Feasibility Study on Energy Policy & Infrastructure for the Wycombe District
Final Report

Prepared March 2008
1 Executive Summary

This report has been commissioned by Wycombe District Council to assess the feasibility of developing low carbon infrastructure and renewable energy installations in a number of regeneration sites and to set out the policies required to enable this development. The sites, which represent the main allocated regeneration sites in the district, are:

- Compair / De La Rue
- Handy Cross
- Cressex Island
- RAF Daws Hill
- Abbey Barn South
- Molins, Saunderton

The study gives an indication of the likely costs involved and carbon benefits for each of the sites, as well as examining planning policy issues and Energy Services Company (ESCo) delivery mechanisms with a view to development of future infrastructure development in the wider area.

Further aims of the study were to assess requirements of these sites in terms of density, type of development and layout, for ensuring that low carbon infrastructure would be economically viable and the potential to extend infrastructure into the wider area.

Carbon Reduction Targets

As this report has been under preparation the UK government has been finalising its national indicator framework of which the per capita carbon emissions for each local authority in the UK will form indicator 186. As part of the framework for indicator 186, target reductions of 10.7% by 2010 and 19.9% by 2020 have been proposed by DEFRA for Wycombe, as shown below.

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>National measures</td>
<td>6.6%</td>
<td>4.1%</td>
</tr>
<tr>
<td>National measures with LA influence</td>
<td>9.2%</td>
<td>10.7%</td>
</tr>
<tr>
<td>Local measures</td>
<td>4.1%</td>
<td>10.7%</td>
</tr>
</tbody>
</table>

Table 1 DEFRA Carbon Reduction Targets for Wycombe

These very demanding targets underline the need for Wycombe DC to maximise the potential for:

- any new building in Wycombe to be low carbon
- regeneration to assist in developing low carbon infrastructure which can be extended to serve the existing building stock.

This is further underpinned by previous work looking at longer term targets to 2050 for other areas of the UK. This work has found that in order to tackle the very significant carbon emissions resulting from heating and hot water use within buildings, the development of city or town-wide district heating systems incorporating CHP is required. The first step in the development of such schemes is normally considered to be the interconnection of large public sector heat loads such as hospitals, universities and municipal buildings with newbuild or regeneration schemes where the installation of community heating is relatively inexpensive and its installation can be enforced through the planning system. Newbuild and regeneration sites have much lower costs for CH/CHP as the civil engineering costs of installing the heat distribution
network can be offset against the cost of installing a gas network. Where the density of the development is highest, schemes are at their most economic as there are lower infrastructure costs per connection due to shorter pipe runs, higher capacity pipe networks and economies of scale. This study clearly looks forward to this eventuality.

**CH/CHP Feasibility**

Table 2 summarises the potential for CH/CHP at each of the sites analysed for this study. The loads represented in the newbuild schemes individually would justify at least 1MWe of CHP in total with a saving of around 1.2kt CO$_2$pa. Generally for each site there is a mismatch between achieving the optimal carbon saving and optimal financial return. A larger engine in most cases achieves a better carbon reduction than the engine which is financially optimal. The table presents the figures for the optimal financial return.

**Control strategies**

There are different control strategy options in operating CHP plant. We have analysed both heat led and power led strategies.

A heat led strategy power can be exported to the grid but heat cannot be rejected, so the engine would not run unless there was sufficient thermal demand to use at least as much heat as the engine would supply at minimum part load. A heat led strategy tends to save more CO$_2$ since this makes best use of the energy produced by the CHP unit.

A power led strategy allows heat rejection but not power export. Note that the use of thermal storage could improve the performance of a CHP system by evening out peaks in demand. A power led strategy often performs better economically because electricity sold directly to consumers can be sold at an end user price, whereas electricity exported to the grid will be sold at a lower rate, similar to the wholesale electricity price. In most cases, a power led strategy will still save CO$_2$ compared to a non-CHP scenario provided that a reasonable proportion of the heat is utilised (as this is the source of carbon savings relative to conventional thermal electricity generation).

The analysis shows that where a scheme is viable, it is viable irrespective of which of these strategies is adopted.

<table>
<thead>
<tr>
<th>Development Site</th>
<th>Engine Size (kW$_e$)</th>
<th>Net Present Value (£)</th>
<th>CO$_2$ savings (tpa)</th>
<th>Network infrastructure cost (£)</th>
<th>Marginal Cost of infrastructure (£)</th>
<th>Viability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abbey Barn South</td>
<td>90</td>
<td>141,000 (low)</td>
<td>101 (low)</td>
<td>4,010,000</td>
<td>1,000,000</td>
<td>Heat or Power led strategies</td>
</tr>
<tr>
<td></td>
<td></td>
<td>245,000 (high)</td>
<td>123 (high)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compair / De la Rue</td>
<td>150</td>
<td>730,300</td>
<td>132</td>
<td>990,000</td>
<td>330,000</td>
<td>Heat or Power led strategies</td>
</tr>
<tr>
<td>Cressex Island</td>
<td>70</td>
<td>-160,700 (low)</td>
<td>35 (low)</td>
<td>172,000</td>
<td>57,000</td>
<td>Not economically viable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-48,500 (high)</td>
<td>62 (high)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RAF Daws Hill</td>
<td>110</td>
<td>367,200 (low)</td>
<td>105 (low)</td>
<td>4,450,000</td>
<td>750,000</td>
<td>Heat or Power led strategies</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1,803,800 (high)</td>
<td>144 (high)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Handy Cross</td>
<td>100 - 200</td>
<td>1,339,100 (low)</td>
<td>155 (low)</td>
<td>2,948,000</td>
<td>330,000</td>
<td>Heat or Power led strategies</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1,800,700 (high)</td>
<td>176 (high)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 2 Key results of CHP modelling

<table>
<thead>
<tr>
<th>Site</th>
<th>NPV (kWh)</th>
<th>Heat (kWh)</th>
<th>CHP (kW)</th>
<th>Fuel</th>
<th>Dependent on data centre absorption cooling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molins</td>
<td>228</td>
<td>384,100</td>
<td>445</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

All the sites analysed bar Cressex Island are financially viable on the assumptions made in this report. Viability is measured here on the basis of Net Present Value (NPV). A positive NPV indicates that over a period of, in this case, 25 years, there will be a profit once all of the current and future costs and income have been taken into account.

The smaller development sites may also be suited to a CHP scheme although an energy demand estimate for each site would be needed to identify the scale of renewable/CHP system(s) required. There is also the scope for some of the smaller development sites which are near to the larger regeneration sites to link in to district heating networks at these sites.

The key assumption that underpins this analysis is the use of a direct sales approach whereby electricity sales from the CHP units are made directly to the same buildings connected to the heat network via a private wire network. In this approach, it is important to ensure that the site has a good balance of heat and power demand. This approach has been pioneered in Woking and demonstrated in other locations.

Energy prices have been taken from figures published by BERR in the Quarterly Energy Prices report this has been used to estimate the cost of fuel for both the CHP engine and the alternative conventional boilers scenario. Heat sales are estimated to be at a price of 3 p/kWh which allows for the conversion efficiency of the CHP engine and is slightly lower than the 3.3 p/kWh charged by Aberdeen CHP to public sector customers. Electricity sales are estimated to be at 8 p/kWh which is based on the average split of domestic and industrial clients.

A second important assumption is in terms of marginal cost. As the proposed developments are new build, the figure used in our analysis is not the total cost of the system but the marginal cost of community heating infrastructure over the alternative scenario of a gas distribution system with individual boilers.

The heat and power loads are also important and, given the uncertainties in the detailed design and use of the buildings, we have presented high and low scenarios in terms of those demands. However the load profiles generally affect the optimal size of unit rather than the choice of CHP as a technology option.

**Interconnection and Extension of CH/CHP**

The potential exists to interconnect the schemes set out in the table above. The capital costs for this have been estimated by Ramboll by connecting the four minor networks for Cressex Island, Handy Cross, RAF Daws Hill and Abbey Barn South (Molins and Compair/de La Rue were considered to be too distant to be connected at this stage). The total capital cost of the larger network connecting these sites is estimated to be around £14.625 million. Despite the additional pipework cost of connecting the sites, CHP is likely to be viable for this scenario with a positive NPV of between £1.66M and £2.4M and CO₂ savings of between 781 and 937 tonnes per annum with an optimal engine size of 845kWe.

**Renewable Potential**

Along with the need to tackle heating and hot water demand by using CHP, the use of renewable energy sources is also important. The potential for each renewable technology analysed is set out for Wycombe District as a whole in the summary table below. The potential for wind far outstrips the other technologies with a potential of 500ktpa CO₂ saving, almost 40% of Wycombe’s current carbon emissions. Together
renewables have the potential to reduce current emissions by almost 48%. However it is important to note that the Area of Outstanding Natural designation of much of Wycombe could severely constrain the potential for wind energy. It’s also important to note that for the biomass CHP option to be realised a heat network would be required. This would clearly be assisted by the requirement for community heating at the development sites.

<table>
<thead>
<tr>
<th>Renewable</th>
<th>Capacity</th>
<th>Carbon Reduction ktCO2 pa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar PV</td>
<td>122MWpk</td>
<td>58</td>
</tr>
<tr>
<td>Wind</td>
<td>552MW</td>
<td>500</td>
</tr>
<tr>
<td>Biomass CHP</td>
<td>1.6-7.9MWe</td>
<td>11-58</td>
</tr>
</tbody>
</table>

Table 3 Renewable Energy Potential for Wycombe

Energy Service Companies (ESCOs)

An ESCO provides an extremely flexible vehicle to assist in the delivery and operation of low carbon infrastructure such as CHP, district heating and the operation of renewable energy systems.

The flexibility inherent in the ESCO concept should be used to create a structure which is aligned with the local authority's overall vision and strategy for developing low carbon infrastructure and energy services. For example, a number of local authorities in the UK have established their own ESCOs, whereas others have engaged with existing (private sector) ESCOs via arm's length contractual arrangements. There are a number of alternative approaches, but the choice of structure depends on a number of factors, the main drivers being:

- the particular strategic vision that the ESCO will be tasked with implementing - the clarity and robustness of the local authority's strategic vision is fundamental, as the structure of the ESCO must be 'designed' from the outset to be capable of implementing that vision. Moreover, the existence of a coherent and credible strategy will be more likely to help the private sector understand and appraise the investment opportunity;
- the resources that the local authority is able to commit to the ESCO (land, labour, capital);
- the availability and capability of the local authority's in-house resources;
- the local authority's approach to engaging with the private sector - in particular the extent to which it is prepared / willing to take on risk, and to assume responsibility for the delivery of certain aspects of the services;
- the characteristics of the particular sites in relation to which the ESCO will develop infrastructure and/or provide energy services - size, location, aspect, existing/proposed land use, and proximity to other sites; and
- the need for proper and fair representation of other stakeholders in the ESCO's ownership and/or governance arrangements.

To illustrate the flexibility of the ESCO concept, three models are outlined in this report:

Model A: A public sector driven ESCO

In this model, a public sector body establishes the ESCO, and retains a significant (and possibly a controlling) interest in its ownership and/or management. This model is particularly useful where a market driven solution would not necessarily meet the local authority's strategic vision. For example, if the local authority wishes CHP/district heating schemes to be implemented on individual sites so as to be capable of subsequent integration, it will need to have sufficient control over the ESCO to ensure that outcome.
Model A requires a significant commitment of local authority resources. One local authority which established an ESCO under this model utilised a full-time employee, with additional input from other in-house resources (e.g. finance, administrative support). The local authority subsequently entered into an agreement with the ESCO to provide it with administrative services, including support to billing arrangements, and preparation of accounts. A full-time resource could also eventually transfer from the local authority to the ESCO under this model. Professional advisers would normally be required in order to establish the ESCO, run a competitive procurement for the design and construction of the infrastructure (and possibly the subsequent operation and maintenance of the assets), and to negotiate the various agreements. For budgeting purposes, a provision of the order of £60k would be necessary in respect of legal fees. Technical advisers (and possibly also financial advisers) should also be budgeted for.

Model B: A private sector driven ESCO

In this model, the ESCO is established, controlled and managed entirely by the private sector, but interfaces with a public sector body (e.g. with a local authority via the planning process). This model is appropriate where the local authority is confident that a market driven solution will meet its overall objectives, and where the local authority is relatively risk averse in its approach to engaging with the private sector.

The staff time and external costs would be much lower for a Model B type ESCO, in which the solution is principally driven by the private sector. Some in-house resources would be required, for example in relation to the use of the planning process as a tool to take forward the relevant Council policies. Where the local authority wishes to take a supply from the ESCO for its own buildings, there will be an interface to be managed (similar to any other interface with a services provider).

Model C: Public sector as facilitator

In this model, a public sector body facilitates the establishment of, or engagement with, an ESCO, but does not play a significant role in its subsequent ownership or management. This represents a compromise between models A and C in terms of the resource implications for the local authority - and the control which it can exert over outcomes - but there is considerable room for manoeuvre based on what is being procured and the precise nature of the facilitation role that the local authority would adopt.

Capital contribution to infrastructure

Experience to date has been one of developers looking to local authorities (or other sources of funding, e.g. regional development agencies) to fund the additional cost of a CHP network over and above that which they would have had to incur in laying a conventional network. One way of achieving value for money here is to compete the amount of capital contribution amongst potential developers. The extent and complexity of the required network will also impact on the capital contribution. State aid issues would need to be carefully considered in relation to any proposed capital contribution.

Next steps

It is important for WDC to clarify its strategic objectives in relation to the development of low carbon infrastructure. Following that, WDC may wish to conduct a market testing exercise to inform the private sector about the opportunity, and to understand the range of solutions potentially capable of meeting its overall needs. It is important to note that the private sector’s assessment of the investment opportunity will be influenced by its perception of the credibility and coherence of the overall strategy.

In determining which model of ESCO WDC may ultimately wish to adopt, it is critical to appreciate that the level of control that WDC can exercise over outcomes is related to the nature and extent of its involvement in the ESCO.

Planning

Following the London Borough of Merton’s adoption of a 10% on-site renewable energy requirement, many local authorities have adopted increasingly bolder planning policies in relation to sustainability. However
WDC needs to carefully consider the national policy framework with regard to setting its own planning policies.

**Wycombe District Council will have to take into consideration those policies for renewable energy and low carbon technology within the South-East Plan when adopted.**

Planning conditions which require developers to meet resource efficiency standards are entirely in line with national government policy. However these should be implemented through a Development Plan Document (DPD) - in WDC’s case its Site Allocations DPD - rather than Supplementary Planning Documents (SPD). SPD based standards would be open to challenge by a developer.

