these chapters based on the physical and environmental characteristics of the District. Table 29 shows the type of low carbon solutions that may be suitable for each possible urban extension sites, based on the Energy Opportunity Plan for the District.

Discussion with Harrogate Borough Council has suggested that new development is likely to be relatively low density. It should be noted that although the number of units planned for these sites means dedicated, site wide heating system could be an option, the low density of development will increase pipework length, which will affect viability. District heating systems with CHP system could be viable if dwelling density was increased to approximately 55 dwellings/hectare or a diversity of uses was introduced to increase the CHP hours of operation. A mix of building uses in new development helps the viability of district heating and combined heat and power. The mix of uses and resulting diverse occupancy patterns creates a more stable energy demand which improves CHP engine efficiency, improving $CO_2$ saving and commercial viability.

Table 29 Potential for low carbon and renewable energy generation on possible urban extensions in Harrogate District.

| | Energy Constrained Area | District Heating Opportunity Area | Wind Energy Opportunity Area | Hydro Energy Opportunity Area |
|---|---|---|---|---|
| NW1 | Yes | No | Yes | No |
| NW2 | Yes | Yes | No | No |
| NW3 | Yes | No | Yes | No |
| N1/N2 | Yes | Yes | No | No |
| NE1 | Yes | Yes | Yes | No |
| NE2 | Yes | Yes | Yes | No |
| SE1 | Yes | No | No | Yes |
| SE2 | Yes | No | No | Yes |
| S1 | Yes | No | Yes | Yes |
| S2 | Yes | No | No | Yes |
| SW1 | Yes | No | Yes | No |

Figure 20: Costs associated with complying with the Code for Sustainable Homes. The light blue and light green colours represent the minimum cost to developers, for example, on an urban brownfield site. The dark blue and dark green colours represent the maximum cost to developers, for example, on a large, edge of town site similar to the proposed Harrogate urban extension areas . (Source: Code for Sustainable Homes: A Cost Review, March 2010)




The adopted Harrogate District Core Strategy policy EQ1 expects new developments to attain various Code standards, depending on when the development comes forward. The cost implications of this on a 2 bed flat and on a 3 bed, semi-detached house are shown in Figure 20.The additional costs above base construction are typically 3–4% for Code level 3, 6–8% for Code level 4, 25–30% for Code level 5 and between 30-40 % for Code level 6.

The most critical factor in determining the total cost of building to the Code is the approach taken to meeting the mandatory reduction in carbon emissions, which will now be necessary for meeting Building Regulations and so could be considered as part of base build cost. Section 8.2 presents cost estimates of different carbon reduction strategies on typical development types that can be expected in the District.

## 8.2 Low carbon and renewable energy generation on typical development in Harrogate District

The size and type of development proposed are important factors to take into account when considering the level of energy performance that may be feasible and viable.

We have assessed the technical feasibility and financial viability of new developments installing these technologies to meet Building Regulations obligations and policy targets. Three development types have been used that are considered to be typical of development expected across Harrogate District over the period of the Core Strategy, the assumptions for these are shown below and the modelling approach is described in detail in Appendix B.

- Site 1: A large, 100 unit residential development, with a density of 35 dwellings per hectare.
- Site 2: A small, 10 unit residential development, with a density of 30 dwellings per hectare.
- Site 3: A commercial 1000 $m^2$ development containing a mix of B1/B8 office and industrial uses.

Each development type was tested against the set of Energy Opportunity Areas defined in chapter 7 . A range of technology options were compared for each character area and the cheapest option that complies with the policy in question was selected. The purpose of this was to ensure that there were appropriate low carbon solutions available to meet policy recommendations. Three policy options have been tested for the representative development types.

For each policy and for each step change in the Building Regulations requirements, the associated cost and percentage $CO_2$ saving over and above the Building Regulations requirement is shown.

When interpreting the model findings it should be noted that the costs presented do not in themselves constitute a viability assessment. To make a judgement on the viability of $CO_2$ targets, these numbers should be included in a full viability assessment that includes, for example, an assessment of affordable housing viability in the District.

Table 30 Policy target testing options. It has been assumed that any required reduction in $CO_2$ emissions can be achieved through the use of both energy efficiency measures and/or installation of renewable technologies.

| Policy Type | Policy Target |
|---|---|
| **Policy 1**<br>("Base case". Based on existing Harrogate District Core Strategy Policy EQ1) | Homes: Code level 4 from 2011 (including a 44% reduction in regulated $CO_2$ emissions)<br>Non domestic development: Building Regulations compliance |
| **Policy 2** | Base case + 10% additional reduction in regulated site $CO_2$ emissions |
| **Policy 3** | Base case + 15% additional reduction in regulated site $CO_2$ emissions |

Our analysis is based on standard assumptions about the $CO_2$ savings which different combinations of energy technologies and energy efficiency improvements could deliver, based on the model inputs described in Appendix B. We have assumed a typical size of technology, according to the size of dwelling (or floor area for non-domestic buildings) which is not scaled according to the target. The $CO_2$ savings and cost of each technology are therefore also fixed for each dwelling type. This means, for example, that a detached house would have the same size of solar hot water system with the same cost, whether the target is compliance with the 2010 Building Regulations or an additional 15% $CO_2$ saving on top of that. Because installation and tank costs would remain, a smaller system to comply with lower targets would still cost a similar amount. If the Building Regulations requirements can be assumed to be viable, and additional savings over and above this could be delivered with no or minimal increase in cost, then it could be argued that a planning target which requires these additional savings is also viable.

Table 31 Assumed mix for the development typologies considered in Harrogate District

| Development Name | Site 1<br>Large 100 unit residential development | Site 2<br>Small 10 unit residential development | Site 3<br>Commercial 1000 $m^2$ development |
|---|---|---|---|
| **Detached, 4 bed houses** | 20 | 2 | - |
| **Semi-detached, 3 bed houses** | 40 | 5 | - |
| **Terraced, 2 bed houses** | 20 | 3 | - |
| **2 bed flats** | 10 | - | - |
| **1 bed flats** | 10 | - | - |
| **Commercial B1 use** | - | - | 500 $m^2$ |
| **Commercial B8 use** | - | - | 500 $m^2$ |

#### 8.2.1 Results of modelling for a small residential development

The results of the character area modelling for a small, residential development are shown in Table 32 and in Figure 21 to Figure 22.

- Figure 21 shows that the most cost-effective solutions for delivering $CO_2$ savings are energy efficiency measures. However, these have limited potential for saving $CO_2$ up to 25%, and so would not be sufficient to meet the standards for Building Regulations after 2010.
- Standard energy efficiency measures would not be sufficient to comply with any of the tested policies; viable solutions to meet all policies would require some low carbon or renewable energy technologies.
- The current 2006 Building Regulations could be achieved by increased energy efficiency (Energy Efficiency 1). In Energy Constrained Areas, Harrogate District Core Strategy policy EQ1 (policy 1) could only be achieved by solar PV; a medium sized array on each house would reduce regulated $CO_2$ emissions by 50% compared to current Building Regulations, at a cost of £10,627 per tonne$CO_2$ saved.
- In Energy Constrained Areas, the lowest capital cost solution to achieve policy 2 and policy 3 would be individual biomass heating for each home. This would reduce regulated $CO_2$ emissions by 63% compared to current Building Regulations, at a cost of £8,549 per tonne$CO_2$ saved.
- With today's grid mix, air source heat pumps (omitted from graph) and ground source heat pumps are the least cost-effective technology for reducing $CO_2$ emissions.
- In parts of Harrogate District that are in Energy Constrained Areas and also in Conservation Areas where more visible technologies (i.e. solar and wind turbines) are unlikely to be permissible, Harrogate District Core Strategy policy EQ1 (policy 1) could only be achieved by individual biomass heating (see above) or by advanced energy efficiency measures (e.g. approaching PassivHaus standard). Ground source heat pumps alone will not be sufficient to comply with the policy.
- For small residential development in Energy Constrained Areas, there are technically feasible solutions to meet all the policies modelled until 2016, where the shortfall in attaining zero carbon status is likely to be met through allowable solutions. This will be challenging in these areas, where physical constraints or local opposition may

make it unacceptable to install more visually intrusive technologies, such as large scale wind energy.

- District heating is unlikely to be viable for small, residential developments in District Heating Opportunity Areas; the number of units will be insufficient to justify its own on-site CHP and communal heating system, due to the size of technology available and the overheads associated with operating communal plant. For a small residential development between 2011 and 2016, Core strategy policy EQ1 could be met by connection to a Gas CHP system with biomass backup boilers, with a reduction in $CO_2$ emissions of 47% on 2006 Building Regulations. This would have a relatively high capital cost of £147,500, or around £18,000 per tonne$CO_2$ saved.
- A source of waste heat would make district heating more viable in District Heating Opportunity Areas.
- Utilisation of waste heat could reduce regulated $CO_2$ emissions by 51% compared to 2006 Building Regulations, at a capital cost of £63,500 or around £7,000 per tonne$CO_2$ saved. This would make it cost-effective in terms of financial viability to microgeneration technologies, as described above.
- Small residential developments in Wind Energy Opportunity Areas could comply with all of the modelled policy options through installation of a wind turbine. A 15kW wind turbine would reduce regulated $CO_2$ emissions by 64%, with a significantly lower cost per tonne$CO_2$ of around £4,500. Additional land and infrastructure costs would need to be factored in if the turbine were installed outside of the site boundary.
- For developments near Hydro Energy Opportunities, the potential $CO_2$ savings from a 100kW hydro energy installation would not be sufficient to meet policies 1, 2 or 3 and would have significantly high cost uplift on the cost of typical Building Regulations compliance.

Table 32 Costs and $CO_2$ savings of low carbon technology solutions in Harrogate, by policy, for a small residential development. Waste heat has been omitted from District Heating Opportunity Area solutions since it is likely on very few sites. Costs have been rounded up and are based on modelling assumptions described in Appendix B (Source: AECOM analysis).

| Character area | Policy | Low carbon solutions | Approximate capital cost of installing technology (£) | % $CO_2$ Saving (Regulated emissions) | % Cost Uplift on Building Regulations compliance |
|---|---|---|---|---|---|
| Energy Constrained Area | 2006 Building Regulations | Energy Efficiency 1 | £ 12,700 | 15.2% | 1.9% |
| | Policy 1 | PV (medium size array) | £ 94,500 | 50% | 15.4% |
| | Policy 2 | Biomass heating | £ 96,000 | 63% | 15.6% |
| | Policy 3 | Biomass heating | £ 96,000 | 63% | 15.6% |
| District Heating Opportunity Area | 2006 Building Regulations | Gas CHP (Gas) | £137,000 | 27% | 22.4% |
| | Policy 1 | Gas CHP (Biomass) | £147,000 | 47% | 24.0% |
| | Policy 2 | Biomass CHP | £164,000 | 109% | 26.8% |
| | Policy 3 | Biomass CHP | £164,000 | 109% | 26.8% |
| Wind Energy Opportunity Area | 2006 Building Regulations | 1 small wind turbine | £ 50,886 | 64% | 7.7% |
| | Policy 1 | 1 small wind turbine | £ 50,886 | 64% | 7.7% |
| | Policy 2 | 1 small wind turbine | £ 50,886 | 64% | 7.7% |
| | Policy 3 | 1 small wind turbine | £ 50,886 | 64% | 7.7% |
| Hydro Energy Opportunity Area | 2006 Building Regulations | 1 small scale hydro energy facility | £280,000 | 0% | 40% |
| | Policy 1 | 1 small scale hydro energy facility | £280,000 | 0% | 40% |
| | Policy 2 | 1 small scale hydro energy facility | £280,000 | 0% | 40% |
| | Policy 3 | 1 small scale hydro energy facility | £280,000 | 0% | 40% |

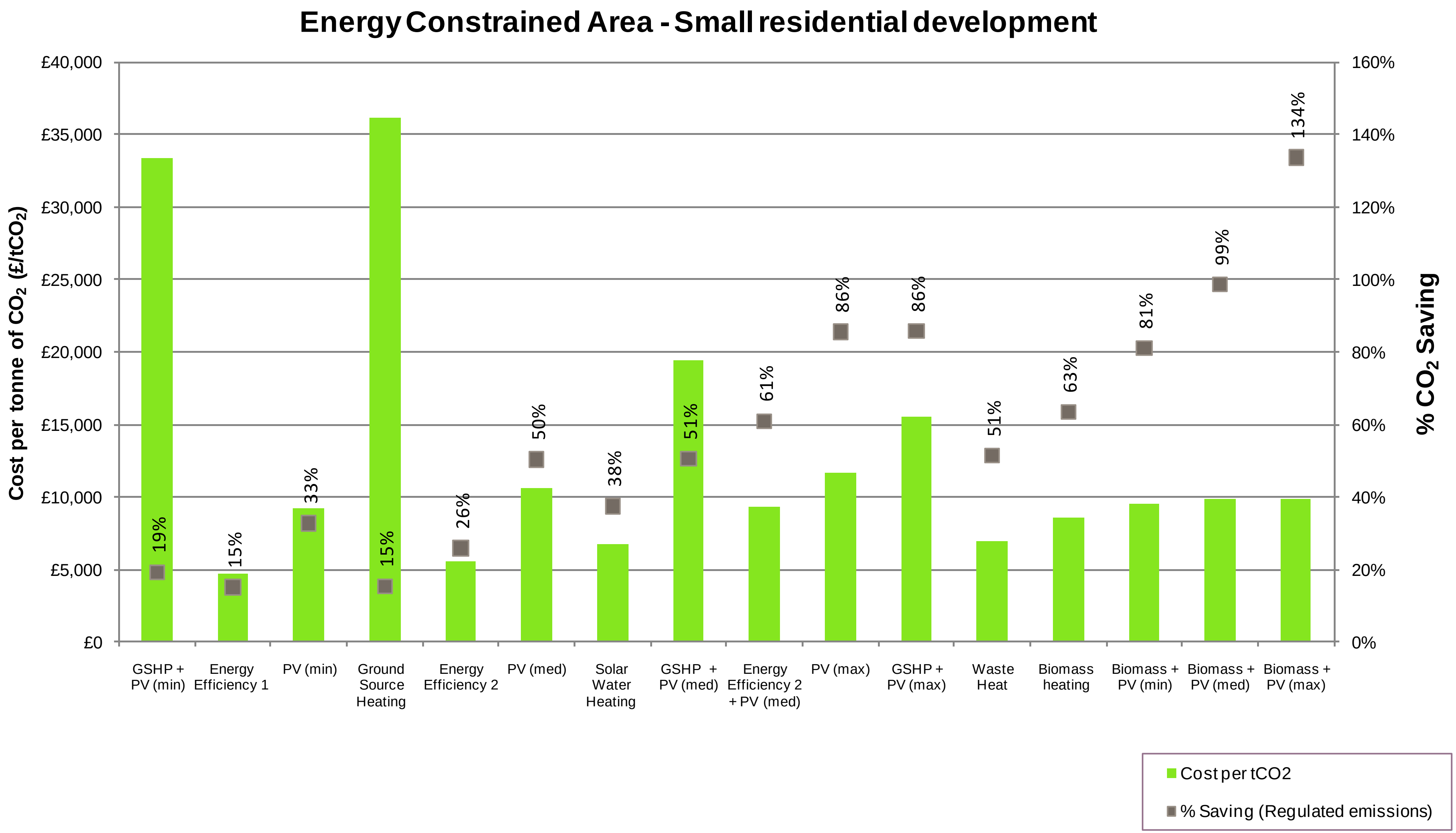



Figure 21 Comparison of indicative costs and savings on regulated $CO_2$ emissions for a large residential development in an Energy Constrained Area (where microgeneration technologies are likely to dominate) in Harrogate. GSHP refers to ground source heat pump installations. Solutions requiring district heating or CHP have been omitted from the analysis. Air source heating has been omitted from chart for clarity – this would cost a total of £72,713 per tonne$CO_2$ saved for the development, with potential $CO_2$ savings of 2%. (Source: AECOM analysis)

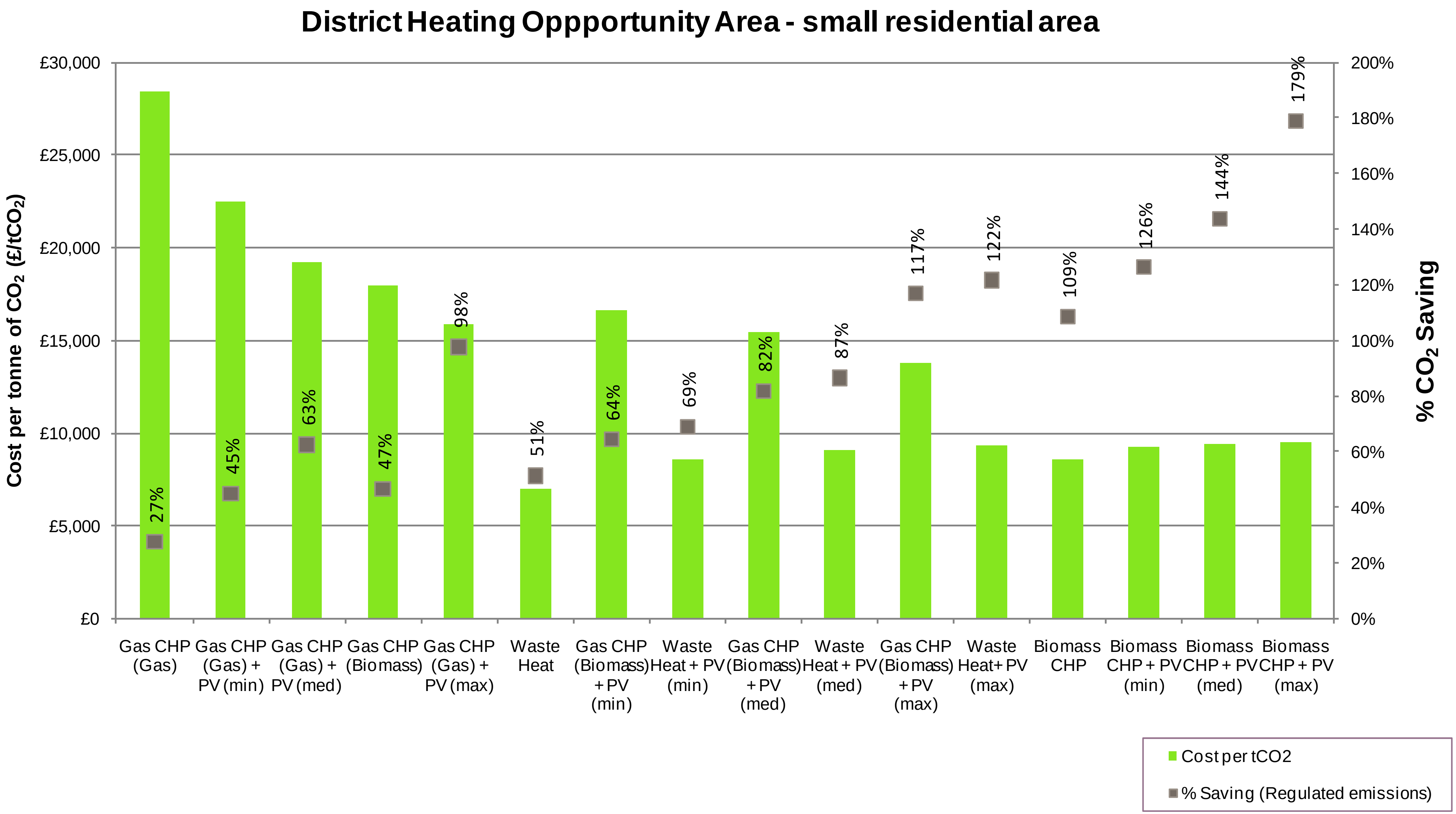



Figure 22: Comparison of indicative costs and savings on regulated $CO_2$ emissions for a small residential development in a District Heating Opportunity Area (where district heating is likely to be viable) in Harrogate District. (Source: AECOM analysis).

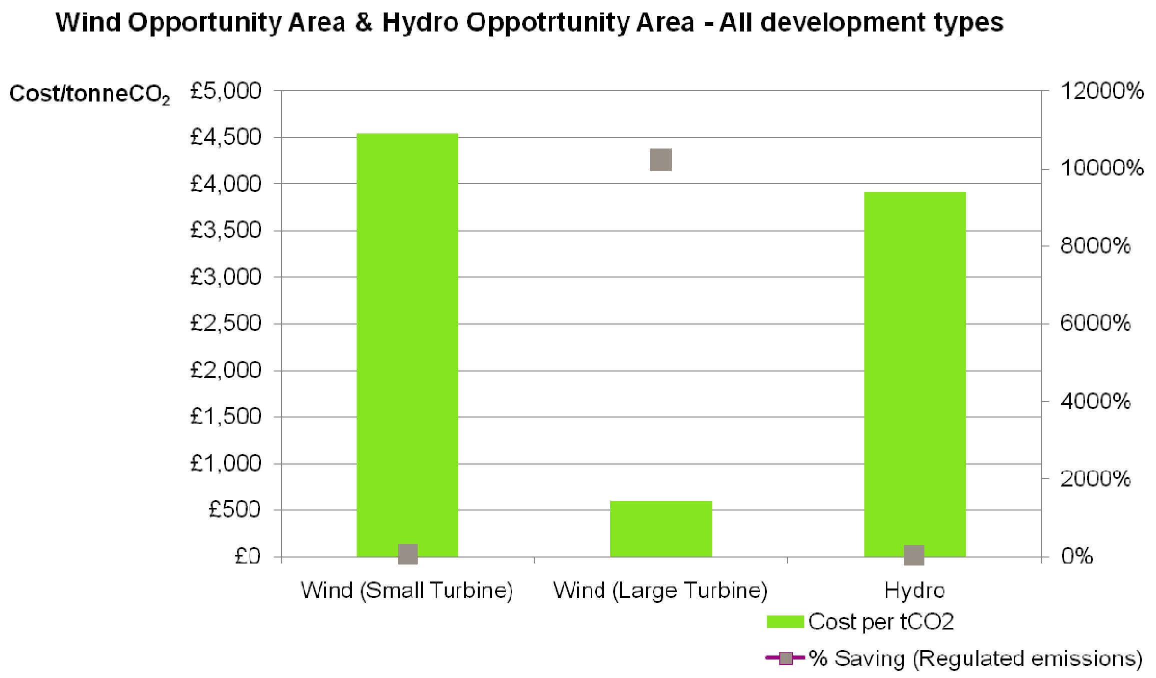



Figure 23 Comparison of indicative costs and savings on regulated $CO_2$ emissions for all types of development in a Wind Energy Opportunity Area and in a Hydro Energy Opportunity Area in Harrogate District. Note that regulated $CO_2$ savings of 43% for a small wind turbine and 33% for a hydro installation are too low (compared to a large wind turbine) to distinguish on chart (Source: AECOM analysis).

