Delta Energy & Environment Ltd
Registered in Scotland: No SC259964
Registered Office: 15 Great Stuart Street, Edinburgh, EH3 7TS

Low Carbon Energy Delivery in Tunbridge Wells Borough

Delivering the Opportunities

July 2009

Introduction

Local Authorities can play a major role in reducing greenhouse gas emissions and combating climate change. Today there is an expanding range of options available to ensure that these goals can be achieved. This is as a result of:

- The development of new low carbon products, technologies and services – including decentralised energy (DE) systems
- New policy initiatives and energy market regulatory reform
- Changing energy company strategies and offerings

In light of this, Tunbridge Wells Borough Council has a wide range of initiatives currently underway. This is also in response to the plethora of climate change and renewable energy policies at the national and regional level.

The Council has acknowledged that in order to maximise the benefits of its initiatives, there is a need for a more co-ordinated and focused approach. The development of a low carbon strategy would help to bring this about. To this end the Council commissioned Delta Energy and Environment to undertake this study to:

- Identify some of the main opportunities available to reduce carbon emissions in the Borough
- Identify the most effective strategic options to deliver these opportunities

The findings of the study will inform the development of the Borough's low carbon strategy.

The Opportunities

We have identified a number of different opportunities open to the Council to help it achieve its emission objectives. A principal opportunity lies in **energy efficiency in existing development**, in particular since around 87% of today's buildings will still be present, forming about 70% of the building stock, in 2050. Insulation (cavity wall and loft) yields significant CO2 savings when compared with other measures (Section 5.3).

Other opportunities relate to planned future development. Here, a key technology for implementation is **biomass heating**, at both building and community levels. Biomass-based combined heat and power (CHP) is also an important technology for consideration in the medium to long terms, when the technology is proven. And for community schemes (district heating), we have highlighted the possibility of linkage with existing development.

Delivering the Opportunities

There are a variety of delivery mechanisms available to the Council. This study made the following recommendations based on the Council's appetite for risk and innovation:

Recommendation 1: Grant schemes, revolving loans and council tax discounts (Council-led Initiatives)

A step change is likely to be required in the levels of funds made available if energy efficiency is to be improved significantly. As resources are limited, we recommend exploring alternative arrangements regarding grant funding (e.g. repayable grants or council tax discounts) to maximise the potential of funds available.

Recommendation 2: Bulk purchase of products (Local Authority Partnerships)

Through bulk purchase, technologies and products are made available to property owners at discounted prices. There are, however, potential difficulties in quantifying future demand and storage of products. We therefore recommend that the Council explores potential partnership with neighbouring authorities to ensure that there is sufficient demand to justify the arrangements. An alternative would be to arrange discount schemes with manufacturers/suppliers.

Recommendation 3: Development of a register/directory of suppliers and installers (Local Strategic Partnerships)

Developing links and partnerships with suppliers and installers will help promote access to discounted products. This can be arranged through the Economic Development department via existing liaison channels with local businesses. To ensure reliability of products, requirements should be put in place for those suppliers/installers wishing to be on the Council's register (e.g. accreditation under the Low Carbon Buildings Programme).

Recommendation 4: Alternative Planning Policies

Alternative arrangements for delivering opportunities through planning requirements may be more appealing to developers. The two approaches that the Council could consider are as follows:

- **Community Infrastructure Levies or Allowable Solutions** (as proposed under the consultation on the definition of zero carbon) can be used to fund development of low carbon solutions at a community level. These can also be arranged as carbon offset funds into which developers pay to supplement the grant schemes and council tax discounts discussed in Section 7.2.
- Where developments have high energy standards, **lower land receipts** from developers can be negotiated.

Recommendation 5: Establishing an ESCo

This recommendation underpins all the others. For focused, coordinated delivery of the opportunities in the Borough, the most appropriate approach is through an ESCo. We recommend that the Council investigates the establishment of a borough-wide ESCo for the delivery of all the opportunities identified through this study and any future ones.

Given that a public-private partnership already exists with John Laing, we also recommend the possible establishment of a new arm of the Regeneration Company which will act as the borough-wide ESCo. Given the Council's appetite for risk and innovation, this approach would be appropriate as it:

- Allows the Council to take the lead and maintain control while maintaining a degree of separation for effective management
- Ensures close alignment of the ESCo's activities with strategic objectives
- Allows the Council to accept lower discount rates and thereby pass on lower costs to customers.

Going Forward

The outcomes of this study provide the Council with the foundation to develop and take forward a low carbon strategy. The next crucial step will be to develop challenging but achievable goals for the strategy. The key requirement is that the goals achieve a low carbon performance that goes *beyond* business-as-usual (as required by regulation). Importantly, this goal needs to be supported by a robust baseline (e.g. energy demand profiles by sector, load curves (to differentiate between base and peak demand), and housing conditions) which will need to be established on the basis of the high-level estimates provided in this report.

To turn this goal into a strategy it will be necessary to:

- Consolidate the policy framework and review internal institutional arrangements
- Identify and consult with the diverse array external partners
- Identify funding/finance opportunities
- Develop a programme of action, in part on the basis of the findings of this report, to deliver the goals.

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Contents

1 Introduction: Why Low Carbon Energy Delivery?

Local Authorities can play a major role in reducing greenhouse gas emissions and combating climate change. Today there is an expanding range of options available to ensure that goals can be achieved. This is as a result of:

- The development of new products, technologies and services – including decentralised energy (DE) systems
- The emergence of business models well-suited to local authority applications
- New policy initiatives and energy market regulatory reform
- Changing energy company strategies and offerings

With these changes and new opportunities comes a diverse range of different options available to Tunbridge Wells Borough Council, and a potentially complex series of decisions that need to be taken. To enable the Council to make these decisions, the following are necessary:

- Understanding of the different options available
- Simplification of the complexities surrounding the options and issues
- Mechanisms to enable development and implementation of the right low carbon strategy to ensure that emissions goals can be achieved successfully and in a cost-effective manner

To this end, the Borough Council of Tunbridge Wells appointed Delta Energy & Environment to carry out this study to provide a clear understanding of:

- The options available to reduce carbon emissions in the Borough.
- The most effective strategic options available to implement these opportunities.

The time-frames for consideration of strategy implementation will be the short-term (1 to 5 years) and medium-term (5 to 15 years).

This is a report of findings which sets out the policy and activities context, describes the sustainable energy resources available in the Borough, identifies opportunities for sustainable energy development and identifies options for a low carbon strategy for the Borough.

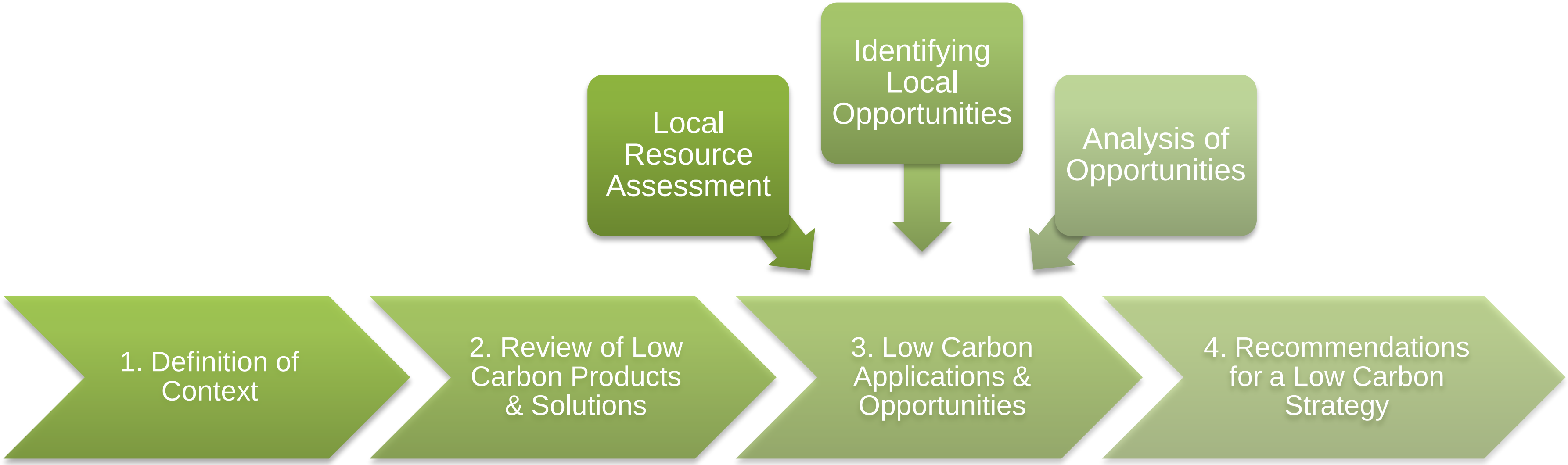
To assist the Council in taking forward the findings from this study, next steps are outlined in Section 8.

2 Methodology: How have the objectives been achieved?

As shown in the diagram below the approach to delivering the objectives of the study was as follows:

1. Define the context – including the Council's current low carbon activity, its obligations, aspirations and its appetite for innovation / risk.
2. Review of the low carbon products and solutions available to the Council – with an emphasis on decentralised energy.
3. Identify the main low carbon applications and opportunities for the Council.
4. Develop recommendations for strategic options available to the Council to implement these opportunities.

For point 3 above, detailed methodologies are provided for each element in the relevant sections of this report.



3.1 National Drivers for Local Action

Climate Change Act 2008

- This Act includes provision for a legally binding emissions reduction of between 26% and 32% by 2020, 5 year rolling targets and the establishment of a new independent body to oversee progress.
- Implementation of these targets will be at the local level and therefore there are implications for local authorities. Targets already exist at regional and county levels and these will need to be reviewed in light of this Act.
- The PPS1 Supplement on Planning and Climate Change (discussed below) , sets out a framework to guide local planning authorities in delivering these objectives.

Energy Act 2008

- The Act implements the Energy White Paper and is built on the two headline themes of climate change and energy security.
- Key elements of relevance to Tunbridge Wells include the following:
  - Feed-in Tariffs: generators will receive a guaranteed payment for generating low carbon electricity
  - Renewable Heat Incentives: which will provide financial support for renewable heat, from large industrial sites down to the household level
- Both of these aspects will have positive financial implications for schemes developed in the Borough, although, at present, the level of impact is uncertain.

Supplement to PPS1 (2007)

- The Supplement on Planning and Climate Change, together with PPS 3and 22, establishes a robust framework for tackling climate change and delivering more sustainable decentralised energy through planning.
- The Supplement highlights the need for local planning authorities to have an evidence-based understanding of the local feasibility and potential for renewable and low-carbon technologies to supply new development.
- This study will provide an indication of the potential an feasibility. However a robust evidence base will be required to support this high level review.

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3.1 National Drivers for Local Action (…contd)

PPS22 and Companion Guide (2004)

- PPS22 sets out the Government's policies for renewable energy, to which planning authorities should have regard when preparing local development documents and when taking planning decisions. The Companion Guide discusses the planning and development of renewable energy schemes across England
- The guidance is specific to large scale, stand alone renewable energy projects. Although the drive is to encourage development of renewable energy generation, the PPS and Companion Guide are intended to ensure the appropriate development of such schemes.

Local Government White Paper (2006)

- The White Paper highlights the important role of local authorities in coordinating reductions in CO_2 emissions in their communities. Climate change is one of seven key challenges and the White Paper calls for Local Area Agreements setting out climate change targets and supported by Sustainable Community Strategies. The Council has already signed up to the local area agreement between Kent local authorities.
- The White Paper establishes 200 National Indicators which the Council is already reporting on.

Building a Greener Future (2007)

- The Government has set out its ambition that all new UK homes should be zero carbon by 2016.
- The "Building a Greener Future" policy statement sets out a staged approach to achieving the zero carbon homes objective: 2010 to a 25% improvement in the energy/carbon performance set in Building Regulations; in 2013 a 44% improvement; and zero carbon in 2016. We said that zero carbon means that, over a year, the net carbon emissions from all energy use in the home would be zero.

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3.1 National Drivers for Local Action (…contd)

Code for Sustainable Homes (2008)

- Introduced together with the "Building a Greener Community" Policy Statement (discussed above), the Code sets standards for energy and carbon as well as other sustainability issues in buildings such as water, waste and materials. One of the objectives is that by 2016, all new homes should be zero carbon. The Council can therefore put measures in place ahead of requirements becoming mandatory, thus capturing more of the new development to be delivered in the Borough.
- In the short term compliance is voluntary, although it is mandatory for publicly funded development. This has implications for developments delivered through the Tunbridge Wells Regeneration Company.

Heat & Energy Saving Strategy (Consultation Draft) 2009

- Sets out the four objectives of the Government's strategy for saving energy and decarbonising heating, now and into the future. The document focuses on reducing emissions from the existing building stock, primarily people's homes which account for over a quarter of the UK's CO_2 emissions.
- The Document proposes a community-based approach such as the Community Energy Savings Programme beyond the CERT programme. Also discussed are the Renewable Heat Incentive and Feed-in Tariffs. All of these proposals will have positive implications for the uptake of renewable and low carbon technologies. The economics of developing low carbon energy generation will be improved although, the significance of the implications is unknown at present.

3.2 Regional/County Level Policy Drivers

The South East Plan (May 2009)

The South East Plan requires LDDs to expect and encourage high standards of energy efficiency & integration of renewable energy in all developments. It sets renewable energy targets for the region & all counties and requires local authorities to investigate and promote the use of biomass fuels.

The targets set out for Kent are as follows:

- By 2010 – 111MW
- By 2016 – 154MW

Kent Local Area Agreement 2 (March 2008)

The Kent Local Area Agreement 2 identifies local priorities relating to four social and economic themes. Under these themes, it sets out 35 indicators selected from the National Indicator set of 198.(Doc 1- National Indicator Set). Included in these are National Indicators 165, 186, 187 and 188 which relate to climate change and energy. The Council has signed up to this agreement and therefore monitors and reports progress on these indicators.

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3.3 Local Planning & Strategies

Vision 2026

- Part of the Council's vision is to ensure that "all residential properties in the Borough … conform to the highest standards of sustainable resource conservation to minimise energy use, carbon footprint, fuel poverty and water consumption".
- Also that "the borough will have locally derived renewable energy sources to reduce CO_2 emissions including biomass, ground and air source energy, together with wind and solar sources where compatible with other environmental considerations".
- The Council will also endeavour to reduce its own use of resources and its carbon footprint.

Local Plan 2006

- One of the aims set out in the Local plan is to "encourage energy efficiency and the conservation of finite or non-renewable energy resources, and reduce the emission of greenhouse gases through the location, layout, materials and design of development".
- All new development proposals will need to take account of the efficient use of energy.

LDF Core Strategy Submission Document (April 2009)

- The Core Strategy is an emerging document and does not at this stage carry weight in planning decisions. It highlights that climate change is a significant challenge for the Borough. As such two of the sustainability objectives of the Strategy are to "conserve, wherever possible, finite non-renewable resources, including … energy …" and to "ensure development gives full consideration to design principles, including energy efficiency…".
- Under this Strategy, all developments will be expected to "have regard to, and contribute towards, South East Plan renewable energy and energy efficiency targets, to meet carbon reduction targets".
- The Core Strategy takes into account the Borough's Low Carbon Strategy and also indicates that energy related businesses have a role to play in the economic development of the Borough.

3.3 Local Planning & Strategies (…contd)

Environment Strategy 2005 - 2010

- In relation to resource use and climate change, the Strategy indicates that Council action in the past focused on energy conservation. The Strategy objectives, however are much broader and include the need to reduce use of energy generated from fossil fuels; promote and raise awareness of conservation and improved efficiency use of resources; support the appropriate use and generation of energy from renewable sources; and promote sustainable building design and construction.

Service Plan 2009-12

- The plan includes the need for Council departments to carry out full climate change risk assessments. These assessments will fulfil requirement under the National Indicator 188 – *Adaptation to Climate Change*.
- This indicator is designed to help local authorities ensure that they are prepared to manage risks to service delivery, the public, local communities, local infrastructure, businesses and the natural environment from a changing climate, and to make the most of new opportunities

Housing Strategy 2006-2011

- The Strategy indicates that the average SAP rating for a dwelling in Borough was recorded to be 50 (where the national average is 51). An estimated 19% of dwellings have a SAP rating below 40, compared to only 9% nationally. 3,839 (8.5%) of households are fuel poor. The Strategy highlights that there is still much to be done to improve home energy efficiency and tackle fuel poverty within the borough.
- A number of initiatives are underway to address these two issues in existing housing stock and in new developments.

3.3 Local Planning & Strategies (…contd)

SPD on Renewable Energy (2007)

- The SPD provides guidance on small scale renewable energy generation that can be integrated into building design. It provides information on the technologies available and how developers and householders can integrate renewable energy within new developments and conversions. This document is intended principally for those submitting planning application and their agents, together with planning officers who will be able to apply it in determining applications.

Carbon Management Action Plan 2006

- The Action Plan sets out activities to develop and enhance the Council's role towards efficient energy usage and therefore carbon management. It presents a structured approach focusing on the areas of the Council's own estate, private housing, social housing, transport and the wider community.
- Progress against the actions set out in the Action Plan were reviewed in 2008. The review indicates that a number of actions are still ongoing and some are outstanding. Elements of the Action plan have now been updated.

3.4 Local Initiatives and Projects

Within the context of policies and strategies identified above, a variety of initiatives and projects are underway within the borough. These are highlighted below and detailed in preceding sections where they are integrated into the assessment of opportunities within the Borough.

Initiatives – Reducing CO_2 emissions and improving energy efficiency:

- *One-to-One support from the Energy Saving Trust* – to help the Council reduce its carbon footprint as a business and in the community
- *Forestry Commission* – an initial feasibility study was undertaken to determine potential demand for wood fuel in the County. The aim is to managing woodland through use of wood fuels.
- *Mapping of wood fuel boilers (2008)* – the High Weald AONB Unit has mapped the location of wood fuel boiler installations across the Borough
- *Transition towns* – the Transition Tunbridge Wells Energy Groups seeks to work with the Council to establish current knowledge about Tunbridge Wells' carbon footprint and what needs to be done to meet targets set out in national and regional policy.
- *Fuel Poverty Activities* – provision of grants under the Housing Strategy for housing renewal and energy efficiency improvements (see Section 6).

Projects and Installations:

- *North Farm Depot* – the Council has developed a new depot north of Tunbridge Wells. Onsite renewable energy generation will be integrated with the development. A study has been commissioned to look at the options and funding opportunities.
- *Biomass CHP at Council Buildings* – a number of options are being explored for the installation of a wood boiler in Council properties. A variety of business models are being considered for the installation.
- *SEWF Biomass Study* – identified suitable sites for use by TWBC as wood chip (for fuel) production facility and for the storage and processing of green wood by-product for composting. The intended source material for this is wood from TWBC's own woodland and parks management and from tree surgeons working on behalf of TWBC.
- *Renewable energy opportunities in Kent schools* – a county-wide renewable energy assessment of a selection of schools was undertaken, focussing on schools which currently have boilers at the end of their life and considered replacement with biomass. A final list of forty-five sites was taken forward for further investigation. 22 schools (one of which is in Tunbridge Wells) were found to be both technically and economically feasible for wood fuel heating, while potential for solar was high for most schools and wind was found feasible for those in remote locations.

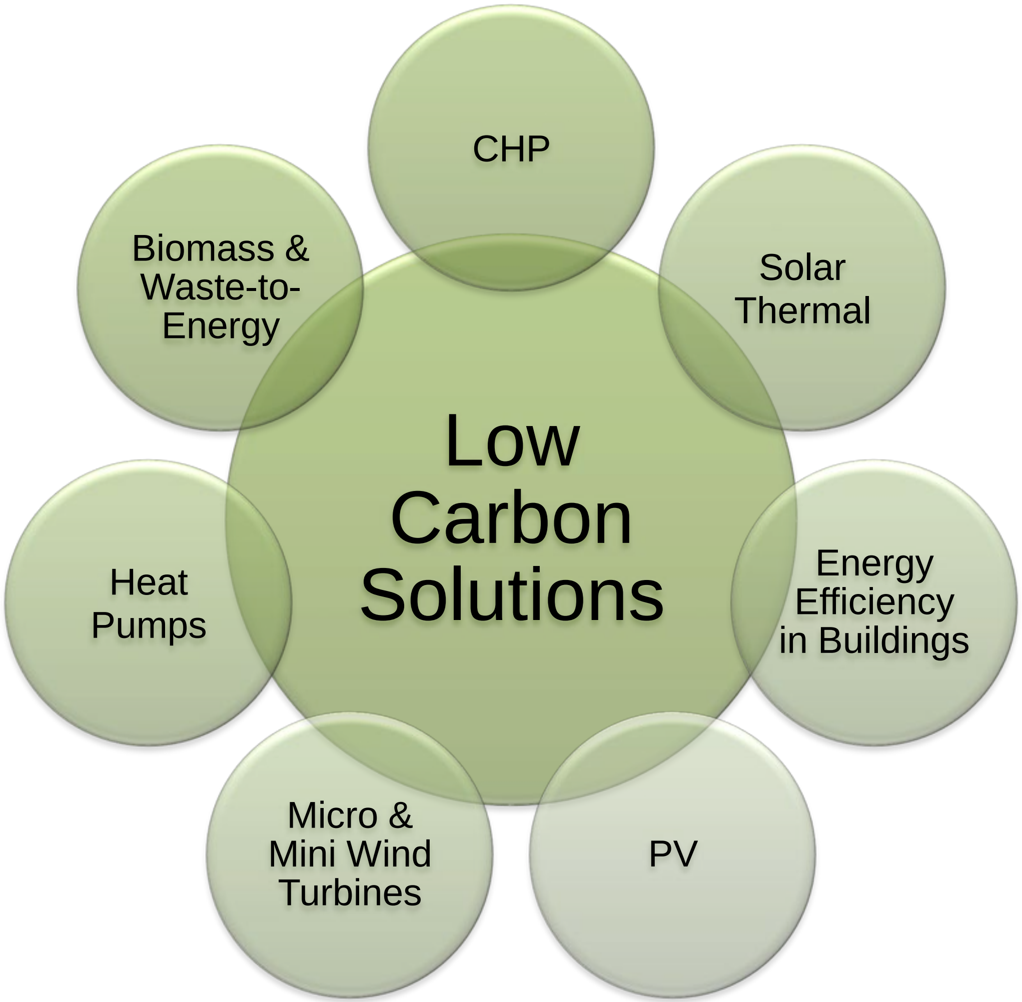

Figure 4.1: Relevant Technologies for Tunbridge Wells Borough

4.1 Technologies discussed in this report

From a wide selection of renewable technologies, this report considers only those shown here. These technologies are chosen on the basis of maturity and proven effectiveness elsewhere.

The Table 4.1 overleaf provides a summary of the following for each of these technologies:

- Indicative CO_2 savings
- Indicative installed costs
- Typical lifetime
- Simple payback
- Lifetime cost of CO_2 saved

Annex A provides the detailed assessment of each of these technologies, providing an overview of the technology status, key applications and costs where possible.

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Table 4.1: Summary of Technologies Assessed (Please refer to Annex A for assumptions and sources used for the values in this table)

Technology	Indicative annual CO_2 saving	Indicative installed cost	Typical lifetime	Simple payback	Lifetime cost of carbon saved per tCO_2
Combined heat and power					
Micro-CHP	~850 kg / home	£3,500 – £11,000 /kWe	~15 yrs	3 – 4 yrs (4,7)	£40 – £60 (4)
Packaged & district heating CHP*	~280 t (100 kWe)	£750 - £1,000 / kWe	~15 yrs	4 – 5 yrs (iii)	£80 – £250 (3,5,6)
Energy-efficiency in buildings					
Loft insulation (up to 270 mm)	~800 kg / home	£150 - £250 / home	~40 yrs	~2 yrs (i)	~£10 (1)
Solid wall insulation	~2 t / home	Up to £15,000 / home	~30 yrs	~14.2 yrs (2)	~£111 (1)
Cavity wall insulation	~610 kg / home	~£250 / home	~40 yrs	~2 yrs (i)	~£14 (1)
Photovoltaics	1 – 1.2 t / home	£5,000 - £7,500 / kWp	~25 yrs	48 – 63 yrs (2,4)	£265 – £1,000 (4,6)
Solar thermal (displacing natural gas)	~325 kg / home	£3,000 - £5,000 / home	~25 yrs	~50 yrs (2,4)	£180 – £438 (1,3,4,5,6)
Heat pumps (Ground-source)	850 kg – 1.2 t / home	£1,000 – 1,500 / kW_{th}	~20 yrs	~20 yrs (4)	£44 – £520 (4,5,6)
Biomass and waste-to-energy					
Solid biomass boiler (domestic, displacing natural gas)	Up to 3.75 t / home (8)	£500 - £1,000 / kW_{th}	~20 yrs	~45 yrs (4)	£60 – £102 (3,4,5,6)
Biomass boiler (commercial/industrial/DH, displacing natural gas)*	~1.75 t/kW_{th} (8)	~£615 / kW_{th}	~15 yrs	N/A	£80 - £150
Anaerobic digestion	Up to 34 t (100 kWe)	~£5,000 / kWe	~20 yrs	10 – 12 yrs (iii)	~£140 (5)
Mini wind turbines	Up to 17 t (25 kWe)	£3,000 – £4,000 / kWe	~20 yrs	13 – 26 yrs (2,4)	£150 – £355 (3,4,6)

* Indicative costs for CHP and biomass boiler projects do not include heat network costs of £910/m as these are very site specific.

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4.2 Appropriate Technologies for Tunbridge Wells

On the basis of the resource assessment (detailed in Annex A), the low carbon solutions that would be technically appropriate for Tunbridge Wells are shown in Table 4.2 below.

Table 4.2: Appropriate Technologies for Tunbridge Wells

Technology	Technical Opportunity?	Justification
Combined heat and power & District Heating	✓	• Potential for integration with planned development
Biomass and waste-to-energy	✓	• Biomass resource is widely available. • Biomass boilers are easily retrofitted. • Landfill gas and sewage are key resources for energy from waste
Energy-efficiency in buildings	✓	• A requirement as we move to zero carbon homes • Also easily retrofitted to existing buildings
Photovoltaics	✓	• The South of England has the highest solar irradiation in the UK. • Also easily retrofitted.
Solar thermal	✓	• The South of England has the highest solar irradiation in the UK. • Also easily retrofitted.
Heat pumps	✓	• Applicable only where gas is not the fuel displaced (30% of the Borough has no access to the gas network)
Micro and mini wind turbines	?	• The wind resource in the Borough is not optimal and much of the Borough is in the AONB. • There are some isolated opportunities.

5.1 Approach to Identifying the Opportunities

This section identifies the opportunities in the Borough for significant carbon savings in buildings. These savings can be achieved across a range of site types.

To identify the low carbon opportunities in the Borough, the building stock was analysed on a sectoral basis:

- *Existing stock:* This sector offers the largest volume opportunity for carbon savings. The majority of the building stock in 2050 will consist of buildings that exist today - a significant proportion of which have insufficient loft insulation and unfilled cavity walls.
- *New build residential:* Through the Code for Sustainable Homes, new build residential dwellings are required to meet minimum standards in efficiency. These standards are currently met through insulation and other efficiency measures. As we move towards 2016, when all new homes are to be zero-carbon, other energy measures need to be adopted to meet tighter standards. The opportunity for the Borough is therefore to achieve additional carbon savings in this sector through low/zero carbon microgeneration technologies.
- *Strategic Sites:* There are a number of sites in the Borough which offer a clear opportunity for integrated energy solutions, serving more than one dwelling. These sites offer a mix of uses (commercial, residential, industrial) that provide a more constant heat demand. A selection of strategic sites has been analysed in this report. The list is not exhaustive, but indicates the type of opportunities that the Council should seek to address in the future.
- *The Council Estate:* This sector also offers a clear opportunity to achieve significant carbon savings, as the Council has a direct say over how the buildings are managed.

The methodology for identifying opportunities on strategic sites (with the exception of existing stock opportunities) is set out in Figures 5.1 to 5.3 below. This methodology can be used by the Council to identify future strategic opportunities in the Borough.

The approach to determining the CO_2 savings opportunities in existing development across the Borough is detailed in Section 5.4.

5.1 Approach to Identifying the Opportunities

New Build Residential

Step 1: Identify Sites

- A review of the candidate sites set out in the SHLAA* was undertaken. This gave an indication of the potential for new development in the Borough. The potential for new build in the four main hubs of Tunbridge Wells was calculated to be around 4,860. Delta considers all of these dwellings suitable for decentralised energy solutions that would enable building standards to be exceeded.

Estimate Energy Demand

- As the size of each new potential dwelling is unknown, all new build is assumed to be an average three bedroom family home. There will be many larger and many smaller dwellings than this in the Borough, but this size dwelling will correspond broadly to the average.
- The overall energy (electricity and heat) demand was estimated based on benchmark figures for electricity and gas consumption (see table on Page 23)

Propose Suitable Solutions

- Based on the building type, non-suitable technologies were ruled out
- For new build residential, only individual home solutions were considered. Therefore, packaged and district heating CHP and anaerobic digestion were not considered.

Assess Possible Solutions

- Each technology was assessed in terms of its cost and CO_2 savings.

* It is appreciated that not all sites included in the SHLAA will be allocated in the LDF. The objective of including sites in the SHLAA is to inform the sites' allocation process by identifying those sites that present opportunities for low carbon solutions.

5.1 Approach to Identifying the Opportunities

Strategic Sites

Identify Sites

- The goal for this sector was to identify large developments with a mix of building types. These mixed sites offer a more steady heat demand , which would suit a larger, more community-based scheme such as district heating .
- A review of planning allocations in the current Local Plan was undertaken to identify any such mixed commercial or industrial developments.
- A review of the submitted sites set out in the SHLAA* was undertaken to identify larger residential developments, which could be linked in to a district heating scheme.
- Discussions were held with officers and other stakeholders to confirm the suitability of sites chosen and to identify any other key sites.

Estimate Energy Demand

- The floorspace suggested for each type of building use (e.g. office, retail) was determined.
- The overall energy (electricity and heat) demand was estimated based on benchmark figures for electricity and gas consumption (see table on Page 23)

Propose Suitable Solutions

- Based on the type of site and building type, non-suitable technologies were ruled out:
  - For larger commercial/industrial sites, our opinion is that the focus should be on larger district heating solutions as they offer the best CO_2 savings in these cases.
  - Anaerobic digestion CHP was only considered suitable for more industrial sites, where visual impact and transport of waste is less of an issue.

Assess Possible Solutions

- Each technology was assessed in terms of its cost and CO_2 savings.

* It is appreciated that not all sites included in the SHLAA will be allocated in the LDF. The objective of including sites in the SHLAA is to inform the sites allocation process by identifying those sites that present opportunities for low carbon solutions.

5 What are the opportunities in the Borough?

5.1 Approach to Identifying the Opportunities

Council Estate

Identify Sites

- The Council's asset register was consulted to identify suitable sites where carbon savings could be achieved.
- Suitable sites were limited: the Town Hall site and three leisure centres were identified as key opportunities.

Estimate Energy Demand

- The floorspace suggested for each type of building use was determined.
- The overall energy (electricity and heat) demand was estimated based on benchmark figures for electricity and gas consumption (see table on Page 23)

Propose Suitable Solutions

- Based on the type of site and building type, non-suitable technologies were ruled out.
- For larger commercial/leisure sites, our opinion is that the focus should be on larger district heating solutions as they offer the best CO_2 savings in these cases.

Assess Possible Solutions

- Each technology was assessed in terms of its cost and CO_2 savings.

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5.2 Assumptions Adopted for Quantifying New Opportunities

Energy Demand Benchmark Figures

To enable the quantification of opportunities, the benchmark figures shown below for various building types were used in our estimates.

Building Type[1]	Gas Consumption ($kWh/m^2/year$)	Electricity Consumption ($kWh/m^2/year$)
Residential[2]	18,200 (per home)	4,000 (per home)
Retail (department stores)	194	237
Retail (DIY stores)	149	127
Cinemas	515	135
Hotels	260	80
Industry (light manufacturing)	175	43
Primary Schools	126	20
Secondary Schools	136	24
Storage & Distribution	135	29
Supermarkets	200	915
Sports Facility (with pool)	360	150
Sports Facility (without pool)	215	75
Offices	150	55
Hospitals	414	41

1 All non-residential values are benchmark values published in1995 by the Energy Efficiency Office. These values will have changed since then, as buildings have become more energy efficient. Therefore, these values are taken to be the worst-case scenario.

2 Residential energy consumption data is according to the latest Ofgem average UK values (March 2009)

5.2 Assumptions Adopted for Quantifying New Opportunities (…contd)

CO_2 *Savings vs. Meeting Energy Demand*

Given that the Code for Sustainable Homes will be the overarching energy performance policy for all buildings by 2016 based on carbon emissions, we have quantified opportunities on the basis of potential carbon savings (CO_2 equivalent).

However, some current policies (such as the Merton Rule) take into account the *proportion of energy demand* met by low carbon solutions. For this reason, the indicative values of the proportion of energy demand met from a typical residential DE system have been taken into account. Our assumptions are shown below.

Technology	Proportion of Energy Demand Met		
	Electricity	Heat	Total Energy
Micro-CHP			~ 40%
Packaged CHP			~ 60%
District Heating CHP			60 – 70%
PV	50%		9%
Solar thermal		33[1]% hot water demand[2]	8%
Ground source heat pump		75%	60%
Pellet boiler		100%	80%

1 33% is the figure published by the Energy Savings Trust.

2 Hot water demand is assumed to constitute 25% of overall residential energy consumption (European Commission, 2000)

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5.2 Assumptions Adopted for Quantifying New Opportunities (…contd)

Rules of Thumb for District Heating and CHP

In sizing packaged CHP and large biomass boiler systems it has been assumed that they will meet 60% of the baseload heat demand. This is common practice deployed by project developers such as Ener.G and Cogenco.

For district heating (DH) systems (including natural gas CHP and biomass heat-only), the heat loads are more diverse, so we assume that 75% of baseload heat demand will be met.

Heat networks are assumed to have a cost of £910 / m as assumed by the 2007 Defra report on the *Analysis of the UK potential for Combined Heat and Power.*

Other assumptions made relating to DH/CHP systems are shown in the table below.

Other Assumptions	
Biogas CHP Costs	£1000/kWe
Biogas CHP Efficiencies	40% thermal
	30% electrical
Natural Gas CHP Efficiencies	40% thermal
	35% electrical
Natural Gas CHP Costs	£800/kWe
Heat Network Costs	£910/m

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5.3 Opportunities Identified

On the basis of the resource assessment and contextual information outlined in Section 3 and 4, Delta has identified 4 key opportunities (see below) for TWBC to deploy low carbon energy solutions. This section outlines the key CO_2 savings that can be achieved through these opportunities, while Annex B sets out the detailed assessment of each of the strategic sites.

The opportunities listed are by no means exhaustive. The methodology set out in Section 5.1 can be employed to identify future sites.

All CO_2 savings outlined here are based on informed approximations and would need to be validated through a full feasibility study.