Given that WDC’s DPD will not be adopted until 2010, WDC should in the meantime consider the following options:

- To ensure compliance with national policy, WDC should require developers to bring forward developments with high standards of resource efficiency
- **WDC can use its broad power to impose planning conditions containing resource efficiency standards for developments on a site-by-site basis, justifying these by reference to national, regional and policy 18 of its core strategy.**
- WDC can adopt an interim Woking-style educational SPD outlining WDC’s approach to resource efficiency in light of national, regional and local policy and relevant Inspectors’ decisions.
- The use of “prematurity” as a basis for rejecting planning applications, although this can only work if planning applications can be deemed to prejudice the DPD and if the DPD is close to adoption and cannot be the only reason for rejection in respect of a housing site. WDC’s own experience is that this cannot be relied on as successful strategy.

**Conclusion**

The study shows that for the major regeneration sites analysed, CHP and district heating is viable in each case bar one (Cressex Island) and that an interconnected scheme involving four of the sites is also viable under the assumptions used here. At this stage of development without detailed design information to determine precise pipe lengths and heat loads and so on, these figures are only indicative. Generally speaking, however, the scale of development and newbuild context where the cost of heat infrastructure can be offset against the cost of gas infrastructure which would have been required anyway, mean that viability should be achieved under most design configurations. It is essential to note that underpinning the analysis is that a private wire approach will be used whereby electricity, as well as heat, is sold directly to the building occupants. Without this approach under the current UK support framework, CHP is unlikely to be economically viable.

One of the most effective methods of selling energy produced by a CHP district heating scheme is an ESCo model. There are a variety of different approaches which predominantly relate to the difference in the split of public sector and private sector control. It is important that before embarking on setting up an ESCo, WDC consider what the objectives of the ESCo would be, and how much control they would wish to retain. Once the structure of the ESCo has been decided, WDC should run soft market testing with potential partners to develop an understanding of the options open to them. Private sector interest is likely to be enhanced by a clear and coherent strategy.

Renewable energy systems are generally more difficult to assess without detailed design information, but under the assumptions used here the potential to incorporate electric systems could also make significant carbon reduction contributions. It is not recommended that thermal renewable systems are utilised as these are not optimally suited to be used in combination with CHP.
Whilst this study has assessed particular regeneration sites within the district, the existing building stock in Wycombe represents the major source of carbon emissions within the district and the work undertaken here underlines the need for a district wide carbon reduction strategy to meet the increasingly demanding national and local climate change targets.
# Table of Contents

1 EXECUTIVE SUMMARY

2 INTRODUCTION
   2.1 PURPOSE OF THE STUDY
   2.2 WYCOMBE CARBON BASELINE
   2.3 RENEWABLE RESOURCES
      2.3.1 Solar photovoltaics
      2.3.2 Wind
      2.3.3 Biomass
   2.4 SUMMARY
   2.5 SITE BY SITE RENEWABLE POTENTIAL ASSESSMENTS
      2.5.1 Solar Photovoltaic
      2.5.2 Small Scale Wind
      2.5.3 Biomass

3 DISTRICT HEATING SITE ASSESSMENTS
   3.1 OVERVIEW
      3.1.1 Methodology
   3.2 RESULTS AND DISCUSSION
      3.2.1 Control Strategies
      3.2.2 Space requirements
      3.2.3 Key results
      3.2.4 Abbey Barn
      3.2.5 Compair and De la Rue
      3.2.6 Cressex Island
      3.2.7 RAF Daws Hill
      3.2.8 Handy Cross
      3.2.9 Combined Site
      3.2.10 Molins

4 LEGAL REPORT - BRODIES LLP
   4.1 3.1 INTRODUCTION
   4.2 ESCOS
      4.2.1 The nature and role of ESCOs
      4.2.2 Model A: public sector driven ESCO
      4.2.3 Model B: private sector driven ESCO
      4.2.4 Model C: public sector as facilitator
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.5.6</td>
<td>Summary of estimated cost</td>
<td>33</td>
</tr>
<tr>
<td>6.6</td>
<td>Study Sensitivity</td>
<td>33</td>
</tr>
<tr>
<td>6.7</td>
<td>Way Forward</td>
<td>34</td>
</tr>
<tr>
<td>6.8</td>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>6.9</td>
<td>The Development’s baseline information</td>
<td>1</td>
</tr>
<tr>
<td>6.10</td>
<td>Heat Demands &amp; Diversity</td>
<td>2</td>
</tr>
<tr>
<td>6.11</td>
<td>General Heat Network Evaluation</td>
<td>4</td>
</tr>
<tr>
<td>6.11.1</td>
<td>District Heating Network Considerations</td>
<td>4</td>
</tr>
<tr>
<td>6.11.2</td>
<td>Interface of consumers to the district heating network</td>
<td>5</td>
</tr>
<tr>
<td>6.11.3</td>
<td>Branches</td>
<td>5</td>
</tr>
<tr>
<td>6.12</td>
<td>Site Specific DH Network Layout</td>
<td>6</td>
</tr>
<tr>
<td>6.12.1</td>
<td>RAF Daws Hill</td>
<td>6</td>
</tr>
<tr>
<td>6.12.2</td>
<td>Abbey Barn South</td>
<td>7</td>
</tr>
<tr>
<td>6.12.3</td>
<td>Handy Cross</td>
<td>8</td>
</tr>
<tr>
<td>6.12.4</td>
<td>Cressex Island</td>
<td>9</td>
</tr>
<tr>
<td>6.12.5</td>
<td>Hydraulic Interface Units and/or Heat Exchangers</td>
<td>10</td>
</tr>
<tr>
<td>6.12.6</td>
<td>Summary of estimated individual network cost</td>
<td>10</td>
</tr>
<tr>
<td>6.13</td>
<td>Larger Scale District Heating</td>
<td>10</td>
</tr>
<tr>
<td>6.13.1</td>
<td>Larger Scale baseline information</td>
<td>11</td>
</tr>
<tr>
<td>6.13.2</td>
<td>Network outline</td>
<td>11</td>
</tr>
<tr>
<td>6.13.3</td>
<td>Service Pipes</td>
<td>12</td>
</tr>
<tr>
<td>6.13.4</td>
<td>Hydraulic Interface Units and/or Heat Exchangers</td>
<td>12</td>
</tr>
<tr>
<td>6.13.5</td>
<td>Summary of estimated network cost</td>
<td>12</td>
</tr>
<tr>
<td>6.13.6</td>
<td>Potential for connecting existing buildings and other developments</td>
<td>13</td>
</tr>
<tr>
<td>6.14</td>
<td>Thermal Storage</td>
<td>13</td>
</tr>
<tr>
<td>6.15</td>
<td>Study Sensitivity</td>
<td>14</td>
</tr>
<tr>
<td>6.16</td>
<td>Way Forward</td>
<td>15</td>
</tr>
</tbody>
</table>
Table of Figures

Figure 1 Defra greenhouse gas emissions for Wycombe (kt CO$_2$pa) ..................................................... 2
Figure 2 A graph of total CO$_2$ emissions and potential savings from renewables ........................................... 5

Table of Tables

Table 1 DEFRA Carbon Reduction Targets for Wycombe ......................................................................................... i
Table 2 Key results of CHP modelling .................................................................................................................. iii
Table 3 Renewable Energy Potential for Wycombe ................................................................................................ iv
Table 4 Greenhouse gas emissions from Wycombe district council for the years 2003 to 2005 (kt CO$_2$pa)…… 1
Table 5 Biomass resource ........................................................................................................................................ 3
Table 6 Renewable Energy Potential for Wycombe ................................................................................................ 4
Table 7 Potential for solar electricity by site ............................................................................................................. 5
Table 8 Potential for small wind energy by site ......................................................................................................... 6
Table 9 Key results of CHP modelling .................................................................................................................... 8
2 Introduction

2.1 Purpose of the study

This study has been commissioned by Wycombe District Council to assess the feasibility of developing low carbon infrastructure and renewable energy installations in a number of regeneration sites and to set out the policies required to enable this development. The sites, which represent the main allocated regeneration sites in the district, are:

- Compair / De La Rue
- Handy Cross
- Cressex Island
- RAF Daws Hill
- Abbey Barn South
- Molins, Saunderton

The study gives an indication of the likely costs involved and carbon benefits for each of the sites, as well as examining planning policy issues and Energy Services Company (ESCo) delivery mechanisms with a view to development of future infrastructure development in the wider area.

Further aims of the study were to assess requirements of these sites in terms of density, type of development and layout, for ensuring that low carbon infrastructure would be economically viable and the potential to extend infrastructure into the wider area.

2.2 Wycombe carbon baseline

Since 2003, Defra have published an annual inventory of emissions broken down to local authority (NUTS 4) level. These are sub-divided into emissions from the domestic, industrial & commercial and transport sectors. The figures for Wycombe from 2003 - 2005 (the most recent data available) are given in Table 4.

<table>
<thead>
<tr>
<th></th>
<th>Industry and Commercial</th>
<th>Domestic</th>
<th>Road Transport</th>
<th>LULUCF</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>429</td>
<td>524</td>
<td>425</td>
<td>19.9</td>
<td>1399</td>
</tr>
<tr>
<td>2004</td>
<td>403</td>
<td>458</td>
<td>483</td>
<td>5.6</td>
<td>1350</td>
</tr>
<tr>
<td>2005</td>
<td>373</td>
<td>432</td>
<td>473</td>
<td>7.0</td>
<td>1286</td>
</tr>
</tbody>
</table>

Table 4 Greenhouse gas emissions from Wycombe district council for the years 2003 to 2005\(^2\) (kt CO\(_2\)pa)

Defra currently classifies these statistics as experimental because the methodology has been adapted and improved from year to year, as such comparisons between years should be taken as being indicative. From 2006, the methodology is to be fixed and the emissions inventory will become a full national statistic.

---

\(^1\) LULUCF is Land use, Land use change and Forestry. It corresponds to emissions from soils etc due to changes in land use (for example building on previously open land)

\(^2\) Defra, Emissions of Carbon Dioxide for Local Authority Areas. www.defra.gov.uk/environment/statistics/globatmos/galocalghg.htm
The emissions from Wycombe are consistent with those in other similar local authority areas, the split may be slightly lower for stationary emissions and higher for road transport although it is well within the boundaries of a normal split.

2.3 Renewable resources

2.3.1 Solar photovoltaics

The potential for solar photovoltaics (electricity generation) in Wycombe has been derived from the total number of homes and area of non-domestic roofspace. The generating potential was produced assuming that 30% of properties have a suitably oriented roof (facing roughly south), that an area of 8 m² is required for 1 kW<sub>p</sub> of installed capacity, and that each kW of installed capacity generates 846 kWh of electricity per year. For a domestic system, a 2.5 kW<sub>p</sub> array is assumed.

Using these assumptions, we estimate that almost 20,000 homes and 668,000 square metres of non-domestic roofspace are likely to be suitable for a PV system. These calculations suggest that there is potential for 38 MW<sub>p</sub> of domestic PV systems and 84 MW<sub>p</sub> of non-domestic systems. Under the assumptions outlined above this could generate 40 and 70 GWh of renewable electricity respectively, which would save a total of 58,000 tonnes of CO₂ per year based on the carbon intensity of UK grid-mix electricity.

2.3.2 Wind

The wind speeds across the Wycombe region are relatively consistent based on the DBERR windspeed database. The speeds at 10m above ground level range from 4.5 to 5.7 m/s rising to between 5.1 and 6.8 m/s at 45 m above ground level. The maximum potential level of wind which could be installed has been derived using a series of constraints and typical turbine density figures. The BWEA quotes a typical turbine density on (on shore) wind farms of 20 turbines per square kilometre and an output of 3,500 MWh per year at

---

3 Source, National Statistics (accessed March 2008). neighbourhood.statistics.gov.uk/dissemination/LeadAreaSearch.do?a=3&i=1001&m=0&es=1206954819046&enc=1&areaSearchText=wycombe&areaSearchType=13&extendedList=false&areaSearchAreas=


the wind speeds found around Wycombe\(^6\). The size of the turbines envisaged is 2 MW; this is amongst the largest and most efficient onshore turbines currently available. A study into wind power by the Sustainable Development Commission in 2005 found that people will tolerate turbines on up to 5% of available land\(^7\). Using these figures and the amount of green space in the district from national statistics, we estimate that the maximum amount of turbines which would be feasible in Wycombe is 276 to give an installed capacity of 552 MW. This number of turbines could generate around 1,000 GWh of energy in a year which would save 500,000 tonnes per year of CO\(_2\).

### 2.3.3 Biomass

The major sources of biomass in the UK are wood from forestry sources, wastes (e.g. food waste, paper and card) and energy crops such as short rotation coppice (SRC) willow.

There are also a range of different technologies for extracting energy from biomass although the most common are using the biomass as a direct heating fuel in place of natural gas or oil, producing electricity using a conventional thermal process or via a CHP system and (for ‘wet’ biomass) anaerobic digestion. There are other technologies such as gasification and pyrolysis which are promising but not yet in widespread use.

Information on the biomass resources available local to Wycombe are not readily available. Consequently, our approach has been to take the results of national resource assessments and assign a “fair share” to Wycombe on a per capita basis. The studies which we have used are:

- The Royal Commission on Environmental Pollution: Biomass as a Renewable Energy Source\(^8\)
- The UK Biomass Strategy\(^9\)
- Biomass Task Force: Report to Government, October 2005\(^10\)

The biomass strategy and biomass task force produced a similar analysis of the overall resource, expressed in GWh. The RCEP study gives a lower figure as it has different terms of reference; this report investigates how biomass can contribute to 2003 energy white paper renewable targets to 2050 and not the full technically achievable potential. In this case the resource is quoted in MW, converting this to MWh sets an absolute maximum calculated by multiplying the figure in MW by the number of hours in a year. The figures derived from these reports are shown in Table 5.

<table>
<thead>
<tr>
<th></th>
<th>National resource (TWh/yr)</th>
<th>Wycombe resource (GWh/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RCEP report</td>
<td>14.3</td>
<td>39.4</td>
</tr>
<tr>
<td>Biomass Strategy</td>
<td>71.5</td>
<td>197.2</td>
</tr>
<tr>
<td>Biomass Task Force</td>
<td>62.9</td>
<td>173.4</td>
</tr>
</tbody>
</table>

Table 5 Biomass resource

---


\(^8\) [www.rcep.org.uk/bioreport.htm](http://www.rcep.org.uk/bioreport.htm)


Unlike other renewable energy sources such as wind and solar, biomass has much in common with traditional fuel sources. It can be transported over large distances from point of production to point of use; this increases the carbon footprint to a modest extent although not nearly enough to make biomass an unattractive proposition from a climate change perspective.

The issue of local sourcing is primarily a social and economic dilemma. The majority of other fuels are sourced from considerable distances. The primary practical reason for the preference of sourcing biomass locally is that it has a lower energy density than fossil hydrocarbons and consequently less energy can be transported in a given container which raises the cost of transport per unit of utility derived. Countries such as the Scandinavian nations and Canada have large quantities of surplus biomass whereas the UK and the South East in particular have very intense pressure on land. An additional issue with biomass is that the countries from which it could be imported are much more politically stable than those from which much of our fossil fuels are sourced.

