South Cambridgeshire Hall
Cambourne Business Park
Cambourne
Cambridge
CB3 6EA

t: 08450 450 500
f: 01954 713149
dx: DX 729500 Cambridge 15
minicom: 01480 376743
www.scambs.gov.uk

South Cambridgeshire District Council

1 April 2008

To: Chairman – Councillor JH Stewart
Vice-Chairman – Councillor RE Barrett
All Members of the Council
Quorum: 15

Dear Councillor

Please find attached a supplement to the agenda for the special meeting of **COUNCIL,** which will be held in **COUNCIL CHAMBER, FIRST FLOOR** at South Cambridgeshire Hall on **MONDAY, 7 APRIL 2008** at **10.00 a.m.**

Yours faithfully
GJ HARLOCK
Chief Executive

AGENDA

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3.	**NORTH WEST CAMBRIDGE AREA ACTION PLAN: RESPONSES TO THE PREFERRED OPTIONS CONSULTATION AND THE DRAFT AREA ACTION PLAN FOR SUBMISSION (Key)**	**1 - 76**

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Appendix 7 – Climate Change and Sustainable Design and Construction Paper

Cambridge City & South Cambridgeshire District Councils

**North West Cambridge Area Action Plan
Submission Draft**

Local Evidence Base for Climate Change and Sustainable Design & Construction Policy Requirements

1.0 Executive Summary

1.1 In line with PPS1 Climate Change Supplement Cambridge City Council and South Cambridgeshire District Council have developed a local evidence base to demonstrate why there are specific opportunities at North West Cambridge to set standards in the Area Action Plan (AAP) that are in advance of building regulations changes, in terms of sustainability.

1.2 These requirements are essentially that:

- A decentralised energy system must be applied across the majority of the site, with a specified hierarchy of the form of provision;
- Code for Sustainable Homes Level 4 or higher will be required up until 2013, following which level 5 or higher will be required;
- BREEAM Excellent will be required for non-residential uses from the outset;
- 20% onsite renewables will also be required to serve non-residential uses, but only where a renewably fuelled decentralised energy system is shown not to be viable;
- Water conservation standards in line with the Code requirements will be required for residential uses;
- Significant reductions in potable water consumption will be required from non-residential uses;
- All of the above will be subject to viability;

1.3 These policy requirements have been developed in line with latest national policy and the emerging regional plan, which are set out as part of the evidence base, and also have regard to existing and emerging local requirements in development plan documents. Regard has also been had to recent experience of what has proved to be achievable so far with developers of other major and growth sites in the sub-region. There are a number of sites which have already committed to go one step ahead of the building regulations, as is being proposed in the policy for North West Cambridge, which are smaller in scale and/or more constrained sites. This helps to demonstrate that the requirements are likely to be appropriate and reasonable.

1.4 As part of the evidence base, a report has been commissioned by both Councils from independent consultants, Bidwells with K J Tait Engineers, with the principal objectives of:

- Testing whether decentralised energy is likely to be technically viable for this site;
- Indicating the likely implications in terms of economic viability of different options;
- Demonstrating where these are viable, how it will help the applicant meet the proposed Code for Sustainable Homes, BREEAM and renewable energy requirements.

1.5 The report, North West Cambridge: Planning Policy Sustainability Standards - Technical Viability Study (March 2008), concludes that there are a number of technically viable options for renewably fuelled decentralised energy and has indicated what the determining factors will be for the economic viability of these options. It is not possible at this stage to investigate fully all the viability issues, as insufficient information about the development and wider costs of bringing it to market are known. The report showed that if a renewably fuelled Combined Heat and Power (CHP) option proved to be economically, as well as technically viable, then it would not be challenging for the developer to meet the energy requirements set out in the policy, based on levels in the Code for Sustainable Homes and BREEAM, or to deliver the 20% onsite renewables requirement. The viability clause will provide for a lower standard of provision where it can be demonstrated that certain options are not viable, but still with the objective of securing the maximum sustainability benefit that can reasonably be achieved.

1.6 The University has also commissioned an in depth energy study that includes North West Cambridge and explores strategic options for decentralised energy, such as anaerobic digestion on a location in the vicinity. The findings of this study were made available to the City Council on the 26th March 2008 and therefore, too late to be taken into account in this evidence base, but it is hoped it will help to inform a joint position on what is the most viable option for the site going forward. The University has expressed, through its consultation responses and other means, a firm commitment to achieving high levels of sustainability at North West Cambridge, although has objected to certain of the detailed policy requirements.

1.7 The evidence base also looks at the particular opportunities and constraints presented by this site, the scale and nature of the proposed development and the partners involved. These indicate that there are significant opportunities at North West Cambridge and that the policy requirements reflect this and are therefore justified.

2.0 Context

2.1 Both Cambridge City Council and South Cambridgeshire District Council are committed to ensuring that they deliver high quality, sustainable new developments, particularly in relation to the very large sites coming forward as part of high levels of housing growth in the Cambridge area. This is reflected in the City Council's Medium Term Objectives, of which tackling climate change is the most important, and several of South Cambridgeshire's Corporate Objectives where responding to climate change and delivering low carbon growth are central considerations.

2.2 The Councils have been working jointly to deliver the North West Cambridge Area Action Plan in partnership with the University, local residents and other stakeholders. The development is proposed in a sensitive Green Belt location on the edge of Cambridge but is justified by the long-term development needs of Cambridge University. However, the scale of development and involvement of the University present a unique opportunity to deliver an innovative and leading sustainable new extension to the city of Cambridge. There are considerable opportunities on this Greenfield site, with few apparent constraints on development beyond what would be expected ordinarily for bringing any site to market. This has also been recognised by the University, which is the landowner and main (though not necessarily the sole) developer of the site, that has shown its commitment to delivering high levels of sustainability, wherever possible by adopting an environmental policy which aims to conserve and enhance natural resources to bring about a continual improvement in its environmental performance, (see paragraph 8.1(d)).

2.3 During the time frame in which the AAP has been developed the political and planning framework surrounding sustainability has advanced considerably. The sustainability requirements as they were first set out in the issues and options document for consultation predicted this direction of travel and are very much in line with the government programme that has since been drawn up. As a result of the various stages of consultation and recently published guidance from central government, in particular the PPS1 Climate Change Supplement, the policies contained in the Preferred Options AAP have been amended and updated.

2.4 The Councils' objective for all the strategic developments around Cambridge and the new town of Northstowe has been to seek exemplar developments in sustainability, maximising the opportunities presented by such large scale developments and the dynamic national sustainability and climate change agendas, and the recently adopted AAPs for these developments include such policies. This also seeks to build on the cluster of knowledge based industries in the Cambridge Sub Region and the role of the

University in research on climate change initiatives. The publication of the PPS1 Supplement moves the agenda on again and provides the opportunity for local planning authorities to propose specific policy targets that go ahead of national policy where this is justified by a local evidence base. The North West Cambridge site offers particular opportunities due to several key factors, including the scale of the development, the mix of uses proposed, land ownership and long term interest in the site by the University, and phasing of development over the long term amongst others. However, whilst seeking to make the most of this opportunity, the Councils do not wish to place an undue burden on the developer of this site, which could threaten the delivery of housing growth and the trajectory for this, (as recognised in PPS3 and the PPS1 Supplement). Any standards set need to be appropriate and justified, in line with government guidance. Therefore this paper and the appended technical report from independent consultants provides the necessary local evidence base for these requirements.

2.5 However, not all factors that will influence whether the AAP policy requirements can be met are known at this time. For example, the technical and practical viability of Combined Heat and Power plant (CHP) will be heavily influenced by whether the relevant technology will be available and whether the fuel supply can be assured. Economic viability is another factor that cannot be fully taken into account until more information is available about the development and its energy demands, and the implications of installing such a system are factored into a wider viability study for the development. These are important factors, but they could change considerably over the time frame from the completion of the submission draft AAP to when detailed schemes are prepared for this site. Many factors could change, either favourably or unfavourably, with regard to the installation of renewable energy technologies and the ability to deliver the high levels of CO^2 reductions sought by the Government through the Building Regulations, the Code for Sustainable Homes and other recognised sustainability standards, such as BREEAM (for non-residential development).

2.6 It is nevertheless essential that the AAP includes the policy approach and targets that the Councils wish to see implemented at North West Cambridge, to provide adequate weight in decisions on planning applications. For this reason, sustainability requirements have been included in the AAP that can be justified by a local evidence base and reflect the sustainability objectives for the site. These have been future proofed to ensure they provide an appropriate policy framework both now and into the future. The policy also includes a viability clause, similar to that which is commonly applied to the ‘Merton Rule’, to ensure that factors that could arise following the adoption of the AAP can be taken into account at the planning application stage and if the developer can demonstrate that a development that fully meets the policy targets is not viable, a lower standard of provision would be acceptable, but still with the objective of securing the maximum sustainability benefit that can reasonably be achieved.

3.0 National Policy Context

Climate Change Policy Context

3.1 The Draft Climate Change Bill was published in March 2007, with consultation on the Bill closing in June 2007. The Bill proposes a series of legally binding national targets for reducing carbon emissions, by 26-32% by 2020 and 60% by 2050, among other proposals.

Planning Policy Statements

3.2 The key national planning policy statements (PPS) that are relevant are:

- PPS1: Delivering Sustainable Development (Jan 2005) and its supplement ‘Climate Change and Planning’ (Dec 2007), in which the following elements are particularly relevant:
  a) New development should be planned to minimise future vulnerability in a changing climate, (paragraph 10);
  b) Local planning authorities should expect a proportion of the energy supply of a new development to be secured from decentralised and renewable or low-carbon energy sources, (paragraph 20);
  c) When proposing any local requirements planning authorities must be able to demonstrate clearly the local circumstances that warrant and allow this, (paragraph 31);
  d) Demonstrate that the proposed approach is consistent with securing the expected supply and pace of housing development shown in the housing trajectory required by PPS3, and does not inhibit the provision of affordable housing (and) what is proposed is evidence-based and viable, having regard to the overall costs of bringing sites to the market, (paragraph 33).

- PPS22 Renewable Energy (Aug 2004) & Companion Guide (Dec 2004) set out the Government's policies for renewable energy, which planning authorities should have regard to when preparing local development documents and when taking planning decisions.

National Building Regulations Context

3.3 The Government has set out proposed changes to the building regulations (Part L Conservation of Heat & Power), that will take place in 2010, 2013 and 2016 for all new housing, to bring it up to zero carbon, in Building A Greener Future, in 2007. This will see a progressive tightening of the dwelling emission rate by 25% in 2010 (compared to 2006 requirements), 44% in 2013 and making all homes zero carbon by 2016, (this is in excess of 100% improvement).

3.4 Whilst achieving a particular rating under the Code for Sustainable Homes is not currently mandatory, the Government has linked the changes in the building regulations to particular levels of energy performance within the Code. Therefore, the changes to building regulations have the following effect in relation to the energy requirements of the Code:

- 2010 - equivalent to achieving Code level 3
- 2013 - equivalent to achieving Code level 4, and
- 2016 - equivalent to achieving Code level 6, the highest level within the Code.

4.3 The implication therefore is that when the building regulations increase, achieving higher levels of the Code should become easier. For example, in 2010 achieving level 3 should be more or less the norm, as the energy requirements are the most technically and economically challenging part of meeting the Code[1].

4.0 Regional Planning Policy Context

4.1 The East of England Draft RSS includes Policy ENV8, which states that local authorities should:
'Maximise opportunities, particularly in major growth locations and Key Centres for Development and Change, for developments to set new yardsticks of performance in the use of energy from onsite renewable and/or decentralised renewable or low carbon energy sources, and for reducing emissions; and
' Encourage the supply of energy from on-site renewables and/or decentralised renewables or low carbon energy sources and through Development Plan Documents set ambitious but viable proportions of the energy supply of substantial new development…from these sources'.

[1] Cyril Sweett: A Cost Review of the Code for Sustainable Homes. Report for English Partnerships and the Housing Corporation, February 2007.

5.0 Local Policy Context

5.1 In the Cambridge Local Plan (2006) there is a requirement for all major development to provide 10% of its energy requirements on-site from renewable energy sources. The minimum threshold for 'major development' is 10 units for residential and 1,000 square metres for non-residential.

5.2 Since the Local Plan was adopted in July 2006, there have been approximately 12 applications to which the policy has applied, which have been to approved by the Council. All have achieved the 10% minimum requirement, with one known exception, where a first floor retail extension in the historic centre had difficulty meeting the full 10% requirement on-site. In another case, the applicants were able to achieve an 18% reduction in emissions for a very large research building, with significant predicted process loads, for the same cost as achieving 10%.

5.3 The Core Strategy for the new Cambridge Local Development Framework (LDF) is currently being prepared and the Council intends to develop more ambitious, targets regarding the sustainability and carbon emissions of all new development during the plan making process (see paragraph 7.2).

5.4 The current Cambridge Local Plan (2006) does not have a specific requirement for a level within the Code for Sustainable Homes, or its predecessor EcoHomes, or for BRREAM standards for non-residential development, as it predates the PPS1 Climate Change Supplement and government advice on how to apply sustainability standards was not as defined before this.

5.5 The adopted South Cambridgeshire LDF Development Control Policies Development Plan Document (2007) includes a Sustainable Development policy (Policy DP/1), which includes a requirement, where practicable, for development to minimise the use of energy and maximise the use of renewable energy sources and to incorporate water conservation measures. This is a key policy, which ensures all the fundamental principles of sustainable development underpin all development proposals. The issues dealt with are covered in greater detail in the following policies:

a) Policy NE/1 requires development to demonstrate it would achieve a high degree of measures to increase energy efficiency, and encourages developers to reduce the amount of CO_2 m^3 / year emitted by 10% compared to the minimum Building Regulation requirement.

b) In addition, all developments greater than 1,000m^2 or 10 dwellings are required to include technology for renewable energy to provide at least 10% of their predicted energy requirements in Policy NE/3.

c) Policy NE/12 requires developments to incorporate all practicable water conservation measures, with developments greater than 1,000m^2 or 10 dwellings required to submit a Water Conservation Strategy to demonstrate how this is to be achieved.

5.6 The current adopted AAPs for Northstowe (approximately 10,000 new homes as part of a mixed use new town) and Cambridge East (10,000-12,000 new homes as part of a major, mixed use extension to Cambridge) have the following relevant policies:

a) Policy CE/28 of the Cambridge East AAP and Policy NS/23 of the Northstowe AAP both require an 'exemplar in sustainability', which will include energy efficiency measures;

b) Policy CE/24 of the Cambridge East AAP also requires a 10% improvement (in energy efficiency) compared to building regulations and a high degree of other measures; and

c) Policy CE/25 of the same plan requires sustainable building methods and materials to be used where practicable.

5.7 Whilst not in policy, the reasoned justification for Policy NS/23 states that a major development of the scale of Northstowe, and the fact that it will be a freestanding new settlement, enhances the potential for a comprehensive approach towards the provision of energy and offers the opportunity for innovative measures, including the use of renewable energy. It also states that the Northstowe proposals should seek to do better than the district wide policy where possible, aiming towards a target of 20% of predicted energy needs from renewable energy subject to wider economic viability and social testing.

5.8 Whilst there is no requirement in the Northstowe AAP for decentralised energy, there is still an on-going discussion among the development partners and local authorities about the incorporation of such a scheme, preferably fuelled by biomass, that will assist in the development meeting the increasing building regulations requirements leading up to and after 2016, as much of the development will be built out after this time.

5.9 The draft spatial masterplan from the landowners of Cambridge East currently shows a 20% contribution from onsite renewable energy and a desire to go significantly beyond this in developing a highly sustainable urban extension to Cambridge. The landowner is also aware that much of the development will be built out after 2016 and will need to be zero carbon in any case and has therefore allowed provision for local energy centres for decentralised energy within the draft spatial masterplan.