### 8.2.2 Results of modelling for a large residential development

The results of the character area modelling for a large, residential development are shown Table 33 and in Figure 24 to Figure 25.

Results for locating a large residential development in a Wind Energy Opportunity Area or Hydro Energy Opportunity Area can be seen in Figure 23.

- In Energy Constrained Areas, Core Strategy policy EQ1 (policy 1) could be achieved for a large, residential development through the installation of a medium sized PV array to each home at a capital cost of around £99,000 or £5,000 per tonne $CO_2$ saved.
- Large, residential developments are more likely to contain blocks of flats, making a district heating network potentially viable. If a source of waste heat could be used (for example, an urban extension that could be connected to existing anchor loads), then a district heating network could be installed relatively cost-effectively at a capital cost of around £500,000, or £,7500 per tonne$CO_2$ saved.
- The size of the modelled large residential development is sufficient to support an on-site district heating network with CHP in District Heating Opportunity Areas, if the site were designed appropriately, including density over 55 dwellings per hectare. This density is unlikely to be acceptable in general design terms for developments at the fringe of existing settlements in Harrogate District, particularly as local developers are reluctant to build blocks of flats in these locations. The costs for Energy Constrained Areas will apply to these cases, where large residential developments are designed with insufficient density to support district heating.
- Where district heating is an acceptable solution, solutions that achieve Buildings Regulation compliance are also likely to achieve the higher standards for $CO_2$ emissions required for Core Strategy policy EQ1. Larger developments tend to be designed in phases and these sites may also need to comply with more stringent $CO_2$ standards in later versions of the Building Regulations it is recommended that masterplans for these large, residential developments are encouraged to accommodate efficient district heating network layouts and safeguard utility corridors to

accommodate future connection to district heating networks.

- For large residential developments in Wind Energy Opportunity Areas, a large scale wind turbine is the most cost-effective solution for $CO_2$ reductions. One large scale turbine would reduce $CO_2$ emissions by 2047%, at a capital cost of around £1,600,000 or £600 per tonne$CO_2$ saved.
- The potential $CO_2$ savings from a 100kW hydro energy installation would not be sufficient to meet policies 1, 2 or 3.

Table 33 Costs and $CO_2$ savings of low carbon technology solutions in Harrogate District, by policy, for a large residential development. Waste heat has been omitted from District Heating Opportunity Area solutions since it is likely on very few sites. Costs have been rounded up and are based on modelling assumptions described in Appendix B (Source: AECOM analysis).

| Character area | Policy | Technology | Approximate capital cost of installing technology (£) | % $CO_2$ Saving (Regulated emissions) | % Cost Uplift on Building Regulations compliance |
|---|---|---|---|---|---|
| Energy Constrained Area | 2006 Building Regulations | Energy Efficiency 1 | £ 99,000 | 15% | 2% |
| | Policy 1 | PV (medium sized array) | £ 646,000 | 52% | 12% |
| | Policy 2 | Energy Efficiency 2 + PV (medium sized array) | £ 698,000 | 57% | 13% |
| | Policy 3 | Biomass heating | £ 741,000 | 61% | 14% |
| District Heating Opportunity Area | 2006 Building Regulations | Gas CHP (Gas) | £ 1,100,000 | 27% | 20% |
| | Policy 1 | Gas CHP (Biomass) | £1,200,000 | 47% | 22% |
| | Policy 2 | Gas CHP (Biomass) + PV (minimum sized array) | £1,500,000 | 62% | 27% |
| | Policy 3 | Biomass CHP | £1,500,000 | 62% | 27% |
| Wind Energy Opportunity Area | 2006 Building Regulations | 1 large scale wind turbine | £1,600,000 | 2047% | 30% |
| | Policy 1 | 1 large scale wind turbine | £1,600, 000 | 2047% | 30% |
| | Policy 2 | 1 large scale wind turbine | £1,600, 000 | 2047% | 30% |
| | Policy 3 | 1 large scale wind turbine | £1,600, 000 | 2047% | 30% |
| Hydro Energy Opportunity Area | 2006 Building Regulations | 1 small scale hydro energy facility | £280,000 | 0% | 5% |
| | Policy 1 | 1 small scale hydro energy facility | £280,000 | 0% | 5% |
| | Policy 2 | 1 small scale hydro energy facility | £280,000 | 0% | 5% |
| | Policy 3 | 1 small scale hydro energy facility | £280,000 | 0% | 5% |

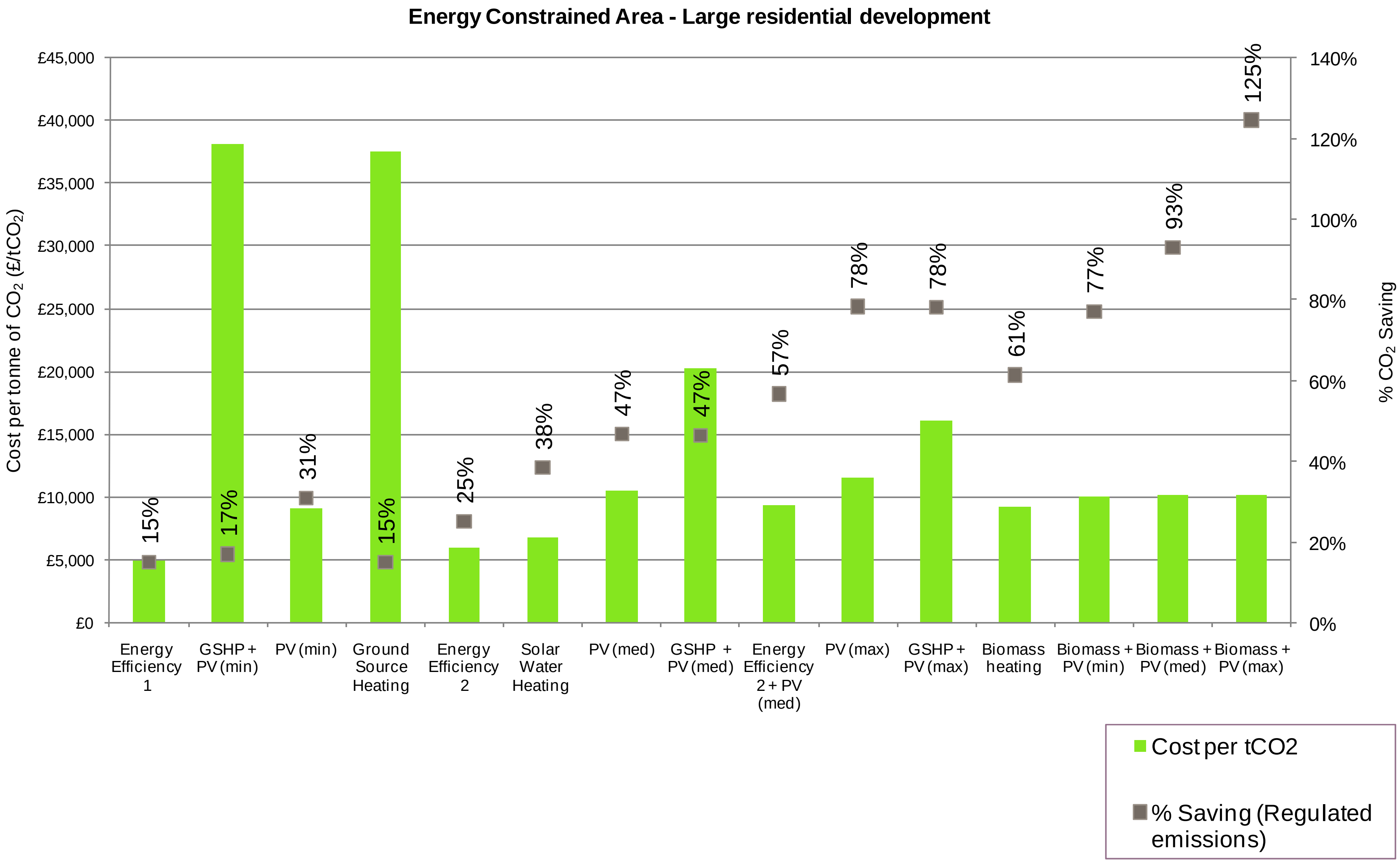



Figure 24 Comparison of indicative costs and savings on regulated $CO_2$ emissions for a large residential development in an Energy Constrained Area (where microgeneration technologies are likely to dominate) in Harrogate. GSHP refers to ground source heat pump installations. Solutions requiring district heating or CHP have been omitted from the analysis. Air source heating has been omitted from chart for clarity – this would cost a total of £578,365 per tonne$CO_2$ saved for the development, with potential $CO_2$ savings of 1.2%. (Source: AECOM analysis)

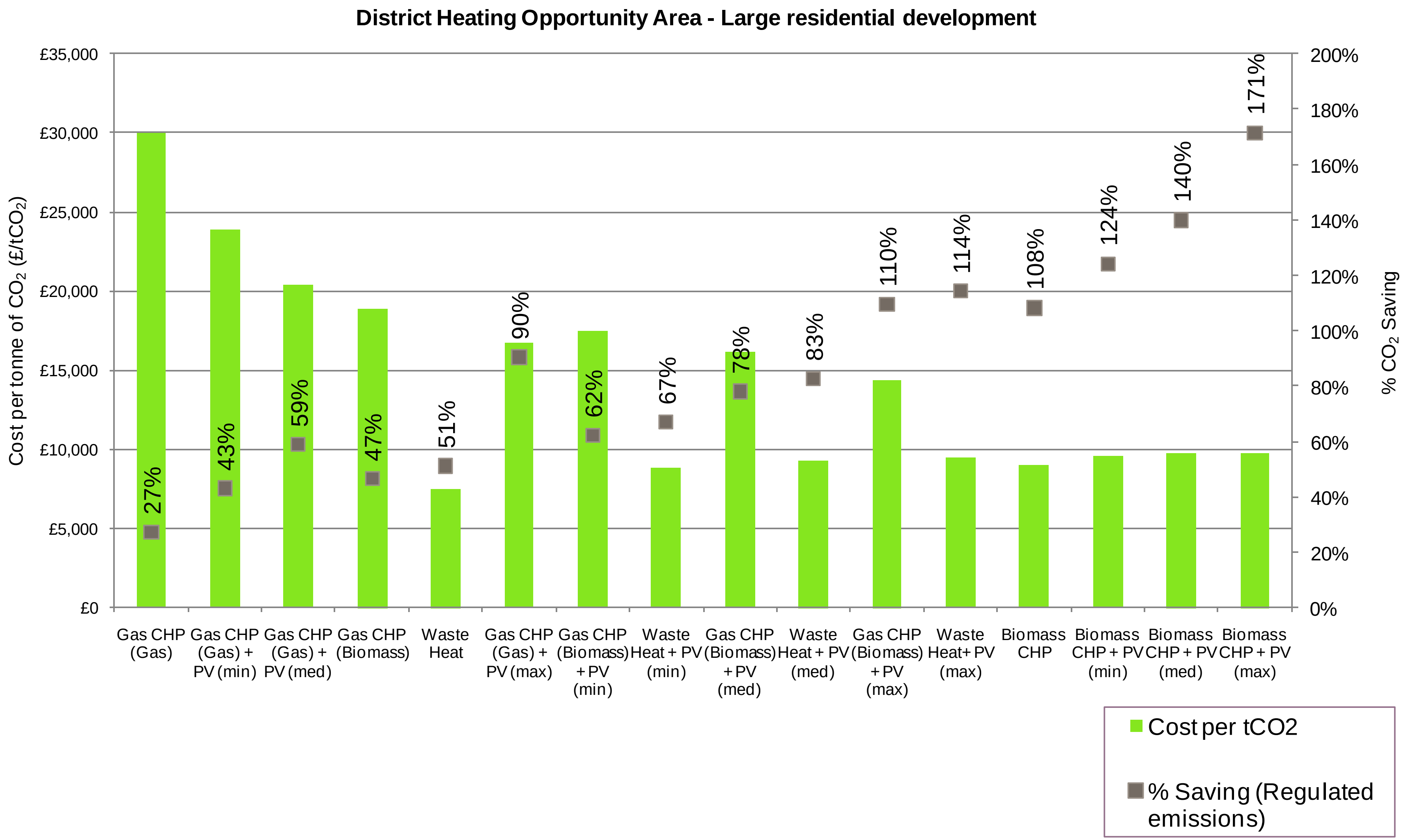



Figure 25 Comparison of indicative costs and savings on regulated $CO_2$ emissions for a large residential development in a District Heating Opportunity Area (where district heating is likely to be viable) in Harrogate District. (Source: AECOM analysis)

### 8.2.3 Results of modelling for a commercial development

The results of the character area modelling for a commercial development are shown in Table 34 and Figure 26. Results for locating a large residential development in a Wind Energy Opportunity Area or Hydro Energy Opportunity Area can be seen in Figure 23.

- In Energy Constrained Areas, Core Strategy policy EQ1 (policy 1) could be achieved for a commercial development through the installation of biomass heating, at a capital cost of around £51,000 or £4,000 per tonne$CO_2$ saved. The suitability of this solution would depend on the type of commercial development, on whether it had a high heat demand.
- In District Heating Opportunity Areas, perhaps as part of a mixed use development, the cheapest solution would be Gas CHP supported by biomass. This would result in 57% saving on regulated $CO_2$ emissions compared to current 2006 Building Regulations. A biomass CHP would cost slightly more but would result in 85% saving on regulated CO2 emissions.
- For commercial developments in Wind Energy Opportunity Areas, a large scale wind turbine is only likely to be viable if it can be connected to other development that can use the excess energy generated. One large scale turbine would offset significantly more than the total of all of the developments $CO_2$ emissions, at an indicative capital cost of around £1,600,000 or £600 per tonne$CO_2$ saved

Table 34 Costs and $CO_2$ savings of low carbon technology solutions in Harrogate District, by policy, for a commercial development. Waste heat has been omitted from District Heating Opportunity Area solutions since it is likely on very few sites. Costs have been rounded up and are based on modelling assumptions described in Appendix B (Source: AECOM analysis).

| Character areas | Policy | Low carbon solution | Approximate capital cost of installing technology (£) | % $CO_2$ Savings (Regulated emissions) | % Cost Uplift on Building Regulations compliance |
|---|---|---|---|---|---|
| Energy Constrained Area | 2006 Building Regulations | Energy Efficiency 1 | £20,000 | 7.9% | 1.5% |
| | Policy 1 | Biomass Heating | £51,000 | 44.6% | 3.8% |
| | Policy 2 | Biomass + PV (medium) | £118,000 | 64% | 11% |
| | Policy 3 | Biomass + PV (medium) | £118,000 | 64% | 11% |
| District Heating Opportunity Area | 2006 Building Regulations | Gas CHP (Gas) | £130,000 | 32% | 10% |
| | Policy 1 | Gas CHP (Biomass) | £142,000 | 57% | 11% |
| | Policy 2 | Gas CHP (Biomass) | £142,000 | 57% | 11% |
| | Policy 3 | Biomass CHP | £165,000 | 85% | 12% |
| Wind Energy Opportunity Area | 2006 Building Regulations | 1 small scale wind turbine | £51,000 | 42% | 4% |
| | Policy 1 | 1 large scale wind turbine | £1,600,000 | Not estimated | Not estimated |
| | Policy 2 | 1 large scale wind turbine | £1,600,000 | Not estimated | Not estimated |
| | Policy 3 | 1 large scale wind turbine | £1,600,000 | Not estimated | Not estimated |
| Hydro Energy Opportunity Area | 2006 Building Regulations | 1 small scale hydro energy facility | £280,000 | Not estimated | 20% |
| | Policy 1 | 1 small scale hydro energy facility | £280,000 | Not estimated | 20% |
| | Policy 2 | 1 small scale hydro energy facility | £280,000 | Not estimated | 20% |
| | Policy 3 | 1 small scale hydro energy facility | £280,000 | Not estimated | 20% |

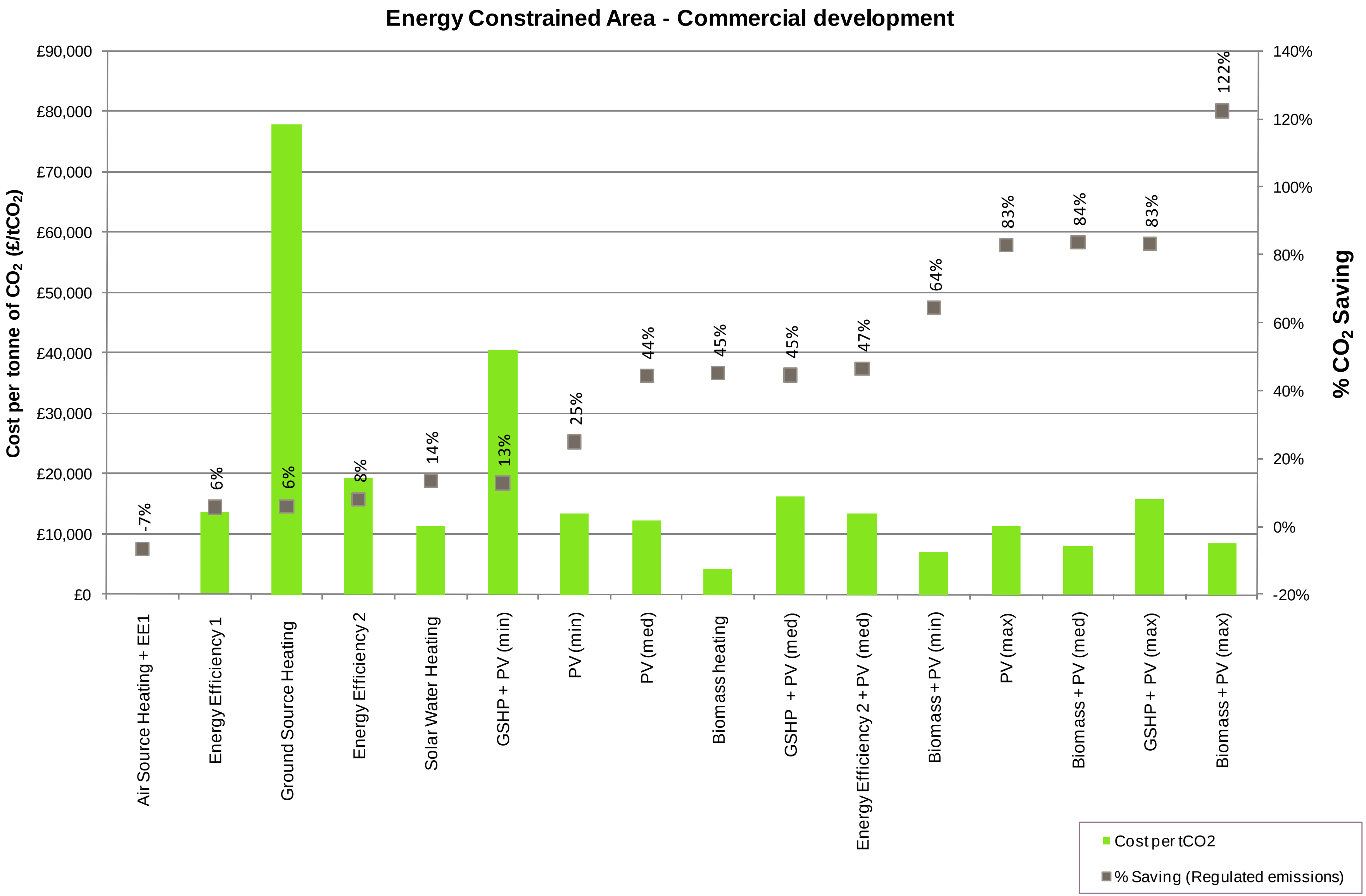



Figure 26 Comparison of indicative costs and savings on regulated $CO_2$ emissions for a commercial development in an Energy Constrained Area (where microgeneration technologies are likely to dominate) in Harrogate District. GSHP refers to ground source heat pump installations. Solutions requiring district heating or CHP have been omitted from the analysis. Air source heating has been omitted from chart for clarity – this would cost a total of negative £40,000 per tonne$CO_2$ saved for the development, with an increase in $CO_2$ emissions of 7%. (Source: AECOM analysis)

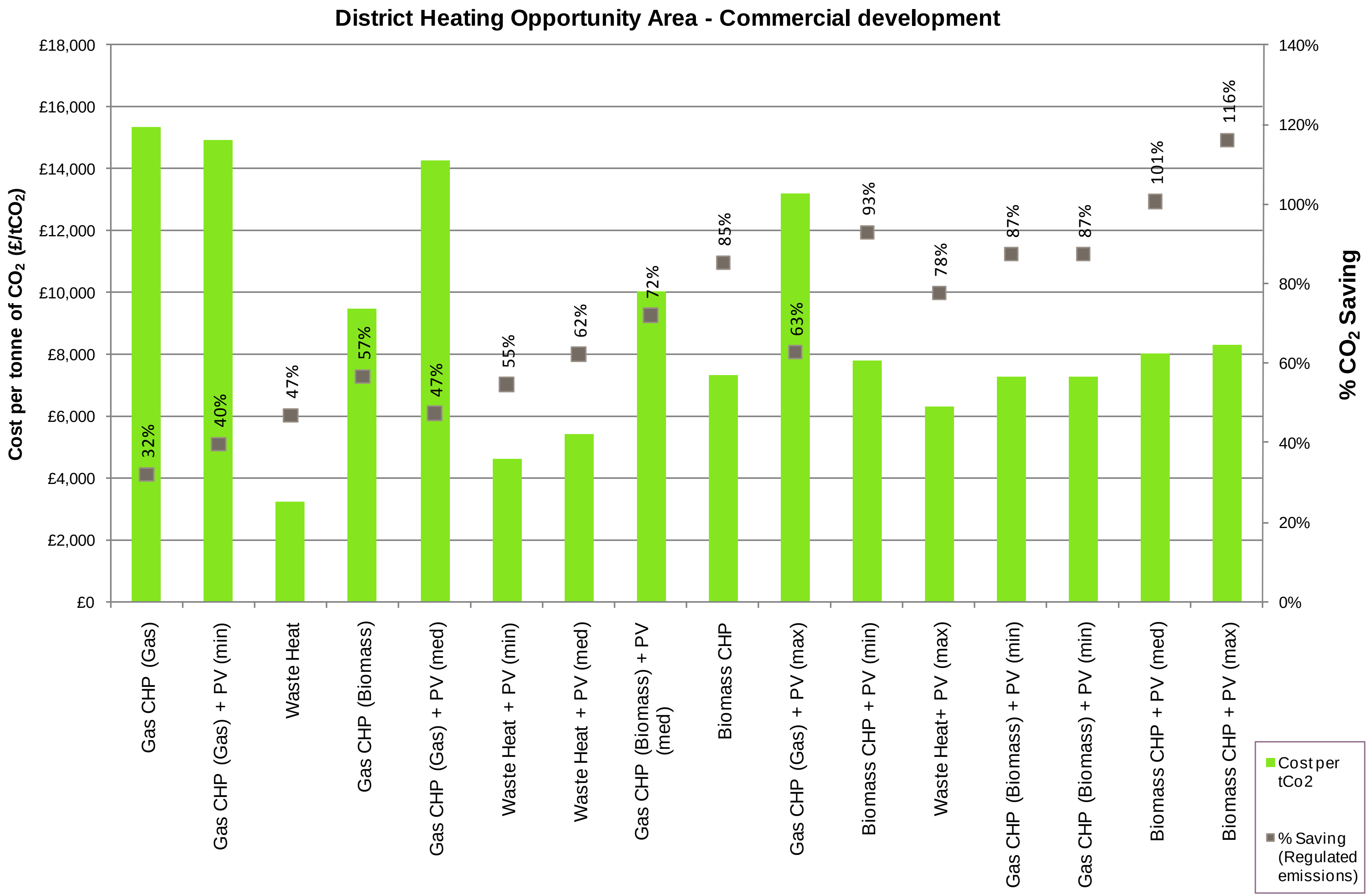



Figure 27 Comparison of indicative costs and savings on regulated $CO_2$ emissions for a commercial development in a District Heating Opportunity Area (where district heating is likely to be viable) in Harrogate. (Source: AECOM analysis)

### 8.3 Key considerations emerging from this chapter

A range of policy options for Harrogate District have been assessed in this chapter. Key considerations emerging from this chapter are:

- The main driver for improvement in energy efficiency and increased contribution from renewable and low carbon energy technologies is the progressive tightening of the Building Regulations, up to and including the introduction of the zero carbon requirement for homes in 2016 and for other buildings in 2019. Introducing $CO_2$ targets are unlikely to deliver higher $CO_2$ savings.
- Biomass heating was identified in our analysis as the cheapest option for commercial buildings to comply with the various policy options up to 2016, when we have assumed tighter interim standards will be introduced in the updated Building Regulations.