It is entirely reasonable to propose that biomass could be grown and traded just as any other commodity such as grain or metals, although because of the inherent sustainability dimension and the economic cost of transporting biomass over larger distances, perhaps a regional rather than global commodity market is the most likely scenario.

### 2.4 Summary

The potential for each renewable technology analysed above is set out in the summary table below. The potential for wind far outstrips the other technologies with a potential of 500ktCo2 saving, almost 40% of Wycombe’s current carbon emissions. Together renewables have the potential to reduce current emissions by almost 48%.

<table>
<thead>
<tr>
<th>Renewable</th>
<th>Capacity</th>
<th>Carbon Reduction (ktCO2 pa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar PV</td>
<td>122MWpk</td>
<td>58</td>
</tr>
<tr>
<td>Wind</td>
<td>552MW</td>
<td>500</td>
</tr>
<tr>
<td>Biomass CHP</td>
<td>1.6-7.9MWe</td>
<td>11-58</td>
</tr>
</tbody>
</table>

It’s important to note that for the biomass CHP option to be realised a heat network would be required.

**Table 6 Renewable Energy Potential for Wycombe**

### 2.5 Site by Site Renewable Potential Assessments

The potential for solar photovoltaic and small wind electricity generation have been estimated for each site. Heat producing renewables (i.e. solar thermal and ground source heat pumps) have not been assessed as they are incompatible with district heating schemes. An overview of the results of the assessment is given in Table 7 and Table 8 for PV and wind respectively.

Figure 2 shows the estimated total CO2 emissions for each site and the potential CO2 savings from wind and solar electricity, these are based on the five-year rolling average CO2 emissions factor for grid electricity, 0.523 kg/kWh. Depending on what approach may be taken to direct energy pricing from CHP, renewable electricity may hinder the financial performance of a CHP scheme. As CHP is likely to be heat led, photovoltaics will be more likely than wind to integrate well with CHP as their output will peak outside the heating season.
2.5.1 Solar Photovoltaic

The potential for solar photovoltaics has been calculated using the same set of assumptions as the Wycombe-wide assessment with the exception of the proportion of buildings which would be suitably oriented for PV; as the developments are new-build, the orientation can be pre-determined to suit PV. As such the proportion of buildings which are suitable for PV has been increased from 30% to 50%.

<table>
<thead>
<tr>
<th>Site</th>
<th>PV capacity (kWp)</th>
<th>PV generation (MWh/yr)</th>
<th>CO₂ savings (tonnes/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Domestic</td>
<td>Non-domestic</td>
<td>Domestic</td>
</tr>
<tr>
<td>Abbey Barn</td>
<td>625</td>
<td>203</td>
<td>529</td>
</tr>
<tr>
<td>Compair</td>
<td>62.5</td>
<td>718</td>
<td>53</td>
</tr>
<tr>
<td>Cressex</td>
<td>0</td>
<td>568</td>
<td>0</td>
</tr>
<tr>
<td>Daws hill</td>
<td>687.5</td>
<td>0</td>
<td>582</td>
</tr>
<tr>
<td>De la Rue</td>
<td>62.5</td>
<td>375</td>
<td>53</td>
</tr>
<tr>
<td>Handy Cross</td>
<td>375</td>
<td>437</td>
<td>317</td>
</tr>
<tr>
<td>Molins</td>
<td>0</td>
<td>2343</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 7 Potential for solar electricity by site

2.5.2 Small Scale Wind

The amount of energy from wind turbines has been calculated based on figures in the London Renewables Toolkit\textsuperscript{11}. The number of turbines which could be installed has been estimated for each site and a capacity of 1.5 kW and 5 kW assumed for domestic and non-domestic scale turbines respectively. The number of turbines was estimated by assuming 70% of dwellings at each site could accommodate a wind turbine and giving each non-domestic turbine a circular zone of 10 m radius separation (i.e. 341 m\textsuperscript{2}) from any other turbine’s zone.

The wind speed for each site was found using the BERR wind speed database, in each case the speed at 10 m above ground level has been used in the calculations of the amount of electricity generated. As the

electricity generated is proportional to the cube of the wind speed, there is a strong correlation between windspeed and generation.

Wind capacity (kW) | Wind generation (MWh/yr) | CO₂ savings (tonnes/yr)
---|---|---
| Domestic | Non-domestic | Domestic | Non-domestic |
---|---|---|---|
Abbey Barn | 525 | 50 | 599 | 60 | 345 |
Compair | 0 | 595 | 0 | 941 | 492 |
Cressex | 52.5 | 180 | 79 | 285 | 190 |
Daws hill | 52.5 | 95 | 79 | 150 | 120 |
De la Rue | 0 | 140 | 0 | 333 | 174 |
Handy Cross | 577.5 | 0 | 1,055 | 0 | 552 |
Molins | 315 | 110 | 576 | 210 | 411 |

Table 8 Potential for small wind energy by site

2.5.3 Biomass

Given the lack of data on the locally available biomass resource, it is not appropriate to analyse in detail the potential for biomass on each site. For details of the estimated resource level for Wycombe as a whole please refer to section Error! Reference source not found..

Many developers are currently proposing biomass and biodiesel CHP schemes to meet planning conditions on renewable and low carbon energy provision. While this approach has its merits, at present biomass CHP is a less efficient technology than gas CHP and is best implemented at larger scales (>20MWₑ). At smaller scales biomass back-up and peak plant is often proposed to provide heat to the CHP based district heating scheme. The slower response rate of biomass plant compared to conventional fossil fuelled equipment means it is not particularly well suited to fulfilling this role.

None of the development sites (or the combined Southern sites) meets anything near a 20 MW demand, therefore biomass CHP may not be suitable in the early phases of a CHP/district heating scheme. However, if a larger scale network develops covering such a demand, a large biomass CHP plant could be introduced at a later time, such as when the original CHP engines are replaced.
3 District Heating Site Assessments

3.1 Overview
The economics and viability of a CHP/district heating system has been assessed at seven proposed mixed use development sites around Wycombe. The basic approach was to model the heat demand and load profiles for each site based on the proposed mix of building types. These were then used by Ramboll to investigate how a district heating network might be developed and the associated costs. A separate study was carried out for each site except the neighbouring Compair and De la Rue sites which have been assessed together. The Molins site development is for a single building and therefore there has only been a CHP assessment with no district heating study.

3.1.1 Methodology
SEA/Renue has developed an in house CHP modelling tool that can be used to estimate thermal and electrical demand profiles and model the performance of various CHP and boiler units in meeting this demand. The model’s technical outputs include hours of operation, fuel input, thermal and electrical output, heat supply from boilers and electrical supply from the grid. In addition the model includes a financial analysis providing simple payback, net present value (NPV) and internal rate of return (IRR).

Load profiles are generated using a database of typical profiles for the various building types and degree hour data for each month of the year. These have been scaled to match the total energy demand predicted for the sites based on master planning data on the numbers and types of buildings expected to be constructed on these sites. The load profiles used in the model are provided in accompanying spreadsheets.

Heat network costs have been estimated by Ramboll.

A list of assumptions used in the modelling process and their sources is included at the end of this document.

Note that all costs and performances outlined here are indicative only. A detailed feasibility study and system design would be required to correctly size and fully evaluate the financial, technical and environmental performance of such a system. In particular the precise location and size of the buildings has not been determined yet, and this will affect the results outlined here.

3.2 Results and Discussion
The results output from the model are provided in an accompanying spreadsheet. A set of results has been provided based on two sets of load profiles (for a lower and higher demand estimate), and two different control strategies (heat led and power led).

3.2.1 Control Strategies
Two different control strategies have been assessed. In a heat led strategy power can be exported to the grid but heat cannot be rejected, so the engine would not run unless there was sufficient thermal demand to use at least as much heat as the engine would supply at minimum part load. A power led strategy allows heat rejection but not power export. Note that the use of thermal storage could improve the performance of a CHP system by evening out peaks in demand.

A heat led strategy tends to save more CO₂ since this makes best use of the energy produced by the CHP unit. A power led strategy is often better economically because electricity sold directly to consumers can be sold at an end user price, whereas electricity exported to the grid will be sold at a lower rate, similar to the wholesale electricity price.
3.2.2 Space requirements
A 1 MW_{e} engine can fit in a shipping container; none of the sites looked at in this study require an engine as big as this hence it can be assumed that the energy centre required for each site could be smaller than this.

Community heating infrastructure can be expected to last for in excess of 40 to 50 years. CHP engines have a lifetime of approximately 10 to 15 years depending on running hours. The model assumes an engine replacement every 13 years and factors the cost of this into the financial assessment.

3.2.3 Key results
Table 9 shows the main results for the most effective engine size at each site. A range of engine sizes was modelled at each site, further details are given below.

<table>
<thead>
<tr>
<th>Development Site</th>
<th>Engine Size (kW_{e})</th>
<th>Net Present Value (£)</th>
<th>CO_{2} savings (tpa)</th>
<th>Network infrastructure cost (£)</th>
<th>Marginal Cost of infrastructure (£)</th>
<th>Viability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abbey Barn South</td>
<td>90</td>
<td>141,000 (low) 245,000 (high)</td>
<td>101 (low) 123 (high)</td>
<td>4,010,000</td>
<td>1,000,000</td>
<td>Heat or Power led strategies</td>
</tr>
<tr>
<td>Compair / De la Rue</td>
<td>150</td>
<td>730,300</td>
<td>132</td>
<td>990,000</td>
<td>330,000</td>
<td>Heat or Power led strategies</td>
</tr>
<tr>
<td>Cressex Island</td>
<td>70</td>
<td>-160,700 (low) -48,500 (high)</td>
<td>35 (low) 62 (high)</td>
<td>172,000</td>
<td>57,000</td>
<td>Not economically viable</td>
</tr>
<tr>
<td>RAF Daws Hill</td>
<td>110</td>
<td>367,200 (low) 1,803,800 (high)</td>
<td>105 (low) 144 (high)</td>
<td>4,450,000</td>
<td>750,000</td>
<td>Heat or Power led strategies</td>
</tr>
<tr>
<td>Handy Cross</td>
<td>100 - 200</td>
<td>1,339,100 (low) 1,800,700 (high)</td>
<td>155 (low) 176 (high)</td>
<td>2,948,000</td>
<td>330,000</td>
<td>Heat or Power led strategies</td>
</tr>
<tr>
<td>Molins</td>
<td>228</td>
<td>384,100</td>
<td>445</td>
<td>N/A</td>
<td>N/A</td>
<td>Dependent on data centre absorption cooling</td>
</tr>
</tbody>
</table>

Table 9 Key results of CHP modelling

3.2.4 Abbey Barn
3.2.4.1 Unit sizing and performance
Engine sizes ranging from 70 kW_{e} to 305 kW_{e} were modelled.

Following a heat led strategy, the model shows reasonably good financial returns with the most positive NPV for a 90 kW_{e} engine; £141,000 and £245,000 respectively for lower and higher demand estimates. CO_{2} savings increase with engine size although this must be traded off against increasingly poor financial performance with a 305 kW_{e} engine having a negative NPV.

For a power led strategy, financial returns are optimised for a 110 kW_{e} engine although they are also good for a 90 kW_{e} engine. CO_{2} savings would be maximised using a 150 kW_{e} engine with a power led strategy although a range of engines from 90 - 300 kW_{e} all offer relatively similar CO_{2} savings.
3.2.4.2 Plant and infrastructure costs
As the proposed development is new build, the key figure is not the total cost of the system but the marginal cost of community heating infrastructure over the alternative scenario of a gas distribution system with individual boilers. For Abbey Barn, we have used a figure of £1M which is 25% of the total costs.

3.2.4.3 Conclusion
CHP would probably be viable with either a heat or power led strategy. The most suitable engine size would be in the region of 100 kWe based on financial performance although if CO$_2$ savings are prioritised, a larger engine may be able to make a greater impact.

3.2.5 Compair and De la Rue
3.2.5.1 Unit sizing and performance
Engine sizes ranging from 135 kW$_e$ to 1,028 kW$_e$ were modelled for this site. This range includes the optimum sizes depending on the choice of demand assumption.

The model shows financial returns are optimised by choosing a relatively small engine of around 150 kW because this would run for a greater number of hours per year. Engines of 410 kW and below show a positive NPV so would be financially viable. Under a heat led strategy CO$_2$ savings are maximised using an 845 kW unit but for a power led strategy a 185 kW unit would maximise CO$_2$ savings.

3.2.5.2 Plant and infrastructure costs
The marginal cost for this site would be around 33% of the total costs, this would be £330,000 for this site.

3.2.5.3 Conclusion
CHP is viable for the site and would make a significant contribution to CO$_2$ savings. The scheme can be cost effective at a local authority discount rate of 3.5% or at the private sector discount factor of 10% although a higher desired return on investment could lead to a choice of engine size that does not maximise CO$_2$ savings.

3.2.6 Cressex Island
3.2.6.1 Unit sizing and performance
Engine sizes ranging from 33 kW$_e$ to 110 kW$_e$ were modelled.

Following a heat led strategy, the model shows financial returns are poor with no engine size offering a positive NPV. In this case the smaller the engine is, the greater the NPV is. CO$_2$ savings are maximised using a 70 kW unit with a higher estimate of demand and a 110kW engine offering greatest savings for the lower demand estimate.

For a power led strategy, financial returns are optimised for a 70 kW engine but the NPV is still negative. The performance advantage of this engine size is due to having the highest heat utilisation factor. CO$_2$ savings would also be maximised using a 70 kW engine with a power led strategy.

3.2.6.2 Plant and infrastructure costs
Due to the small size of the site, the infrastructure costs for Cressex Island are very small. Ramboll estimate a total infrastructure cost of £172,000 - using the same marginal cost methodology as used for the other sites, the additional cost of a CHP network over the alternative gas and boilers option is £57,000.
3.2.6.3 Conclusion
CHP is unlikely to be viable for the site in spite of the fact it would make a significant contribution to CO$_2$ savings.

3.2.7 RAF Daws Hill

3.2.7.1 Unit sizing and performance
Engine sizes ranging from 70 kW$_e$ to 305 kW$_e$ have been modelled. This range includes the optimum sizes depending on the choice of demand assumption.

Following a heat led strategy, the best financial performance is for a 110 kW engine both with a lower and higher demand estimate, getting progressively worse as engine size increases. CO$_2$ savings increase with engine size although this must be traded off against increasingly poor financial performance with engines over 250 kW$_e$ having a negative NPV.

For a power led strategy, financial returns are also optimised for a 110 kW engine although the NPV is positive for engine sizes of up to 305 kW. CO$_2$ savings would be maximised using a 228 kW engine with a power led strategy.

3.2.7.2 Plant and infrastructure costs
The marginal cost estimated for Daws Hill was £750,000. This was based on the costs for the Compair/De la Rue site scaled up to the size of the site. Having received the report on Daws Hill from Ramboll, this estimate may be a little low. The EST community energy programme recommends that the marginal cost of a district heating network is around 20% of the total costs, for Daws Hill, this would be £900,000.