6.0 Current Local Experience

6.1 Sustainability standards for affordable housing in the sub-region are already pushing forward the climate change agenda:

- From April 2008 the Housing Corporation will require all grant-assisted affordable housing to be a minimum of level 3 of the Code for Sustainable Homes, 2 years ahead of the building regulations requirement.
- As a result of the Cambridge Challenge, all affordable housing delivered by the winner of this Housing Corporation led competition for the growth sites in the sub-region will be at level 4 of the Code from 2008, (this applies to Northstowe, the Southern Fringe and NIAB), not required by building regulations until 2013.

There is also a proposal for a 40 unit affordable housing development in Cambridge to achieve Code level 5, subject to funding from the Housing Corporation.

6.2 With regards to market-led housing sites within the sub-region, the following standards have been achieved:

Cambridge Southern Fringe - Clay Farm and NW Cambridge - NIAB

- Two of the major growth sites on the edge of Cambridge are currently offering to meet EcoHomes Very Good, with 5% Excellent ratings on their site for the market housing and equivalent BREEAM standards, with 10% onsite renewables provision for both developments.
- Both these sites have outline planning applications outstanding as at March 2008 for developments that are housing led and are for up to 2,300 and 1,593 dwellings respectively, with associated community facilities. Both are expected to be determined during 2008.
- There were no specific sustainability policy requirements for these sites beyond what is required within the Cambridge Local Plan (2006). In the case of Clay Farm it has been agreed that should higher standards be set out in the new LDF that go beyond the renewables requirement of the current Local Plan, then future phases of the development will be required to comply with these.
- There are on-going discussions about converting the EcoHomes standards to the Code for Sustainable Homes and to additional future proofing measures that could be offered to ensure sustainability upgrades will be made easier and more affordable in the future for residents.
- Both of these developments have been in pre-application discussions for some years, particularly Clay Farm, significantly pre-dating the recent climate change

agenda and related national policy changes. The Southern Fringe Area Development Framework (ADF) which is relevant to Clay Farm, was adopted in January 2006. There was no ADF or AAP for the NIAB site.

Southern Fringe – Bell Site

- This is a greenfield residential site, for approximately 300 homes, and is another of the Southern Fringe growth sites.
- It is subject to the same 10% renewable energy requirement under the Local Plan (2006) and the Southern Fringe ADF, where no additional sustainability policies were included.
- The developers are proposing to meet Code level 3 for all the market housing, with an ambition to deliver a proportion at level 4.

Trumpington Meadows

- Outline planning applications for this site, another of the growth sites and on land in both Cambridge City and South Cambridgeshire, were granted planning permission in February 2008 subject to the signing of a Section 106 agreement for up to 1,200 dwellings and associated community facilities.
- There is a policy requirement in the South Cambridgeshire Southern Fringe AAP (adopted February 2008) to deliver an exemplar in terms of sustainability on the site either by raising standards across the site or delivering a high achieving component.
- This is comparable with the sustainability exemplar policies in the Cambridge East and Northstowe Area Action Plans.
- Through the negotiations with the developers it has been agreed that all market-housing units submitted for approval before June 2010 will be at level 3 of the Code (to a maximum of 200 market housing units), and thereafter will be at level 4. This is essentially one step ahead of the building regulations changes, which is the same approach as that being taken in the North West Cambridge AAP. However, Trumpington Meadows is at a significantly more advanced stage in planning terms, having been in pre-applications discussions for several years.
- In addition, it has been agreed that to satisfy the policy, a proportion of the show houses will have features of Code level 5 technologies and materials, available for prospective buyers to purchase off-plan, to help establish whether there is market demand for these.
- This is in addition to the Cambridge Local Plan (2006) and South Cambridgeshire Development Control Policies DPD (2007) requirements for 10% on site renewable energy provision, as there were no specific sustainability policies within the Southern Fringe ADF, which relates to this site and was adopted in January 2006.

- This is also despite concerns over the overall economic viability of the site, which has been independently tested by consultants on behalf of the Councils. Nevertheless, the developers felt able to offer these standards, without compromising the economic viability of their proposal.

CB1 (Station Area)

- Another major site at Cambridge rail station, known as CB1, includes proposals to go one step ahead of the building regulations changes for the housing component of this development, of approximately 300 dwellings. This means achieving level 3 until 2010, then achieving level 4 until 2013 and then meeting level 5 for anything after 2013 until 2016, when building regulations will require energy performance equivalent to level 6 of the Code.
- There are also proposals from the developer to build to BREEAM Very Good, rising to Excellent for all the non-residential uses, in this non-residential led development.
- This is in addition to the 10% on site renewable energy requirement set out in the Cambridge Local Plan (2006) which applies to the development.
- There were no other sustainability requirements (such as EcoHomes, BREEAM or the Code for Sustainable Homes) in the Station Area ADF, as this was adopted in April 2004.
- This site is a more complex site than those predominantly greenfield sites listed above and North West Cambridge, as it is an urban, brownfield site, with greater existing constraints.
- It is expected to seek outline planning approval in the second quarter of 2008, with reserved matters applications being submitted shortly after for parts of the development, subject to the outline being granted permission.

6.3 This demonstrates a number of cases where the earliest major schemes that have been in discussion for several years without the challenging sustainability requirements that are now in place or coming forward in response to the climate change agenda, are securing reasonable standards of sustainability from the various developers. These represent voluntary proposals that developers have been able to provide without compromising the viability of their schemes.

6.4 Clearly, these are significantly below what both Councils would hope to achieve on major sites of the size of North West Cambridge that are coming forward in the context of the new climate change supplement to PPS1. However, the proposals were well advanced at the time the PPS1 Supplement was published and it was therefore not reasonable to require more demanding standards for these developments.

6.5 However, where a policy requirement was in place, as at Trumpington Meadows, the developers were able to offer a step beyond building regulations for the market housing, without compromising viability, on a site where viability was a major issue for some time. The affordable housing was already two steps ahead coming forward under the Cambridge Challenge. The developers were also able to offer a phased improvement, keeping the development one step ahead of building regulations. This is the policy approach proposed for North West Cambridge.

6.6 At CB1, a more complicated, brownfield site without specific local policy requirements, the developers have also been able to agree Code for Sustainable Homes requirements that will keep the development one step ahead of building regulations requirements until 2016, again with a phased approach, as is being proposed for North West Cambridge, and despite this being for a significantly smaller number of dwellings. A similar approach is also being proposed for the BREEAM standards. Furthermore, this development is likely to be built out considerably in advance of North West Cambridge.

7.0 Area wide Sustainability Policy Development

7.2 The City Council will have the opportunity through its new LDF to set more challenging sustainability requirements for development within the City, which will also take into account the new policy context and ensuring adequate future proofing of standards where developments will be built out over many years. The Core Strategy Issues and Options consultation asked how developments should be designed to adapt to inevitable climate change and suggested that policies be developed relating to climate change that deal with mitigation and adaptation. These ambitions will also be reflected in and consistent with any future AAPs that are developed.

7.3 These changes are likely to include setting Code for Sustainable Homes requirements for different scales and types of development and BREEAM requirements for non-residential, combined with an increase in the onsite renewable energy requirement, until such time as an equivalent Code for non-residential buildings is introduced, with a trajectory for zero carbon in new buildings. This is emerging from the ongoing work on the Core Strategy and has considerable political support.

7.4 South Cambridgeshire District Council has recently adopted its Core Strategy and Development Control Policies DPDs and first round of AAPs and therefore has less immediate opportunities to review its policies to take account of the PPS1 Supplement. The Council intends to start work on a review of its Core Strategy soon and consideration will be given as to whether this should include a review of the sustainability policies contained in the Development Control Policies DPD. It is also intended to prepare a Supplementary Planning Document addressing sustainable construction.

8.0 Opportunities & Constraints at North West Cambridge

8.1 There are a number of key reasons why development at North West Cambridge presents significant opportunities for delivering a highly sustainable development and in particular why it is appropriate and reasonable for the AAP to require decentralised energy provision and Code for Sustainable Homes standards that remain one step ahead of building regulations changes. These principally are:

a) Nature, scale and mix of uses of the development

- The development at North West Cambridge is currently expected to be approximately 73 hectares in area, one of the largest to come forward in Cambridge and South Cambridgeshire.
- This is also a mixed-use development with between 2,000 - 2,500 dwellings, 100,000m^2 of non-residential uses and accommodation for 2,000 students as well as associated local retail and community uses. This mix of uses is likely to be highly suited for decentralised energy, as combined heat and power plants need to have a spread of loads throughout the day/night and also seasonally, as far as is possible to ensure both technical and economic viability, maximise efficiency and optimise carbon emissions. This is an advantage over housing led sites, that rarely have the right energy demands to make a decentralised energy system such as CHP viable, and therefore cannot benefit from the carbon emissions reductions this is likely to bring. Decentralised energy is also suited to high density developments. At North West Cambridge most if not all of the site is likely to be at relatively high densities, (an average of 50dph net overall, although the range of densities to achieve this is not known currently).
- In addition, this is also a greenfield site, with few if any of the constraints that a brownfield site may be likely to have, which can add considerably to the cost of bringing the site forward for development, such as contaminated land and constraints from existing buildings and road layouts.

b) Technical and Economic Viability of Sustainability Measures

- At this scale of development, a greater range of technologies will be available to the developer(s) of the site than for smaller sites, which although still major may be significantly smaller, (such as Bell Site, for around 300 homes) and therefore are likely to have a more limited range of applicable technologies available to them.

- There are also very likely to be economic advantages that can be gained through bulk purchasing to which a smaller site would not have access.

c) Role of the University as Landowner and Developer

- The land proposed for development is within the sole ownership of the University of Cambridge. This is again unusual as it is not uncommon for such large sites to be in multiple ownership, which may result in competing and/or conflicting interests.
- It has also been in their ownership for many years and therefore the University is not affected by land purchase agreements that would normally impact upon the residual value of a development and the level of planning requirements that can be supported.
- Furthermore, the development has been allocated to serve the long term interests of the University, which suggests that the University will be very likely to maintain a long term interest in the land, unlike a speculative developer. Where landowners and/or developers maintain a long term interest in the land, they can more easily benefit from any of the whole life savings that sustainable measures may result in, than a speculative developer, who has financial pressures to sell properties as quickly as possible in order to safeguard profit. This can potentially significantly alter the economic viability for more sustainable building methods and technologies.
- Furthermore, the University has considerable buildings land holdings within the area and further afield, which is unusual for conventional developers. This could potentially assist in improving the sustainability at North West Cambridge, as there is scope for biomass crops to be grown on University land within a few miles of the site and availability of food and other wastes available from the colleges, and animal waste arisings from their various farms in the area, that could supply an anaerobic digestion plant at relatively low cost and possibly even financial benefit to the University.

d) University's Commitment and Experience of Sustainable Building

- The University has adopted an environmental policy, which seeks to 'manage its activities, buildings and estates to promote environmental sustainability, to conserve and enhance natural resources and to prevent environmental pollution to bring about a continual improvement in its environmental performance' (source: Low Carbon Energy Strategy, University of Cambridge Nov 2007).
- It actively manages its carbon emissions from its existing stock, with a commitment to reduce emissions by 10% by 2010.
- It has also set a standard for new non-residential development of aiming to achieve BREEAM Excellent, but always achieving no less than a BREEAM Very Good rating.

- It has also published guidance for designers entitled 'The Design and Construction of New Environmentally Sustainable Buildings'.
- The University also has a strong Estates Management and Building Services team, who have monitored the energy and water consumption performance of their entire stock for some time.
- Several of their buildings in recent years have trialled and are in the process of trialling new sustainability features, such as green roofs (Faculty of Mathematics), natural ventilation (Faculty of English) and a passive ventilation labyrinth under a building on the West Cambridge site. They also have a very good record at maintaining and managing biodiversity at the West Cambridge site.
- The University's representations on the North West Cambridge AAP consultations stress its aspirations to make the development sustainable through the use of renewable energy and energy efficiency measures, although it has objected to a number of the detailed policy requirements proposed.
- In addition, they have commissioned their own study to look at the opportunities for decentralised and renewable energy for this and other major University sites in the area. It was hoped this would have been available to help inform policy development for the AAP, but has only been made available as the Submission AAP and this supporting document are about to be considered by the Councils. However, it is anticipated that a collaborative approach will be taken to working with the University to deliver a highly sustainable development at North West Cambridge and discussions to date have indicated this is also the position of the University.

e) Financial Leverage of the University

- The University is also different from conventional developers, in the way it is able to finance many of its development projects, which is likely to help reduce the financial imperative to build quickly and cheaply to reduce finance costs by which other developers are constrained. Exemplar aspects of the development may have several sources of income, some of which are relatively unconstrained and allow for higher standards to be achieved. This matter will be explored further with the University as the proposal progresses. Notwithstanding, the proposed policy includes a viability clause to enable financial considerations to be taken into account in determining any planning application.

f) Development of Sustainability Exemplar Schemes

- Whilst there are few exemplar schemes currently built out at this scale in the UK, it is known that there are a number in development, which are in advance of the timescales for North West Cambridge and from which it will be able to learn and benefit from. These include One Gallions in London, by BioRegional Quintain, developer, on brownfield land, and CK1 in central Milton Keynes, another large scale brownfield development of similar scale.

- There are examples abroad of sustainable energy schemes in new developments. The lessons of these should also be taken into account in developing proposals for North West Cambridge.
- The Government has also launched the Carbon Challenge programme and a developer has already been selected to deliver a zero carbon and Code level 6 development on land close to Bristol for 150 homes, a considerably smaller scale than that of North West Cambridge. Several other sites around the country have been selected as Challenge sites, including a site in Peterborough, with considerable interest from developers both small and large scale, and up to 10 schemes are expected in advance of 2016.

g) Other Infrastructure Requirements

- At the current time it is not possible to anticipate all the infrastructure requirements for this site and how that will affect viability of the development.
- However, unlike proposed developments on the Southern Fringe a major access road does not need to be implemented before the site can be accessed for development, resulting in large upfront costs for the developer. Nor are there other unusual anticipated costs, which would significantly affect the costs of bringing this site forward for development.
- If such costs were to arise, there are mechanisms to help relieve the developers of the entire, upfront financial burden such as the sub-regional 'rolling fund', managed by Cambridgeshire Horizons, which can lend funds for major capital projects of this sort, to help unlock development opportunities for developers and deliver required housing targets.

h) Site Constraints

- The constraints of the site appear at this time to be relatively few. The site is on the edge of Cambridge bounded by the Cambridge Green Belt, and therefore visual impact would be a consideration for the erection of one or multiple large-scale wind turbines, though it may not prohibit such provision. Likewise, the close proximity of existing housing could have an impact on windspeeds, which could impact on the technical viability of such technologies.
- Similar considerations could arise in any proposal for an anaerobic digestion plant or biomass CHP plant, either within the development footprint or close to it. However, initial discussions are currently being held with the University about possible locations for this and it would appear there are several options that are being considered and may be appropriate to serve North West Cambridge.

9.0 Key Findings from Independent Consultants' Report

9.1 The key findings from the consultants' report North West Cambridge: Planning Policy Sustainability Standards - Technical Viability Study (Bidwells / K J Tait Engineers, March 2008) were that there were a number of different renewably fuelled CHP options for the site that are likely to be technically viable. The report is attached as Appendix 1 to this document. The factors that will be key in determining economic viability are also given, although detailed economic viability cannot be determined at this stage as there is insufficient information about the development and the associated costs with bringing development forward. Without this wider context, economic viability of the energy infrastructure cannot be assessed. However, the report did particularly flag up that phasing of the development would be key, particularly the relationship between the development of the residential and non-residential components.