Opportunity		Specific Sites	
1	Borough-wide opportunities for existing development	1.1	Town Centre
		1.2	Edge of Centre
		1.3	Industrial Hinterland
		1.4	Suburban Districts
		1.5	Rural Hinterland
2	Council-owned estate	2.1	Town Hall Site
		2.2	Tunbridge Wells Sports Centre
		2.3	Putlands Sports and Leisure Centre
		2.4	Weald Sports Centre
3	Integration of low carbon solutions in new residential developments	All sites listed in the Strategic Housing Land Availability Assessment (SHLAA) with the potential for housing	
4	Examples of strategic sites for DH/CHP schemes	2.1	North Farm & Knights Way
		2.2	Old Kent & Sussex Hospital Site
		2.3	Royal Victoria Place Shopping Centre
		2.4	Pembury Hospital
		2.5	Broadwater Lane

5.4 Existing Development

Introduction

87% of today's buildings will still be present forming about 70% of the building stock in 2050 (TSB & ESRC). This presents a significant opportunity for carbon emissions reduction in existing buildings if regional and national targets are to be met.

A variety of energy efficiency measures and low carbon energy technologies can be retrofitted to existing buildings to improve their carbon performance. These technologies include the following:

- *Energy efficiency measures* – cavity wall and loft insulation can be retrofitted to existing developments (particularly existing homes) to improve their energy performance. The focus is on insulation as it is the most effective (in terms of cost per unit of carbon saved) energy efficiency measure that the Council can deliver in existing development (see Table 4.1).
- *Boiler Replacements (with micro-CHP or biomass boilers)* – on average, over 1.4 million boilers are sold each year for replacements in the UK (BSRIA, 2007). This is approximately 7% of all gas customers in the UK. Similar proportions have been applied in Tunbridge Wells to calculate the potential CO_2 savings. It has been assumed that 86% (Homes Energy Efficiency Database, EST 2009) of all homes have boilers and 7% of these will be changed every year.
- *PV and Solar thermal installations* – with the significant number of listed buildings, conservation areas and designated landscapes, installation will need to be may not be appropriate for all buildings. The actual number of systems that can be installed will depend on current levels of penetration, which are likely to be very low. The actual number of installations is not known.
- *Heat pumps (ground and air source)* – applicable mainly in rural homes not connected to the gas network (approximately 30% of dwellings in the Borough).
- *District Heating or CHP (DH/CHP)* – applicable in areas where there are both residential and commercial uses. Where DH/CHP is applicable, this has been addressed in Section 5.6.

Details on each of these technologies can be found in Annex A. The potential carbon savings opportunities set out in this section are the maximum possible. The actual levels of penetration that can be achieved will depend on suitability of individual buildings for each of the above technologies.

5.4 Existing Development

Defining the Opportunity

The TCPA/CHPA Guide, 'Community Energy: Urban Planning for a Low Carbon Future' (TCPA & CHPA 2009), explores different character areas and opportunities which exist for low carbon and renewable energy supply technologies. For ease of reference, a similar approach has been adopted for this assessment based on the typical urban character areas (TUCAs) set out in *Strategic Housing Land Availability Assessment: Volume 2 Section 3, March 2008*. The relevant TCPA/CHPA character areas are shown below together with the corresponding TUCA codes:

- Village or Town Centre – A1, A2, A3, A4, V1
- Edge of Centre (High Density) – B3, B4, C2, G2, E4, F3
- Industrial Hinterland – H1, H2, H3, H4
- Suburban Districts (Low Density) – B1, B2, D1, D2, D3, E1, E2, E5, G1, C1
- Urban or Village Extensions – E3, F1, F2, V2
- Rural Hinterland – All areas not defined in the TUCAs and outside the Limits to Built Development (LBD)

In allocating the TUCA codes to the TCPA/CHPA character areas, the following key considerations were taken into account:

- Dwelling density
- Mix of uses
- Geographical spread/location
- Building morphology

Annex 1 of the *Typical Urban Character Area Appraisal* (Tunbridge Wells Borough Council, April 2009) sets out the methodology employed in defining the TUCAs. This section looks at each of these character areas and identifies the portfolio of technologies that could be delivered . The approach adopted in sizing the opportunity is outlined overleaf.

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5.4 Existing Development

Sizing the Opportunity

For each character area, the potential carbon savings that can be achieved from deployment of each technology have been estimated for the residential stock only. Non-residential stock also presents a significant opportunity with 3800 business premises across the Borough. ODPM Planning Statistics indicate that there is a total employment floorspace of 834m2 across the Borough. The opportunity in non-residential stock has been considered under Section 5.6 Strategic Sites.

The carbon savings set out in this section are high level estimates and the following points should be taken into account:

- Due to the wide range of dwelling types in the Borough, from one bedroom apartments to large family homes, three bedroom family homes have been used as an average dwelling size in calculating the carbon saved per dwelling..
- Where the total number of dwellings has not been available, the number of dwellings has been estimated using the total land area of the character areas and the housing density for that character area as set out in the *Strategic Housing Land Availability Assessment: Volume 2 Section 3, March 2008.*
- The amount of carbon saved will depend on the fuel and electricity displaced, this is taken into account in the ranges provided
- The proportion of dwellings to which technologies can be applied is based on the figures provided in the *Housing Strategy 2006 – 2011* (see below).
- Assumptions provided in Section 4 and Annex A for each technology also apply here.

The Housing Strategy 2006 details the condition of the housing stock in the Borough. On the basis of this information it is possible to identify opportunities for delivery of low carbon solutions in conjunction with housing renewal. The following points highlighted in the Housing Strategy provide an indication of the size of the opportunity:

- 51% of dwellings in the Borough have unfilled cavity walls
- 56% of dwellings in the Borough have insufficient loft insulation

As mentioned above, these figures have been used to estimate the number of dwellings in which low carbon and renewable energy technologies can be applied.

The following pages present the possible portfolios of technologies that can be developed in each of the character areas identified above. The choice of technology and the technology mix will depend on various factors relating to residential properties.

5.4 Existing Development

Village or Town Centres

The figure below shows the geographical spread of areas characterised as village or town centres across the Borough. The character areas included in this category are

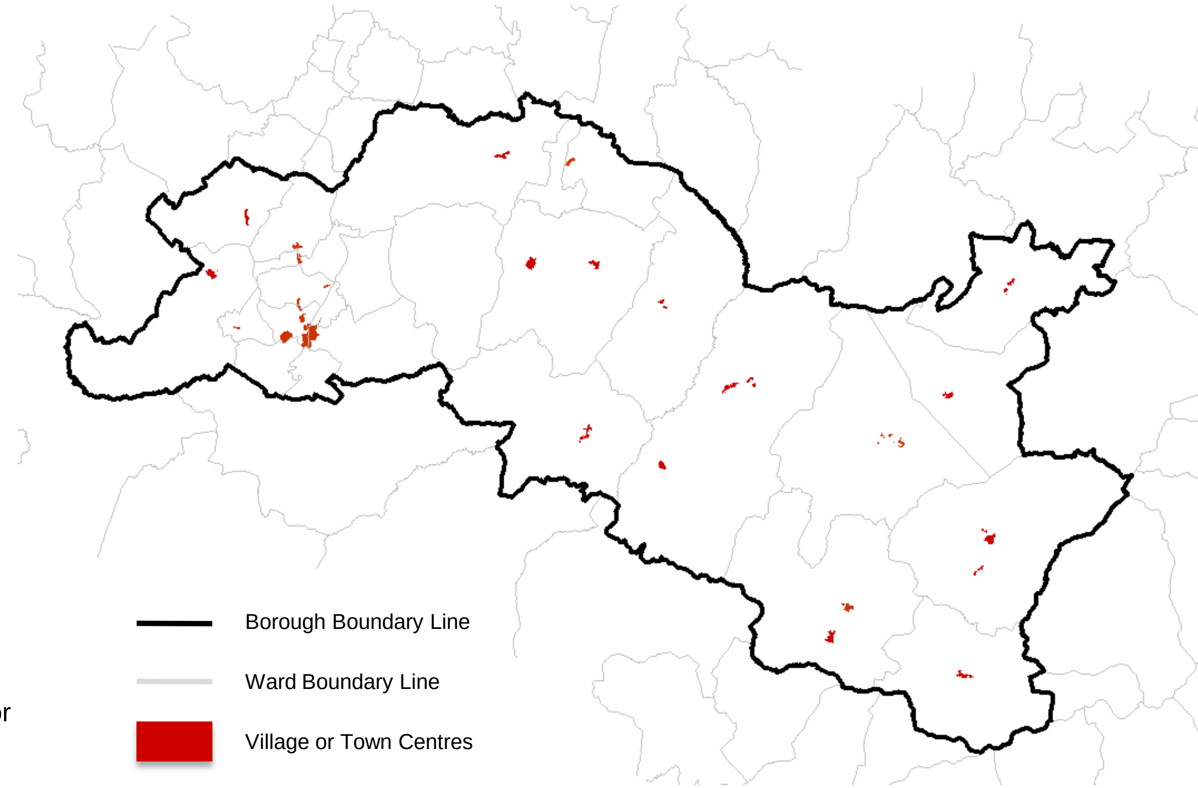
A1 – Historic Town Centre

A2 – Retail Frontage

A3 – Town Centre

A4 – Edge of Town Centre

V1 – Historic Village Centre



The TCPA & CHPA Guide highlights that deployment of CHP for district heating is most suitable for town centres. With substantial regeneration planned for the four main town centres in the Borough, there is an opportunity to develop DH/CHP schemes integrating new development and surrounding existing development. Section 5.6 Strategic Sites discusses some of the strategic sites identified for redevelopment highlighting how DH/CHP can be developed in parallel.

There are between 2,470 and 2,600 dwellings in this category. The potential opportunity for deployment of low carbon and renewable technologies in these character areas is shown in the table overleaf. Where properties are part of a DH system, some of the technologies discussed overleaf would not apply to those buildings.

5.4 Existing Development

Village or Town Centres (…contd)

Technology	Potential (Residential)
Solar Thermal & PV	Solar thermal and PV systems can be applied to all dwellings although the majority of dwellings in the town centres are likely to be apartments. Assuming that Solar thermal & PV systems can be installed in all buildings, potential CO_2 savings in these character areas could be up to • **845t per annum** for Solar thermal • **3,120t per annum** for PV
Boiler Replacements (Biomass/Micro-CHP)	Approximately 156 boilers could be replaced annually in these character areas. For a single year, replacement of these boilers with biomass boilers could lead to CO_2 savings of up **585t**, while replacement with micro-CHP could lead to savings of up to **132t**. Biomass boilers require space for fuel storage and this may be limited in town centres as development is more compact.
Energy Efficiency (Cavity Wall /Loft Insulation)	Approximately 1,330 homes require cavity wall insulation, while approximately 1,460 homes require loft insulation. On the basis of these figures, up to **811t** of CO_2 savings can be achieved from cavity wall insulation of homes in these character areas. Up to **1,170t** of CO_2 can be saved through loft insulation. It has been assumed for this character area that the main heating fuel is natural gas.

5.4 Existing Development

Edge of Centre

The figure below shows the geographical spread of areas characterised as edge of centre across the Borough. The character areas included in this category are

B3 – Victorian Three – and Four-Storey Houses

B4 – Victorian Small Town Houses

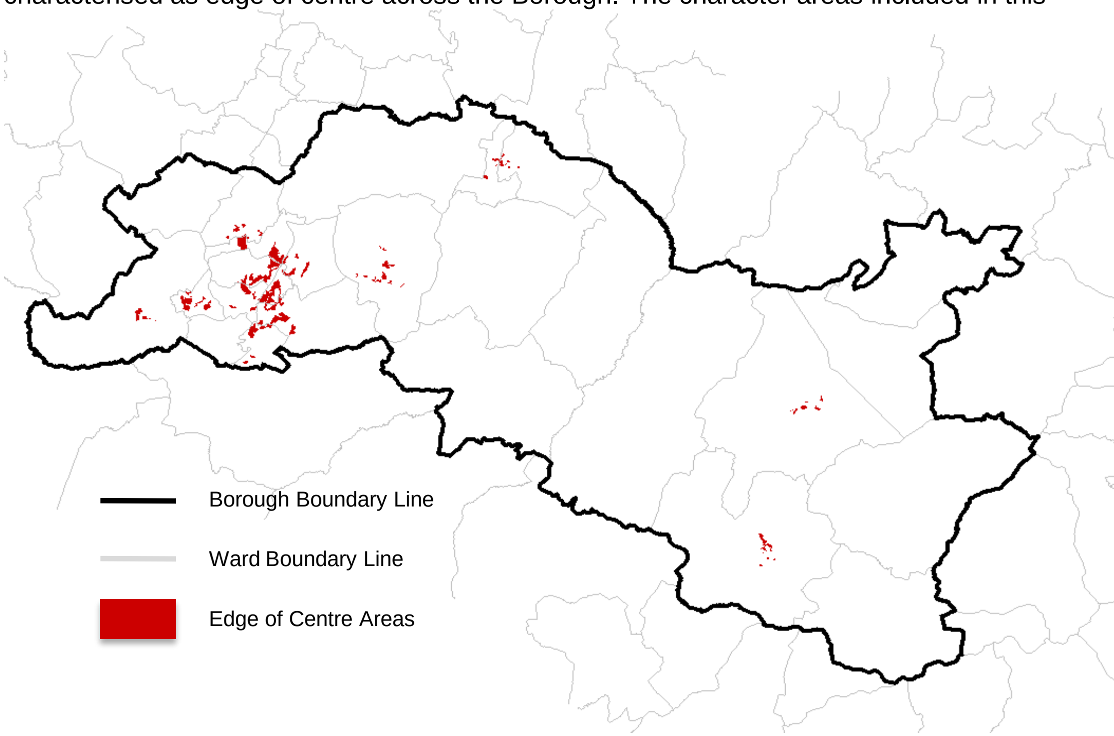
C2 – Edwardian Terrace

E4 – Post-war High Density Terraces and Flats

F3 – Modern High Rise

G2 – Mixed Age Medium/High Density

A review of the SHLAA urban characterisation highlights that these are high density areas with terrace housing and flatted accommodation. The density of dwellings is suitable for DH/CHP. These can be developed in clusters as illustrated in the TCPA/CHPA Guidance document. Other opportunities include PV, solar thermal and biomass heating.



There are between 11,800 & 12,400 dwellings in this category. Residential properties in the E4, F3 and G2 character areas are post-1920 and likely to have cavity walls. Dwellings in the B3, B4 and C2 character areas are pre-1920s and have solid walls. Potential carbon savings in the residential sector are shown in the table overleaf.

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5.4 Existing Development

Edge of Centre (…continued)

Technology	Potential (Residential)
Solar Thermal & PV	Based on the number of dwelling in these character areas, up to **4,030t** of CO_2 could be saved per annum assuming installation on all dwellings. PV installations could result in up to **14,880t** CO_2 savings.
Boiler Replacements (Biomass/Micro-CHP)	Approximately 746 boilers could be replaced annually in these character areas. For a single year, replacement of these boilers with biomass boilers could lead to CO_2 savings of up **2,800t**, while replacement with micro-CHP could lead to savings of up to **635t**. Again, biomass boilers require space for storage of fuel. This may be limited in edge of centre areas due to the high density characteristics, although less so than the village and town centre character areas.
Energy Efficiency (Cavity Wall /Loft Insulation)	Assuming the Housing Strategy figures set out in the beginning of Section 5.4 and assuming that only dwellings in the character areas E4, F3 and G2 have cavity walls, approximately 1,240 homes require cavity wall insulation. Based on Housing Strategy figures, up to 6,945 homes require loft insulation (not taking into account high flatted dwellings). On this basis, up to **760t** of CO_2 savings can be achieved from cavity wall insulation and up to **5,560t** of CO_2 can be saved through loft insulation. It has been assumed for these character areas that the main heating fuel is natural gas.

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5.4 Existing Development

Industrial Hinterland

The figure below shows the geographical spread of areas characterised as industrial hinterland across the Borough. The character areas included in this category are

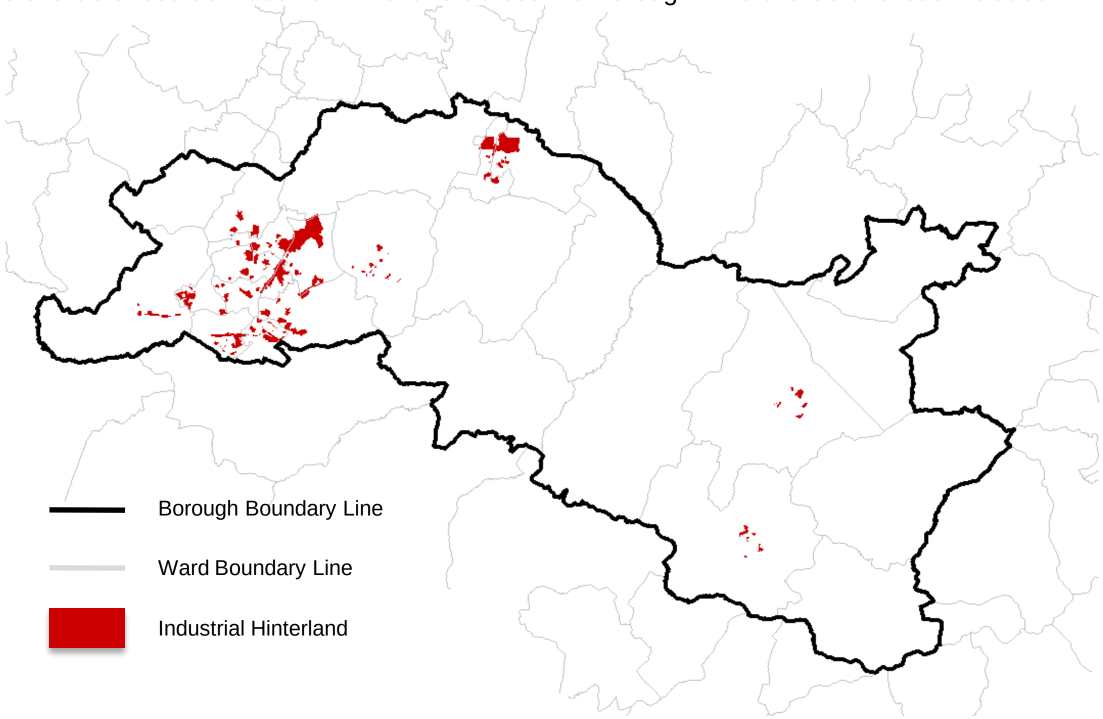
H1 – Industrial/Commercial

H2 – Community/Health

H3 – Education

H4 – Leisure/Recreation

These character areas are predominantly non-residential, with a total of only 962 dwellings, over 516ha. These areas offer anchor heat loads for DH/CHP. They are also suitable for larger schemes that are highly visible and may require large vehicle movements (e.g. anaerobic digestion CHP and large scale biomass DH).



In Section 5.6 Strategic Sites, 2 of the strategic sites identified – Broadwater Lane and North Farm, fall within this category. The methodology provided in Section 5.1 can be used to identify future sites in these character areas.

The residential opportunity is limited to the 962 dwellings in this category. The opportunities for deployment of low carbon and renewable technologies in these character areas is shown in the table overleaf. The DH/CHP opportunity is discussed in Section 5.6 Strategic Sites.

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5.4 Existing Development

Industrial Hinterland (…continued)

Technology	Potential (Residential)
Solar Thermal & PV	The majority of properties in these character areas could have solar thermal installed. Based on the number of dwellings in these character areas, up to **315t** of CO_2 could be save per annum from the installation of solar thermal systems. PV installations could result in up to **1,155t** CO_2 savings in these character areas.
Boiler Replacements (Biomass/Micro-CHP)	Approximately 57 boilers could be replaced annually in these character areas. For a single year, replacement of these boilers with biomass boilers could lead to CO_2 savings of up **215t**, while replacement with micro-CHP could lead to savings of up to **50t**.
Energy Efficiency (Cavity Wall /Loft Insulation)	Assuming the Housing Strategy figures set out in the beginning of Section 5.4, approximately 490 homes require cavity wall insulation, while up to 540 homes require loft insulation. On this basis, up to **300t** of CO_2 savings can be achieved from cavity wall insulation of homes in these character areas. Up to **435t** of CO_2 can be saved through loft insulation. It has been assumed for these character areas that the main heating fuel is natural gas.

5.4 Existing Development

Suburban Districts

The figure below shows the geographical spread of areas characterised as suburban across the Borough. The character areas included in this category are:

B1 – Victorian Detached

B2 – Victorian 'Middle Class'

C1 – Edwardian Villas

D1 – Inter-war Spacious

D2 – Inter-war Detached

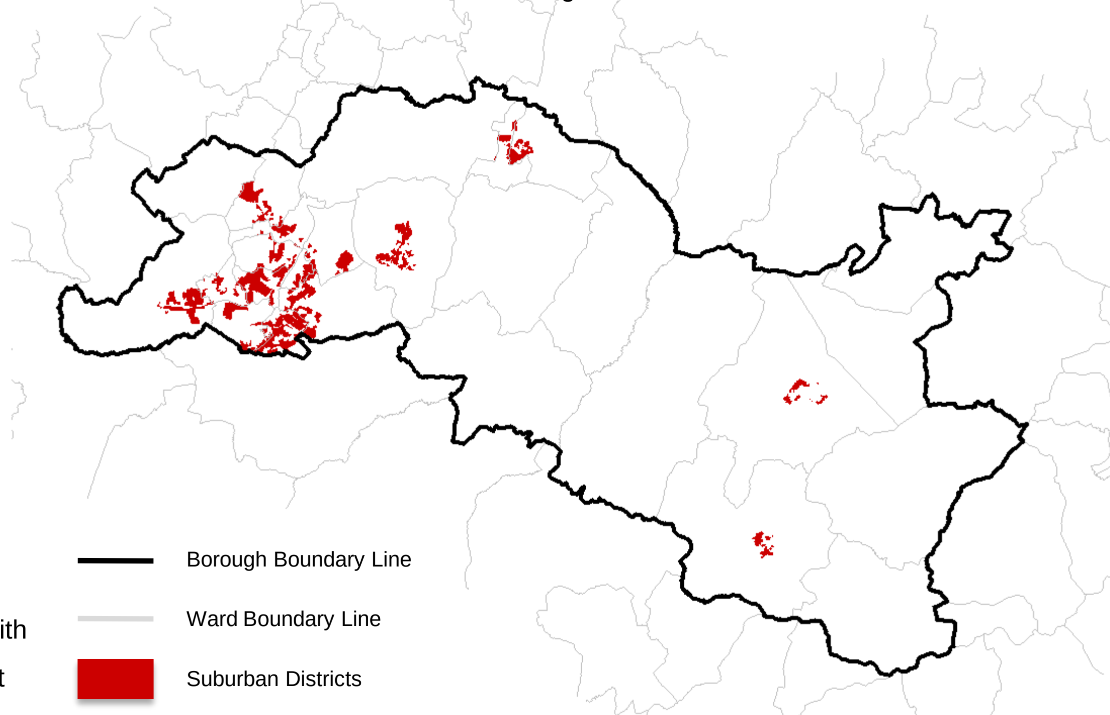
D3 – Inter-war Semi-detached

E1 – Post-war Spacious Detached

E2 – Post-war Speculative Estate

E5 – Bungalows

G1 – Mixed Age Detached/Semi



These character areas are predominantly residential with medium to low densities. Given that these areas do not have highly mixed uses and are of low densities, CHP and district heating schemes are unlikely to be viable.

There is a total of approximately 12,700 dwellings in this category. Approximately 40% of these will have solid walls (character areas E1, E2 and E5 being the exceptions). Potential carbon savings from the deployment of low carbon and renewable technologies in these areas is provided overleaf.

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5.4 Existing Development

Suburban Districts (…continued)

Technology	Potential (Residential)
Solar Thermal & PV	All properties in these character areas could have solar thermal installed. Based on the number of dwellings in these character areas, up to **4,130t** of CO_2 could be save per annum from the installation of solar thermal systems. PV installations could result in up to **15,240t** CO_2 savings in these character areas.
Boiler Replacements (Biomass/Micro-CHP)	Approximately 765 boilers could be replaced annually in these character areas. For a single year, replacement of these boilers with biomass boilers could lead to CO_2 savings of up **2,870t**, while replacement with micro-CHP could lead to savings of up to **650t**. Give that these character areas are low density residential areas, it is likely that most homes will have sufficient space for fuel storage. As such biomass boilers are appropriate in this character area.
Energy Efficiency (Cavity Wall /Loft Insulation)	Assuming the Housing Strategy figures set out in the beginning of Section 5.4 and assuming that only dwellings in the character areas E1, E3 and E5 have cavity walls, approximately 2,660 homes require cavity wall insulation. Based on Housing Strategy figures, up to 7,100 homes require loft insulation. On this basis, up to **1,620t** of CO_2 savings can be achieved from cavity wall insulation of homes in these character areas. Up to **5,680t** of CO_2 can be saved through loft insulation. It has been assumed for these character areas that the main heating fuel is natural gas.

5.4 Existing Development

Urban or Village Extension

The figure below shows the geographical spread of areas characterised as urban or village extension across the Borough. The character areas included in this category are

E3 – Post-war Council Estate

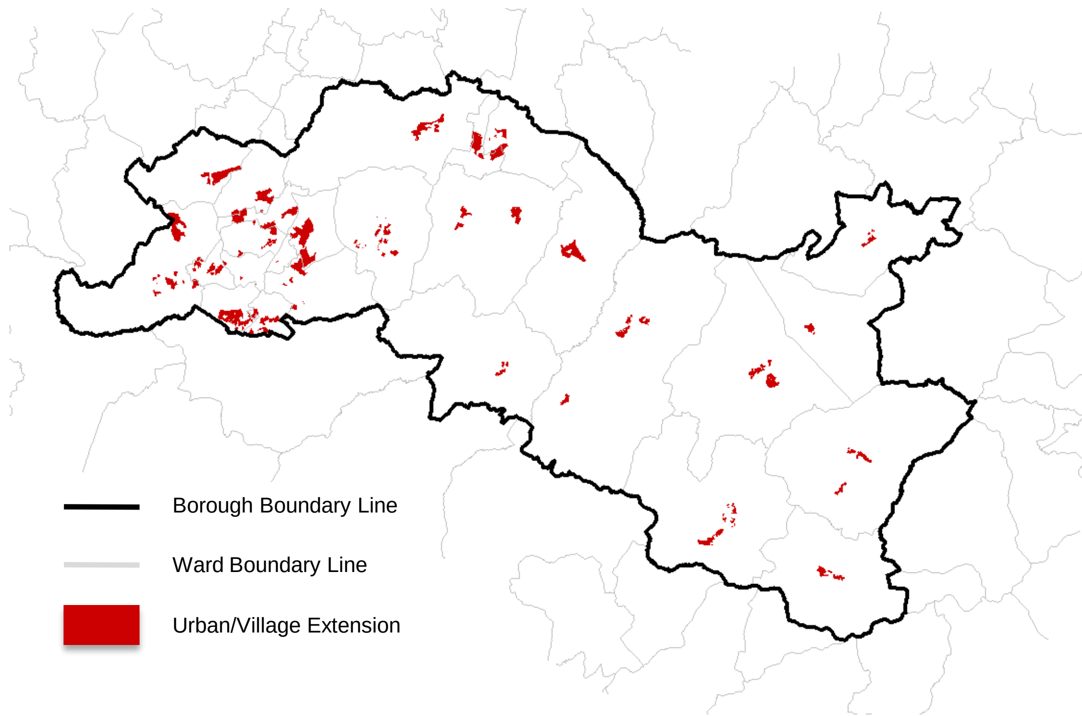
F1 – Modern Detached

F2 – Modern Semi-Linked

V2 – Residential Village Expansion

These tend to be medium to low density residential areas. As with the suburban districts, CHP and district heating schemes are unlikely to be appropriate for these areas. However ,the potential in relation to energy efficiency is particularly high, with approximately 15,000 dwellings in this category.

As with suburban districts, technologies can be deployed on a dwelling by dwelling basis. Appropriate technologies include PV, solar thermal and biomass.



5.4 Existing Development

Urban or Village Extension (…continued)

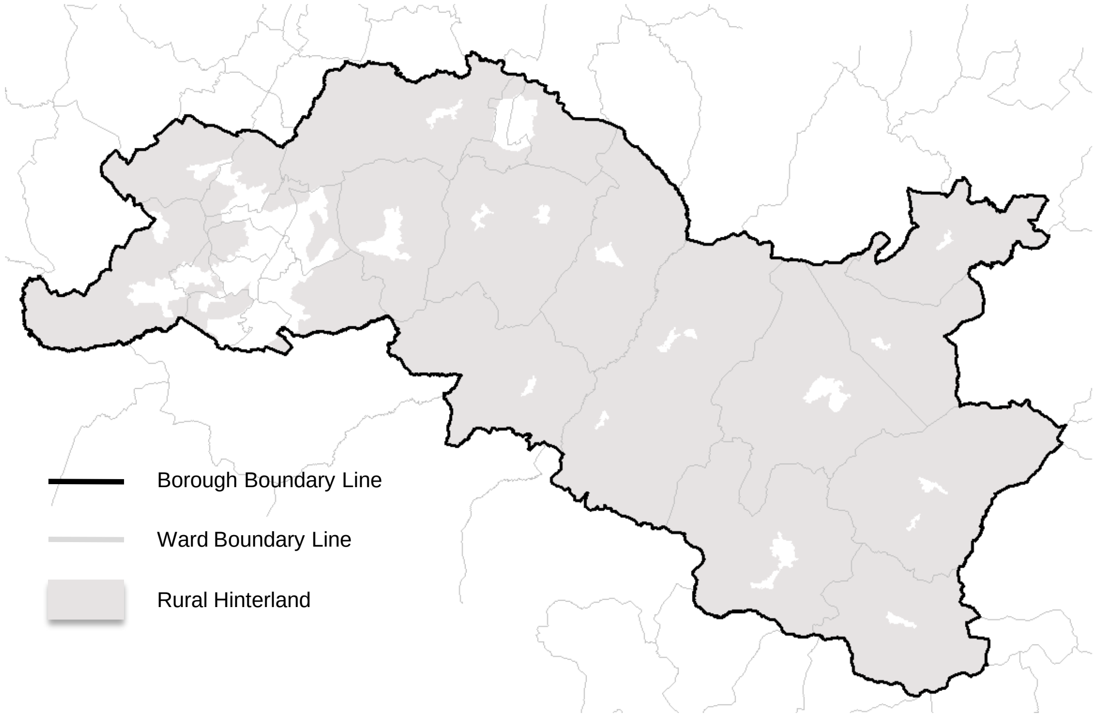
Technology	Potential (Residential)
Solar Thermal & PV	All properties in these character areas could have solar thermal installed. Based on the number of dwelling in these character areas, up to **4,875t** of CO_2 could be s**ave** per annum from the installation of solar thermal systems. PV installations could result in up to **18,000t** CO_2 savings in these character areas.
Boiler Replacements (Biomass/Micro-CHP)	Approximately 903 boilers could be replaced annually in these character areas. For a single year, replacement of these boilers with biomass boilers could lead to CO_2 savings of up **3,390t**, while replacement with micro-CHP could lead to savings of up to **770t**.
Energy Efficiency (Cavity Wall /Loft Insulation)	Assuming the Housing Strategy figures set out in the beginning of Section 5.4, approximately 7,650 homes require cavity wall insulation, while up to 8,400 homes require loft insulation. On this basis, up to **4,670t** of CO_2 savings can be achieved from cavity wall insulation of homes in these character areas. Up to **6,720t** of CO_2 can be saved through loft insulation. It has been assumed for these character areas that the main heating fuel is natural gas.

5.4 Existing Development

Rural Hinterland

The figure below shows the geographical spread of areas characterised as rural hinterland across the Borough.

This category is characterised by large areas of agricultural land with the associated infrastructure, farmsteads, hamlets and individual house. Although some low carbon and renewable energy technologies can be delivered in housing, the biggest opportunity would be in sourcing biomass from these areas. This is available from animal waste and forestry (see Annex A for details on resources).



The majority of properties in these are**as are** not connected to the gas network and use fuels such as oil for heating. As such, there is a significant opportunity to provide alternative heating through solar thermal, heat pumps or biomass boilers.

There is approximately up to 3,000 dwellings in the rural hinterland. It is likely that the majority of these properties in these areas are pre-1920 and therefore have solid walls. Loft insulation can be considered to improve the energy efficiency of these properties. The table overleaf sets out the potential carbon savings that could be achieved through deployment of low carbon or renewable energy technologies in this category.

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5.4 Existing Development

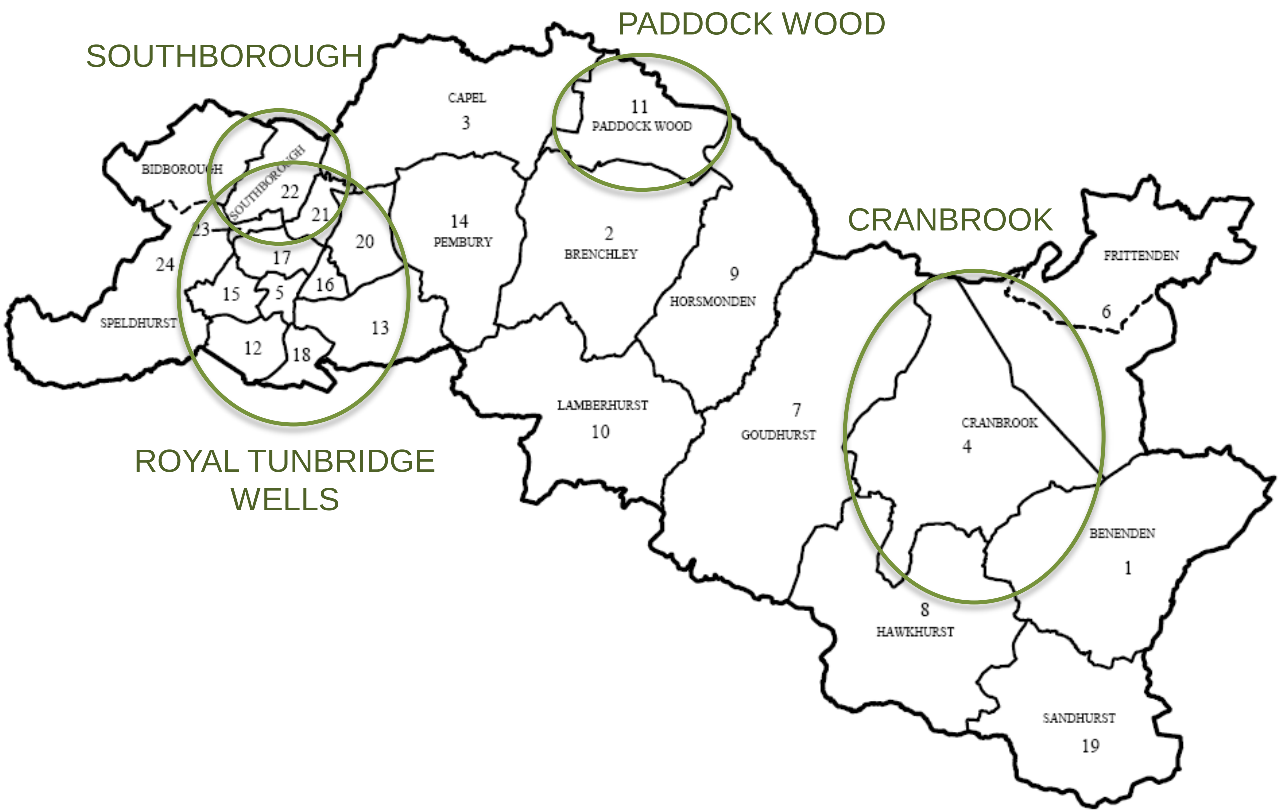
Rural Hinterland (…continued)

Technology	Potential (Residential)
Solar Thermal & PV	All properties in these character areas could have solar thermal installed. Based on the number of dwelling in these character areas, up to **975t** of CO_2 could be save per annum from the installation of solar thermal systems. PV installations could result in up to **3,600t** CO_2 savings in these character areas.
Boiler Replacements (Biomass/Micro-CHP)	Approximately 181 boilers could be replaced annually in these character areas. For a single year, replacement of these boilers with biomass boilers could lead to CO_2 savings of up **680t.** Given the likely absence of gas, micro-CHP is not appropriate for this character area.
Energy Efficiency (Cavity Wall /Loft Insulation)	Based on Housing Strategy figures, up to 1,680 homes require loft insulation. On this basis, up to **1,345t** of CO_2 can be saved through loft insulation. It has been assumed for these character areas that the main heating fuel is oil.
Heat Pumps	Ground source heat pumps may be appropriate for application in dwellings in the rural hinterland as most properties use oil for heating and are not connected to the gas network (see Annex A for the review of this technology). Up to **3,600t** of CO_2 could be saved were all households in the rural hinterland to install ground source heat pumps.