3.2.7.3 Conclusion
CHP is likely to be viable for the site and would make a significant contribution to CO$_2$ savings. The scheme can be cost effective at a local authority discount rate of 3.5%.

3.2.8 Handy Cross

3.2.8.1 Unit sizing and performance
Engine sizes ranging from 70 kW$_{e}$ to 1,027 kW$_{e}$ have been modelled as this range includes the optimum sizes depending on the choice of demand assumption.

Following a heat led strategy, the model shows financial returns are optimised for an engine size of between 100 and 200 kW all offering a similar positive NPV. CO$_2$ savings are maximised using an 835 kW unit with a lower estimate of demand and a 625 kW engine offering greatest savings for the lower demand estimate.

For a power led strategy, financial returns are optimised for a 110 kW engine although the NPV for a number of engines are very close to each other. CO$_2$ savings would be maximised using a 625 kW engine with a power led strategy for both demand estimates.

3.2.8.2 Plant and infrastructure costs
As the size of the Handy Cross site is similar to the Compair/De la Rue site, the same £330,000 marginal costs figure was used for Handy Cross. However, having received the report on the site from Ramboll, this estimate is too low. The EST community energy programme recommends that the marginal cost of a district heating network is around 20% of the total costs, for Handy Cross, this would be £600,000.
3.2.8.3 Conclusion
CHP is likely to be viable for the site with a positive NPV of as much as £1.7M\textsuperscript{12} and CO\textsubscript{2} savings of up to 421 tonnes per annum.

3.2.9 Combined Site

3.2.9.1 Overview
Due to their close proximity, a combined assessment of the Abbey Barn, Daws Hill, Handy Cross and Cressex sites has also been carried out. In this case, additional pipes are laid to connect up the sites, an indicative route has been provided by Ramboll (see Appendix A).

3.2.9.2 Unit sizing and performance
Engine sizes ranging from 305 kWe to 1,027 kW\textsubscript{e} have been modelled as this range includes the optimum sizes depending on the choice of demand assumption.

For both a heat and power led strategy the optimum engine size if 845 kWe from either a financial or CO\textsubscript{2} standpoint. The NPV is very good under either demand estimate; £1.658M and £2.431M under a low and high heat demand estimate respectively.

3.2.9.3 Plant and infrastructure costs
Ramboll estimate the cost of a combined site CHP network to be around £15M. The marginal cost estimates which have been used for the other sites are not quite as appropriate for this site as the connecting pipes between the sites are in addition to the marginal cost over the gas network etc on each site. As Ramboll’s report does not contain a specific breakdown of trench and pipe costs for the connecting sections and the site sections, we have used a conservative figure of £3M for the marginal cost over the traditional approach.

3.2.9.4 Conclusion
CHP is likely to be viable for the site with a positive NPV of as much as £2.4M and CO\textsubscript{2} savings of up to 937 tonnes per annum.

3.2.10 Molins

3.2.10.1 Unit sizing and performance
Engine sizes ranging from 110 kWe to 770 kW\textsubscript{e} have been modelled for the Molins site. This assumes that the heat generated is used in an absorption cooling system for the data centre, therefore the cooling demand counts towards the thermal demand.

Following a heat led strategy, the financial returns are optimised for a 228 kW engine. CO\textsubscript{2} savings are maximised with a 305 kW unit.

For a power led strategy, financial returns are optimised for a 526 kW engine. CO\textsubscript{2} savings would also be maximised using a 526 kW engine.

3.2.10.2 Conclusion
Provided the data centre is cooled using absorption chillers, CHP is a viable option for the Molins site.

\textsuperscript{12} Incorporating the higher marginal infrastructure cost, the NPV will fall to £1.4M.
4 Legal Report - Brodies LLP

4.1 Introduction

The objectives of this legal section of the Feasibility Study are:

- to outline some options for Wycombe District Council (“WDC”) as regards the establishment of, or engagement with, an energy services company (“ESCO”) to provide long-term local delivery of cooling, heat and power to a number of sites in the Wycombe District (the “Sites”) (section 4.2); and
- to outline options for WDC with regard to what steps it can take to secure resource efficiency standards prior to the adoption of a Site Allocations Development Plan Document (section 4.3).

4.2 ESCOs

4.2.1 The nature and role of ESCOs

It is difficult, if not impossible, to provide a standard description of an ESCO: essentially, it can be whatever its stakeholders wish it to be. There are many different roles performed by ESCOs, both within the UK and elsewhere. A number of local authorities in the UK have set up ESCOs to provide heat and power to local housing estates in order to tackle fuel poverty, or as part of a strategy to increase energy efficiency and reduce the local authority’s carbon footprint. Some ESCOs are wholly or partly owned by local authorities, whereas others operate largely within the private sector and engage with local authorities through arm’s length contractual arrangements.

The legal structure of an ESCO may also take a variety of forms: many have been established as companies limited by guarantee, but there is no legal reason why an ESCO has to adopt this particular form, or, indeed, be a company incorporated under the Companies Acts at all.

The fact that ESCOs have been established in different forms to undertake a variety of different roles illustrates the essential flexibility of the concept. In essence, an ESCO is simply a vehicle for meeting a set of energy services needs identified by a group of stakeholders. Once the needs and stakeholders are identified, the ESCO should be ‘designed’ to meet those needs, having regard to proper and fair representation of the interests of stakeholders.

It is not the intention to attempt here a detailed mapping of particular ESCO structures onto individual Sites. Nor is it the intention to consider regulatory issues associated with the supply of electricity or power, or with local authority participation in ESCOs.

Instead, we consider three generic models for ESCOs which we think may ultimately be relevant to WDC’s intentions as regards the Sites, and comment, in general terms, on their relative advantages and disadvantages.

Although these models by no means exhaust the options for ESCO models, they do serve to illustrate one of the key parameters, namely the nature and extent of public sector involvement in the ESCO, which will be a significant factor in the decision making process, along with other factors such as the availability of funding and the attractiveness of the opportunity to the private sector.

The main characteristics of the three models outlined in this Report are:

- a public sector body establishes the ESCO, and retains a significant (and possibly a controlling) interest in its ownership and/or management (“Model A”);
• the ESCO is established, controlled and managed entirely by the private sector, but interfaces with a public sector body (e.g. with a local authority via the planning process) (“Model B”); and
• a public sector body facilitates the establishment of, or engagement with, an ESCO, but does not play a significant role in its subsequent ownership or management (“Model C”).

These models are considered in sections 4.2.2, 4.2.3, & 4.2.4 respectively. We also outline a process for ‘soft market testing’ of WDC’s ESCO proposals in due course - this is described in section 4.2.5.

4.2.2 Model A: public sector driven ESCO

In this model the ESCO is largely public sector driven. This typically reflects the underlying public sector concerns that provide the main motivation for establishing the ESCO, namely the desire to provide a secure, long-term source of affordable heat and power to local authority premises or to local authority tenants.

Local authorities are also becoming increasingly aware of the strategic role that they can play in managing carbon footprints within their administrative boundaries and are becoming increasingly willing to exercise their powers to influence energy use and efficiency on new developments. This can provide an additional motivation for a local authority to take the lead in establishing an ESCO.

In this model, a local authority will establish the ESCO, usually in the form of a new legal entity distinct from, and at arm’s length to, the local authority. Whilst there is no legal reason why the ESCO should be a separate legal entity, there are clear advantages in doing so: the setting up of a separate entity helps to ensure both momentum and concentration on the job in hand, and provides clarity as to allocation of resources. It also mitigates, but cannot entirely remove, the risks associated with conflicting priorities (e.g. expenditure and personnel) within local authorities, which can easily deprive in-house projects of focussed management and adequate resources.

The most common form of legal structure used for public-sector driven ESCOs is a company established under the Companies Acts. As well as providing limited liability (to the owners of the ESCO), a company structure offers a great deal of flexibility to represent the differing, and evolving, interests of the ESCO’s stakeholders. Most ESCOs established as companies by local authorities are created as companies limited by guarantee, though it is perfectly possible to use other company structures (e.g. companies limited by shares or community interest companies), or different legal structures (e.g. industrial and provident societies).

As well as taking a lead role in setting up the ESCO, the local authority will usually retain a significant interest in the ESCO. Typically, it will either wholly own or partly own the ESCO, and will be involved in its ongoing management (e.g. the ESCO’s constitution may provide the local authority with a right to appoint one or more directors to its board).

It is important to note that Model A encompasses a number of sub-models, which reflect the differing desires and abilities of local authorities to participate in the ESCO:

• **Design and construction** - normally undertaken by the private sector.

• **Finance** - in some cases, the private sector will be involved in arranging finance.

• **Operation and maintenance** - there are a number of options here: some local authorities have assumed responsibility for the operation and maintenance of the physical assets - this approach has been adopted by, for example, Aberdeen Heat and Power and Caithness Heat and Power; for other ESCOs, the private sector is responsible for the operation and maintenance of the assets.

The precise approach will depend on the local authority’s appetite for assuming certain risks during the operational phase, and its ability to manage that risk.

The main advantages for a local authority in adopting this model of ESCO include:

• the local authority retains significant control over the activities of the ESCO, and is therefore well placed to promote and protect its interests;
• in engaging with developers, the local authority can exercise its control to influence outcomes - for example, to encourage the design of a network with potential for expansion to other sites;
• the local authority may benefit from a secure long-term source of heat and power for sites which it owns or occupies;

The main disadvantage for a local authority in adopting this model is the significant amount of time, effort and cost involved:

• a professional team involving legal, technical, and possibly financial advisers will need to be engaged, depending on the local authority's in-house capability;
• the ESCO will need to conduct a procurement process (or possibly more than one) for the design and construction of the relevant infrastructure, and the operation and maintenance of the assets (unless the ESCO wishes to take on this role itself);
• although it may be possible to secure contributions from developers towards the capital costs of the infrastructure, such contributions may be limited to the costs that the developers would have incurred in constructing traditional heat and power networks - developers may look to the local authority to fund the additional costs associated with (say) a combined heat and power network; and
• a number of other agreements will need to be negotiated, including heat / power supply agreements with the ESCO's customers.

4.2.3 Model B: private sector driven ESCO

In this model, the creation, development and subsequent exploitation of the relevant infrastructure is essentially driven by the private sector. It would be left to developers to engage with an ESCO - most likely this will be one of the energy utilities currently offering such services, or a new entity created (again, probably by an energy utility) in relation to the specific opportunity.

The main reason that some local authorities have adopted this is a desire to avoid or minimise risk. Examples of this type of ESCO are Southampton Geothermal Heating Company Limited (wholly owned by Utilicom) and Barkantine Heat and Power Company (owned by the London Electricity Group).

The role of a local authority in this model is much more limited:

• the local authority's ability to implement policies regarding energy use will be limited to acting through its formal interfaces with the private sector, for example engaging with developers through the planning regime or pursuant to other statutory powers; and
• the local authority may be an off-taker for heat and/or power from the ESCO for properties forming part of its estate.

The main advantages of this model for a local authority is the lack of cost and effort required on its part - due to the essentially market-driven nature of the solution - and the lack of risk taken by the local authority in relation to the activities undertaken by the ESCO.

On the other hand, the lack of engagement by a local authority in the ESCO will limit the ability of the local authority to influence outcomes. In particular:

• the local authority would need to persuade developers to implement combined heat and power rather than conventional solutions; and
• the solution adopted by the ESCO is likely to be tailored to the particular development and may not be designed to be integrated with, or scalable to, further developments.

Therefore, whilst a local authority may be able under this model to promote high-level policies regarding sustainability and energy efficiency within its administrative boundaries, at a practical level, such policy instruments may not be sufficient to ensure that individual developments are scalable and capable of integration to the extent and in the manner desired by the local authority.
Another significant problem associated with this model is the funding of relevant infrastructure, in particular the capital costs of constructing the plant and laying the heat network. From the perspective of the private sector (whether that of the ESCO, or that of developers), the investment opportunity may be appraised as uneconomic in the absence of part-funding of capital costs from the public sector. In other words, a market driven solution may simply not be forthcoming in the absence of public sector contribution to capital costs.

If a local authority is able and willing to contribute to the capital costs of infrastructure, it will clearly wish to influence how the funding is used. However, it may not be in a position to exercise sufficient controls under the private sector model of ESCO.

A contribution by a local authority to capital costs may also give rise to state aid concerns, as, at first sight, public funding would be being used to benefit a private sector entity in the absence of a procurement carried out in accordance with the public procurement regime. Although there are exemptions to the general prohibition on state aid for certain projects with environmental objectives, the detailed application of state aid rules would require specialist advice in light of the particular circumstances.

4.2.4 Model C: public sector as facilitator

In this model, a public sector body facilitates the establishment of, or engagement with, an ESCO, but does not play a significant role in its subsequent ownership or management.

One example of this type of role being undertaken by a public body is Yorkshire Forward (a Regional Development Agency), which is currently engaged in a procurement of an agreement in which it will act as ‘facilitator’ for the development of a combined cooling, heat and power network for Holbeck Urban Village.

In some ways, this model represents a compromise between Model A and Model B: in essence, the public sector body has a significant opportunity to influence outcomes (compared with Model B), but in doing so takes a limited amount of risk in relation to the ESCO (compared with Model A).

The opportunity to influence outcomes arises in relation to sites owned or controlled by (say) a local authority. In relation to such sites, the local authority can procure a long-term partner to provide energy services, including the design and construction of plant and the laying of a heat and power network. Buildings owned or occupied by the local authority can secure long-term supplies of energy and heat from the ESCO at reasonable cost.

The main advantage for a local authority (or other public sector body) in facilitating a relationship with a supplier to provide energy services to a multiplicity of sites is the potential for an integrated approach to environmental management standards and sustainability: the plant and network can be designed from the outset with scalability in mind, both in relation to further developments on the same site and developments on different sites (for example, a ‘ring-main’ heat, cooling and power network serving several sites).

As well as providing the potential for increased economies of scale as regards the physical infrastructure, this approach also avoids the need for developers to have to procure network infrastructure themselves, and reduces the potential for differential charging across different developments.

This model also allows for the subsequent operation and management of the plant to be handed over to a management entity representing the interests of stakeholders (e.g. off-takers).

There are a number of disadvantages associated with this approach. For example, a time consuming and expensive procurement will be required to appoint the private sector partner. The procurement would probably be carried out under the competitive dialogue procedure, which allows suppliers the opportunity to propose solutions designed to meet broadly-defined needs and to discuss and refine those solutions during a dialogue with the public body.

Also, whilst the local authority would have a degree of strategic oversight as regards the expansion of the network and integration of new developments, the degree of day-to-day control which the local authority could exercise would be less than under Model A. For example, the local authority may not be able to force the ESCO to undertake further developments.
The funding of capital costs would also be a key consideration. As in Model B, it may be possible to persuade developers to make a contribution to capital costs, but their contribution may be limited to the amount they would have had to pay in order to construct traditional heat and power infrastructure.