9.2 The table below summarises the Code levels that these different options will help to deliver, in energy terms:

Energy Option	**Code Level**
Base-line Scheme (Condensing boilers, grid electricity)	3
Organic Rankine Cycle Biomass CHP	5
Biomass gasification CHP	5
Anaerobic Digester (Biogas) CHP	5
Biomass Heat-only District heating serving 90% of heat load	4
Gas-fired CHP	4

9.3 This shows that level 3 of the Code can be considered the base case, before any decentralised energy options are considered. Three of the options would deliver at least level 5 in terms of energy performance, whilst biomass district heating and gas fired CHP would only achieve level 4. These could, however, be combined with other renewables to reach level 5, but this was beyond the scope of the report. The report also showed that the energy components of the BREEAM and 20% renewable options could easily be satisfied if any of the renewably fuelled CHP options (achieving Code 5), were to prove economically viable for the site. However, if a fossil fuel based system was installed these requirements may create an additional burden.

10.0 North West Cambridge AAP Policy Approach

10.1 The approach to the policy contained in the AAP is drawn from the evidence base provided by the PPS1 Supplement, the emerging Regional Plan, the direction of travel of the Councils' plans and the consultants' report for North West Cambridge. The various components of the policy are considered in turn below:

Climate change adaptation

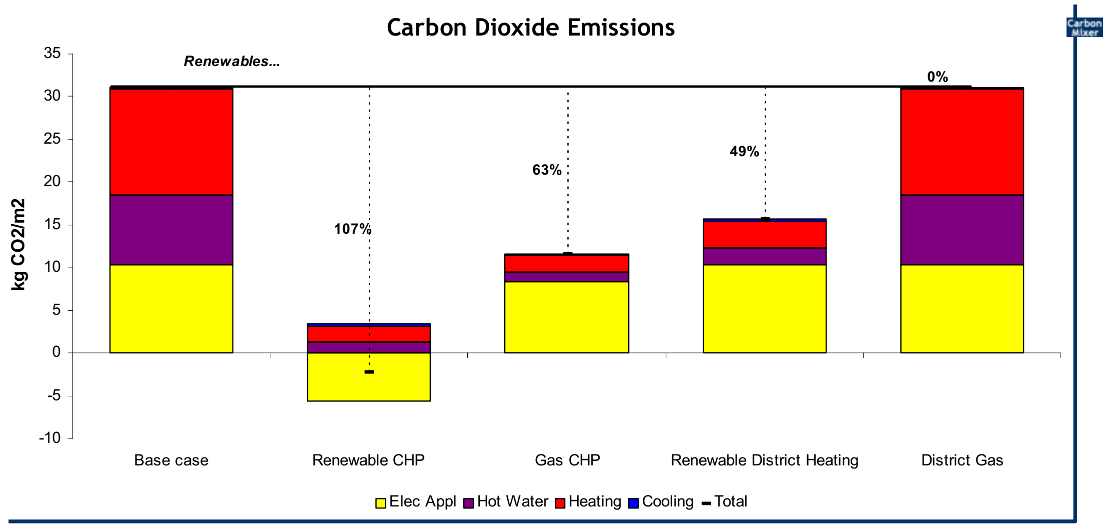
10.2 This has been set in line with the requirements of the PPS1 Supplement, where one of the key planning objectives is "shaping new places that minimise vulnerability, and provide resilience, to climate change," (paragraph 9).

Decentralised Energy

10.3 A requirement relating to decentralised energy has been included for North West Cambridge as it was recognised at an early stage that the characteristics of this site were likely to be very favourable to the development of decentralised energy, which could substantially reduce the carbon emissions of the development, if it proved to be viable. It was also recognised that this needed to be a policy requirement in the AAP, in order to provide clarity of the requirement on the development and to ensure that thorough consideration was given to this from the outset. This will ensure it can be designed in at the front end of development in order to minimise costs and ensure it is suitably sited within the masterplan and the installation can be appropriately phased with the build out of the development.

10.4 A hierarchical approach to carbon emission reductions through decentralised energy has been taken for this development to ensure that the types of system that are most likely to yield the greatest carbon emissions savings are considered first, and other options are only considered if it can be demonstrated that the first options would not be viable for the site.

10.5 As is shown indicatively in the graph below, the potential carbon emission savings vary considerably depending on the type of system and the fuel source for that system. It uses the Carbon Mixer software, a tool approved by the BRE and used by a number of planning authorities and consultants around the country to give approximate carbon emissions calculations and test scenarios for different renewable energy strategies. It is based on benchmark data from accredited sources such as the Chartered Institution of Building Services Engineers and guides such as ECON 19 published by the Carbon Trust. It also uses data for renewable energy systems from manufacturers data, adjusted for use in the UK. The purpose is to give initial and approximate comparisons between different energy strategies when a development is first being considered, before any designs have been done and detailed modelling of the particular form of development proposed is available.



Graph 1: Indicative carbon savings possible with different decentralised energy options (Source: Carbon Mixer)

10.6 The graph shows that with renewably fuelled CHP, the highest carbon savings can achieved (approximately 107%), with gas CHP offering the second highest savings, (approximately 68%), followed by renewably fuelled district heating c49%) and finally gas fired district heating providing no savings compared to the base case of gas boilers in each dwelling. However, this last technology has advantages which are discussed later, which facilitate a shift to a renewable fuel in the future.

10.7 Therefore, the order of the hierarchy included in the policy has been determined on the basis of the system and fuel type that it is anticipated will yield the greatest carbon reductions. Whilst it is not possible at this stage to accurately predict the actual reductions until more is known about the scheme and its demands, this model provides an accepted method of assessing the comparative benefits of different technologies to guide the AAP Policy.

10.8 In general, CHP systems tend to be more viable, the larger the scheme and a greater range of options is likely to be available at a larger scales. It is recognised, however, that it can be prohibitively expensive to connect a heat main to lower density parts of the development. The policy therefore includes a requirement for a decentralised energy system to be connected to a ‘substantial proportion’ of the development. This has been defined as around 75% to provide clarity that installing a system that only serves part of the development will not be sufficient to meet the policy requirements, but that this must be a significant part. The range and distribution of densities on the site is not currently known and therefore it was considered that it would not be possible to provide a more accurate indicative figure at this stage. However, if as the scheme progresses it becomes clear that the University will be able to deliver a system that serves close to, but not exactly 75% of the development floorspace, this will be taken into consideration. This is a view supported by the independent consultants.

10.9 Another key factor in determining viability of such systems, particularly CHP, is for there to be a mix of uses on the site, as such a system will depend on a particular balance of electrical and heat requirements, that are often ideally provided on a diurnal and seasonal basis, from a mix of residential and non-residential uses. There is therefore reference in the policy to the system being connected to a mix of uses on the site. This is again intended to ensure that proposals for a decentralised system only serving certain uses within the development, such as residential, do not come forward. This would particularly guard against the question of viability being raised as a result of a proposal that only included one use.

Residential sustainability requirements

10.10 The Code for Sustainable Homes (CSH) has been used, as recommended in the PPS1 Supplement (paragraph 32). This is the voluntary, national standard for assessing the environmental performance of new housing in England and Wales; it covers a range of topics including energy, water, drainage, waste, materials, biodiversity and pollution. Ratings under this standard range from level 1 which is the lowest, to level 6 which is the highest.

10.11 The Code has been linked to Part L1A of the Building Regulations, which deals with energy use and carbon performance in new housing. The government has set a target for all new housing to be zero carbon by 2016. This is equivalent to the energy standards of level 6 of the Code. Each level of the Code between 1 and 5 represents an increase in carbon performance compared to 2006 Building Regulations, rising towards the 2016 zero carbon goal. In 2010 the standards will increase by 25% compared to 2006, which is the same as reaching the energy requirements of level 3 of the Code. In 2013 they will rise by another 19% (to 44% cumulatively), which is equivalent of level 4.

10.12 Therefore as time passes, the additional cost of achieving the higher levels of the Code will be reduced, as this will be a national requirement, through the building regulations. The AAP policy requires the development to achieve Code level 4 until 2013, which is one step ahead of the building regulations requirements for that period. This is generally recognised to be achievable in 2007, without significant cost penalties, as was demonstrated in the Cyril Sweett report for the Housing Corporation and English Partnerships (2007). This shows that the bulk of the cost of meeting the Code is in the energy requirements. Therefore, where decentralised energy is viable on a site, the energy requirements of the Code, certainly up until level 5, if not beyond, are likely to be relatively easily fulfilled. Depending on the construction method, certain stand-alone, on site, renewable technologies such as solar thermal panels, photovoltaics (electricity generation) and/or biomass heating could be employed to meet Code 4. A site wide energy strategy, whilst desirable, would not be essential at this level and much could be achieved with improved building fabric and construction.

10.13 At Code level 5, the energy requirements become significantly more demanding. They represent a 100% reduction in carbon emissions compared to 2006 requirements. It is widely understood that a comprehensive, whole site strategy for any particular development is essential to meet these standards, as stand alone technologies will not be cost effective or viable to meet them in full. Therefore, where it is viable to implement a renewably fuelled decentralised system, these standards can be met and even exceeded at no extra cost. This is demonstrated in graph 1 above.

10.14 Clearly with some of the decentralised energy options shown in this graph, if certain higher order options do not prove economically viable, there may be options such as gas CHP or renewably fuelled district heating that can be combined with other renewable energy technologies and still viably deliver the 100% carbon reductions necessary to meet level 5 of the Code. However, this cannot be determined at this stage, due to insufficient information.

10.15 It is due to the increasing standards of the Building Regulations proposed by 2016 that two different code levels have been required at North West Cambridge, level 4 up until 2013 and then level 5, as the development will be built out over a relatively long period of time. In view of the direction of travel of national and indeed international policy, standards that are appropriate at the outset, will become outdated and therefore this future proofing policy approach has been adopted.

10.16 2013 has been chosen as the date at which to make the shift between the Code requirements, for consistency with the change in building regulations. To ensure that the intention of the policy is secured with dwellings being built after 2013 meeting higher sustainability standards, the policy includes the number of dwellings predicted in the housing trajectory to be completed by this date (550), linked to the change in Code level. This will prevent submission of an application for the whole site prior to 2013 that would effectively set the standards at level 4, for all the housing units, including those to be built after 2013, and indeed potentially after 2016 when zero carbon developments will be required by building regulations.

10.17 In line with the guidance at paragraph 33 of the PPS1 Supplement, consideration has been given to ensuring that these standards do not adversely affect the supply and pace of housing delivery, as set out in the housing trajectory of PPS3. The current housing trajectory for North West Cambridge is ambitious and whilst it has been prepared in consultation with the University and has regard to its aspirations for early development to help meet the housing needs of University staff, until more detailed proposals have been prepared and an application been submitted and determined it is possible that this may slip. In such circumstances the development of 550 units before 2013 acts as an incentive to the developer to keep to this trajectory and not allow any slippage, as it would not be in their economic interest.

10.18 In overall terms this means that development of North West Cambridge will be one step ahead of the building regulations. This is the same approach as has been secured for Trumpington Meadows and CB1.

10.19 Given the considerable opportunities at North West Cambridge (listed in section 6) and the relatively few constraints anticipated, it is considered that this is a reasonable expectation. It will essentially mean that for planning approvals from 2013, homes at North West Cambridge will have to achieve level 5 (100% reduction) rather than the building regulations requirement of 44%. However, by 2016 all new homes being built out across England will have to meet the equivalent of level 6 – which may equate to more like a 140% reduction. The current housing trajectory shows that a proportion of the development will be completed after 2016 when zero carbon development will be required of all new development.

10.20 The Renewables Advisory Board has emphasised in a recent report[2] the need for larger sites to move to more challenging levels of the Code than required by building regulations in advance of 2016 to help build the market for smaller sites. It is important to recognise that all housing will need to meet the zero carbon building regulations target of 2016, including individual houses and small scale developments, which will have considerably more challenges in doing so, than a scheme of the scale and nature of North West Cambridge.

10.21 The PPS1 Supplement recognises that there may be local circumstances in which it is justifiable for a local authority to set standards in advance of the building regulations. In this situation a local evidence base must be provided, which is provided by this report, including the independent consultants' report appended to it.

[2] The Role of Onsite Energy Generation in Delivering Zero Carbon Homes, Renewables Advisory Board, 2007

10.22 One of the central reasons for including the policy in the AAP and its required standards is that where decentralised energy is viable, considerable carbon savings will be made, as shown in graph 1. This is demonstrated by the consultants' report, (see Executive Summary, page 4). This will assist considerably in being able to achieve the higher standards within the Code and will not place a considerable additional burden on the developer in energy terms.

10.23 The viability clause in the final section of the AAP policy ensures that if the developer demonstrated that decentralised energy were either not viable, or could not yield the predicted high carbon savings, then the requirements may be relaxed in part or in full. This could also relate to the Code requirements if it was shown that it would make the development not viable to meet them in full.

Non-Residential & Student Housing Requirements

10.24 BREEAM has been selected as the policy tool with which to measure the environmental performance of the non-residential buildings and student housing. This is in the absence of an equivalent of the code for non-residential buildings having been launched by government. BREEAM is a nationally well recognised tool. However, the policy includes a clause that any replacement to BREEAM would also apply to the development to future proof the suitability of the policy to secure its objectives.

10.25 The reason for applying this to the student housing is because the Code for Sustainable Homes is understood to apply only to new housing development in the strictest sense (use class: C3), and student housing has a different designation in the Use Class C. However, the Code is in the early stages of implementation and this may possibly change. At the current time BREEAM has a specific tool to deal with this type of development.

10.26 Given the considerable scale of non-residential uses proposed on the North West Cambridge site, the environmental performance from this sector will clearly have a considerable bearing on the overall sustainability of the development. As the shared aspirations of the Councils, and indeed the University, are for this site to be as sustainable as possible, BREEAM Excellent is being required from the outset.

10.27 This is in light of other developments around the City, that have been cited previously, where BREEAM Very Good is currently considered the norm. It also has regard to the University's aim for every new building to meet this level already. Given the new national policy framework provided by PPS1 Supplement and the long timescales of this development, setting a more ambitious goal would be consistent with this and in line with future policy development.

10.28 It is generally recognised that achieving BREEAM Excellent is not equivalent, certainly in energy or water terms, to levels 5 or 6 of the Code. Equating it directly is not possible. BREEAM also lacks a target of zero carbon, which the Code has. The government is therefore considering introducing a standard for non-residential buildings equivalent to the Code for Sustainable Homes in due course, with preliminary advice from the Green Building Council suggesting that zero carbon could be achieved in new build from 2020, through the same mechanisms as the current Code.

10.29 In light of the lower requirements of BREEAM compared to the Code, a Merton style policy, requiring 20% of predicted carbon emissions to be met by onsite renewable energy technologies has been included in the policy for non-residential buildings only. This is because to have included it for residential, would have effectively duplicated requirements within the Code, which now have a carbon reduction target in line with the Building Regulations methodology.

10.30 The target required is also higher than the current 10% in the Development Plan Documents (DPDs) of both Councils as it reflects the direction that this policy is likely to go in the near future and the exemplar nature of the development. The PPS1 Supplement supports increases in onsite renewable energy provision of this sort. The Northstowe Area Action Plan (2007), which predated the PPS1 Supplement, includes a supporting text aspiration to achieve 20% renewable energy provision. Several authorities around the country already have 15% policies adopted, such as North Devon District Council (Local Plan adopted 2006, Policy ECN15).

10.31 There is a caveat included in the policy that if a renewably based decentralised energy scheme can be provided for the development, then this can count towards this renewable energy target. In actual fact, if such technologies are viable, it is likely to meet fully or even significantly exceed the 20% target. This should therefore act as another incentive to adopt a site wide decentralised energy system based on renewable energy serving a substantial proportion of the development. However, if this is found to be not viable and a decentralised energy system based on fossil fuels is implemented, with the resulting lower carbon emissions savings, then the 20% contribution from onsite renewable energy will supplement this.