5.5 New build Residential

The SHLAA indicates that **there is the potential to build 4,860 new dwellings** in the four main hubs in the Borough:

- Royal Tunbridge Wells
- Paddock Wood
- Southborough
- Cranbrook



5.5 New build Residential (…contd)

Suitable Technologies

The majority of the sites included in the SHLAA are in relatively isolated locations, with few dwellings – the average number of dwellings per site is just over 50. The sites are generally residential only, not mixed use, with low heat density. For these reasons, district heating is generally not applicable.

There are some cases where sites can be combined with other residential, mixed use or industrial development areas. These specific cases are assessed as parts of strategic sites discussed later in this report. The assessment here of the new build residential opportunity has therefore been limited to solutions for individual homes. The table below provides an indication of the technologies that are appropriate for new build residential developments.

Technology	Technically Feasible?	Comments
Micro-CHP	?	New-build homes are expected to have a high thermal efficiency due to improved standards required under the Building Regulations. This may make them unsuitable for Stirling engine micro-CHP as the heat output is too high. Solid oxide fuel cell (SOFC) units are more suitable but will not be commercially available until 2012 or after. Biomass micro-CHP has not been considered as the technology is not reliable or cost-effective.
Packaged, mid-sized CHP	✗	Individual residential heat load too small to support packaged CHP units.
District heating CHP	✗	Mixed, higher density loads (both residential and non-residential) are required for district heating to run economically.
PV	✓	PV is most appropriate on south-facing surfaces. East and West-facing schemes will experience a 20 – 25% reduction in yield.
Solar thermal	✓	As with PV, solar thermal is most appropriate where the dwelling is south-facing, but can be applied to east and west-facing dwellings.
Heat pumps	✓	Heat pumps are potentially feasible on all new properties. However, for ground source heat pumps, sufficient space is required to allow for drilling.
Wood pellet boilers	✓	Wood pellet boilers are feasible in all homes although there needs to be sufficient space for fuel storage.
Anaerobic digestion (AD) biogas	✗	Residential areas are not suitable for production, transport or processing of biogas.

5.5 New build Residential (…contd)

Technology Assessment

We have estimated the overall indicative costs and CO_2 savings for each technology based on a system being installed in a typical home (see assumptions in Section 5.2 and in Annex A). For this comparison, we have assumed that **each technology is installed in every dwelling o**n candidate sites set out in the SHLAA (each technology will meet a different proportion of the energy demand of the average home).

The table below sets out these indicative costs and CO_2 savings on this basis. Costs are lifetime costs per carbon saved, including operation and maintenance and fuel costs. Please refer to Annex A for assumptions and sources used to arrive at these values.

The assessment does not take into account the potential integration of two or more technologies in a single dwelling, although this approach would yield significantly higher CO_2 savings.

As shown in the table below, ***wood pellet boilers offer the most significant carbon savings for new build residential, and are second only to micro-CHP in terms of cost per CO_2 savings***. ***The only limit to deployment is that there must be space for pellet storage.***

Micro-CHP and PV are the only technologies that generate electricity, and therefore can potentially provide a revenue stream for households where electricity is exported. This revenue (in the form of a feed-in tariffs for microgeneration) might be a strong positive factor for the homeowner.

The costs of micro-CHP and solar PV are falling at a significant rate. Although micro-CHP developers' current costs cannot compete with traditional gas boilers, in 5 years or so they aim for the difference in cost to be no more than £2,000 to £3,000, while PV prices may fall by up to 40% by 2015.

Ranking	Technology	Lifetime CO_2 Savings (kg)
1	Pellet boiler	Up to 365 million
2	PV	122 - 146 million
3	Ground source heat pumps	83 – 117 million
4	Micro-CHP	62 million
5	Solar thermal	40 million

Ranking	Technology	Lifetime cost of carbon saved per t CO_2
1	Micro-CHP	£40 - £60
2	Pellet boiler	£60 - £102
3	Ground source heat pumps	£44 - £520
4	Solar thermal	£180 - £438
6	PV	£265 - £1,000

5.6 Strategic Sites

There are a number of sites within the town centres that present key opportunities for the deployment of larger, integrated solutions. These sites typically provide key anchor heat loads such as hospitals, schools, hotels or shopping centres as well as new residential and mixed use developments. Such sites support the development of district heating, be that biomass heat-only or CHP. While not an exhaustive list, the *key* strategic sites identified in this study are:

- North Farm & Knights Way
- Old Kent & Sussex Hospital Site
- Royal Victoria Place Shopping Centre
- Pembury Hospital
- Broadwater Lane

The characteristics of the opportunities at these sites are discussed in detail in **Annex B**. The identification of opportunities has been guided by the general rules of thumb set out in the table below, while the recommendations for each site are set out in the following pages. In general, district heating (whether biomass heat-only or CHP) is more viable when there is a steady, stable heat load.

Area Characterisation	Suitability for DH/CHP	Comments	Local Example
Residential	Low	Peak hot water demand tends to be early morning and evening. For CHP, a thermal store would therefore be required to enable it to run throughout the day, maximising electricity generation.	The majority of existing and new build residential already discussed
Mixed Use (residential + commercial)	Medium	Mixed use sites provide daytime heat loads, more suitable for DH. For CHP there is less of a requirement for a thermal store.	Old Kent & Sussex Hospital
Mixed Use + Large Public Buildings	High	The inclusion of large public buildings creates a more consistent heat load profile.	Royal Victoria Place
Industrial Mixed Use	High	Suitable for larger projects with more visual impact and requiring large movements of vehicles for bio-based fuel delivery.	North Farm

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5.6 Strategic Sites (…contd)

North Farm & Knights Way

The sewage treatment works at North Farm currently utilises the existing supply of biogas from the digestion process. This biogas could be used to fuel a biogas CHP system that serves the entire site. It would be necessary, however, to upscale the existing system. In estimating installation costs (as shown in the table below), the available biogas resource from the sewage works or the landfill has been excluded.

For the district heating network, approximately 2 to 4 km of piping would be required, a sizeable investment at £910/m.

As shown in the table below, ***biogas CHP district heating offers the greatest carbon savings but the lifetime cost of carbon saved could be higher than the biomass or natural gas equivalent.***

There are risks with all technologies:

- The biogas system is quite large, and there may be issues in securing sufficient waste for AD processing
- Biomass security of supply is also an issue for such a large installation. There is also a fuel price risk associated with biomass, although not as much as for natural gas. However, the renewable heat incentive (to be introduced in 2011) will improve the economics of the project.
- Natural gas is subject to significant fuel price risk. The introduction of a price for carbon would also damage the economic effectiveness of natural gas CHP compared to that of biomass heat-only. The method in which a carbon price will be introduced is unknown, but could come in the shape of the feed-in tariff for renewable electricity/heat or through the Carbon Reduction Commitment.

Technology	CHP Size		Approx. Heat Demand Covered (GWh/year)	Approx. Annual CO_2 Savings (t CO_2/year)	Approx. Lifetime CO_2 Savings (t CO_2)	Approx. Lifetime Cost of Carbon Saved (£/t CO_2)
	(kWe)	(kWth)				
Biogas DH CHP	1,591	2,122	12.7	8,000	120,000	~£140
Natural Gas DH CHP	1,591	1,819	12.7	1,400	21,000	£80 - £250
Packaged CHP (Hospital only)	307	351	2.5	270	4,000	£80 - £250
Biomass District Heating	-	1,670	12.7	2,900	44,000	£80 - £150
Biomass Boiler (Hospital only)	-	320	2.5	563	8,400	£80 - £150

5.6 Strategic Sites (…contd)

Old Kent & Sussex Hospital Site

For a heating network at this site, we estimate a pipe length of between 200m and 650m to be required.

Calculations show that installing a district heating system offers significantly higher carbon savings than just the hospital site only. However, a sizeable investment will need to be made in the heating network (at £910/m).

Installing a biomass system offers carbon savings in the order of 2 times more than natural gas DH CHP. Indicative costs per CO_2 savings are comparable. Therefore, biomass is likely to be the fuel of choice.

The site is suitable for the use of biomass as it is on the edge of town and there is ample space for handling.

Several other factors point to biomass as being the fuel of choice:

- There is less of a fuel price risk associated with biomass
- The renewable heat incentive will improve the economics of a biomass scheme
- A carbon price will damage the economic viability of a natural gas project

Technology	CHP Size		Approx. Heat Demand Covered (GWh/year)	Approx. Annual CO_2 Savings (t CO_2/year)	Approx. Lifetime CO_2 Savings (t CO_2)	Approx. Lifetime Cost of Carbon Saved (£/t CO_2)
	(kWe)	(kWth)				
Biomass District Heating	-	490	3.8	858	12,900	£80 - £150
Biomass Boiler (Hospital site only)	-	310	2.4	543	8,100	£80 - £150
Natural Gas DH CHP	469	536	3.8	409	6,100	£80 - £250
Packaged CHP (Hospital site only)	296	339	2.4	259	3,900	£80 - £250

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5.6 Strategic Sites (…contd)

Royal Victoria Place Shopping Centre

For the heating network, a range of between 350 m and 1 km is assumed to be needed.

As the lifetime cost of carbon saved is comparable for the two types of fuel considered, biomass looks likely to be the preferred option. However, the location of this site (town centre) complicates this. Access to the site is more restricted and the higher land-value associated with the town centre means that storage of fuel becomes more costly.

A detailed feasibility study is required to determine if the extra costs and disruption associated with delivery and storage of biomass outweigh the extra carbon savings.

Again, the same fuel price risks and future rewards from the renewable heat incentive must be considered when choosing which option to deploy at the site.

Technology	CHP Size		Approx. Heat Demand Covered (GWh/year)	Approx. Annual CO_2 Savings (t CO_2/year)	Approx. Lifetime CO_2 Savings (t CO_2)	Approx. Lifetime Cost of Carbon Saved (£/t CO_2)
	(kWe)	(kWth)				
Natural Gas DH CHP	873	997	7	762	11,400	£80 - £250
Packaged CHP (Shopping centre only)	532	608	4.3	465	7,000	£80 - £250
Biomass District Heating	-	915	7	1,600	24,000	£80 - £150
Biomass Boiler (Shopping centre only)	-	560	4.3	975	14,600	£80 - £150

5.6 Strategic Sites (…contd)

Pembury Hospital (Tonbridge Road)

The site has undergone an assessment (performed by Equion) of several renewable technologies. As the table (right) demonstrates, the 3 most viable technology options were:

- Off-site wind
- Solar air collectors
- Biomass heating

The criteria for assessment were environmental, technical implementation, economics and public perception.

CHP was not considered feasible due to a lack of summer heat demand, while off-site wind was ruled out as an on-site solution is preferred. Solar air collectors offer limited CO_2 savings but significant architectural impacts, and was therefore rejected.

Biomass heating was the preferred option. The table below details the proposed system.

Ranking	Technology
System rating	1 MW
Fuel store	2 External bunkers
Fuel deliveries	2-3 vehicles per week
Energy generated per annum	5,800,000 kWh/yr
CO_2 savings per annum	1,102,000 kg CO_2
Total annual CO_2 savings	11.8%

Ranking	Technology
1	Off-site wind
2	Solar air collectors
3	Biomass heating
4	Solar thermal
5	Ground source heat pump
6	Solar PV
7	On-site wind
8	Air/ground heat exchanger
9	CHP with absorption chillers
10	Fuel cell
11	Energy from waste CHP (mass incineration)
12	Energy from waste CHP (pyrolysis/gasification)

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5.6 Strategic Sites (…contd)

Broadwater Lane

On the basis of current land uses, ***biomass district heating could be the most appropriate technology for this site***. The food processing factory could provide a heat anchor load. The main disadvantage to district heating of any type at this site would be the need to install a DH network. This would cause some disruption as there is no new development planned for the site.

Although it would deliver the most significant carbon savings, biogas CHP may not be the most appropriate given the location of residential properties in the immediate surrounding area.

Natural gas DH CHP offers the least carbon savings, but it does not involve any disruption in terms of fuel delivery and storage. but given the commercial/industrial nature of the site, Delta also does not foresee any major issues in the handling of biomass. The site is located outside the town centre, so the cost of land for storage of biomass may not be a significant a concern.

Again, the same fuel price and carbon risks, and renewable heat incentive issues must be taken into consideration when selecting the most appropriate solution. For this, a detailed feasibility analysis is required.

Technology	CHP Size		Approx. Heat Demand Covered (GWh/year)	Approx. Annual CO_2 Savings (t CO_2/year)	Approx. Lifetime CO_2 Savings (t CO_2)	Approx. Lifetime Cost of Carbon Saved (£/t CO_2)
	(kWe)	(kWth)				
Natural Gas DH CHP	244	279	2	210	3,200	£80 - £250
Biogas DH CHP	244	325	2	1,200	18,300	~£140
Biomass District Heating	-	255	2	4,500	6,700	£80 - £150

5.6 Strategic Sites (…contd)

Town Hall and Surrounds

A district heating network is likely to be the only option for significant carbon savings at this site, as the individual buildings offer little in the way of a steady heat load.

Biomass district heating is likely to offer the most significant carbon savings. However, the site is located in the town centre, where access for fuel delivery and space for storage is limited. This high land value for storage and disruption of deliveries is also a concern. However, since a biomass boiler of considerable size (900 kW) is to be installed in the cinema site, directly across the road, delivery and even storage of biomass could be shared between the two sites.

A detailed feasibility analysis is required to choose the most appropriate solution. Fuel price risk, carbon price and future incentives such as the renewable heat incentive, will need to be taken into consideration.

Technology	CHP Size		Approx. Heat Demand Covered (GWh/year)	Approx. Annual CO_2 Savings (t CO_2/year)	Approx. Lifetime CO_2 Savings (t CO_2)	Approx. Lifetime Cost of Carbon Saved (£/t CO_2)
	(kWe)	(kWth)				
Natural Gas DH CHP	417	476	4.2	364	5,500	£80 - £250
Biomass District Heating	-	545	4.2	954	14,300	£80 - £150

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5.6 Strategic Sites (…contd)

Tunbridge Wells Sports Centre

Biomass heating is likely to offer the most significant carbon savings and may provide the best combination of carbon savings and cost-effectiveness. However, the sports centre is located in the town centre and has very limited space for fuel storage. Delivery could also be an issue. If biomass is not viable for these logistical reasons, then natural gas CHP is likely to be the next best alternative.

An important consideration to note is that there are two schools adjacent to the centre:

- Tunbridge Wells Boys' Grammar School, within 100m
- St Gregory's School House, within 50m

Although schools fall outside the responsibility of the Borough Council, they offer an opportunity for significant further carbon savings by linking in to the leisure centre. Delta recommends that the Council approach Kent County Council to explore the feasibility of creating an integrated heating scheme between the three buildings.

A detailed feasibility study must be completed to decide which solution is most acceptable. This should include an examination of the option of linking the heating scheme with the two adjacent school buildings. Fuel price risk associated with natural gas and biomass, security of supply of biomass and future incentives for renewable heat should be considered.

Technology	CHP Size		Approx. Heat Demand Covered (GWh/year)	Approx. Annual CO_2 Savings (t CO_2/year)	Approx. Lifetime CO_2 Savings (t CO_2)	Approx. Lifetime Cost of Carbon Saved (£/t CO_2)
	(kWe)	(kWth)				
Natural Gas CHP	287	328	2.29	250	3,800	£80 - £250
Biomass Boiler	-	300	2.29	525	7,900	£80 - £150

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5.6 Strategic Sites (…contd)

Putlands Sports and Leisure Centre

The opportunity for carbon savings here is limited, but should not be overlooked. ***Biomass heating offers the largest savings.*** The site is at the edge of the town of Paddock Wood, with ample space for handling of biomass fuel.

There is a school within 300 m of the centre, but considering the size of the heat load at Putlands, it is probably not worth linking in with the school.

Technology	CHP Size		Approx. Heat Demand Covered (GWh/year)	Approx. Annual CO_2 Savings (t CO_2/year)	Approx. Lifetime CO_2 Savings (t CO_2)	Approx. Lifetime Cost of Carbon Saved (£/t CO_2)
	(kWe)	(kWth)				
Natural Gas CHP	19	22	0.15	17	250	£80 - £250
Biomass Boiler	-	20	0.15	35	525	£80 - £150

5.6 Strategic Sites (…contd)

Weald Sports Centre

Biomass heating offers the most significant carbon savings, and may turn out to be the best all-round option.

The site is located at the edge of the town of Cranbrook, with easy access for delivery and ample space for biomass storage. Therefore, handling of fuel should not be an issue.

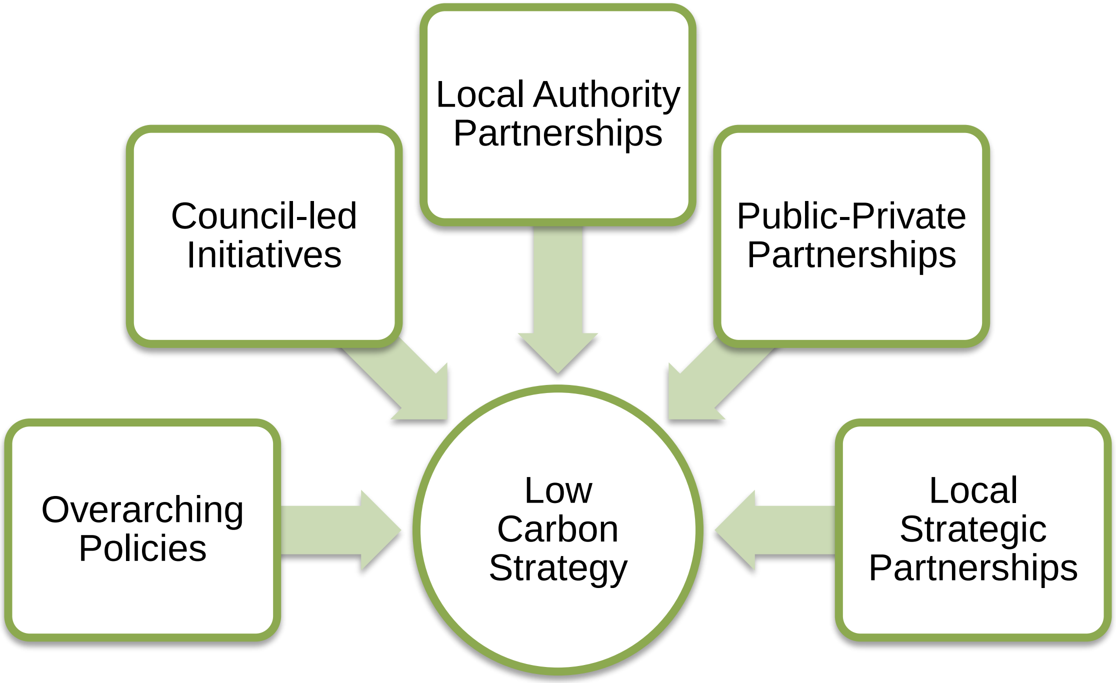
There is also a school adjacent to the centre - Angley School, within 150m.Again, although not under the direct control of the Borough Council, this school should be examined for suitability for linking in to the leisure centre heating scheme.

A detailed feasibility study must be completed to decide which solution is most acceptable. This should include an examination of the option of linking the heating scheme with the adjacent school building. Fuel price risk associated with natural gas and biomass, security of supply of biomass and future incentives for renewable heat should be considered.

Technology	CHP Size		Approx. Heat Demand Covered (GWh/year)	Approx. Annual CO_2 Savings (t CO_2/year)	Approx. Lifetime CO_2 Savings (t CO_2)	Approx. Lifetime Cost of Carbon Saved (£/t CO_2)
	(kWe)	(kWth)				
Natural Gas CHP	91	104	0.73	80	1,200	£80 - £250
Biomass Boiler	-	96	0.73	167	2,500	£80 - £150

6.1 Overview

Enabling the development of the low carbon opportunities identified in Section 5 will critically depend on the appropriateness of the delivery mechanisms employed. The options available to the Borough vary widely, and for the purposes of this report, they have been grouped under the following five headings:



The following sections detail the mechanisms under each of these headings, providing case studies to illustrate how these mechanisms can be brought into play. Table 6.1 overleaf provides a summary of the pros and cons of each of these mechanisms.

Table 6.1: Summary of Pros and Cons of Delivery Mechanisms

Delivery Mechanisms	Pros	Cons
Overarching Policies	• Provides an effective policy framework. • Demonstrates an authority's commitment and leadership and enables the development of partnerships. • A broad range of overarching policies will enable the Council to deliver low carbon solutions in both existing (e.g. Housing Strategy) and new (planning policy) developments.	• Potential that unrealistic targets can be set and not been met, with negative, mainly political, implications. • Where there is a variety of policies, ensuring integration can be a challenge. • Developers may not be prepared to meet 'stringent' planning requirements. This could lead to these developers choosing not to develop in Tunbridge Wells.
Council-led Initiatives	• Demonstrates an authority's commitment and leadership and enables the development of partnerships. • Local authorities are not entirely dependent upon third parties for the delivery of their policy objectives and have control over their success. • Awareness raising.	• There may be difficulty in ensuring that all investment is maximised, particularly with grant schemes.
Local Authority Partnerships	• Sharing of information, resources and experiences. • Wider opportunities are available across borders • Leveraging demand for renewable resources such as biomass.	• Where partners' objectives are not aligned it may be difficult to focus efforts.
Public-Private Partnerships	• The advantage of the private sector access to funds and finance that can complement public sector investment. • Outsourcing skills while maintaining control over delivery of schemes	• Legal and financial limitations to the extent to which local authorities can invest in PPPs.
Local Strategic Partnerships	• Buy-in across relevant parties provides momentum for the delivery of projects. • Involvement of local business	• With the involvement of a wide variety of stakeholders, focusing effort may prove difficult.

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6.2 Overarching Policies

Overarching policies essentially provide the "backbone" of a low carbon strategy. Such policies can be developed specifically for a strategy or exist under the various functions of the local authority. Together, all relevant policies form a framework upon which the whole strategy is hinged. TWBC is in a great position in that it has already adopted the majority of the key policies upon which a strategy can be built. There is a wide range of policies that can be adopted. These can be defined under the following headings:

- National and Regional Strategic Policy
- Procurement Policy
- Planning Policy
- Local Strategic Policy

Policy Type	Already in place in TWBC?
Strategic Policy (includes Nottingham Declaration, carbon targets, adoption of National Indicators)	As well as adopting the Kent County Council targets for carbon reduction, the Borough Council signed the Nottingham Declaration in February 2007. National Indicators that relate to climate change, carbon and fuel poverty (185, 186,187 and 188) have been adopted by relevant departments of the Borough Council.
Procurement Policy	The current Procurement Strategy states that environmental specifications will be included in contracts. Potential contractors will be assisted to enable them to make informed decisions about the environmental impact of products and their whole life cost.
Planning Policy (includes Local Plan, LDF Core Strategy, DPDs, LDOs, Development Control)	The current Local Plan sets out a number of policies relating to energy efficiency, renewable energy, climate change and fuel poverty. This is supported by the Renewable Energy SPD which will be saved as part of the LDF currently being developed. The Core Strategy for this LDF has been drafted and includes policies which commit the LDF to delivering the objectives of a low carbon strategy.
Local Strategic Policy (includes Housing Strategy, Environment Strategy, Carbon Management Plan etc)	The Borough Council has adopted a range of strategies relevant to climate change and carbon reduction. A review of these has been undertaken in Section 3 of this Report.

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6.2 Overarching Policies (…contd)

Effectiveness

- As demonstrated by the case studies outlined overleaf, having a policy framework in place has proved most effective in providing a basis upon which to develop implementation strategies for the delivery of low carbon development.
- Overarching policy demonstrates an authority's commitment and enables the development of partnerships.
- An authority can demonstrate leadership through procurement policy also influencing suppliers/contractors to work towards similar objectives.
- It is clear from experience throughout the UK and globally that policy alone will not deliver the desirable results. Overarching policies need to be a part a strategic approach that is complemented by enabling delivery mechanisms.
- A broad range of overarching policies, will enable the Council to deliver low carbon solutions in both existing (e.g. Housing Strategy) and new (planning policy) developments (TCPA/CHPA, 2008 *Community energy: Urban Planning for a Low Carbon Future*).

Risks/Challenges

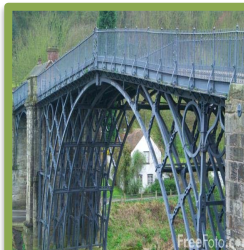
- With regards to carbon targets, without strong delivery policy and effective delivery mechanisms they may not be met.
- In some cases, unrealistic targets have been set and not been met and this has had negative, mainly political, implications.
- In a situation where there is a variety of policies, ensuring integration can be a challenge and is essential to bring all relevant policies under the umbrella of a low carbon strategy.
- Another risk is that developers may not be prepared to meet what they may consider to be 'stringent' planning requirements. This could lead to these developers choosing not to develop in Tunbridge Wells.
- With procurement policy, there is a need to ensure that it is policed and enforced to avoid window-dressing.

Capital Investment

- There are no significant capital investment requirements (if any) in developing overarching policies

Dover Core Strategy

- Dover's Core Strategy policy on sustainable construction and renewable energy is one of the first to take a rounded approach. To inform this policy, a project was undertaken involving the creation of a district-tailored evidence base and testing of four strategic sites to demonstrate where opportunities exist for setting higher sustainability standards than those across the rest of the District.
- This study showed that to deliver significant carbon reductions the role of the local authority can be pivotal in more ways than just setting carbon targets for different delivery areas. The need for both coordination of local supply and energy technology selection to ensure that targets are delivered is where planners have a key enabling role. The study also highlighted the need for planners to take a lead role in master planning key new developments to ensure that energy strategies are considered early, to determine their relationship with density and place-making and to quantify the carbon reductions that could be achieved through a spatial planning approach.
- Further information: Planning Magazine 13 March 2009 http://www.planningresource.co.uk



Shropshire Community Strategy

- Shropshire County Council's community strategy examines the potential to reduce greenhouse gas emissions from the county as a whole, and is used as a method of determining actions that the council should engage in to achieve the most effective reductions.
- In this arena, the council works in partnership with Marches Energy Agency to engage both geographical communities and communities of interest in changing behaviour (for example, Women's Institute groups, church congregations and specific towns).
- Further information: Steve Fowkes http://www.shropshire.gov.uk/index.nsf

6.3 Council-led Initiatives

As well as demonstrating leadership and commitment through adoption of overarching policies, Councils can also run initiatives to achieve some of the objectives set out in policy. There is a wide range of types of initiatives that a local authority can undertake. These include:

- Grant Schemes
- Loans
- Awareness Raising
- Community Infrastructure Levies
- Land Grant Receipts Negotiations
- Involvement in other programmes (e.g. Building Schools for the Future, Transition Towns)

Initiatives	Already in place in TWBC?
Grant Schemes	The Borough Council has a range of grants available to local residents under the Housing Renewal Assistance Policy. Some of these grants enable households to improve the energy performance of their homes. These grants include Coldbusters Initiative, Top-up for Renewal Grants, Making rural homes more energy efficient, Renewable Initiative, Hard to Heat Homes and landlord grants (Private Accredited Landlord scheme). Other housing grants are available and could potentially be linked to energy efficiency and carbon reduction objectives.
Loans	Currently the Borough Council provides repayable grants (some of the Coldbusters Initiative grants that are over £1,500)
Awareness Raising	The Borough Council has run a variety of campaigns associated with various schemes and programmes. Awareness raising activities include leaflet distribution through council tax mailing; advertising in the Council newsletter and displays at public events.
Community Infrastructure Levies	The Council has not had significant experience in any of these mechanisms.
Land Receipts Negotiations	

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6.3 Council-led Initiatives (…contd)

Effectiveness

- As with overarching policy, Council-led initiatives demonstrate commitment and leadership. This encourages stakeholders to follow suit.
- In undertaking various initiatives, local authorities are not entirely dependent upon third parties for the delivery of their policy objectives.
- By owning the initiatives, local authorities have control over their success.
- Raising awareness educates the community and informs them of the options available to them in which to participate.

Risks/Challenges

- The key challenge will be ensuring that the potential of any initiative (grants in particular) is maximised. Implementation needs to be innovative in a way that encourages beneficiaries to show initiative before grants are made available (e.g. as opposed to issuing grants, households that improve their energy efficiency can receive council tax discounts from a fund financed by developers).
- Ensuring that grants are directed to where they are needed

Capital Investment

- There are significant capital investments necessary, particularly for grant schemes.
- Alternatives to providing grants would be revolving interest-free loans.

6 Delivering the Opportunities (Case Studies)

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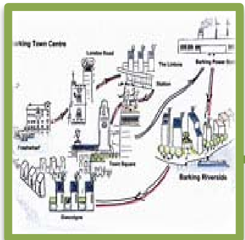

Borough of Barking & Dagenham

- The London Borough of Barking and Dagenham has developed a climate change strategy and have organised a series of awareness raising events with a number of local age and faith groups.
- Events were organised by the climate change officers responsible for writing the strategy and promoting projects, with support by other members of the team.
- Groups were contacted directly or through intermediaries, with the first contact being facilitated by the Council's community engagement team.
- This was one of many initiatives to disseminate information on climate change for the purpose of mitigation and adaptation. Other initiatives included festivals and fairs, school quizzes and articles in the local press.
- Monitoring their effect on residents will help the council fine-tune its community engagement strategies.
- Further Information: http://www.beacons.idea.gov.uk

Woking Borough Council

- Woking has sought to include different community groups in the decision-making process about how they should address climate change.
- The awareness raising campaign involved Local Residents – from ethnic minorities who have incorporated energy efficiency measures into their home have opened their homes to interested neighbours so they can see the installations and ask questions; Faith/Community organisations – have taken part in training sessions and debated local climate change issues e.g. through the Woking People of Faith Forum; and The Energy Care Network (TECN) – has delivered energy efficiency training and helped to target grants through referrals.
- Further Information: http://www.beacons.idea.gov.uk

6.4 Local Authority Partnerships

Partnerships between local authorities and/or Central Government are most useful where parties share similar objectives and wish to make resources go further. In relation to delivering low carbon solutions, partnerships can take the following forms:

- Local Area Agreements
- Local Authority Energy Partnerships
- Public Sector Agreements
- Project Delivery Partnerships/ Joint Procurement

Partnership Type	Already in place in TWBC?
Local Area Agreements	Under National Indicator 185, the Borough Council is part of the local area agreement between Kent local authorities. As part of this LAA, the Council agrees to contribute to the carbon reduction targets set out in the Structure plan and Kent Agreement 2.
Local Authority Energy Partnerships	The Borough Council is involved in Energy Saving Trust Advice Centre (ESTAC), the Kent Energy Efficiency Partnership and the South East Carbon Action Network. Involvement in both organisations is primarily for information sharing, although there has been project level involvement with ESTAC.
Public Sector Agreements	The Council has limited experience with PSAs.
Joint Procurement	The Council has partnered with other Councils in the North and West Kent Partnership to procure a managing agent to administer the grant schemes currently available over the next two years. This is the extent of the Council's experience in joint procurement.

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6.4 Local Authority Partnerships (…contd)

Effectiveness	Risks/Challenges	Capital Investment
• Partnerships enable the sharing of information, resources and experiences. • As shown in the Greater Manchester Association case study, resources go further when they are pooled to achieve/deliver joint purposes. Also duplication is avoided. • Where projects are delivered jointly at a strategic level, wider opportunities are available particularly where developments/ communities are situated across borders. • Local authority partnerships are particularly effective means of ensuring sufficient demand for renewable energy resources such as biomass. Thus investment in processing and delivery of biomass resources becomes viable.	• It is essential that partners share similar objectives to ensure focused efforts.	• Capital investment requirements depend on the purpose of the partnership. Policy collaborations would not require any capital investment while project delivery or joint grant schemes would require significant levels of capital. However, by sharing resources, the requirements are relatively lower for each party.

Association of Greater Manchester Authorities

- Through Urbed, the Association of Greater Manchester Authorities are undertaking a study to produce a very useful delivery focussed evidence base for ten authorities. The study is being funded through the £22,000 made available to each local authority to help implement PPS1 Planning and Climate Change.
- The study uses the PPS1 methodology and an approach developed in Community Energy: Urban Planning for a Low Carbon Future . A series of 'character areas' have been identified based on distinctive locational characteristics, including land use mix, density, age of stock and tenure. These will help define the likely technology mix since a mixed use town centre will have different opportunities to those in a largely residential suburb or rural village.
- Policy approaches and targets can be tailored to each if necessary.
- Further Information: Planning Magazine 13 March 2009 http://www.planningresource.co.uk

SunGain – Nottingham Energy Partnership

- SunGain is a Nottinghamshire / Derbyshire Local Authority Energy Partnership (LAEP) initiative to install solar hot water systems in public and private sector homes, project managed by Nottingham Energy Partnership.
- The project has installed approximately 120 solar hot water units so far, thereby demonstrating the practical use of a renewable energy resource and the positive role of renewables within the overall context of energy efficiency and climate change.
- The Energy Saving Trust (EST) and Nottingham City Council provided funding for an initial feasibility study. The EST Innovation Programme provided funding for a further 2 years. Capital grant funding comes from the Clear Skies programme and the Local Authority Energy Partnership (LAEP).
- Local Installers have been trained and accredited to supply appropriate systems selected through a rigorous tender process. Quality Assurance is managed by private consultants T4 Sustainability.
- Further Information: http://www.nottenergy.com

6.5 Public-Private Partnership

Public-Private Partnerships (PPPs) enable the involvement of the private sector in achieving public sector objectives. The key benefit is the private sectors ability to raise capital investment and funding for public sector projects. PPPs can be arranged to deliver specific projects, set up companies or establish grant schemes. The way PPPs are set up varies depending on their purpose. Relevant examples include :

- Joint Ventures
- Special Purpose Vehicles
- Energy Services Companies
- Bulk Purchase Cooperatives
- Private Finance Institutions

Partnership Type	Already in place in TWBC?
Joint Ventures	The Borough Council has partnered with John Laing to set up the Tunbridge Wells Regeneration Company Limited which will regenerate four towns in the Borough over the next ten years. This partnership offers the opportunity for the Council to demonstrate leadership in sustainable energy development on its own estate and its own developments.
Special Purpose Vehicle	The Borough Council has not had recent experience of setting up these PPPs
Energy Services Companies	
Bulk Purchase Cooperatives	
Private Finance Institutions	PFIs have been used to finance housing and energy efficiency grants schemes.