4.2.5 Market testing

Prior to commencing any procurement process, it may be beneficial to engage in a soft market testing / market sounding exercise. This is simply a dialogue with potential suppliers, the objectives of which would be:

- to assist WDC build up a more detailed understanding of the supplier market and the range of potential solutions available;
- to help WDC assess further the relative merits of models A, B and C and decide which model of ESCO would be best suited to its requirements; and
- to help WDC further specify its requirements prior to commencing a formal procurement process.

The purpose of the exercise must be clearly communicated to potential suppliers so as to avoid any risk of misunderstanding.

Any such exercise should be carried out in accordance with the principles of equal treatment, non-discrimination and transparency (derived from the EC Treaty), so as not to compromise the WDC's ability to carry out a subsequent procurement exercise in accordance with the EC public procurement regime. In particular, potential suppliers taking part in the market testing should be afforded an equal opportunity to present ideas to WDC and should be treated equally throughout. In any subsequent procurement exercise, WDC will need to disclose to all bidders all information disclosed by WDC during the market testing exercise, irrespective of whether or not a particular bidder participated in that exercise.

The best way to demonstrate compliance with these principles would be run the market testing exercise following the publication of a Prior Information Notice ("PIN") in the Official Journal of the European Union. The PIN would outline the nature of the opportunity and details of how potential suppliers could request further information and contribute to the market testing. If there is no advertisement, the risk is that bidders who are not invited to participate in the market testing will claim that they have been unfairly treated, in the sense that bidders that are invited to participate have been given an advantage in any subsequent procurement exercise.

Whether or not the market testing is advertised, it could take the form of:

- a presentation by WDC to learn about the potential opportunity; and/or
- one-to-one meetings with suppliers who request them, in order for WDC to build up a picture of solutions potentially capable of meeting its needs. In conducting meetings with potential suppliers, WDC must not be careful not to disclose ideas presented in confidence by one supplier to any other suppliers.

If a PIN is published, upon completion of the market sounding exercise, the PIN must either be cancelled or followed up with a Contract Notice published in OJEU.

Although not part of the formal market testing exercise, WDC should also consider holding prior, or parallel, discussions with developers for the purposes of gauging developers' views as to the best way in which WDC's policies and commitments regarding sustainability and energy use could be met in relation to particular Sites. Such information could help to inform WDC's approach to the market testing exercise and any subsequent procurement.
4.2.6 ESCO Conclusions

Although ESCOs can provide a very flexible tool for helping to implement a local authority's policies on sustainability and energy use, there are a number of important questions which need to be addressed in order to determine the model best suited to WDC's needs:

- to what extent would WDC wish to be involved in the operational aspects of an ESCO?
- what is WDC’s attitude to risk in relation to engagements with the private sector?
- what resources (land, capital, personnel) would WDC envisage being able to commit to an ESCO?
- as regards developments on the Sites, how important is it that buildings owned or occupied by WDC will be able to receive supplies of heat, cooling and/or power from the ESCO?
- does WDC wish to take a common approach to the Sites - for example, so that relevant infrastructure is designed to be scalable and capable of integration?

It is also important to note that the individual characteristics of the Sites may not be such as to lend themselves to a 'one size fits all' ESCO solution. For example, it may be appropriate to take different approaches to different Sites based on the extent of property interests held by WDC in the Sites. For example, WDC may wish to exercise significant control (i.e. Model A) over an ESCO established to deliver energy services in respect of Sites where it retains significant property interests, but may wish to have a lesser degree of control (i.e. Model B, or Model C) in respect of Sites where it has little or no property interests.

4.3 Planning

4.3.1 Introduction

WDC is in the process of adopting a Site Allocations Development Plan Document (“DPD”), policy A 22 of which would require developers to meet targets for resource efficiency. These would be a minimum of Level 3 Sustainable Homes Code for developments of 15 or more dwellings; a minimum of Very Good BREEAM for commercial development of 1000m² or more and 15% of energy to be generated on site from a renewable source. The Site Allocations DPD is, however, not due to be adopted until 2010.

A large number of sites are due to come forward during the period before the adoption of the policy. Therefore, WDC initially sought to have the targets applied in the interim by a Supplementary Planning Document (“SPD”). However, the policy statement, Building a Greener Future, indicated that a policy setting higher standards for homes such as these should be tested through the planning system, and therefore that it should be imposed through a DPD and not a SPD. Planning and Climate Change (the supplement to PPS1), similarly requires (at paragraph 33) that any policy relating to local requirements for decentralised energy supply to new development or for sustainable buildings should be set out in a DPD, not a SPD, so as to ensure examination by an independent inspector.

WDC has sought advice from the Government Office South East (“GOSE”) with regard to what steps it can take towards introducing an interim planning policy to secure its targets.

4.3.2 Options for WDC to impose resource efficiency standards

There is no national policy setting specific targets for resource efficiency such as those WDC seeks to create. The question is whether, in the absence of specific local or national targets, WDC can impose any resource efficiency standards on new development.

We will examine the following potential solutions: first, the options for creating an interim policy setting resource efficiency standards and, second, the option of taking decisions about resource efficiency standards on a site-by-site basis. We will then examine the legality and possible application of the inspector’s decision
in the former Downley School and Turner’s Field application. In light of these, we will suggest an approach that WDC might take to making interim policy.

### 4.3.3 Legality of an interim planning policy containing targets

A statement of environmental objectives relevant to the development and use of land and any general policies relating to those objectives must be specified as a Local Development Document (LDD) by virtue of the Local Development Scheme (Planning and Compulsory Purchase) Act 2004 (‘2004 Act’) section 17(1) and the Town and Country Planning (Local Development) (England) Regulations 2004 (‘2004 Regulations’) regulation 6. By definition, it must therefore be either a DPD or a SPD (regulation 2 of the 2004 Regulations). There is no third way: it is unlikely that any weight would be attached to a policy of the local planning authority that was not a LDD and yet purported to set environmental objectives or policy for achieving them.

National policy (both Building a Greener Future and Planning and Climate Change) states clearly that policy targets for decentralised energy supply and for sustainable buildings must be set by a DPD, not a SPD. The Government’s reason is that it considers that the policy should be examined by an independent Inspector.

A local planning authority must consider whether national policy should be set aside in any particular case. WDC could seek to make a SPD setting resource efficiency targets. This would not comply with national policy but might be justified on account of the specific circumstances in WDC’s area. However, it would be open to the Secretary of State to direct the local planning authority not to adopt the SPD (2004 Regulations, regulation 22).

It is highly likely that the Secretary of State would direct WDC not to adopt the SPD. The Government, in making its policy, plainly took into account a situation like that of WDC where there would be an interim period before a DPD could be made. There are references to such an interim situation in Planning and Climate Change at paragraph 39 and in Building a Greener Future at paragraph 3.49. The Government has therefore specifically envisaged WDC’s situation and nevertheless made its policy. GOSE would have to have a very strong reason to justify exempting WDC from that policy. If GOSE allows a departure from the policy for WDC only, without a strong justification addressing the Government’s reason that the policy should be examined by an independent inspector, its decision may be open to challenge, in particular on grounds of irrationality. Furthermore, if WDC obtains an exemption, other authorities may consider that they should be granted an exemption too.

### 4.3.4 Prematurity as a ground of refusing applications before DPD is adopted

A draft DPD can be a material consideration in a decision on a planning application. While formulating policy in a DPD for specific sites, local planning authorities might consider refusing applications on the ground of prematurity. As set out in The Planning System: General Principles (2005), prematurity can only be used as a ground for refusal where the proposed development is so substantial or where the cumulative effect would be so significant that granting permission could prejudice the DPD by predetermining decisions about the scale, location or phasing of the new development which are being addressed in the policy in the DPD.

Additionally, prematurity can justifiably be used as a ground of refusal generally only where a DPD is close to submission or has been submitted for examination. Furthermore, PPS 3 on housing states at paragraph 72 that local planning authorities should not refuse applications solely on the ground of prematurity.

WDC is in the process of preparing a site-specific DPD. For six major sites consultants have been commissioned to examine the feasibility of low-carbon infrastructure. Once the DPD has been formulated and consulted upon, WDC might consider that an application failing to meet the target in the proposed DPD is premature. For a housing site, this could not be the sole reason for rejecting a proposal, but cumulatively, where there is failure to meet other policy goals, this could contribute to the reasons for refusal of an application.
4.3.5 National policy and resource efficiency standards

Despite the restriction on the use of SPDs to impose local targets for resource efficiency, national policy does support high resource efficiency standards in new development. A local planning authority may consider the use of conditions to secure high standards on a site-by-site basis.

As stated in paragraph 3.49 of Building a Greener Future, although an application should not be refused solely on the grounds of failing to meet the higher standards or providing renewable or decentralised energy, local authorities can negotiate with developers for higher standards or provision of renewable energy.

Circular 11/95: Use of Conditions in Planning Permission sets out that a planning condition should be imposed generally only where, without it, planning permission would be refused. However, a condition may be imposed in other cases where there are special and precise reasons for it. The higher standards that WDC negotiates with developers might be secured by condition, on the justification that it will secure the achievement of national policy goals, such as sustainable development.

Furthermore, national policy does provide that in certain circumstances a planning application may be refused for failing to meet certain resource efficiency standards set out in national policy. In paragraph 39 of Planning and Climate Change, in the period before the adoption of a DPD, planning authorities are required to ensure that proposed development is consistent with PPS 1 and with the Key Planning Objectives set out in it. Conditions may be imposed to ensure proposals are acceptable, and proposals that cannot be made acceptable may be refused. The Key Planning Objectives include making a full contribution to delivering the Government's Climate Change Programme, securing the highest viable resource and energy efficiency and reduction in emissions in providing for the homes, jobs, services and infrastructure needed by communities, and reflecting the development needs and interests of communities and enabling them to contribute effectively to tackling climate change.

Paragraph 42 of Planning and Climate Change states that "planning authorities should expect new development to ... take account of landform, layout, building orientation, massing and landscaping to minimise energy consumption, including maximising cooling and avoiding solar gain in the summer; and, overall, be planned so as to minimise carbon dioxide emissions through giving careful consideration to how all aspects of development form, together with the proposed density and mix of development, support opportunities for decentralised and renewable or low-carbon energy supply."

Paragraph 43 of Planning and Climate Change provides that "planning authorities should also consider ... the likely impact of proposed development on existing or proposed development and its renewable or low-carbon energy supply..." These last two cited paragraphs taken together would seem to provide a justification for ensuring that developments are able to connect into a combined heat and power scheme.

PPS 22: Renewable Energy paragraph 18 requires that "local planning authorities and developers should consider the opportunity for incorporating renewable energy projects in all new developments." If a local planning authority failed in this obligation to consider incorporating renewable energy, then it would be misunderstanding relevant policy, and its decision might be open to challenge.

PPS3: Housing sets out the planning for housing policy objectives at paragraph 10. These require the housing outcomes to be achieved in accordance with certain principles, including the principle of sustainable development. Sustainable development specifically includes taking account of climate change as dealt with in Planning and Climate Change. In determining planning applications for housing, local planning authorities are required to ensure the proposed development is in line with planning for housing objectives. Furthermore, paragraph 16 sets out that in assessing design quality, planning authorities should consider the extent to which the proposed development facilitates the efficient use of resources, during construction and in use, and seeks to adapt to and reduce the impact of, and on, climate change.

4.3.6 Legal powers to impose planning conditions

Planning authorities have broad power to grant planning applications subject to such conditions as they think fit, so long as they are for a planning purpose, fairly and reasonably relate to the development to be
permitted, and are not manifestly unreasonable. Planning authorities must state reasons for the conditions they impose.

While the legal powers of a planning authority to impose conditions are very broad, the decision on conditions is subject to appeal by the developer, and at appeal the inspector can examine the merits of the conditions imposed. Parties to an appeal can expect an inspector, acting on delegated authority from the Government, normally to make a decision which accords with Government policy unless the particular circumstances justify a departure. Therefore, a local planning authority similarly is well advised to ensure that the conditions it imposes are consistent with national planning policy as well as with the provisions of its development plan, unless it has a reason for departing from policy in the particular case. Otherwise, the local planning authority will leave its decision open to appeal. Furthermore, if the planning authority (or an inspector) misinterprets planning policy relevant to its decision then the decision may be quashed (Royal Borough of Kensington & Chelsea v Secretary of State for the Environment, Transport and the Regions (2000) (unreported)). Therefore, a planning authority should ensure it can demonstrate how it understood relevant planning policy and set out its reason for a departure from it. Preferably, this should be stated in the written reason for the condition.

4.3.7 Imposing resource efficiency standards site by site

Before its DPD is adopted, WDC can apply national policies to decisions it takes on planning applications for particular sites. WDC will be assisted in decision-making for individual sites by the information it will receive on the contribution that its six major sites can make to maximising resource efficiency and therefore to tackling climate change. WDC can put this information to developers when it is approached for pre-application discussions, and the developers can be encouraged to set out what they consider can be achieved to improve resource efficiency in line with national policy. Conditions may be imposed to secure such improvements. Applications may be rejected where developers fail to provide improvements in resource efficiency sufficient to satisfy certain key aims of national policy, such as the Key Planning Objectives in Planning and Climate Change. The information provided through the assessment of the six major sites to feed into the DPD will provide evidence of any such failure that WDC can use as a justification for rejecting an application.

The aims set out in national policy tend to be couched in very broad terms. WDC will have to rely to a considerable degree on negotiations with developers to obtain site-specific resource efficiency standards. In the absence of an adopted local policy, WDC will have to take care to be reasonably consistent in the approach it takes to such negotiations.

4.3.8 Inspector’s decision regarding Downley Middle School and Turners Field application

We have obtained the Inspector’s decision on the planning appeal for the former Downley Middle School and Turners Field. It seems to provide support to the site-by-site approach set out above.

The Inspector has imposed a condition requiring the development to comply with the Very Good Ecohomes Standard as set out in the Building Research Establishment document BREEAM Ecohomes Environmental Rating for Homes Guidance 2006. The reason that he gives in his decision is that he considers a condition relating to Ecohomes Standards to be appropriate to ensure future development contributes towards sustainability.

This reason is rather briefer than might be hoped for. It is not clear on what evidence the Inspector has decided that the condition is appropriate for the site. If there was evidence before the Inspector, as to the level of resource efficiency that could be provided by the building, there would appear to be justification in national policy for imposing such a condition.

For WDC, although this decision is not a binding precedent, it indicates how national policy is to be interpreted. Furthermore, the decision will be a material consideration should any future Inspector be required to decide an appeal against a similar condition in a similar application. It would appear therefore
that at other housing sites, WDC can be confident in imposing a similar condition for the purpose of contributing to sustainability and to the Key Planning Objectives of Planning and Climate Change.