10.32 Likewise, if no form of decentralised energy was found to be viable, the 20% onsite renewables requirement will help reduce the carbon impact of the non-residential parts of the development. This will help to address to some extent the imbalance between the Code and BREEAM requirements. This is important as much of the non-residential development, as well as being a large proportion of the site by floor area, will be designated for research facilities, a use which will have potentially very high energy demands and therefore carbon impacts. It is expected that cooling will be required, which is typically electrically based in the form of air conditioning. As the government as yet has no plan for improvements to the building regulations for non-residential buildings, assumptions have to be based on the 2006 building regulations remaining the same for the duration of the construction of North West Cambridge.

10.33 However, were the government to introduce a code for non-residential buildings, which worked on a similar basis to the Code for Sustainable Homes, then this could potentially replace both the BREEAM and the 20% renewables requirements for the non-residential and this eventuality is therefore provided for by the policy. This would avoid any duplication or excessive burden on the developer.

Water Conservation

10.34 The North West Cambridge site is within one of the lowest rainfall areas of the country. Water conservation is an important issue therefore, in this part of the East of England, and high standards included in the AAP are considered essential. This aspiration has been supported by the University in its representations to the AAP consultations. The water conservation targets for residential development set out in the policy correspond with the requirements of the corresponding levels of the Code being required. This is in line with advice from GO-East.

10.35 In terms of water conservation measures required in non-residential buildings, because of the range of buildings that are covered under the term ‘non-residential’, it is not possible to have fixed targets, and the situation is therefore different from residential uses that correspond directly to targets in the Code. Therefore, the policy requires it to be demonstrated that the non-residential parts of the development will ‘significantly reduce potable water consumption’.

10.36 This will be from a combination of water saving devices, and either grey water recycling or rainwater harvesting. The reason for this is because water saving devices can be fitted in any type of building irrespective of use and location. These include such things as low flush toilets and low flow taps. However, these measures can only reduce potable water consumption to a certain extent and then either grey water recycling and/or rainwater harvesting are required. This is shown by the technical guidance for the Code for Sustainable Homes. A number of factors will determine which of the technologies and approaches is most suited to the building and its predicted water consumption patterns, taking rainfall distribution and other factors into account, and therefore this has been left to the discretion of the developer to decide on a building by building basis. However, it has been made clear that water efficiency measures alone are unlikely to 'significantly reduce' potable water consumption as the policy requires.

10.37 It is important that these measures are applied to each building to ensure that there is a comprehensive strategy to water reduction across the site and measures are not applied to some buildings and not others.

10.38 The final clause, relating to impacts on the water environment, was a result of comments from the Environment Agency and other bodies to ensure there were no indirect impacts on the wider environment and biodiversity as a result of these measures.

11.0 Conclusions

11.1 The proposed development at North West Cambridge demonstrates a significant number of opportunities to achieve high levels of sustainability, securing development that is one step ahead of the revisions to building regulations during the course of the development. This is in large part due to the fact that it is likely to be ideally suited to CHP or another form of decentralised energy, which will make a substantial contribution to reducing carbon emissions on the site, subject to wider viability testing.

11.2 Other sustainability requirements have therefore taken into account these opportunities and been set accordingly. The Code for Sustainable Homes has been used along with BREEAM, as the most appropriate tools currently available that are nationally recognised and recommended by government. The particular levels requested have taken into account numerous factors including the University's own environmental policy and commitments, standards that are being achieved currently on other major growth sites in the sub-region and high level comparisons made about the relative opportunities and constraints of these compared to North West Cambridge, and comparisons with other schemes coming forward around the country.

11.3 Key parts of these requirements have been tested by independent consultants and found to be sound and provided some of the framework for future decision making on what will be reasonable and what may not. The requirements have also been future proofed, to ensure that over the long timescales of the build out of this site, that the standards do not become outdated, but can keep up with what is a rapidly developing field technically, financially, ecologically and politically. There is also a viability clause, in the event that these requirements prove not to be deliverable on this site and/or pose an excessive burden on the developer, in light of other costs of bringing the site forward, which are not currently known.

11.4 These requirements are consistent with the planning framework provided by PPS1, its Supplement and emerging regional policy, which require LPAs to set out their sustainability requirements for development through a DPD, to demonstrate the local evidence base for any locally derived policies, and be fully in line with the Councils' aspiration to achieve the highest reasonable carbon emissions savings through decentralised and renewable and/or low carbon energy sources. The Councils' intention is to take these proposals forward in partnership with the University and ensure that the relevant work is undertaken to ensure the optimal sustainability scheme for the site is delivered.

APPENDIX 1: TECHNICAL VIABILITY STUDY

CAMBRIDGE CITY COUNCIL &
SOUTH CAMBRIDGESHIRE DISTRICT COUNCIL

NORTH WEST CAMBRIDGE

PLANNING POLICY SUSTAINABILITY STANDARDS TECHNICAL VIABILITY STUDY

ISSUE 2.0

BIDWELLS
TRUMPINGTON ROAD
CAMBRIDGE
CB2 9LD

TEL: 01223 841 841
FAX: 01223 559 300

KJ TAIT ENGINEERS
4 HILLS ROAD
CAMBRIDGE
CB2 1JP

TEL: 01223 460 508
FAX: 01223 351 093

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Issue History

Issue	**Purpose & Comments**	**Date**	***Issued by:***
1.0	*1st Issue*		
2.0	*Amended to include reference to South-Cambs, & CO_2 emissions tables added.*		

1.0 EXECUTIVE SUMMARY

Cambridge City Council and South Cambridgeshire District Council (SCDC) are considering a policy requirement for the North West (NW) Cambridge site to utilise a site-wide energy system in order to reduce the CO_2 emissions of the development, and achieve a higher Code for Sustainable Homes (CSH) rating than using conventional grid-supplied electricity and gas.

This report assesses the technical viability of the following options for the site and what carbon reduction contribution each is likely to make, to assist in meeting the higher Code standards proposed:

- Renewably fuelled combined heat and power (CHP)
- Gas CHP
- Renewably fuelled district heating

In addition, Cambridge City Council is looking to address the following specific questions in relation to the development:

1. Is it justified to set Code for Sustainable Homes Level 4 and 5, and BREEAM Excellent for the development?
2. Is the proposal to deliver district energy to the at least 75% of the development sensible and achievable?
3. Is the requirement to deliver at least 20% of overall energy demand from renewable sources, in addition to the CSH and BREEAM requirements, sensible and achievable?
4. Will the proposed phasing plan affect viability of any district energy scheme?

In order to address these objectives the viability of a range of district energy options has been assessed. The political, economic, social, technical, environmental and legislative issues aspects of the use of a range of technologies have been considered (PESTEL appraisal).

The following factors are important in determining whether or not a technology option is likely to be viable for the NW Cambridge site:

1. The heat to electricity ratio delivered by the combined heat and power plant
2. The maturity of the technology and the existence of operating schemes of relevance to the NW Cambridge site.
3. The likely economic viability of the technology as applied to the NW Cambridge site. A full assessment of economic viability is outside the scope and terms of this report.
4. The availability of suitable plant at a scale appropriate to the NW Cambridge site.
5. The availability of suitable fuel or feedstock for the renewably fuelled energy systems.

Of the renewably fuelled CHP technologies considered here, biomass gasification and anaerobic digestion (AD or biogas) CHP are likely to offer the most scope for incorporation into the NW Cambridge site. The AD option is unlikely to be able to provide for all the heat demand of the site. Therefore the use of biomass district heating has been considered to be complimentary to the AD.

Of importance for all the renewably fuelled (biomass) CHP options is fuel or feedstock supply. A well established biomass fuel supply chain does not currently exist in Cambridgeshire. However, a development of the scale proposed at NW Cambridge is of a sufficient scale to stimulate significant interest from local landowners and businesses which are looking to enter the biomass energy sector. In the case of AD, the feedstock is likely to consist in part of animal slurries which could be sourced from farms close to the NW Cambridge site. The bulk of the AD feedstock is likely to derive from municipal or commercial food and green waste collections in the sub-region. Therefore the feedstock is likely to be available but is not currently being utilised for energy.

Natural (mains) gas CHP is able to provide for the energy requirements of the NW Cambridge site. However, it is unable to meet the requirement for renewable energy provision, nor is it able to meet the requirement for 'zero carbon' electricity to meet CSH level 5. Natural gas CHP may be an efficient and low carbon way of supplementing any biomass energy provision to the site.

This investigation has found that subject to the renewably fuelled CHP options being economically viable, the requirement for CSH level 4 and 5, and BREEAM Excellent, is technically feasible. It should be noted that if a site-wide district energy scheme on the scale proposed for NW Cambridge is implemented it would be larger and more complex than any currently operating schemes in the UK. This means that the technology and economic risks will have to be weighed against the desire to deliver an ambitious low carbon development for NW Cambridge.

The proposal for any site-wide energy scheme to incorporate at least 75% of the properties does not impose any further burden than those already described. It is likely to add to the capital cost through increased costs for the heat and/or electricity network, and will therefore impact on economic viability.

The use of biomass CHP as considered here will meet the requirement for a minimum of 20% renewable energy to be supplied from on-site generation.

The phasing of the development will have a significant impact on the economic viability of any site wide energy scheme. The full assessment of this impact is beyond the scope of this investigation.

Note: This investigation relates solely to the special circumstances pertaining to the University Area Action Plan site ('NW Cambridge site'). The findings cannot be rolled out across other developments where circumstances are different.

2.0 INTRODUCTION

The 'North West Cambridge' site or 'University Area Action Plan site', as referred to in this report, is a section of land between Huntingdon Road and the M11 on the north west side of Cambridge.

Cambridge City Council and SCDC are considering a policy requirement for the site to utilise a site-wide energy system in order to reduce the CO_2 emissions of the development, and achieve a higher Code for Sustainable Homes (CSH) rating than using conventional grid-supplied electricity and gas.

The long-title for this report is as follows:

> **North West Cambridge - Testing the viability of CHP and district heating for the site, with a view to helping meet more ambitious levels of the Code for Sustainable Homes.**

This report investigates the technical feasibility of the provision of site wide CHP (preferably biomass fuelled) to serve the development. If CHP is not viable, then renewably fuelled district heating will be considered. There is an additional planning requirement for dwellings, prior to 2013, to achieve level 4 of the Code for Sustainable Homes (CSH) and thereafter to achieve level 5. This is ahead of the building regulations changes set out by Government.

There is, additionally, a 20% renewables requirement for all non-residential buildings, in the absence of a CSH equivalent having been developed. These buildings are also likely to have to meet BREEAM Excellent.

3.0 TERMS OF REFERENCE

This report assesses the technical viability of the following options for the site and what carbon reduction contribution each is likely to make, to assist in meeting the higher Code standards proposed:

- Renewably fuelled combined heat and power (CHP)
- Gas CHP
- Renewably fuelled district heating

In addition, Cambridge City Council and SCDC are looking to address the following specific questions in relation to the development:

1. Is it justified to set Code for Sustainable Homes Level 4 and 5, and BREEAM Excellent for the development?

2. Is the proposal to deliver district energy to the at least 75% of the development sensible and achievable?

3. Is the requirement to deliver at least 20% of overall energy demand from renewable sources, in addition to the CSH and BREEAM requirements, sensible and achievable?

4. Will the proposed phasing plan affect viability of any district energy scheme?

Each of the options will be investigated initially to serve the whole site. If engineering or practical limitations restrict the use of technology to a portion of the site, then this is made clear.

The report comments on projected phasing of the development and highlights where any changes to this may have implications for the viability of either the CHP or district heating scheme.

The report also indicates the fuel requirements each option would have and equate this to the number of vehicle movements.

Reference to the option for delivering tri-generation (heat, electricity and cooling) on this site, and how this might interact with the scheme viability is also made, including how this would help meet carbon emission targets.

The report does not cover detailed economic viability, or detailed pay backs for the proposed schemes, or biomass fuel availability which Cambridge City Council has made clear would be covered as a separate exercise.

4.0 OBJECTIVES

In addition to the requirement to test the viability of using site wide district energy using combined heat and power, Cambridge City Council and SCDC set out four key objectives which this investigation was required to address. These are as follows:

1. Is it justified to set Code for Sustainable Homes Level 4 and 5, and BREEAM Excellent for the development?
2. Is the proposal to deliver district energy to the at least 75% of the development sensible and achievable?
3. Is the requirement to deliver at least 205 of overall energy demand from renewable sources, in addition to the CSH and BREEAM requirements, sensible and achievable?
4. Will the proposed phasing plan affect viability of any district energy scheme?

5.0 CODE FOR SUSTAINABLE HOMES AND BREEAM

1. Code For Sustainable Homes Rating

The Code for Sustainable Homes (CSH) energy definition differs markedly between level 4 and 5.

Level 4 requires a 44% improvement in CO_2 emissions over Building-Regulations SAP calculations. This can be met with a well-insulated house using biomass for space and water heating, as the heat is relatively carbon free (with a low CO_2 emissions factor) and the building electrical demand below the 44% of the minimum standard (excl appliances).

Level 5 of CSH requires that energy usage associated with space and water heating, and electricity usage for pumps, fans and lighting, are carbon neutral. This means that in addition to space and water heating, the “building” electricity demand (excluding appliances) must be met by a zero carbon source.

In order to assess whether the considered CHP technologies were able to meet the demands of CSH levels 4 and 5 the electrical and heat demand of the dwellings was estimated, excluding electricity used for appliances (which needs to be met from a zero carbon source for CSH level 6 only). The ability of the CHP technologies to deliver the CO_2 emissions savings required for level 4 and level 5 was assessed.

2. BREEAM

The Building Research Establishment Environmental Assessment Method (BREEAM) can be used to assess the environmental performance of **any** type of building (new and existing). Buildings are assessed against a variety of environmental criteria – one of which is CO_2 emissions, but there are no mandatory benchmarks for achieving a better-than-average CO_2 emission rating.

There is talk of BREEAM being modified in line with the Code for Sustainable Homes such that a BREEAM excellent cannot be achieved unless the CO_2 performance is below a particular benchmark – but since this is only in discussion at present we have not assumed a lower benchmark than CIBSE “Good-Practice”.

In the event that a site-wide renewable energy network is installed, any buildings utilising the renewable energy would be able to include the CO_2 benefits in their Building Regulation Part-L which would contribute to their achieving a BREEAM “Excellent” rating (the University’s current target for all new buildings).

6.0 ENERGY DEMAND PROJECTIONS

For any central site-wide energy scheme, be it district heating, Combined Heat & Power (CHP), or Tri-generation using central cooling - establishing the base loads that the system has to meet (in part or in full) is the starting point.

The estimated gross floor areas of development for the site were supplied by Cambridge City Council, and form the basis for the load study.

Table 1: Floor areas for the development (provided by Cambridge City Council)

Built Area m²	Usage Type
60,000	Up to 60,000 m^2 within Use Class D1 - higher education uses
26,667	Up to 40,000 m^2 within Use Class B1(b) & Sui Generis
13,333	Air-conditioned Offices (Assumed 3:1 ratio of nat-vent vs AC)
4,500	Primary School
120,000	1470x houses (60% of 2450) 82m² GIFA each
80,000	980x Flats (40% of 2450) 82m² GIFA each
80,000	2000x units 840x undergrad, 1,160x post-grad (using 40m² per student GIFA)

650	Community Centre 650 m^2
1,050	A1 Retail: Local Supermarket 500 m^2 + 4x other A1 totalling 550 m^2
150	D1/sui generis: 150 m^2
200	A3 Restaurant/Cafe: 200 m^2
450	A4 Drinking establishment: 450 m^2
360	A5 Takeaway: 360 m^2
600	D1 Nursery: 600 m^2 (no residential above)
1,000	Primary Health Care Centre 1,000 m^2
240	A2 Financial and Professional Services: 240 m^2
389,200	m^2

In order to develop these into load profiles one must make informed assumptions regarding the nature and construction methods used in the proposed buildings. The remainder of this section clarifies the assumptions and methodology used to generate the load profiles.