  The biomass supply chain may need to be developed further to cope with the potential increase in demand if a large proportion of new developments opt to install boilers on-site, although it is encouraging that there is already a local supplier in the district. In addition, major growth in the use of biomass fuel could have implications for air quality. Harrogate Borough Council should seek to ensure appropriate mitigation of emissions from new installations.
- Where viable (as defined as District Heating Opportunity Areas on the Energy Opportunities Plan), utilisation of waste heat (for example, through connection to a process user or an existing district heating network) could provide a cost effective option for compliance for all types of development.
- In Wind Energy Opportunity Areas, wind turbines are a cost-effective option for compliance. Large wind turbines are a particular opportunity for large commercial sites located away from residential areas, such as industrial estates or business parks, where multiple developments could share the installation costs.
- For developments near to Hydro Energy Opportunities, installation of hydro energy generation facilities have relatively high capital costs per tonne$CO_2$ saved compared to other technologies considered.
- Although our analysis suggests that there are technically feasible options for complying with the various targets considered, they will lead to an increase in the cost of construction, which could affect viability.
- Cost increases will be particularly significant in later years when the Building Regulations requirements are strengthened. It is recommended that the Affordable Housing Viability Assessment (2009) is revisited in future to consider the impact of the compliance costs presented here on development viability. It could also be worth considering whether affordable housing targets could be adjusted to offset the cost of compliance where viability is a concern.

# Policy analysis

# 9 Policy Analysis & Recommendations

This chapter considers options for planning policies on decentralised, renewable and low carbon energy that could be included in the Harrogate District 'Sites and Policies' DPD.

### 9.1 Basis for considering policy options

Planning policy on decentralised, renewable and low carbon energy should be based on sound evidence of local opportunities and constraints. It should account for feasibility of technologies in the range of developments expected over the planning period and the viability of 'standalone' decentralised and low carbon energy schemes. A key issue for testing policy is whether any requirement places an "undue burden" on developers, primarily in terms of additional build cost. What constitutes an undue burden will vary from development to development.

The Building Regulations are the primary drivers for higher energy performance standards in new development. As Building Regulations are updated to implement the agenda for zero carbon homes in 2016 and zero carbon non domestic buildings in 2019 they will also increasingly drive low carbon and renewable energy generation in new development.

Harrogate Borough Council has made corporate commitments to reduce carbon emissions in the District and has an interest in facilitating development to meet its adopted housing targets and identified needs for employment and other development. On that basis the Council can consider policies that expect carbon savings in new development beyond those required by Building Regulations in the period up to 2016, relative to local opportunities and subject to feasibility and viability. In the context of zero carbon policy, the Council can play a role in encouraging and/or delivering decentralised, renewable and low carbon energy schemes that can contribute to 'allowable solutions' for developers bringing forward planned development in the District, potentially reducing the burden of meeting zero carbon policy under future Building Regulations.

The challenges of climate change and increasing renewable and low carbon energy capacity cannot and should not be delivered through planning alone. The planning system has a distinct role to play in promoting decentralised renewable and low carbon energy in the right locations. The difficult issue of shifting much of the additional cost burden away from developers and onto third parties as investment opportunities may require Council activity beyond the remit of planning. Coordination of community and large-scale renewable and low carbon energy opportunities will enable developers to access a broader range of allowable solutions for Building Regulations compliance.

Policy recommendations and predicted $CO_2$ savings are based on the assumption that the trajectory to zero carbon continues as proposed. Changes to national policy, including future proposals for the Building Regulations, would alter the relative impact of the policies described here.

Consideration of policy options had regard to both current national policy guidance and the draft replacement PPS1 Supplement. However, given the uncertainty around future planning policy, national policy on 'decentralised, renewable and low carbon energy', and future Building Regulations, the construction of policy  be reviewed after the expected 2013 Building Regulations update and on publication of a revised PPS 1 Supplement.

### 9.2 Policy options

Based on the identification of Energy Opportunity Areas and on testing of policy options, four draft policies have been recommended for the 'Sites and Policies' DPD. They encourage the strategic delivery of decentralised, low carbon and renewable energy generation and infrastructure in Harrogate District.

#### 9.2.1 Recommended policy 1: Delivering the Energy Opportunities Plan.

Harrogate Borough Council considers climate change to be one if its highest priorities. Planning applications for new development will need to demonstrate how they contribute to delivery of the opportunities identified in the current Energy Opportunities Plan.

Where necessary, the Council will seek to protect land for decentralised renewable and low carbon energy. Development that falls within an Energy Opportunity Area should not unnecessarily restrict the exploitation of that opportunity.

**Justification for recommended policy 1**

Climate change is a priority issue for Harrogate Borough Council, as noted in the Climate Change Strategy [section 1.4].

Opportunities for growth and development should be prioritised where they are likely to drive low carbon solutions: in Energy Opportunity Areas, near viable district heating networks, where development sites are of a size to accommodate their own decentralised systems, or where clear opportunities exist to support wind or hydro energy as identified on the Energy Opportunities Plan.

Often the most cost-effective options for carbon reduction can be realised when a development is considered in its wider context, and hence it is in the interest of developers and the Council to deliver wider opportunities.

The Energy Opportunities Plan has been designed to act as the key spatial map for energy projects in Harrogate District over the period of the Core Strategy. It underpins the policies described here and should also be used to inform actions in the Harrogate District Climate Change Strategy and other corporate strategies, and investment decisions taken by the local authority and local strategic partnership (see Chapter 10 for further detail on delivery mechanisms).

The Energy Opportunity Areas are designed to help applicants determine which technologies are likely to be most suited to a given area. The Energy Opportunities Plan should be incorporated into the Sites and Policies DPD and should be reviewed regularly to ensure it remains up-to-date.

It should be recognised that the pace of change is rapid in this field. Technologies may emerge or mature over the lifetime of the Core Strategy and the applicability of existing technologies to different development types may change. This could mean that technologies not currently considered suitable to particular areas may become so. It is not the intention to restrict this kind of innovation and Harrogate Borough Council should be prepared to discuss proposals that deviate from the Energy Opportunities Plan with applicants at the pre-application stage.

### 9.2.2 Recommended policy 2: Development in District Heating Opportunity Areas.

The Energy Opportunities Plan identifies certain development opportunities and existing urban areas as District Heating Opportunity Areas. All new development in District Heating Opportunity Areas should consider district heating as their first option for the heat supply to the site. This should be assessed as part of the Design & Access statement or equivalent. An assessment should consider density, mix of use, layout, phasing and specification of heating, cooling and hot water systems.

The secondary elements of a district heating network (i.e. from the wider network to buildings) should be installed where a network exists.

Where a district heating and / or cooling network is planned but does not yet exist, applicants should install heating and / or cooling equipment that can be connected at a later date.

Where appropriate, applicants may be required to provide land, buildings and/or equipment for an energy centre to serve existing or new development. In cases where the applicant can demonstrate that this is not viable, a payment into a carbon fund may be required.

**Justification for recommended policy 2**

The purpose of this policy is to prioritise district heating in areas where opportunities are the greatest. It should be applied on sites located within “District Heating Opportunity Areas” on the Energy Opportunities Plan. The PPS1 Supplement allows local authorities to “set specific requirements to facilitate connection” in order to secure energy from decentralised, low carbon or renewable sources.

The advantage of this approach is that it secures the heat load for district heating systems where opportunities are the greatest and the guaranteed customer base can be used to underwrite project finance.

Where a district heating network is planned, planning policy should ensure availability of the necessary space in the right location for energy centres and other network infrastructure, particularly where the viability of a network depends on the connection of multiple sites. Where potentially connected sites come forward prior to the network being in place, developers should be required to enable eventual connection, e.g. by installing compatible heating systems, interface units, and providing space for a temporary energy centre if necessary. Such requirements would be the subject of pre-application discussions with agreed provisions included as planning conditions in the event that permission is granted.

There may be a need for the Council to provide strategic heat planning guidance and technical information to developers on common standards, and requirements for future-proofing. For example, the London Development Agency has produced technical design guidance for developers, e.g. covering flow and return temperatures[47], to ensure that new buildings are compatible with heat networks.

Recommended policy 2 is most relevant to new development, although the Council could also consider connecting its own existing properties and incentivising other existing buildings to connect. For example, the Council may wish to consider the use of Local Development Orders in relation to District Heating Opportunity Areas. Specifically, an LDO could permit existing

[47] Consumer connection to a large CHP district heating system, LDA, 2009

buildings in defined locations close to a district heating network to connect without needing to submit a planning application.

Precedents exist for policies requiring connection to pre-existing district heating networks, for example in Southampton's draft Core Strategy. Southampton has been operating a district heating system since 1986 and has now developed two separate CHP based ESCos to deliver, manage and maintain the network.

### 9.2.3 Recommended policy 3: Development in Wind Energy Opportunity Areas

The Energy Opportunities Plan identifies potential locations for large scale wind turbines as Wind Energy Opportunity Areas. New developments in Wind Energy Opportunity Areas should demonstrate that they have considered delivering a reduction in $CO_2$ emissions using wind turbines on site. In doing so, applicants should engage with the Council, third parties and communities.

An assessment should be contained within the Design & Access statement or equivalent. It should include expected $CO_2$ savings from wind turbines and, in the case that an Environmental Impact Assessment is not required, describe the environmental impact of the wind turbine(s) in the vicinity of the development and cumulative impacts for turbines larger than 50m in tip height.

**Justification for recommended new policy 3**

The PPS1 Supplement on Planning and Climate Change and PPS22 (Renewable Energy) are both supportive of wind power and this policy has been worded accordingly. The primary driver for a strongly worded supportive policy for wind are the twin challenges of achieving the national and legally binding 34% reduction in $CO_2$ emissions over 1990 levels by 2020 and the equally binding requirement for the UK to generate 15% of its total energy from renewable sources, also by 2020. The UK Renewable Energy Strategy expects a significant proportion of this to be delivered from onshore wind, therefore every good opportunity for wind power needs to be realised.

The Energy Opportunities Plan has identified Wind Energy Opportunity Areas to encourage applications for large and small turbines. The Council may wish to consider how community groups, co-operatives and individuals can be encouraged to take a stake in wind developments related to new housing and non-domestic developments.

Developers within Wind Energy Opportunity Areas should consider wind energy as their first option for meeting $CO_2$ requirements and be expected to demonstrate that they have fully considered the potential to deliver $CO_2$ reductions using on-site wind energy generation.

The Council may wish to explore ways that this policy could be modified to encourage the identification and development of optimal wind turbine locations in the Wind Energy Opportunity Areas, related to new development, but off site. Final policy wording should take into account the emerging proposals for allowable solutions, which currently do not explicitly include connection to off site wind turbines as an option.

The inclusion of policy related to an identified Wind Energy Opportunity Area is not intended to prevent developments elsewhere in the district from using the available wind energy resource.

### 9.2.4 Policy option 4: Development near Hydro Energy Opportunities

The Energy Opportunities Plan identifies potential locations for hydroelectric systems, defined as "Hydro Energy Opportunities".

**Considerations for policy option 4**

Consideration was given to proposing a specific policy relating to new developments near Hydro Energy Opportunities. The policy would have followed the same principles as those underpinning wind energy opportunities.

Policy 4 was not recommended for several reasons. First, it is unclear that any of the potential hydro sites lies in an area identified as an option for future development in the strategic housing land availability assessment. Second, notwithstanding the feed in tariffs available for small-scale hydro systems, the cost per tonne of carbon savings is currently relatively high compared to other available options. In general, and where a windfall site with hydro potential comes forward, recommended policy 1 on delivering the energy opportunities plan should be sufficient to ensure the feasibility of a hydro system is studied.

### 9.2.5 Policy option 5: Additional $CO_2$ savings target / minimum contribution from renewable or low carbon technologies.

Planning authorities have the scope to adopt policies expecting developments to achieve carbon savings beyond those required by Building Regulations, where these are stated in terms of nationally recognised standards, and where justified by an evidence base.

**Considerations for policy option 5**

Policy 5 was not recommended on the basis that it would add to the complexity of the planning and development control process, with potentially little impact on resultant $CO_2$ emissions or generating capacity. Planning policy targets of this nature would only have a short term impact, as they would effectively be superseded by the Building Regulations zero carbon requirement from 2016 onwards for homes and 2019 for other types of building.

## 9.3 Option for a carbon offset fund

Recommended policy 2 refers to payments into a carbon fund as an alternative for developers unable to establish or connect to district heating networks.

### 9.3.1 Concept of a carbon offset fund

The option of Harrogate Borough Council establishing a carbon offset fund may allow developers to comply on sites where installation of low carbon and renewable energy generation technologies may not be feasible or viable. The idea with this approach is that a developer pays a sum of money into a fund that is proportional to the predicted $CO_2$ emissions from the development. This fund can be used by the local authority to reduce $CO_2$ emissions elsewhere, for example through the creation of or extension to district heating schemes.

This approach could provide an opportunity to raise funds to improve the existing building stock or drive other low carbon and renewable energy measures or infrastructure in the District. They could be particularly useful for delivering energy capacity that is not directly related to new development.

Contributions could be in the form of equivalent onsite $CO_2$ reductions delivered off site (for example, in the existing building stock) or a simple tariff contribution, based a per $m^2$ of development basis for example.

There is the danger that developers may decide just to pay into the fund rather than delivering onsite $CO_2$ reduction, which potentially risks losing opportunities for real demonstrable onsite carbon saving. Developers should be expected to demonstrate that they have explored all low carbon and renewable energy options for a particular development before payment into a fund. Strong justification should be required if the policy cannot be achieved and developers should be expected to include in their proposals the $CO_2$ savings that they judge are feasible.

### 9.3.2 Precedents for carbon offset funds

Milton Keynes Borough Council has instigated a carbon offset fund, supported by policy D4 of the Milton Keynes Local Plan (2005). The fund, which has been receiving payments since 2006, requires a one-off contribution at a rate of £200 (index-linked) for any net increase in $CO_2$ emissions from a development, by means of a Section 106 agreement or unilateral undertaking. The fund rate was based on a feasibility study and set at a value that enabled Milton Keynes Council to retrofit insulation into homes. It is reported to have saved nearly 570 tonnes of $CO_2$ in 508 properties between April 2008 and March 2009.

The Offset Fund is accompanied by a Merton requirement for a minimum 10% $CO_2$ reduction to be provided from on-site renewable energy sources and a requirement for energy efficiency. [48]

For the Aylesbury AAP, Southwark Council have developed a tariff based mechanism to work alongside the Section 106 agreements. The Section 106 contributions are used for non-physical requirements while the tariff will fund strategic physical infrastructure.

Tariff payments are applied to each dwelling constructed within the AAP. It allows Southwark Council to coordinate and phase new infrastructure, facilitating early delivery of the infrastructure required to meet the growing needs of the AAP[49]. The tariff scheme is based on a flat charge per dwelling. The costs are therefore transparent and provide certainty to the developers as to the extent of their planning obligations. As of March 2009, the Aylesbury AAP tariff equates to £13,420 per unit and will be corrected for inflation.

More recently, the GLA, Brighton and Hove and Ashford have also sought to implement a fund through Section 106 agreements.

The rules for setting a Section 106 dictate that the payment must be demonstrably related to the proposed development and necessary to make the proposed development acceptable in planning terms. Therefore, this can limit what money raised can be spent on. Additionally, in order to be legally compliant

[48] Meeting documents for Milton Keynes Local Development Framework Core Strategy Item 10 (Milton Keynes Cabinet, June 2009 http://cmis.milton-keynes.gov.uk/CmisWebPublic/Binary.ashx?Document=27063)
[49] Background paper: Infrastructure Tariff and s106 Planning Obligations (Aylesbury Area Action Plan, March 2009)

the scheme would need to adhere to the requirements of ODPM Circular 05/2005, Annex A paragraph A2, which states:

*"Such obligations may restrict development or use of the land; require operations or activities to be carried out in, on, under or over the land; require the land to be used in any specified way; or require payments to be made to the authority either in a single sum or periodically".*

There are potential legal issues in meeting the rules for Section 106 agreement, although the carbon offset fund proposed in the Dover Core Strategy has recently been through Examination in Public where the proposed development contributions were not queried.

Section 106 agreements are criticised as having a lack of transparency and for taking a long time to negotiate. Numerous calls are made on Section106 contributions for matters such as affordable housing, local transport provision, education etc. Payments collected to fund carbon reductions may result in reduced contribution towards other issues.

### 9.4 Key considerations emerging from this chapter

The sections above have described the opportunities for planning policy to influence the reduction of $CO_2$ emissions from new development in Harrogate District. Key considerations emerging from this chapter are:

- Opportunities exist for the Council to facilitate $CO_2$ reductions and installation of decentralised, low carbon and renewable energy technologies as identified in the Energy Opportunities Plan. These opportunities do not need to be delivered in association with new development, although the two are not mutually exclusive.
- Post 2016, allowable solutions will place emphasis on local authorities to identify and support delivery of community scale solutions. Large cost savings can often be made by planning in low carbon and renewable infrastructure at the start of the design process.
- Harrogate Borough Council will need to play a role in coordinating and delivering allowable solutions. A strategic approach is recommended for the delivery of low carbon and renewable energy technologies based on the Energy Opportunities Plan. Opportunities for growth and development should be prioritised where they are likely to drive low carbon solutions.
- A mechanism should be developed to enable $CO_2$ emissions to be reduced elsewhere in the borough where onsite installation is not feasible or viable. An option could be payment into a carbon offset fund. A precedent for this approach has been set, for example, by the Milton Keynes fund and the Dover fund.

# Delivering the energy opportunities in Harrogate

# 10 Delivering the energy opportunities in Harrogate District

This chapter describes some of the mechanisms available to Harrogate Borough Council to deliver the principal opportunities for decentralised renewable and low carbon energy opportunities identified in the energy opportunities plan.

It is not intended to be an exhaustive list, nor does it reach definitive conclusions about which mechanisms are most suited to Harrogate District. Rather it seeks to clarify the importance of considering delivery at the same time as planning policy and provide guidance on what opportunities exist and where further work is required.

## 10.1 Creating a framework for action

As part of the Yorkshire and Humber Renewable and Low Carbon Energy Capacity Study, a specification for local studies in the region is being prepared. The aim is to prepare most of the energy opportunities and constraints mapping needed to underpin Core Strategy policies on energy and climate change as part of this regional study.

In general, the principal output for local authorities from the regional study will be an energy opportunities plan and the GIS datasets that underpin this. Specifically, this will include:

- GIS datasets searchable by region, local authority or functional sub-region. This will provide the resource needed for local planning and enable users to produce tailored maps and outputs. This may include a 10km boundary around each output to enable cross-boundary issues to be taken into account.
- Energy opportunities plans for each local authorities or functional sub-region, again including a 10km boundary.
- More detailed analysis of specific areas of change, such as the potential urban extensions, in order to set site-specific targets, policies or briefs and to inform discussions with developers and identify appropriate business models and delivery vehicles.
- Opportunities for local authorities to lead and coordinate delivery of energy opportunities identified in the regional study. This will not only facilitate new development's compliance with planning policy and building regulations by providing the physical infrastructure and organisational structures for them to link into, but will also contribute to the local authority's response to a wider range of drivers for action in this area, including the Government's Household Energy Management Strategy (2010) and Renewable Energy Strategy (2009).
- This approach to developing local delivery plans is consistent with the emerging proposals for Local Carbon Frameworks[50] which are currently being piloted with nine local authorities. These are evidence based delivery plans, which will be negotiated with central Government in a similar way to Local Area Agreements. Through this, CLG is promoting a stronger role for local authorities in:
- Coordinating local action by energy suppliers to deliver whole street, neighbourhood and area action on energy efficiency.
- Setting out how local energy infrastructure could be delivered by allowable solutions as part of the zero carbon buildings agenda.

The Total Place initiative, which is mapping funding available to local authorities and considering how this could be most effectively invested and co-ordinated, should help to clarify the funding sources available for delivery of energy opportunities.

Harrogate should monitor the Local Carbon Frameworks and Total Place processes as they develop, and reflect the emerging approach and lessons learned in their future approach to delivering low carbon energy generation technology.