4.3.9 A SPD to educate developers and the public on resource efficiency in Wycombe

WDC could look at creating a SPD that does not set specific targets, but seeks to educate developers on the opportunities for increasing resource efficiency and gives guidance on the Council's approach to application of national policy relevant to resource efficiency. This seems to be an approach taken by Woking Borough Council and to have been approved by the Secretary of State. The Secretary of State has approved a Woking Local Development Scheme which includes a proposal for a SPD to provide guidance on incorporating climate neutral technologies in new developments. This document is to be adopted before the Core Strategy DPD which it supplements. Such a policy might draw attention to the interpretation of national policy on standards for resource efficiency by the Inspectors in the former Downley Middle School and Turners Field decision, and other similar decisions. It would provide a reasonable degree of certainty for developers about WDC's approach, while meeting the national policy requirement that targets should only be set in a DPD. We recommend that WDC takes this approach.

4.3.10 Planning Conclusions

WDC can seek to create a SPD imposing resource efficiency standards in the interim before its Site Allocations DPD is adopted. However, it is likely that, in the light of national policy, the Secretary of State would prevent adoption of such a SPD.

Other than for housing sites, WDC can, before the DPD is adopted, reject planning applications on the ground of prematurity, where the application if granted would prejudice the DPD. The DPD would have to be close to adoption however.

To comply with national policy, WDC should require developers to bring forward developments with high standards of resource efficiency. WDC can use the information that it has gathered in drafting its DPD to test developers' compliance with national policy requirements.

WDC can use its broad legal power to impose planning conditions to impose resource efficiency standards for particular developments. Such conditions may be justified by reference to national policy.

Inspectors' decisions such as that on the former Downley Middle School and Turners Field site indicate how national policy is to be interpreted and what conditions might be imposed in compliance with national policy.

WDC may create a SPD that seeks to educate developers on its approach to resource efficiency in the light of national policy, and its interpretation of Inspectors' decisions. This should assist developers in understanding WDC's approach and assist WDC in taking a consistent approach in each case.
5 List of assumptions

5.1 Fuel prices
For modelling purposes electricity and heat sales prices are based on a weighted average of domestic and non domestic prices\textsuperscript{14} weighted by proportion of estimated demand for each sector. The following prices have been used for this study.

5.1.1 Buying
Gas: 2.5 p/kWh
Electricity: 6 p/kWh

5.1.2 Selling
Electricity: 8 p/kWh
Gas: 2.78 p/kWh
Heat value: 3 p/kWh (assuming gas price above and boiler at 90\% efficiency)
Electricity export: 2 p/kWh

5.2 Financial
Discount factor: 3.5\%
Inflation: 3\%

5.3 Capital costs
The model includes estimates of the capital, installation and maintenance costs for the CHP engines in the database. In addition, it allows the capital costs to be modified to account for a range of scenarios. These can include fixed costs (e.g. the cost of the heating network) or as a percentage of the CHP cost.

In this study, the capital costs have been calculated by Ramboll. Based on the findings of the EST Community Energy Report\textsuperscript{15} we have taken a figure of 20\% of the total costs of the network as the marginal cost over and above the equivalent conventional system (gas distribution and individual boilers).


\textsuperscript{15} EST, Community heating for planners and developers, 2004
6 Appendix. Ramboll reports

SEA / RENUE
High Wycombe DH Network Assessment
Compair / De La Rue Development
February 2008
6.1 Introduction

As part of the Feasibility Study on Energy Policy & infrastructure for the Wycombe District Ramboll Denmark district heating systems department (Ramboll DH) is to carry out an assessment of a district heating network for the Compair / De La Rue new development.

SEA / Renue and Ramboll DH are currently working on the Feasibility Study on Energy Policy & infrastructure for a number of new developments around High Wycombe. Part of the brief is to explore the potential for CHP and district heating systems for the individual sites.

The development plans are at a very early planning stage and there is a lack of detail on the layout for most of the sites. The Compair / De La Rue development is the one with most detail available with a framework plane together with a site plan for Bucks New University student housing.

The level of information available at this stage is not adequate for a detailed assessment of the cost of a district heating system but based on the plans, Compair / De La Rue, Ramboll DH has carried out a basic outline for a district heating network with an indication of likely network costs.

Ramboll DH will in this brief report outline the heat network and estimate its likely capital.

An outline of the district heating network, its optimal combinations of pipe diameters which fulfil certain requirements and which is based on certain assumptions is calculated by using SYSTEM RØRNET program package which is developed by Ramboll DH.

The report does not look at the production of heat for the DH system or any detail on equipment associated. The specification for installing and maintaining the network is also not part of this commission.

The budget cost in this proposal is based on a number of assumptions which will be outlined and they will need clarification in a later detail study, preliminary and/or detailed design.

6.2 Compair / De La Rue development baseline information

The Compair / De La Rue site is intended as a mixed use area as part of the Wycombe development framework comprising dwellings, offices, light industry, a sports centre and the Amersham & Wycombe College.

The Compair / De La Rue development consists of 100 dwellings, 936 student accommodation as part of the Hughenden Quarter and around 32,000 m² of non-residential area.

A part from for the student accommodation, there is no detail information available of the layout of individual plot area, the connection and the outline of the district heating network therefore stop at the interface with the individual plot areas.
It is assumed that there is to be a heat exchanger or hydraulic interface unit. For the student accommodation it has been assumed that there are six connections for the blocks, each having an interface heat exchanger.

The DHW is assumed to be supplied via hot water cylinders.

6.3 Energy Demands & Diversity

6.3.1 Heat demands

The heat demand to the buildings depends on the heat loss of the building and the domestic hot water (DHW) demand of the building.

The provision of DHW i.e. instantaneous or via individual storage cylinders is important in determining the load.

The advantage of DHW via a storage cylinder is that the peak load capacity demand from the dwellings is reduced considerably which results in smaller pipe dimensions of the DH system compared to a system based on instantaneous DHW via a heat exchanger. The disadvantage is that the hot water cylinder will take up a little more space and it is a little more expensive than the heat exchanger. It is considered that the advantages are greater than the disadvantages.

Instantaneous DHW will have a higher demand and will subsequently it can generally be assumed that the size (diameter) of the network will increase.

Benchmark heat consumptions figures corresponding with the Code for Sustainable homes have been provided by SEA / RENUE.

The total yearly heat consumptions for the different areas have the following values:

**Compair**

- Dwellings - 235,600 kWh/yr
- Light industrial i.e. supermarket - 324,918 kWh/yr
- Offices - 166,520 kWh/yr
- Sports centre (dry) - 1,568,630 kWh/yr
- Site for educational relocation - 2,621,002 kWh/yr
- Hughenden Quarter Student Housing - 4,410,432 kWh/yr

**De La Rue**

- Dwellings - 235,600 kWh/yr
- Light industry: 487,377 kWh/yr
The values for Comair are from the “Compair De La Rue demand estimates” spread sheet. It is assumed that the heat demand for “Amersham & Wycombe College” from the spread sheet corresponds to the heat demand of the “Site for educational relocation”, due to its low heat demand. The heat demand for the “Hughenden Quarter Student Housing” has been calculated assuming identical heat demands as that of the dwellings i.e. an average of 4,712 kWh/yr/unit.

The values for De La Rue part of the site has been obtained by assuming the same heat demand per square meter for both dwellings and industry as for Compair.

The heat usage figures provided are quite low and it therefore has to be assumed that the DHW is supplied through storage cylinders.

From the yearly heat demands stated above the heat loads for the six areas in Compair are determined assuming a yearly utilisation time of 2000 hours/year:

- Dwellings: 118 kW.
- Light industrial i.e. supermarket: 163 kW.
- Offices: 84 kW.
- Sports centre (dry): 785 kW.
- Site for educational relocation - 439 kW.
- Hughenden Quarter Student Housing - 2,205 kW.

The same approach is used for De La Rue:

- Dwellings: 118 kW.
- Light industry: 245 kW.

### 6.3.2 Electricity Demand

The electricity demand only gets interesting and important when considering CHP in combination with selling the electricity through a private wire network.

The electricity demand is not part of the district heating network assessment.

### 6.3.3 Cooling Demand
6.3.4 Diversity

As the peak load consumption will not occur simultaneously from all the dwellings in a development and the flow in the various pipes should be multiplied by a diversity factors. The heat demand and the diversity will depend on individual usage i.e. non residential will have a different profile to that of residential. The individual use of DHW will also vary between residential dwellings and it is unlikely that everybody within a development will use their maximum demand at the same time.

In Denmark we use a factor for simultaneous use of both heating and DHW, but it can also be divided up and a diversity factor applied for space heating and DHW respectively.

For this outline assessment of the network a factor of 0.4, meaning that this particular outline of the DH system will meet the heat demands listed above multiplied by 0.4.

The diversity is assessed for individual schemes based experience and may vary depending on the combination of dwellings and buildings together with their usage i.e. domestic, retail, offices, industry etc.

6.4 District Heating

District heating is a method of delivering heat from a variation of heat producing sources to a variation of heat customers. Heat produced from fossil fuel sources such as natural gas, oil burned directly in boilers or through combined heat and power (CHP) and also renewable energy can be delivered to residential dwellings, commercial & public offices, schools, warehouse and factory, hospitals plus industrial process heating.

Denmark’s experience is that district heating offers many environmental benefits to society. Of the around 60% of all households in Denmark connected to a heat network, three-quarters of the heat supplied is waste heat from CHP plants, some of which are biomass fuelled. Further 12% comes from waste incineration, 6% is biomass burned in boilers and 3% is industrial waste heat. The remaining 4% only is natural gas or oil used in peak load and spare capacity boilers. A few district heating companies have established central solar panels (thermal), contributing quite significantly to the heat production.
6.4.1 District Heating Network Considerations

The design of the heat network that would supply heat to connected properties within a development is critical, as it represents both a significant capital investment and incurs ongoing operational costs. Buildings to interface with the primary heat network, and specifications for individual residential consumer units and heat metering, also require attention in order to ensure future proofing and to build the confidence of property developers and residents.

The cost of installing the heating network depends largely on four factors:

- The design operating temperature and pressure.
- The complexity of services.
- The length of the network.
- The peak heat demand.

A district heating network can generally be split into three levels:

- The Branches and connections to supply buildings.
- The distribution heat network.
- The transmission heat network.

It is the temperatures and pressure required to transport the heat energy that distinguishes between distribution and transmission. For most developments in the UK is unlikely that there will be a requirement the use of a transmission network.

It is important to the cost of the scheme as a whole, both in relation to installation and operational costs, that the network is fully optimised.

6.4.2 Interface of consumers to the district heating network

The heating system is assumed to be a central heating system for all dwellings and buildings with good individual controls and heat metering.
The individual flats and buildings heating system can be either directly or indirectly connected to the district heating network.

In the direct connection there is no barrier between the hot water and that can be an issue concerning safety and quality of the district heating water.

Generally we would therefore recommend in-direct connection for reasons of security and quality of the district heating water.

In Denmark a "rule of thumb" is that direct connection is certainly not recommended for dwellings with risers. In tower blocks or blocks of flats the interchange could take place in the basement or ground floor with one large heat exchanger and the connections to the individual flats would then be "direct". Alternatively a Hydraulic Interface Unit (HIU) or heat exchanger with associated pump and controls could be placed on each floor.

Generally Ramboll DH will at this stage of a study assume that all connections are indirect to the heating network.

6.5 Compair / De La Rue - DH General Preconditions

The diameters of the pipes should be chosen in order to minimise all costs associated with the installation and the operation of the district heating network. The costs can be divided into fixed and variable costs. Fixed costs will consist of investment in pipes and pumps and the variable costs will be coming from pump operation and heat loss.

To enable Ramboll DH to evaluate this scheme, a very basic appraisal of the district heating network has been carried out based on the following preconditions:

The flow temperature is 80ºC and the return temperature is 40ºC, which gives a temperature difference of 40ºC. The Delta T of 40ºC is chosen based on previous experience and is one of the determining factors for sizing the network.

A flow temperature of 80ºC is normally chosen as a very cost effective option to minimise construction costs of district heating network whilst still meeting the standard heating design temperatures within the properties.

This does not however correspond well with utilising the heating network for absorption/sorption cooling. Here the flow temperature needs to be as high as possible and the
return temperature will generally be higher which increases the required pipe dimension and cost of the network.

When utilising CHP and biomass heat production a low return temperature is desirable. This will enable the CHP unit and the energy in the fuel to be utilised most efficiently. A return temperature of 40 - 35°C would be preferable.

A maximum pressure of 10 bar and a static pressure of 2 bar has been used. A pressure difference of 1 bar at the end-user installations is used.

Furthermore, it has been taken into account that the Compair / De La Rue development area has some changes in altitude across the site (10m), as well as 8 storeys buildings within the Hughenden Quarter Student Housing.

6.5.1 Pipeline routing
A district heating system is designed using the layout shown in appendix A, the assumptions listed and the heat demands above; including the diversity factor.

The energy centre is placed as suggested at the “Future CHP site” within the sports centre area. It is indeed preferable that the location of the energy centre is fairly central in terms of the cost of the network.

The district heating network from appendix A can be viewed in appendix B without the map as background. The nodes (numbers), illustrates a connection point, meaning that only the primary grid is modelled.

The heat demand for the Hughenden Quarter Student Housing is distributed using the following figures:
- Heat demand per bed/penthouse unit: 2.2 kW
- Office: 25 kW
- Laundrette: 60 kW
- Common room: 25 kW
- Incubator units: 35.8 kW
The district heating network will be designed to meet the demands above multiplied by the diversity factor. Furthermore, it is assumed that the laundrette receives heat for washing through district heating.

The heat demands for the different areas - excluding the Hughenden Quarter Student Housing - are distributed evenly between the nodes in the particular geographic areas after having multiplied by the diversity factor. This is a rough assumption but hard to do better without more detailed information.

### 6.5.2 Main heat network - Site Wide

SYSTEM RØRNET (SR) has been used to outline a likely design for a district heating system. SR seeks to design a network using the smallest pipe dimensions possible and thereby reducing the cost of the system. How small the pipe dimensions can get is limited by the pressure available and an upper water velocity limit depending on the diameter of the pipe. The velocity is limited to avoid water hammering - and other problems.

The result of the dimensioning can be seen in the table below (Table 1):

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal Diameter</td>
<td>Main network (m)</td>
</tr>
<tr>
<td>DN 20</td>
<td>654</td>
</tr>
<tr>
<td>DN 25</td>
<td>329</td>
</tr>
<tr>
<td>DN 32</td>
<td>149</td>
</tr>
<tr>
<td>DN 40</td>
<td>245</td>
</tr>
<tr>
<td>DN 50</td>
<td>129</td>
</tr>
<tr>
<td>DN 65</td>
<td>79</td>
</tr>
<tr>
<td>DN 80</td>
<td>154</td>
</tr>
<tr>
<td>Total</td>
<td>1,739</td>
</tr>
</tbody>
</table>

**Table 1: CompAIR / De La Rue main heating network**

To get the total length of pipe work required the “trench length” should be multiplied with two (2) for flow and return.
The total cost of the construction of the main network pipes is estimated to £820,000.