6.5 Public-Private Partnership (…contd)

Effectiveness	Risks/Challenges	Capital Investment
• PPPs are effective delivery mechanisms that have the advantage of the private sector access to funds and finance that can complement public sector investment. • PPPs are an alternative to straightforward procurement/outsourcing which enables local authorities to deliver their objectives where they may not necessarily have the skills or resources. Local authorities are also able to maintain controlling interest.	• There are legal limitations to local authority involvement in PPPs. It is essential to check legal obligations before a local authority arranges a PPP. • It will be essential to ensure that the legal and financial structure of the PPP is appropriate for a local authorities obligations. • There are uncertainties associated with bulk purchasing, specifically relating to storage and uncertain future demand. Furthermore, the demand may not be high enough to warrant a discount from suppliers.	• Capital investment requirements can be significant depending on the purpose of the partnership. However, investment does not always have to be financial. In the case of the Borough Council's partnership with John Ling, the Council's investment was in the form of Council estate.

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Woking Borough Council Working with ESCos

- Woking Borough Council realised that a special purpose vehicle would be required if it was to further its energy and environmental objectives. After some Energy Saving Trust funded research in to the legal issues surrounding public/private partnerships the Council established Thamesway Limited (TW) – an Energy and Environmental Services Company (ESCO).
- The purpose of TW is to enter into public/private joint ventures to deliver its energy and environmental strategies and targets (primarily energy, tackling fuel poverty, waste, water and green transport). The company has allowed the council to capitalise on its intellectual property in small-scale CHP to enable large-scale district CHP to be implemented, primarily with private finance.
- Further Information: www.woking.gov.uk

Ouse Valley Energy Services Company

- The Ouse Valley Energy Services Company was formed in 2007 by a group of Lewes residents to deliver a range of energy saving, renewable energy and related projects to the residents of the Ouse Valley & East Sussex . It has come from the Transition Town process, and has been founded by members of the TTL Energy Group.
- The ESCo assists the residents of the Lewes District Council (LDC) area to reduce their carbon emissions through a range of different measures. OVESCo has already run one round of the renewables grant scheme for LDC. With the help of the LDC grants over 50 solar thermal panels were fitted November 07 - April 08. effects of local fuel poverty.
- OVESCo is now seeking funding to back future schemes. Please contact OVESCo should you be in a position to fund future projects.
- Further Information: http://www.ovesco.co.uk/

6.6 Local Strategic Partnerships

Local Strategic Partnerships (LSPs) enable the involvement of key stakeholders in achieving local objectives and delivering community benefits. The key benefit is the there is buy-in from all stakeholders and there is momentum for the delivery of projects. Local authorities can partner with a variety of stakeholders depending on what needs to be achieved:

- Transitions Towns
- Health Authorities
- Education Authorities
- Technology manufacturers and installers

Partnership Type	Already in place in TWBC?
Transition Towns	Transition Tunbridge Wells has been running for 10 months. The organisation has been in dialogue with the Borough Council to identify opportunities for collaboration.
Health Authorities	There is currently no specific collaboration with the NHS
Education Authorities	There is some collaboration with Kent County Council as the education authority although further opportunities could be explored to maximise the potential of the collaboration.
Technology manufacturers and installers	At present local businesses are engaged through economic development initiatives. There is specific partnerships or collaboration with this stakeholder.
Cleaner Greener Partnerships	The Borough Council services and maintains the Cleaner Greener Thematic Group under the Tunbridge Wells Together Partnership (TWP). The purpose of this group is to “provide a forum in which partners can work together to plan services and programmes and to oversee their delivery.” The Cleaner Greener Group advises the TWP on the content of the Sustainable Community Strategy and the Local Area Agreement Two and supports their delivery.

6.6 Local Strategic Partnerships (…contd)

Effectiveness	Risks/Challenges	Capital Investment
• Buy-in across relevant parties provides momentum for the delivery of projects. • Works well in conjunction with awareness raising • Involvement of local business	• Keeping focused and involving only relevant stakeholders. • Ensuring that all parties share the same objectives	• Varies depending on projects to be delivered through partnership.

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Cornwall Sustainable Energy Partnership

- The Cornwall Sustainable Energy Partnership is an innovative and cohesive county approach to addressing the social, environmental and economic issues of energy supply and demand.
- Since 2001, the partnership has brought together over 80 key organisations to develop policies and active sustainable energy programmes. It has particularly concentrated on promoting the role that energy plays within sustainable development, placing it within an integrated energy strategy and delivery plan.
- The partnership was instigated by the eight councils of Cornwall and the Isles of Scilly: Cornwall County Council; Caradon District Council; Carrick District Council; Kerrier District Council; North Cornwall District Council, Penwith District Council; Restormel Borough Council and the Council of the Isles of Scilly.
- The partnership receives funding from the Energy Saving Trust via its Local Authority Support Programme (now called Local Energy Support), and its staffing has been increased through the funding from various sources, including the private sector (EDF Energy), project management income, and staff secondments from local authorities.
- Further Information: www.csep.co.uk

Bath & North East Somerset

- In 2006 the Centre for Sustainable Energy (CSE) developed an energy efficiency scheme, which involves Bath & North East Somerset Council and its partners in the Local Strategic Partnership (LSP).
- Funding for this project was from the Treasury's Invest to Save Budget designed to bring about improvements in the delivery of local public services.
- The aim of the project is to cut energy consumption for participating members of the LSP by at least 10 per cent over the next three years. The objective was to save an estimated £4.7 million between 2006 and 2012.
- The project has a two pronged approach. On the one hand more than 20 high energy use buildings had monitoring and metering equipment installed in the first two years. In addition, thousands of staff have been trained at all levels in each organisation to deliver changes at a grass roots level. This included training energy champions, building managers and frontline staff.
- Further Information: http://www.bathnes.gov.uk

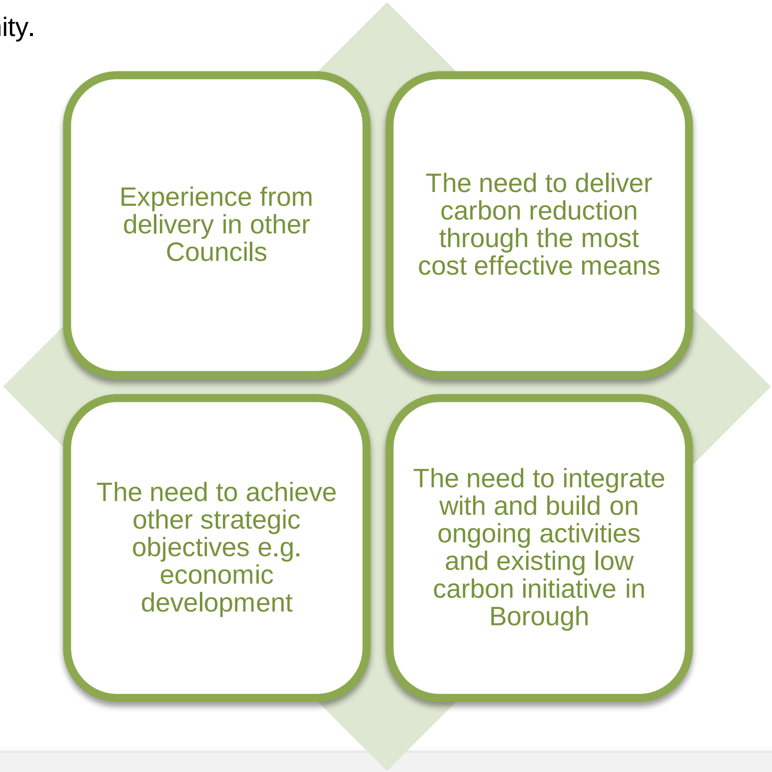
7.1 An opportunity to innovate

On the basis of the opportunities set out in Section 5, Delta identified the appropriate mechanisms for delivery of these opportunities. In doing this, we have taken account of the four key considerations shown in **Figure 7.1** below.

In addition to building on the Council's experience and existing initiatives, some of the recommendations may be described as 'bold'. We have included these given the Council's appetite for risk and innovation. As such some of these recommendations present the Council with the opportunity to develop innovative approaches to carbon emissions reduction in the Borough.

The following sections highlight the relevant mechanisms for each opportunity identified in Section 5, providing an outline of the approach that we recommend be adopted for the delivery of each opportunity.

Figure 7.1: Considerations for appropriate delivery mechanisms



7.2 Existing Stock

Section 5.4 highlights that existing stock presents the greatest and most immediate opportunity for reduction of carbon emissions, particularly in residential properties. This can be achieved through energy efficiency improvements and installation of low carbon and renewable energy technologies.

Challenges to be addressed in realising this potential include:

- The lack of skilled labour for installation of products.
- The difficulty face by some households in preparing lofts for insulation - grant schemes are not tailored to include clearance of lofts.

The key to success in realising this opportunity is in incentivising property owners to take the necessary steps to improve the energy/carbon performance of their properties. The relevant delivery mechanisms that will enable this are outlined below.

We recommend that first priority is given to the dense character areas, such as the edge of centre character. By prioritising these character areas, the most effective use can be made of grant funding. To deliver carbon emissions reductions in the other character areas, the key lies in providing homeowners with the necessary support through access to discounted products and information on suppliers / installers as outlined below.

Recommendation 1: Grant schemes, revolving loans and council tax discounts (Council-led Initiatives)

Given that the Council already has grant schemes in place for housing renewable and energy efficiency improvements, we recommend that these schemes continue under a low carbon strategy. However, a step change is likely to be required in the levels of funds made available if energy efficiency is to be improved significantly.

At present, £817,412 is available for 2009/10 and £727,293 for 2010/11. As resources are limited, we recommend exploration of the following to maximise potential of funds available:

- Making funding available as repayable grants, revolving loans (where larger sums are required), or council tax discounts. Council tax discounts are currently funded through a British Gas CERT Scheme. Alternative funding is discussed in Section 7.3. This approach would make grants available to both disadvantaged households and those able to repay grants.
- Directing the existing awareness raising campaign more to those who would benefit from the available funds thereby ensuring that they are aware that they can apply for them.

7.2 Existing Stock (…contd)

Recommendation 2: Bulk purchase of products (Local Authority Partnerships)

As highlighted under Section 6.5, there are uncertainties associated with the arrangement of bulk purchases. These relate to difficulties in quantifying future demand and storage of products. To avoid and/or overcome these difficulties, we recommend that the Council explores the following options:

- Partnering with neighbouring authorities to ensure that there is sufficient demand to justify the arrangements
- Arranging the bulk purchases as discount schemes with manufacturers/suppliers. The schemes could be based on the partnership councils purchasing a certain quota annually.

Recommendation 3: Development of a register/directory of suppliers and installers (Local Strategic Partnerships)

Developing links and partnerships with suppliers and installers will aid efforts to arrange access to discounted products. This can be arranged through the Economic Development department via existing liaison channels with local businesses. To ensure reliability of products, certain requirements should be put in place for those suppliers/installers wishing to be on the Council's register (e.g. accreditation under the Low Carbon Buildings Programme).

7.3 New Build and Developments

Local planning policy and development control are key to delivery of the potential discussed in Sections 5.5 and 5.6. The following mechanisms can be integrated with planning policy:

- Planning gain
- Local Development Orders
- Setting targets for low carbon or renewable energy generation for large developments
- Section 106 Agreements

As well as being set out in the Core Strategy, such policies can be detailed in Area Action Plans and Supplementary Planning Documents.

Recommendation 4: Alternative Planning Policies

The introduction of more stringent planning requirements may discourage developers and therefore we recommend that alternative approaches be explored, including:

- **Community Infrastructure Levies or Allowable Solutions** (as proposed under the consultation on the definition of zero carbon) can be used to fund development of low carbon solutions (amongst other initiatives) at a community level. These can also be arranged as carbon offset funds into which developers pay to supplement the grant schemes and council tax discounts discussed in Section 7.2.
- Where developments have high energy standards, **lower land receipts** from developers can be negotiated.

For residential developments, higher standards in terms of energy standards will be required as a result of the Code for Sustainable Homes. By 2016 all new homes will be expected to be code level 6 (zero carbon). The opportunities identified in Section 5 would assist the Council in meeting, and potentially exceeding, regulatory requirements (such as the Code for Sustainable Homes).

7.4 Council Estate and Other Strategic Sites

Recommendation 5: Establishing an ESCo

For site-specific opportunities, the most appropriate approach to delivering low carbon solutions is likely to be through an **ESCo**. The manner in which an ESCo will deliver solutions at each site will vary depending on the stakeholders involved as outlined below. We recommend that the Council investigates the establishment of a borough-wide ESCo for the delivery of all the opportunities identified in Section 5.

As well as focusing on specific sites, the ESCo can also be responsible for the administration of initiatives relating to existing development (Section 7.2) and management of community schemes delivered through the community infrastructure levies.

Given that a public-private partnership already exists with John Laing, we also recommend the possible establishment of a new arm of the Regeneration Company which will act as the borough-wide ESCo. Given the Council's appetite for risk and innovation, this approach would be appropriate as it:

- Allows the Council to take the lead and maintain control while maintaining a degree of separation for effective management
- Ensures close alignment of the ESCo's activities with strategic objectives
- Allows the Council to accept lower discount rates and thereby pass on lower costs to customers

Table 7.1 overleaf sets out approaches to the delivery of the site-specific opportunities identified in Section 5.

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Table 7.1: Delivery of Site-Specific Opportunities through an ESCo

<table>
<tr><th>Opportunity</th><th>Delivery</th></tr>
<tr><td>North Farm</td><td>Public-Private Partnership

The development of a DH/CHP scheme at North Farm is likely to have a number of stakeholders:
Southern Water
Kent County Council
Tunbridge Wells Borough Council
Private Hospital Operators
The most effective delivery mechanism in this situation would be the establishment of an ESCo. Consultation with stakeholders will be necessary to determine the preferred structure of the ESCo. If anaerobic digestion is to be developed on the site, this could be developed and operated by the ESCo.</td></tr>
<tr><td>Old Kent & Sussex Hospital Site</td><td rowspan="2">Planning Policy and Public-Private Partnership

Local planning policy (LDF or Local Plan) will have a significant role in the delivery of DH/CHP at these sites as they are both allocated for new development. It will be necessary however to have requirements for inclusion of CHP at these sites clearly set out in policy. The means of delivery will depend on the number of developers involved in developing the sites. An ESCo set up for the purposes of delivering low carbon solutions across the Borough could be the delivery vehicle at these sites in agreement with developers.</td></tr>
<tr><td>Royal Victoria Place</td></tr>
<tr><td>Broadwater Lane</td><td>Public-Private Partnership

The DH/CHP opportunity at this site would need to be delivered through stakeholders currently occupying the site. An ESCo could be the main vehicle for delivery although its structure and involvement of occupiers would need to be reviewed in consultation with them.</td></tr>
<tr><td>Leisure Centres</td><td>Public-Private Partnership

The three opportunities at the leisure centres discussed in Section 5 can be delivered by an ESCo in partnership with Kent County Council where schools are to be integrated. The ESCo would arrange the installation and maintenance of the systems installed. It would be necessary for the ESCo to work in collaboration with the management contractors for these leisure centres.</td></tr>
<tr><td>Town Hall and Surrounds</td><td>Public-Private Partnership

The Joint Venture established between John Laing and the Borough Council (Tunbridge Wells Regeneration Company) is a key delivery vehicle on this strategic site and others that the Council has brought to the partnership. Although the partnership will operate like any other developer (on the basis of planning requirements), there are opportunities for the cost-effective development of flagship projects.</td></tr>
</table>

8 Next Steps

8.1 Overview

As highlighted earlier in this report, the potential opportunities identified have been assessed on the basis of information available without liaising with developers, and on indicative planning allocations which are yet to be finalised. Therefore, the recommendations provided in Section 7 are high level and would need to be explored further in developing a low carbon strategy for the Borough.

We envisage that the key elements of a low carbon strategy would be as follows:

- A clearly defined goal to be achieved over the lifetime of the strategy
- An action plan setting out key deliverables, responsibility and funding necessary to achieve the goal
- A monitoring framework to track progress towards achievement of the goal.

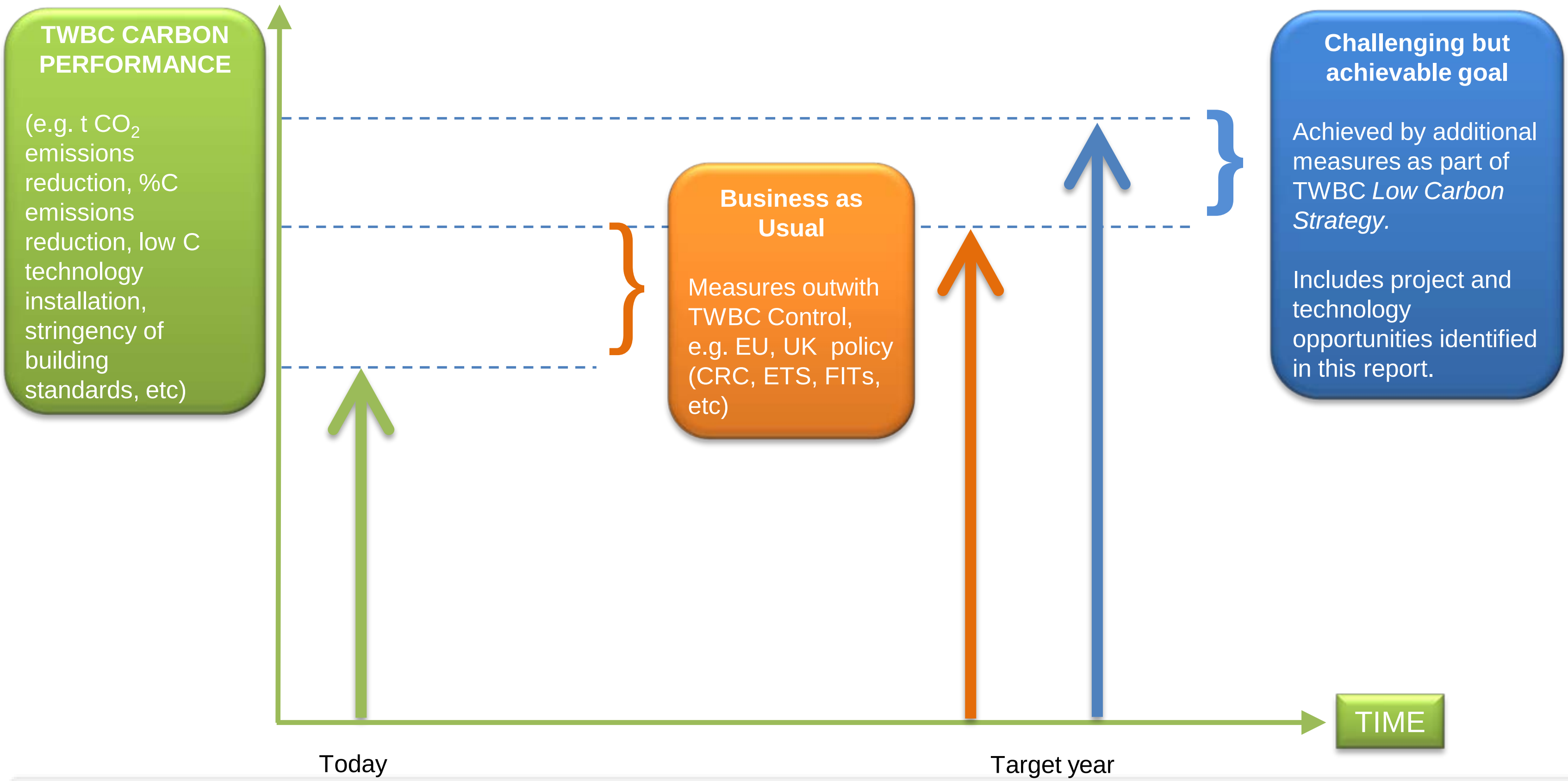
Such a strategy will pull together all the relevant initiatives, highlighted in Section 3 of this report, integrating the opportunities and recommendations in Sections 5 and 7. This will enable a more coordinated approach to delivering low carbon energy.

We recommend that the Council proceeds with the steps shown below to develop a low carbon strategy for the Borough. These actions are briefly discussed overleaf.

1. **Develop a challenging, but achievable goal**
2. **Consolidate the policy framework & review internal institutional arrangements**
3. **Identify and consult with external partners**
4. **Identify funding/finance opportunities**
5. **Develop Action Plan**

8.2 Developing Strategy Goals

The Goals / Targets of the Strategy can be expressed in different ways – relating directly to emissions (e.g. t CO_2 emissions reduction) or to specific DE measures (e.g. number of PV units installed, tighter new building standards, etc). A variety of such targets may be chosen. The key requirement is that the goals achieve a low carbon performance that goes *beyond* business-as-usual. Importantly, this goal needs to be supported by a robust baseline (e.g. energy demand profiles by sector, load curves (to differentiate between base and peak demand), and housing conditions) which will need to be established on the basis of the high-level estimates provided in this report. This would also require detailed feasibility studies for the opportunities identified here.



8.3 Other Steps in the Process

Institutional Arrangements & Policy Framework

- It will be key to identify a "Champion" within the Council to oversee the development and delivery of the Strategy. The Champion could be supported by a group of officers from a range of departments. The Sustainability Officers Board which currently exists in the Council could take on this role. An internal discussion would be necessary to determine to whom this group reports. Consideration would need to be given to capacity building to enable delivery and monitoring.
- Building on the contextual review (Section 1) and the goals as set out in Section 8.2 above, gaps need to be identified in existing policy (e.g. policies relating to use of Community Infrastructure Levies for the development of community energy schemes). Where there are gaps, the necessary policies need to be developed and included in the Strategy

External Partners

- A variety of stakeholders have been identified in this report (property owners, energy utilities, neighbouring authorities). Dialogue with these stakeholders needs to be initiated to understand their appetite for involvement. Consultation with these stakeholders may also highlight other partners with which the Council could work.

Funding & Finance

- A variety of delivery mechanisms have been recommended in this report, some of which will require capital investment (e.g. grant funding, revolving loans and bulk purchase of products). Potential sources of funding have been identified including Community Infrastructure Levies and utility CERT (and post-CERT) schemes.
- Although some of these arrangements are already in place, discussions with potential partners will need to highlight financial arrangements for the low carbon strategy.
- We recommend that the ESCo be set up to arrange and manage the finances.

Action Plan

- Some of the opportunities identified in Section 5 offer immediate 'easy' wins, while others can only be delivered over the medium to long term. As such, we recommend the following phasing of delivery:
  - *In the short term (up to 5 years)* – putting in place a framework for delivery of the carbon reduction potential in existing development as outlined in Section 7.2.
  - *In the medium term (up to 15 years)* – work with stakeholders at North Farm and Broadwater Lane to plan feasibility studies and development of opportunities identified at these sites. Other strategic sites discussed can also be delivered within this time period.
  - *In the long term (beyond 15 years)* – through liaison with developers of allocated sites (including the Regeneration Company) agree appropriate technologies to be taken forward further to feasibility studies. Other sites can be identified using the methodology outlined in Section 5.1.

Delta Energy & Environment Ltd
Registered in Scotland: No SC259964
Registered Office: 15 Great Stuart Street, Edinburgh, EH3 7TS

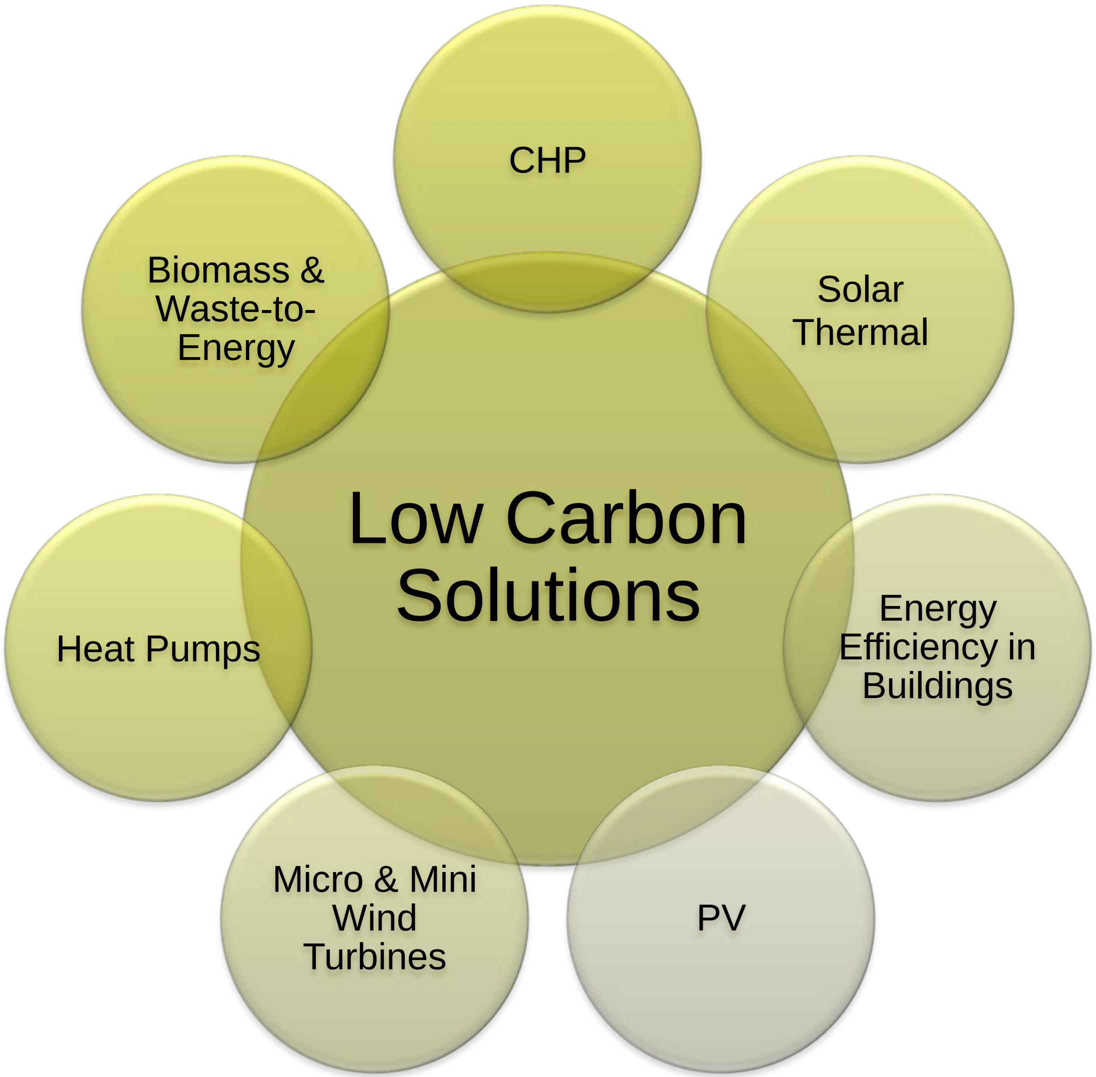
A Low Carbon Strategy For Tunbridge Wells Borough

Annex A: Technologies & Resource Assessment

July 2009

Contents

1. What are the relevant technologies?



Technologies discussed in this report

From a wide selection of decentralised energy technologies, this report considers covers those agreed in the scope of work and shown here. These technologies are chosen on the basis of maturity and proven effectiveness elsewhere.

The following slides will address each of these technologies in turn, providing an overview of the technology status, key applications and costs.

1. What are the relevant technologies?

1.1 Combined Heat and Power [CHP]

The following slides will address the three relevant types of gas-fired CHP (Micro-CHP, Packaged CHP and District Heating CHP) in more detail

	Micro-CHP	Packaged CHP	District heating CHP
Indicative annual CO_2 saving	850 kg per home	280 t per 100 kW system	700 t per 500 kW system
Indicative cost (£/kWe)	£3,500 - £11,000	£750 - £1,000	£750 (CHP system) £800 per m (network)
Typical lifetime	15 yrs	15 yrs	15 yrs (CHP unit)
Simple payback	3 – 4 yrs	4 – 5 yrs	>5 yrs
Lifetime cost of carbon saving (£/t CO_2)	44 – 66	80 – 190	190 – 250
Suitable applications in Tunbridge Wells	Individual homes	Commercial offices Leisure and recreation Schools and education Community and health Council estate	Industrial and commercial Denser residential zones

Pros	Cons
• Mature and proven (except micro-CHP) • Cost-effective GHG emissions savings • No visual impact	• Low-carbon, rather than zero carbon renewable • Need stable heat demand • High capital costs for district heating networks

1. What are the relevant technologies?

1.2 Combined Heat and Power [CHP] (...cont)

Internal Combustion Engine

Micro-CHP

Description and applications

- 1-5 kWe CHP systems replacing gas boilers in individual homes
- Stirling Engine, Internal Combustion Engine and Organic Rankine Cycle
- Fuel Cell products in development, unlikely to be commercial before 2012

Stirling engine system

Organic Rankine Cycle system

Technology status (Stirling engines, internal combustion engine and Organic Rankine Cycle)

- Electrical efficiencies of 10% - 25%, total efficiency up to 80%
- Emerging technology – first commercial products available in 2009/10
- Cost up to ~£11,000 for a 1 kWe Stirling engine system (installed cost; costs will fall with mass production).

1.3 Combined Heat and Power [CHP] (...cont)

Micro-turbine

Packaged CHP

Description and status

- Supplying heat and electricity for commercial and public buildings
- Typical applications in leisure centres, hotels, hospitals and schools
- Internal Combustion Engines (ICE) and Micro-turbines
- Electrical capacity of 10s to 100s kWe

Technology status

- Mature and reliable technology
- Electrical efficiencies of 25% (Micro-turbine) to 35% (ICE)
- Costs of around £750+ per kWe (ICEs) to around £1,000+ per kWe (Micro-turbine)

ICE

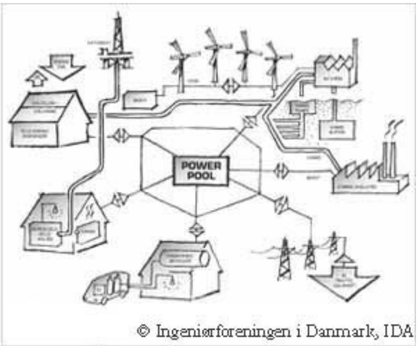
	Pros	Cons
ICE	• Lower capital costs • Higher efficiency	• Needs regular servicing (every 1,000 h) • Higher NOx emissions
Micro-turbine	• Lower operational costs • Lower noise and NOx emissions	• Higher capital costs • Lower efficiency

1.4 Combined Heat and Power [CHP] (...cont)

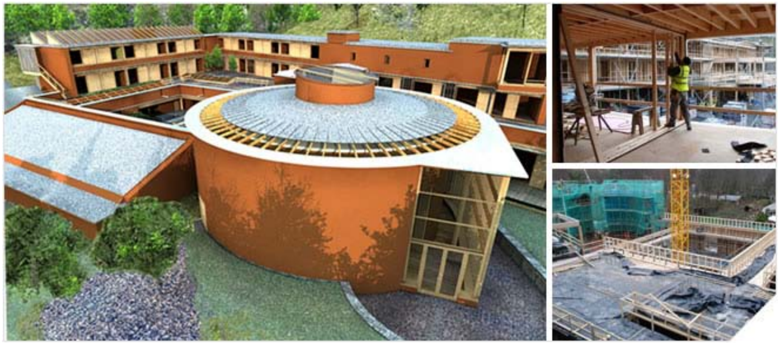
District Heating CHP

Description and applications

- Central CHP system supplying heat and power to multiple buildings linked by a heat network
- Can start with small number of high energy using buildings (anchor load) and expand over time
- Technology: ICEs and gas turbines of 100s kWe to several MWe



District heating network with various technologies



District heating scheme at Centre for Alternative Technology

Pros	Cons
• Based on large, stable heat demand • Can be higher CO_2 savings through economies of scale • Future proofing – allows for switch to renewable fuels	• High capital costs, especially for heat network • Less cost-effective in existing zones • Requires multi-stakeholder co-ordination

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1.5 Combined Heat and Power [CHP] (...cont)

Sample products and suppliers (not exhaustive)

Micro-CHP

Technology	Product	UK Supplier	Comments
Stirling engine	Ecogen	Baxi UK	First commercial sales likely in 2009/10
	Whispergen	Efficient Home Energy	
Organic Rankine Cycle	Energetix Genlec	Energetix	
Internal Combustion Engine (ICE)	Senertec Dachs	Baxi-Senertec UK	20,000 installed in Germany
	EC Power XRGI	SAV UK Ltd.	Thousands successfully installed in Europe
	Yanmar Genelink	Yanmar UK	Several thousand installed in Japan, entering the UK market

Packaged and District Heating CHP

Technology includes:	Manufacturer	UK Supplier	Comments
Internal Combustion Engine (ICE)	ENER.G	ENER.G	Leading packaged CHP developers in the UK
	Cogenco	Cogenco (Dalkia)	
	Jenbacher	Clarke Energy	Leading global ICE product
Micro-turbine	Capstone	Capstone Turbine UK	Higher upfront costs than ICEs, but lower servicing requirement.
	Turbec	NewEnCo	

1.6 Combined Heat and Power [CHP] (...cont)

UK Local Council Case Study

Woking Borough Council

Description	Woking Council set up a public/private ESCO to install a range of low-carbon energy supplies, including a new 1.35 MWe CHP system and 1.4 MW absorption chiller, supplying a district heating network.
Drivers	Leadership in local environmental policy
Achievements	• 43.8% energy savings • 71.5% CO_2 emissions reduction • £4.9 million saving for the Council and additional savings for residents
Lessons learned	• District heating CHP effective in existing town centre • Public/private ESCO model effective vehicle to deliver CHP • Use of private electricity network effective but adds to costs

CHP plant in Woking

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1.7 Energy Efficiency in Buildings

	Lighting	Building materials			
		Double Glazing	Loft insulation	Cavity wall insulation	Solid wall insulation
Indicative annual CO_2 saving	~60 kg per bulb	720 kg per house	1 t per home	800 kg per home	2 t per home
Indicative cost	£1 - £4 per kLm	~£300 per frame	£150 - £250 per home	~£250 per home	Up to £2,000 per home
Typical lifetime	7 yrs	20 yrs	30 yrs	30 yrs	40 yrs
Simple payback	0.9 yrs	9.1 yrs	16.7 yrs	4.2 yrs	14.2 yrs
Lifetime cost of carbon saving (£/t CO_2)	~5	120	10	14	111
Suitable applications in Tunbridge Wells	Council estates Commercial offices Town centre buildings	Council estates New council developments			

Pros	Cons
• Often the most cost-effective way of reducing costs and emissions • Lighting usually easy to change and products widely available • Suitable for all types of buildings	• A range of well documented non-economic barriers. • Efficiency measures like insulation can be difficult to retrofit in existing buildings

1.8 Energy Efficiency in Buildings (...cont)

Energy Efficient Lighting

Description and applications

Technology	Application	Efficacy (Lm/W)	Lifetime (h)	Price (£/kLm)
Compact fluorescent lamp (CFL)	General lighting	45	8,000 – 10,000	4
Linear fluorescent lamps (LFL)	Office lighting	85	25,000	0.75
Ceramic metal halide lamps	Retail lighting	80	12,000	~15
High-intensity discharge lamps	Street lighting	80	24,000	3
Light-emitting diodes (LEDs)	Indoor lighting	50	~40,000	~50

Technology Status

- CFLs, LFLs, Ceramic metal halide lamps and high-intensity discharge lamps state-of the-art are generally available products
- Most CFLs not dimmable, and concerns about mercury content
- LEDs available for niche applications, introduction for general lighting from 2010

CFLs

LED

1.9 Energy Efficiency in Buildings (...cont)

Energy Efficient Building Material

Description and applications

- A design issue – not a challenge of new technologies or knowledge
- Holistic approach options, e.g. Passive house concept (see next slide)
- Typical approaches
  - South-facing orientation of building façade & glazing
  - Use walls as thermal mass
  - Optimise insulation (loft, solid wall)
  - Double/triple glazing
  - Minimise loss through thermal bridges (e.g. draft proofing)

Technologies and Status – Advanced materials

Technology	Description	Status
Insulated concrete	Insulation consisting of pre-fabricated panels with concrete centre	Available in the UK from ~10 suppliers
Aerogel	Low-density solid insulation material	Costs currently too high
Cool roofs	Roofing materials with high reflectance and emittance	Available but more expensive than normal roofing
Structurally insulated panels	High-performance building panels of foam sandwiched in plywood	Available in the US, less common in the UK

1.10 Energy Efficiency in Buildings (...cont)

<u>Energy Efficient Building Material</u>

Case Study – Passive House concept

A passive house is a building in which a comfortable interior climate can be maintained without active heating and cooling systems

Main Measures and Approaches

- Compact form and good insulation
- Southern orientation
- Energy-efficient glazing and window frames
- Air-tight building envelope
- Passive pre-heating of fresh air (using ground heat)
- Heat recovery from exhaust air
- Use of renewable heating sources – e.g. solar thermal
- Energy-efficiency appliances

Passive House Standards

- Annual heat requirement < 15 kWh/m^2
- Annual primary energy use < 120 kWh/m^2

Passive house in Germany

Passive vs. Zero-carbon

Passive House standards are less stringent than zero-carbon (level 6 of the Code for Sustainable Homes). Achieving level 6 therefore requires renewable energy generation in the building to offset imported grid electricity.