## 10.2 Delivery of low carbon and renewable energy in existing development

The $CO_2$ savings that can be achieved through improvements to existing buildings are substantial and this should be a priority across all areas. In addition to energy efficiency measures, there is the potential to retrofit low

[50] Speech by John Denham (28th January 2010) http://www.communities.gov.uk/news/corporate/1449033

carbon and renewable energy microgeneration technologies within existing development. This cannot easily be required by planning, but can be encouraged by the Council, which can seek to engage communities and highlight the benefits of microgeneration, especially with the introduction of the feed-in-tariff.

Most funding for improving the energy performance of the existing stock, including Community Energy Saving Programme and the Carbon Emissions Reduction Target, are coordinated through utility companies. The government's recently published Household Energy Management Strategy suggests that more co-ordinated approach to the street or neighbourhood level will be necessary to deliver the level improvements necessary to meet the demanding $CO_2$ emission reduction targets required through the Climate Change Act. Local authorities have a key role to play.

In the meantime, local authorities have the powers to deliver energy opportunities in the existing stock using the Wellbeing Power. There are examples of the use of this power for this purpose by local authority around the country: South Hams Council used the power as the basis of a District/County agreement to establish a waste transfer station; Nottinghamshire County Council use it to set up a non-profit wood fuel distribution company limited by guarantee; and Torbay Council used it to set up a public-private partnership regeneration company.

Other potential mechanisms that could be used individually or as a package by Harrogate District to stimulate the uptake of energy efficiency measures and microgeneration technologies are described below. The initiative could be financed using a combination of SALIX and CESP and coordinated through the Council, possibly in partnership with the private sector and energy companies for finance and with installation companies for delivery:

- Discount provision – available finance could be used by the Council to bulk buy technologies, enabling them be sold on at a discount to households and businesses.
- Householder or business hire purchase – appropriate technologies could be leased to householders and businesses. Rental costs could be charged as a proportion of the generation income received by the beneficiary. After a period of time, ownership of the kit would transfer to the householder or business.
- Householder or business rental – a third model could be for the Council, or its delivery vehicle of choice, to retain ownership of the technologies and to rent roof or other suitable space. Again, rental costs would be set as a proportion of generation income. As with the hire purchase option, this approach would give benefits of low carbon and renewable energy to communities without the up-front expense. The advantage of this option would be the retention of control over phasing and technology choice, and greater flexibility to respond to changes in technology and demand.

Table 35 Delivery options for existing development.

| Delivery options for $CO_2$ reductions in existing development | | |
|---|---|---|
| **$CO_2$ reduction measures** | **Potential Partners** | **Delivery option** |
| Increased energy efficiency<br><br>Increased microgeneration | - Local authority<br>- Energy companies<br>- Community groups<br>- Private installation companies | - Provision of discounted $CO_2$ reduction solutions<br>- Hire purchase of $CO_2$ reduction solutions<br>- Rental of space for $CO_2$ reduction solutions<br>- Awareness and education campaign for householders and businesses.<br>- Salix Finance<br>- Community Sustainable Energy Programme<br>- Warm Front<br>- Carbon Emissions Reduction Target<br>- Big Lottery Fund<br>- Energy Saving Trust<br>- Low Carbon Communities Challenge<br>- Low Carbon Buildings Programme<br>- Feed-in-tariff |

## 10.3 Delivery of low carbon energy in new development

Building Regulations are the primary drivers for higher energy performance standards and renewable and low carbon energy generation in new developments. The role of Harrogate Borough Council is therefore limited beyond specifying more stringent planning policies to achieve this.

An option is to apply conditions to sales of local authority owned land, whereby a lower than market value sale price is agreed with the developer in return for a commitment to meet higher specified sustainability standards. Rules governing this are contained within the Treasury Green Book which governs disposal of assets and in within the Best Value - General Disposal Consent 2003 'for less than best consideration' without consent. It is our understanding that undervalues currently have a cap of £2 million without requiring consent from Secretary of State.

A third opportunity is to prioritise delivery of energy opportunities through spending of money raised through a local carbon fund as described in section 9.3, or the proposed allowable solutions. Contributions collected from development could be used to fund energy infrastructure identified in the Energy Opportunities Plan.

Table 36 Delivery options for new development.

| Delivery options for $CO_2$ reductions in new development | | |
|---|---|---|
| **$CO_2$ reduction measures** | **Potential Partners** | **Delivery option** |
| Lower $CO_2$ emissions standards<br><br>Higher sustainability standards | - Local authority<br>- Energy companies<br>- Community groups<br>- Private installation companies<br>- Homes and Communities Agency | - Conditions attached to local authority owned land sales<br>- Policy requiring high sustainability standards<br>- Policy requiring connection to district heating networks<br>- Policy requiring lower $CO_2$ emissions |

### 10.3.1 Delivery of district heating infrastructure

Successfully delivering district heating and CHP requires the consideration of a number of factors including:

*Anchor loads* – The location of such facilities is key, as district heating schemes often need an 'anchor load' or consistent energy user to operate efficiently. Therefore, areas around these anchor loads are priorities for development.

A strategic approach will be necessary to successfully manage and coordinate delivery. The Council would be ideally placed to plan, deliver and operate part or all of a district heating network through establishment of a special purpose vehicle (for example an energy service company, ESCo), partnership arrangement or joint-venture.

*Council property* – Retrofitting private properties can be a slow and time intensive process before the required critical mass for a district heating network is achieved. Therefore, an opportunity exists for Council owned property to retrofit their properties first. This would eliminate issues related to piecemeal retrofitting, and provide the leadership and critical mass for an effective district heating network.

*New developments* – CHP required density can also be achieved by ensuring new developments are built with the infrastructure. However, new developments are often built in phases. Each phase on its own is often small and makes district heating on a larger scale difficult. Where possible, new developments should be built in conjunction with large anchor loads, such as hospitals, schools, or community facilities that would make a larger CHP network feasible.

*Financing* – the different elements of a network can be treated differently. The operating costs of the insulated pipes that move heat between the energy centre and customers are relatively low. The main cost is installing the pipeline at the start. The pipe work, therefore, could be competitively tendered by a local authority-led vehicle partnership and, since the Council may have access to low interest rates and repayments over a long time period using prudential borrowing, repayments can be kept to a minimum.

Repayments could be serviced by energy sales and income from the renewable heat incentive and for a CHP system generating both heat and electricity, from ROCs and/or the proposed feed-in-tariff. It needs to be recognised however the ability of the public sector to raise finances is likely to be severely hampered for the foreseeable future by the current economic crisis. Alternative sources of funding may need to be considered, including: bond financing; local asset-backed vehicles; and accelerated development zones or tax increment financing.

Energy centres tend to have lower upfront costs. The expense comes with ongoing operation and maintenance, a shorter life span (around 15 years) and exposure to fluctuations in energy prices. While ownership of the sites and buildings may be retained by the local authority, the plant itself could be operated by a private sector ESCo. To simplify things further for the Council, the billing and customer service elements could be contracted out to a third party.

Delivery of networks as part of new development could also be undertaken by a local authority-led delivery vehicle or partnership, leaving the secondary network to be installed by the developer. The developer could then be charged a connection fee to the primary network. This option would necessitate redrafting the proposed planning policy.

The PPS1 Supplement presents opportunities at the local level in the form of an LDO, which can be applied by local authorities to extend permitted development rights across whole local authority areas or to grant permission for certain types of development. Although there is little experience of local planning authorities having used LDOs, the PPS suggests that the government is keen on them being used stating that: "*planning authorities should give positive consideration to the use of Local Developments Orders to secure renewable and low-carbon energy supply systems*". Should the Council agree to lead installation of a district heating network then it is recommended that they explore the option of establishing an LDO in order to add certainty to the development process and potentially speed up delivery.

*Phasing* –the Energy Opportunities Plan gives an indication of potential anchor loads around which to start a district heating system. Installing a district heating network is a major capital investment. The cost depends on the number of buildings to be connected, how close together they are and how much heat they require. District heating infrastructure also requires long-term investment to maintain the network over a period of at least 25 years.

In order to minimise risk, a general strategy for developing a scheme would be to secure the connection of a large anchor load within close proximity to the generating plant. Suitable anchor loads are often public sector owned facilities such as swimming pools and leisure centres, therefore much of the co-ordination will fall upon the Council. Further work on prioritising schemes for more detailed feasibility work should be identified, potentially using Strategic Design Advice support.

#### 10.3.2 Establishing a biomass supply chain

This study has identified biomass as a resource for delivering $CO_2$ reductions in the District. Similar studies for nearby areas are likely to reach the same conclusions and since the available resource is finite and relatively limited, it is useful to take a district or even region-wide approach to sourcing and supply to ensure that sufficient biomass is available, but also that its use is managed and sustainable.

Greater use of biomass as fuel raises some considerations which need addressing. Biomass is generally transported by lorry, and therefore transportation related $CO_2$ emissions should be taken into account. There is conflicting evidence as to the environmental impact of transporting biomass. A recent report by the Environment Agency provides data which suggests an increase in $CO_2$ emissions of between 5% (wood chip) and 18% (wood pellets) for European imports, but the data is not clear for transport within the UK. As there is a good potential biomass resource in the District and an established supply chain for wood chip and wood pellets produced from locally grown energy crops, transport-related emissions may not be a concern in Harrogate.

#### 10.3.3 Delivery of wind energy infrastructure

As with district heating, there are opportunities in Harrogate District to install stand-alone, large scale wind as well as opportunities that relate to proposed development.

Commercial developers are likely to be attracted to standalone sites. Where opportunities are too small to attract commercial developers, the Council could take forward the opportunities, perhaps in partnership with the community. Project finances could be raised by the issuing of bonds to residents and businesses. Returns on investments could be based on energy sales, ROCs and feed-in-tariffs. Further community incentives could include discounts on council tax.

A cooperative venture, possibly with the involvement of the local authority is another option that should be explored. Merchant wind is a wind-specific mechanism that the Council could use for delivering large scale wind energy. Alternatively, to ensure that sufficient expertise and resource is devoted to making local authority-led delivery initiative a success, Harrogate District Borough Council could explore establishing a local authority-led delivery vehicle partnership.

#### 10.3.4 Delivery of hydro energy infrastructure

This study highlights the spatial distribution for potential hydro sites. To be most viable they need to be located within reasonable proximity to a grid connection, and most potential sites are, naturally, predominantly rural. Given the spatial options, major new development is unlikely to be situated in a way to take direct advantage of hydro sites, but might make contributions through allowable solutions to help support schemes.

Table 37 Delivery options for community-wide $CO_2$ reduction solutions. The Opportunity Areas are described in more detail in chapter 7.

<table>
<tr><th colspan="3">Delivery options for community energy solutions</th></tr>
<tr><th>CO2 reduction measure</th><th>Potential Partners</th><th>Delivery Option</th></tr>
<tr><td>Establishment of Wind Turbines in appropriate Opportunity Areas</td><td rowspan="4">- Local authority<br>- Carbon Trust<br>- Regional and sub-regional bodies<br>- Energy companies<br>- Homes and Communities Agency<br>- Partnerships for Renewables<br>- NHS<br>- Developers<br>- Community groups</td><td rowspan="4">- Community Infrastructure Levy or local carbon buyout fund<br>- ‘Allowable solutions’ or off-site opportunities<br>- Local authority led delivery company, partnerships and joint ventures<br>- Merchant wind<br>- Development and coordination of biomass supply chains<br>- ROCs and feed-in-tariff (April 2010) and possibly renewable heat incentive in 2011<br>- District heating priority areas<br>- Wind priority areas<br>- Cooperatives and community involvement<br>- EDF Renewable Energy Fund<br>- Carbon Emissions Reduction Target<br>- Building Schools for the Future</td></tr>
<tr><td>Establishment of District Heating with CHP in appropriate Opportunity Areas</td></tr>
<tr><td>Establishment of Hydro Energy schemes in appropriate Opportunity Areas</td></tr>
<tr><td>Cultivation of crops for Biomass energy generation</td></tr>
</table>

### 10.4 Delivery partners

It is clear that a planned approach is necessary, with targets complemented by spatial and infrastructure planning. The implications of this for the Council are significant. We are no longer simply talking about a set of planning policies; rather success depends on coordination between planners, other local authority departments (including the corporate level) and local strategic partners.

A coordinated relationship between planning, politicians, the local strategic partnership (LSP) and other local authority departments, including legal, finance, and environment and housing, will be crucial. To be effective, leadership will be needed by the LSP, the environment sub group and elected members to provide strategic direction for energy policy and delivery of the Energy Opportunities Plan.

The two central elements for coordinating delivery of low carbon and renewable energy projects at the local level are the climate change strategy review and the Local Development Framework (LDF) prepared by the planners. The Climate Change strategy review sets out the overarching $CO_2$ reduction target for the borough, along with a commitment to consider ESCo options. This is particularly helpful as a starting point for delivering energy opportunities

Consideration will need to be given to the extent of private sector or community involvement. Where market delivery is not forthcoming, Harrogate District Council can lead delivery of energy infrastructure, potentially with support from the private sector, investors or even communities. Communities may also want to join together to deliver energy infrastructure, investing and in capital cost receiving income from selling energy. The key to success is likely to be:

- Integration of the findings of this study into development plan documents and the design of the proposed ESCo and other delivery mechanisms.
- Leadership from senior local authority management or, at least initially, from committed individuals in planning or other departments.
- ESCo models range from fully public, through partnerships between public, private and community sectors to fully private.Broadly speaking, the greater the involvement of third parties the lower the risk to the authority but, importantly also, the less control the authority will have over the company. Whichever route is chosen, it is recommended that the ESCo should be put in place as early on in the development process as possible, so that its technical and financial requirements can be fed through into negotiations with potential customers

| | Private SectoPrivater Led ESCo | Public Sector Led ESCo |
|---|---|---|
| Advantages | ▪ Private sector capital<br>▪ Transfer of risk<br>▪ Commercial and technical expertise | ▪ Lower interest rates on available capital can be secured through Prudential Borrowing<br>▪ Transfer of risk on a district heating network through construction contracts<br>▪ More control over strategic direction<br>▪ No profit needed<br>▪ Incremental expansion more likely<br>▪ Low set-up costs (internal accounting only) |
| Disadvantages | ▪ Loss of control<br>▪ Most profit retained by private sector<br>▪ Incremental expansion more difficult<br>▪ High set-up costs | ▪ Greater risk<br>▪ Less access to private capital and expertise, though expertise can be obtained through outsourcing and specific recruitment |

Table 38 Advantages and disadvantages of ESCo models

## 10.5 Key considerations emerging from this chapter

The sections above have considered the options for delivering the low carbon and renewable energy resource in Harrogate District. Key considerations emerging from this chapter are:

- Opportunities exist for the Council to take a lead role in delivering low carbon and renewable energy opportunities across existing development, new development and community-scale interventions.
- The primary opportunities include promoting faster uptake of energy efficiency measures and microgeneration technologies than could be expected by relying on national support measures alone, development of wind energy delivered by the Council and/or community, development of district heating networks and creation of a biomass supply chain;
- The opportunities identified in the Energy Opportunities Plan will not all be deliverable through individual developments or planning applications. A coordinated approach between planning, other Council departments, the Local Strategic Partnership and the local community will be crucial to effective delivery.
- Communities are likely to play a crucial role in the delivery of energy infrastructure. To be successful further work will be needed to explore how communities function within Harrogate District.

# Appendices

# Appendix A: GIS Maps

**A.1 List of figures**


Figure 28 Harrogate District in the context of the Yorkshire and Humber region and the UK

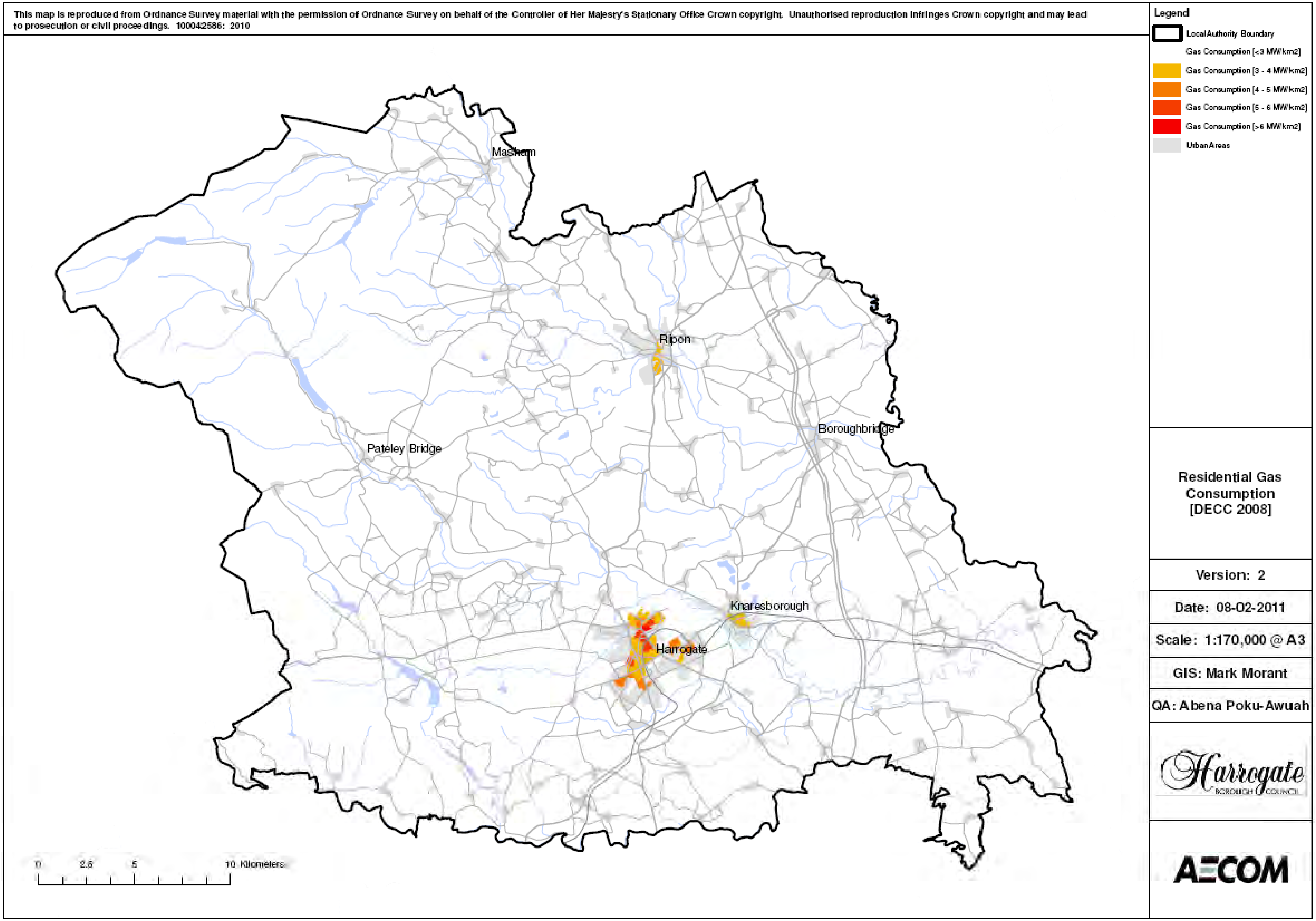



Figure 29 Residential gas consumption across Harrogate District (Source: Consumption of non-gas, non-electricity and non-road transport fuels, DECC and National Statistics, 2008)