The Chartered Institute of Building Services Engineer's Guide F (2004) is used to bench-mark the energy used by the retail buildings and generate kWh demand figures. The Building Regulations changed in April 2006 which will have decreased the energy use for new-build by around 25%. For this reason only the 'Good-Practice' figures are used in this report – which are generally 25% of the 'Typical' figures given in the 2004 Guide F.

Where it is necessary to take into account the planning aspiration to meet the Code for Sustainable Homes level 4 or 5 a separate thermal model has been used using IES Apache calculation software to see how an enhanced envelope performance affects the heat/electricity demand – although part of the CSH calculation depends on the method used to generate the heat, a code-level cannot be stated from the envelope performance alone – the code-level is covered elsewhere in this report.

We have also done some comparisons between similar schemes, and used data from Carbon-Mixer (an energy/carbon calculation Planning Tool).

1. D1 Research use: 60,000m²

The Planning brief outlines an aspiration for some or all of the Research buildings to meet the BREEAM "Excellent" rating. Currently BREEAM does not dictate any energy performance thresholds in order to achieve an "Excellent" (although additional points are awarded for exceeding mandatory Building Regulation Pass threshold).

In addition to this, many research buildings have additional process loads associated with fume-cupboard exhaust which are independent of Building Regulation assessment. We have undertaken some recent detailed studies (including process load) for University and other Research buildings and shall base our energy assessment on these.

Since the spread of Research Building Energy use can be so varied, we have also referred to the Labs21C report which used recent real measured data (included below) as a point of reference.

Table 2: Provisional Lab Benchmarks based on 2004-05 and 2005-06 data

Laboratory Type	**Typical Practice Energy Performance (kWh/m^2)**		**Good Practice Energy Performance (kWh/m^2)**		**Best Practice Energy Performance (kWh/m^2)**	
	Fossil Fuel	Electricity	Fossil Fuel	Electricity	Fossil Fuel	Electricity
All Labs	296	312	135	227	79	143
Medical/bioscience (with secure facility)	397	362	(198)	(227)	100	245
Medical/bioscience (w/o secure facility)	289	300	196	242	130	109
Chemical Science	353	367	(244)	(333)	177	327
Physical Engineering	177	196	(104)	(86)	119	52

Figures in parentheses are where there is strictly insufficient data (sample <15) to calculate lower quartile, but are provided for indicative purposes.

2. B1 commercial use: 40,000m²

Recognising the use of air-conditioning in offices we have used an arbitrary split of one-third air-conditioned offices, and two-thirds naturally ventilated.

3. 1 X primary school (2.5ha, floor area 4,500m²)

In the absence of any other information we shall assume the Primary School has an area of approximately 4,500m². We have used CIBSE Guide-F Good-Practice for the Load assessments.

Energy Use Profile Summary:

Using the assumptions outlined in this section the annual energy demand from the buildings in the North-West Cambridge Site is summarised in the following table.

Table 3: Energy demand (excluding absorption cooling)

Built Area m²	Usage Type	kWh/m²/year Heat	kWh/m²/year Power	MWh/year Heat	MWh/year Power
60,000	Up to 60,000 m² within Use Class D1 - higher education uses	175	223	10,500	13,380
26,667	Up to 40,000 m² within Use Class B1(b) & Sui Generis	79	54	2,107	1,440
13,333	Air-Conditioned Office (ratio of nat-vent vs AC)	114	234	1,520	3,120
4,500	Primary School	113	22	509	99
120,000	1470x houses (60% of 2450) 82m² GIFA each	48.0	42.7	5,760	5,119
80,000	980x Flats (40% of 2450) 82m² GIFA each	41.0	42.7	3,280	3,413
80,000	2000x units 840x undergrad, 1,160x post-grad (using 40m² per student GIFA)	200	45	16,000	3,600
650	Community Centre 650 m²	125	22	81	14
1,050	A1 Retail: Local Supermarket 500 m² + 4x other A1 totalling 550 m²	200	915	210	961
150	D1/sui generis: 150 m²	65	234	10	35
200	A3 Restaurant/Cafe: 200 m²	480	820	96	164
450	A4 Drinking establishment: 450 m²	1100	650	495	293
360	A5 Takeaway: 360 m²	480	820	173	295
600	D1 Nursery: 600 m² (no residential above)	121	17	73	10
1,000	Primary Health Care Centre 1,000 m²	203	51	203	51
240	A2 Financial and Professional Services: 240 m²	140	45	34	11
389,200	m²	*105 kWh/m²*	*82 kWh/m²*	41,049 MWh	32,004 MWh

Separate Energy Profile for Absorption Cooling.

1. **Absorption chillers**

Trigeneration converting heat from the CHP unit to cooling using absorption chillers affects the ratio of heat to electricity demand of the development. Within the NW Cambridge development there is a relatively small demand for cooling however by including this in the system it is expected that the demand for thermal energy will rise and the demand for electricity will decrease. This acts to make the ratio of heat to power greater and therefore more attractive for biomass CHP which struggles to deliver low ratio heat to power.

A description of the alternative load-profile used to asses the use of absorption chilling in the development is included below.

We have not taken a view on whether the use of absorption chilling is via a central system with distributed chilled water, or decentralised, where buildings are encouraged to utilise absorption chilling via the District-Heating. Thermodynamically the effect of overall imported levels of site fuel and CO_2 emissions are similar.

As described above, the use of absorption chillers for cooling in some or all of the development has an effect on both the electrical and heat demand profiles, decreasing electrical energy from chillers, and increasing (by a greater amount) the heat demand – because absorption chilling has a much lower Co-efficient of performance (CoP) than conventional vapour compression refrigeration.

We have used BRE Energy Efficiency In Offices (Econ 19) to ascertain the proportion of air-conditioned office energy used for refrigeration. This proportion was then used to calculate the corresponding increase in heat demand that absorption chilling would have.

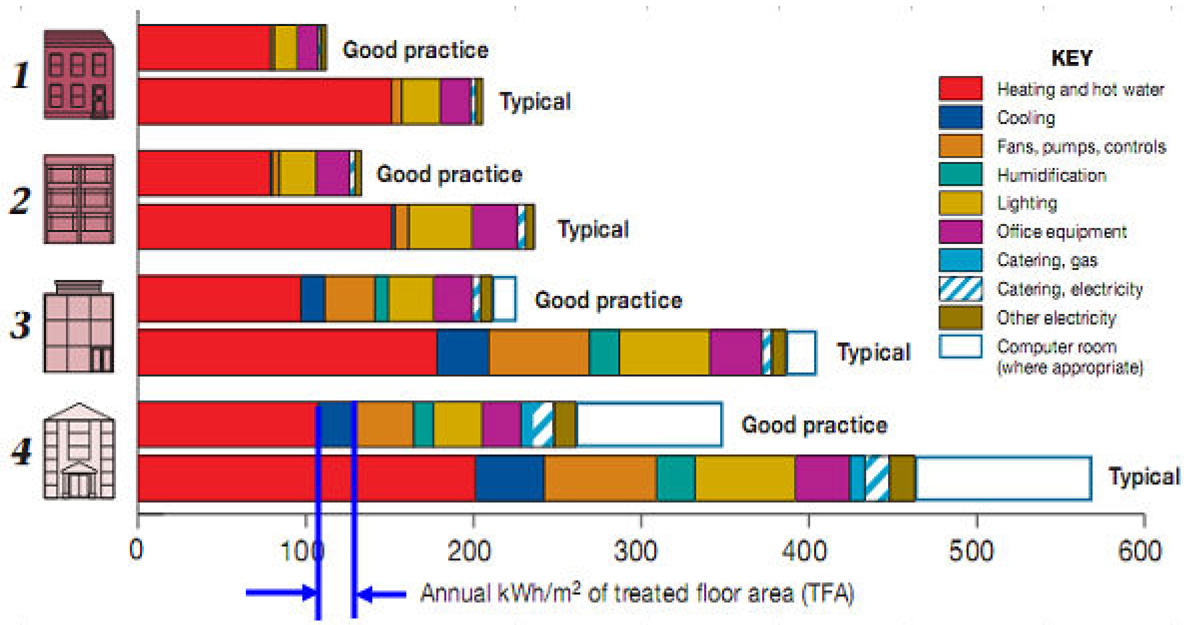


Figure 1: BRE Energy Efficiency In Offices (Econ 19)

Notes:

1) On a good-practice Air-conditioned office, 25kWh/m² of elctricity are due to cooling. This can be deducted from the elec profile

2) At an assumed "good-practice" chiller CoP of 4:1 this equates to 100kWh/m² of chilling effect

3) An good high input temp (>90ºC) absorption chiller CoP is 1:1 so the same 100kWh/m² must be added to the heat profile

4) The research building is assumed to have similar change to its demand per m²

Table 4: Benchmarks for air conditioning and absorption cooling

Non-Absorption Energy Use "Good-Practice" Benchmarks used for air-conditioned spaces		
	kWh/m²/year	
	Heat	Power
Up to 60,000 m2 within Use Class D1 - higher education uses	175	223
Assumed 3:1 ratio of nat-vent vs AC	114	234
Derived "Good-Practice" Benchmarks used for air-conditioned spaces assuming Absorption Cooling		
	kWh/m²/year	
	Heat	Power
Up to 60,000 m2 within Use Class D1 - higher education uses	275	198
Assumed 3:1 ratio of nat-vent vs AC	214	209

Using these assumptions, the following demand profile has been generated, which is studied for each CHP option along with the non-absorption scenario.

Table 5: Energy demand (including absorption cooling)

Built Area m²	Usage Type	kWh/m²/year Heat	kWh/m²/year Power	MWh/year Heat	MWh/year Power
60,000	Up to 60,000 m^2 **within Use Class D1 - higher education uses**	**275**	**198**	16,500	11,880
26,667	Up to 40,000 m^2 within Use Class B1(b) & Sui Generis	79	54	2,107	1,440
13,333	Air-Conditioned Office (ratio of nat-vent vs AC)	**214**	**209**	2,853	2,787
4,500	Primary School	113	22	509	99
120,000	1470x houses (60% of 2450) 82m² GIFA each	48.0	42.7	5,760	5,119
80,000	980x Flats (40% of 2450) 82m² GIFA each	41.0	42.7	3,280	3,413
80,000	2000x units 840x undergrad, 1,160x post-grad (using 40m² per student GIFA)	200	45	16,000	3,600
650	Community Centre 650 m^2	125	22	81	14
1,050	A1 Retail: Local Supermarket 500 m^2 + 4x other A1 totalling 550 m^2	200	915	210	961
150	D1/sui generis: 150 m^2	65	234	10	35
200	A3 Restaurant/Cafe: 200 m^2	480	820	96	164
450	A4 Drinking establishment: 450 m^2	1100	650	495	293
360	A5 Takeaway: 360 m^2	480	820	173	295
600	D1 Nursery: 600 m^2 (no residential above)	121	17	73	10
1,000	Primary Health Care Centre 1,000 m^2	203	51	203	51
240	A2 Financial and Professional Services: 240 m^2	140	45	34	11
389,200	m²	*124*	*78*	48,382 MWh	30,171 MWh

2. Sizing of CHP Plant Capacity

The delivery of the total heat energy demand (41,049MWh per annum) over the 8760 hours in a year would equate to a heat capacity of 4686kWth (4.69MWth). However, the demand for heat will not be spread evenly over the year, with the demand in the winter months exceeding the summer demand. Since it is costly and uneconomic to reject heat to keep the CHP plant running, no sacrificial heat-production has been allowed for in this study. Relatively poorly insulated buildings can be used in conjunction with CHP to maximise the amount of electricity generated, but this is not an approach we have considered – even though with biomass-source CHP this electricity may be lower-carbon than grid-electricity.

The highly insulated low-energy house-type used in the energy model, and the "Good-Practice" energy figures used for other building types relate to buildings with low intrinsic heat-losses, so the key figure in sizing the CHP is the base-load at which even in summer the heat shall be utilised. This is mainly in the form of domestic hot-water, particularly for showers & laundry.

The monthly energy profile outlined in figure 1 shows that this base-load is 10kWh/m² (per day). Over the whole 390,000m² GIFA of development, this equates to a theoretical constant daily load of around 3.9MW.

This load would be un-evenly distributed throughout a typical day, but providing sufficient thermal storage in the form of large buffer-tanks of stored hot-water, or more compact media such as eutectic salts, is common-place by Energy Services Companies (ESCO's) to minimise plant capacity, and maximise utilisation. The short-fall in thermal capacity could be met by supplementary heat only boilers running on either mains gas or biomass.

When absorption cooling is utilised in the offices (whether by tri-generation or locally in each building) the base heat-demand goes up in high summer, the utilisation of CHP plant is consequently increased in the summary calculations where absorption is studied.

3.9MW thermal equates to a theoretical maximum utilisation of 83% based on the (without absorption) total of 41MWh. In practice the CHP plant will need some down-time for when heat-demand is fully satisfied and it is uneconomic to run the plant, or for routine maintenance. For these reasons the over-all utilisation factor of 75% for CHP plant (thermal) is used as the basis for the CO_2 and energy calculations in this study – with varying electrical outputs depending on the process.

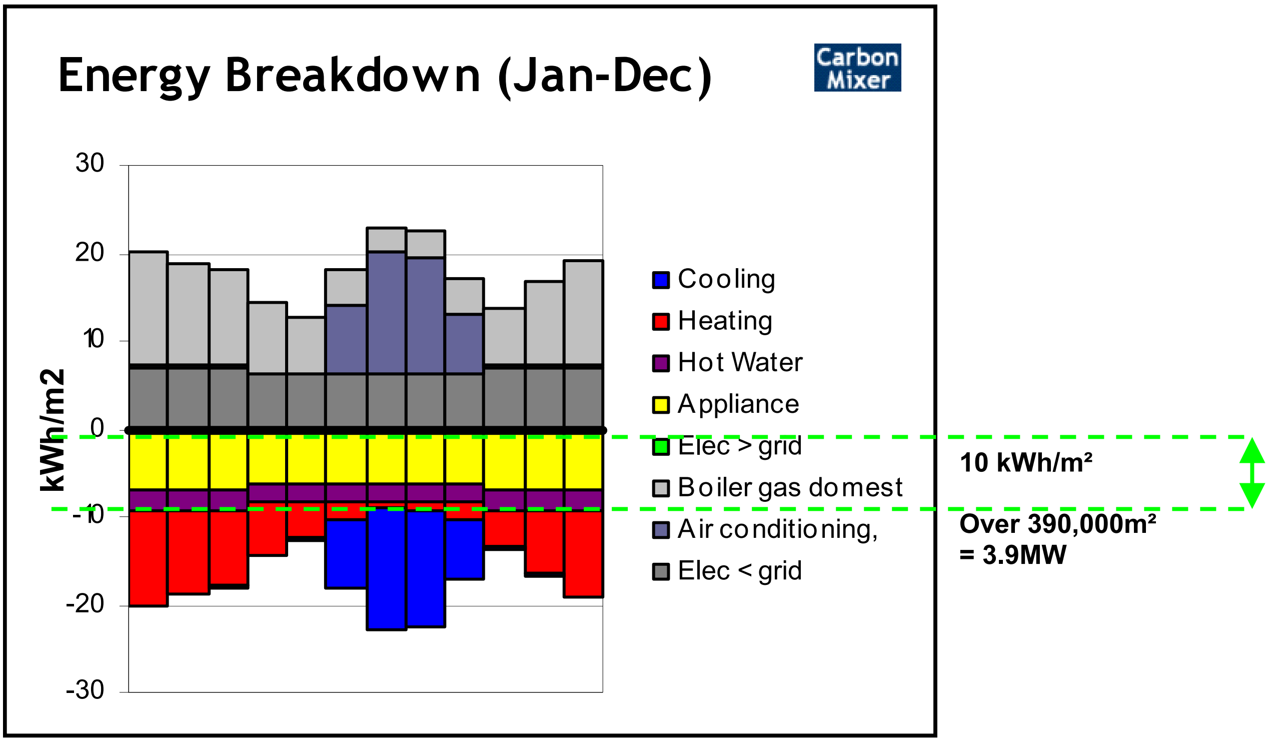


Figure 2: Whole-site monthly energy totals (*From Carbon-Mixer).*

<u>Summary Table Notes</u>

In order to make a meaningful comparison between the various options, the mid-range efficiencies of thermal process have been assumed for the four biomass CHP options studied.