1.11 Energy Efficiency in Buildings (...cont)

UK Local Council Case Study

Kirklees Council - Warm Zone Initiative		
Description	Kirklees Council's Warm Zone initiative offers free insulation to all council houses, regardless of their means. This aimed to contribute to reducing council emissions by 12%. These savings allowed it to participate in the UK Emissions Trading Scheme (ETS), the only local council to do so.	 Fitting insulation in Kirklees
Drivers	• Address fuel poverty (affecting 26% of residents) • Reduce CO_2 emissions • Participate in the UK ETS	
Achievements	• Reduced CO_2 emissions by 34% by 2005	
Lessons learned	• Effective measures start with closely monitoring consumption • Smart meters central to effective monitoring • Community engagement essential for success • Successfully combined energy efficiency with renewables and district heating	

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1.12 Photovoltaics [PV]

	Crystalline Silicon PV	Thin-film PV
Indicative annual CO_2 saving	1,200 kg per home	1,000 kg per home
Indicative cost (£/kWp)	£5,000	£7,500
Typical lifetime	25 yrs	
Simple payback	Up to 48 – 63 yrs	
Lifetime cost of carbon saving (£/t CO_2)	265 - 1,000	
Suitable applications in Tunbridge Wells	Industrial and commercial Schools and education Leisure and recreation Community and health Council estates and individual homes	

Pros	Cons
• Some public and political support • Usually easy to retrofit on existing buildings • Possible to integrate in building materials • Little maintenance required	• Costs are high •Visual impact on listed buildings

1. What are the relevant technologies?

1.13 Photovoltaics [PV] (...cont)

Description and applications

- PV cells installed on roofs or integrated in building materials
- Suitable for installing on existing buildings (both private and public)
- Typically 1.5 to 3 kWp per domestic house
- Good solution for integrating in building materials, e.g. for zero-carbon homes

Technologies and Status

- Products available, but still expensive
- Market development almost entirely incentive driven, e.g. is widespread in Germany through feed-in tariff

	Crystalline silicon	Thin-film
Module efficiency	12% - 15%	5% - 7%
Area needed for modules per kWp	~7 m^2	~15 m^2
Average annual energy generated per kW in the UK	800 kWh/kWp	800 kWh/kWp
Status	Readily available but expensive	Less costly, more versatile; needs larger area because of lower efficiency

Crystalline silicon PV

Thin-film PV

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1.14 Solar Thermal

	Flat-plate	Evacuated Tube
Indicative annual CO_2 saving	350 kg per home	
Indicative cost (£/home)	£3,000	£5,000
Typical lifetime	25 yrs	
Simple payback	Up to c. 50 yrs	
Lifetime cost of carbon saving (£/t CO_2)	180 – 438	
Suitable applications in Tunbridge Wells	Industrial and commercial Schools and education Leisure and recreation Community and health Council estates and individual homes	

Pros	Cons
• Generally mature and proven technology •Usually easy to retrofit on existing buildings • Little maintenance required	• Costs remain high • Visual impact on listed buildings

1.15 Solar Thermal (...cont)

Description and applications

- Thermal absorption panels installed on roofs and connected to hot water system
- Suitable for installing on existing buildings (both private and public)
- Typically 3 to 4 m^2 per domestic house

Technologies and Status

Flat-plate collectors

- Cheaper
- Slightly lower efficiency
- Lower profile
- Easier to building integrate
- Produced worldwide

Evacuated tube collectors

- Slightly more expensive
- Better efficiency, especially in cold climates
- Better cold weather performance
- Vast majority of production in China

1.16 Photovoltaics and Solar Thermal

UK Local Council Case Study

Kirklees Council – SunCities Initiative		
Description	Kirklees Council took part in the SunCities project, which aims to install 3.05 MWp PV in the UK, Germany and the Netherlands from 2000 to 2006.	 PV panels in Kirklees
Drivers	• Reduce CO_2 emissions • Reduce tenants' energy bills	
Achievements	• 351 kWp PV installed in Kirklees (4.9% of UK total), involving 518 households • 63 solar thermal panels installed • Saves ~110 t CO_2 per year, and ~£85 per house • Attracted funding of £1.8 million • Won Ashden Award for Sustainable Energy	
Lessons learned	• Strong support from local residents • Shows PV can be well-integrated into both existing and new buildings	

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1.17 Heat Pumps

	Ground-source HP	Air-source HP
Indicative annual CO_2 saving	1.2 t per home	Max. 850 kg per home (but potential increase in CO_2 emissions)
Indicative cost (£/kW_{th})	£1,000 + drilling costs	£1,000 - £1,500
Typical lifetime	20 yrs	20 yrs
Simple payback	Around 20 yrs	Around 5 yrs
Lifetime cost of carbon saving (£/t CO_2)	44 - 520	Potential increase in carbon emissions
Suitable applications in Tunbridge Wells	Rural houses Farms	Council estates and individual homes New council buildings

Pros	Cons
• Reliable technology •Can be a good solution for highly efficient and zero-carbon homes	• Ground-source heat pumps requires space for drilling • Climate change impacts of HCFC refrigerants

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1.18 Heat Pumps (...cont)

Description and applications

- Heat pumps take the ambient temperature of an external source (air, ground, water) and produce heat using a vapour-compression cycle
- Supply both heat in winter and cooling in summer
- Typically 6 to 10 kW_{th} for commercial and domestic applications
- Generally a mature and reliable technology

Technology status

- Ground source – widespread in central Europe
- Air-source – common in Japan and US, starting to enter European markets
- Refrigerant – traditionally CFCs and HCFCs, now also brine and CO_2

Carbon savings from air-source heat pumps

Heat pumps use grid electricity to drive the compression cycle, so the carbon savings relative to the reference heating system depend on the carbon-intensity of the electricity network and the efficiency of the heat pump [Coefficient of Performance (COP)*].

	Current	Future
Carbon intensity of the UK grid (kg CO_2/kWh)	430	Possible fall of 20% over 20 yrs
Heat pump COP	2.0	3.5
CO_2 saving relative to condensing gas boiler	Increase	
Source	Pöyry	Claverton Energy

These figures suggest that:

- Air-source heat pumps may not be well-suited for replacing condensing boilers under current conditions, as this would increase CO_2 emissions.
- As the carbon intensity of the UK grid falls over time and the COP of heat pumps improves, air-source heat pumps will start yielding emissions reduction. They are therefore a suitable option for future low- and zero-carbon homes.

*A heat pump with Cop 3 produces 3 units heat for each unit of electricity used

Ground-source vs. Air source

Ground-source	Air-source
• Generally a mature technology • Costs: ~£1,000 per kW_{th} plus drilling costs • Coefficient of Performance*: 3 to 4 (2˚C) • Need space for drilling – suitable in countryside	• Generally mature but less common in Europe • Costs: ~£1,000 to £1,500 per kW_{th} • Coefficient of Performance: 3 - 4 • Suitable for low- and zero-carbon homes in the future

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1.19 Heat Pumps (...cont)

Examples of products and suppliers

Ground-source heat pump

Indoor air-source heat pump

Outdoor air-source heat pump

Company	Products		UK Supplier
	Ground source	Air source	
Viessmann Group	Vitocal (4.8 – 43 kW_{th})	Vitocal (up to 20 kW_{th})	Viessmann UK
Danfoss	Thermia (4 – 45 kW_{th})	DHP (6 – 12 kW_{th})	Danfoss UK
Daikin	-	Altherma (6 – 16 kW_{th})	Altherma
Mitsubishi	-	City Multi (11.2 – 145 kW_{th})	ICE Energy
Bosch Group	Greenstore (6 – 11 kW_{th})	Greensource (6 – 9.5 kW_{th})	Worcester-Bosch
Baxi Group	Geoflo (4 – 20 kW_{th})	Ambiflo (7.5 – 10.5 kW_{th})	Baxi Ecogen

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1.20 Biomass & Waste-to-Energy CHP/Heating

	Solid biomass heating	Anaerobic digestion	Advanced biomass processing
Indicative annual CO_2 saving	Up to 3.75 t per home	Up to 340t per 100 kWe system	Up to 4,000t per 2 MWe system
Indicative cost (£/kW)	£500 - £1,000 (per kWth)	£5,000	£3,500 - £8,000
Typical lifetime	20 yrs	20 yrs	15 yrs
Simple payback	Up to 45 yrs	Around 10 – 12 yrs	NA
Lifetime cost of carbon saving (£/t CO_2)	c. 60 – 102	~140	NA
Suitable applications in Tunbridge Wells	Some individual homes Industrial and commercial Leisure, recreation, community New developments	Sewage treatment Farms Waste-processing	Waste-processing Forestry areas

Pros	Cons
• Can use local wood resource • Can reduce forestry and agricultural wastes • Wood boiler technology is mature and common in continental Europe	• Transport of wood reduces carbon savings • CHP technologies not yet mature • Requires local supply chain

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1.21 Biomass & Waste-to-Energy CHP/Heating – Solid Biomass Heating

Description and Applications

- Wood pellet boilers for homes or small offices
- Wood chip boilers for larger buildings, like schools or leisure centres
- Requires local wood supply chain, including chipping or pelleting facility

Technologies and Status

- Generally a mature and reliable technology
- State-of-the-art systems achieve efficiencies >90%
- Cost-effective, starting at ~£500 per kWth
- Austria and Germany leading in products and application
- Increasingly popular in the UK

Wood-pellet boiler for the home

Example Products and Suppliers

Manufacturer	Pellet boiler		Chip boiler		UK Supplier
	Product	Size (kW_{th})	Product	Size (kW_{th})	
Hoval	Biolyt	50 - 70	Forester	180 – 2,000	Hoval UK
KWB Biomasseheizung	Easyfire	10 - 30	Powerfire	130 - 300	Econergy Ltd
Fröling	Turbomatic	28 - 55	Turbomatic	85 - 110	Econergy Ltd

1. What are the relevant technologies?

1.22 Biomass & Waste-to-Energy CHP/Heating – Solid Biomass CHP Systems

Description and Applications

- Direct combustion of solid biomass in micro and mini CHP systems is possible in air turbines, Stirling engines and ORC systems
- Direct combustion of solid biomass in Steam Turbine CHP systems is feasible from several MWe upwards

Biomass CHP systems are commercially available, but are expensive and have not moved beyond demonstration projects or niche applications. Solid biomass CHP has therefore not been analysed as a feasible option in Tunbridge Wells.

Technologies and Status

Biomass CHP systems are for sale, but are not yet sufficiently technologically mature – most installers will not provide guarantees.

- The Talbott 100 kWe air turbine is the most well-known UK product. It is commercially available and 15 – 25 have been installed, but there remains doubt about their reliability.
- Austrian biomass heating companies KWB and Őkofen have developed the 1 kWe StirlingPowerModule for solid biomass. At over €10,000 per unit it is still an expensive alternative to pellet boilers, and product developers expect it to remain a niche-market product.
- Austrian and German Stirling engine companies have developed pellet versions of their products, but these are sold for niche applications only

Leading Product Developers

Manufacturer	Product	Technology	Capacity	Technology status
Talbott	Talbott's BG100	Air turbine	100 kWe	Reliability questioned
KWB & Őkofen	StirlingPowerModule	Stirling engine	1 kWe	Sold for niche applications in Austria
Hoval	Agrolyt / Biolyt Stirling	Stirling engine	1.1 kWe	Initial sales
Mawera	Biomass Stirling Engine	Stirling engine	70 kWe	Commercial product for the UK under development
Sunmachine Vertriebsgesellschaft	Sunmachine Pellet	Stirling engine	3 kWe	Sold for niche applications in Germany
Solo GmbH	Solo Stirling	Stirling engine	2 – 9 kWe	Testing

Sunmachine Pellet

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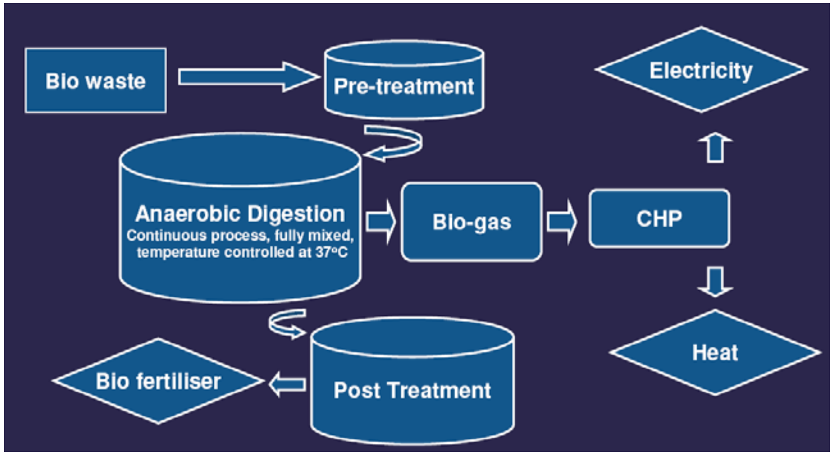
1.23 Biomass & Waste-to-Energy CHP/Heating – Anaerobic Digestion (AD) of Waste and Biomass

Description

- Produces biogas from solid or fluid biomass or waste steams
- Biogas used for generating heat and/or electricity in an Internal Combustion Engine (see CHP)

Technologies and Status

- Readily available technology
- Gas cleaning is potentially expensive
- German companies are technology and market leaders



Application	Status	Processing
Sewage treatment	Common in the UK	Can require gas cleaning
AD of agricultural residues	Widespread in Germany, not yet in UK	Integrated AD and cleaning systems
AD of biodegradable waste	Common for industrial wastes (>1,300 sites worldwide, less for household waste)	Advanced waste-processing plants

Biogas from AD can be upgraded to bio-methane, using chemical processes to remove impurities like sulphur and water. The bio-methane can then be injected into the gas network and used elsewhere – effectively like renewable electricity in the electricity network.
Bio-methane injection schemes existing in Continental Europe (10 – 20 in Germany, and a handful in the Benelux and France), but is still relatively new. There are no technical barriers, but cleaning systems are expensive. National Grid in the UK is aware of the opportunity of bio-methane injection, but can allow only small quantities to meet pipeline gas quality specifications.

The limitation set by National Grid, limited experience of AD in the UK and high price of bio-methane cleaning systems suggest that on-site use of AD biogas is likely to be a better option in Tunbridge Wells than network injection.

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1.24 Biomass & Waste-to-Energy CHP/Heating – Advanced Biomass and Waste Processing

Description

- Chemical and physical processing of solid biomass or waste
- Yields oil or gas fuel
- Fuel used to generate heat and/or electricity in Internal Combustion Engine (see CHP)

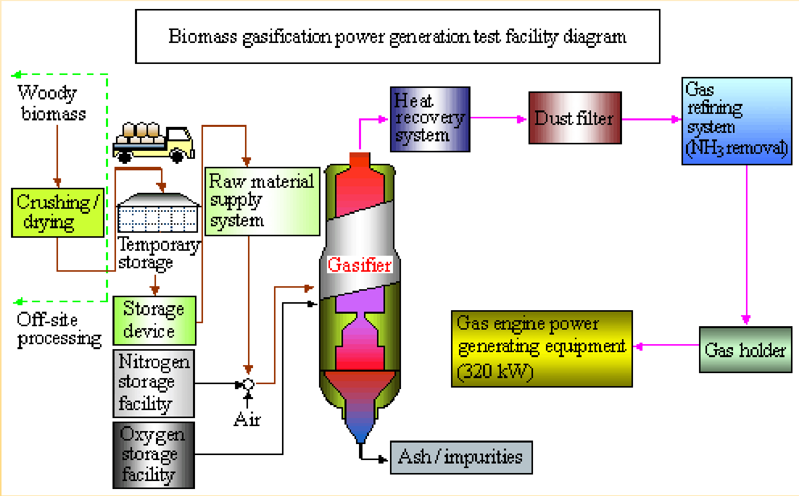
Types and Applications

Type	Gasification	Pyrolysis
Resulting fuel	Syn-gas	Gas and oil
Typical size (kWe)	>= 100	>2 MWe
Status	Commercial from several MWe	First commercial plants being installed
Applications	• Industry • Commercial buildings	• Industry • Municipal solid waste

Advanced Biomass Processing is still expensive and relatively unproven. It has therefore not been considered as a feasible option in Tunbridge Wells.

Technologies and Status

- Emerging technologies
- Only commercial at large scale
- Total electrical efficiencies ~20%



1.25 Biomass & Waste-to-Energy CHP/Heating – Biomass Heating

UK Social Housing Case Study

Oban - Glenshellach Community District Heating Scheme

Description	The Glenshellach district heating scheme consists of a 600_{th} kW wood chip boiler supplying 90 houses of the West Highland Housing Association. The project combines the biomass system with building efficiency measures like high levels of insulation, passive solar gain and south-facing orientation.
Drivers	• Provide affordable heating for social housing • Displace natural gas consumption and reduce CO_2 emissions
Achievements	• Best Renewable Project 2006 at the Scottish Green Energy Awards
Lessons learned	• Shows that biomass heating is viable for new housing developments through economies of scale achieved through heating network • Establishing reliable local wood supply chain was a major challenge • EasyPay prepayment system effective in providing affordable heating for residents

Glenshellach housing development

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1.26 Micro and Mini Wind Turbines

	Roof-mounted turbines	Pole-mounted turbines
Indicative annual CO_2 saving	~350 kg for 1 kWe system	Up to 17 t for 25 kWe system
Indicative cost (£/kWe)	£3,800	£3,000 - £4,000
Typical lifetime	Max 15 yrs	20 yrs
Simple payback	Up to 30 – 40 yrs	Up to 13 – 26 yrs
Lifetime cost of carbon saving (£/t CO_2)	250 – 355	150 – 280
Suitable applications in Tunbridge Wells	Possibly some residential buildings	Schools and education Community buildings Rural buildings outside AONB

Pros	Cons
• Pole-mounted turbines effective when rightly sited • Relatively low-cost	• Roof-mounted turbines ineffective in most places, low load factors • Visual impact in AONB and historic town centre • Potentially insufficient wind resource in the Borough

1.27 Micro and Mini Wind Turbines – Roof-mounted Micro-wind Turbines

Description and applications

- 1 – 6 kWe turbine installed on domestic house
- Horizontal-axis and vertical-axis products
- Can face planning objections because of visual impact
- Customer experience poor – electricity yield much lower than promised

Technologies and Status

- Products readily available
- Output capacity often <5% rated capacity, due to poor wind resource in build-up areas
- Costs from £1,500 per kWe
- No DC/AC invertors readily available

Selected Products

Manufacturer	Size	Notes
Windsave	1.25 kWe	Questions about quality
Wind Energy Solutions	2.5 kWe	~15,000 installations worldwide
Turby	2.5 kWe	Vertical-axis turbine

Horizontal-axis turbine

Vertical-axis turbine

1.28 Micro and Mini Wind Turbines – Pole-mounted Micro-wind Turbines

Description, Applications and Status

Capacity Range	Typical Applications	UK Installations (2009)	Status
2-6 kWe	Rural homes (freestanding), farms, commercial buildings, small schools	3,517	• Steady growth over the last few years • Several manufacturers are active. • Most activity focused at 5-6 kW
7-30 kWe	Commercial buildings, schools, new housing developments, farms	538	• 'Sweet spot' in the market • Large potential – so far mostly un-tapped. • Beginning to show signs of growth • Potential applications wide-spread.
30 - 500 kWe	Large commercial buildings, new housing developments, water treatment plants, large farms, industrial sites	151	• Immature sector - a handful of turbines installed. • Few manufacturers but strong ones are emerging • Sales expectations for 2010/11 are orders of magnitude greater than today.

Technology Status and Manufacturers

Capacity	Costs (£/kWe)	Load factor	Selected Manufacturers
2-6 kWe	£4,150	14% - 20%	Proven, Iskra, Eoltec
7-30 kWe	£2,400	14% - 24%	Gazelle, Wind Turbine Industries Corp.
30-500 kWe	£2,500	18% - 28%	Wind Energy Solutions (WES)

1.29 Micro and Mini Wind Turbines – Mini Wind Turbines

UK Local Community Case Study

Dulas Valley – Community-owned Wind Turbine

Description	The Dulas Valley 75 kWe wind turbine started operating in 2003 as the first community-owned turbine in the UK. Local residents run the whole project through the Dulas Valley Community Wind Partnership (DVCWP). The scheme is supported by the Centre for Alternative Technology, which supplied the second-hand turbine and buys the electricity.
Drivers	• Promote wind energy projects with direct benefit for the local community.
Achievements	• The turbine generated 94 MWh in the first year •Participating residents receive a share of the revenue from electricity sales. • Shares in the project were over-subscribed and had to be limited to £1,000 per resident. • The project brought ~£55,000 into the community.
Lessons learned	• Community participation and ownership created strong local support. • Voluntary work essential for community energy projects. • One-third of the project revenue contributes to a community fund for energy efficiency measures.

Dulas Valley wind turbine

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1.30 Technologies Summary – Indicative costs and CO_2 savings

Technology	Indicative annual CO_2 saving	Indicative installed cost	Typical lifetime	Simple payback	Lifetime cost of carbon saved per tCO_2
Combined heat and power					
Micro-CHP	~850 kg / home	£3,500 – £11,000 /kWe	~15 yrs	3 – 4 yrs (4,7)	£40 – £60 (4)
Packaged & district heating CHP*	~280 t (100 kWe)	£750 - £1,000 / kWe	~15 yrs	4 – 5 yrs (iii)	£80 – £250 (3,5,6)
Energy-efficiency in buildings					
Loft insulation (up to 270 mm)	~800 kg / home	£150 - £250 / home	~40 yrs	~2 yrs (i)	~£10 (1)
Solid wall insulation	~2 t / home	Up to £15,000 / home	~30 yrs	~14.2 yrs (2)	~£111 (1)
Cavity wall insulation	~610 kg / home	~£250 / home	~40 yrs	~2 yrs (i)	~£14 (1)
Photovoltaics	1 – 1.2 t / home	£5,000 - £7,500 / kWp	~25 yrs	48 – 63 yrs (2,4)	£265 – £1,000 (4,6)
Solar thermal (displacing natural gas)	~325 kg / home	£3,000 - £5,000 / home	~25 yrs	~50 yrs (2,4)	£180 – £438 (1,3,4,5,6)
Heat pumps (Ground-source)	850 kg – 1.2 t / home	£1,000 – 1,500 / kW_{th}	~20 yrs	~20 yrs (4)	£44 – £520 (4,5,6)
Biomass and waste-to-energy					
Solid biomass boiler (domestic, displacing natural gas)	Up to 3.75 t / home (8)	£500 - £1,000 / kW_{th}	~20 yrs	~45 yrs (4)	£60 – £102 (3,4,5,6)
Biomass boiler (commercial/industrial/DH, displacing natural gas)*	~1.75 t/kW_{th} (8)	~£615 / kW_{th}	~15 yrs	N/A	£80 - £150
Anaerobic digestion	Up to 34 t (100 kWe)	~£5,000 / kWe	~20 yrs	10 – 12 yrs (iii)	~£140 (5)
Mini wind turbines	Up to 17 t (25 kWe)	£3,000 – £4,000 / kWe	~20 yrs	13 – 26 yrs (2,4)	£150 – £355 (3,4,6)

* Indicative costs for CHP and biomass boiler projects do not include heat network costs of £910/m as these are very site specific.

1.31 Sources and Assumptions

- CO_2 savings are indicative and reflect the typical benefit of the technologies in a UK situation, relative to UK grid electricity and gas-fired heat boilers.

- Indicative capital costs refer to the installed cost of the system.

- The figures for indicative CO_2 savings, indicative costs and lifetimes show the consensus of data from three principal sources:
  i. Energy Saving Trust, 2009.
  Basis for Analysis: the figures are based on the EST's analysis of the existing technologies on its recommended product list, and its experience with the performance of actual systems in the UK. The assumptions behind the analysis and figures for the relevant technologies are available on http://www.energysavingtrust.org.uk/Energy-saving-assumptions

  ii. Element Energy for DTI, *Potential for Microgeneration - Study and Analysis*, 2006.
  Basis for Analysis: Computer model combining technology development curves, technology uptake curves and Game theory models of consumer behaviour.

  iii. Delta conversations with product manufacturers and installers, 2009
  Basis of Analysis: These reflect the rated performance of the technologies and their experience of specific projects. Developer sources can be optimistic; Delta tempers this with other sources and its own more balanced view.

1.32 Sources and Assumptions (...cont)

The data on lifetime cost of carbon savings and simple payback are the synthesis of reported figures from a range of sources:

1. Reigate and Banstead April 2008 Borough Council Local Carbon Reduction Fund, *Housing Projects Summary*, April 2008. **Basis for analysis:** Evaluation of outcome of cost-effectiveness of actual scheme implemented by Reigate and Banstead Borough Council. As such, it does not use generic assumptions on costs, lifetimes, and prices.

2. DEFRA, *Delivering Cost-effective Carbon Saving Measures to Existing Homes*, September 2007. **Basis for Analysis**: Computer modelling using the BRE's BREDEM-12 Model. This uses installation costs, fuel prices, O&M costs and carbon intensities to calculate paybacks and carbon abatement costs. The report does not specify the inputs for this in the model runs applied.

3. Town and Country Planning Association, *Sustainability by Design*, January 2006. **Basis for Analysis**: based on performance of case-study data, no detailed modelling applied. As such, it does not use generic assumptions on costs, lifetimes, and prices.

4. Claverton Energy Research Group, *What is Microgeneration?*, November 2008. **Basis for Analysis**: based on the experience of installing micro-generation technologies by E.ON UK plc, combined with analysis of UK studies and field trials. References of the studies informing this analysis are available on: http://www.claverton-energy.com/what-is-microgeneration.html

5. Pöyry and Faber Maunsell for DECC, *Potential Cost of District Heating Networks*, April 2009. **Basis for Analysis**: Computer modelling based on the average situation for the UK energy system, building stock and existing technologies.

6. Committee for Climate Change, *Building a low-carbon economy – the UK's contribution to tackling climate change*, December 2009. **Basis for Analysis**: Least-cost optimisation of energy use (UK MARKAL Model)

7. E.ON UK plc, *Performance of Whispergen micro CHP in UK homes*, May 2006. B**asis for Analysis**: measured results from Carbon Trust field trials. The payback is based on the measured energy savings in the test units and 2006 UK energy prices.

1.33 Sources and Assumptions (...cont)

Summary of Selected Key Assumptions (where stated in the report)

Source	UK Grid Carbon Intensity	Fuel price	O&M cost	Plant lifetime	Discount rates
2	NA	NA	NA	Insulation: 30 - 40 yrs Lighting: 7 yrs PV, Solar thermal: 25 yrs Small wind: 22.5 yrs	NA
5	430 g/kWh currently	Gas: £0.18 - £0.32 per kWh Biomass: £0.05 per kWh Electricity: £0.09 – £0.12 per kWh	CHP: £80/yr Biomass CHP: £180/yr Biomass boiler: £18/yr AD: £775/yr HP: £9/yr Solar Thermal: £4/yr	CHP, Biomass CHP, Biomass boiler: 15 yrs AD, HP, Solar Thermal: 20 yrs	3.5%, 6% and 10%
6	560 g/kWh in 2006 310 - 370 g/kWh in 2020	Central scenario costs based on oil price of $65-75 per barrel in real terms out to 2030	NA	NA	3.5%

2. What resources are available in the Borough?

The local resources available in or near Tunbridge Wells are assessed in the following slides. This resource assessment informs recommendations on which technologies are best suited to the Borough.

Resources to be assessed are:

- Wind
- Solar
- Biomass & Waste
- Natural Gas
- Heating Networks

Energy & Environment

2.1 Wind resources

Overall availability of wind resources → **Influence of ground surface characteristics** → **Opportunity for wind turbines**

Wind Speed
- Annual Mean Wind Speed
- Height above ground level

Wind Direction
- Prevailing wind direction

Topography
- Altitude
- Exposed mountain vs. sheltered valley
- Exposed coastal areas

Surface Features
- Proximity to tree cover
- Proximity to buildings

This section addresses:

1. Overall availability of wind resources - the wind speed and wind direction patterns in TW, and in the context of the UK.
2. The influence of ground surface characteristics on overall wind resources in TW – topography and other surface features superimpose their own wind flow patterns on a micro- level.

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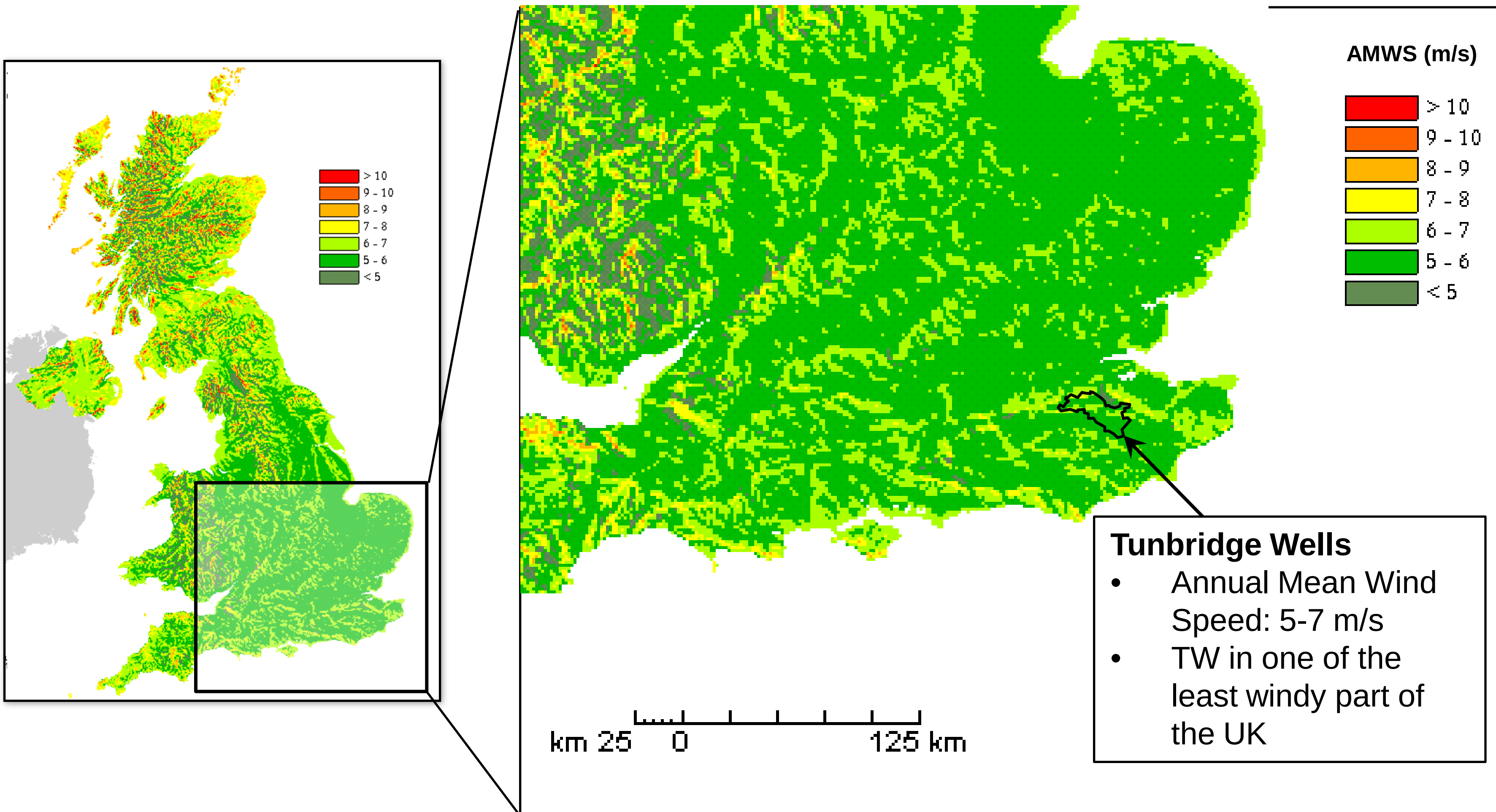
2.2 Wind Resources – Wind speed and Prevailing Wind Direction

Annual mean wind speed at 25m above ground level (m/s): UK & south-east England



Source: ETSU for DTI, 1999 (based on NOABL)

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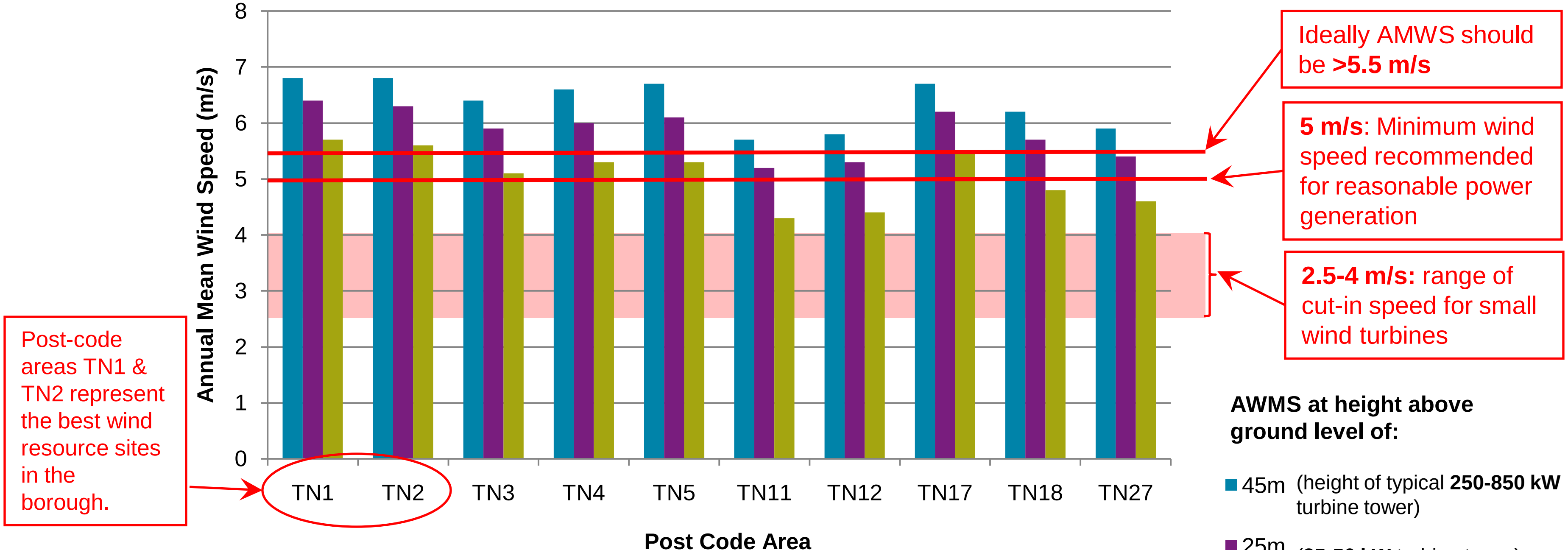
2.3 Wind Resources – AMWS for Tunbridge Wells Borough

The following Table & Figure show Annual Mean Wind Speed (AMWS) for postcode areas covered by Tunbridge Wells Borough.