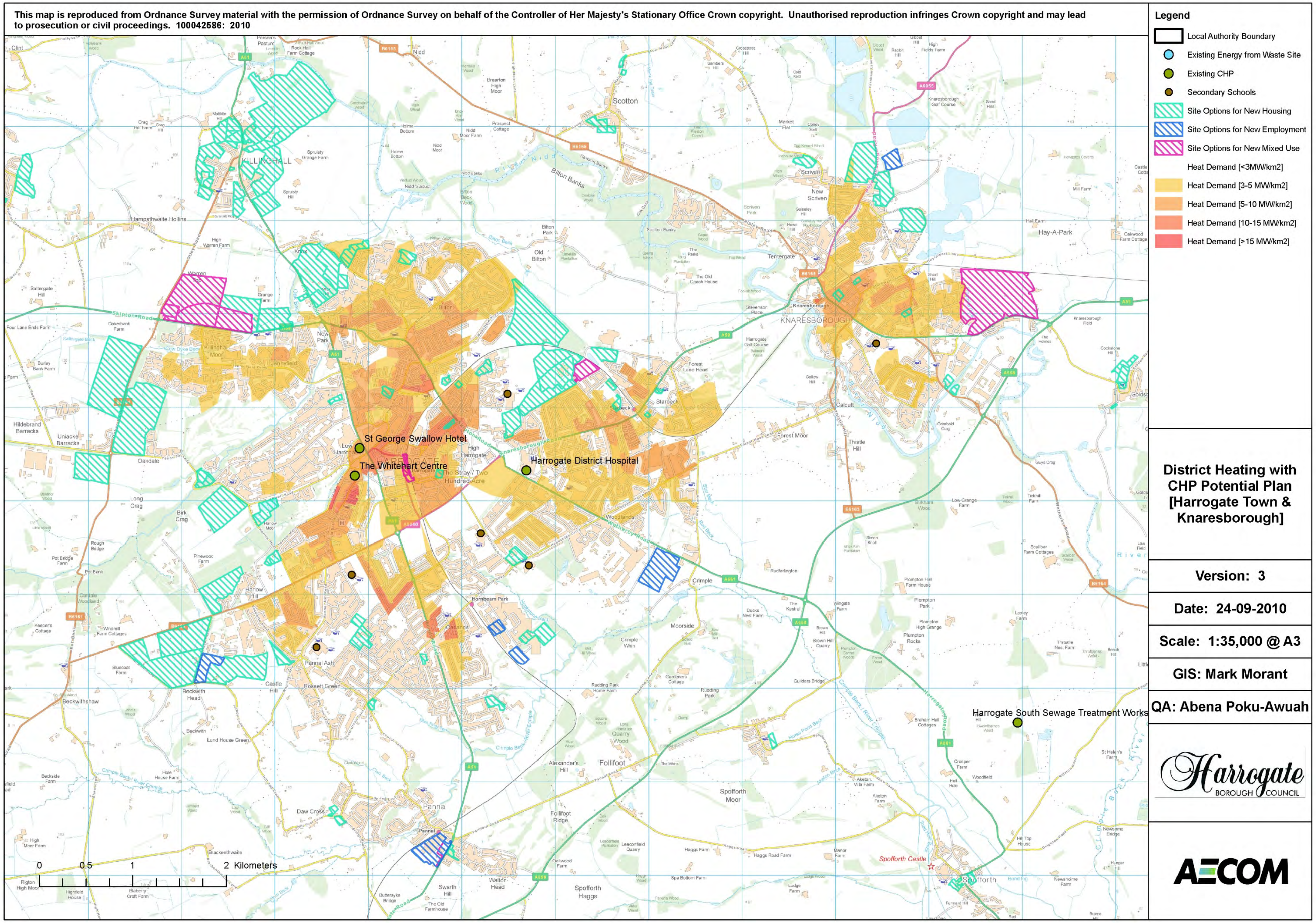



Figure 30 Heat demand by output area across Harrogate and Knaresborough

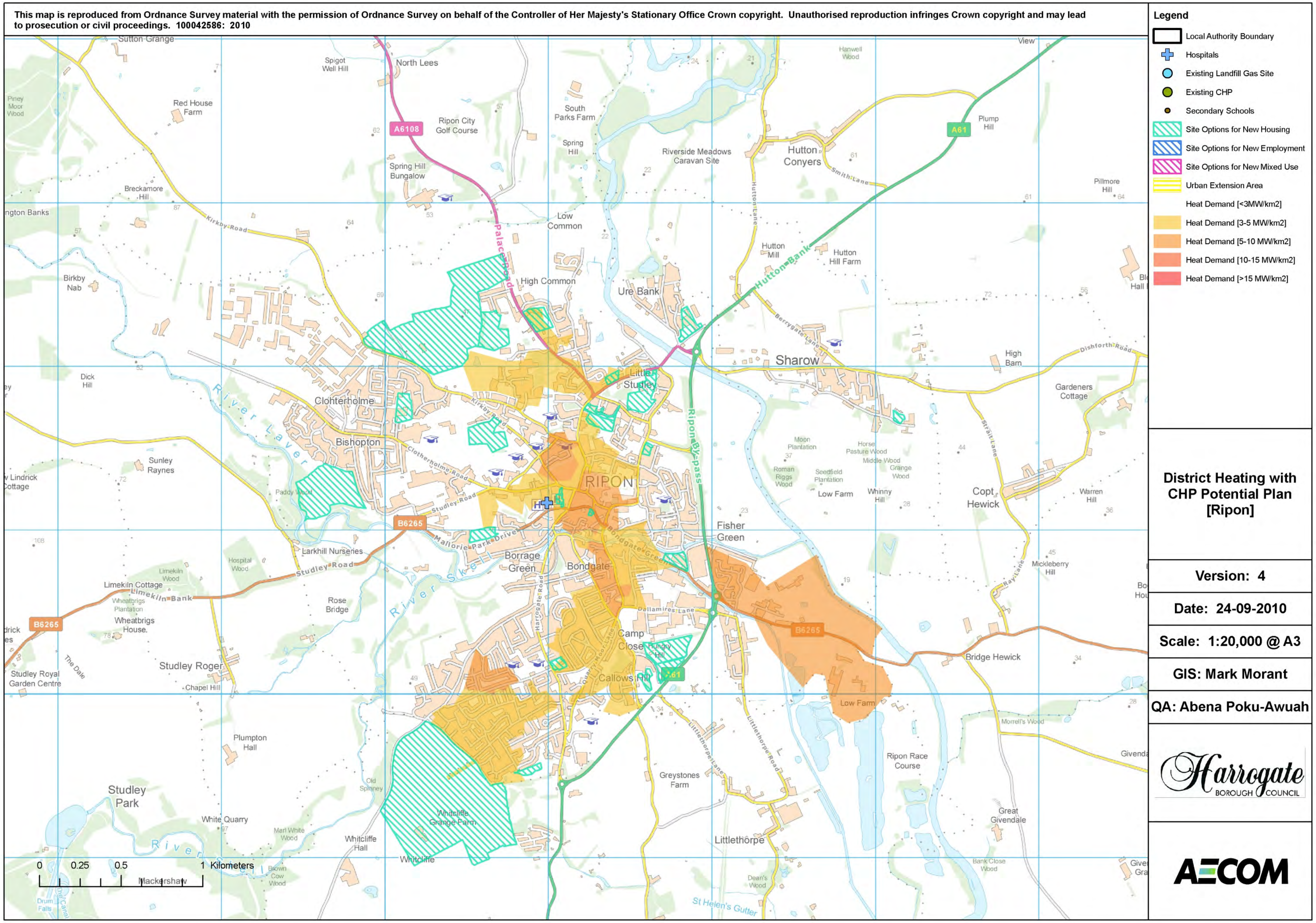



Figure 31 Heat demand by output area across Ripon

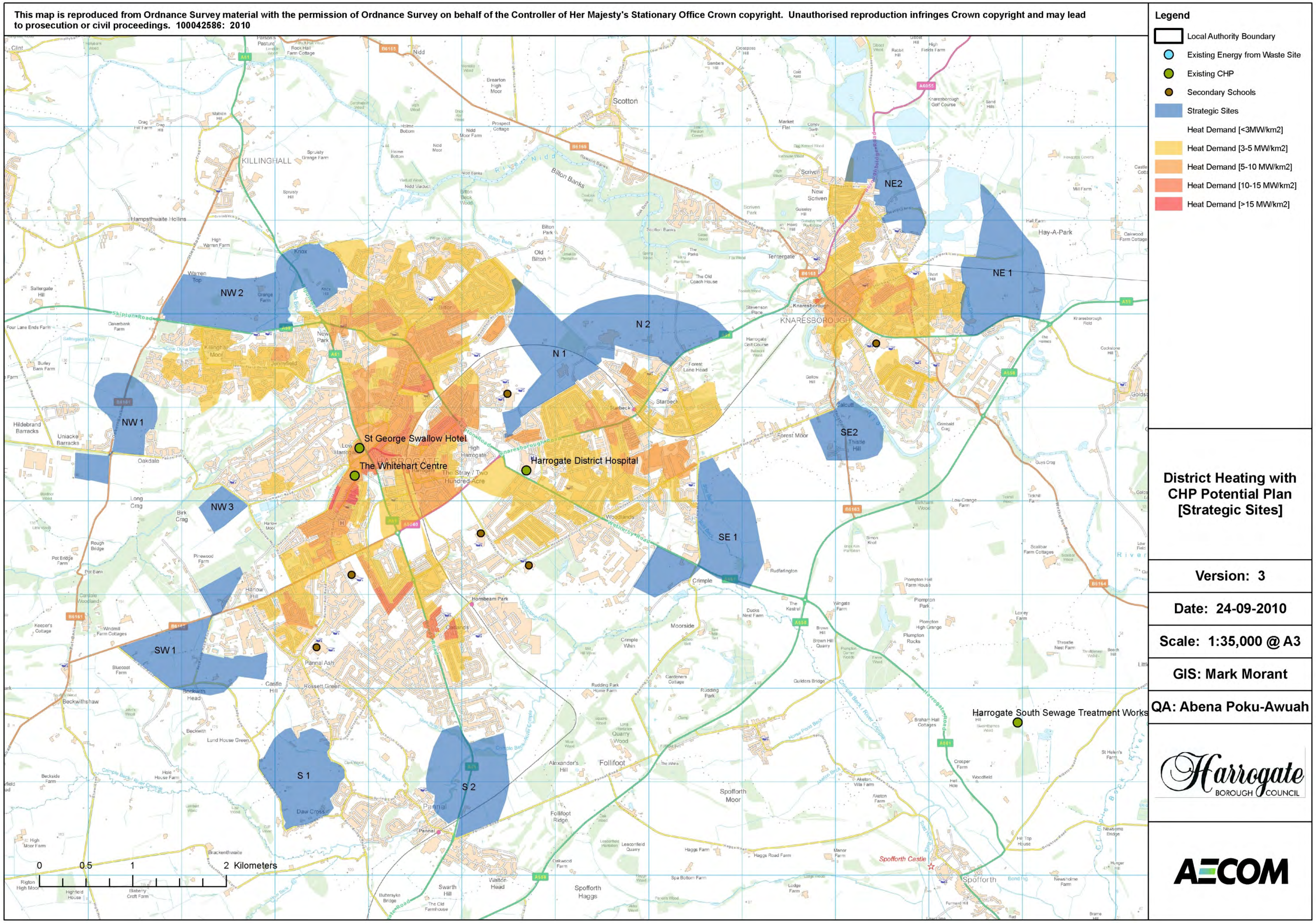



Figure 32 Heat demand by output area across Harrogate District, with potential urban extension sites (Harrogate & Knaresborough Urban Extension Study - Volume 2, Harrogate Borough Council, June 2008).

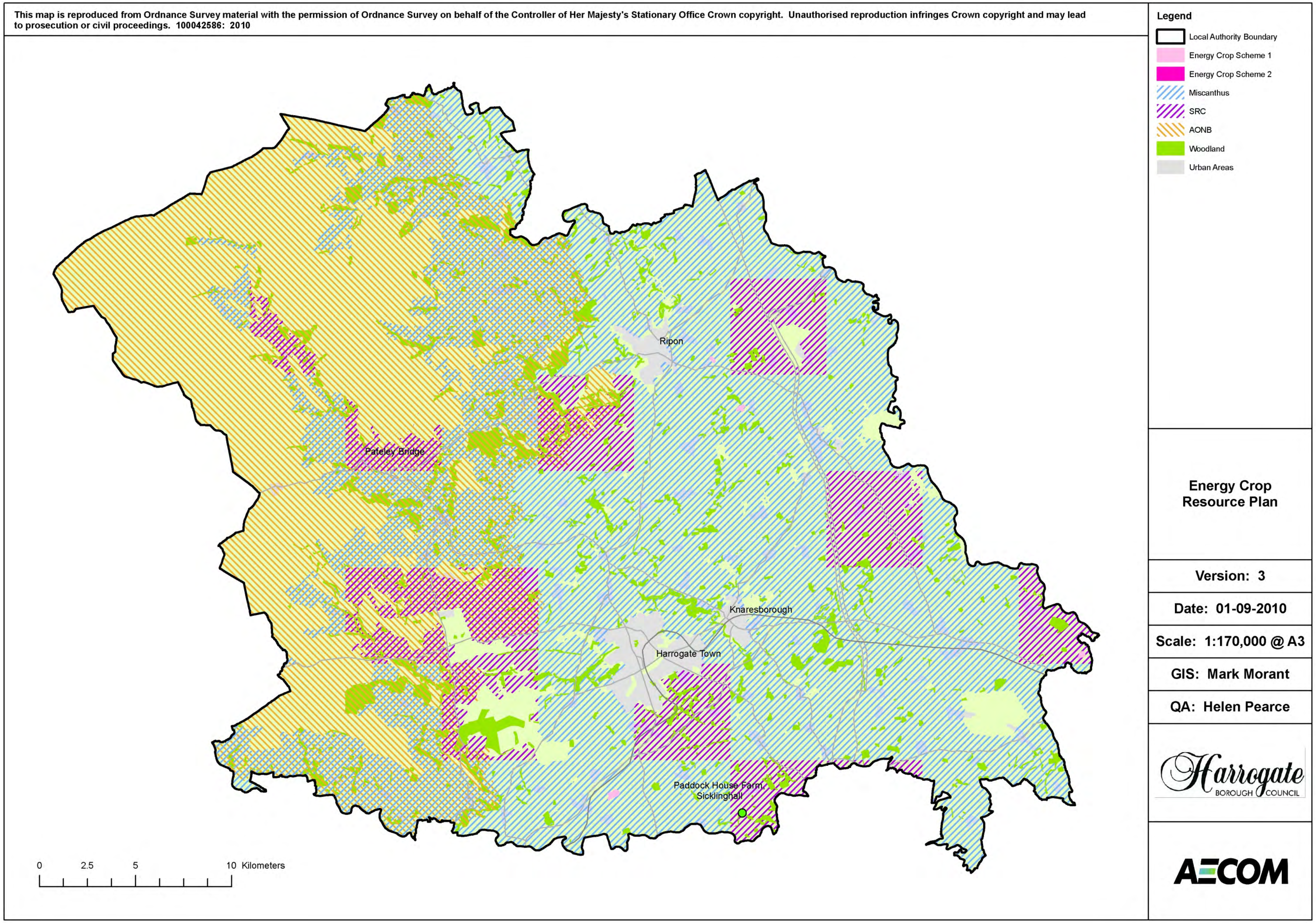



Figure 33 Biomass resource across Harrogate District

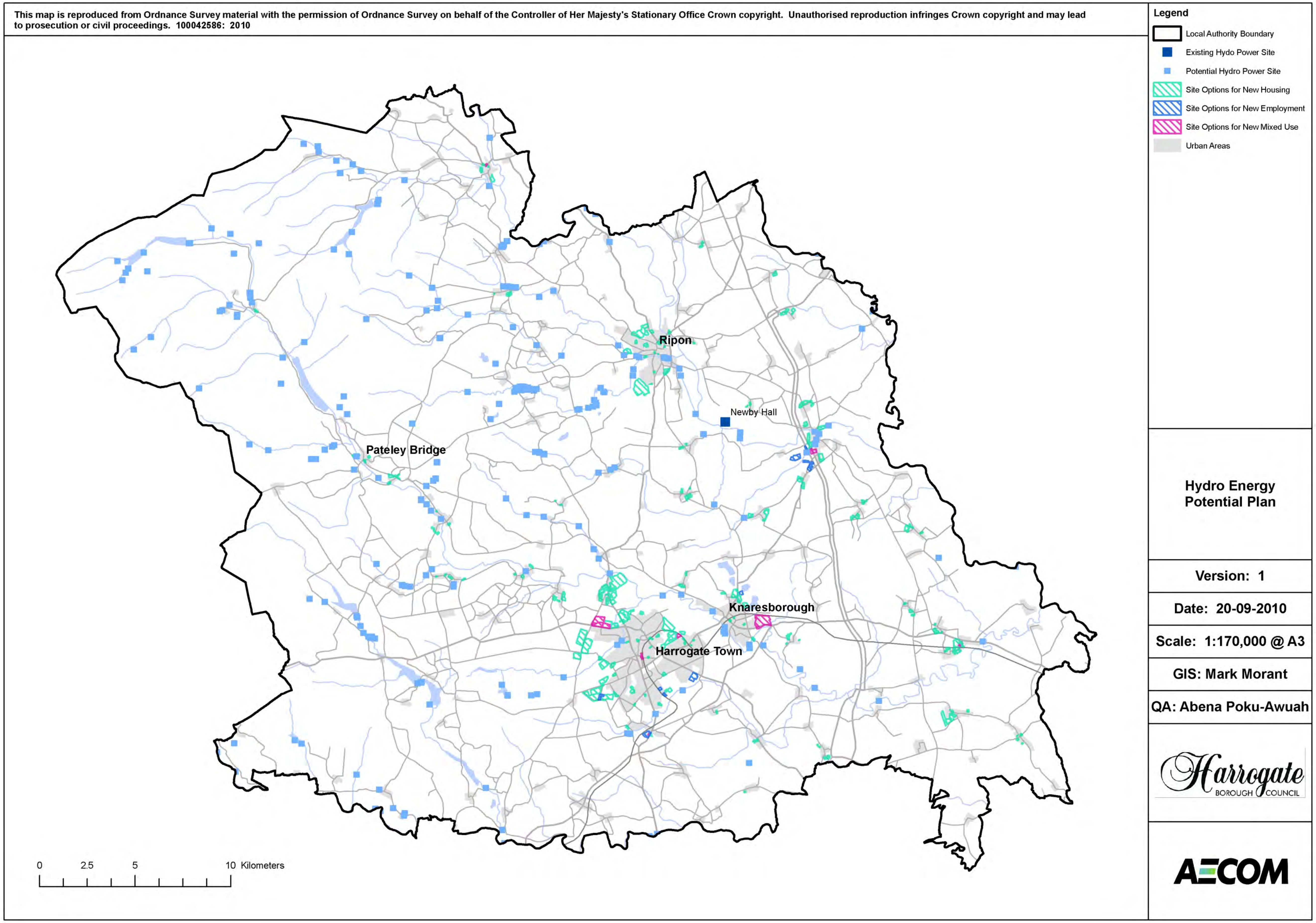



Figure 34 Existing and potential hydro electric sites in Harrogate District

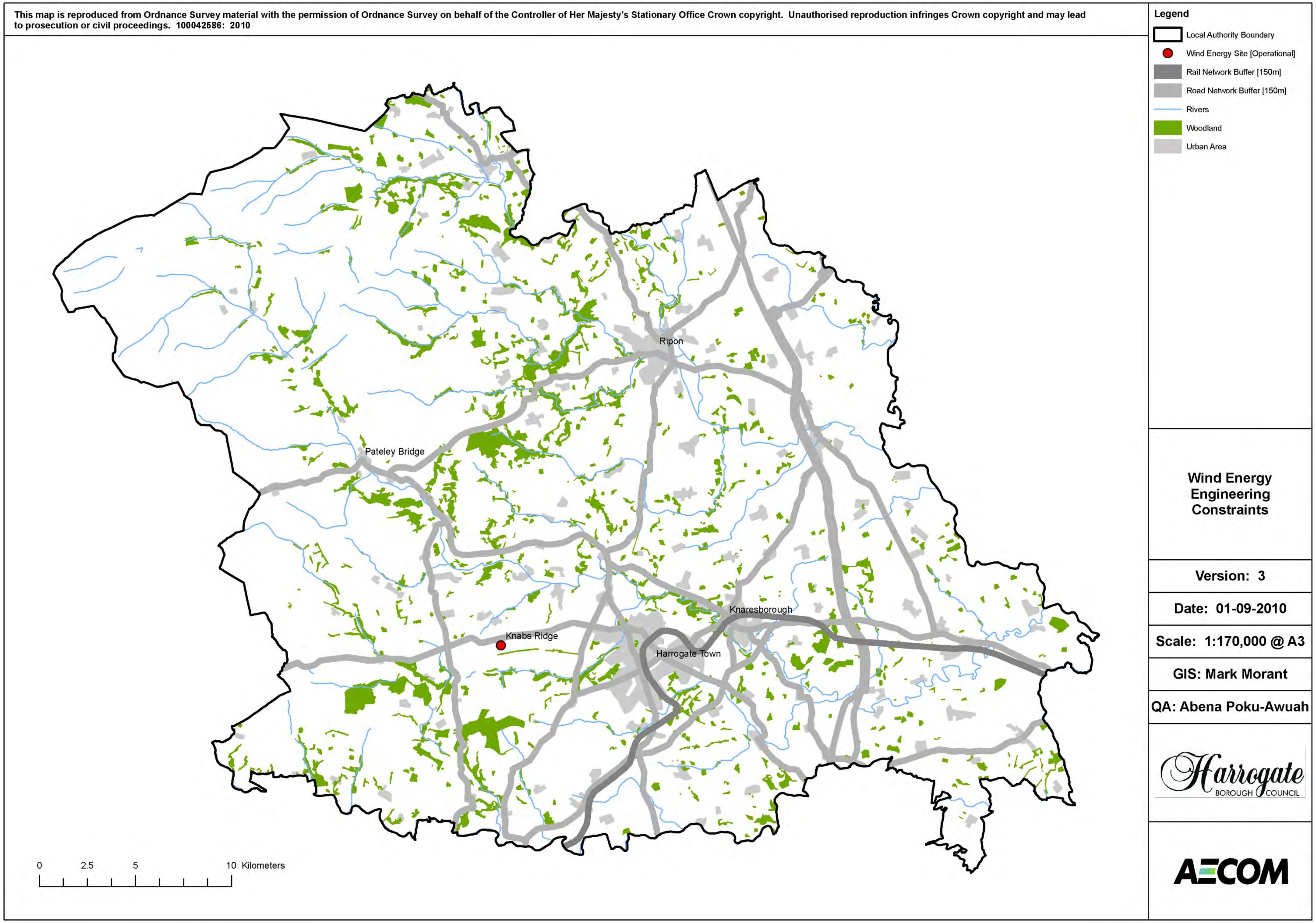



Figure 35 Engineering constraints on large scale wind energy in Harrogate District