The total annual energy demands calculated from the development floor areas are used as the basis for the comparison against the base-case of fully imported gas-heat and grid-electricity. Both on-site-generated energy utilisation, and the CO_2 savings against the base case are calculated.

To take into consideration absorption cooling, the separate adjusted demands were used with increased utilisation of heat, and the same central energy generation options are considered. The same annual utilisation factor was used, although in reality a slightly increased utilisation of site-heat is likely with absorption cooling.

Heat losses in the distribution of the heat have not been estimated since no firm idea of the pipe-line distance is known at this stage. These losses will be in the order of 5-10% and will be the same whichever technology is used.

7.0 TECHNOLOGY REVIEW

This assessment has been based on a demand for the heat and electricity at the NW Cambridge development as follows:

	Annual usage	Required plant capacity
Heat	41,049MWh	5MW @ 8322hrs (95% of running time)
Electricity	32,004MWh	4MW @ 8322hrs (95% of running time)

The demand of the site represents a heat to electricity ratio of 1.25 to 1. In order to provide the heat and electricity demand of the site most efficiently, a CHP technology which provides energy in a ratio close to this will be most desirable.

As mentioned previously the CHP technologies have been considered at a scale which delivers approximately 75% of the base load heat demand. This equates to 3.5MWth capacity requirement.

A range of combined heat and power (CHP) options have been considered for integration at the North West Cambridge development. These are:

- Organic Rankine Cycle (ORC) biomass CHP
- Gasification biomass CHP
- Anaerobic digestion (AD) CHP
- Vegetable oil CHP
- Natural gas CHP

The table on the following page summarises the characteristics of the six technologies:

Table 6: A summary of the characteristics of the six technologies reviewed

Technology	System – electricity generation	System – heat generation	Approx. scale of plant available	Typical Heat : Electricity ratio (electrical efficiency)	Ratio and scale used for calculation	Feedstock	Examples
Biomass boiler + Turbine (Organic Rankine Cycle (ORC))	Biomass boiler generates heat which is used to vaporise a working fluid (usually mineral oil) which drives a turbine connected to a generator.	Working fluid is condensed back to a liquid, heat is captured through a heat exchanger.	0.3MWe to 2MWe	Between 5 :1 and 3.25 : 1 (14-20%)	4.5:1 3.5MWth 0.8MWe	Woodchip, wood based waste e.g. sawmill waste, other wastes	Bios Bioenergy Leinz, Austria
Biomass gasification and combustion in a CHP engine	Biomass fuel is heated in a boiler to a high temperature, producing a 'syngas'. This gas is burnt in an engine connected to a generator.	Heat is captured from exhaust gases and oil/water cooling operations through heat exchangers.	2MWe to 300MWe	Between 2.5 : 1 and 1.2 : 1 (24 – 39%)	1.5:1 3.5MWth 2.3MWe	Woodchip, wood based waste e.g. sawmill waste	Caithness Heat and Power Wick, Scotland
Anaerobic digestion (Biogas) CHP	Anaerobic digestion produces a gas which is combusted in a CHP engine that is connected to a generator	Heat is captured from exhaust gases and oil/water cooling operations through heat exchangers.	0.1MWe to 1.5MWe	Between 3.25 : 1 1.8 : 1 (20-30%)	1.5:1 1.5MWth 1.0MWe	Animal slurries, food waste, household waste	Biogen Bedford, England

Table continued overleaf

Technology	System – electricity generation	System – heat generation	Approx. scale of plant available	Typical Heat : Electricity ratio (electrical efficiency)	Ratio and scale used for calculation	Feedstock	Examples
Vegetable oil CHP	Vegetable oil used in a generator as a replacement for diesel or fuel oil.	Heat extracted using heat exchangers from exhaust gases and areas of heat loss.	5MWe to 8MWe	Between 3.25 : 1 0.9 : 1 (20-45%)	3:1 3.5MWth 1.2MWe	Vegetable oil from oilseed rape (UK), soya oil, palm oil (imported) and waste oil.	Bios Bioenergy, Germany
Natural gas CHP	Gas turbine drives a generator to produce electricity.	Heat is collected from the exhaust gases via a heat exchanger	0.5MWe to 250MWe	Between 2 : 1 and 1.1 : 1 (28-40%)	1.3:1 3.5MWth 2.7MWe	Natural gas	Thameswey Woking, Surrey
Biomass district heating	Not applicable	Combustion of woody biomass in a boiler to provide hot water only	0.05MWth to 5MWth	Not applicable	- 2.0MWth	Wood chip, wood pellets	Barnsley Council flats, England

Note: Overall fuel conversion efficiency for all technologies has been taken to be 85%

References:

Bios-bioenergy, Austria

Combined Heat and Power Association - Biomass Energy Centre Information Sheet 4, 2007

Commercial assessment: Advanced conversion technology (Gasification) for biomass projects. Renewables East, June 2007

8.0 PESTEL APPRAISAL

The viability of CHP for the NW Cambridge development has been assessed by considering the political, economic, social, technical, environmental and legislative issues (PESTEL appraisal) associated with its use. This appraisal has been carried out for CHP in general and also for each of the specific CHP technologies.

1. Generic biomass CHP

Political

- The UK Government has a target to increase the amount of CHP from 5792MWe (2005 figure) to 10,000MWe by 2010. This implies government support and incentives will continue in the short to medium term in order to achieve this target.
- Currently the following incentives are in place to encourage the uptake of CHP in the UK aside from planning policy:
    - Exemption from Climate Change Levy for businesses that install CHP.
    - Eligibility for Enhanced Capital Allowances (ECA's) on CHP capital goods.
    - Exemption from business rates on CHP plant and machinery
    - Eligibility for Renewable Obligation Certificates (ROC's) on biomass CHP (see below)
    - Bioenergy Capital Grants Scheme (BCGS) is applicable to capital expenditure on biomass CHP plants (see below)
- The RO is the key mechanism used by the UK government to incentivise renewable electricity generation. ROC's are 'earned' by an eligible installation for each MWh of renewable electricity generated. The number of ROC's earned for each MWh of renewable electricity is dependent on the technology. Biomass CHP is likely to qualify for two ROC's per MWh from April 2009. This increases the value of electricity generated from such installations relative to other renewable energy, such as on-shore wind, and natural gas fired CHP (which does not qualify for ROC's). For the purposes of this appraisal it has been assumed that at least a proportion of the on-site generated electricity will be eligible for ROC's.
- The Bioenergy Capital Grants Scheme (BCGS) is designed to support the additional capital expenditure required to install biomass CHP over fossil fuel CHP. The grant can fund 40% of the cost difference between a biomass system and the equivalent fossil fuel based system. This equates to around 20 – 30% of capital

invested. Biomass CHP schemes could be eligible for this grant at NW Cambridge development.

Economic

- The economics of biomass CHP plant are dependent on the income that can be obtained from the sale of generated electricity and heat . The income from electricity sales will be supplemented by access to ROC's.
- The main running cost will be the purchase of biomass fuel/feedstock. Potential sources of biomass are energy crops, products of woodland management or waste wood.
- The cost of transporting biomass fuel to the site will affect the economics of any plant. Currently there are limited sources of biomass in Cambridgeshire so fuel would need to be sourced from outside the sub-region, at least in the short term, leading to increased transport costs.

Social

- There will be a continuous noise level associated with the plant, although this can be mitigated through good insulation of the plant building.
- All biomass CHP requires the delivery of fuel or feedstock in order to operate. These deliveries will clearly add to local transport movements in and around the development. These transport movements are not required when natural (mains) gas CHP is utilised.
- The development of local biomass supply chains could have positive socio-economic impacts on the local rural community.

Technical

See specific technologies

Environmental

- Biomass CHP will reduce the CO_2 emissions associated with heat and power used at the development when compared with a fossil fuel based system.
- If a local biomass source is developed through growing energy crops in Cambridgeshire then there will be environmental impacts on the rural environment.

- Energy crops (e.g. short rotation coppice willow, *Miscanthus*) can lead to increased farmland biodiversity when replacing conventional arable crops.
- Woodland managed for fuel can increase biodiversity compared to unmanaged woodland.

Legislative

- The Renewables Obligation requires electricity generators to provide an increasing proportion of electricity from renewable sources (up to 15% by 2015). Biomass CHP is an eligible source.
- The requirements of the NW Cambridge development to meet Code for Sustainable Homes levels 4 and 5 means that a proportion of heat and electricity must be generated on site. Biomass CHP plant could fulfil this requirement.
- Waste regulations may apply to biomass CHP if waste wood is used as a fuel. They may also apply to ash disposal as this needs to be removed from the boiler and permission from the Environment Agency will be needed to spread this to land.
- Biomass CHP will need to comply with the Clean Air Act and Integrated Pollution Prevention and Control (IPPC) regulations. NOx emissions may be an issue as they are higher from woody biomass than for other solid fuels such as coal.

2. Organic Rankine Cycle (ORC) biomass CHP

Political

See generic biomass CHP PESTEL

Economic

We have not undertaken an economic appraisal of the gasification biomass CHP system. However, the following points are significant:

- The financial performance of an ORC biomass CHP plant is determined by:
    - Cost of fuel.
    - Revenue received through sales of heat.
    - Revenue received through sales of electricity, including ROC's where available.

- The relatively low electrical conversion efficiency of ORC biomass CHP means that large amounts of fuel are required for each MWh of electricity generated. This means that the relative cost of each unit of electricity generated is higher than for some of the other biomass CHP options. This could affect the overall economic viability of any scheme.
- The relatively low output of electricity compared to other CHP options may make ORC biomass CHP less attractive to ESCO operators, who rely on maximising revenue from both heat and electricity.

Social

- A large number of vehicle movements will be required to deliver biomass fuel to the CHP plant when compared to a gas system. The ORC biomass plant, if scaled to generate 30,000MWhth and 6,700MWhe, will require 20 loads of woodchip (10 tonne loads) to be delivered per week.
- An ORC biomass CHP plant will occupy significant space in the development and will therefore have a visual as well as economic impact in terms of occupying space for marketable buildings.

Technical

- ORC biomass CHP is a mature and proven technology that has been in commercial use for over ten years. There are approximately 50 plants in operation in Europe. However, this study was unable to identify any existing ORC biomass plants operating in the UK.
- ORC biomass CHP plant is available at the 0.8MWe (3.5MWth) capacity required for the NW Cambridge development.
- The ORC system is flexible in terms of partial load performance and can operate at a level from 10% to 100% of capacity. This would allow the ORC system to accommodate fluctuations in energy demand from the development.
- The relatively low electrical conversion efficiency of ORC biomass CHP means that the operation of plant is dependent upon the utilisation of the significant heat output. A valuable use for this heat is required to avoid costly and environmentally damaging heat rejection.

Environmental

See generic biomass CHP PESTEL

Legislative

See generic biomass CHP PESTEL

Case Study

Location: Lienz, Austria

System: ORC biomass CHP for district heating

Scale: 1.5MWe, 10MWth

Heat : Power ratio: 6.7 :1

3. Gasification biomass CHP

Political

See generic biomass CHP PESTEL

Economic

We have not undertaken an economic appraisal of the gasification biomass CHP system. However, the following points are significant:

- The financial performance of an ORC biomass CHP plant is determined by:
    - Cost of fuel.
    - Revenue received through sales of heat.
    - Revenue received through sales of electricity, including ROC's where available.
- The relatively high electrical conversion efficiency of gasification biomass CHP means that small amounts of fuel are required for each MWh of electricity generated. This means that the relative cost of each unit of electricity generated is lower than for some of the other biomass CHP options. This could affect the overall economic viability of any scheme.
- Gasification relies on producing a gas (syngas) that is clean enough to burn in an internal combustion engine. Low tar levels are required in the gas and this may

affect the type of fuel that can be used. This may limit the choice of waste woody fuels which could be used.

Social

- A large number of vehicle movements will be required to deliver biomass fuel to the CHP plant. Due to the higher electrical conversion efficiency of gasification compared with ORC biomass CHP more fuel is required to meet the heat demand of the development. In order to generate 30,000MWhth and 20,000MWhe approximately 27 loads of woodchip (10t loads) will be required per week.
- A gasification biomass CHP plant will occupy significant space in the development and will therefore have a visual as well as economic impact in terms of occupying space for marketable buildings.

Technical

- Gasification biomass CHP is not a mature technology at the scale required for the NW Cambridge development. There is one plant at a similar scale which started operating in Scotland in early 2008. There are a small number of plants operating elsewhere in Europe.
- Gasification biomass CHP plants can be constructed from 2MWe – 300MWe capacity. If sized to the heat demand, the requirement for the NW Cambridge development should be below the lower end of this range.
- The higher electrical conversion efficiency of gasification biomass CHP compared with ORC biomass CHP means that if the plant is sized to the heat demand then more electricity will be available from a gasification system. This will be more favourable to ESCO operators.

Environmental

See generic biomass CHP PESTEL

Legislative

See generic biomass CHP PESTEL

Case Study

Location: Wick, Scotland

System: Gasification biomass CHP for district and distillery heating and power.

Scale: 1.5MWe, 3MWth

Heat : Power ratio: 2 :1

4. Anaerobic Digestion (AD) CHP

Political

- AD is eligible for direct support from government regulation via the Renewables Obligation and other fiscal incentives as described previously, as for other biomass CHP.
- AD also receives indirect support from government through the imposition of tax on waste disposal to landfill. If wastes are diverted from landfill to AD then the AD operator is able to earn a 'gate fee' for the acceptance of this waste. The level of gate fee is directly related to level of tax payable on the waste which would otherwise be landfilled.
- There may be further fiscal incentives and grant schemes put in place to support the treatment of wastes in AD plants in the future.

Economic

We have not undertaken an economic appraisal of an anaerobic digestion (AD) CHP system. However, the following points are significant:

- The financial performance of an AD plant is determined by:
    - Gate fee earned for accepting waste feedstocks.
    - Costs (if any) of other feedstocks.
    - Revenue received through sales of heat.
    - Revenue received through sales of electricity, including ROC's where available.
    - Cost incurred or revenue received through the disposal of digestate (biofertiliser) which is a by-product of the AD process, and requires disposal to agricultural land.

- The availability of suitable gate fee earning feedstocks is likely to be important to the economic viability of an AD plant at NW Cambridge.