The result applies for the situation with no pool in the leisure centre.

6.5.3 Branches
From the distribution network, branches or service pipes will feed individual buildings.

The branches will also consist of a flow and return pipe.

As no detailed information is available about the building position on the plots and their layout this aspect of the network can not be evaluated.

The dimension of the branches depends on the estimated peak heat load demand of each building.

6.5.4 Internal network
In addition to the main network and the branch network there is likely to be an internal network distributing the heat within blocks of student accommodation.

Without detailed layouts of the individual plots and their buildings and location of dwellings it is not possible to assess the internal network along the same parameters as with the network in the ground.

6.5.5 Hydraulic Interface Units
Based on the number of dwellings within the development it is assumed that 100 HIU’s will be required for the scheme, in addition to six (6) heat exchanger units for the Hughenden Quarter Student Housing.

For the larger non-residential connections it is assumed that a HIU or heat exchanger is required for the interface with the heat network. The number of units required is based on the number of connection points (nodes) assumed when outlining the network (see above).

Based on these rough assumptions it is estimated that the cost for interface between individual dwellings and non-residential connections will be around £170,000 for this site wide scheme.
6.5.6 Summary of estimated cost

The site wide scheme is estimated to cost £990,000 based on the limited information available. The cost covers the main heat network and interface connections.

The actual cost will depend on the chosen design parameters, please see section on study sensitivity below.

6.6 Study Sensitivity

The assessment highlights a number of issues where more information and/or design decisions are required.

More detailed information about the development as a whole and the individual parcels together with the parcels layout is required to be able to assess the branches/service pipes to buildings.

The decision on whether to have direct or indirect connections and whether to have instantaneous DHW or a cylinder can make the scheme either more or less expensive.

The overall layout and especially the parameters in respect to the central heating system of individual dwellings and buildings also needs to be established to match that of the parameters of the heating network. The houses, flats and buildings can be heated either by radiators, floor heating or by a combination of radiators and floor heating. The type of system and its design parameters will need to be established to enable the district heating network to be developed in more detail.

Customer interface connections for indirect connection can be delivered as pre-fabricated units also known as hydraulic interface units (HIU) or it can be built by the heating installer. The choice of unit reflects the type of connection i.e. direct / indirect heating and cylinder / instantaneous DHW connection. Temperatures and pressure levels, also for the mains cold water supply and for the domestic hot water, are among the important parameters when specifying the units.

One important issue is the capacity of the unit in relation to the building’s heat demand and the demand for domestic hot water. This will lead to requirements in terms of flow over the installation, combined with the obtainable supply and return temperature.

The specific requirements for supplying heat and DHW to taller buildings also require a detail assessment to establish the consequences for the network.
Whether there is a requirement for cooling and a case for implementing absorption or sorption cooling needs also to be established.

6.7 Way forward

When implementing district heating there is a number of good practises and recommendations, in relation to the design and installation that has been developed over the years. Many of these are based on the experience gained in Denmark, where district heating is common and have been developed over the last 40 years.

The detailed specification for the installation and maintenance of the district heating network is outside the scope of this work at this early stage of the establishment of the development but it is something worth while considering as early as possible in the project process.

Once the decision has been taken to establish a district heating scheme it is Ramboll DH’s experience that the next stage should be a preliminary design. It is likely that even following a detailed feasibility there is still left open a number of questions and uncertainties and these should be thoroughly investigated and/or determined directly by the developer(s).

The next stages of developing the scheme therefore should be preliminary design, detailed design, tendering/procurement, construction and commissioning. The tendering and procurement stage covers the preparation of technical specifications and procurement documents.

The content of these stages will be influenced by the possible ways of splitting the design into “preliminary” and “detailed”. The same may apply to the “tendering / procurement” stage, which can be more or less comprehensive, depending on the number of work packages that will be tendered. Also the contract with contractors or suppliers may include a smaller or greater part of the design.

It is important that there is a closer working relationship and liaison with all developers and stakeholders through out the project and its development. Experience show that the best schemes with greatest customer satisfaction are those implemented with detailed communication and information sharing. Ramboll DH suggest that at an early stage information meetings are held with/offered to all developers and stakeholders about the scheme’s technical and practical details and progress.
SEA / RENUE

High Wycombe DH Network Assessment

Individual Site Assessment & Advantage of larger scale system

March 2008
6.8 Introduction

SEA / Renue and Ramboll Denmark district heating systems department (Ramboll DH) are currently working on the Feasibility Study on Energy Policy & Infrastructure for a number of new developments around High Wycombe. Part of the brief is to explore the potential for CHP and district heating systems for the individual sites.

Ramboll DH is to carry out the assessment of district heating networks for the following sites for development:

- RAF Daws Hill
- Abbey Barn South
- Handy Cross
- Cressex Island
- Molins

The development plans are at a very early planning stage and there is a lack of detail on the layout of the sites.

In addition the client identified an additional site for assessment, the Compair / De La Rue site where the plans for the development are further advanced. The Compair / De La Rue development is the one with most detail available, it has a framework plan together with a site plan for Bucks New University student housing.

The Compair / De La Rue site was due to its advanced planning stage, for specifically the Bucks New University student housing, put forward for a separate DH analysis.

The level of information available at this stage is not adequate for a detailed assessment of the cost of a district heating system but based on the plans for Compair / De La Rue, Ramboll DH carried out a basic outline for a district heating network with an indication of likely network costs.

The findings were presented in a separate brief report.

The outline of the district heating network in this report, its optimal combinations of pipe diameters which fulfil certain requirements and which is based on certain assumptions where calculated using SYSTEM RØRNET (SR) program package which is developed by Ramboll DH.

The report did not look at the production of heat for the DH system or any detail on equipment associated. The specification for installing and maintaining the network was also not part of the commission.

The remaining sites have too limited information to make any detailed enough outline of a network to benefit from a SR analysis.

Ramboll DH will in this brief report evaluate a likely heat network and estimate its capital cost.

The budget cost is based on a number of assumptions which will be outlined and they will need clarification in a later detail study once further information is available for the actual plans of the developments.

In addition Ramboll DH will in this report briefly outline the advantage of looking at joining up some of these and/or other development in a larger heat network.

6.9 The Development’s baseline information

Evaluating the site data for the five sites listed above it becomes clear that one of the sites is not suitable for a heat network assessment.
Molins is a large data building where just one local CHP unit is likely to be installed. There is no potential for a heat network but just local heat and/or cooling of the building itself.

The four other sites, RAF Daws Hill, Abbey Barn Hill, Handy Cross and Cressex Island are all intended as mixed use areas as part of the Wycombe development framework comprising dwellings, offices, light industry and for Handy Cross a sports centre with a swimming pool.

The following information is available for the sites:

RAF Daws Hill:
- 550 dwellings
- Existing community facility (School + Gym & Sports centre)

Abbey Barn South:
- 500 dwellings
- 4,000 m$^2$ business area
- 2,500 m$^2$ community use

Handy Cross:
- 300 dwellings
- 27,000 m$^2$ business area
- 150 bed hotel
- 11,000 m$^2$ sports centre with swimming pool

Cressex Island:
- 7,000 m$^2$ commercial leisure
- 100 bed hotel
- 40 care homes
- 5,600 m$^2$ car show room
- 7,000 m$^2$ sports centre (David Lloyd)

There are no detailed site plans available for the four sites.

**6.10 Heat Demands & Diversity**

The heat demand of the buildings depends on the heat loss of the building and the domestic hot water (DHW) demand of the building.

The provision of DHW i.e. instantaneous or via individual storage cylinders is important in determining the load.
The advantage of DHW via a storage cylinder is that the peak load capacity demand from the dwellings is reduced considerably which results in smaller pipe dimensions of the DH system compared to a system based on instantaneous DHW via a heat exchanger. The disadvantage is that the hot water cylinder will take up a little more space. Instantaneous DHW will have a higher demand and subsequently it can generally be assumed that the size (diameter) of the network will increase.

It is considered that the advantages of having DHW supplied via a storage cylinder are greater than the disadvantages.

It is assumed that there is to be a heat exchanger or hydraulic interface unit for the connection to the network.

As the peak load consumption will not occur simultaneously for all the dwellings in a development the flow in the various pipes should be multiplied by a diversity factor. The heat demand and the diversity will depend on individual usage i.e. non residential will have a different profile to that of residential. The individual use of DHW will also vary between residential dwellings and it is unlikely that everybody within a development will need their maximum demand at the same time.

The diversity is assessed for individual schemes based on experience and may vary depending on the combination of dwellings and buildings together with their usage i.e. domestic, retail, offices, industry etc.

In Denmark we use a factor for simultaneous use of both heating and DHW, but it can also be divided up and a diversity factor applied for space heating and one for DHW.

For the simplicity of this outline assessment of the networks in this report a global diversity factor of 0.4 is used, meaning that this particular outline of the district heating system will meet the heat demands listed below multiplied by 0.4.

Benchmark heat consumptions figures corresponding with the Code for Sustainable homes have been provided by SEA / RENUE.

The total yearly heat consumptions for the different areas have the following values:

RAF Daws Hill:
- Dwellings - 3,443 MWh/yr
- Existing community facility (School + Gym & Sports centre) - 107 MWh/yr

Abbey Barn South:
- Dwellings - 3,135 MWh/yr
- Business Area - 250 MWh/yr
- Community area - 211 MWh/yr

Handy Cross:
- Dwellings - 1,881 MWh/yr
- Business area - 1,686 MWh/yr
- Hotel - 1,021 MWh/yr
- Sport centre & swimming pool - 1,966 MWh/yr

Cressex Island:
- Light Industry - 341 MWh/yr
- Hotel - 817 MWh/yr
- Care Home - 613 MWh/yr
- Sports facility - 749 MWh/yr

The yearly heat demands are transformed to heat rates using a yearly utilisation time of 2,000 hrs per annum.

6.11 General Heat Network Evaluation

District heating is a method of delivering heat from a variation of heat producing sources to a variation of heat customers. Heat produced from fossil fuel sources such as natural gas, oil burned directly in boilers or through combined heat and power (CHP) and also renewable energy can be delivered to residential dwellings, commercial & public offices, schools, warehouse and factory, hospitals plus industrial process heating.

6.11.1 District Heating Network Considerations

The design of the heat network that would supply heat to connected properties within a development is critical, as it represents both a significant capital investment and incurs ongoing operational costs. Buildings to interface with the primary heat network, and specifications for individual residential consumer units and heat metering, also require attention in order to ensure future proofing and to build the confidence of property developers and residents.

The cost of installing the heating network depends largely on four factors:

- The design operating temperature and pressure.
- The complexity of services.
- The length of the network.
- The peak heat demand.

A district heating network can generally be split into three levels:

- The Branches and connections to supply buildings.
- The distribution heat network.
- The transmission heat network.
It is the temperatures and pressure required to transport the heat energy that distinguishes between distribution and transmission. For most developments in the UK it is unlikely that there will be a requirement for the use of a transmission network.

It is important to the cost of the scheme as a whole, both in relation to installation and operational costs, that the network is fully optimised.

6.11.2 Interface of consumers to the district heating network
The heating system is assumed to be a central heating system for all dwellings and buildings with good individual controls and heat metering.

The individual flats and buildings heating system can be either directly or indirectly connected to the district heating network.

In the direct connection there is no barrier between the hot water and that can be an issue concerning safety and quality of the district heating water.

Generally we would therefore recommend in-direct connection for reasons of security and quality of the district heating water.

In Denmark a “rule of thumb” is that direct connection is certainly not recommended for dwellings with risers. In tower blocks or blocks of flats the interchange could take place in the basement or ground floor with one large heat exchanger and the connections to the individual flats would then be “direct”. Alternatively a Hydraulic Interface Unit (HIU) or heat exchanger with associated pump and controls could be placed on each floor.

Generally Ramboll DH will at this stage of a study assume that all connections are indirect to the heating network.

6.11.3 Branches
From the distribution network, branches and service pipes will feed individual buildings.

The branches and service pipes will also consist of a flow and return pipe.

As no detailed information is available about the type of dwellings and building positions this aspect of the network is very difficult to evaluate.

The dimension of the branches and service pipes will depend on the estimated peak heat load demand of each building.
6.12 Site Specific DH network layout

As there is no detail information available concerning the layout of the developments this basic assessment assumes that the three areas RAF Daws Hill, Abbey Barn South and Handy Cross have identical basic layouts, as illustrated in Figure 1 below. As Cressex Island appears not to have a residential area to supply, the layout for that particular area for development is slightly different (please see section further down).

![Figure 1: DH network](image)

Generally it is considered the optimum location for an energy centre to be at the centre of the network. The CHP site for the areas is therefore assumed to constitute the centre of the DH network having a main supply branch on either side. One supplies the residential area only, while the other supplies all non-residential areas.

The residential areas are assumed to be symmetrical around the main supply branch having secondary branches on either side. The number - and the length of the secondary branches depend on the number of dwellings.

Based on the heat demand assumptions the pipe dimension DN 20 is sufficient for all secondary branches as well as the service pipes into the individual buildings.

The dimension of the main supply branch depends on the rate of heat to be transported and varies along its length, decreasing as the flow (heat demand) decreases. Similar assumptions can be allocated to the main branch supplying industry, offices etc.

6.12.1 RAF Daws Hill

It is assumed that the majority of the 550 dwellings are semi-detached, and that each dwelling will require its own supply connection.

The DH network for the residential area consists of 11 secondary branches on either side of the main supply branch, each branch supplying 25 dwellings.

It is assumed that there is 10 metres between the dwellings, and that each dwelling needs 10 metres of service pipe which means that a total 8,250 metres DN20 pipes is needed. Note that this is the trench length. To get the total length of pipe work required the trench length should be multiplied by two for flow and return pipe.
The main supply branch for dwellings is estimated to be 350 metres long, starting at DN65 and decreasing to DN25. The outline of the pipe dimensions can be seen below.

**Figure 2: Outline of pipe dimensions**

The required pipe work (trench length) is found in table 1.

<table>
<thead>
<tr>
<th>Pipe dimension</th>
<th>Length (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DN20</td>
<td>8,250</td>
</tr>
<tr>
<td>DN25</td>
<td>25</td>
</tr>
<tr>
<td>DN32</td>
<td>50</td>
</tr>
<tr>
<td>DN40</td>
<td>25</td>
</tr>
<tr>
<td>DN50</td>
<td>100</td>
</tr>
<tr>
<td>DN65</td>
<td>150</td>
</tr>
</tbody>
</table>

**Table 1: RAF Daws Hill residential area**

The existing community facility in RAF Daws Hill is also intended a future DH customer. As already mentioned, heat to non-residential areas is thought to be supplied through another main supply branch. In this case the main supply branch with the dimension DN20 is sufficient to cover the assumed heat demand of the facility.

Since there is a lack of information about the outline of the area it is assumed that the distance between the CHP site and the community facility is 100 metres.