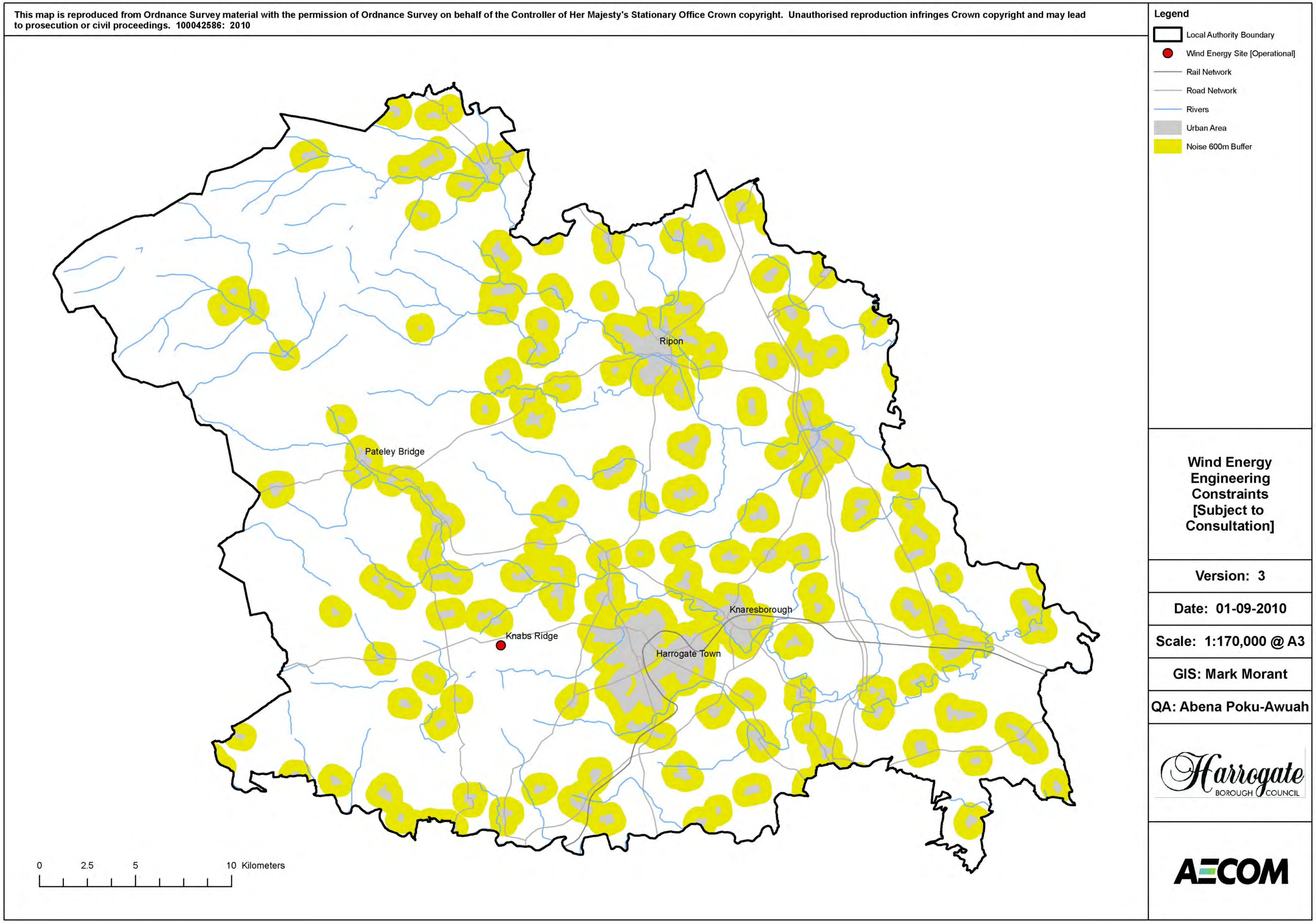



Figure 36 Noise constraints on large scale wind energy in Harrogate District

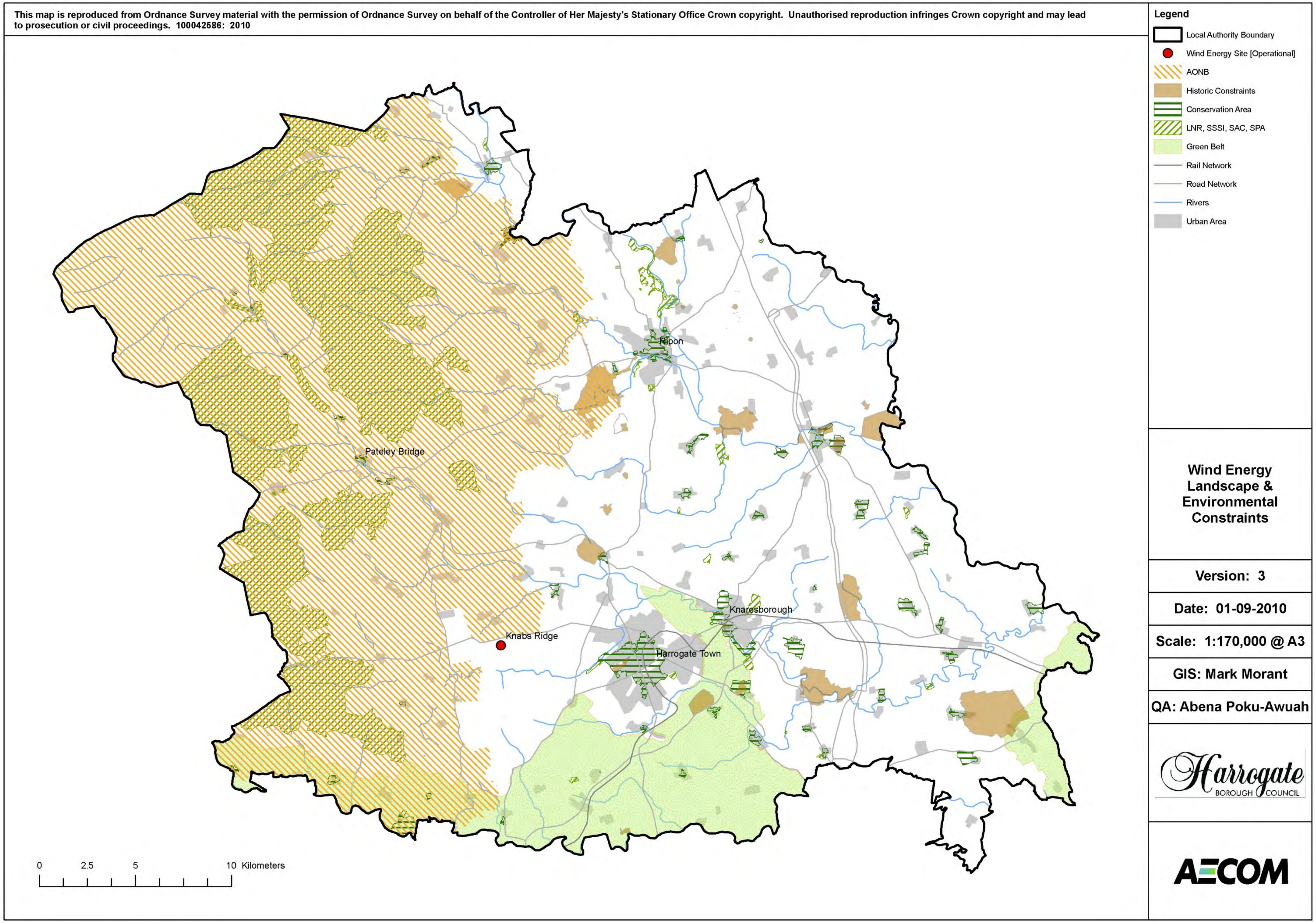



Figure 37 Landscape and environmental constraints on large scale wind energy in Harrogate District

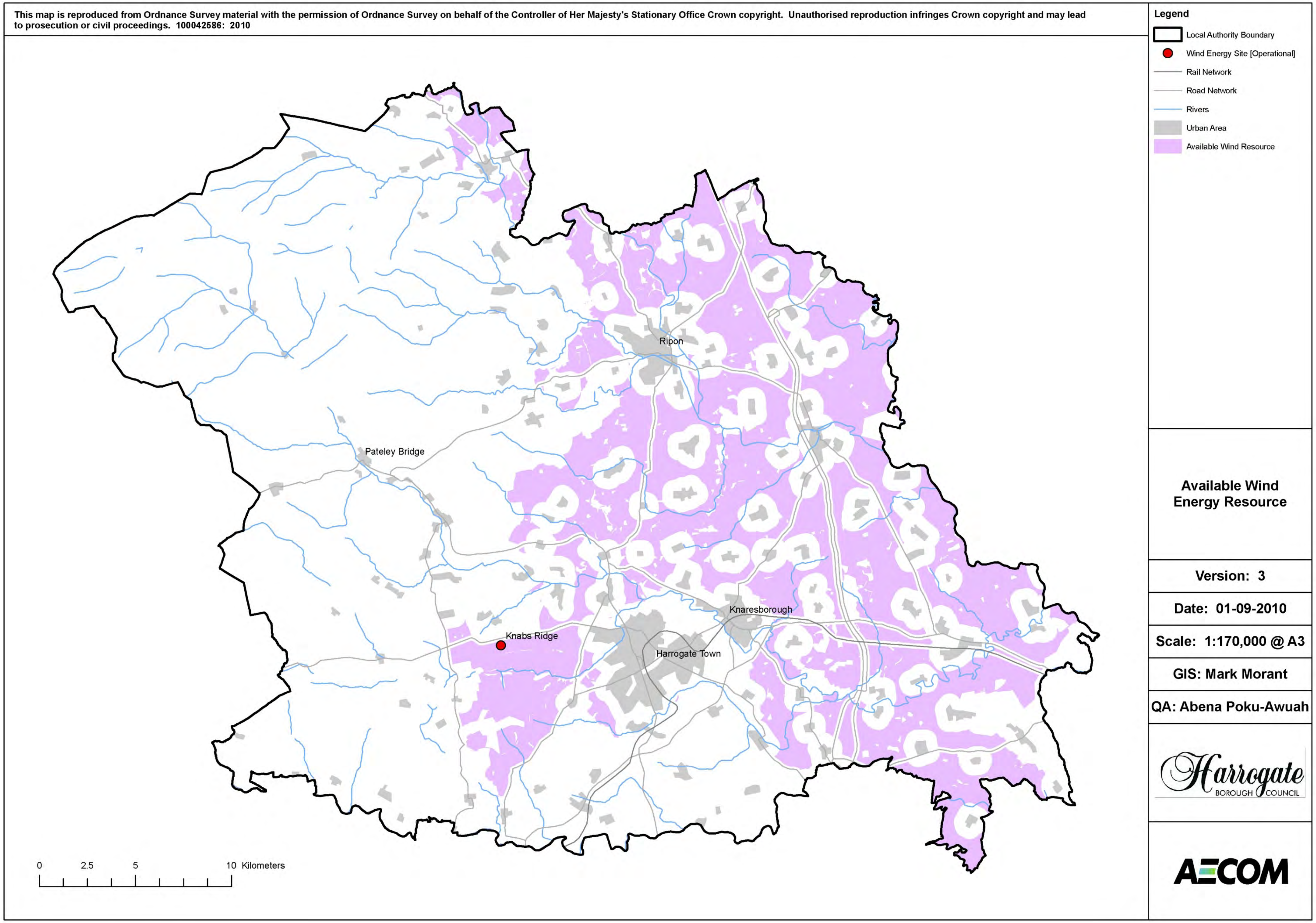



Figure 38 Large scale wind energy resource across Harrogate District (once constraints have been applied).