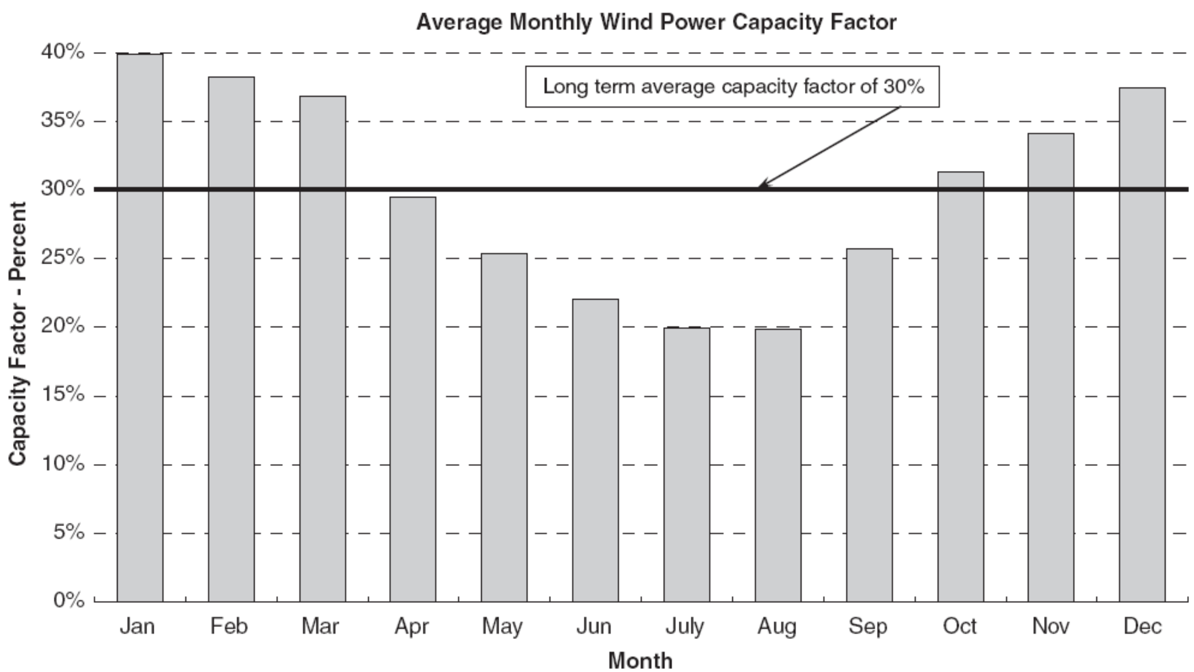
		Annual Mean Wind Speed (m/s)									
Postcode		TN1	TN2	TN3	TN4	TN5	TN11	TN12	TN17	TN18	TN27
Grid reference		TQ5836	TQ5939	TQ5738	TQ5740	TQ6531	TQ5847	TQ7044	TQ7736	TQ7629	TQ8844
Height above ground level	45m	6.8	6.8	6.4	6.6	6.7	5.7	5.8	6.7	6.2	5.9
	25m	6.4	6.3	5.9	6	6.1	5.2	5.3	6.2	5.7	5.4
	10m	5.7	5.6	5.1	5.3	5.3	4.3	4.4	5.5	4.8	4.6

Data: NOABL Wind Speed Database, BERR, 2009

2.4 Wind Resources – Seasonal Variation

Seasonal variation in wind resources occurs, with the summer months typically being less windy than the winter months, as shown below. This must be taken into account when assessing the available wind resources in Tunbridge Wells

Monthly wind power availability (averaged over 34yrs of wind speed data)



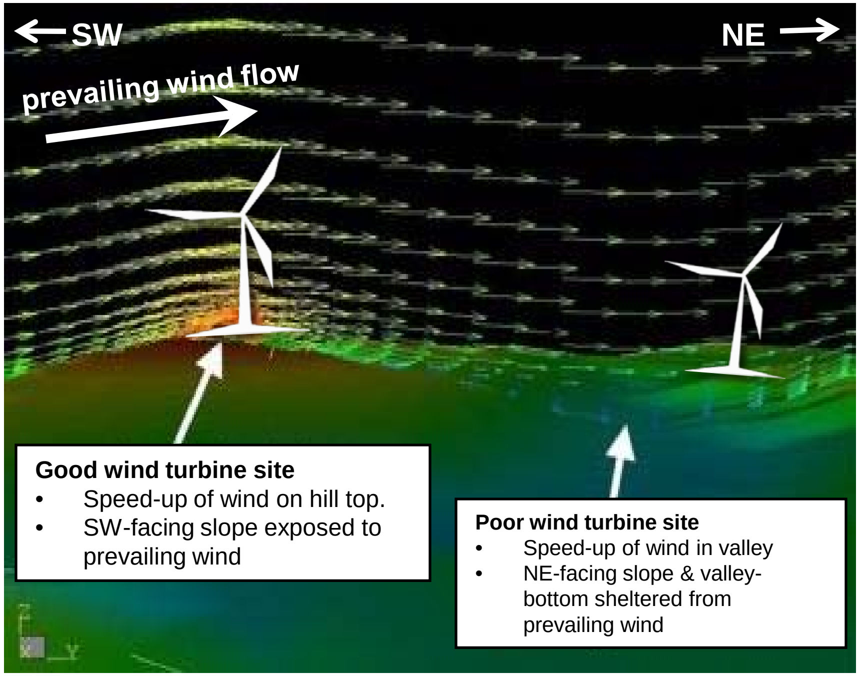
Sinden G, 2006, *Characteristics of the UK wind resource: Long-term patterns and relationship to electricity demand*, **Energy Policy**

2.5 Wind Resources – Influence of ground surface characteristics

Effects of Topography

The effects of topography are superimposed on general wind speed and direction patterns.

- Wind flow over hills is faster than wind flow in valleys
- Slopes exposed to prevailing wind have higher wind speeds



Topography in Tunbridge Wells

An indicative map is presented on the following slide.

Tunbridge Wells Borough is relatively flat, with most of the land area lying between 80m and 120 metres above sea level.

As such, the topographic characteristics do not represent a big opportunity for wind. Further, the general orientation of ridge lines in the borough is south-west to north-east. For maximum exposure to prevailing winds, ridge-lines oriented south-east to north-west (perpendicular to air flow), would provide better wind turbine locations.

Many of the most hilly areas in TW are tree-covered, which further reduces the opportunity.

Despite these points, there are some isolated, tree-free small hills and south-west facing slopes which may represent some limited opportunities.

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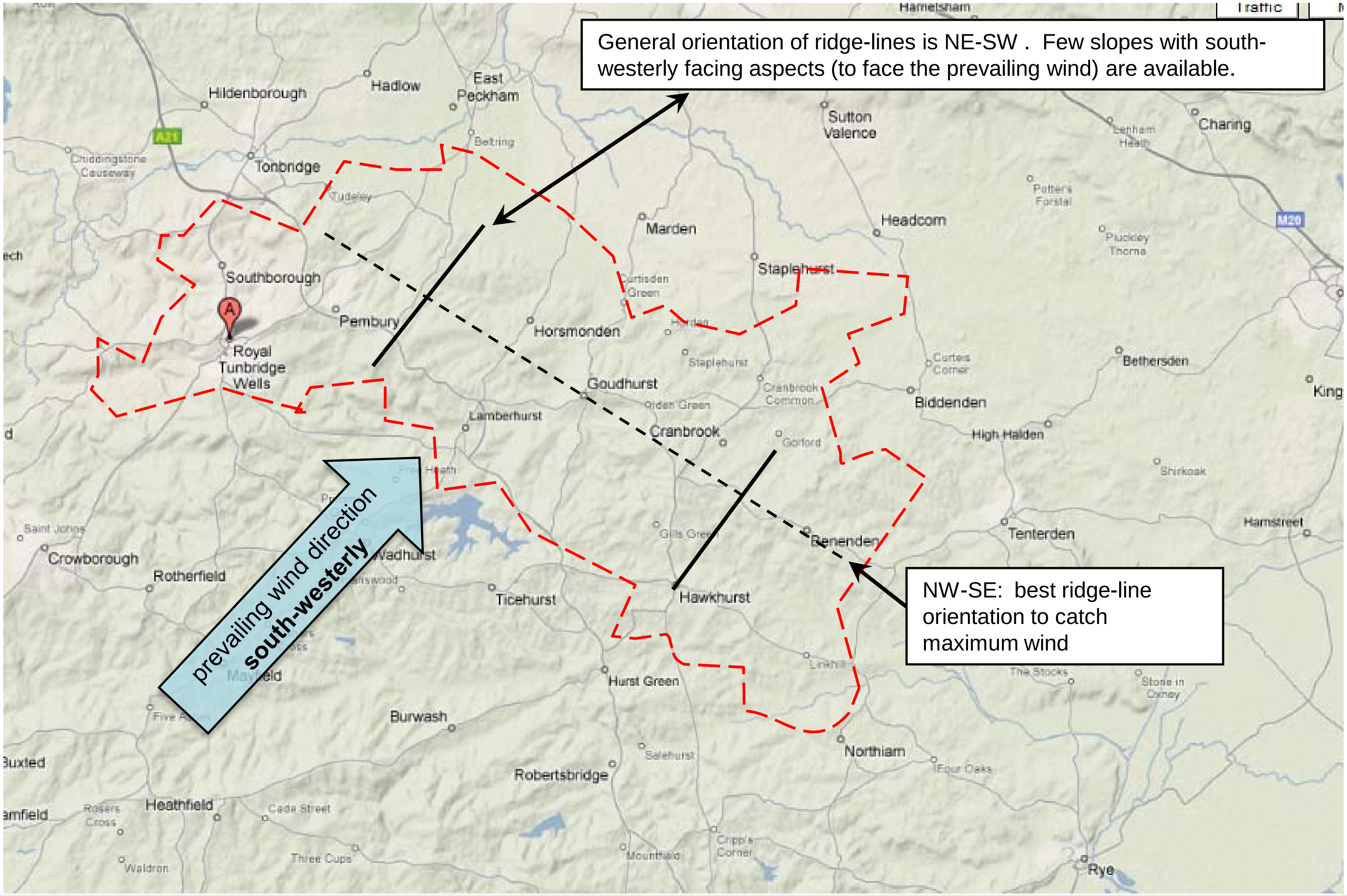
2.6 Wind Resources – Topography in Tunbridge Wells



2. What resources are available in the Borough?

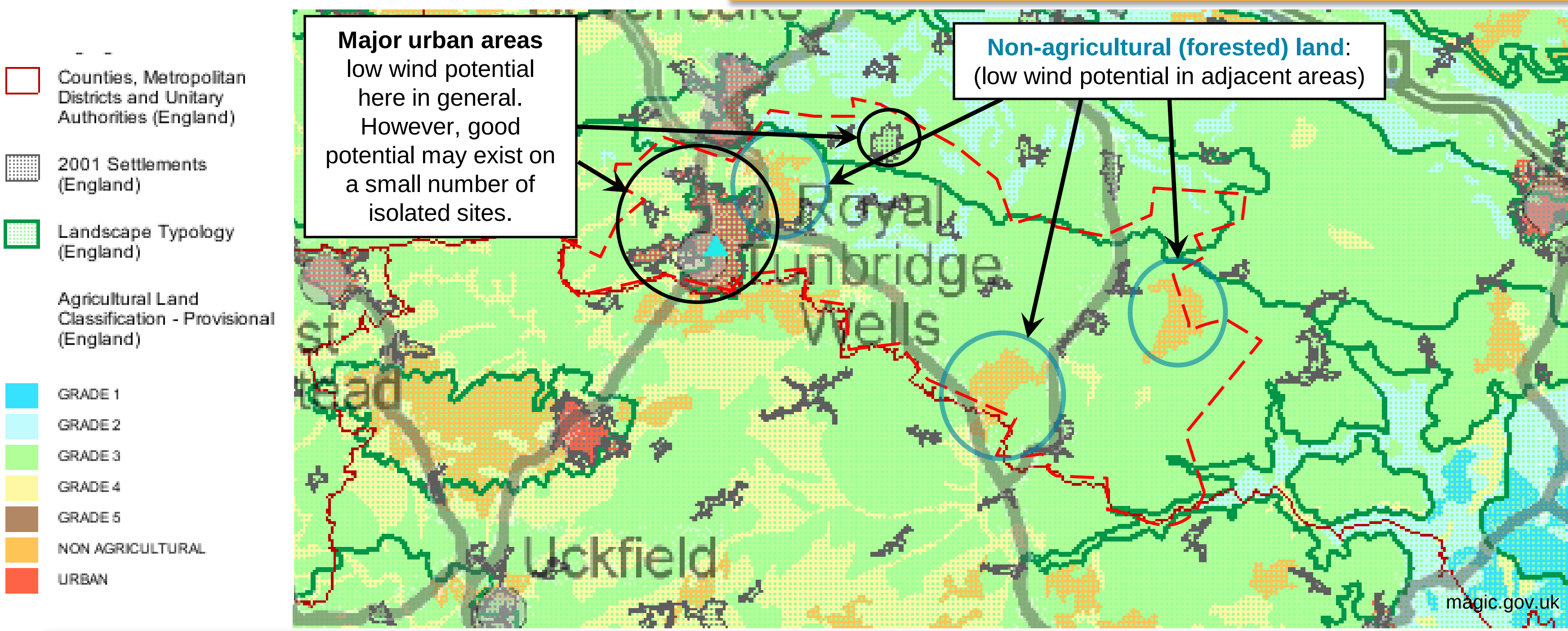
2.7 Wind Resources – Influence of ground surface characteristics & land use

Effects of Surface Features

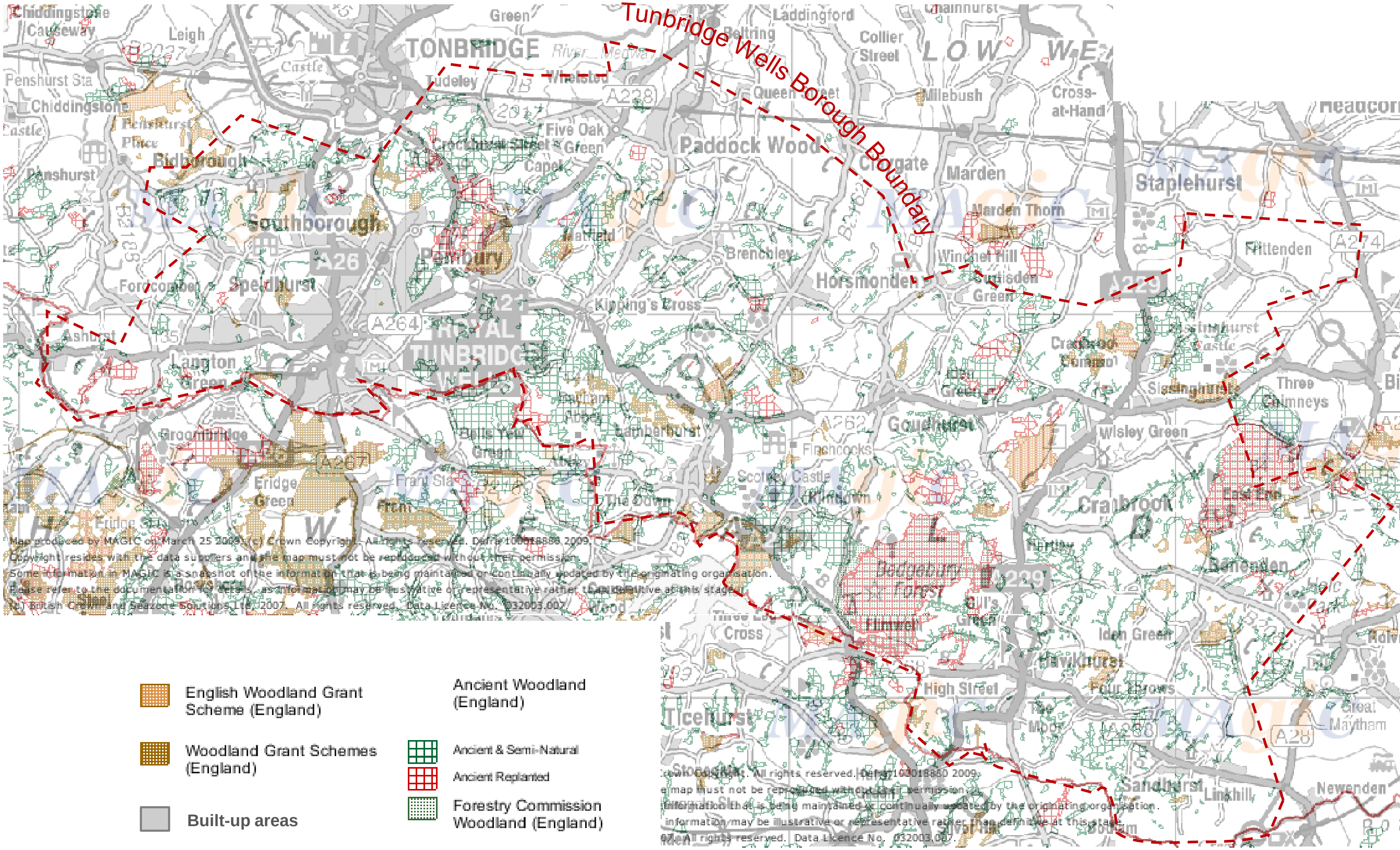
The existence of buildings and tree cover causes localised reductions in wind speed (due to increased surface drag, and due to their sheltering effect) as well as increased wind turbulence. Therefore the best locations for wind turbines are in non-urban areas, and away from major forested areas. Agricultural / rural areas are generally best-suited to wind development.

Characteristics of Tunbridge Wells: Mostly agricultural land

- Rural / agricultural land is good for wind. Farms represent one of the strongest UK markets for small wind turbines.
- There is **813 hectares of "set aside" land, on 92 farm holdings in TW borough**. This land represents potentially good potential for wind development, and many small wind turbine manufacturers are specifically targeting this.



2.8 Wind Resources – Urban and forested areas: to be avoided for wind turbines



2. What resources are available in the Borough?

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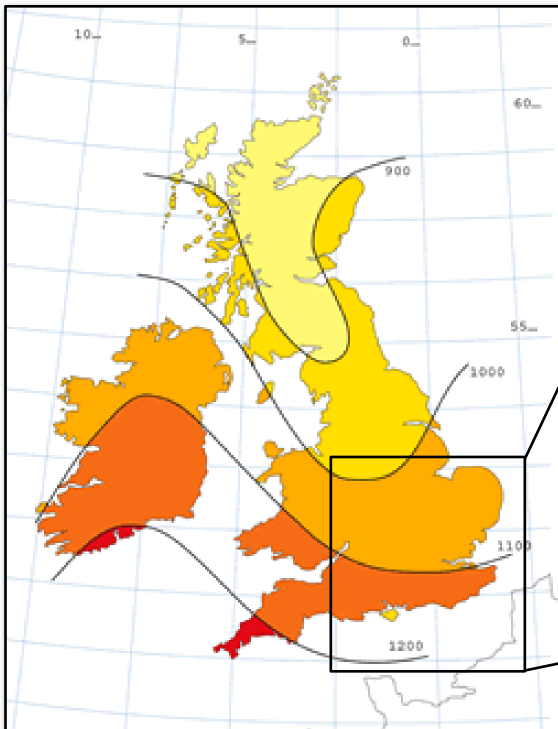
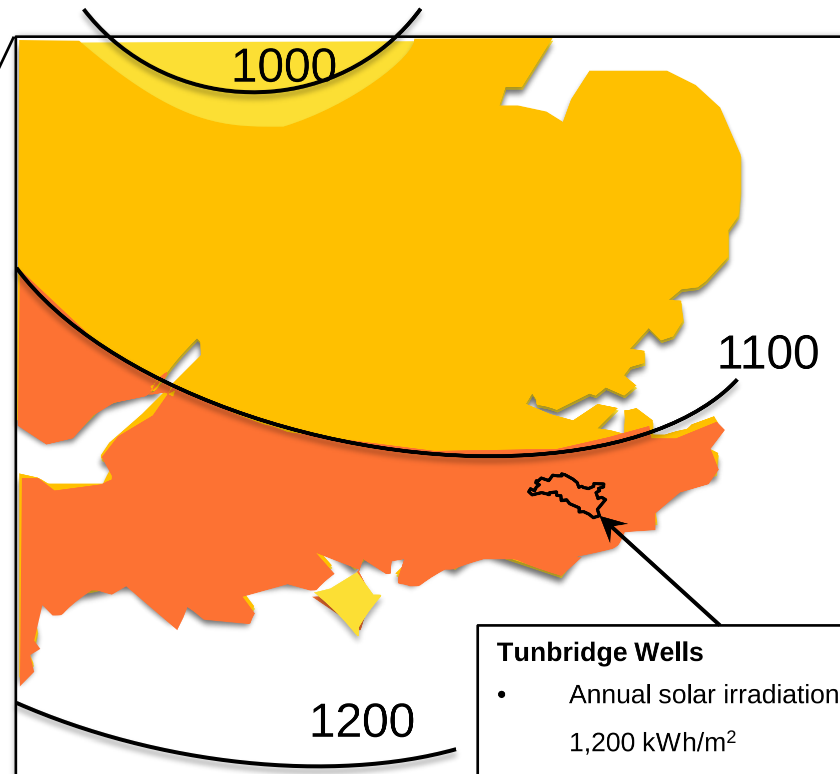
2.9 Solar Resources

Average solar irradiation on a 30° south-facing incline: UK & SE England

Solar Irradiation (kWh/m²)		
	<900	>1100
	>900	>1200
	>1000	





Tunbridge Wells

- Annual solar irradiation 1,100-1,200 kWh/m^2
- TW has some of the best solar resources in the UK

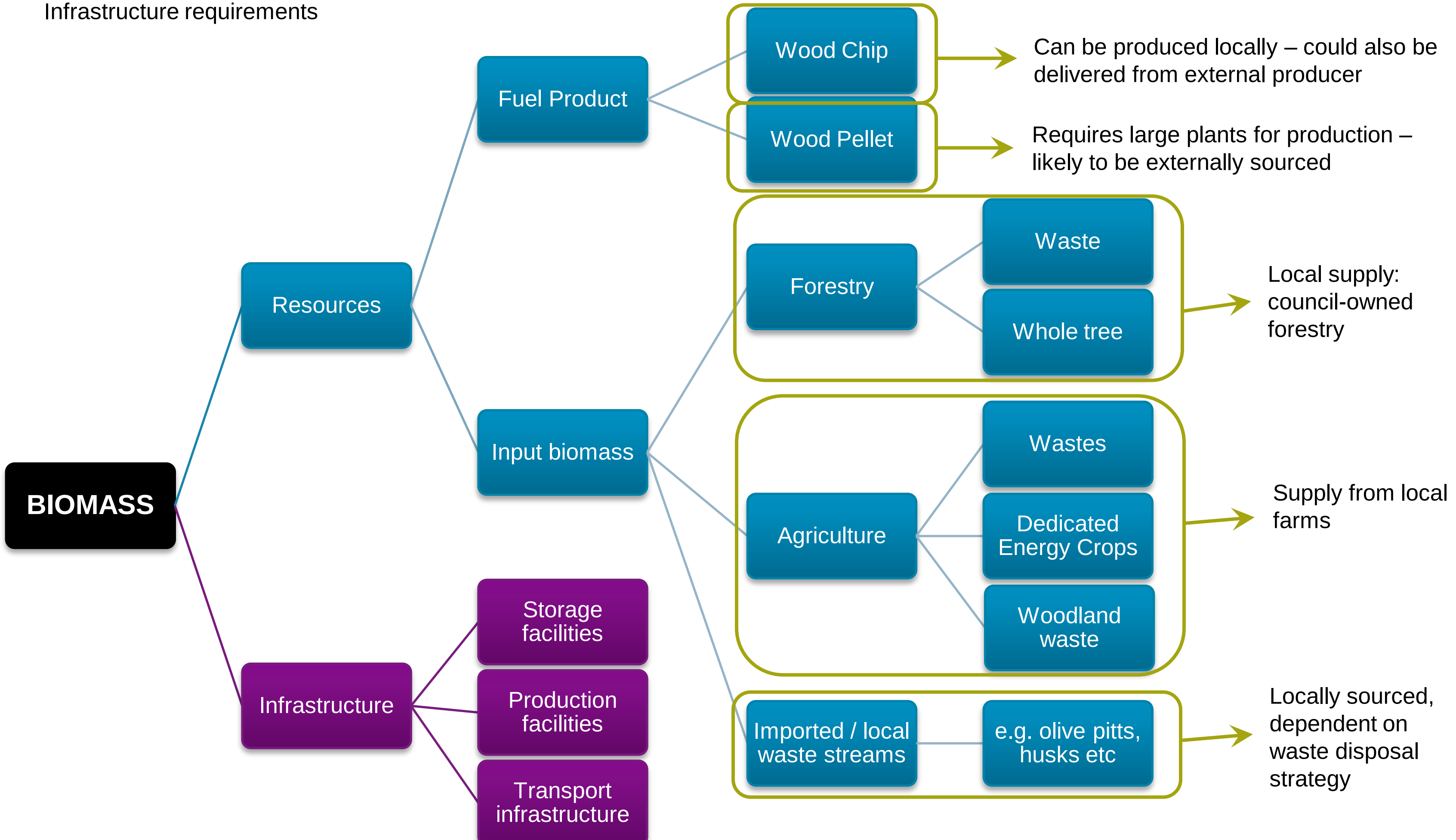
The Solar Trade Association, 2009

2. What resources are available in the Borough?

2.10 Solid biomass resource options

Assessment of the potential for energy production from biomass in TW must consider:

- Available biomass resources
- Infrastructure requirements



2.11 Biomass: Selecting the best resource options for Tunbridge Wells

Locally sourced

Forestry resources

- Tunbridge Wells has a good local forestry resource, some of which is council-owned. This represents a stable source of wood waste, although requires set-up of wood chipping and processing facilities.
- This option is already being taken forward with the help of SEWF

Local wood fuel suppliers – processed wood chip

- Local companies supplying processed wood chips for fuel

Agricultural resources

- Agricultural waste – dealt with in the 'waste' section of this report
- Dedicated energy crops – no farms producing energy crops at present
- Agricultural woodland - 1817 hectares of woodland exist on 247 farm holdings in TW borough. This represents a further local source of wood, though would require co-operation from farm owners.

Externally sourced

Wood pellets

- Wood pellet production requires large processing plants, and as such there are fewer suppliers available. However, some large suppliers of pellets now guarantee UK-wide delivery.
- e.g. Balcas will open a new wood pellet facility in far-away Inverness in 2010, with guaranteed delivery UK-wide.

Wood Chip

- While wood chip can be produced locally, there are also many suppliers in the wider UK who will guarantee delivery of these resources UK-wide.

2.12 Biomass: Building on existing work

Delta recommends building on existing studies into the potential for biomass in Tunbridge Wells.

1. SEWF study: Site search for woodchip production and composting

Tunbridge Wells has an existing site for composting wood products, but now requires to extend this capacity at a new site, and develop the site to incorporate production of biomass fuel.

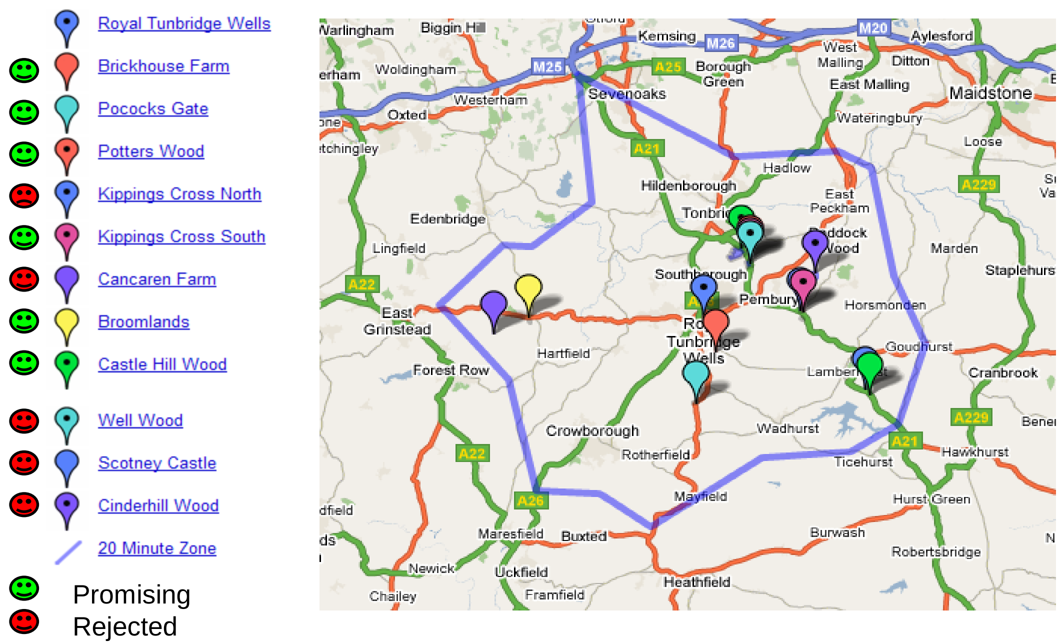
SEWF carried out a study to identify sites for:

- Production of wood chip for biomass fuel
- Processing of the green wood by-product for composting

This work has now progressed to Phases 2 and 3:

2. Assessing the business case for project development

3. Administrative assistance in scoping possible collaborations with neighbouring Councils

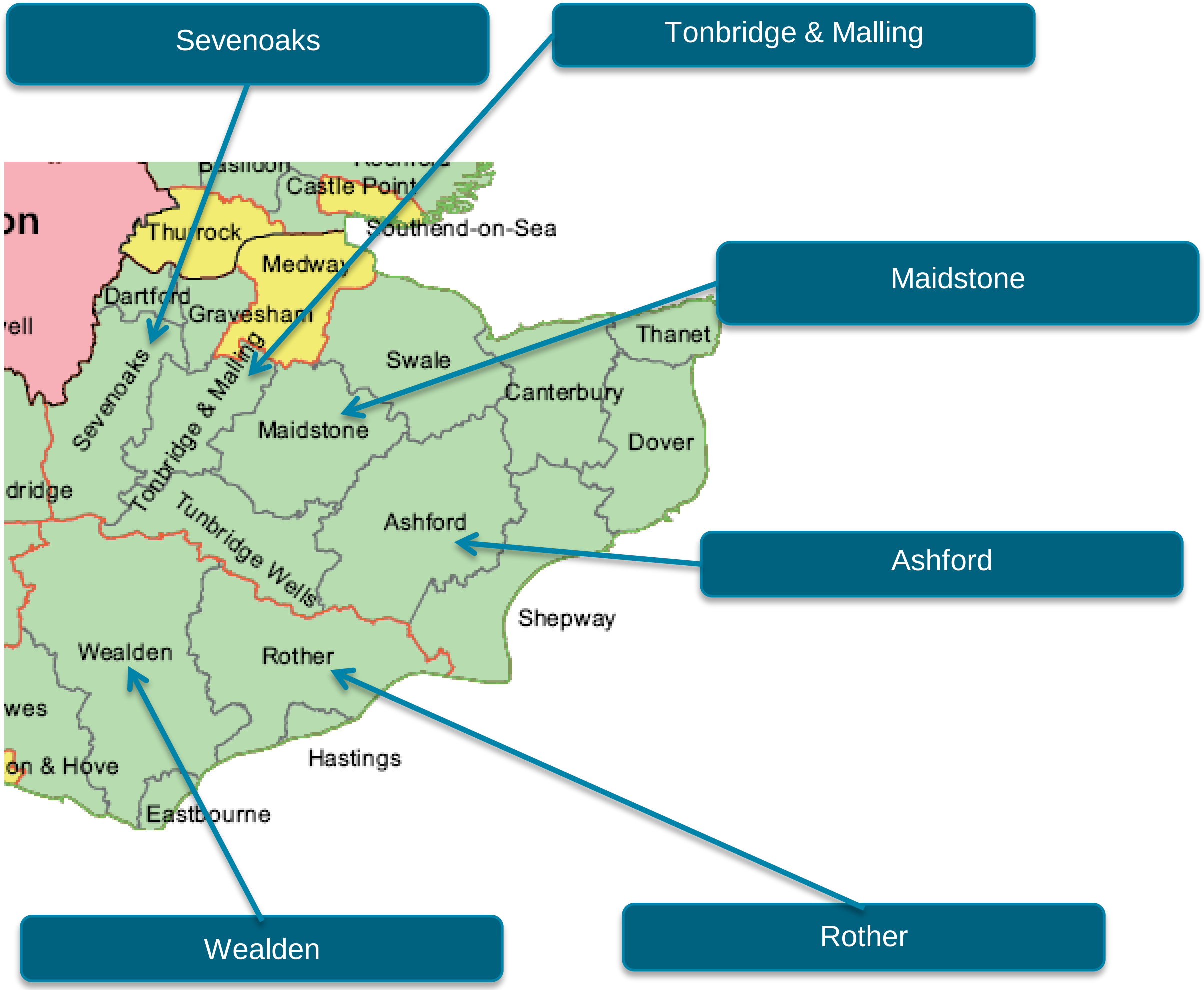


2.13 Biomass: SEWF Phase 3 – Partnerships with neighbouring Councils

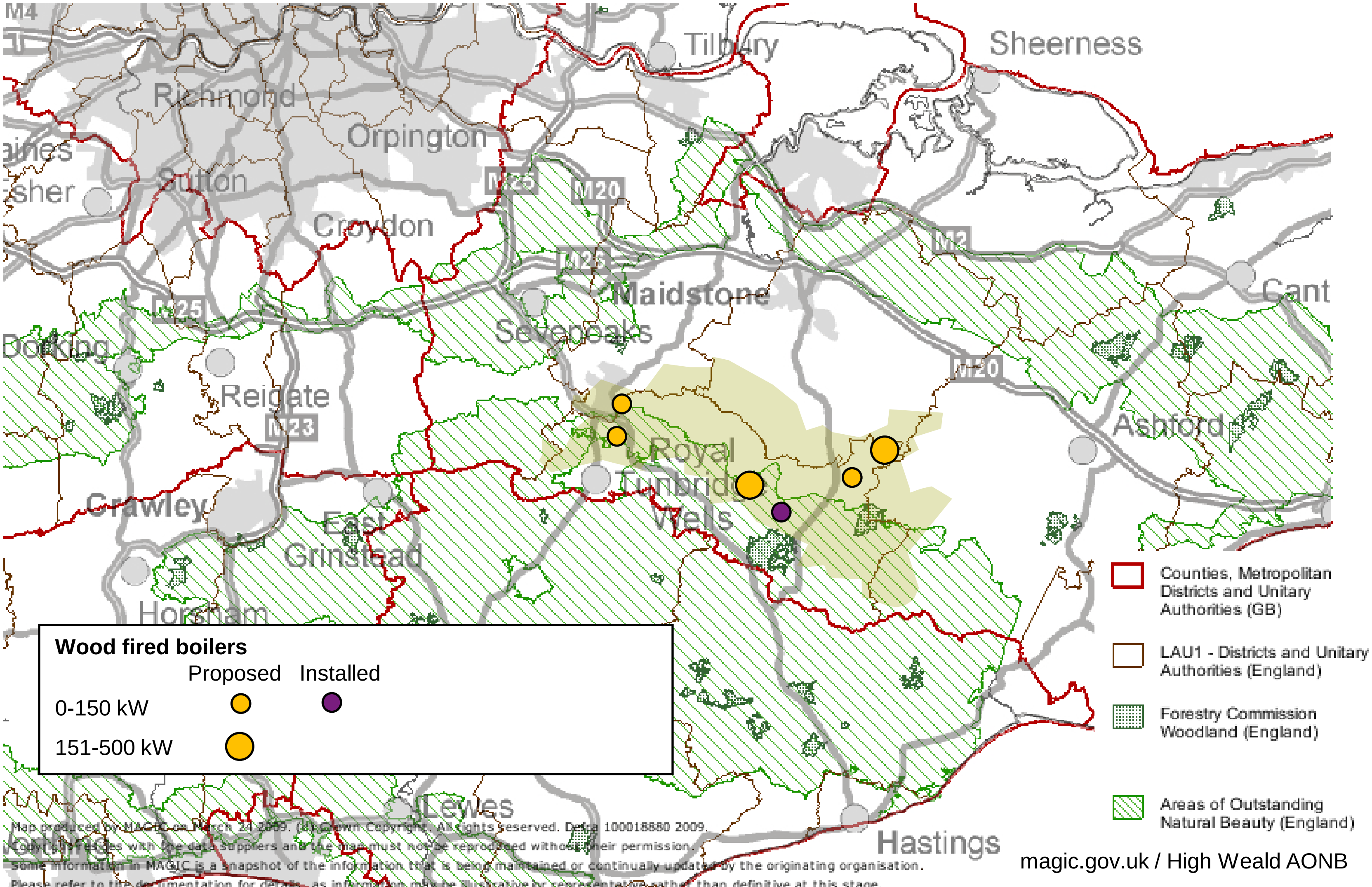
Phase 1 of the SEWF assessment has identified that there is not enough woodland resource in the Borough to provide a business case for development of a chipping facility. Therefore, the optimum solution is to partner with one or more neighbouring Councils, local estates and other local wood chip providers .