Based on the assumption made the total cost of the DH network for RAF Daws Hill is found to be around £3.9 million. The price is only to be considered a very rough estimate.

**6.12.2 Abbey Barn South**

Due to the minimum information available the same assumptions as for RAF Daws Hill is made for the Abbey Barn South development.

The DH network for the 500 dwelling residential area consists of 10 secondary branches on either side of the main supply branch, each branch supplying 25 dwellings. See figure 3.
Figure 3: Outline of pipe dimensions

Table 2 summarises the result.

<table>
<thead>
<tr>
<th>Pipe dimension</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nom. diameter</td>
<td>(m)</td>
</tr>
<tr>
<td>DN20</td>
<td>7,500</td>
</tr>
<tr>
<td>DN25</td>
<td>25</td>
</tr>
<tr>
<td>DN32</td>
<td>50</td>
</tr>
<tr>
<td>DN40</td>
<td>25</td>
</tr>
<tr>
<td>DN50</td>
<td>100</td>
</tr>
<tr>
<td>DN65</td>
<td>125</td>
</tr>
</tbody>
</table>

Table 2: Abbey Barn South residential area

For the non-residential area it has been found that a main supply pipe with the dimension DN32 is sufficient to transport the required rate of heat. Service pipes with the dimension DN20 are suitable as long as the heat requirement does not exceed 45 kW.

Again, there is a lack of information about the distance between the CHP site and the business/community area. As an example, it has been assumed that the distance between the CHP site and the business/community area is 100 metres and that four service pipes of 25 metres are needed.

The total cost of the DH network related to the Abbey Barn South development is based on the assumptions made estimated to be around £ 3.5 million.

6.12.3 Handy Cross

The DH network assumed for the 300 dwellings for the residential area at Handy Cross consists of 10 secondary branches on either side of the main supply branch, each branch supplying 15 dwellings.

The dimension of the main supply branch decreases from DN50 to DN20 as illustrated in figure 4 below.
Figure 4: Outline of pipe dimensions

Table 3 summarises the result.

<table>
<thead>
<tr>
<th>Pipe dimension</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nom. diameter</td>
<td>(m)</td>
</tr>
<tr>
<td>DN20</td>
<td>4,500</td>
</tr>
<tr>
<td>DN25</td>
<td>50</td>
</tr>
<tr>
<td>DN32</td>
<td>50</td>
</tr>
<tr>
<td>DN40</td>
<td>50</td>
</tr>
<tr>
<td>DN50</td>
<td>150</td>
</tr>
</tbody>
</table>

Table 3: Handy Cross residential area

For the non-residential area it has been estimated that the main supply pipe needs to have the dimension DN65 to carry the required heat rate.

As an example, it has been assumed that the distance from the CHP site to the business/hotel/Sports Centre area of the development is roughly 300 metres and that 10 off DN32 service pipes each as an average estimated at 50 metres are used.

The total cost of the DH network related to the Handy Cross development is based on the assumptions made estimated to be around £2.6 million.

6.12.4 Cressex Island

Cressex Island does not have a residential area. The outline of the DH network in this area is assumed to be as outlined in Figure 5 below. Although in practice when the site only consist of commercial buildings it is likely that the CHP plant room would be located within or nearby one of the buildings.

Figure 5: DH network Cressex Island
The sports centre and the care home are supplied by one supply pipe while the light industry and the hotel are supplied by another. The supply pipes are each assumed to be 100 metres. It is assumed that only one service pipe is used for each of the four facilities and that there is one point of connection for each facility. In practice there might be more connections within the light industry area.

The supply pipes are based on the heat demand figures, likely to have the dimension DN50 while three of the service pipes should have the dimension DN40. For the supply pipe feeding the light industry the dimension DN32 is sufficient.

The cost of this network is estimated to be around £150,000

6.12.5 Hydraulic Interface Units and/or Heat Exchangers

It is assumed that each dwelling will be connected through a Hydraulic Interface Unit (HIU).

For the larger non-residential connections it is assumed that a HIU or heat exchanger is required for the interface with the heat network.

Based on the rough assumptions in this assessment it is estimated that the cost for interface between individual dwellings and non-residential connections within each development are as listed below.

RAF Daws Hill - £553,000
Abbey Barn South - £510,000
Handy Cross - £337,000
Cressex Island - £22,000

6.12.6 Summary of estimated individual network cost

The cost of the individual schemes has been estimated based on the limited information available. The estimates cover the capital cost the main heat network and interface connections and are listed below.

The actual cost will depend on the chosen design parameters, please see section on study sensitivity below.

RAF Daws Hill - £4.450 million
Abbey Barn South - £4.010 million
Handy Cross - £2.940 million
Cressex Island - £172,000

6.13 Larger scale District heating

In this assessment the areas for development located in same proximity i.e. Cressex Island, RAF Daws Hill, Abbey Barn South and Handy Cross have been treated as separate areas, each having their own DH network independently of each other. In many cases there are advantages of connecting local DH network and thereby forming larger district networks.

Some of the advantages are listed below:

- Higher energy efficiency
- Lower CO₂ emissions
- Higher fuel flexibility
Better local air quality
- Reduced visual impact

Higher energy efficiency is achieved as a few larger district CHP plants will be more energy efficient than several smaller local units. This is something that is worth considering in the early planning stage of a project that involves CHP generation. In many cases, the capital cost of a single large CHP plant will be comparatively smaller than that of smaller units producing the same amount of energy, since several smaller units require more buildings, control systems, pumps etc.

Higher energy efficiency means lower CO\(_2\) emissions which is an issue that is becoming increasingly important.

High fuel flexibility is even more so gained through large scale CHP plants where the mass incineration of waste or combustion of biomass in a conventional boiler to raise steam for steam turbine power generation constitutes an environmentally friendly alternative to natural gas.

Large scale CHP has the advantage compared to small scale that the emission of air pollutants is confined to fewer sites. By choosing the sites rationally, i.e. at the edge of a city, much can be accomplished in terms of local air quality. Furthermore, centralised high efficiency CHP or boilers are able to control emissions to a higher level than smaller units.

Fewer strategically placed, large CHP plants mean reduced visible impact on the city aesthetics.

6.13.1 Larger Scale baseline information

A larger scale DH network has been modelled by connecting the four minor networks for Cressex Island, Handy Cross, RAF Daws Hill and Abbey Barn South.

It is assumed that the heat demands stated earlier still applies. Although the diversity factor could in a detailed study be estimated and applied differently. However, at this level of detail we find it reasonable to utilise the same heat demand figures.

The pipe dimensions in this larger network will be different. This is a result of the fact that only one central energy centre is to overcome the hydraulic resistance in the network instead of the previous four.

6.13.2 Network outline

The energy centre in this model has been placed within the RAF Daws Hill area. It makes good sense to place the energy centre close to the network centre in terms of minimizing the cost of both the pipe system and/or pumping required.

Similar assumption has been made to the pipe network for the residential areas although they do not exactly match the networks described earlier (Figure 1) although they are not duplicated.

The DH network can be seen in appendix A. The network has been designed based on AutoCAD material provided by Wycombe Council. All service pipes for both residential - and non-residential units is not included in this illustration and calculation.

In appendix B the same network is seen; now with pipe diameters shown. SYSTEM RØRNET (SR) has been used to outline a likely design for a district heating system connecting the four sites. SR seeks to design a network using the smallest pipe dimensions possible and thereby reducing the cost of the system. How small the pipe dimensions can get is limited by the pressure available and an upper water velocity limit depending on the diameter of the pipe. The velocity is limited to avoid water hammering - and other problems.
The flow temperature is 80ºC and the return temperature is 40ºC, which gives a temperature difference of 40ºC. The Delta T of 40ºC is chosen based on previous experience and is one of the determining factors for sizing the network.

For this outline of the network it is assumed that it is a 6 bar system resulting in a differential pressure of 0.5 bar at the critical consumer, which based ion the assumptions made will be the sports centre in Cressex Island.

The total trench length amounts to 14,560 metres costing £ 7.1 million.

6.13.3 Service Pipes
From the main network, service pipes will feed individual buildings. These service pipes will also consist of a flow and return pipe.

As no detailed information is available about the building position on the plots and their layout this aspect of the network is difficult to evaluate.

The dimension of the branches depends on the estimated peak heat load demand of each building.

Based on the assumption made for the individual developments and their outlined network, the service pipes are expected DN20 pipes. The total cost for the service pipes connecting the individual dwellings and buildings is expected to be around £6.1 million.

6.13.4 Hydraulic Interface Units and/or Heat Exchangers
As for the individual developments it is assumed that each dwelling will be connected through a Hydraulic Interface Unit (HIU).

For the larger non-residential connections it is assumed that a HIU or heat exchanger is required for the interface with the heat network.

Based on the rough assumptions in this assessment it is estimated that the cost for interface between individual dwellings and non-residential connections is £1.425 million.

6.13.5 Summary of estimated network cost
The cost of the larger scheme has been estimated based on the limited information available. The estimates cover the capital cost of the main heat network and interface connections.

The actual cost will depend on the chosen design parameters, please see section on study sensitivity below.

The total capital cost of the larger network is estimated to be around £14.625 million.
6.13.6 Potential for connecting existing buildings and other developments
Looking at the High Wycombe area map it becomes clear that the potential for developing a larger district heating network and extending it beyond the areas considered in this report is significant.

The area between Handy Cross and RAF Daws Hill seems to be residential and with a heating pipe following Daws Hill Lane the area is an obvious candidate for district heating.

North of Cressex Island a vast area comprising existing dwellings as well as the Cressex Business Park is found. The Business Par area here could be a candidate for a large biomass CHP or EfW plant supplying low carbon heat to a large area of High Wycombe.

If it is likely that the DH network will be extended in the future it is vital that the main network is prepared for it. This means that the dimensioning of the system should be based on the future scenario.

Individual islands of smaller schemes can be developed for future connection to a larger scheme. The individual CHP engines and peak load boilers would be taken in by the larger scheme operating as base load and back up.

6.14 Thermal Storage
A thermal store makes it possible to create a time delay between heat consumption and heat production.

The purpose of such time delay is mainly of economical nature and is related to the fact that the cost of heat production may vary with time. By introducing a thermal store in the district heating system it is possible to produce heat at a time where the heat production price is low and then utilise this low cost heat at a time, where the production cost for the heat would be high.

The implementation of a thermal store is normally associated with systems supplied from a Combined Heat and Power (CHP) plant, because the heat production cost here is not only related to the fuel cost but also to the selling price of electricity. There is an advantage in producing and storing heat at times when electricity prices are low.

Some schemes in Denmark have their Thermal Store sized based on the weekend demand and switches the production plant off at weekends. This can be to avoid fuel delivery at weekends if the plant is fuelled by for instance wood chip.

The connection of the thermal store to the DH system will depend on the type of DH system.

The main issue here is the maximum temperature of the DH system where there is a distinction between systems with supply temperature up to approx. 97 oC and systems with higher supply temperatures.

If the maximum temperature is lower than the boiling point of the water (in Denmark which is near the surface of the sea this means in practice 95-97oC) a non-pressurised tank can be used. This is less complicated and cheaper to install.
Sometimes a non-pressurised tank is also used for maintaining the static pressure in the DH system. The non-pressurised tank is often used in the smaller or medium sized systems and they will typically have a height of between 15 and 25 meters. Depending of the topography of the network, whether the tank is placed high or low compared to the other parts of the DH system, the water column in the tank may be sufficient to provide the required static pressure in the DH system.

In large existing DH transmission systems the maximum temperature is often above 100°C (typically up to 120°C). If water with that temperature should be stored in a non-pressurised tank, permanent boiling would take place at the top of the tank which is highly undesirable. In order to avoid this, temperature lowering installations or pressurised tanks may be used.

This is just one of many reasons why also transmission systems are looking to lower their design and operation temperatures.

6.15 Study Sensitivity

In this assessment we have tried to consider good district heating design parameters keeping in mind the limited information the estimates are very rough and we would recommend that a more detailed and specific study is carried out. The assessment highlights a number of issues where more information and/or design decisions are required. The cost estimates highlights that the connections of individual dwellings are capital cost incentive. It is likely that a reduction of the capital connection cost especially in relation to cost of branches and services pipes can be reduced once more detailed information about the developments is available. The decision on whether to have direct or indirect connections and whether to have instantaneous DHW or a cylinder can make the scheme either more or less expensive.

The overall layout and especially the parameters in respect to the central heating system of individual dwellings and buildings also needs to be established to mach that of the parameters of the heating network. The houses, flats and buildings can be heated either by radiators, floor heating or by a combination of radiators and floor heating. The type of system and its design parameters will need to be established to enable the district heating network to be developed in more detail.

Customer interface connections for indirect connection can be delivered as pre-fabricated units also known as hydraulic interface units (HIU) or it can be build by the heating installer. The choice of unit reflects the type of connection i.e. direct / indirect heating and cylinder / instantaneous DHW connection. Temperatures and pressure levels, also for the mains cold water supply and for the domestic hot water, are among the important parameters when specifying the units.

One important issue is the capacity of the unit in relation to the building’s heat demand and the demand for domestic hot water. This will lead to requirements in terms of flow over the installation, combined with the obtainable supply and return temperature.

The specific requirements for supplying heat and DHW to taller buildings may also require a detail assessment if these are considered for a development so to establish the consequences for the network.
Whether there is a requirement for cooling and a case for implementing absorption or sorption cooling needs also to be established.

6.16 Way forward

When implementing district heating there are a number of good practises and recommendations, in relation to the design and installation that has been developed over the years. Many of these are based on the experience gained in Denmark, where district heating is common and have been developed over the last 40 years.

The detailed specification for the installation and maintenance of the district heating network is outside the scope of this work at this early stage of the establishment of the development but it is something worth while considering as early as possible in the project process.

Due to the limited information available at this stage of the study it is Ramboll DHs’ recommendation that a more detailed study is carried out considering a wider area network and heat production facility.

Once the decision has been taken to establish a district heating scheme it is Ramboll DH’s experience that the next stage should be a preliminary design. It is likely that even following a detailed feasibility there is still left open a number of questions and uncertainties and these should be thoroughly investigated and/or determined directly by the developer(s).

The next stages of developing the scheme therefore should be preliminary design, detailed design, tendering/procurement, construction and commissioning. The tendering and procurement stage covers the preparation of technical specifications and procurement documents.

The content of these stages will be influenced by the possible ways of splitting the design into “preliminary” and “detailed”. The same may apply to the “tendering / procurement” stage, which can be more or less comprehensive, depending on the number of work packages that will be tendered. Also the contract with contractors or suppliers may include a smaller or greater part of the design.

It is important that there is a closer working relationship and liaison with all developers and stakeholders through out the project and its development. Experience show that the best schemes with greatest customer satisfaction are those implemented with detailed communication and information sharing. Ramboll DH suggest that at an early stage information meetings are held with/ offered to all developers and stakeholders about the scheme’s technical and practical details and progress.