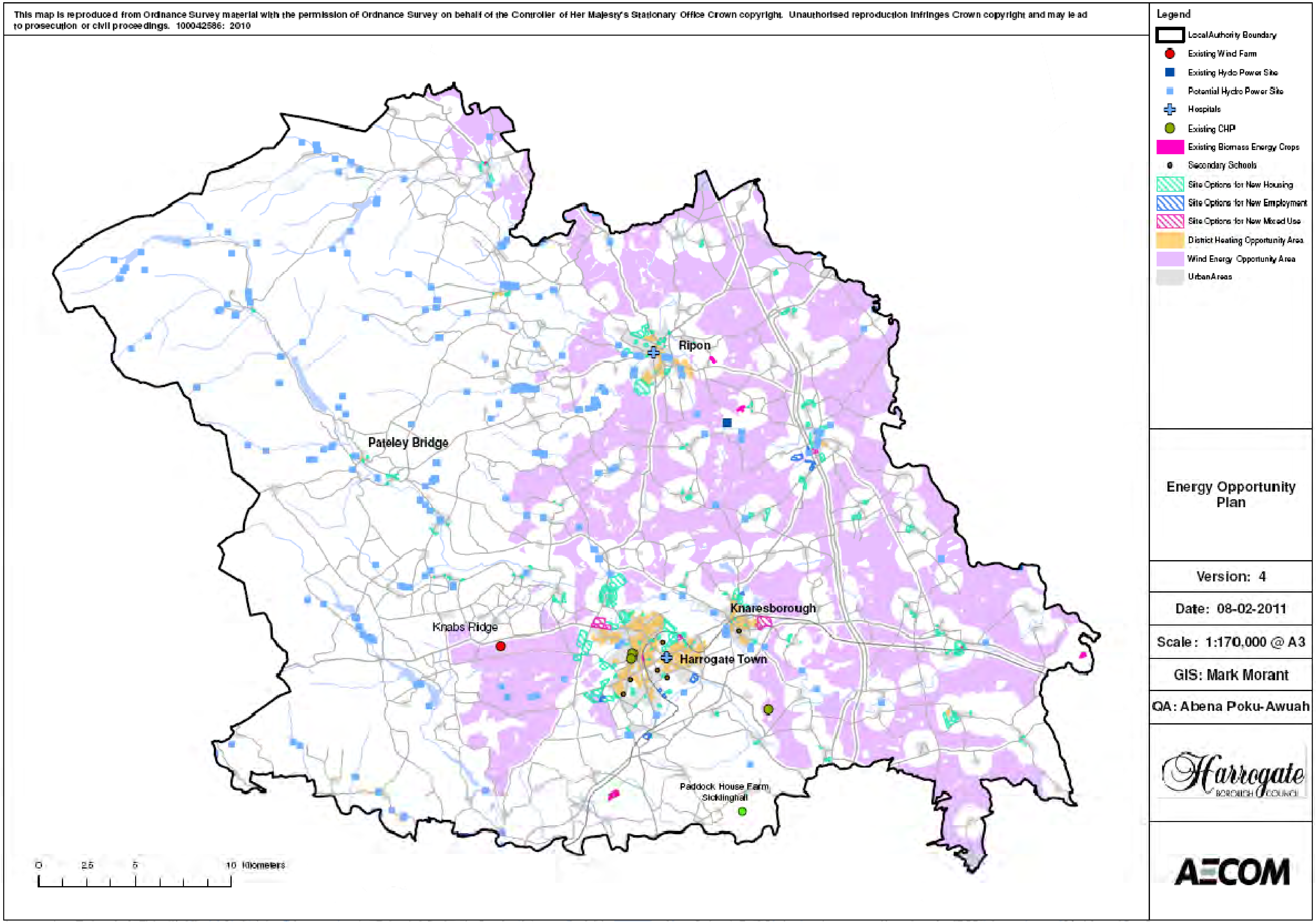



Figure 39 Energy Opportunities Plan for Harrogate District

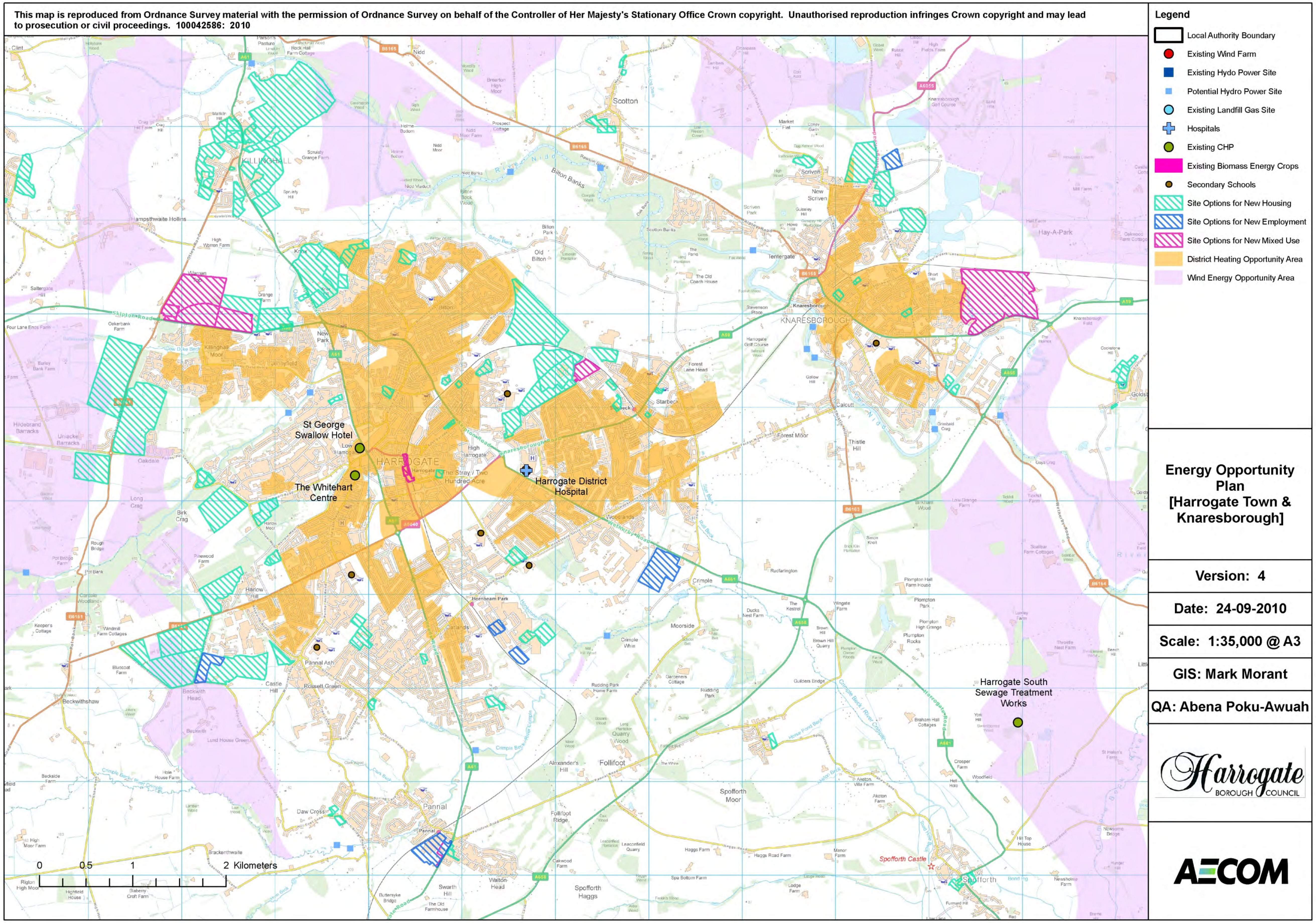



Figure 40 Energy Opportunities Plan for Harrogate and Knaresborough

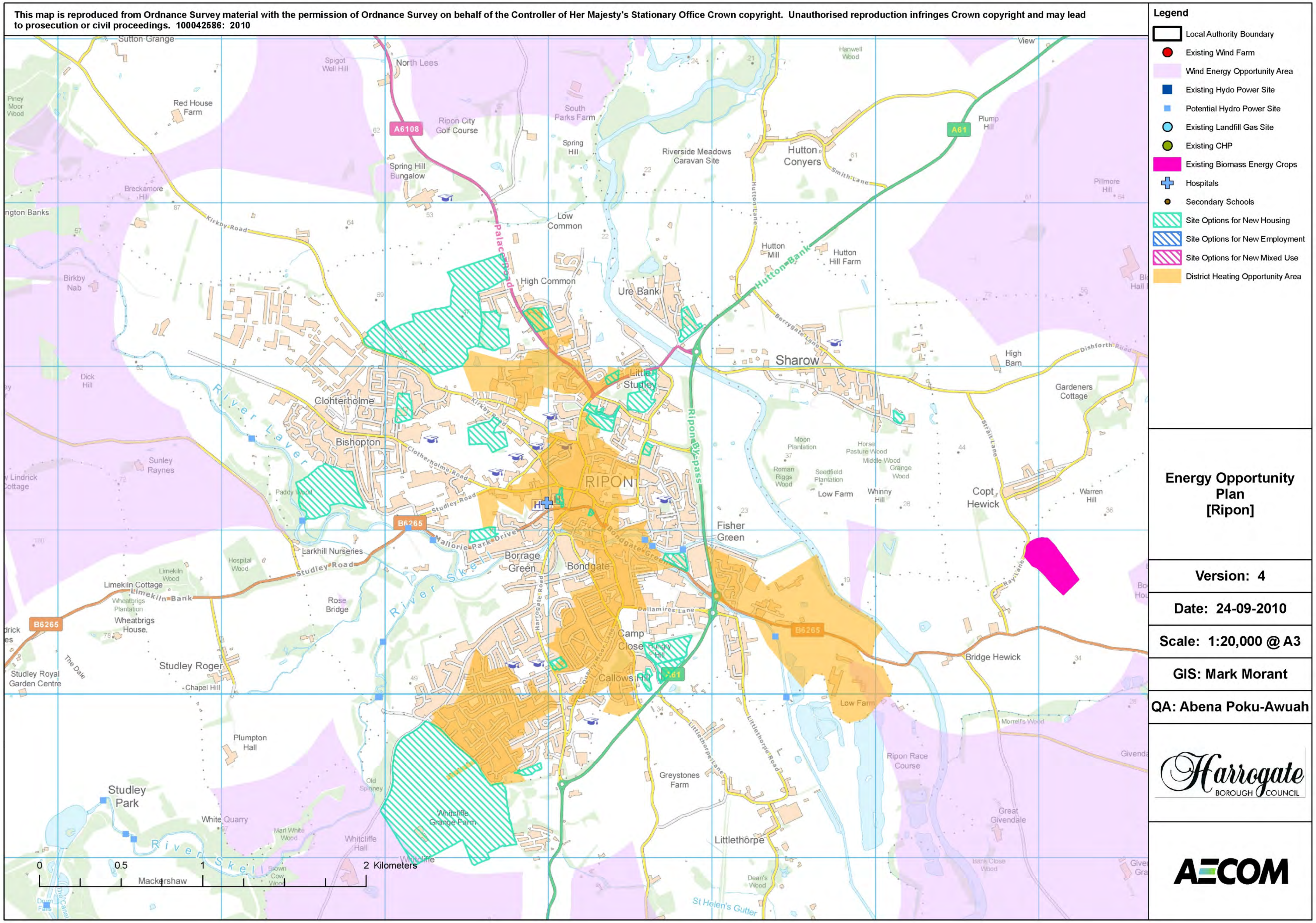



Figure 41 Energy Opportunities Plan for Ripon

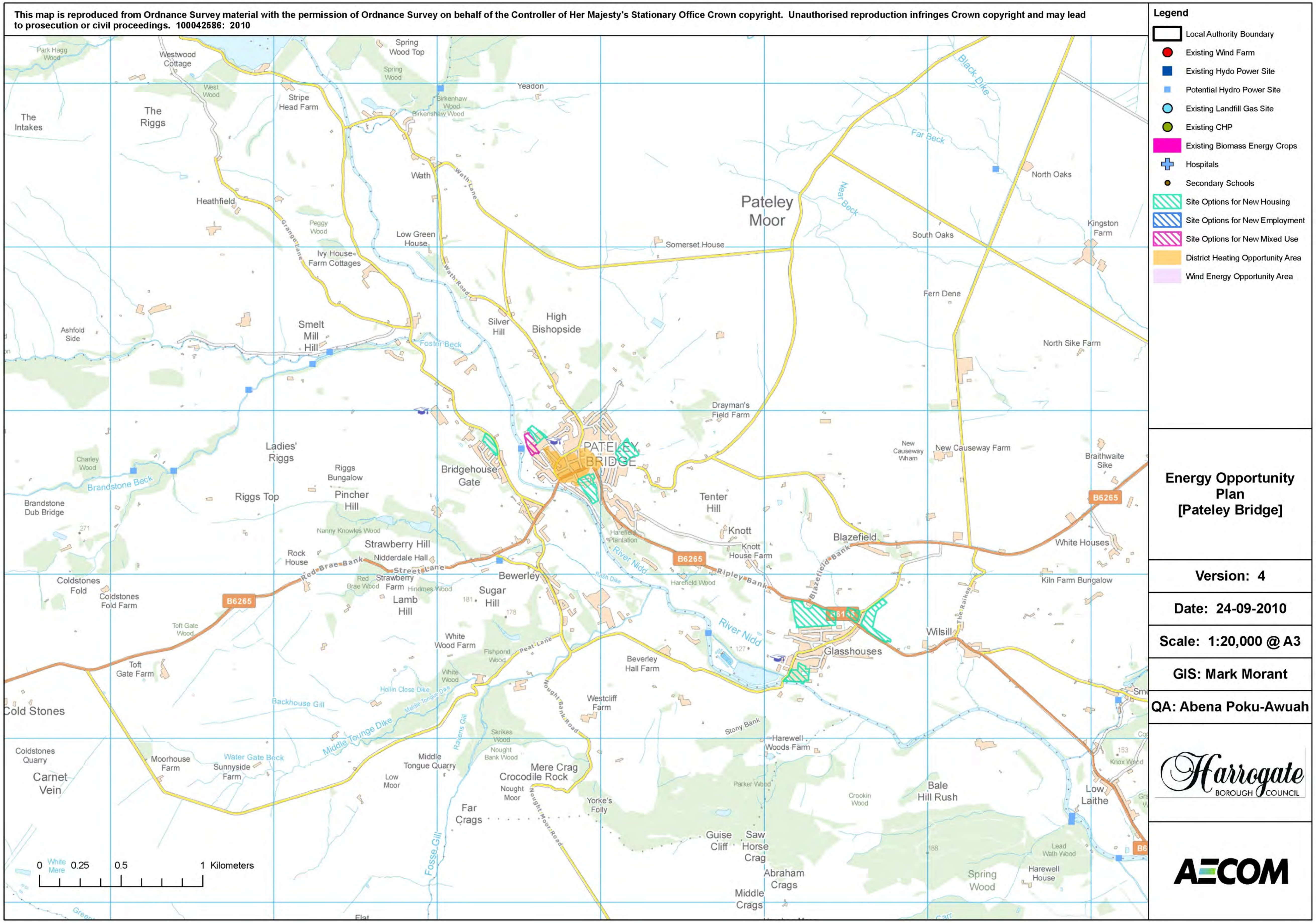



Figure 42 Energy Opportunities Plan for Pateley Bridge

Figure 43 Energy Opportunities Plan for Masham

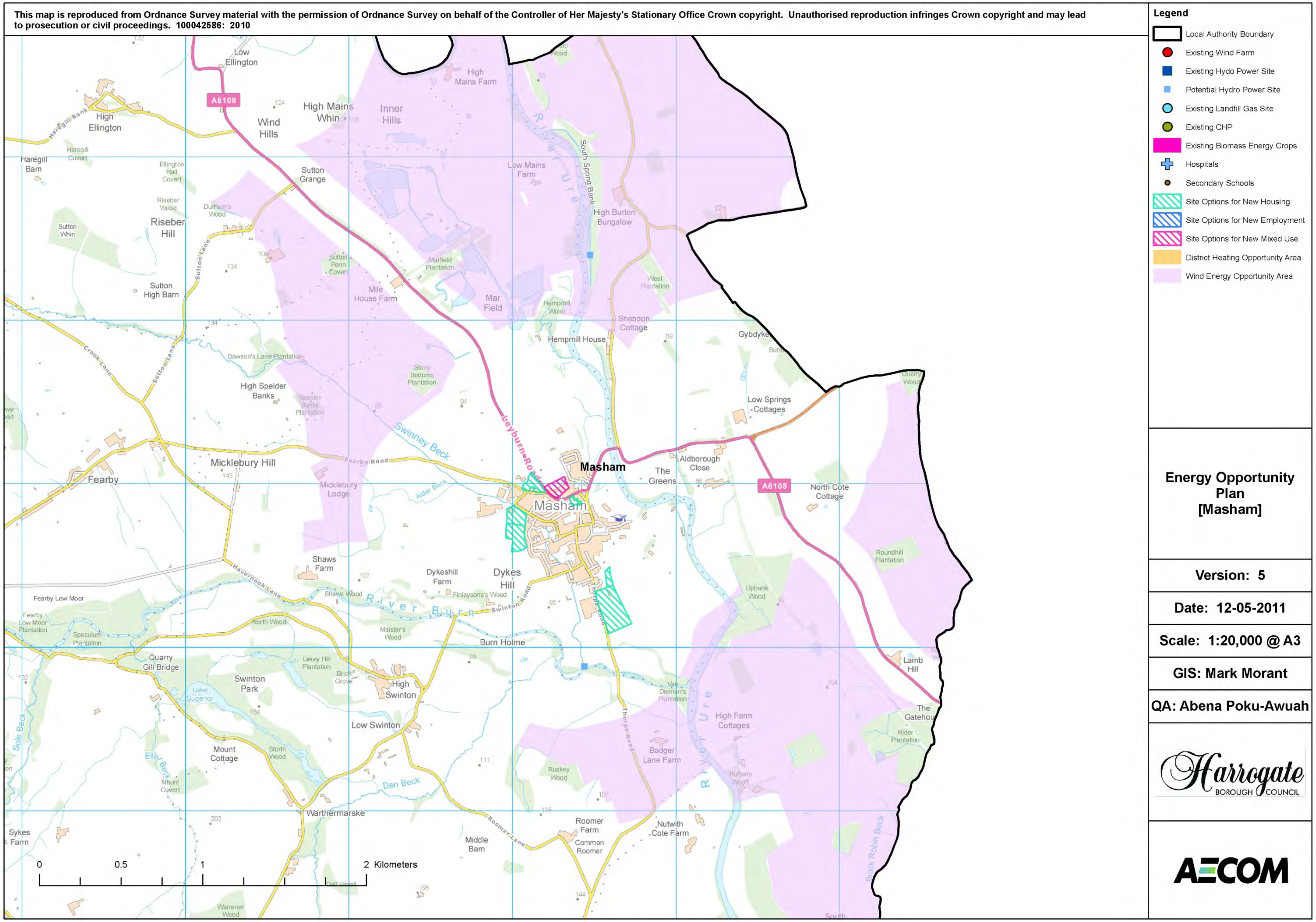
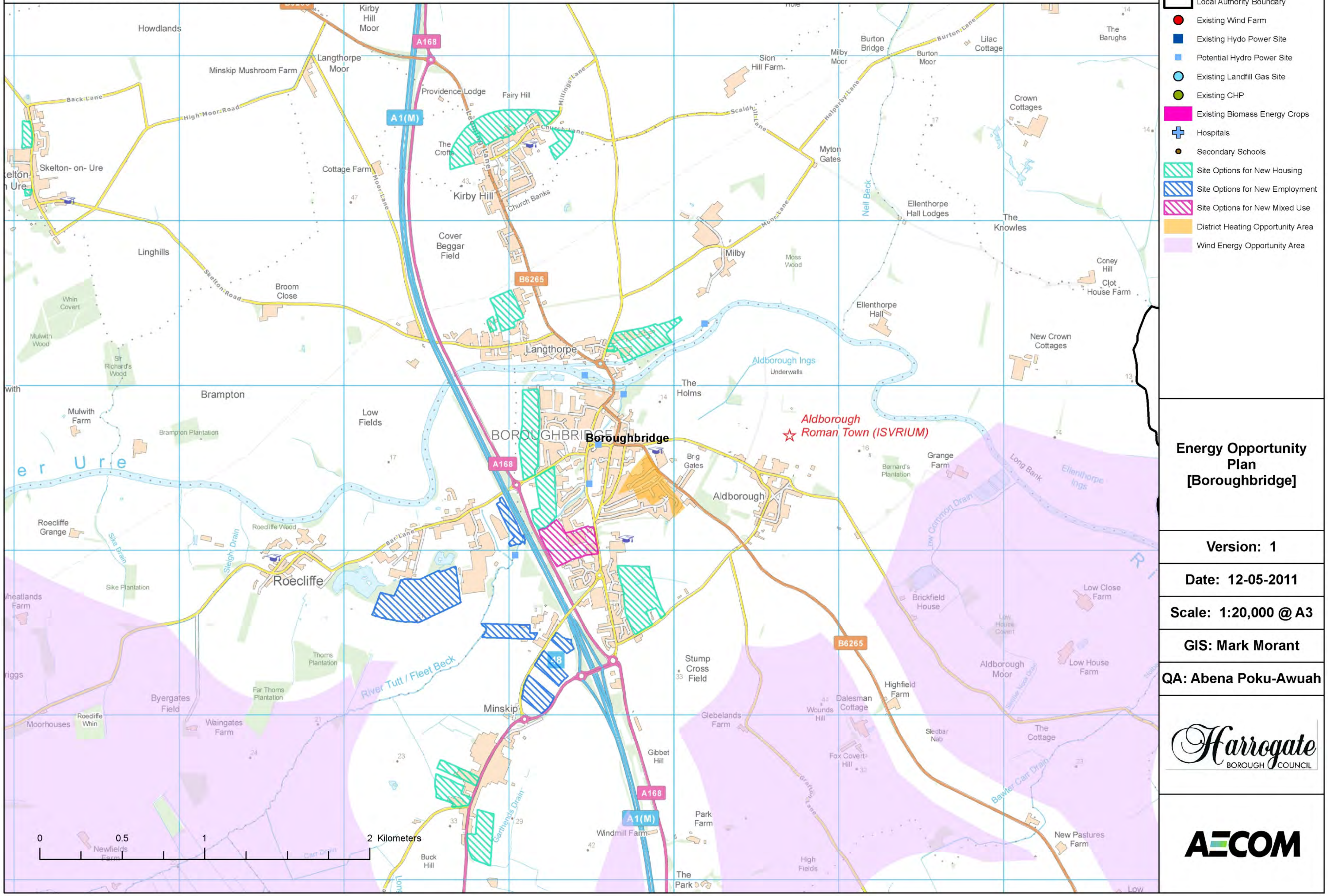


Figure 44 Energy Opportunities Plan for Boroughbridge





# Appendix B: Stakeholder consultation

Interim findings for this study were tested with stakeholders at a workshop held at 26 February 2010. The aim of the workshop was to obtain the opinions of key stakeholders regarding opportunities and barriers for realising the low carbon and renewable energy resource within the borough and the types of planning policies that will be needed in order to facilitate their development.

Table 39 Attendees of workshop. HBC refers to Harrogate District Borough Council.

| Name | Organisation | Name | Organisation |
|---|---|---|---|
| Robert Shaw | AECOM | Owen Barton | HBC Heritage and Design Team |
| Natalie Isaac | AECOM | Andrew Ellis | HBC Home Energy Conservation Officer |
| Derek Devereaux | Arup | Wendy Wright | HBC Landscape Architect |
| Martin Percival | Building Management, HBC | Paul Burgess | HBC Nidderdale AONB Officer |
| Councillor Don Mackenzie | Cabinet Member for Planning and Transport | Linda Marfitt | HBC Planning Policy |
| Nigel Heptinstall | Chair, Action for the Environment | Andy Darby | HBC Planning Policy |
| Mr Jo Adlard | CO2 Sense | William Dixon | ICE Renewables |
| Matthew Cotton | Carbon Trust | Ruth Hardingham | Local Government Yorkshire and Humber |
| John Gumbley | Eagle Power | Martin Elliot | Local Government Yorkshire and Humber |
| Alan Sandy | Economic Development, HBC | Michael Hepburn | Nathaniel Lichfield |
| Clive Fagg | Environmental Planning Specialist | James Walsh | Natural England |
| Henry Pankhurst | Harrogate Civic Society | Helen Bawn | North Yorkshire County Council |
| Matthew Field | HBC Building Control | Helen Pineo | Planning Advisory Service |
| Stuart Mills | HBC DC District Team | Paul Teather | The Healthy Home |
| Anne Smith | HBC DC Majors Team | Tim Wilson | Wilson Kennett Partnership |
| Jane Money | HBC Environmental Strategy Manger | Mark Kennett | Wilson Kennett Partnership |
| | | John Pilgrim | Yorkshire Forward |

**B.1 Achieving $CO_2$ reductions in Harrogate – feedback from breakout session:**

- Full range of renewable and low carbon technologies to be considered (including nuclear, hydro)
- Incentivising and including tourism (i.e. guidance to operators)
- Moving from Merton – equitable targets, not just for the new developments
- Consideration of micro renewable energy
- Education – currently feeling is that losing the climate change argument
- Planning – too many directions, needs to be clearer
- Transport infrastructure needs to also be considered – visitor & local car travel is high -> improvements needed to rail, possible tram system, interchange at the station
- District heating – system needs to be extended
- Identify eco-development sites
- GSHP under The Stray (200 acres of land which wraps around the main urban “old town” – currently protected by an Act of Parliament and classified as green land).

**B.2 Comments and notes from throughout the meeting:**

- Andrew Ellis – interested in findings for potential of GSHP under The Stray.
- In Harrogate approved micro wind of approximately 180kW (not sure how much of this is grid connected)

- Jo Adlard - If considering district heating in study would like it to address efficiency problems with gas systems. Would prefer systems that enable biomass, waste, CHP etc.
- Rob explained that gas systems should be considered with capacity to change from this to other forms of fuel at a later date.
- Concern from residents re: feed-in-tariffs and potential large increase in small systems in what would be considered inappropriate visual settings. PV on the Duchy estate was given as an example.
- Concern regarding current draft of permitted developments regarding wind at between 2-2.25 meters. Without suitable measurement of wind resource there is the possibility of inefficient systems being installed and being over-subsidised.
- Planning for small scale (or any other wind) should be clear on avoidance of shading issues from other turbines etc.
- The possibility of energy from waste for the District was discussed.
- Rob Shaw noted that it has been found that this is something that an individual district is unable to do without linking with surrounding districts.
- General point made about resource from biomass and how one attendee believes this does not fit with electricity and heating based targets. It is a constrained resource but it doesn't cost much to transport this around.
- Andy Derby – interested in waste heat recovery to be channelled into the district heating system.
- Attendees would like to see micro-hydro considered in study. CO2 Sense can provide us with a study. Derwent Hydro has recently looked at hydro capacity in Harrogate AONB. There has been approval for a system at Linton Lock (this crosses district boundaries).
- Action for study could be to make links with people who own water in the area - water producers as well as energy producers.
- Andy Derby: Currently scoping for 8x 2MW turbines in Melmerby (north of Ripon)
- The only biomass pellet producers in area are in Melmerby.
- Biomass district heating scheme at Denton Hall in Ilkley, (stately home in south of the district) – Site owned by N G Baileys.
- Yorkshire Forward can provide details of biomass (ask John Pilgram).
- Country's biggest feed mill in Masham.
- Paul Burgess – Yorwoods, biomass. Woodland regeneration company, working on biomass supply chain
- Wendy Wright – regarding our Landscape Character Assessment – referenced the Natural England, Topic Paper 6 and is concerned that we shouldn't be placing a blanket "no" on the inclusion of micro renewable energy in the AONB and considers that in fact this area could be more suitable than other parts of the District.
- Opportunity to utilise the impact of the feed-in-tariff into policy with regards to developments.
- Discussion around consequential improvements. Some attendees wondering if it will happen considering it have not already come through in Building Regulations. Harrogate may provide guidance on this or include it as part of planning policy.
- One attendee noted that the Core Strategy suggests 390 homes per annum in the area and that the Harrogate area will account for 48% of these (i.e. 190 homes). Harrogate prefers the use of brownfield sites and has identified urban extension areas. Questioned whether solutions better delivered on greenfield or brownfield sites?
- Rob Shaw noted that the size of the site is key, with more options are available on bigger new sites as opposed to small developments squeezed in and that the study will explore the scale issue.
- One attendee commented that input must be read as a whole. He noted Harrogate's requirement for a large amount of affordable homes (and the burden that this places on the District). He wanted to know if the study considered this issue.
- Rob Shaw explained that this was beyond the scope of the current study and this type of question highlighted the distinction between it and a full viability study – but, that this study will enable that work to be completed.
- Ongoing life cost of systems should be considered.
- Jo Adlard – Harrogate should be focusing on 2050 target and drafting policy for encouragement through energy efficiency – CO2 Sense have a tool that suggests that a focus on $CO_2$ is a blunt approach (i.e. without tackling energy efficiency too).
- A discussion was held around Europe's 'PassivHaus' approach and likelihood of this being implemented in UK.
- The point was made that it was important to look at existing building stock as reductions from new development was only tackling new sources of $CO_2$ emission and that if Harrogate needs to reduce overall $CO_2$ then this has to be done beyond new developments.

- Rob Shaw noted that the study would provide information as to how far these polices can go
- The question was raised as to whether the study looked at energy security.
- Rob Shaw said that it does in some aspects as it is looking at decentralised energy.
- One attendee noted that the District has thin electricity transmission in some parts (especially in the upper areas).
- This will be considered at the higher level as part of the Y&H study.
- When considering partners the study should also include farmers and land owners. Suggested look at peat in the Moorland and also forestry & English.

**B.3 Attendees views on delivery mechanisms**

- Concerns that this type of study can become a political issue during elections. Particularly with regards to wind.
- Study leads to a lot more work at the delivery end. Planning needs to move away from this and need to develop a skills base to allow development control offices to educate developers.
- Starting point is to get the Chief Execs involved
- It was suggested that generally it is possible to gain consensus in Harrogate from Chief Execs. This is an action from the Environment Group and that the Council needs to take the lead on this
- Spaces need to be made available near heat loads for possible future CHP
- Rob Shaw agreed that where necessary land could be set aside for future energy centres where necessary
- The question was asked as to whether or not the study engaged with developers?
- Rob Shaw said that developers should not shoulder the full burden. The local authority’s role is to create the necessary infrastructure. Planning aimed at helping developers to meet future targets much more cheaply.
- Wendy Wright highlighted Policy YH8 [Green Infrastructure] as she has been working with Natural England on green corridors for renewable energy. She thinks that there should be stronger links to this.
- Paul Burgess mentioned the Yorkshire Dales community footprint assessments that include actions plans which are intended to be rolled out.

# Appendix C: Energy Modelling

**C.1 Introduction**

To test and monitor the effects of national, regional and local targets on the District, we have developed a Microsoft Excel® based model of the energy use and $CO_2$ emissions of buildings in the District covering the period of influence of the Core Strategy.

Integral to our model is an input sheet which includes energy demands and $CO_2$ emissions for 76 different building types - both in the 'base case' (i.e. Part L 2006 compliant) and assuming a range of $CO_2$ reduction improvements (i.e. energy efficiency measures and low and zero carbon technologies). The outputs from the input sheet, although derived from only these 76 assumed building forms, are expressed in a form which can then be applied to the actual building stock.

It is recognised that there are a number of alternative approaches to sizing renewable and low carbon technologies and for calculating the likely energy and $CO_2$ savings. Technology costs also vary greatly between product and suppliers and are expected to fall in future at differing rates, as a result of technology 'learning'. For these reasons we felt it important to set out clearly what has been assumed at this stage, so that it will be possible to update the model input sheet as more robust data becomes available.

We have tended to use 'rules of thumb' to estimate installed technology capacities, annual energy generation, $CO_2$ savings and costs. Some, but not all, of these 'rules of thumb' can be referenced to external and authoritative sources. Unreferenced assumptions are based on our experience of undertaking renewable and low carbon feasibility studies for a range of developer clients over the last 10 years.

Costs in the model input sheet are capital cost only. Our model does not consider maintenance and replacement costs over technology lifetime and allows no benefit for revenue gained from feed in tariffs or renewable heat incentives. These lifecycle costs and benefits are important for some developers (for example, housing associations and commercial owner occupiers) and need to be considered alongside results from the model

The Government has published consultations on future Building Regulations requirements for the energy efficiency of new homes and the definition of zero carbon for non-domestic buildings. Both were both published after the bulk of the work for this study had been completed and the initial draft of this report had been issued. The modelling and analysis in this report are therefore based on assumptions drawn from previous consultations and have not been updated to reflect the latest Government proposals. This is not likely to have a significant impact on the findings of the report and the policy recommendations should still be considered to be valid.

**C.2 Calculating energy demand of development**

As far as possible the model aims to use locally specific data for Harrogate District (e.g. Census data, Valuations Office Agency (VOA) data) on the number, types and size of buildings. Although building numbers and floor areas in the model are informed directly by local data, in order to develop the modelling, and specifically to make assumptions relating to the types and likely cost of appropriate low carbon and renewable technologies, the buildings have been split into a manageable number of categories.

**C.2.1. Homes**

Data on the number of existing residential buildings in Harrogate District was taken from the 2001 Census in England and Wales and information from Harrogate Borough Council regarding post-2001 developments. Both the age and dwelling type was taken into account to characterise differences in building fabric, occupant density, and the likelihood of building fabric improvements having been made.

Projected figures for location and number of future homes were taken from the draft SHLAA and information on proposed development provided by the Council. Assumptions have been made on likely phasing of development where necessary. Modelling for energy use of future homes takes into account proposed changes to Building Regulations Part L requirements expected in 2010, 2013 and 2016.

**C.2.2. Non-domestic buildings**

Data on floor areas was collected from the Valuation Office Agency (VOA) for existing, non-domestic buildings. Each building type was assigned to one of the benchmark categories set out in CIBSE TM46, which defines energy benchmarks to allow assumptions to be made of $CO_2$ emissions from a range of building types.

Information on public buildings and buildings not eligible for business rates was obtained from the Council and from the Harrogate Borough Council website.

The size and form of future, non-domestic building types in the model is assumed. As a result the model does not deal well with commercial buildings that are integrated as part of mixed us developments (i.e. where the commercial element is one floor of a multi floor development). In these cases the calculated roof area available for solar panels will be greater than would be expected in reality and the model may assume an over reliance on solar technologies to deliver on policy targets.

CIBSE TM46 benchmarks were used to model energy demand of future non-domestic buildings. A 25% reduction was applied to account for higher energy efficiency standards in new buildings.

### C.3 Building type assumptions

The 76 building categories that were modelled comprise;

- 4 existing dwelling types –detached, semi detached, terraced and flat/apartment, modelled in three different age bands - pre 1919, 1919-1975 and post 1975
- 6 new dwellings types (i.e. post 2006), comprising detached, semi detached, end terrace, 1 bed flat, 2 bed flat and 3 bed flat.
- 29 commercial building types (existing)
- 29 commercial building types (new, post 2006)

The housing types and floor areas used for modelling are shown Table 41 and Table 42.

### C.4 Roof areas

Assumptions relating to available roof areas are important with respect to potential energy generation from solar technologies.

For all building types, the available roof area for the installation of solar technologies has been assumed to be 45% of the total floor area, divided by the number of storeys. Floor areas and assumed storey heights for each of the building types are shown in tables 1 and 2 above.

On pitched roofs, only half of the roof will face south, whereas on flat roofs, panels are mounted on frames which need to be spaced apart to limit over shading. Some area is also required for circulation, maintenance etc. Therefore, the maximum roof area that can be used for mounting solar panels, whether on flat or pitch roofs, has been considered to be 90% of half the available roof area i.e. 45% of the total roof area.