Phase 3 involves engaging these Councils in dialogue and is now underway.

The 6 neighbouring Councils identified (figure on the right) are being approached. There is also ongoing dialogue with Kent and East Sussex County Councils.



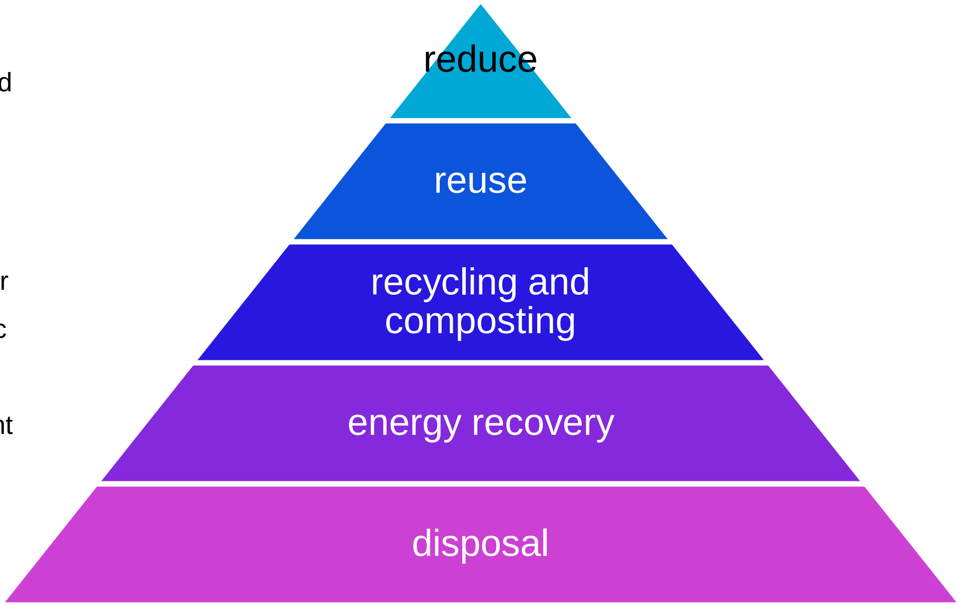
2.14 Biomass: Existing & proposed biomass boilers in Tunbridge Wells



magic.gov.uk / High Weald AONB

2.15 Kent Joint Municipal Waste Management Strategy

- All Tunbridge Wells' municipal solid waste (MSW) falls under this Strategy
  - Devised April 2007 to manage Kent's MSW for 20 years
  - The strategy addresses collection and disposal issues. This includes waste collected from households, street sweepings, trade waste collections (where appropriate) and waste collected at Household Waste Recycling Centres (HWRCs).
  - The Strategy does not address waste generated by businesses in Kent other than where authorities arrange for its collection. Neither does it include information on specific sites or the location of waste treatment facilities. Those issues are being addressed through the Local Development Framework (LDF) for Waste.
  - There are 812,830 tonnes of MSW produced annually (2005/2006) in Kent
  - One possible solution (outside the remit of the Joint MSW Strategy) is energy from waste (EfW) recovery
    - The only EfW plant in Kent is Allington Waste Management Facility



2.16 Allington Waste Management Facility

- Capable of generating up to 43 MW power
  - 34 MW of which will feed the local supply network, the remaining is to be self-consumed
- The plant will deal with 349,000 tonnes of waste annually – waste that would otherwise be sent to landfill
- Total investment in the plant: over £150 million
- The scheme is in the final stages of commissioning, to be fully operational later in 2009

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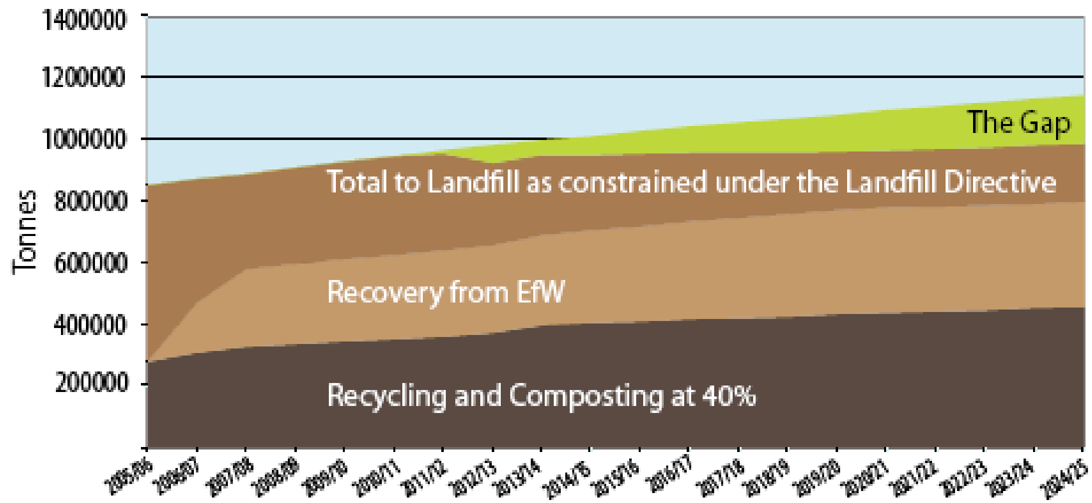
2.17 Meeting Statutory Landfill Directive Targets

- The Allington EfW plant will contribute to meet statutory targets in the short-term, but as the figure (right) shows there will be a need for further recovery beyond 2010/11.
- This need will increase over time as waste arising grows – the increasing gap is shown in the figure (right)
- There is an opportunity for Tunbridge Wells to help close this gap.
- A study was commissioned by Kent County Council in 2006 to assess residual options to meet the targets of the Landfill Allowance and Trading Scheme (LATS)
- The 8 options are listed in the Table
  - Option 7 was deemed to be the most suitable against a range of criteria including GHG emissions, cost, energy consumption, land use, deliverability and risk.



Option	Description
1	New EfW facility in East Kent
2	Expand current contracted capacity at Allington EfW
3	Mechanical Biological Treatment (MBT) plant ain East Kent providing Refuse Derived Fuel (RDF) to Allington EfW
4	MBT plant in East Kent stabilising material to be sent to landfill
5	Autoclave in East Kent with ‘fluff’ to Allington EfW
6	Gasification plant in East Kent
7	**Anaerobic Digestion facility in East Kent**
8	In-vessel composting facilities across Kent for Garden and Kitchen Waste

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2.18 Energy from Waste Options for Tunbridge Wells

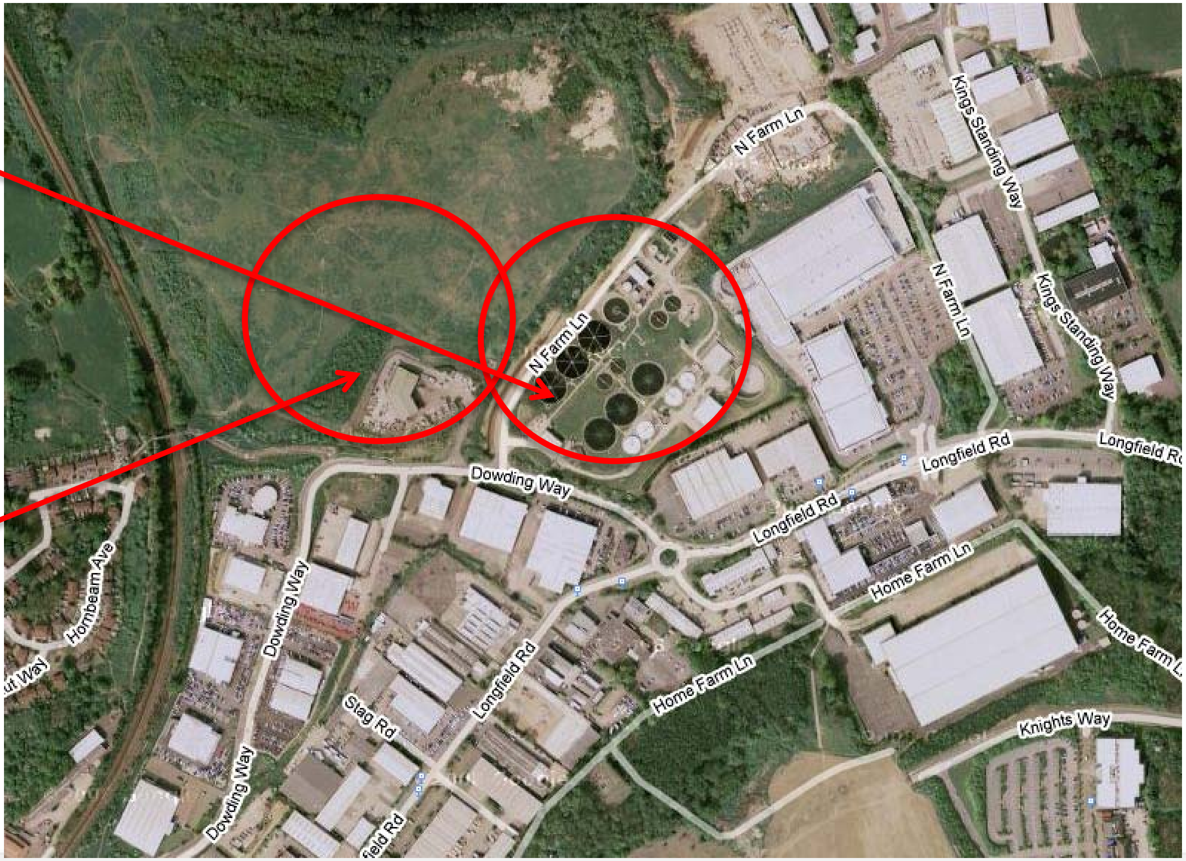
- Aside from the treatment of MSW, which is covered by the Kent Joint Municipal Waste Management Strategy, there are several resources available for EfW projects in Tunbridge Wells:
  - Agricultural waste from the 757 farms located in and around the Borough
  - Sewage, at the North Farm sewage treatment works
  - Landfill gas, currently being flared at the disused North Farm landfill site

Sewage Works

Owned and operated by Southern Water Services, this works treats X amount of sewage per annum. Using anaerobic digestion, Y amount of biogas could be produced.

North Farm Landfill

Closed since ~ 1990, this site has been flaring landfill gas since then. Kent County Council are currently assessing the feasibility of installing a gas engine at the site.



2. What resources are available in the Borough?

2.19 North Farm Landfill

- The North Farm Landfill has been twice assessed as a site with the potential for a gas engine to be installed:
  - AHS Emstar looked at it in July 1992
  - Soiltec in 1999
- Both assessments deemed the generation and sale of electricity to the grid as economically unfeasible.
- However, new legislation (Renewables Obligation) and political & environmental pressures mean the project may now be feasible. Kent County Council are in the process of performing an updated feasibility assessment.
- The table below details the available resource at the landfill site as of 2008

Methane Production Rate in 2008 (m3/hr)	Recovery Coefficient	Recoverable Yield of Methane in 2008 (m3/hr)	Methane Quality
164 – 210	63%	100 – 130	< 50%

- Due to the low flow rate and poor quality of methane, only microturbine technologies are feasible
  - Microturbines range from 30 kW to 100 kW and can burn landfill gas with methane concentrations as low as 12%
- KCC is currently performing an updated feasibility assessment for a 100 kWh microturbine engine with 90% efficiency
- The new banding of the RO will have a detrimental effect on the economics of the project as landfill gas electricity now only receives 0.25 ROCs/MWh
- **This banding of the RO has caused the price paid for landfill gas generated electricity to fall from 14.81 p/kWh to 9.43 p/kWh**

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2.20 Agricultural Waste

- Based on Defra's 2007 Agricultural and Horticultural Survey of England, there are currently 757 farms in the Borough.
- Production of biogas from animal manure offers the best opportunity for energy generation on farms
- The table below details the number of animals that existed in TW at the time of Defra's survey, and the associated CHP potential (derived from other studies of kWh potential from animal waste).
- The total electrical generation capacity potential from all animals in TW based on this analysis is approximately 1.2 MW

	Sheep	Pigs	Cattle	Poultry	Goats	Horses
Total numbers of animals on Tunbridge Wells farms *(source: DEFRA, 2007)*	33,402	720	5,361	1,506,905	986	1,037
kWh potential per animal per day *(Source: California Energy Commission, 2008)*	0.18	0.33	1.24	0.01	N/A	N/A
Technical electricity generation potential in TW (kWh/day)	6012	238	6648	15069	N/A	N/A
TOTAL generation capacity potential in Tunbridge Wells from animal waste (MW)	0.26	0.01	0.28	0.60	N/A	N/A
Total potential from animal waste in TW (sheep, pigs, cattle & poultry)	**1.15 MW**				*0.1-0.3 from goats & horses (estimate)*	

- The potential data shown here assumes that ALL animal manure is processed for biogas CHP.
- Watts per animal figures are derived from analysis of data from real projects where animal waste is being used in this way. For example, the California Energy Commission Study (http://www.energy.ca.gov/research/renewable/biomass/anaerobic_digestion/index.html).
- Watts per animal data not available for goats and horses. However, estimate is based on the assumption that goats have similar potential to sheep, and horses similar potential to cows.

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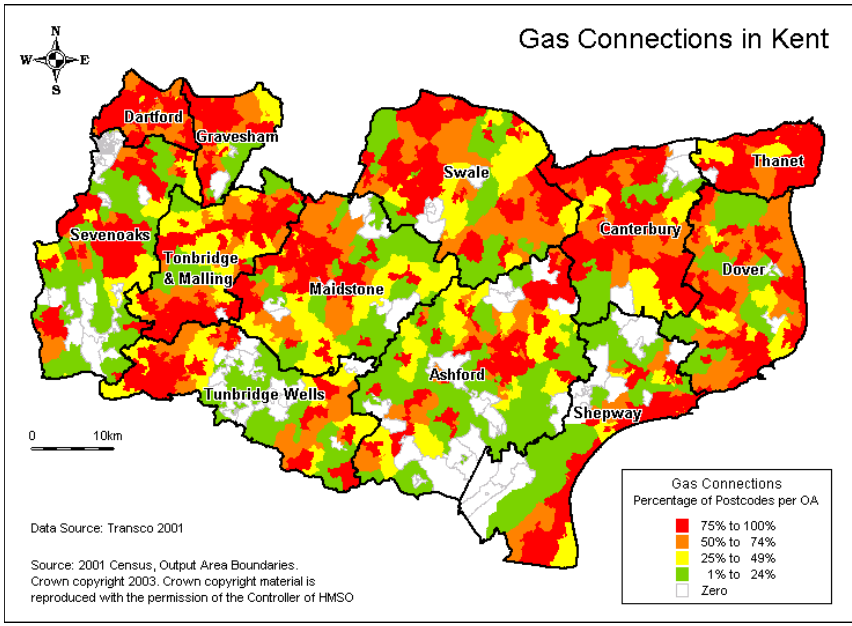
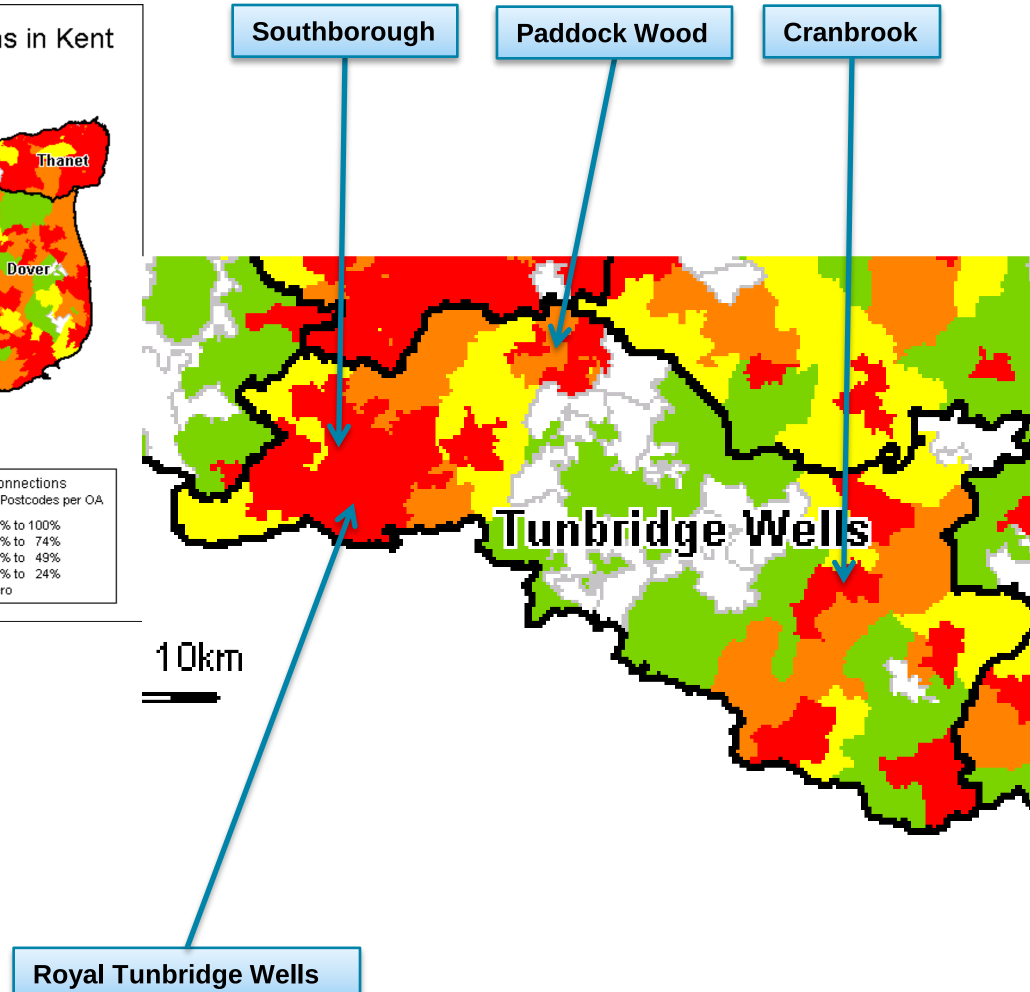
2.21 Natural Gas Network





- All 4 development hubs lie within the range of 75% to 100% for gas connections (2001)
- We assume that all areas of new development will have the same proportion of gas connection or better.
- Therefore, we assume a connection proportion of 90% for all allocated development areas.

3. Which technologies should form part of a low carbon strategy?

On the basis of the resource assessment, the low carbon solutions that are likely to be technically suitable for Tunbridge Wells are shown in the table below.

Technology	Tech Opportunity?	Justification
Combined heat and power & District Heating	✓	• Cost-effectiveness, maturity of technology and potential for integration with existing and planned development
Biomass (incl. district heating) and waste-to-energy	✓	• Biomass resource is widely available. • Biomass boilers are generally easily retrofitted. • Landfill gas and sewage are key resources for energy from waste
Energy-efficiency in buildings	✓	• A growing requirement as we move to zero carbon homes • Also generally easily retrofitted to existing buildings
Photovoltaics	✓	• The South of England has the highest solar irradiation in the UK. • Also easily retrofitted.
Solar thermal	✓	• The South of England has the highest solar irradiation in the UK. • Also easily retrofitted.
Heat pumps	✓	• Air and ground source heat pumps can be easily retrofitted or integrated with new developments
Micro and mini wind turbines	?	• The wind resource in the Borough is not optimal and much of the Borough is in the AONB. • There are some isolated opportunities.

Delta Energy & Environment Ltd
Registered in Scotland: No SC259964
Registered Office: 15 Great Stuart Street, Edinburgh, EH3 7TS

A Low Carbon Strategy For Tunbridge Wells Borough Council

Annex B: Strategic Sites

July 2009

Introduction

This Annex presents an assessment of the opportunities identified on strategic sites in the Borough. For each site the following information is provided:

- A description of proposed or existing land uses
- A high level estimate of energy demand based on approximate floorspace and benchmark figures as outlined in the main report.
- An assessment of potentially feasible technologies (only those that can be installed at a community level have been considered)
- A high level assessment of possible costs and carbon savings for each of these technologies
- Indicative recommendations relating to options for the most cost-effective DE solutions.

The recommendations for each site are also provided in the main report.

Note: the costs and potential carbon savings set out in this Annex are high level estimates and should be used as indicative figures only. The actual savings are highly site-specific and it will be necessary to validate these figures through full feasibility studies.

Contents

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1.1 North Farm & Knights Way

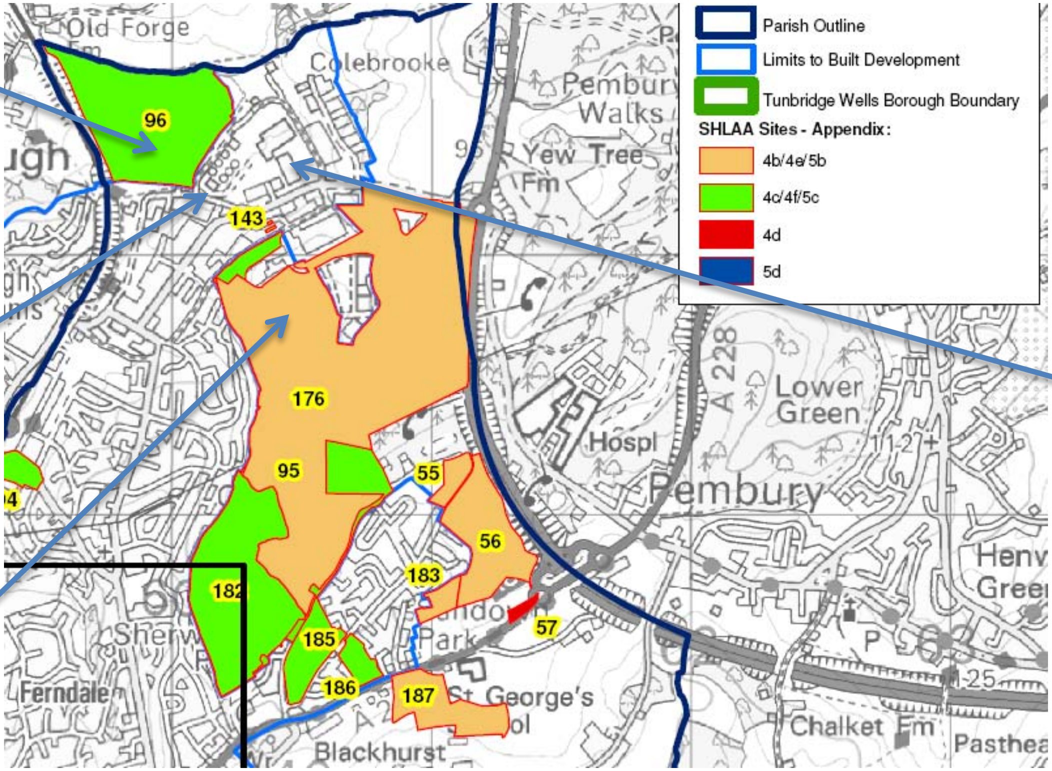
North Farm presents a good renewable energy opportunity as an industrial site:

- It holds two possible sources of energy from waste - landfill gas and biogas from anaerobic digestion of sewage sludge
- It is allocated for economic development in the current Local Plan
- There is likely to be a new private hospital developed adjacent to the site
- As an industrial site, it can accommodate technologies with more significant visual impacts, such as anaerobic digestion or the handling of biomass fuel
- The site has good road access for the delivery of fuel (biomass or waste)

North Farm Tip
Landfill gas currently being flared

Sewage Treatment Works
Potential to recover energy from waste

Knights Way - Hospital
Planning permission granted for private hospital



Economic Development Area
Currently allocated in the Local Plan for B1, B2 and B8 mixed use, i.e. business and light industry, general industry and storage or distribution

1.2 North Farm & Knights Way (...cont)

Energy from Waste Opportunity

The combination of the landfill gas and the biogas from the sewage treatment works would be a key starting point for the development of a low carbon solution at the North Farm site. However, it will be necessary to supplement the resource available onsite, because:

a. The landfill gas resource is only enough for a 100 kWe gas engine, and

b. The sewage treatment works opportunity is already being exploited by Southern Water – the biogas from the anaerobic digestion of sewage sludge is used to fuel a 70 kWe CHP gas engine which provides heat for the digestion process and spills excess electricity generation to the grid.

Banding of ROCs – Bad for Landfill & Sewage Gas

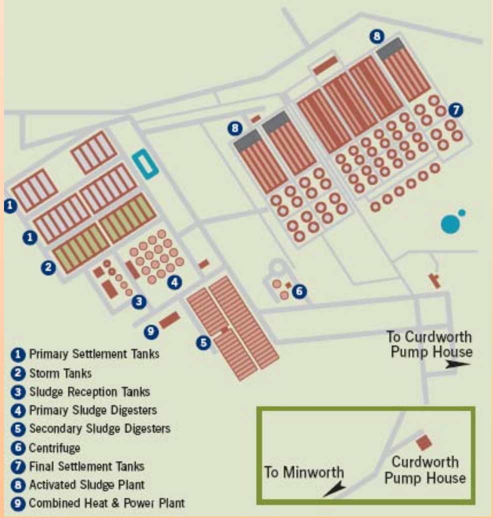
As of 1 April 2009, the financial incentive for renewable electricity has changed. Instead of each MWh of renewable electricity receiving 1 ROC (currently worth ~ £50), ROC allocations are now banded according to technology.

Electricity generated from landfill gas now only receives 0.25 ROC/MWh.

Electricity generated from sewage gas now receives 0.5 ROC/MWh.

Case Study: Minworth Sewage Treatment Works

Although a larger site than the Works at North Farm, this case study highlights the opportunity available from recovering energy from sewage. This site consumes the heat produced on-site, as opposed to supplying it to local consumers.



Details	
Input	500 million L/day (from 1.3 million people including domestic and industrial discharges.
Energy recovery	5 x 1.9 MW gas engines 22 MWh/day
Energy efficiency	Completely self-sufficient. Exports 12% surplus to the grid. Waste heat used to heat digesters.
Economics	Unknown, but Severn Trent Water is now looking to develop similar schemes at 35 of its sites.

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1.3 North Farm & Knights Way (...cont)

New Hospital Development

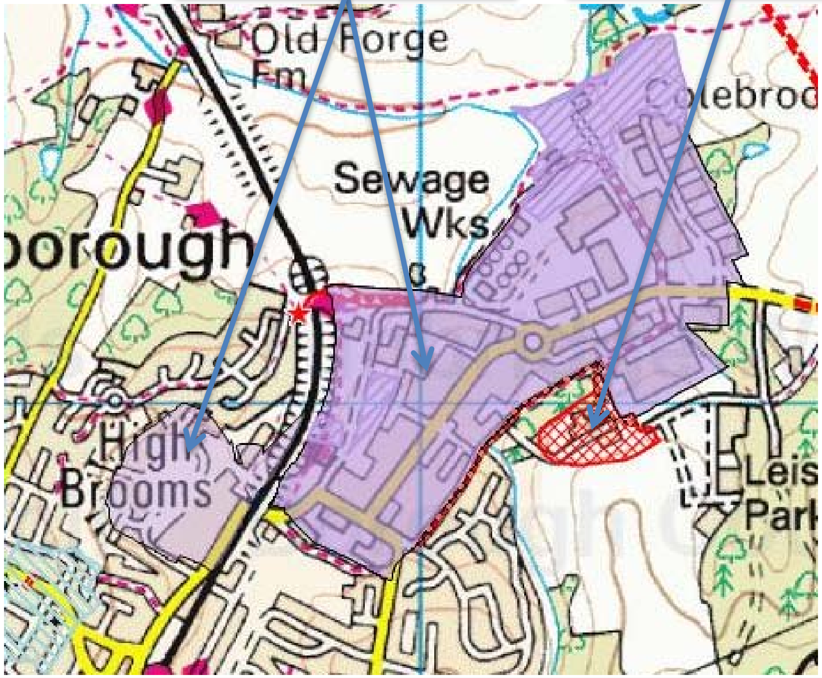
- Just south of the Economic Development area of North Farm is the site of the proposed new private hospital. This is an obvious opportunity providing a key anchor heat load for a CHP plant.
- Currently, the developers of the hospital are analysing options for meeting local renewables targets. No decision has been reached as to how this will be achieved. This presents a great opportunity for the Council to get involved in the decision making and make use of the larger opportunity available.

Economic Development Area

- A large area of North Farm is already allocated in the Local Plan for economic development.
- The specific breakdown in terms of land use of this site is unknown. For the purposes of this study it has been assumed that one third of the site will be taken up by development.
- The site area is approximately 280,000 m^2. This excludes the sewage treatment works, the energy demand for which is currently being met by the biogas CHP plant.
- Using the assumption above, the total treatable floorspace is around 93,300 m^2 which will be divided equally into:
  - Offices
  - Light manufacturing
  - Storage & distribution

Economic Development Area
Estimated floorspace: 280,000 m^2

Knights Way – Hospital
Proposed floorspace: 11,000 m^2



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1.4 North Farm & Knights Way (...cont)

Technology Options

There are several technology options for the North Farm site, summarised in the table on the right. Utilising the existing biogas opportunity is a probable first choice.

The table below shows the likely heat demand for the site based on benchmark figures for gas consumption of the different building types (see Section 1 of Main Report). The estimated heat demand is based on the assumption that all natural gas is currently supplied for heat and burned in a 90% efficient combination boiler.

Technology	Likely suitability	Comments
Biogas DH CHP	Very High	• As North Farm is an industrial area, it is a suitable site for an AD facility. • The Sewage Works is already producing biogas, so this facility could be scaled up. • Transport of waste for processing would not be an issue. • Landfill gas from the North Farm Tip could supply the CHP system.
Biomass District Heating	High	A biomass, heat only system is also a suitable option. North Farm is a large industrial site, with good road access and ample space for fuel delivery and storage.
Natural Gas DH CHP	High	If there is not enough biogas resource for biogas DH CHP to be viable, then natural gas is the next best alternative.
Natural Gas Packaged CHP	High (hospital only)	If a community-scale system is not feasible, packaged CHP should certainly be considered for the Knights Way hospital development. Hospitals are ideal heat hosts for CHP.

Building Type	Estimated Floorspace	Heat demand (GWh/year)	Electricity Consumption (GWh/year)
Industry (light manufacturing)	31,100	4.9	1.3
Storage & Distribution	31,100	3.8	0.9
Offices	31,100	4.2	1.7
Hospitals	11,000	4.1	0.5
	Total Heat Demand =	**17 GWh/year**	

1.5 North Farm & Knights Way (...cont)

Carbon Saving, Cost-Effectiveness and Risk

The sewage treatment works at North Farm currently utilises the existing supply of biogas from the digestion process. This biogas could be used to fuel a biogas CHP system that serves the entire site. It would be necessary, however, to upscale the existing system. In estimating installation costs (as shown in the table below), the available biogas resource from the sewage works or the landfill has been excluded.

For the district heating network, approximately 2 to 4 km of piping would be required, a sizeable investment at £910/m.

As shown in the table below, ***biogas CHP district heating offers the greatest carbon savings but the lifetime cost of carbon saved could be higher than the biomass or natural gas equivalent.***

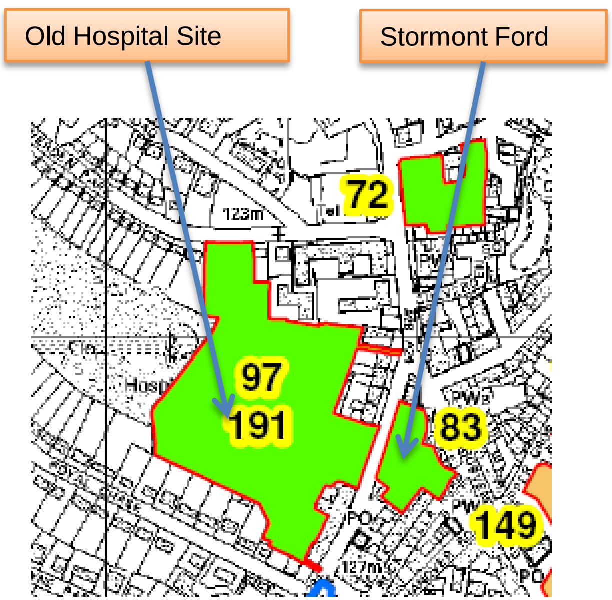
There are risks with all technologies:

- The biogas system is quite large, and there may be issues in securing sufficient waste for AD processing
- Biomass security of supply is also an issue for such a large installation. There is also a fuel price risk associated with biomass, although not as much as for natural gas. However, the renewable heat incentive (to be introduced in 2011) will improve the economics of the project.
- Natural gas is subject to significant fuel price risk. The introduction of a price for carbon would also damage the economic effectiveness of natural gas CHP compared to that of biomass heat-only. The method in which a carbon price will be introduced is unknown, but could come in the shape of the feed-in tariff for renewable electricity/heat or through the Carbon Reduction Commitment.