Social

- There will be vehicle movements associated with the delivery of AD feedstock and removal of the digestate by-product. These are likely to be more frequent than for the woodchip biomass systems. In order to generate 9,000MWhth and 8,000MWhe approximately 38 loads of food waste (20t loads) will be required per week. In addition to this a large amount of vehicle movements are associated with the removal of disgestate from the site. The exact quantities of solid and liquid produced are variable but it is estimated that the quantity of digestate output will be 85% of input feedstock (c. 32 loads).
- The AD plant is likely to have a large footprint in order to accommodate the required digestion tanks, feedstock reception facilities and gas storage. This will have visual and economic impacts which are likely to be more significant than for the other technologies considered here.
- The siting of what amounts to a waste disposal facility close to the NW Cambridge development may not be popular with existing and potential occupiers of the site.
- There may be an odour associated with the AD plant.
- AD offers a sustainable solution to waste disposal which could offer opportunities for the development to be used as a demonstration site for the wider community.

Technical

- The technology to burn the biogas (methane) in a CHP engine to produce heat and electricity is mature and well proven, with many examples in the UK and overseas.
- Digestion of feedstocks for the generation of the biogas is less well understood and subject to variation depending on the precise nature and composition of the feedstock. Some feedstocks, such as sewage sludge, animal slurries and maize, are well understood in terms of management for biogas production. However, the use of mixed waste feedstocks, including food and municipal waste, for the production of biogas through AD are less well understood, though there are commercial plants operating with these wastes in the UK. Food/municipal waste is likely to offer the most economically viable solution for the NW Cambridge development.

- If sized to the heat demand of the development (3.5MWth) then the electrical capacity required will be outside the most commonly used single AD CHP engines (usually up to 1.5 MWe).
- The electrical efficiency is high at c.30% with some plants operates at up to 40%.

Environmental

- An AD CHP plant reduces CO_2 emissions compared with fossil fuel generation. Emissions savings are greatly enhanced when wastes which would ordinarily release methane through their disposal are used in AD.
- The use of AD digestate (biofertiliser) as a substitute for synthetic fertilisers could offer further environmental benefits.
- Storage, treatment and management of wastes could present potential risks to the local environment.

Legislative

- The Renewables Obligation requires electricity generators to provide an increasing proportion of electricity from renewable sources (up to 15% by 2015). Anaerobic digestion CHP is an eligible source.
- Waste regulations may apply to an AD CHP plant, dependent on the feedstock used. Disposal of digestate to land is subject to legislation.
- AD CHP is likely to comply with the Clean Air Act.

Case Study

Location: Biogen, Bedford

System: AD CHP, feedstocks: pig slurry and food waste

Scale: 1.1 MWe

Heat : Electricity ratio: unknown

5. Vegetable oil CHP

Political

See generic biomass CHP PESTEL

Economic

- The financial performance of a vegetable oil biomass CHP plant is determined by:

  - Cost of fuel
  - Revenue received through sales of heat.
  - Revenue received through sales of electricity, including ROC's where available.

- The cost of vegetable oil to fuel the CHP system will be the most significant running cost. Vegetable oil prices have increased considerably over the last year due to a number of factors including increasing demand for food and biofuels. The table below shows the change in selected vegetable oil prices over the last year.

Table 7: Vegetable oil prices in 2007 and 2008

	March 2007	March 2008	% Increase
Palm oil	£435/ t	£616/ t	42%
Soya oil	£470/ t	£767/ t	63%
Rapeseed oil	£470/ t	£745/ t	59%

Current vegetable oil prices are likely to make vegetable oil CHP economically unviable in the short to medium term.

- One way to improve the financial viability of using vegetable oil as a fuel would be to use waste vegetable oil. There are no established local supply chains for this and obtaining a consistent quality of oil could be an issue.

Social

- Vehicle movements will be required to deliver the vegetable oil to the plant which may not be popular with local residents. In order to generate 30,000MWh of heat and 10,000MWh of electricity approximately 2 tanker deliveries will be required per week (c. 42,800litre loads). This is considerably less than for the other renewable technologies.
- There will be a continuous noise level associated with the plant, although this can be mitigated through good insulation of the plant building.
- Odour from a vegetable oil CHP plant is unlikely to be a significant issue.
- The footprint of the plant will be larger than the gas CHP system due to the requirements for fuel storage.

Technical

- This technology is very similar to that of a fossil fuel system and therefore is a well understood and mature technology. The use of vegetable oil may have some impact on wearing parts in terms of corrosion.

- Vegetable oil CHP is usually operated at a scale between 5 – 8 MWe. This may be larger than required for the NW Cambridge development.
- Electrical efficiency could be between 20 and 45%. 20- 25% of the heat is high grade collected from exhaust gases. Up to 35% is low grade heat at c 40 – 70 degrees C. This means that although electrical efficiency is high this system may not deliver the appropriate quality of heat required for the NW Cambridge development.

<u>Environmental</u>

- The source of vegetable oil used would have a significant impact on whether CO_2 emissions would be saved compared with fossil fuels. Non-domestic sources of oil such as palm and soya oil may have significant transport emissions associated with their delivery to the NW Cambridge development. There may also be emissions associated with land use change in order to grow the vegetable oil crops.
- The use of waste vegetable oil as a fuel will offer the best performances in CO2 emissions savings, as long as reliable supplies of the appropriate quality are available.

<u>Legislative</u>

- The Renewables Obligation requires electricity generators to provide an increasing proportion of electricity from renewable sources (up to 15% by 2015). Vegetable oil CHP is an eligible source.
- The requirements of the NW Cambridge development to meet Code for Sustainable Homes levels 4 and 5 means that a proportion of heat and electricity must be generated on site. A vegetable oil CHP plant could help fulfil this.
- Waste regulations will apply to a vegetable oil CHP plant only if waste vegeatable oil is collected and used as a fuel.
- Vegetable oil CHP is likely to comply with the Clean Air Act and the Integrated Pollution Prevention and Control (IPPC)

<u>Case Study</u>

Location: Germany

System: Vegetable oil CHP

Scale: 4.7 MWe

Heat : Power ratio: c. 2 : 1

6. Natural gas CHP

Political

- Natural gas CHP cannot be used to provide for the onsite renewable energy generation that is required by planning policy. This is due to the non-renewable nature of natural gas.
- Currently the following incentives are in place to encourage the uptake of gas CHP in the UK:
    - Exemption from Climate Change Levy
    - Eligibility for Enhanced Capital Allowances (ECA's)
    - Exemption from business rates on plant and machinery

Economic

- The capital cost of a natural gas CHP plant will be considerably less than that for biomass CHP plants.
- Natural gas CHP is dependent on:
    - Cost of gas
    - Revenue received through sales of heat
    - Revenue received through sales of electricity
- The relatively low heat to electricity ratio of natural gas CHP compared to biomass CHP make it suited to the energy demand of NW Cambridge.
- Natural gas CHP is not a renewable energy technology and therefore is not eligible to receive ROC's.

Social

- There will be no vehicle movements associated with delivery of fuel to the central energy centre as natural gas will be received through an underground mains supply.
- The footprint of the plant would be smaller than the biomass systems as no storage or processing of fuel is required on site.

Technical

- Natural gas CHP is a mature technology that is currently being used in district energy supply and industry in the UK.
- Natural gas CHP can be installed at scales from 0.5MWe to 250MWe. The NW Cambridge development would need a plant towards the lower end of this scale.
- The electrical efficiency of natural gas CHP is c. 30% - 40% with an overall efficiency of c. 90%.

Environmental

- Natural gas CHP will reduce CO_2 emissions when compared with grid electricity if the heat is utilised. However, the combustion of a fossil fuel for energy is likely to lead to higher CO2 gas emissions than with the biomass CHP options.
- There are no waste disposal issues concerned with natural gas CHP.

Legislative

- The requirements of the NW Cambridge development to meet Code for Sustainable Homes levels 4 and 5 means that a proportion of heat and electricity must be generated on site. Natural gas CHP could not be used alone to achieve these CSH levels.
- Waste regulations will not apply to natural gas CHP.
- Natural gas CHP is likely to comply with the Clean Air Act and the Integrated Pollution Prevention and Control (IPPC)

Case Study

Location: Woking Borough Council

System: Natural gas CHP for district energy supply to business, offices and residential property.

Scale: 1.35 MWe, 1.4 MWth

Heat : Power ratio: c. 1.1 : 1

7. Biomass heating

Political

- Biomass heating can be used to provide on-site renewable energy for the NW Cambridge development. However, it will not fulfil the higher levels of the Code for Sustainable Homes as only renewable heat is generated and not renewable electricity.
- Currently the following incentives are in place to encourage the uptake of biomass heating in the UK:
    - Eligibility for Enhanced Capital Allowances (ECA's)
    - Exemption from business rates on plant and machinery
    - Eligibility for the Bioenergy Capital Grants Scheme (subject to availability)
    - Eligibility for Low Carbon Building Programme grants (subject to availability)

Economic

- The capital cost of a biomass heating plant will be considerably less than that for biomass CHP plants.
- Biomass heating is dependent on:
    - Cost of biomass fuel
    - Revenue received for heat
- Biomass heating does not generate electricity and therefore is not eligible to receive ROC's.

Social

- A large number of vehicle movements will be required to deliver fuel to the biomass heating plant. In order to generate 17,000MWh of heat approximately 9 loads of woodchip (10t loads) will be required per week.

Technical

- Biomass heating is a mature well proven technology that is widely used in Europe at a range of scales for both residential and non-residential properties.

- Biomass heating is starting to be used for individual residential properties and developments in the UK. There are few operating schemes in the UK of a scale similar to that proposed for the NW Cambridge development, with most existing district heating schemes in the range of 1 to 30 properties.
- Biomass heating could provide for the 3.5MWth demand at the NW Cambridge development.
- The efficiency of a biomass heating system is c. 90%.

Environmental

- Biomass heating will reduce the CO_2 emissions associated with heat used at the development when compared with a fossil fuel based system.
- If a local biomass source is developed through growing energy crops in Cambridgeshire then there will be impacts on the rural environment.
- Energy crops (e.g. short rotation coppice willow, *Miscanthus*) can lead to increased farmland biodiversity when replacing conventional arable crops.
- Woodland managed for fuel can increase biodiversity compared to unmanaged woodland.

Legislative

- The requirements of the NW Cambridge development to meet Code for Sustainable Homes levels 4 and 5 means that a proportion of heat and electricity must be generated on site. Biomass heating can only fulfil the heating requirements.
- Waste regulations may apply to biomass heating if waste wood is used as a fuel. Disposal of ash may require permission from the Environment Agency.
- Biomass heating will need to comply with the Clean Air Act and Integrated Pollution Prevention and Control (IPPC) regulations. NOx emissions may be an issue as they are higher from woody biomass than for other solid fuels such as coal.

Case Study

- Location: Callow Place Flats, Sheffield
- Installer: Econergy
- Scale: 500kW thermal
- Efficiency of heat conversion: 90%

9.0 FUEL REQUIREMENTS

A significant impact of the use of biomass CHP on the NW Cambridge site will be the number of vehicle movements associated with the delivery of fuel and removal of by-products. The table below compares the relative frequency of fuel deliveries to the installed plant, based upon an estimate of the predicted plant size and estimated fuel requirements. These figures are only presented for broad comparisons and should not be used for any other purpose. In order to fully assess the impacts of the use of biomass CHP and separate investigation into the biomass fuel supply chain would be required.

Table 8: Estimated fuel requirements for the technologies reviewed

Technology	Fuel/feedstock	Estimated annual fuel usage	Estimated fuel deliveries per week
ORC biomass CHP	Woodchip	10,500 tonnes (at 30% moisture)	20 (at10t/load)
Gasification biomass CHP	Woodchip	14,300 tonnes (at 30% moisture)	27 (at10t/load)
Anaerobic Digestion CHP	Food waste	40,000 tonnes	38 (at 20t/load)
Vegetable oil CHP	Vegetable oil	4.4 million litres	2 (at 42,800 litres/load)
Biomass district heating	Wood chip	4,900 tonnes (at 30% moisture)	9 (at 10t/load)

N.B. Anaerobic digestion CHP will also require vehicle movements to remove digestate (biofertiliser) from the plant site. It is estimated that the quantity removed will be c. 85% feedstock intake (34,000t) and require c. 32 vehicle movements per week to remove it.

Table

Table 9: Estimated CO_2 Savings for the technology Options

Option		Imported Energy* Heat	Imported Energy* Elec	CO_2 saved (000's tons)	% of Energy on-site and CO_2 reduction achieved		CSH rating	Comments
Base-line Scheme (Condensing boilers, grid elec)	MWh	**48,293**	**32,004**		**0**	**Energy**		
	CO2 (000's of tons)	*9,176*	*13,762*	-	*0*	*CO2*	3	
	Total CO2		*22,938*					
Organic Rankine Cycle Biomass CHP	MWh	**12,999**	**24,504**		**49%**	**Energy**		
	CO2 (000's of tons)	*2,470*	*10,537*	*9,931*	*57%*	*CO2*	5	
	Total CO2		*13,007*					
Biomass gasification CHP	MWh	**12,999**	**26,004**		**47%**	**Energy**		
	CO2 (000's of tons)	*2,470*	*11,182*	*9,286*	*60%*	*CO2*	5	
	Total CO2		*13,652*					
Anaerobic Digester (Biogas) CHP	MWh	**12,999**	**20,004**		**55%**	**Energy**		Best on-site energy generation quotient of the Biomass CHP options.
	CO2 (000's of tons)	*2,470*	*8,602*	*11,866*	*48%*	*CO2*	5	
	Total CO2		*11,072*					
Biomass Heat-only District heating serving 90% of heat load	MWh	**4,829**	**32,004**		**50%**	**Energy**		
	CO2 (000's of tons)	*918*	*13,762*	*8,258*	*64%*	*CO2*	4	Best CO2 saving quotient
	Total CO2		*14,680*					
Gas-fired CHP	MWh	**12,999**	**12,004**		**66%**	**Energy**		
	CO2 (000's of tons)	*2,470*	*5,162*	*3,906*	*33%*	*CO2*	4	
	Total CO2		*19,032*					

Key

MWh associated with Heat | **MWh associated with Elec**

CO2 associated with heat | *CO2 associated with elec*

CO2 associated with gas-CHP

* Imported energy is that which is not generated by the CHP or Biomass heat option

Table 10: Estimated CO_2 Savings for the technology Options – Including Absorption Chilling

Option		Imported Energy Heat	Imported Energy Elec	CO_2 saved (000's tons)	% of Energy on-site and CO_2 reduction achieved		CSH rating	Comments
Organic Rankine Cycle Biomass CHP 50% use of absorption chilling	MWh	**16,921**	**21,671**		**51%**	**Energy**		
	CO2 (000's of tons)	*3,215*	*9,319*	*10,404*	*55%*	*CO2*	5	
Biomass gasification CHP 50% use of absorption chilling	MWh	**16,921**	**23,371**		**49%**	**Energy**		
	CO2 (000's of tons)	*3,215*	*10,050*	*9,673*	*58%*	*CO2*	5	
Anaerobic Digester (Biogas) CHP 50% use of absorption chilling	MWh	**16,921**	**16,571**		**57%**	**Energy**		Best on-site energy generation quotient of the Biomass CHP options if Absorption chilling utilised
	CO2 (000's of tons)	*3,215*	*7,126*	*12,597*	*45%*	*CO2*	5	
Biomass Heat-only District heating serving 90% of heat load + absorption chilling	MWh	**5,692**	**30,171**		**54%**	**Energy**		
	CO2 (000's of tons)	*1,081*	*12,974*	*8,883*	*61%*	*CO2*	4	
Gas-fired CHP with 50% use of absorption chilling	MWh	**16,921**	**10,171**		**66%**	**Energy**		Has the highest proportion of on-site energy, but this is from natural gas utilised in CHP - so low CO2 saving.
	CO2 (000's of tons)	*3,215*	*4,374*	*3,949*	*33%*	*CO2*	4	
			18,989					

Key
MWh associated with Heat **MWh associated with Elec**
CO2 associated with heat *CO2 associated with elec*
CO2 associated with gas-CHP
* Imported energy is that which is not generated by the CHP or Biomass heat option

10.0 DISCUSSION – TECHNOLOGIES AND FUEL SUPPLY

The technology review highlights the issues which could have an impact on the viability of biomass combined heat and power at the NW Cambridge site. It is clear that many of the issues are generic to all technologies considered here. Of particular importance are the maturity of the technology, the heat to electricity ratio, access to suitable fuels or feedstocks and the vehicle movements associated with their delivery.