### C.5 Energy Demand Assumptions

Dwelling energy demands were modelled in SAP, input assumptions where altered to take account of the likely fabric and plant performance in homes of varying age. The new dwellings have been modelled to comply with Buildings Regulations Part L 2006 or later. Unregulated energy demand (i.e. from non fixed building services - small power) has been calculated using a formula published within the Code for Sustainable Homes. This approach (for the unregulated emissions) has been used for existing and post 2006 dwellings.

For commercial buildings energy demands have been estimated by multiplying the floor areas above with energy benchmarks from CIBSE TM46. Energy use benchmarks have not been altered to differentiate between existing and new (post 2006) commercial uses, as there are no robust sources of information on which to base this.

We have had to assume how the energy benchmarks breakdown according to the energy demands which are regulated under Part L (i.e. for fixed building services such as heating, hot water and lighting) and which are unregulated (i.e. for small power). This is clearly essential where proposed policies being tested are framed in these terms. There is no recognised method for splitting energy benchmarks according to the emissions which are regulated or unregulated, but we have used assumptions that were made in the development of an energy strategy for a major development in the South East.

### C.6 $CO_2$ Emissions

Conversion factors used to calculate $CO_2$ emissions are shown below. These are based on the emissions factors included in the current 2006 Building Regulations Part L, Conservation of Fuel and Power ADL2. It should be noted that revised emissions factors are expected to be published in the 2010 update to Building Regulations Part L.

Table 40 Conversion factors for different fuels

| Fuel | $CO_2$ emissions $kgCO_2$/kWh delivered |
|---|---|
| Gas | 0.194 |

| | |
|---|---|
| Grid Supplied Electricity | 0.422 |
| Grid Displaced Electricity | 0.568 |
| Biomass | 0.025 |
| Waste Heat | 0.018 |

**C.7 Heat Mapping**

Heat mapping has been conducted using gas supply data and assuming an average boiler efficiency of 80%. Heat density is defined as the annual heat demand in kWh, divided by the number of hours per year to give an annual average demand. This was then divided by the area under consideration. Potential issues with this method are:

The use of gas data ignores the use of other heating fuels such as electricity and oil, which is expected to make up a small proportion of heat demand.

The resolution of the heat map is limited by the Middle Layer Super Output Area boundaries, which is the format in which address data is provided. The results only provide an average of each Middle Layer Super Output Area and do not highlight point sources which may have a high heat demand.

Table 41 Modelled house type basic assumptions

| House Type | Age | Floor Area ($m^2$) | Storeys | Sources |
|---|---|---|---|---|
| Semi Detached (Dense) | pre 1919 | 104.65 | 2 | Census Data + English House Condition Survey |
| Semi Detached (Dense) | 1919-1975 | 83.89 | 2 | Census Data + English House Condition Survey |
| Semi Detached (Dense) | post 1975 | 72.13 | 2 | Census Data + English House Condition Survey |
| Semi Detached (Less Dense) | pre 1919 | 104.65 | 2 | Census Data + English House Condition Survey |
| Semi Detached (Less Dense) | 1919-1975 | 83.89 | 2 | Census Data + English House Condition Survey |
| Semi Detached (Less Dense) | post 1975 | 72.13 | 2 | Census Data + English House Condition Survey |
| Small Terrace | pre 1919 | 58.27 | 2 | Census Data + English House Condition Survey |
| Small Terrace | 1919-1975 | 60.40 | 2 | Census Data + English House Condition Survey |
| Small Terrace | post 1975 | 54.32 | 2 | Census Data + English House Condition Survey |
| Flat; maisonette or apartment | pre 1919 | 96.44 | 4 | Census Data + English House Condition Survey |
| Flat; maisonette or apartment | 1919-1975 | 84.76 | 4 | Census Data + English House Condition Survey |
| Flat; maisonette or apartment | post 1975 | 89.21 | 4 | Census Data + English House Condition Survey |
| Detached | post 2006 | 101.61 | 2 | CLG Zero C. RIA (Hurstwood) |
| Semi | post 2006 | 76.32 | 2 | CLG Zero C. RIA (Wessex) |
| End | post 2006 | 76.32 | 2 | CLG Zero C. RIA (Wessex) |

| House Type | Age | Floor Area ($m^2$) | Storeys | Sources |
|---|---|---|---|---|
| 1 bed flat | post 2006 | 43.4 | 5 | Energy Saving Trust NBO Sirocco |
| 2 bed flat | post 2006 | 76.6 | 5 | Energy Saving Trust NBO Sirocco |
| 3 bed flat | post 2006 | 100.9 | 5 | Energy Saving Trust NBO Sirocco |

Table 42 Commercial building types basic assumptions.

| Commercial building type | Floor Area ($m^2$) | Storeys |
|---|---|---|
| General office | 1000 | 4 |
| High street agency | 200 | 1 |
| General retail | 400 | 1 |
| Large non-food shop | 500 | 1 |
| Small food store | 500 | 1 |
| Large food store | 7000 | 1 |
| Restaurant | 250 | 1 |
| Bar, pub or licensed club | 500 | 1 |
| Hotel | 5000 | 6 |
| Cultural activities | 500 | 3 |
| Entertainment halls | 300 | 1 |
| Swimming pool centre | 1000 | 1 |
| Fitness and health centre | 500 | 2 |
| Dry sports and leisure facility | 150 | 1 |
| Covered car park | 500 | 5 |
| Public buildings with light use | 200 | 3 |
| Schools and seasonal public buildings | 6000 | 2 |
| University campus | 500 | 2 |
| Clinic | 200 | 2 |
| Hospital; clinical and research | 500 | 2 |
| Long term residential | 500 | 2 |
| General accommodation | 500 | 2 |
| Emergency services | 500 | 1 |
| Laboratory or operating theatre | 500 | 1 |

| Commercial building type | Floor Area ($m^2$) | Storeys |
|---|---|---|
| Public waiting or circulation, e.g. local station or mall | 500 | 1 |
| Transport terminal, e.g. airport | 500 | 1 |
| Workshop | 1000 | 1 |
| Storage facility | 10000 | 1 |
| Cold storage | 500 | 1 |

Table 43 Commercial building energy demand splits – regulated and unregulated.

| | Benchmarks | | | Assumptions for splitting benchmarks | | | |
|---|---|---|---|---|---|---|---|
| | All Fossil | All Electric | ALL $CO_2$ | a) Assumed % All Electric' (Regulated) | b) Assumed % All Electric' used for space heat (where no Gas) | c) Assumed % All Fossil' used for DHW | d) Assumed % All Electric' used for DHW (where no Gas) |
| | $kWh/m^2$ | $kWh/m^2$ | $kgCO_2/m^2$ | % | % | % | % |
| General office | 120 | 95 | 75.1 | 30% | - | 20% | - |
| High street agency | 0 | 140 | 77 | 60% | 20% | 15% | 10% |
| General retail | 0 | 165 | 90.8 | 60% | 20% | 20% | 10% |
| Large non-food shop | 170 | 70 | 70.8 | 30% | - | 15% | - |
| Small food store | 0 | 310 | 170.5 | 60% | 20% | 20% | 10% |
| Large food store | 105 | 400 | 240 | 30% | - | 20% | - |
| Restaurant | 370 | 90 | 119.8 | 30% | - | 25% | - |
| Bar, pub or licensed club | 350 | 130 | 138 | 30% | - | 25% | - |
| Hotel | 330 | 105 | 120.5 | 30% | - | 20% | - |
| Cultural activities | 200 | 70 | 76.5 | 30% | - | 20% | - |
| Entertainment halls | 420 | 150 | 162.3 | 30% | - | 15% | - |
| Swimming pool centre | 1130 | 245 | 349.5 | 30% | - | 20% | - |
| Fitness and health centre | 440 | 160 | 171.6 | 30% | - | 20% | - |
| Dry sports and leisure facility | 330 | 95 | 115 | 30% | - | 20% | - |

| | Benchmarks | | | Assumptions for splitting benchmarks | | | |
|---|---|---|---|---|---|---|---|
| | All Fossil | All Electric | ALL $CO_2$ | a) Assumed % All Electric' (Regulated) | b) Assumed % All Electric' used for space heat (where no Gas) | c) Assumed % All Fossil' used for DHW | d) Assumed % All Electric' used for DHW (where no Gas) |
| | $kWh/m^2$ | $kWh/m^2$ | $kgCO_2/m^2$ | % | % | % | % |
| Covered car park | 0 | 20 | 11 | 60% | 20% | 0% | 10% |
| Public buildings with light use | 105 | 20 | 31 | 30% | - | 15% | - |
| Schools and seasonal public buildings | 150 | 40 | 50.5 | 30% | - | 20% | - |
| University campus | 240 | 80 | 89.6 | 30% | - | 20% | - |
| Clinic | 200 | 70 | 76.5 | 30% | - | 20% | - |
| Hospital; clinical and research | 420 | 90 | 129.3 | 30% | - | 20% | - |
| Long term residential | 420 | 65 | 115.6 | 30% | - | 20% | - |
| General accommodation | 300 | 60 | 90 | 30% | - | 20% | - |
| Emergency services | 390 | 70 | 112.6 | 30% | - | 20% | - |
| Laboratory or operating theatre | 160 | 160 | 118.4 | 30% | - | 20% | - |
| Public waiting or circulation, e.g. local station or mall | 120 | 30 | 39.3 | 30% | - | 15% | - |
| Transport terminal, e.g. airport | 200 | 75 | 79.3 | 30% | - | 15% | - |
| Workshop | 180 | 35 | 53.5 | 30% | - | 10% | - |
| Storage facility | 160 | 35 | 49.7 | 30% | - | 10% | - |
| Cold storage | 80 | 145 | 95 | 30% | - | 20% | - |

### C.8 Assumptions for Renewable and Low Carbon Energy Packages

The model has been constructed to test different policy options and select the least cost technology option to meet the different policy requirements.

**Energy Efficiency Level 1 (EE1)**

| | | |
|---|---|---|
| Buildings applied | All residential buildings and all commercial buildings | |
| Modelled or assumed savings | Energy savings<br>Modelled<br>Existing residential units:<br>- Pre 1919 – 20% saving on heat demand (regulated)<br>- 1919-1975 – 15% saving on heat demand (regulated)<br>- Post 1975 – 10% saving on heat demand (regulated)<br>New residential units:<br>- Package of measures designed to deliver a 15% - 20% reduction in the DER relative to TER (Part L 2006).<br>- Savings are split across regulated heat and regulated power – as modelled.<br>Assumed<br>Commercial:<br>- Between 5 – 15% (depending on building type) reduction in fossil fuel demand where fossil fuel used for heating and hot water.<br>- Between 5 – 10% (depending on building type) reduction in electricity use where electricity is used for heating and hot water. | AP 2005<br>AECOM |
| Costing assumptions | £15/m$^2$ residential<br>£20/m$^2$ commercial | From unpublished work undertaken by AECOM for Energy Savings Trust |

| **Energy Efficiency Level 2 (EE2)** | | |
|---|---|---|
| Buildings applied | All residential buildings and all commercial buildings | |
| Modelled or assumed savings | Energy savings<br>Modelled<br>Existing residential units:<br>- Pre 1919 – 30% saving on heat demand (regulated)<br>- 1919-1975 – 25% saving on heat demand (regulated)<br>- Post 1975 – 20% saving on heat demand (regulated)<br>New residential units:<br>- Package of measures designed to deliver around a 25% reduction in TER relative to TER (Part L 2006).<br>- Savings are split across regulated heat and regulated power – as modelled.<br>Assumed<br>Commercial:<br>- Between 7 – 21% (depending on building type) reduction in fossil fuel demand | SAP 2005<br>AECOM |

| | | |
|---|---|---|
| | where fossil fuel used for heating and hot water.<br>- Between 7 – 14% (depending on building type) reduction in electricity use where electric used for heating and hot water. | |
| Costing assumptions | £30/m$^2$ residential<br>£40/m$^2$ commercial | From unpublished work undertaken by AECOM for Energy Savings Trust |

| Solar Water Heating | | |
|---|---|---|
| Buildings applied | Residential buildings only. | |
| Technology sizing assumptions | Assumed to deliver 50% Domestic Hot Water. Domestic Hot Water consumption in homes taken from SAP (1). SAP models were run using data from the English House Condition survey for existing homes. For commercial buildings hot water use has been assumed at 20% of the fossil fuel benchmark (2).<br>Evacuated tube Solar Water Heating panels assumed to deliver 520kW per m$^2$ panel (3) | 1. SAP 2005<br>2. CIBSE TM46<br>3. Ofgem |
| Costing assumptions | Evacuated tube system assumed to be £1000 per m$^2$.<br>**Note:** Full system cost including hot water storage tanks etc | Supplier quotes |

| PV – minimum installation | | |
|---|---|---|
| Buildings applied | All residential buildings plus all commercial buildings | |
| Technology sizing assumptions | Assumed kWp taken to be ¼ of maximum possible panel based on the assumed roof areas<br>Panel area assumed to be 7m$^2$/kWp<br>Assumed output to be 800kWhkWp | SAP 2005<br>Supplier data |
| Costing assumptions | Assumed to be £6000 per kWp<br>**Note:** Full system cost including invertors etc | Supplier quotes (2004 – 2008). |

| PV – medium installation | | |
|---|---|---|
| Buildings applied | All residential buildings plus all commercial buildings | |
| Technology sizing assumptions | Assumed kWp taken to be ½ of maximum possible panel area based on the assumed roof areas<br>Panel area assumed to be 7m$^2$/kWp<br>Assumed output to be 800kWh/kWp | SAP<br>Supplier data |
| Costing assumptions | Assumed to be £5500 per kWp. | Supplier quotes (2004 – |

| | | |
|---|---|---|
| | **Note:** Full system cost including invertors etc<br>**Note:** Costs fall as system size gets larger. | 2008). |

| **PV – maximum installation** | | |
|---|---|---|
| Buildings applied | All residential buildings plus all commercial buildings | |
| Technology sizing assumptions | Assumed kWp taken to be maximum possible panel area based on the assumed roof areas<br>Panel area assumed to be $7m^2$/kWp<br>Assumed output to be 800kWh/kWp | SAP<br>Supplier data |
| Costing assumptions | Assumed to be £5000 per kWp.<br>**Note:** Full system cost including invertors etc<br>**Note:** Costs fall as system size gets larger. | Supplier quotes (2004 – 2008). |

| **Biomass Heating** | | |
|---|---|---|
| Buildings applied | New (post 2006) residential and post 2006 commercial buildings only. Different assumptions for new detached and semi detached homes. | |
| Technology sizing assumptions | Biomass assumed to meet 80% of total heat demand, remainder met by gas.<br>Biomass boiler efficiency assumed to be 76%<br>Biomass demand based on energy generation of 3.85kWh/kg based on woodchips at 22% Moisture Content<br>System size per unit assumed to be 50% of peak demand based on $60W/m^2$<br>Detached and semi detached homes are assumed to be fitted with a 10kW individual boiler. Terraced houses and flats assumed to be part of a communal system | AECOM<br>BSRIA 'rules of thumb'<br>Supplier data |
| Costing assumptions | £1020 per kW accounting for boiler, civils and communal heating infrastructure<br>For the detached and semi detached homes – cost assumed £10,000 per dwelling for an individual boiler.<br>**Note:** Costs exclude civils work in connection with the biomass installation – i.e. plant room, fuel storage room etc | Supplier quotes (2004 – 2008).<br>Department for Children, Schools, Families |

| **Ground Source Heat Pumps** | | |
|---|---|---|
| Buildings applied | New (post 2006) residential and post 2006 commercial buildings only. Different assumptions for new detached and semi detached homes. | |
| Technology sizing | Replacing 90% efficient gas boiler (expect for in the case of commercial buildings | SAP 2005 |

| | | |
|---|---|---|
| assumptions | which have no gas demand in the base case and are assumed all electric)<br><br>COP of 3.2 assumed for space heating<br><br>COP of 2.24 assumed for water heating<br><br>System sized to meet peak heat demand - based on $60W/m^2$<br><br>Detached and semi detached homes are assumed to be fitted with an individual heat pump of 10kW. Terraced houses and flats assumed to be part of a communal system | BSRIA 'rules of thumb' |
| Costing assumptions | GSHP costs of £2000 per kW installed.<br><br>**Notes:** Costs exclude costs for ground testing and for laying ground loops either horizontally or vertically.<br><br>Heat pumps provide heating and hot water and therefore often negate the need for a gas connection to the building. Given the strategic nature of this study this is assumed to be covered within the cost benchmark above. | Supplier quotes (2004 – 2008). |

| **Air Source Heat Pumps** | | |
|---|---|---|
| Buildings applied | All residential buildings and all commercial buildings | |
| Technology sizing assumptions | Replacing 90% efficient gas boiler (expect for in the case of commercial buildings which have no gas demand in the base case and are assumed all electric)<br><br>COP of 2.5 assumed for space heating<br><br>COP of 1.75 assumed for water heating<br><br>Assumed all individual systems for residential | SAP 2005<br><br>BSRIA 'rules of thumb' |
| Costing assumptions | Residential – £6000 per system<br><br>Commercial – £800 per kW | Supplier quotes (2006 – 2008). |

| **Gas fired CHP** | | |
|---|---|---|
| Buildings applied | New residential and new commercial buildings only. | |
| Technology sizing assumptions | 60% heat from CHP, 40% from gas fired boilers<br><br>Distribution loss factor: 5%<br><br>CHP Electrical Generation Efficiency assumed to be 33%<br><br>CHP Heat Generation Efficiency assumed to be 45%<br><br>System sized to meet 50% peak thermal demand, assumed to be $60W/m^2$. | AECOM<br><br>SAP 2005<br><br>Supplier system efficiencies<br><br>BSRIA 'rule of thumb' |
| Costing assumptions | Residential: £5000 per dwelling for fixed cost of district heating infrastructure plus £2000 per kWe.<br><br>Commercial: Fixed cost of £20/$m^2$ (floor area) for district heating infrastructure plus | Supplier quotes (2006 – 2008).<br><br>The potential and costs of |

| | | |
|---|---|---|
| | £2000 per kWe. | district heating networks (Faber Maunsell & Poyry, April 2009) |

| Gas fired CHP plus Biomass top-up | | |
|---|---|---|
| Buildings applied | New residential and new commercial buildings only. | |
| Technology sizing assumptions | 60% of total heat requirements delivered by CHP<br>Remaining heat from biomass (80%) and gas fired boilers (20%)<br>Distribution loss factor: 5%<br>CHP Electrical Generation Efficiency assumed to be 33%<br>CHP Heat Generation Efficiency assumed to be 45%<br>System sized to meet 50% peak thermal demand, assumed to be 60W/m$^2$. | AECOM<br>SAP 2005<br>Supplier system efficiencies<br>BSRIA 'rule of thumb' |
| Costing assumptions | Residential: £5000 per dwelling for fixed cost of district heating infrastructure plus £2000 per kWe.<br>Biomass boiler cost assumed to be £200 per kW<br>Commercial: Fixed cost of £20/m$^2$ (floor area) for district heating infrastructure plus £2000 per kWe. | Supplier quotes (2006 – 2008).<br>The potential and costs of district heating networks (Faber Maunsell & Poyry, April 2009) |

| Wind Turbines | | | |
|---|---|---|---|
| Buildings applied | All types of development (assumed free standing) | | |
| Technology sizing assumptions | Small wind turbine<br>Hub height = 15 metres<br>Rotor diameter = 9 metres<br>Rating = 15 kW<br>Capacity factor = 15% | Large wind turbine<br>Hub height = 80 metres<br>Rotor diameter = 80 metres<br>Rating = 2000 kW<br>Capacity factor = 27% | Small wind turbine data based on Proven 35<br>www.provenenergy.co.uk<br>Large wind turbine data from BWEA |
| Costing assumptions | Fixed cost of £50,886 for a small wind turbine.<br>Fixed cost of £1,600,000 for a large scale wind turbine. | | Supplier quotes (2006 – 2008). |

| Biomass CHP | | |
|---|---|---|
| Buildings applied | New residential and new commercial buildings only. | |
| Technology sizing assumptions | 60% heat from CHP, 40% from gas fired boilers | AECOM |

| | | |
|---|---|---|
| | Distribution loss factor: 5%<br><br>CHP Electrical Generation Efficiency assumed to be 25%<br><br>CHP Heat Generation Efficiency assumed to be 50%<br><br>Biomass demand based on energy generation of 3.85kWh/kg based on woodchips at 22% Moisture Content<br><br>System sized to meet 50% peak thermal demand, assumed to be 60W/m$^2$. | SAP 2005<br><br>Supplier system efficiencies<br><br>BSRIA 'rule of thumb' |
| Costing assumptions | Residential: £5000 per dwelling for fixed cost of district heating infrastructure, biomass fuel store etc plus £4000 per kWe.<br><br>Commercial: Fixed cost of £25/m$^2$ (floor area) for district heating infrastructure plus £4000 per kWe. | Supplier quotes (2006 – 2008). |

| Hydro | | |
|---|---|---|
| Buildings applied | All types of development (assumed freestanding) | |
| Technology sizing and costing assumptions | Archimedes double screw, 100kW installed capacity<br><br>Total installed cost of £262,600 | AECOM experience (Boat Slide Weir Hydro Planning report Phase I, Bedford Design Group, September 2009)<br><br>A guide to UK mini hydro developments, British Hydropower Association, June 2006 |

### C.9 Technology combination options

In addition to the 12 basic technology options outlined above, our model input sheet also includes a further 20 technology options made up from various combinations of the above. Allowable solutions are also introduced as a proxy technology measure to provide a way of using the model to help quantify money that could be raised using this mechanism.

For simplicity and because of the high level nature of the study – $CO_2$ savings and costs from the options outlined above are simply summed in the combined options. For example, where energy efficiency is specified with biomass boilers and PV, savings and costs from options 1, 5 and 7 above would be summed together. In actual fact the savings achieved from a range of measures would not be the sum of savings from three separate measures, however this approach is considered sufficiently robust for the purposes of this study. Combination options have been set up to group together only compatible technologies.

It was assumed that a basic level of energy efficiency should always be taken up – as a first step of a $CO_2$ reduction hierarchy, where low carbon energy supply and the use of renewable technologies come later in the hierarchy. Therefore savings from renewable technologies in the LZC sheet were calculated against the buildings where EE1 was already applied. Costs for the basic energy efficiency improvements have been added together with the cost of the LZC technology for every option, except where the advanced energy efficiency standard is applied.