Technology	CHP Size		Approx. Heat Demand Covered (GWh/year)	Approx. Annual CO_2 Savings (t CO_2/year)	Approx. Lifetime CO_2 Savings (t CO_2)	Approx. Lifetime Cost of Carbon Saved (£/t CO_2)
	(kWe)	(kWth)				
Biogas DH CHP	1,591	2,122	12.7	8,000	120,000	~£140
Natural Gas DH CHP	1,591	1,819	12.7	1,400	21,000	£80 - £250
Packaged CHP (Hospital only)	307	351	2.5	270	4,000	£80 - £250
Biomass District Heating	-	1,670	12.7	2,900	44,000	£80 - £150
Biomass Boiler (Hospital only)	-	320	2.5	563	8,400	£80 - £150

1.6 Old Kent & Sussex Hospital

- The old Kent and Sussex Hospital site has been allocated for redevelopment in the Local Plan. The site will be redeveloped when the new District General Hospital at Pembury opens. The site has been allocated for mixed use and residential development.
- With a housing potential of 200 dwellings (at a density of around 60 dwellings per hectare), this presents an opportunity for a district heating scheme.
- Adjacent to the Hospital site is Stormont Ford (SHLAA ref. 83). This candidate site is suitable for 63 dwellings, resulting in a density of over 100 dwellings per hectare. If the hospital heating scheme were to go ahead, linking in Stormont Ford would create economies-of-scale and increase carbon savings.



1.7 Old Kent & Sussex Hospital (...cont)

Technology Options

In this case, biogas CHP is not recommended as there is no viable supply nearby.

According to the Local Plan, this site is allocated for 5,000 m^2 of office space, as well as 200 residential dwellings.

Technology	Suitability	Comments
Biomass District Heating	High	The site is located at the edge of the town centre, ideal for installation of biomass heating. There is easy access to the site for delivery and ample space for fuel storage.
Natural Gas DH CHP	Medium	The high number of dwellings and high density are conducive factors for the development of district heating. However, there may not be sufficient mixed loads from the retail area. In this case, a thermal store will be needed to allow the CHP to maximise its electricity generation.
Natural Gas Packaged CHP	Medium (old hospital site only)	As with the DH option, a thermal store will be required for the engine to run economically.

Building (SHLAA Ref)	Building Type	Estimated Floorspace (m^2)	Heat demand (GWh/year)	Electricity Consumption (GWh/year)
Old Kent & Sussex Hospital (191)	Residential (200 dwellings)	N/A	3.3	0.8
	Offices	5,000	0.7	0.3
Stormont Ford (83)	Residential (64 dwellings)	N/A	1.0	0.3
		Total Heat Demand =	**5.0 GWh/year**	

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1.8 Old Kent & Sussex Hospital (...cont)

Carbon Saving, Cost-Effectiveness and Risk

For a heating network at this site, we estimate a pipe length of between 200m and 650m to be required.

Calculations show that installing a district heating system offers significantly higher carbon savings than just the hospital site only. However, a sizeable investment will need to be made in the heating network (at £910/m).

Installing a biomass system offers carbon savings in the order of 2 times more than natural gas DH CHP. Indicative costs per CO_2 savings are comparable. Therefore, biomass is likely to be the fuel of choice. The site is suitable for the use of biomass as it is on the edge of town and there is ample space for handling.

Several other factors point to biomass as being the fuel of choice:

- There is less of a fuel price risk associated with biomass
- The renewable heat incentive will improve the economics of a biomass scheme
- A carbon price will damage the economic viability of a natural gas project

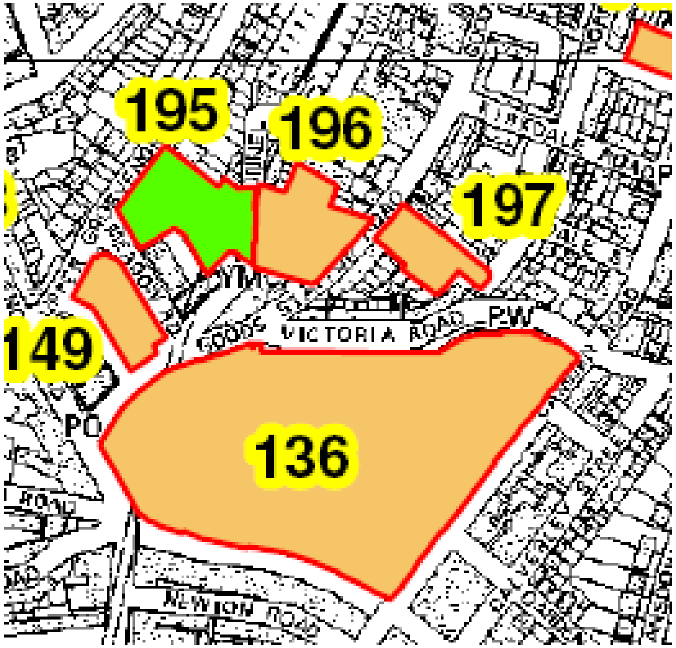
Technology	CHP Size		Approx. Heat Demand Covered (GWh/year)	Approx. Annual CO_2 Savings (t CO_2/year)	Approx. Lifetime CO_2 Savings (t CO_2)	Approx. Lifetime Cost of Carbon Saved (£/t CO_2)
	(kWe)	(kWth)				
Biomass District Heating	-	490	3.8	858	12,900	£80 - £150
Biomass Boiler (Hospital site only)	-	310	2.4	543	8,100	£80 - £150
Natural Gas DH CHP	469	536	3.8	409	6,100	£80 - £250
Packaged CHP (Hospital site only)	296	339	2.4	259	3,900	£80 - £250

1.9 Royal Victoria Place Shopping Centre

The Royal Victoria Place site has been allocated for non-residential use in the Local Plan. The primary allocation is for a significant proportion of retail floorspace. There will be some provision for other commercial uses such as restaurants. Application for community uses and leisure will also be accepted provided non-retail frontage does not exceed 15%. On this basis, the site would potentially provide a suitable heat load for packaged CHP – providing heat and power (and potentially cooling) to the mixed loads.

The multi-storey car park on Meadow Road (SHLAA ref. 149), directly across Victoria Road, is suitable for mixed use, including office, retail and the potential for 135 residential dwellings at a density of over 500 dwellings per hectare.

The combination of the two sites would provide a suitable opportunity for a district heating scheme. This could be extended to reach two other sites (SHLAA ref. 195 and 196), which between them have a housing potential of almost 90 dwellings and an average density of almost 80 dwellings per hectare.



1.10 Royal Victoria Place Shopping Centre (...cont)

Technology Options

The floorspaces used for retail and leisure in Royal Victoria Place (assumed 40,000 m^2 in total) are based on the Local Plan policy that no more than 15% of the floorspace will be used for non-retail purposes.

The retail floorspace (1,200 m^2) in Meadow Road Car Park is calculated assuming that the ground floor is all retail and the floors above hold the residential potential.

On this basis the appropriate technologies would be biomass heating, natural gas CHP/DH and packaged natural gas CHP as shown in the table on the right. Heat demand for all elements is shown in the table below.

Technology	Suitability	Comments
Natural Gas DH CHP	High	Royal Victoria Place provides a suitable anchor heat load for CHP, while the surrounding residential developments provide enough dwellings at a suitable density to justify a district heating network.
Natural Gas Packaged CHP	High (shopping centre only)	As with the DH option, a thermal store would be required for the engine to run economically.
Biomass (District) Heating	High	Biomass heating is a suitable option for this site, however as it is in the town centre, space for delivery and storage of fuel is limited.

Building (SHLAA Ref)	Building Type	Estimated Floorspace (m^2)	Heat demand (GWh/year)	Electricity Consumption (kWh/year)
Royal Victoria Place (136)	Retail (85%)	34,000	5.9	8,058,000
	Leisure (15%)	6,000	1.1	450,000
Meadow Road Car Park (149)	Residential (135 homes)	N/A	2.2	540,000
	Retail	1,200	0.2	284,400
Sites 195 & 196	Residential (90 dwellings)	N/A	1.5	360,000
		Total Heat Demand =	**9.3 GWh/year**	

1.11 Royal Victoria Place Shopping Centre (...cont)

Carbon Saving, Cost-Effectiveness and Risk

For the heating network, a range of between 350 m and 1 km is assumed to be needed.

As the lifetime cost of carbon saved is comparable for the two types of fuel considered, biomass looks likely to be the preferred option. However, the location of this site (town centre) complicates this. Access to the site is more restricted and the higher land-value associated with the town centre means that storage of fuel becomes more costly.

A detailed feasibility study is required to determine if the extra costs and disruption associated with delivery and storage of biomass outweigh the extra carbon savings.

Again, the same fuel price risks and future rewards from the renewable heat incentive must be considered when choosing which option to deploy at the site.

Technology	CHP Size		Approx. Heat Demand Covered (GWh/year)	Approx. Annual CO_2 Savings (t CO_2/year)	Approx. Lifetime CO_2 Savings (t CO_2)	Approx. Lifetime Cost of Carbon Saved (£/t CO_2)
	(kWe)	(kWth)				
Natural Gas DH CHP	873	997	7	762	11,400	£80 - £250
Packaged CHP (Shopping centre only)	532	608	4.3	465	7,000	£80 - £250
Biomass District Heating	-	915	7	1,600	24,000	£80 - £150
Biomass Boiler (Shopping centre only)	-	560	4.3	975	14,600	£80 - £150

1.12 Pembury Hospital

The site has undergone an assessment of several renewable technologies. As the table (right) demonstrates, the 3 most viable technology options identified are:

- Off-site wind
- Solar air collectors
- Biomass heating

CHP was considered unfeasible due to a lack of summer heat demand, while off-site wind was ruled out as an on-site solution is preferred. Solar air collectors offer limited carbon savings but significant architectural impacts, and was therefore rejected.

Biomass heating was the preferred option. The table below details the proposed system.

Ranking	Technology
System rating	1 MW
Fuel store	2 external bunkers
Fuel deliveries	2-3 vehicles per week
Energy generated per annum	5,800,000 kWh
CO_2 savings per annum	1,102,000 kg CO_2
Total annual CO_2 savings	11.8%

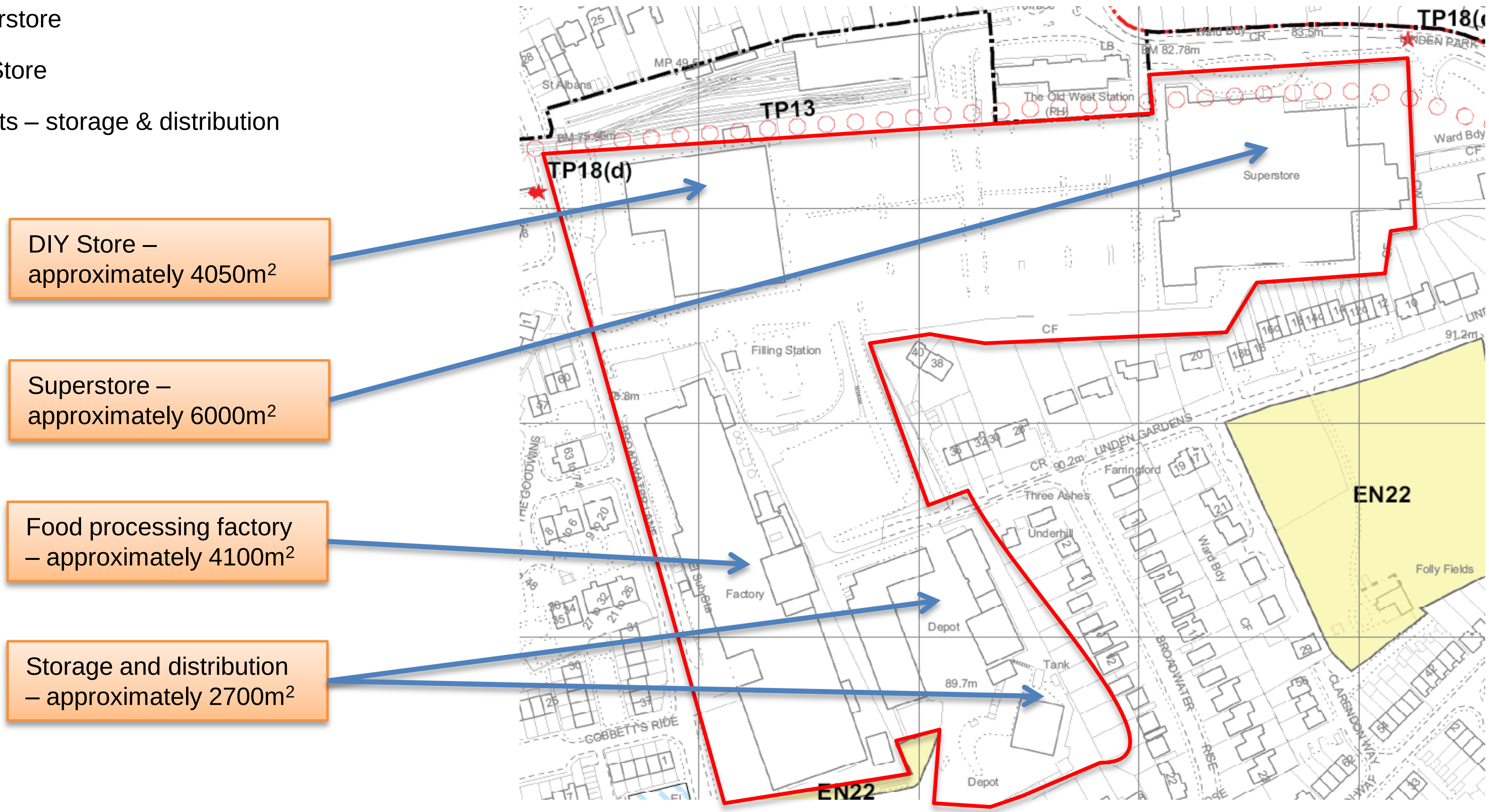
Ranking	Technology
1	Off-site wind
2	Solar air collectors
3	Biomass heating
4	Solar thermal
5	Ground source heat pump
6	Solar PV
7	On-site wind
8	Air/ground heat exchanger
9	CHP with absorption chillers
10	Fuel cell
11	Energy from waste CHP (mass incineration)
12	Energy from waste CHP (pyrolysis/gasification)

1.13 Broadwater Lane

The commercial/industrial site at Broadwater Lane has not been allocated for redevelopment within the current Local Plan.

Up to this point, there is no evidence that consideration has been given to development of low carbon solutions at this site. Given the current land uses on the site, it is potentially suitable for a community renewable energy scheme. Land uses include:

- Food processing factory (savoury pastry and frozen/chilled meat products)
- Superstore
- DIY Store
- Depots – storage & distribution



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1.14 Broadwater Lane (...cont)

Technology	Suitability	Comments
Biogas DH CHP	High	• As the site is an industrial area, it could accommodate an AD facility. • Food waste from the food processing factory could be a source of biomass. • Transport of waste for processing would not be an issue as the site is designed for haulage deliveries.
Biomass District Heating	High	If there is not enough biogas resource for biogas DH CHP to be viable, then biomass district heating is the next best alternative.
Natural Gas DH CHP	High	Natural gas DH CHP is also a suitable option for the site.

Technology Options

Biogas, biomass heating and natural gas CHP are potentially viable options for this site.

Energy demand estimates are based on estimated floor space.

Building Type	Estimated Floorspace (m^2)	Heat demand (MWh/year)	Electricity Consumption (MWh/year)
Industry (light manufacturing)	4,095	645	176
Storage & Distribution	2,708	329	78
Superstore	6,020	1,100	5508
DIY Store	4,046	542	513
	Total	**2.6 GWh/year**	

1.15 Broadwater Lane (...cont)

Carbon Saving, Cost-Effectiveness and Risk

On the basis of current land uses, ***biomass district heating could be the most appropriate technology for this site***. The food processing factory could provide a heat anchor load. The main disadvantage to district heating of any type at this site would be the need to install a DH network. This would cause some disruption as there is no new development planned for the site.

Although it would deliver the most significant carbon savings, biogas CHP may not be the most appropriate given the location of residential properties in the immediate surrounding area.

Natural gas DH CHP offers the least carbon savings, but it does not involve any disruption in terms of fuel delivery and storage. but given the commercial/industrial nature of the site, Delta also does not foresee any major issues in the handling of biomass. The site is located outside the town centre, so the cost of land for storage of biomass may not be a significant a concern.

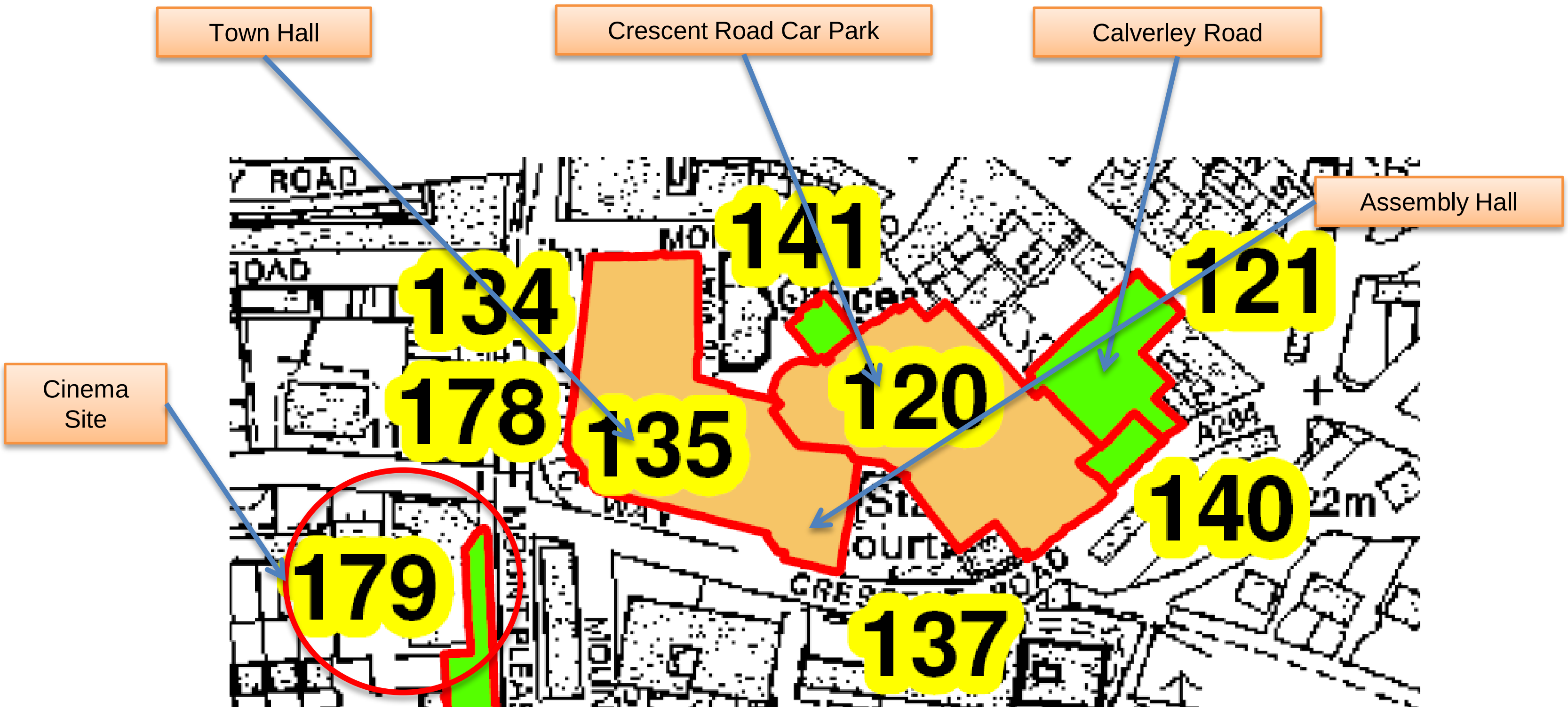
Again, the same fuel price and carbon risks, and renewable heat incentive issues must be taken into consideration when selecting the most appropriate solution. For this, a detailed feasibility analysis is required.

Technology	CHP Size		Approx. Heat Demand Covered (GWh/year)	Approx. Annual CO_2 Savings (t CO_2/year)	Approx. Lifetime CO_2 Savings (t CO_2)	Approx. Lifetime Cost of Carbon Saved (£/t CO_2)
	(kWe)	(kWth)				
Natural Gas DH CHP	244	279	2	210	3,200	£80 - £250
Biogas DH CHP	244	325	2	1,200	18,300	~£140
Biomass District Heating	-	255	2	4,500	6,700	£80 - £150

2.1 Town Hall and Surrounds

The Town Hall site has the potential for redevelopment. Together with surrounding sites, it offers an opportunity for the development of DE. The site is a Conservation Area with several listed buildings (including the Town Hall and Assembly Hall). Therefore only a limited portfolio of technologies can be applied.

Developers of the old cinema site across the street are already considering integration of renewable energy technology solutions. There is an opportunity to link this development with the Town Hall site.



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2.2 Town Hall and Surrounds (...cont)

Technology Options

The layout of the Town Hall and surrounding buildings make them a potential candidate site for district heating, whether it be biomass heat-only or natural gas CHP.

We have assumed that the office floorspace of the Crescent Road Car Park will be equal to the ground floor area, with the rest of the site used for 100 dwellings.

Technology	Suitability	Comments
Natural Gas DH CHP	High	The site presents a key opportunity for the development of a community heating network. The Town Hall and Assembly Hall provide large anchor heat loads.
Biomass District Heating	High	Biomass is a strong candidate to provide heating to the Town Hall site. However, its central location may cause problems for fuel delivery and storage.

Building (SHLAA Ref)	Building Type	Estimated Floorspace (m^2)	Heat demand (GWh/year)	Electricity Consumption (GWh/year)
Town Hall (134)	Retail (department store)	2,000	0.35	0.47
Assembly Hall (135)	Retail (department store)	2,500	0.44	0.59
Crescent Road Car Park (120)	Office	21,600	0.68	0.28
	Residential (100 dwellings)		1.64	0.4
Calverley Road (121)	Residential (150 dwellings)	N/A	2.46	0.6
		Total Heat Demand =	**5.56 GWh/year**	

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2.3 Town Hall and Surrounds (...cont)

- Directly across the street from the Town Hall lies the old cinema site. This is to be redeveloped (planning approved) to a mixed use site, comprising of 4 building types:
  - Offices
  - Hotel
  - Retail
  - Carpark
- A renewable energy assessment has been performed and solutions agreed upon. **These heat only solutions could be linked in to the district heating scheme.**
- The two tables below detail the energy demand of the site and the proposed renewable heating solutions.

Building (SHLAA Ref)	Building Type
Floorspace	40,983 m^2
Site electricity demand	2,799,285 kWh/year
Site gas demand	851,138

Solar Thermal		Air Source Heat Pump		Biomass Heating	
Energy generated per annum (kWh)	317,224 (35% of heat demand)	System rating (kW)	900 kW (with cooling)	System rating (kW)	900
		Energy generated per annum (kWh)	1,170,932	Energy generated per annum (kWh)	589,131 (65% of heat demand)
CO2 savings per annum (kg)	87,916	CO2 savings per annum (kg)	36,435	CO2 savings per annum (kg)	142,233

2.4 Town Hall and Surrounds (...cont)

Carbon Saving, Cost-Effectiveness and Risk

A community heating network is likely to be the only option for significant carbon savings at this site, as the individual buildings offer little in the way of a steady heat load.

Biomass district heating is likely to offer the most significant carbon savings. However, the site is located in the town centre, where access for fuel delivery and space for storage is limited. This high land value for storage and disruption of deliveries is also a concern. However, since a biomass boiler of considerable size (900 kW) is to be installed in the cinema site, directly across the road, delivery and even storage of biomass could be shared between the two sites.

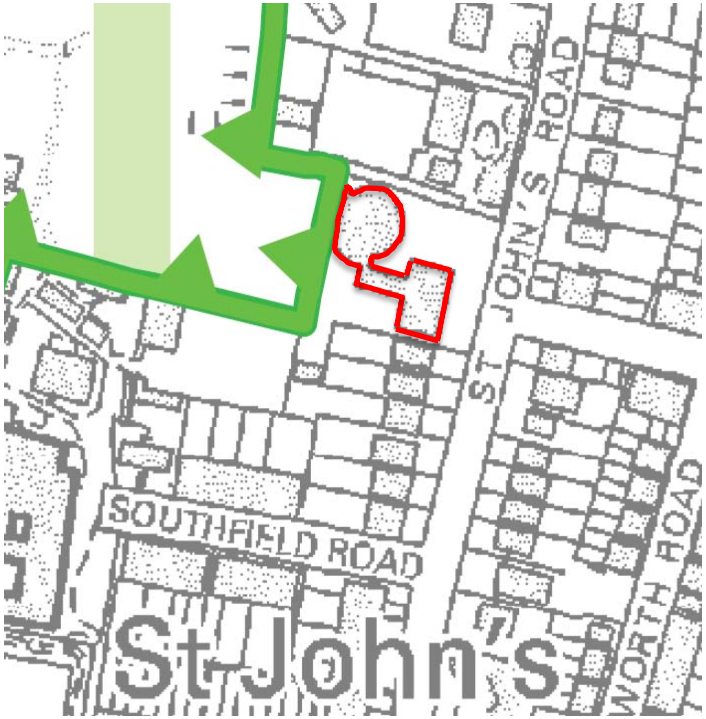
A detailed feasibility analysis is required to choose the most appropriate solution. Fuel price risk, carbon price and future incentives such as the renewable heat incentive, will need to be taken into consideration.

Technology	CHP Size		Approx. Heat Demand Covered (GWh/year)	Approx. Annual CO_2 Savings (t CO_2/year)	Approx. Lifetime CO_2 Savings (t CO_2)	Approx. Lifetime Cost of Carbon Saved (£/t CO_2)
	(kWe)	(kWth)				
Natural Gas DH CHP	417	476	4.2	364	5,500	£80 - £250
Biomass District Heating	-	545	4.2	954	14,300	£80 - £150

2.5 Tunbridge Wells Sports Centre

Sports centres offer a good opportunity for low carbon energy solutions as they have a high energy demand, for heating in particular.

Tunbridge Wells Sports Centre is large, with a gross floorspace of 9,444 m^2. It contains three swimming pools that provide a substantial heat load.



Technology	Suitability	Comments
Natural Gas CHP	Very High	The steady heat load of the sports centre (with indoor swimming pool) makes it an ideal location for natural gas CHP
Biomass Boiler	Very High	Biomass heating is also a very suitable option. However, access and space for fuel delivery and storage may be an issue.

Building Type	Floorspace (m^2)	Heat demand (GWh/year)	Electricity Consumption (GWh/year)
Sports Facility (with pool)	9,444	3.06	1.42
	Total	**3.06 GWh/year**	

2.6 Tunbridge Wells Sports Centre (...cont)

Carbon Saving, Cost-Effectiveness and Risk

Biomass heating is likely to offer the most significant carbon savings and may provide the best combination of carbon savings and cost-effectiveness. However, the sports centre is located close to the town centre and has very limited space for fuel storage. Delivery could also be an issue. If biomass is not viable for these logistical reasons, then natural gas CHP is likely to be the next best alternative.

An important consideration to note is that there are two schools adjacent to the centre:

- Tunbridge Wells Grammar School for Boys, within 100m
- St Gregory's Roman Catholic Comprehensive School, within 50m

Although schools fall outside the responsibility of the Borough Council, they offer an opportunity for significant further carbon savings by linking in to the sports centre. Delta recommends that the Council approach Kent County Council to explore the feasibility of creating an integrated heating scheme between the three buildings.

A detailed feasibility study must be completed to decide which solution is most acceptable. This should include an examination of the option of linking the heating scheme with the two adjacent school buildings. Fuel price risk associated with natural gas and biomass, security of supply of biomass and future incentives for renewable heat should be considered.

Technology	CHP Size		Approx. Heat Demand Covered (GWh/year)	Approx. Annual CO_2 Savings (t CO_2/year)	Approx. Lifetime CO_2 Savings (t CO_2)	Approx. Lifetime Cost of Carbon Saved (£/t CO_2)
	(kWe)	(kWth)				
Natural Gas CHP	287	328	2.29	250	3,800	£80 - £250
Biomass Boiler	-	300	2.29	525	7,900	£80 - £150

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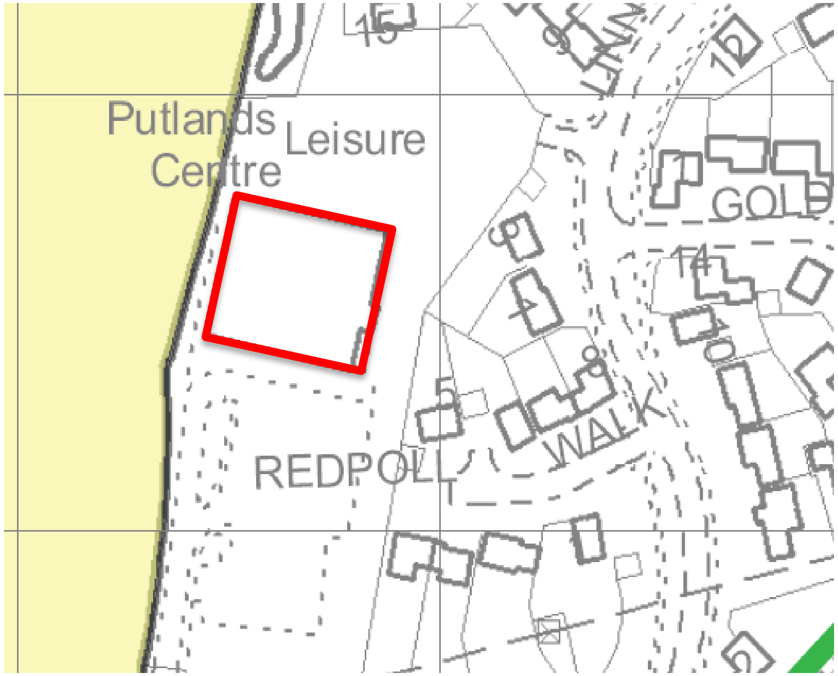
2.7 Putlands Sports & Leisure Centre

Putlands Sports and Leisure Centre is the smallest of the three at just over 1,500 m^2, and it does not contain a swimming pool. There are nonetheless DE options.



Technology	Likely suitability	Comments
Natural Gas CHP	High	The lack of a swimming pool would make CHP less of a viable option, but a small gas engine system may still be feasible.
Biomass Boiler	Very High	Biomass heating is also a suitable option, with ample space for storage and a good transport route.

Building Type	Estimated Floorspace (m^2)	Heat demand (GWh/year)	Electricity Consumption (GWh/year)
Sports Facility	1577	0.31	0.12
	Total	**0.31 GWh/year**	

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2.8 Putlands Sports & Leisure Centre (...cont)

Carbon Saving, Cost-Effectiveness and Risk

The opportunity for carbon savings here is limited, but should not be overlooked. ***Biomass heating offers the largest savings.*** The site is at the edge of the town of Paddock Wood, with ample space for handling of biomass fuel.

There is a school within 300 m of the centre, but considering the size of the heat load at Putlands, it is probably not worth linking in with the school.

Technology	CHP Size		Approx. Heat Demand Covered (GWh/year)	Approx. Annual CO_2 Savings (t CO_2/year)	Approx. Lifetime CO_2 Savings (t CO_2)	Approx. Lifetime Cost of Carbon Saved (£/t CO_2)
	(kWe)	(kWth)				
Natural Gas CHP	19	22	0.15	17	250	£80 - £250
Biomass Boiler	-	20	0.15	35	525	£80 - £150

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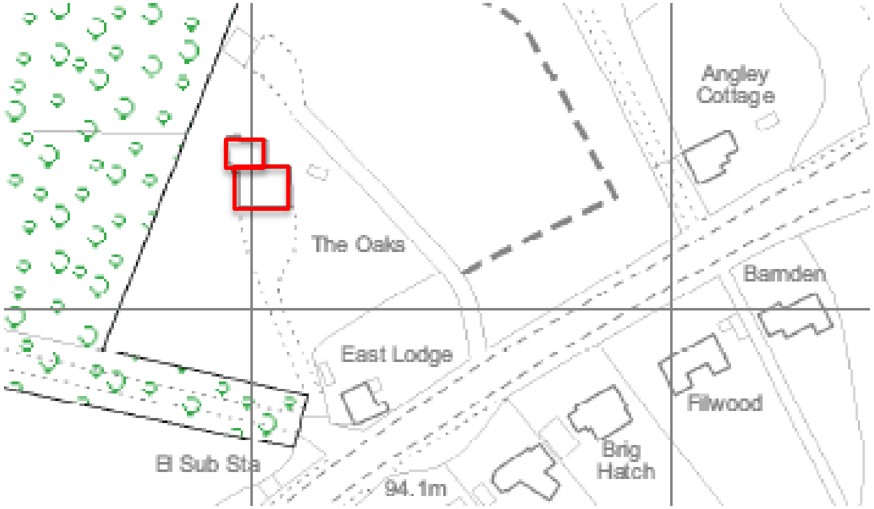
2.9 Weald Sports Centre

Weald Sports Centre in Cranbrook is the final Council-owned opportunity to be analysed. Though not as large as Tunbridge Wells Sports Centre, it contains an indoor swimming pool, providing a stable heat load that is potentially suitable for biomass heating or natural gas CHP.



Technology	Likely suitability	Comments
Natural Gas CHP	Very High	The steady heat load of the sports centre (with indoor swimming pool) could make it an ideal location for natural gas CHP
Biomass Boiler	Very High	Biomass heating is also a suitable option. Weald Sports Centre is situated at the edge of town, just off a primary road. Fuel delivery and storage would not be an issue.

Building Type	Floorspace (m^2)	Heat demand (MWh/year)	Electricity Consumption (MWh/year)
Sports Facility (with pool)	3004	0.97	0.45
	Total	**0.97 GWh/year**	

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2.10 Weald Sports Centre (...cont)

Carbon Saving, Cost-Effectiveness and Risk

Biomass heating offers the most significant carbon savings, and may turn out to be the best all-round option.

The site is located at the edge of the town of Cranbrook, with easy access for delivery and ample space for biomass storage. Therefore, handling of fuel should not be an issue.

There is also a school adjacent to the centre - Angley School, within 150m. Again, although not under the direct control of the Borough Council, this school should be examined for suitability for linking in to the sports centre heating scheme.

A detailed feasibility study must be completed to decide which solution is most acceptable. This should include an examination of the option of linking the heating scheme with the adjacent school building. Fuel price risk associated with natural gas and biomass, security of supply of biomass and future incentives for renewable heat should be considered.

Technology	CHP Size		Approx. Heat Demand Covered (GWh/year)	Approx. Annual CO_2 Savings (t CO_2/year)	Approx. Lifetime CO_2 Savings (t CO_2)	Approx. Lifetime Cost of Carbon Saved (£/t CO_2)
	(kWe)	(kWth)				
Natural Gas CHP	91	104	0.73	80	1,200	£80 - £250
Biomass Boiler	-	96	0.73	167	2,500	£80 - £150