Biomass CHP is not widely used in the UK, for either industrial or district energy applications. This is largely associated with the UK's relatively slow uptake of CHP technology in general, but also due to the relative lack of low cost suitable fuel supplies (e.g. from forestry industries) compared to a number of other European countries such as Austria and Sweden. It is the access to these low cost woody fuels which has largely contributed to the establishment of a large number of ORC and other biomass CHP installations in Europe.

ORC biomass CHP offers a well proven way of generating heat and electricity from a range of woody biomass fuels. It has a relatively low electrical conversion efficiency, meaning large amounts of heat are generated for each unit of electricity supplied. This can be economically acceptable where the cost of fuel is low or the value of heat is high, or both. However, this will present economic challenges where low cost fuel supplies are not readily available as at NW Cambridge, and where overall viability is largely dependent upon the revenue generated through electricity sales and eligibility for ROC's.

Biomass gasification CHP offers a more efficient means of generating electricity from woody biomass fuels. This means that less heat is generated for each unit of electricity produced, in turn meaning less fuel is required for each unit of electricity generated. However, the technology is not well established, and there are few reference plants operating at a scale of relevance to the NW Cambridge site. Of particular interest is the recently commissioned plant at Wick in Scotland which should provide important insights into the use of this technology for the NW Cambridge site. There is also a planned biomass gasification CHP scheme due to be installed at the University of East Anglia campus in Norwich.

Of the two woody biomass CHP options considered here, the higher electrical conversion efficiency of gasification should make it the most favoured of this technology type. However, the particular policy demands of the NW Cambridge site could skew the choice of technology towards ORC. This is because renewable electricity supply, according to the brief provided for this study, is only required to meet Code for Sustainable Homes Level 5. This means that renewable electricity is only required to meet the demand from pumps, fans and fixed lighting in the residential properties. This relatively low demand for renewable electricity is in contrast to the relatively high demand for renewable or low carbon heat. The high heat to low electricity ratio in fact more closely matches the expected efficiency of the ORC biomass CHP.

Whilst this is true of the theoretical response to the demands of the NW Cambridge site, it ignores the likely economic reality of implementing a CHP solution for the development. It is highly likely that the use of CHP will be largely dependent upon the revenue received through electricity sales, together with the associated ROC's. Therefore, any potential ESCO provider is likely to maximise the electricity generation of the technology utilised.

The use of anaerobic digestion CHP for the NW Cambridge site offers a number of advantages. The CHP technology is mature, efficient and well proven both in the UK and throughout Europe. The potential to use waste feedstocks offer a significant additional revenue stream to the operator. The use of putrescible (biodegradable) waste for energy generation offers potentially the most significant CO_2 emissions savings per unit of energy supplied of all the options considered here.

The use of AD to supply the energy for the NW Cambridge development presents a number of challenges. The source of the feedstock for the plant would have to be identified and secured for the life of the scheme. Feedstock supplies could consist of source segregated food waste, potentially from local authority or from food manufacturing businesses. There is also scope to utilise farm animal slurries, though these are unlikely to be viable as the sole feedstock as they are unlikely to generate gate fees.

The scale of plant which is likely to be required to meet the predicted demand of the NW Cambridge site will need very frequent deliveries of feedstock, as well as frequent removal of digestate for application to farmland. This will have an impact on the local transport infrastructure. Traffic issues, as well as odour and the perception of a waste treatment facility are all likely to detract from the acceptance of an AD plant in close proximity to the NW Cambridge site. However, there are ways in which this could be overcome, not least through a programme of community involvement in any scheme, which would emphasise the significant sustainability benefits of the use of AD in waste management. The other mitigating option would be to locate the AD facility away from the NW Cambridge site, though this would present challenges for the supply of heat to the development.

Vegetable oil CHP offers a well proven means of efficiently generating electricity and heat from a widely available fuel source. The challenges of the use of this technology for the NW Cambridge site are two fold. Firstly, vegetable oil CHP is most widely used at a larger scale than that demanded by the proposed policy requirements. Secondly, and most significantly in the short to medium term, vegetable oil prices currently make the use of this fuel for energy generation uneconomic. This is likely to continue to be a factor as demand for vegetable oils continues to rise on the back of world population growth, unpredictable weather patterns impacting on crop yields, and rising demand for transport biofuels.

Biodiesel CHP has not been specifically considered here largely due to the economic considerations presented for vegetable oil CHP, as the base feedstocks for biodiesel are usually vegetable oils. Biodiesel has additional costs associated with its manufacture, which is likely to offset the potential advantage of the availability of smaller scale biodiesel generating plant compared to vegetable oil CHP.

The use of natural gas CHP to provide energy for the NW Cambridge site presents a number of advantages compared to biomass CHP. The technology is mature, well proven and available at any scale required to meet the demands of the site and/or policy. The fuel would be supplied through underground mains pipes, removing the requirement for traffic movements associated with fuel supply. CO_2 emissions savings are significant in comparison to the use of grid electricity.

However, natural gas CHP does not meet the policy requirements to supply renewable energy to the development. Furthermore, the technology does not provide the CO_2 emissions savings required for the provision of heat to the development. Additionally, natural gas CHP does not receive the additional fiscal support available for biomass CHP, the most significant of which is access to ROC's.

Biomass district heating is able to meet a large part of the energy demand of the NW Cambridge development. The heat generation and distribution technology is mature and well proven, and there are a range of examples of the use of the technology at a similar scale in Europe. Biomass district heating at the scale to fully meet the heat demand of the NW Cambridge site would be larger than any existing biomass systems in the UK, where most large scale district heating examples use natural gas as the primary fuel.

Biomass district heating will meet the CO_2 reduction requirements and the renewable energy requirements of proposed planning policy in terms of heat supply. The technology will not contribute to meeting the requirement for renewable electricity supply, as required under Code for Sustainable Homes level 5. However, biomass district heating could be an economically viable technology which could operate alongside a CHP solution which provides for the electricity demand of the site.

In order to utilise biomass district heating a suitable supply of woody biomass fuel is required. Woody biomass fuel supply chains do not currently exist in the area local to the NW Cambridge development. However, the potential for the development of a suitable supply chain exists through the involvement of local landowners who have expressed interest in such a venture.

11.0 PHASING IMPACT

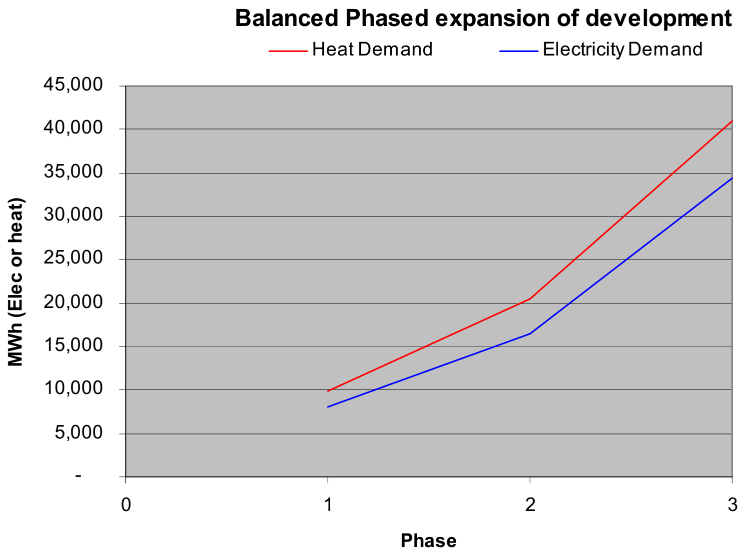
Wastefully rejecting heat just to run the CHP plant is little better (if not worse) than grid-generated electricity. As explained in the CHP phasing section above, the CHP plant has been sized so as to maximise utilisation. The need for a base-load of heat to allow the CHP plant to be utilised is crucial.

Table 2 in the appendix shows how we envisage the development to be phased, with a roughly similar proportion of the office, retail and research completed in tandem with the housing. Having the base-load provided by the housing (summer-time domestic-hot-water demand) is critical in maximising the utilisation of the CHP.

We would advocate an economic model that perhaps utilised capital from the housing construction to fund construction of research buildings so that the proportion of Office/Research space does not significantly outweigh the heat-demand created by housing. If the demand for research and office buildings is met first, the electricity load will need to be imported as the CHP will have no useful outlet for the heat generated.

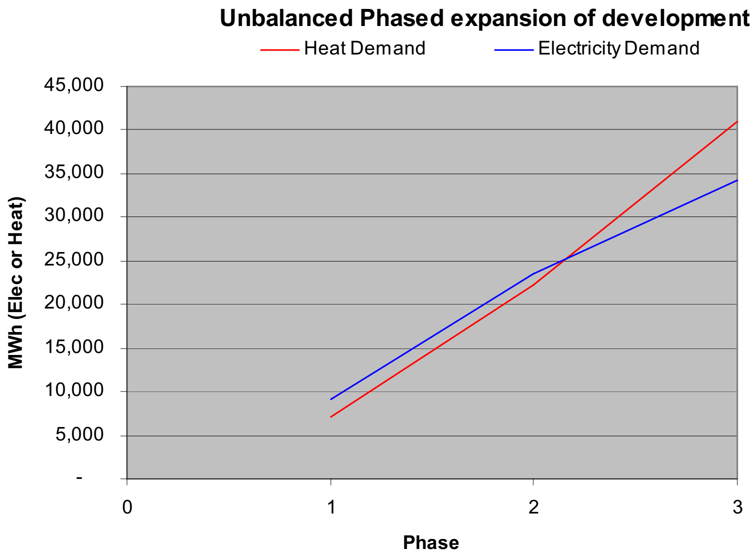
How the development is phased, and the economics of providing for example 25% of the required CHP plant when say only 10% of the houses are completed is a complex and detailed economic study that is beyond the scope of this report.

Balanced Expansion	1	2	3
Development Split	25%housing & Research/Office	50%housing & Research/Office	100%housing & Research/Office
MWh (heat)	9,864	20,487	41,049
MWh (elec)	8,137	16,399	34,324
Unbalanced Expansion	1	2	3
Development Split	0%housing & 50%Research/Office	25%housing & 100%Research/Office	100%housing & Research/Office
MWh (heat)	7,140	22,269	41,049
MWh (elec)	9,027	23,486	34,324



If expansion is balanced, the heat demand is consistently above the electrical demand because the houses provide a constant DHW demand.

The CHP plant can be utilised for a high proportion of the time.



If expansion is un balanced, the heat demand is below the electrical demand during the early phases. The CHP plant would not be able to be fully utilised (if at all) because the office and research do not need the heat.

The economics of providing the CHP plant would be poor.

12.0 ON-SITE RENEWABLE ENERGY PROVISION

All of the CHP schemes considered meet the demand for electricity required for the buildings to meet CSH level 5 (886MWh per year).

If biomass CHP was used and all the electricity allocated to the houses (excluding flats) then the houses could be shown to meet CSH level-6 or “Zero-Carbon” status. This could be of interest to the developer if "Zero-Carbon" status improved the marketability of the houses. However, it should be noted that the CHP schemes considered here have not been sized to meet all the electricity requirements of the site, meaning not all properties could be marketed as "Zero-Carbon".

Alternatively, the developer may wish to utilise the biomass CHP quota of electricity to meet part of the City’s 20% on-site renewable-energy obligations which would be otherwise difficult to meet in an electrically biased research or office building.

13.0 CONCLUSIONS AND RECOMMENDATIONS

This study has investigated the technical viability of using renewably fuelled CHP to provide for the energy demand of the NW Cambridge development. It has considered a range of technologies which may be suitable and viable for the site, and has considered how each of the technologies could meet the specific demands of the proposed planning policies to be enforced on the development.

Renewably fuelled CHP is technically viable for the development. However, there are significant challenges to the use of this technology in the way demanded by the proposed planning policy. The use of district energy to supply approximately 75% of the properties is more extensive than currently operating in the UK. This will be demanding in terms of identifying appropriate experienced ESCO providers. It will also place significant demands on fuel supply chains, local examples of which do not currently exist in Cambridgeshire.

This study has not considered in detail the economic viability of using renewably fuelled CHP. In order to define the specific technology or combination of technologies which is most suited to the NW Cambridge development, a detailed financial appraisal is required, which looks at specific choices of plant and machinery, fuel supply and operation and maintenance.

This study has been able to consider the relative technical and economic viability of the different solutions in broad terms, and this has been used to inform the choice of technology recommended here. We present two options for the provision of renewable energy to the development.

<u>Option 1</u>

The use of anaerobic digestion CHP to provide the renewable electricity demanded by the proposed planning policy could be the most technically and economically viable solution. The availability of sufficient quantities of gate fee earning waste feedstock is critical to this option, as is the availability of an acceptable site for the location of the facility.

The generation of electricity with AD CHP could be supplemented by biomass fuelled heating for a large part of the development. This would be dependent upon the availability of suitable woody biomass fuel, as well as the significant costs associated with provision of the heat distribution network being offset by the potential revenue from electricity and heat sales by the overall scheme.

AD CHP and biomass district heating may be technically and economically viable as separate schemes. However, neither scheme is likely to individually meet the proposed policy requirements for the NW Cambridge development.

Option 2

Biomass gasification CHP could be used to provide for the electricity and heat demands of the NW Cambridge development in line with the proposed planning policy. The technology, though in its infancy in terms of specific examples on a similar scale to that proposed here, offers an efficient way of generating electricity, subject to availability of a suitable reliable plant.

The viability of a biomass gasification CHP scheme will be dependent on the availability of large quantities of woody biomass fuel. This will require either the extension of existing biomass fuel supply chains to cover this application, or the development of a suitable local biomass fuel supply chain to meet the specific needs of the scheme.

As with the other option presented here, the success of a biomass gasification CHP scheme for the NW Cambridge site is dependent on the scheme being sufficiently profitable to attract an ESCO provider. The economic viability of the scheme will have to offset the risk of using a technology which is in the early stages of deployment in the UK.

This investigation has found that subject to the renewably fuelled CHP options being economically viable, the requirement for CSH level 4 and 5, and BREEAM Excellent, is technically feasible. It should be noted that if a site-wide district energy scheme on the scale proposed for NW Cambridge is implemented it would be larger and more complex than any currently operating schemes in the UK. This means that the technology and economic risks will have to be weighed against the desire to deliver an ambitious low carbon development for NW Cambridge.

The proposal for any site-wide energy scheme to incorporate at least 75% of the properties does not impose any further burden than those already described. It is likely to add to the capital cost through increased costs for the heat and/or electricity network, and will therefore impact on economic viability.

The use of biomass CHP as considered here will meet the requirement for a minimum of 20% renewable energy to be supplied from on-site generation.

The phasing of the development will have a significant impact on the economic viability of any site wide energy scheme. The full assessment of this impact is beyond the scope of this investigation.

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This report has been prepared by KJ Tait and Bidwells in response to a brief provided by Cambridge City Council. It is presented in good faith and every effort has been made to ensure the accuracy of the information presented. However, KJ Tait and Bidwells will not accept responsibility for errors or omissions and any impacts which may arise from these.

Note: This investigation relates solely to the special circumstances pertaining to the University Area Action Plan site ('NW Cambridge site'). The findings cannot be rolled out across other developments where circumstances are different.